GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. _____

Project No. A-3717 GTRI/~~GTX~~ DATE 1 / 19 / 84

Project Director: William Bulpitt ~~School~~/Lab TAL

Sponsor: The National Electrification Administration
Metro Manila, Phillipines

Type Agreement: Contract dated 6/27/83

Award Period: From 1/9/84 To ~~7/8/84~~ ~~4-30-84~~ 1-31-85 (Performance) _____ (Reports)
~~4/15/84~~ 3-15-85

Sponsor Amount:	This Change	Total to Date
Estimated: $		$
Funded: $		$ 621,474*

Cost Sharing Amount: $ _____ Cost Sharing No: _____

Title: "Dendro-Thermal Power Generation Program Evaluation Study"

D. Farmer

ADMINISTRATIVE DATA OCA Contact ~~John W. Burdette~~ X4820

1) Sponsor Technical Contact:

2) Sponsor Admin/Contractual Matters:
General Pedro G. Dumol, Administrator
National Electrification Administratio
1050 Quezon Avenue, Quezon City
Metro Manila, Phillipines

Telex 74-242-043 NEA PHIL

Defense Priority Rating: _____ Military Security Classification: _____
(or) Company/Industrial Proprietary: _____

RESTRICTIONS

See Attached -- Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with the sponsor.

COMMENTS:

*In addition to the $621,474, this award includes 134,175 Pesos to be placed in a Phillipine bank account to be used for in-country expenses.

COPIES TO:

Project Director
Research Administrative Network
Research Property Management
Accounting

Procurement/EES Supply Services
Research Security Services
Reports Coordinator (OCA) ✓
Research Communications (2)

GTRI
Library
Project File
Other _____

FORM OCA 4:383

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 6/12/85

Project No. A-3717 ~~School~~/Lab TAL

Includes Subproject No.(s) N/A

Project Director(s) W. S. Bulpitt GTRC /~~GIT~~

Sponsor National Electrification Administration

Title "Dendro-Thermal Power Generation Program Evaluation Study

Effective Completion Date: 3/15/85 (Performance) _____ (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [X] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [X] Govt. Property Inventory & Related Certificate already submitted
- [ ] Classified Material Certificate
- [ ] Other _____

Continues Project No. _____ Continued by Project No. _____

COPIES TO:

Project Director
Research Administrative Network
Research Property Management
Accounting
Procurement/GTRI Supply Services
~~Research Security Services~~
~~Reports Coordinator (OCA)~~
Legal Services

Library
GTRC
Research Communications (2)
Project File
Other Heyser

Jones

FORM OCA 69.285

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

February 10, 1984

Colonel FRANCISO T. SAN MIGUEL
Executive Director
Dendro Thermal Development Office
National Electrification Administration
Quezon City, Philippines

Dear Colonel San Miguel:

Enclosed please find two copies of a brief progress report on our "Dendro-Thermal Power Generation Program Evaluation Study," which was recently initiated with your agency. As you know, the undersigned was assisted by Mssrs. Larson and Thivierge during the startup of this project and we were also assisted by Mssrs. Hodam, Williams, and Dugan of HAI.

Considerable progress was made in getting this project underway and we want to thank you and your staff for your excellent cooperation during our recent stay in Manila.

We trust that you will share this report with Mr. Charleson of ADB through your normal channel. If you have any questions about the report or its contents, please contact Mr. Williams or myself.

Sincerely,

William S. Bulpitt
Project Director

WSB/pk

Enclosures

GEORGIA [illegible] THE UNIVERSITY SYSTEM OF GEORGIA
AND AN EQUAL [illegible] EDUCATION OPPORTUNITY INSTITUTION

Engineering Experiment Station
Georgia Institute of Technology

DENDRO-THERMAL POWER GENERATION PROGRAM EVALUATION STUDY

Progress Report #1.
Period Covered: January 9, 1984 - February 14, 1984

1. General

In late January Mssrs. Bulpitt, Larson, and Thivierge traveled from Atlanta, Georgia to Manila, Philippines for the purpose of starting work on the contract with the National Electrification Agency entitled "Dendro-Thermal Power Generation Program Evaluation Study". This study is being financed with Asian Development Bank funds. The overall objectives for this first trip are as follows:

- Determine current status of NEA Dendro programs
- Establish logistics for support of project team
- Finalize scope of work with NEA and ADB
- Finalizing project team composition
- Establish contacts with various entities involved in project.

During this period significant progress was made toward fulfillment of the above objective, NEA and ADB were most cooperative in getting the project underway. The following paragraphs will describe early accomplishments in greater detail.

2. Meetings with NEA

Upon their arrival in Manila the project team met immediately with General P. G. Dumol, Administrator of the NEA, and Colonel F. San Miguel, Executive Director of the Dendro Thermal Development Office. Both gentlemen expressed their desire to proceed with the program and felt that the work to be performed is largely covered by the contract that has been established, with no major modifications. The project team was encouraged to meet with other staff members of the Dendro Thermal Development Office for further details on the status and progress of the program.

During the course of this reporting period numerous meetings were held with Ms. A. Adriano of the Dendro Office and members of her staff. Highlights of these meetings are as follows:

- Administrative - The "Chain of Command" for communications between Georgia Tech and the NEA was established. The logistics for office space for the Georgia Tech team in the D & E building were established, and a secretary was appointed. Discussions on methods of reporting and invoicing were held, and guidelines were established for the use of NEA vehicles and preparations for field trips. Access to telephones and telex was also established.

- Tree Farms Briefing - A status briefing was given to Georgia Tech on the current situations at the energy plantations by L. Bedaño and her staff.

Emphasis in the discussions was placed on the plantations supporting the power plants which are completed or are approaching completion. A request was made by Georgia Tech that a brief narrative report be prepared on these sites.

The staffs involved in the Dendro Office and at the various sites were discussed, along with the major functions of each.

° Power Plants Briefings - A detailed briefing was given to the Georgia Tech team by Mr. T. Saquilayan and the staff at his engineering division. Each of the fourteen plants on which construction has started were discussed in some detail, and emphasis was placed on construction delays, payment problems, the role of the A/E Consultants, the role and performance of the equipment suppliers, and start-up problems encountered with those plants coming on stream at the present. Emphasis during those discussions was on the British and French plants nearing completion, with same discussion of the plans for the Japanese and American plants to be started in the future. Discussion of plant accessibility and availability for field trips was also held. The assistance of the engineering staff in setting up meetings with the equipment suppliers and A/E Consultants was requested. Copies of current status reports completed by NEA were examined in detail.

° Other NEA Matters Requests were made for descriptions of the objectives and interactions of the various NEA divisions in order for the project team to become more familiar with normal procedures.

3. Meetings with ADB

Soon after arriving in Manila the project team met with Mssrs. Ariacutty Ganason and Michael Charleson of the Asian Development Bank. Discussions were held concerning the makeup of the project team, the scope of work in general, and the overall Dendro Thermal project status at this time. Both ADB personnel had recently visited the dendro plants and shared their observations with the project team. Mr Charleson has been designated as the Project Coordinator for the Georgia Tech study, and he expressed a desire to be keep abreast of progress and developments on the project.

At one of the meetings a draft outline for the final report was shared with Mr. Charleson for his comments. A copy of this outline is attached on this report.

4. Meetings with Equipment Suppliers

During this reporting period meetings held with the suppliers of the British and French powerplant equipment. Results of these meetings are summarized below.

° Balfour Beatty Engineering Ltd. - A meeting was held at the Balfour Beatty offices in Makati with Mr. Peter Tottman. He brought the project team up to date on the status of the British plants as he sees them and discussed various reasons for delays in the project completions and status problems. The topics of operator training needs an in-country fabrication of same of the system components were also brought-up.

° Alsthom-Atlantique/de Vera Trading Company - A meeting was held with Mssrs. Flexer and de Vera at the Vera offices at Makati to discuss the status of the French Power Stations. Reasons for startup delays were discussed, as was the general economic situation which has resulted in work stoppage on some sites. Conversation centered on the Bolinao plant and the problems that have been encountered with the crushing equipment. A plan of action for correcting these problems was also discussed.

Personnel training needs were also discussed with the project team as were the manner in which Alsthom does business in the Philippines and the methods of finance established with the French Government.

° AWIA - A meeting was held by members of the project team with Mssrs. Joaquin and Stoner at the AWIA offices in Makati. A status report on the projects were given by AWIA and some discussion was held on problems areas and program delays.

° MIESCOR - A meeting was held with Mr. Morte of MIESCOR at his office in the MERALCO building. An overview of MIESCOR and its experience was given as well as details on the MIESCOR dendro projects.

5. Meeting with U.S. AID

Several meetings were held with Mr. Lawrence Ervin at U.S. AID during this reporting period. Progress on the construction of the American Plants was reviewed as was the scope of work for the U.S. A/E. The progress on the technical assistance contract being performed by Hodam and Associates was discussed as was the overall status of the dendro thermal power plants and plantations.

6. Meetings with PICOP

During the reporting period, several meetings were held with PICOP to discuss the participation of PICOP personnel in this project. Mr. Picornell of PICOP has been the principal contact and final details of the PICOP work statement and personnel to be assigned are being worked out, as is the subcontract to Georgia Tech.

7. Project Personnel

At the beginning of this reporting period meetings were held with Hodam and Associates to discuss the status of the personnel originally proposed for this project and possible replacements for those that are no longer available. Most of the original Consultants and Subcontractors are available and the main area which may require some recruitment of replacements is in the forestry area. Georgia Tech is presently negotiating with several people who will strengthen the team in the silviculture area. Details on possible candidates should be provided to NEA within the next reporting period.

A tentative schedule for consultants as it stands at this time is included as attachment 2. It should be noted that the scope of Dr. Robert Williams has been expanded to that of "in-country coordinator" in addition to his duties on the power plant aspects at the Project.

8. Site Visits

Mssrs. Bulpitt, Thivierge and Williams visited the dendro sites at Solsona and Bolinao to inspect the progess first hand. The status were discussed with the Co-op management and with the Balfour Beatty Engineer at the site. Major features of the British Plant design were noted, although actual plant operation was not observed during this visit. At Bolinao, the cable transport system was not in use but it was inspected and discussed with the "dendro coordinator" of the site. A brief tour of the plantation was also made.

9. Future Work

During the next reporting period arrangements for subcontractors and consultants will be finalized and discussed with NEA and ADB. Little in-country work will be accomplished in preparation for intense activity in March-April.

APPRAISAL OF THE PHILIPPINES
DENDRO THERMAL POWER PROJECT

Georgia Institute of Technology
National Electrification Administration

Draft
Final Report Outline

I. Executive Summary

II. Introduction

A. Historical Overview

1. Electric Power Sector
2. Development of NEA
3. Establishment of the Dendro Program

B. Basic Concept of Dendro Thermal Power

1. Alternative Fuels
2. Dispersed Power Generation
3. Potential Contribution

C. Rationale for Study

III. Wood-Energy Plantations

A. Description

1. Site Location and Rationale
2. Determination of Supply Needs
3. Formation of Farmer Associations
4. Species Selection, Disease, Insect Control

B. Analysis

1. Site Location and Rationale
2. Determination of Supply Needs
3. Formation of Farmer Associations
4. Species Selection, Disease, Insect Control

C. Findings and Conclusion

1. Site Location and Rationale
2. Determination of Supply Needs
3. Formation of Farmer Associations
4. Species Selection, Disease, Insect Control

D. Recommendations

IV. Woodfuel Harvest and Transport

V. Power Plants

A. Description

1. General Needs of the Plant
2. British Design - 3 MW Plant
   (a) Technical
   (b) Manufacture and Construction
   (c) Operation, Maintenance and Training
3. French Design - 3 MW Plant
   (a) Technical
   (b) Manufacture and Construction
   (c) Operation, Maintenance and Training
4. French Design - 1 MW Gasifier
   (a) Technical
   (b) Manufacture and Construction
   (c) Operation, Maintenance and Training
5. Japanese Design - 3 MW Plant
   (a) Technical
   (b) Manufacture and Construction
   (c) Operation, Maintenance and Training
6. U.S. Design - 5 MW Plant
   (a) Technical
   (b) Manufacture and Construction
   (c) Operation, Maintenance and Training
7. Transmission

B. Analysis

1. General Needs of the Plant
2. British Design - 3 MW Plant
   (a) Technical
   (b) Manufacture and Construction
   (c) Operation, Maintenance and Training
3. French Design - 5 MW Plant
   (a) Technical
   (b) Manufacture and Construction
   (c) Operation, Maintenance and Training

4. French Design - 1 MW Gasifier

(a) Technical
(b) Manufacture and Construction
(c) Operation, Maintenance and Training

5. Japanese Design - 5 MW Plant

(a) Technical
(b) Manufacture and Construction
(c) Operation, Maintenance and Training

6. U.S. Design - 5 MW Plant

(a) Technical
(b) Manufacture and Construction
(c) Operation, Maintenance and Training

7. Transmission

V. Findings and Conclusion

1. Optimal Needs of the Plant
2. British Design - 5 MW Plant

(a) Technical
(b) Manufacture and Construction
(c) Operation, Maintenance and Training

3. French Design - 5 MW Plant

(a) Technical
(b) Manufacture and Construction
(c) Operation, Maintenance and Training

4. French Design - 1 MW Gasifier

(a) Technical
(b) Manufacture and Construction
(c) Operation, Maintenance and Training

5. Japanese Design - 5 MW Plant

(a) Technical
(b) Manufacture and Construction
(c) Operation, Maintenance and Training

6. U.S. Design - 5 MW Plant

(a) Technical
(b) Manufacture and Construction
(c) Operation, Maintenance and Training

7. Transmission

VI. Organization, Management and Administration

A. Description

1. Relationship of Electric Coops, Dendro Offices, NEA, Philippine Power Sector

2. Source of Financing

(a) Foreign Exchange
(b) Local Currency

B. Analysis

1. Relationship of Electric Coops, Dendro Offices, NEA, Philippine Power Sector

2. Source of Financing

(a) Foreign Exchange
(b) Local Currency

C. Findings and Conclusion

1. Relationship of Electric Coops, Dendro Offices, NEA, Philippine Power Sector

2. Source of Financing

(a) Foreign Exchange
(b) Local Currency

D. Recommendation

VII. Economic and Financial

VIII. Enviromental

A. Plantation

1. Discussion

(a) Soil Erosion
(b) Nutrient Balance

2. Analysis

(a) Soil Erosion
(b) Nutrient Balance

3. Findings and Conclusion

(a) Soil Erosion
(b) Nutrient Balance

4. Recommendation

I. Power Plants

1. Discussion

(a) Air Pollution
(b) Thermal Pollution
(c) Ash Disposal
(d) Others

2. Analysis

(a) Air Pollution
(b) Thermal Pollution
(c) Ash Disposal
(d) Others

3. Findings and Conclusion

(a) Air Pollution
(b) Thermal Pollution
(c) Ash Disposal
(d) Others

4. Recommendation

II. Summary of Findings, Conclusions and Recommendations

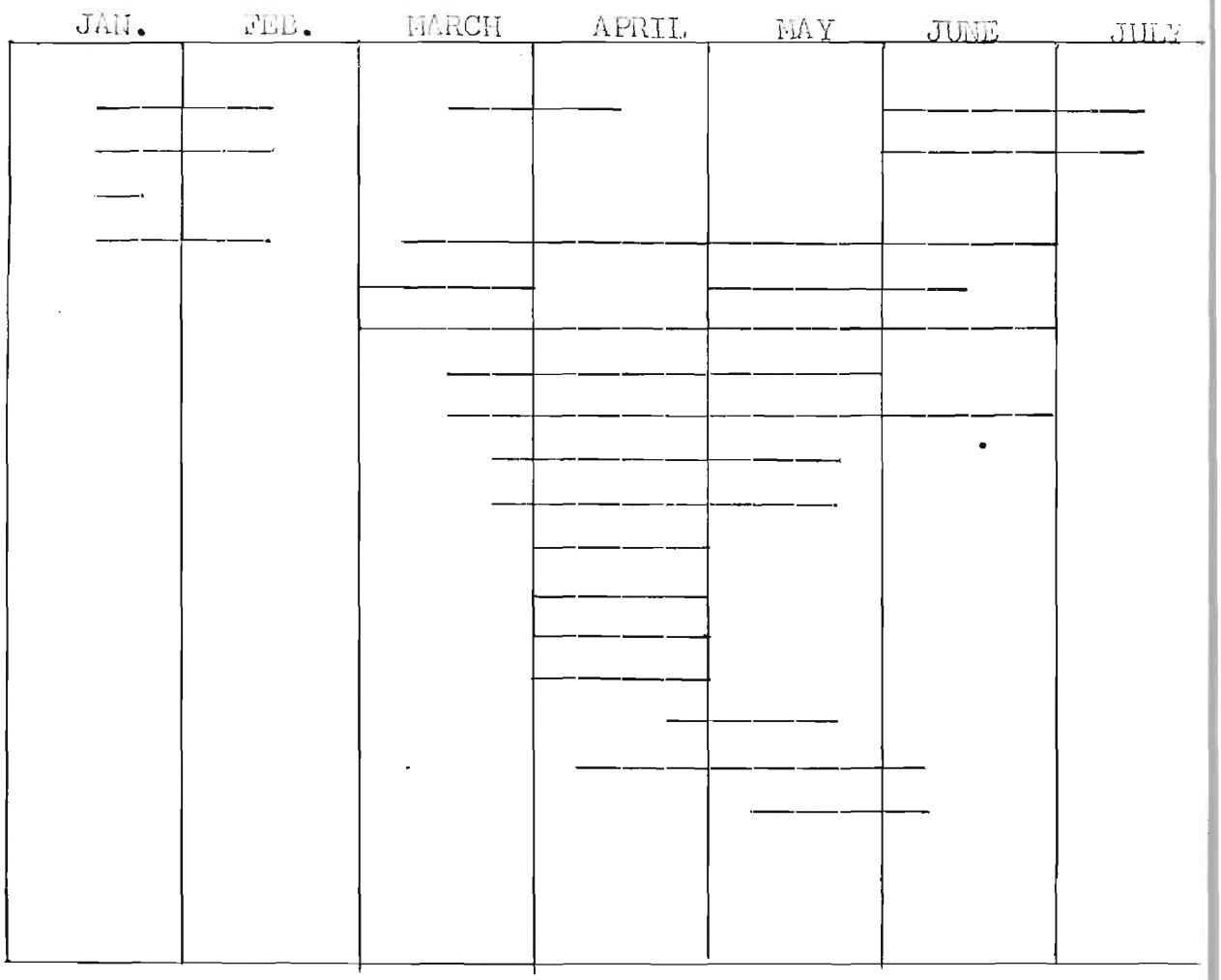
A. Findings & Conclusion from Chapters III, IV, V, VI, VII, VIII

B. Overall Conclusion
If Favorable - reasons and Recommended ... for financing

(1) Components
(2) ... & I/C
(3) Timing
(4) Technical Assistance Required
(5) Training Required
(6) Organizational Requirements
(7) Etc.

GIT CONSULTANTS' SCHEDULE

W. BULPITT	-	Leader
A. THIVIERGE	-	Report
B. LARSON	-	
R. WILLIAMS	-	Coordinater
T. NIBLOCK	-	Institution
	-	Forester
D. AUERLICH	-	Transport
P. DUGAN	-	Forester
E. JOHNSON	-	Ecology & soil
E. HEDEMA	-	ECO
C. HATCH	-	Forester
J. WALSH	-	Power
J. ADAMS	-	Power
M. SCHMORTZ	-	Distributor
T. CHIANG	-	ECO
B. RIALL	-	ECO
	-	Macro ECO
	-	
	-	
	-	



Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

April 5, 1984

Colonel Francisco T. San Miguel
Executive Director, Dendro Thermal
Development Office
National Electrification Administration
D&E Building
Quezon Avenue
Quezon City, Metro Manila, Philippines

Dear Colonel San Miguel:

Enclosed please find a brief progress report outlining progress on the Dendro Thermal evaluation study from February 15 to April 1, 1984. We look forward to seeing you again in Manila about April 10.

Sincerely,

William S. Bulpitt
Project Director

WSB/pk

Enclosure

GEORGIA TECH IS A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
AND AN EQUAL EMPLOYMENT/EDUCATION OPPORTUNITY INSTITUTION

Engineering Experiment Station
Georgia Institute of Technology

Dendro Thermal Power Generation
Program Evaluation Study

Progress Report #2
February 15, 1984 - April 1, 1984

1. General

The emphasis on project work during this time period has been on final assembly of the project team. Due to time lapse between proposal submission and start of project, there have been some unavoidable substitutions of personnel. Actual in-country work performed during this period has been limited.

2. Subcontracts

The project director has spent considerable time this reporting period negotiating subcontracts through the Georgia Tech Office of Contract Administration. As of now, final subcontracts have been established with:

(1) Hodam and Associates, Inc.
(2) Forest Engineering
(3) NRECA
(4) Dr. F. Johnson
(5) Mr. A. Merkel

Work is still being carried out with the following:

(1) PICOP
(2) Mr. Ken MacDicken

There have been several variances in the team members due to the time lapse. NRECA has informed Georgia Tech that Mr. Schwartz (transmission engineer) will not be available until mid to late June which will be too late for effective interface with the other team members. They have offered Mr. William Graw as an alternate. Permission of this substitution has been asked for to NEA.

We have been informed by Dr. E. L. Medema that due to other commitments, he will not be able to participate. We are presently examining alternative candidates.

PICOP has offered the following personnel to assist in the project:

(1) Institutional Development - Eulogio Tagudar
(2) Forest Ecology and Soils - A. G. Veracion
(3) Havest and Transport - C. Delacruz
(4) Power Plant Operations - V. San Jose
(5) Final Report - N. Lansigan/P. Picornell

Resumes are included as an attachment. It has been determined by Georgia Tech that participation in the project by these personnel will greatly enhance the outcome.

3. Engineering Studies

Further information was received from NEA on the Alsthom-Atlantique power plants and this is now being examined in detail by the project team. Contact has been made with Stone and Webster in Boston (designers of USAID funded plants) and preliminary discussions have been held concerning their scope of work.

Preparations for the next field trips are underway. The Georgia Tech team of power plant engineers will be spending the month of April and part of May examining the power plant aspects in detail.

4. Harvesting and Transport

Dr. Aulerich of Forest Engineering was in the Philippines in late March and visited the four sites which have been identified as design

points for harvesting and transport systems. He is now analyzing data obtained and making preparations for a second visit.

5. Economics

The Georgia Tech economic analysis team has prepared questionnaires for obtaining detailed information on representative samples of plantations and power plants. These will be distributed and expedited by the project director during his trip in April.

6. Institutional

Mr. Thomas Niblock will arrive in Manila in early April to begin detailed analysis of the institutional aspects of the project. He has been thoroughly briefed by the project director after his last visit.

7. Forestry

At present, negotiations are under way with Dr. Jan Laarman as replacement for Dr. Lee Medema as a forestry economist. Mssrs. Ken MacDicken and Al Merkel will be involved in silviculture and yield and growth. Dr. Fred Johnson will participate in various aspects of the plantation study, and Mr. Thomas Niblock will be involved in studying the institutional issues.

8. Scheduling

The schedule of in-country consultants as it now stands is included as an attachment. It is anticipated that future minor adjustments will have to be made.

9. Future Work and Modifications

April will be a month of intense activity on this project, and many of the details will begin to come together. Due to the late start on the project and delays in getting the project team assembled, it is anticipated that a no-cost extension of the project until at least the end of August will be requested.

Project No. A-3717

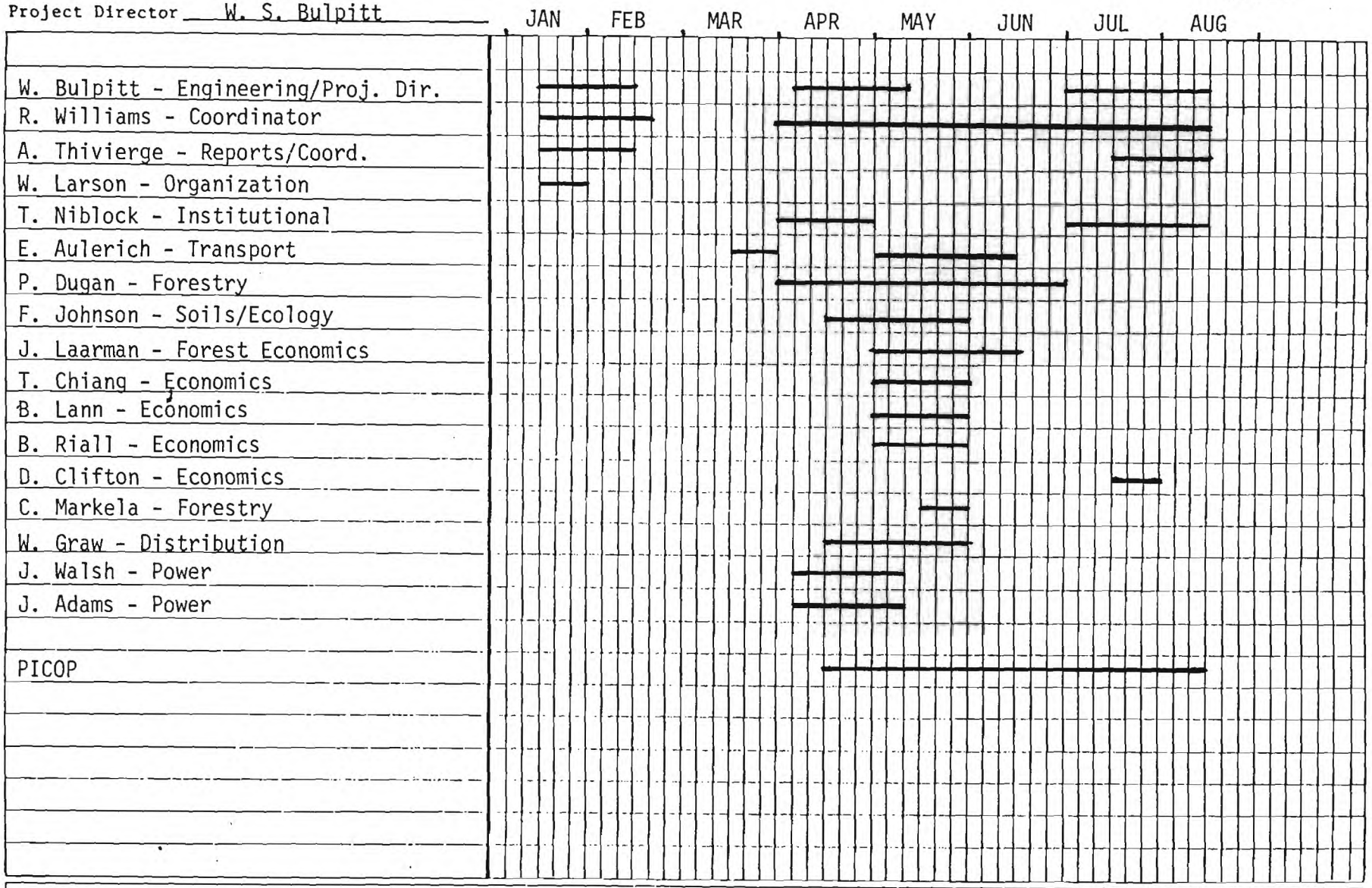
Project Title Philippines Dendro

Project Director W. S. Bulpitt

In-Country Schedule

PROJECT PLAN

4/5/84



Notch →

LEGEND

A. G. VERACION

Age: 44
Manager, Forestry Division, Woods Group.
Hired by PICOP -- July 23, 1968
B.S. Forestry, U.P. Los Baños '60; U.S. Study tour in Forestry Practices, 1979.

Past Experience:-

Nasipit Lumber Co., Surveyor 1960-61.
Reforestation Administration, Diliman, Q.C., Forester 1962.
Anakan Reforestation Project, Gingoog, Misamis Oriental, Forester-in-Charge 1962-64.
Cincona Reforestation Project, Malaybalay, Bukidnon, Forester-in-Charge 1964-67.
Reforestation Regional Office, BFD, Cagayan de Oro, Senior Forester 1967-68.

Personal Contributions/Accomplishments:

Developed and implemented the following:

a. New ITP Contract System - awarding the plantation and maintenance of Falcata planted within the Company's forest concession to private contractors.

b. Forestry Computerization as a Management tool in planning processes.

c. Operating Manuals in ITP and Agroforestry.

d. New plantation inventory system using charts to reflect survival, growth and yield.

e. Introduction of flex-time in Forestry operations resulting in savings in time and transport cost.

f. Modernistic seedling production at the Central Forest Nursery.

g. Establishment of test plantations of bagras, falcata and pine to counter apprehensions on the effect of clear-cutting operations.

h. The concept of Social Forestry which was later on adopted by the Government for implementation nationwide. Initially implemented by PICOP in September, 1983.

C. L. dela Cruz, Jr.
Age: 46
Manager, Wood Supply Division, Woods Group.
Hired by PICOP - October 11, 1965.
B.S. Ch. Engineering, M.I.T. '61

Past Experience:-

Brochem Pharmaceutical, Q. C.
Sales Engineer, June-August, 1964.
PANPISCO, Inc., Manila, Sales Engineer
September-December, 1964.
WM H. Reynolds Co., Manila, Sales Engineer
January-October, 1965.

Personal Contributions/Accomplishments:

Introduced the following innovative techniques resulting to increased log production, higher equipment serviceability and lower harvesting cost in 1983:

a. Combination of Company-owned skidders and contractors' in the harvesting and hauling of falcata logs.

b. Standardization of chokers per equipment from stump (cutting site) to roadside.

c. Realignment of equipment to match the terrain and timber stand.

d. Reorganized Forest Engineering by specialized functions in selective and clearcut operations thru the use of contour maps, aerial photographs, and log densities thereby setting the basis for computing the most productive minimum setting per equipment.

e. Organized more and responsive contractors for ITP harvesting and hauling of logs from Agroforestry, clearcut and LPU operations.

f. As Roads Superintendent for construction and maintenance for almost 10 years, contributed in lowering cost thru proper deployment of equipment to suit terrain.

R. A. DORMENDO

Age: 42
Manager, Industrial Tree Plantation Dept.
Hired - July 21, 1962
B.S. Forestry, U.P. Los Baños '62

Past Experience:-

BBLCI, Mangagoy, as Laborer April-May, 1959

a. Assisted in the introduction of the Agroforestry concept in 1968 wherein private landowners were induced to plant falcata as a means of livelihood. The Project won the ANVIL award of the Public Relations Society of the Philippines.

b. Assisted in organizing a team which was to become the Forest Protection Dept. in later years to solve the problem of squatters in the concession areas in 1972. The thrust was to humanize the penal provisions of the law against squatters. Instead of court suits, squatters were relocated to resettlement areas, given a piece of land to cultivate and provided with employment with the Company. This project also won the ANVIL award of PRSP.

c. The Industrial Tree Plantation - assisted in inviting private participation of private contractors to plant, maintain and harvest falcata within the forest concession. The scheme proved itself to be cost efficient aside from attaining a 96% survival rate of seedlings planted.

d. Municipal Councilor of Bislig for 3 terms; Chairman of the PICOP Consumers Cooperative for 2 terms and PICOP Credit Union for 3 terms.

CURRICULUM VITAE

NAME: PEDRO M. PICORNELL

DATE AND PLACE OF BIRTH: May 21, 1924, Manila, Philippines

CITIZENSHIP: Spanish

CIVIL STATUS AND CHILDREN: Married to Angelita Garcia de Picornell, December 30, 1950.

Name	Date of Birth
Jaime	October 4, 1951
Pedro Jr.	July 18, 1953
Isabel Carlota	April 10, 1958
Asuncion Elena	August 18, 1959
Francisco	November 8, 1961

EDUCATION:

High School Diploma, De La Salle College, Manila, Philippines, 1941

Bachelor of Science - Chemical Engineering, Massachussetts Institute of Technology, Cambridge, Ma., U.S.A., 1947

Master of Science - Chemical Engineering, Massachussetts Institute of Technology, Cambridge, Ma., U.S.A., 1948

LANGUAGES:

English - spoken, read and written fluently

Spanish - spoken, read and written fluently

French - reading knowledge

PRESENT BUSINESS POSITIONS:

A. Soriano Corporation (largest industrial management group in the Philippines) - Senior Vice President

Paper Industries Corporation of the Philippines (largest integrated timber and pulp and paper company in Southeast Asia known for its pioneering work on the manufacture of pulp and paper from tropical hardwoods and the development of tree plantations) - Senior Vice President, Science and Technology

PICOP Trading Corporation (subsidiary of the above, engaged in selling all of its pulp and paper products) - President

Atlas Fertilizer Corporation (large fertilizer and chemical plant managed by A. Soriano Corporation) - Senior Vice President

Asturias Sugar Central, Inc. (Medium sized company engaged in planting and milling sugar) - Vice President-Director

Kapunda Development Co. (Pty.) Ltd. (Developing large industrial plantations in Australia) - Director

PAST BUSINESS POSITIONS:

Benguet Consolidated Mining Co., Balatoc, Philippines - Assistant Mill Shift Boss - 1949

Compañia de Celulosa de Filipinas, Bais, Philippines - Assistant to Superintendent - 1950

San Miguel Brewery, Inc., Glass and Carton Division, Manila, Philippines - Engineer - 1952-53

Paper Industries Corporation of the Philippines, Manila, Philippines - Vice President - 1962-1972
Executive Vice President - 1972-1979
Executive Vice President, Planning - 1979-1982

Bislig Bay Lumber Co., Inc., Manila, Philippines -

Asst. Office Manager	1952-54
Office Manager	1954-57
Asst. Vice President	1958-62
Vice President	1962-72

This company merged with Paper Industries Corporation of the Philippines in 1972.

Kayan River Timber Products, P.T., Indonesia - Director, 1970-78

SEMINARS AND TRAINING COURSES:

Financial Management, Faculty of Syracuse University, Manila 1965

Business Decisions, Faculty of De La Salle College, Manila 1967

Professional Management, Louis Allen, Hongkong - 1974

HONORS:

Tan Beta Pi, National Engineering Honor Fraternity, U. S. A.

Sigma Xi, National Scientific Research Society, U. S. A.

John Henry Newman Society, Honorary Society for Catholic Action Work in Non-Sectarian Colleges in the U. S. A.

Soverign Military Order of Malta, Knight of Magistral Grace and Cross of Officer of Merit.

Philippine Anti-Tuberculosis Society, Plaque of Appreciation

Boy Scouts of the Philippines, Certificate of Appreciation

Philippine Institute of Chemical Engineers, Certificate of Appreciation

FAO, Rome, Member of the Advisory Committee on the Pulp and Paper Industry, 1976 to present

TECHNICAL SOCIETIES:

Technical Association of the Pulp and Paper Industry (USA)

American Institute of Chemical Engineers

Philippine Wood Products Association

Management Association of the Philippines

Camara Oficial Española de Comercio de Filipinas

PUBLICATIONS:

Heat Transfer at High Rates to Water with Surface Boiling (with McAdams, Kennel, Minden, Carl and Dew)	Industrial and Engineering Chemistry (USA)	1949
The First Newsprint Mill in SE Asia	Actos del 7º Congreso Forestal Mundial, Buenos Aires, Argentina	1972
The Pulp and Paper Industry in SE Asia	Financial Times-World Pulp and Paper Conference, Stockholm, Sweden	1974

Some Points to Consider in Improving the Utilization of Tropical Forests	Conference on the Improved Utilization of Tropical Forestry, Madison, Wis.	1978
Some Issues on the Transfer of Technology from Developed Countries to Developing Countries	FAO/PICOP - Rome	1978
The Knights of the Soverign Military Order of Malta in the Philippines in the 16th and 17th Centuries	Soverign Military Order of Malta, Philippine Association - Manila	1979
The Evolution of the Pulp and Paper Industry in a Developing Country - The Case of the Philippines	UN Industrial Development Organization, New Delhi, India	1978
Small Scale Pulp and Paper Mills in Developing Countries	ASEAN - Pulp and Paper Industry Club Bulletin	1979
The Pulping of Mixed Tropical Hardwoods-The Philippine Experience	UN Industrial Development Organization	1981
Why Do Developing Countries Go Into The Pulp and Paper Industry	FAO/PICOP	1981
The PICOP Agro-Forestry Program - Socio Economic and Forestry Aspects	Forestry and Development in Asia, ASIA Society/US-AID, Bangalore, India	1982
The Philippine Chronicles of Fray San Antonio (A Translation)	Historical Conservation Society, Manila	1977

PMP:mgk
8.26.82

BIODATA

NAME : VALERIANO SAN JOSE

POSITION : Manager, Maintenance and Engineering Division, PICOP

BIRTH : Marilao, Bulacan

DATE : April 14, 1951

MARRIED : Eunice Bascug (wife)

ADDRESS : PICOP, Tabon, Bislig, Surigao del Sur

EDUCATIONAL ATTAINMENT

- High School - Meycauayan Institute, Bulacan - 1962-1966
- College - Mechanical Engineering, Mapua Institute of Technology 1966-1971

PROFESSIONAL STATUS

- Registered Mechanical Engineer -
- Professional Mechanical Engineer -

EMPLOYMENT

1973 to 1976	- PICOP trained as Methods Analyst, power plant maintenance planning engineer, later as instructor and trained in analytical trouble shooting and maintenance.
1977-1981	- PICOP, from power plant area engineer to superintendent, Plant Engineering Department.
1982-1983	- PICOP, from asst. general superintendent to senior superintendent, Steam and Power Plant Department.
1983 todAte	- PICOP, from asst. manager to division manager, Maintenance and Engineering Division.

TRAINING/SEMINAR ATTENDED

1977	- Undergone training in Yokohama, Japan on design, assembly, installation of steam generators, turbines, paper machines.
1977	- Tokyo, Japan on International Chemical Exhibition.

1972 to 1976 - Had undergone on several occasions and on different dates training on IBM assembly programming, time and motion studies, PERT/CPM, supervisory management, GENCO seminar for middle management and other management short courses related to his duties.

MEMBERSHIPS IN ORGANIZATION

- Society of Mechanical Engineer, Surigao del Sur Chapter and President, Surigao Chapter in 1983.

OTHER EXPERIENCES/PARTICIPATION

- Project conception, design and equipment selection of PICOP Dendro Thermal power plant.
- Incharge of mechanical installation of steam generator and auxiliaries.
- Operation and improvements of steam and power.
- Analysis of problems and solutions, including improvement.

##

B I O D A T A

O F

E U L O G I O T. T A G U D A R

General Forestry
Superintendent, Forestry Department
Bislig Bay Lumber Company
1964-1970

Manager, Forestry Division
Paper Industries Corporation
of The Philippines
Bislig Surigao del Sur Philippines
1971-1982

Manager, Forestry Makati Head Office
Paper Industries Corporation
of the Philippines
389 UPRC Building
Buendia Extension Avenue
Makati, Metro Manila, Philippines
1983

I. PERSONAL AND FAMILY

Name: Eulogio T. Tagudar; Marital Status: Married; Date of Birth: December 23, 1923; Age: 59 years; Place of Birth: Sto. Domingo, Ilocos Sur, Philippines; Citizenship: Filipino; Health: Excellent; Name of Wife: Benita P. Tagudar; Citizenship: Filipino; Number of Children: 3; Ages: 29, 27 and 20 years

II. EDUCATIONAL ATTAINMENT

SCHOOL	EDUCATION COMPLETED	YEAR COMPLETED
Sto. Domingo Elementary School Sto. Domingo, Ilocos Sur, Philippines	Elementary	1938
Ilocos Sur High School Vigan, Ilocos Sur Philippines	High School (Due to World WarII)	1947
College of Forestry University of the Philippines Los Baños, Laguna Philippines	Ranger Course	1949
College of Forestry University of the Philippines Los Baños, Laguna Philippines	Bachelor of Science in Forestry	1951
Yale School of Forestry Yale University New Haven, Connecticut, USA	Special graduate student for the Fall Term of 1957-1958 for advance courses in forest management, silviculture, economics and logging	1957-1958

SCHOOL	EDUCATION COMPLETED	YEAR COMPLETED
Extensive field study and observation guided by timber management foresters, silviculturists and researchers of the U.S. Forest Service in the U.S.A.	Preparation of long term management and annual operation plans, forest researches, silvicultural practices, logging techniques and forest inventory procedures.	1958
Asian Institute of Management, Makati Philippines	Graduate of Management Development Program (taken the whole MBM subjects)	1971

OTHER TRAINING

- Completed in 1973 the Senior Management Program for Senior Executives in Management Analysis and Decision-making conducted by the Kepner-Tregoe Associates of Princeton, New Jersey, U.S.A.

- Completed in 1976, Situation Analysis in decision-making conducted by the Kepner-Tregoe Associates of Princeton, New Jersey, U.S.A.

- Completed in 1976 the Louis Allen Associates, Inc. of Pali Alto California, U.S.A. the Profession of Management Seminar for Professional Managers.

- Studied and oberserved in 1975 the management of tropical species Papua New Guinea, especially Eucalyptus deglupta and pines.

Professional Admittance: Registered Professional Forester
Registration Certificate No. 202

Significant Achievements (awards received)

- 1950-1951, Bureau of Forestry Scholar to the College of Forestry, University of the Philippines, Los Baños Laguna, Philippines

- 1973, NARRA Award in recognition for exemplary research achievement by the Philippine Forest Research Society

- 1977, awarded as the Most Outstanding Alumni of the U.P. College of Forestry for the Outstanding Professional Achievement in the Forest Industry

- 1978, awarded Bronze Medal by the National Government (Rep. of the Philippines) for significant contribution and achievement in forest management practices in the Philippines.

- 1978, special lecturer of the UN, FAO/SIDA and Government of India in New Delhi, India on Forest Surveys and Planning for an integrated wood industrial complex - A PICOP experience

III. RELEVANT SPECIALIZED FIELDS IN FORESTRY

1. Planning, organizing, controlling and managing the establishment of industrial tree plantations. Had been with this project at PICOP from its start in 1968 under its experimental stage to the actual field operational phase of developing forest plantations up to 6,000 hectares per year and maintaining, thru different stages of weeding sequences, of about 20,000 hectares per year, with specifications for plantation development plans, costs, manpower and budgetary requirements of the project up to 1982. Established monitoring and evaluation systems and organized the team to assure that accomplishments based on goals set for the project are attained. Had also experience in introducing contract system of establishing plantation to reduce cost of development.

   To assure that future sources of seeds for plantation development come from genetically-improved species, established tree improvement projects such as; seed orchards for Eucalyptus deglupta and selection and marking of seed (plus) trees.

2. Planning and implementing forest inventory system (timber cruising) of natural forests and forest plantations, including agroforestry tree farms. From these data, including the forest engineering phase, has extensive experience in the preparation of short-term and long-term plans and projections for:

(a) The wood supply of PICOP processing plants especially the pulp mill from the natural forests up to the time (year) the raw materials from the forest plantations are ready for harvesting, 5 to 10 years, hence.

(b) The area needed to be developed as forest plantations to augment the supply wood requirements of these mills in the years to come.

(c) 10 to 20-year plan for the wood requirements for PICOP'S processing plants.

(d) Short-term annual operation and 5-year timber management plans with specifications for the appropriate logging equipment for harvesting both the natural forests and industrial tree plantations, manpower requirements, production costs and schedule of operations.

3. Planning, organizing, establishing and managing community development projects, the most important and significant of which is the agroforestry tree farming project for the low-income subsistence farmers in the provinces of Surigao del Sur, Agusan del Sur, Davao del Norte and Davao Oriental. Instrumental in the implementation of this project from its initial stage, extensive campaign, establishment of demonstration sites, development and harvesting of the tree farms. Had also set-up supervised and established other community projects such as rice, vegetables and swine and poultry dispersal to tree farmers. In 8 years's time, there were about 20,000 hectares developed by 3,800 small-time farmers.

4. Organization and establishment of social forestry projects such as;

(a) Relocation and resettlement of squatters to resettlement areas inside alienable or disposable areas.

(b) Implementation of community development projects such as vegetable, rice and poultry to improve their economic situation.

5. Corollary to Nos. 1 & 3 above, planned, organized and established central and subsidiary forest nurseries to raise the necessary seedling requirements from 3 to 6 million per year for the massive forest plantation development program of the company.

6. Actual field application of timber stand improvemnt and other silvicultural practices of second growth natural forests and forest plantations to improve stocking and accelerate rates of growth of the favored species/trees.

IV. DETAILED WORK EXPERIENCES IN THE GOVERNMENT AND THE WOOD INDUSTRY

PERIOD AND EMPLYEE/POSITION	RESPONSIBILITIES
A. Government (Bureau of Forestry) Experience	
a. 1951-1953 Bureau of Forestry as Ranger and Forester	Misamis Oriental, Philippines performing scaling, inspection of application for pastures, timber licenses, shifting cultivations, and other uses.
b. 1953-1956 Bureau of Forestry as Timber Management Assistant	First group of Government Foresters to study and implement selective logging at Basilan City, conducted forest researches, and established procedures for selective logging and policies on shifting cultivation.
c. 1957 Bureau of Forestry as Supervisor on timber management in Northern Mindanao, Philippines	Implemented the first selective logging practices in timber licensed areas; prepared and conducted training and workshop seminars on selective logging which became the model for training of forest officers in the Philippines.
d. 1957-1964 Bureau of Forestry as Chief, Management Plan and Supervisor for timber management at BFD Central office at Manila.	Formulated policies, procedures and guidelines on selective logging, silvicultural pracitices, allowable cuts, preparation of 5-year management and annual operation plans, timber stand improvement and other BFD projects.
B. Private Wood Industry Experiences	
Bislig Bay Lumber Company	

a. 1964-1966
As Chief Forester

- Fully implemented the selective logging program.
- Implemented timber stand improvement and other silvicultural practices.
- Conducted forest researches on forest management, silviculture and nursery operations.
- Prepared annual operation plans and long term (5 years) management plans.
- Implemented social forestry projects on shifting cultivations.
- Took charge of felling, bucking and scaling operations.
- Prepared sampling and forestry inventory designs and procedures for virgin and logged-over forests.

b. 1966-1971
As Forestry Superintendent

Similar duties as above including the following:

(i) Conducted early experimental projects on establishment of industrial tree plantations for the first time to learn techniques/procedures, problems and to gain the necessary experience on this which the company shall soon implement in the massive scale.

(ii) Experiment on trial planting of several fast-growing species to determine species suitable for pulpwood or sawtimber manufacture at different sites inside PICOP concession.

(iii) Established and studied nursery operations and techniques to support seedling requirements of forest plantations to be established.

(iv) Established tree improvement projects by establishing seed orchards and marking of plus trees for seed tree purposes as source of seed in the future.

(v) Started the program of tree farming for small and low income subsistence private landowners thru extensive campaigns by radio, brochure, pamphlets, etc. and by establishing demonstration sites to convince these private landowners that tree farming is feasible and profitable.

(vi) Reorganized the forest protection to safeguard the company's valuable resources from being destroyed by squatters.

c. 1971-1982

As General Forestry Superintendent and Manager, Forestry Division of the merged Bislig Bay Lumber Co. and Paper Industries Corporation of the Philippines (PICOP), the two companies known as PICOP.

(i) Implemented the social forestry program for hill-side farmers squatters in the public forest by resettlement in two resettlement sites of the comapny.

(ii) Prepared sampling and forest inventory designs and procedures for forest plantations and agroforestry tree farms.

(iii) Intensified timber stand improvement practices especially in logged-over areas by introducing enrichment planting and intermediate silvicultural treatment therein.

(iv) Member of Government Task Force to plan, schedule and project available wood raw materials from the natural forest needed by the pulp and paper mill of PICOP for the next 10 years, including the plan for the area needed to be developed as forest plantations to augment the wood needs of said pulp mill in the future years to come.

(v) Established industrial tree plantation at the rate of 4,000 to 6,000 hectares per year with the principal species of Eucalyptus deglupta, A. falcataria and Caribbean pines with a total area of about 45,000 hectares at end of 1982,

(vi) From a make-shift nursery, started the expansion of an assembly-type forest nursery operation to support the seedling requirements from 3 to 6 million per year of the massive industrial tree plantation project.

(vii) Intensified the implementation of PICOP'S agroforestry tree farming by extending technical assistance in all aspects of the tree farming project, convincing the Development Bank of the Philippines to finance the tree farming project, and extending the PICOP swine and poultry dispersal program to develop about 20,000 to 23,000 hectares of tree farms by 3,800 small farmers.

(viii) Supervised implementation of other community development projects such as rice, poultry and vegetables.

(ix) Had 3,800 personnel under my supervision performing mostly forest plantation development.

d. As General Logging Superintendent

(i) Duties cover felling, bucking, scaling yarding, skidding, and hauling operations.

(ii) Design and planning of logging operations using modern machineries to harvest the natural forests and forest plantations.

(iii) Processing of raw logs for export and for processing in the Corporation's industrial complex.

e. As Acting Woods Group Manager (was designated several times in this position to be in-charged of Forestry, Logging and Heavy Equipment Divisions)	(i) All phases in the logging, road construction, logging engineering, log processing and all activities in forestry operations and scheduling of repair, maintenance and use of heavy equipment in the harvesting operations.

V. TECHNICAL WRITING CAPABILITIES

(Author of several technical/scientific papers in forestry among which are enumerated below)

1. Prepared a hadbook for forestry practitioners dealing guidelines/ procedures in establishing forest plantations, nurseries, timber cruising, etc. (1976).

2. Forest surveys and forestry planning for an integrated wood industrial complex - A PICOP experience, a paper presented/read in New Delhi, Inida on invitaion of the UN FAO/SIDA and the Government of India.

3. Forest plantation establishment, a paper read in a seminar for reforestation, sponsored by the Inter-Agency for Forestry Researdh Application.

4. Tropical logging in relation to the environment, problems and needs for research, a paper submitted to the XVI International Union of Forest Research Organization, Oslo, Norway, June to July, 1976.

5. Guide for timber stand improvement in the Philippines, a guideline used by the Bureau of Forest Development.

6. A silvicultural treatment of a tropical virgin forest in the Philippines for sustained yield management with special reference to the operations of the Bislig Bay Lumber Company. Published in the Proceedings of the Sixth Forestry Congress, Madrid, Spain, 1966.

7. Agroforestry as practiced in PICOP. Published in Asia News, Bangkok, Thailand.

8. Many other published and unpublished technical papers in Forestry.

VI. MEMBERSHIP

- Life member, Society of Filipino Foresters, as member of the Board of Directors.

- Society of International Tropical Foresters.

- Knight of Columbus

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EULOGIO T. TAGUDAR

NICOLAS P. LANSIGAN

(Bio-Data)

A. Personal Data:

Birth : Bay, Laguna; December 6, 1910

Married : Aurea C. Lansigan (Wife)

Business Addresses :

1) Paper Industries Corporation of the Philippines
389 Buendia Ave. Extension,
Makati. Tel. 86-80-11; 87-22-81

2) Presidential Committee on Wood Industries Development
Chuatuco St., Roxas District, Quezon City
Tel. 98-86-88

3) Tree Preservation Foundation of the Philippines
101 Dr. Lazcano, Quezon City
Tel. 98-23-71

B. Education:

M.B.A., 1949, Manila Central University (Halili Gold Scholarship Medal);

B.S.F., 1941, School of Forestry, U.P.;

A.B. (Journalism), 1936, Far Eastern University (Editor-in-Chief, F.E.U. Advocate);

Ranger Course, 1931, School of Forestry, U.P. (First Honor).

C. Professional status:

Registered Forester (License No. 2)

D. Conferences and Observation Tours Abroad:

1976-1982	:	One month annual vacation usually spent in U.S. observing forestry practices, wood-using industries, ecosystem, etc.);
1974	:	Delegate, International Hardwood Conference, Key Biscayne, Florida;
1970	:	Observation tour, Venezuela and Puerto Rico, community development;
1967	:	Study tour to Taiwan and Japan on industrial forest plantation system;
1966	:	Delegate to the 6th World Forestry Congress, Madrid (presented a paper);
1960	:	Asia Foundation travel grantee, for observation study of comparative forestry and forest policies in Germany, France, Denmark, Spain, Italy, United States and Thailand;
	:	NEC representative, Philippine delegation to the 5th World Forestry Congress, Seattle, U.S. (presented a paper);
1957	:	NEC representative, Philippine delegation, 4th Session, Asia-Pacific Forestry Commission, Tokyo;
1953	:	NEC-PHILCUSA trainee on 6-month observation tour on fertilizer sales, usage, etc. including short term fertilizer course in Clemson Agricultural College, South Carolina.

E. Positions Held:

1. Government Sector:-

1931-1941	:	Bureau of Forestry, Ranger then to Forester, undertaking forest economics researches, editing Makiling Echo, Philippine Journal of Forestry;
1941-1945	:	Bureau of Forestry, (Japanese Occupation), Forester, Manila Office, then at Los Baños, Laguna;
1946-1950	:	Bureau of Forestry, Silviculturist, on detail to the Office of the Secretary of Agriculture and Natural Resources as adviser on forestry matters (successive Secretaries Garchitorena, Mapa, Lopez);
1951-1955	:	Assistant Administrator, Fertilizer Administration, Department of Agriculture and Natural Resources;

1955-1956: Bureau of Forestry, Division Chief, but detailed to the Office of Secretary of Agriculture and Natural Resources as Adviser to Secretary Salvador Araneta on natural resources matters;

1956-1962: National Economic Council, Forest Utilization and Conservation Specialist; in-charge of formulating drafts of national policies and programs relating to forestry, public land disposition and others;

1971-1974: Member, Board of Examiners for Foresters;

1976-1978: Member, Board of Trustees, Forest Research Institute;

1972-todate: Member, Technical Panel, Presidential Committee on Wood Industries Development.

2. Private Sector:-

1962-1964: Forester, A. Soriano Corporation, General Managers of Bislig Bay Lumber Company, Inc. and Paper Industries Corporation of the Philippines (PICOP).

1964-1966: Executive Forester, A. Soriano Corporation.

1967-1968: Manager, Forestry Department, A. Soriano Corporation.

1969-1972: Assistant Vice-President and Head of Forestry Department, A. Soriano Corporation.

1972-todate: Forestry Consultant, Paper Industries Corporation of the Philippines (PICOP).

F. National Policy Formulation and Application into Actual Projects.

1) Headed the technical panel which put together the report and recommendations of the 1958 national conference on FOREST CONSERVATION AND REFORESTATION.

2) Member of the 3-man technical panel of the Presidential Committee on Wood Industries Development Committee which produced the 1971 report: PHILIPPINE FORESTRY AND WOOD INDUSTRIES DEVELOPMENT.

3) Member of the inter-agency group which prepared the draft of the REVISED FORESTRY REFORM CODE (PD 705 of 1975) based on the above-mentioned 1971 report.

4) Initiated the agro-forestry concept as a national approach to resettlement of forest land squatters and the use of idle marginal lands of private landowners; prepared application of concept in the first 5-year AGRO-FORESTRY PROGRAM FOR PICOP which has brought about the establishment of 22,000 hectares of tree farms involving 3,800 small landowners.

5) Negotiated with Development Bank of the Philippines a special financing for tree farms.

6) Persuaded the Government to allow PICOP to pioneer in the development of large scale INDUSTRIAL TREE PLANTATIONS which has brought about over 40,000 hectares of stable resource base of fast growing species for the PICOP paper mill.

7) Assisted in the formulation of strategies on the establishment of resettlement areas for squatters in PICOP forest concessions.

G. Membership in Organizations:

"Fellow", Philippine Association for the Advancement of Science;
Member, National Research Council;
Member, International Society of Tropical Foresters;
Society of Filipino Foresters (past president);
U.P. Forestry Alumni Association (past president);
Alumnus Member, College Editors' Guild;
Philippine Chamber of Wood Industries (past vice-president);
Philippine Lumber and Plywood Association (past vice-president);
President, Tree Preservation Foundation of the Philippines, Inc.

H. Awards, etc.:

1) 1971: Molawin Award (exemplary service to Philippine forestry);
2) 1974: Most Distinguished Forestry Alumnus
3) 1975: Forestry Heritage Award (outstanding service to Philippine forestry);
4) 1978: Forester of the Year (Professional Regulations Commission);
5) 1979: Makiling Award (Outstanding Lagunense).

I. Publications:

BOOK: Vanishing Living Links with Our Past, 1983
Herald Publishing Services, Quezon City.
(Over 200 articles published, technical and popular, on forestry matters).

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[2-15-84]

DENDRO THERMAL POWER GENERATION PROGRAM EVALUATION STUDY

Volume I

Summary

GEORGIA INSTITUTE OF TECHNOLOGY

A Unit of the University System of Georgia
Georgia Tech Research Institute
Atlanta, Georgia 30332

GTRI

Final Report

DENDRO THERMAL POWER GENERATION PROGRAM EVALUATION STUDY

Volume I: Summary

Presented to

The National Electrification Administration
Quezon City, Philippines

The Asian Development Bank
Manila, Philippines

by

The Georgia Institute of Technology
Georgia Tech Research Institute
Atlanta, Georgia, U.S.A.

March 1985

ACKNOWLEDGEMENTS

The successful completion of this project was made possible through the assistance of many individuals in both the Philippines and the United States. The authors would like to take particular note of the help given to the project team by Col. F. T. San Miguel, Ms. Anabelle Adriano, and Mr. Rey Sevilla of the National Electrification Administration and also to Mr. Michael Charleson and Dr. Barin Ganguli of the Asian Development Bank.

Georgia Institute of Technology
Georgia Tech Research Institute

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Senior Research Engineer, GIT

ACRONYMS

A&E	- architect engineer
ADB	- Asian Development Bank
AG&P	- Atlantic Gulf and Pacific Manufacturing
AWIA	- Adrian Wilson International Associates
BFD	- Bureau of Forest Development
BOD	- Biological Oxygen Demand
Btu	- British thermal units
CIMMYT	- Centro Internacional Mejorimiento de Maiz y Trigo
COD	- Chemical Oxygen Demand
DTDO	- Dendro Thermal Development Office
DTDP	- Dendro Thermo Development Program
ECC	- Environmental Compliance Certificate
EIRR	- Economic Internal Rate of Return
FIRR	- Financial Internal Rate of Return
FSDC	- Farm Systems Development Corporation
GIT	- Georgia Institute of Technology
GOP	- Government of the Philippines
GTRI	- Georgia Tech Research Institute
GW	- gigawatt
HAI	- Hodam and Associates, Inc.
IRRI	- International Rice Research Institute
kcal	- kilocalories
kg/cm^2	- kilograms per square centimeter
kVA	- kilovolt-amperes
kWh	- kilowatt-hours
lb/hr	- pounds per hour
Meralco	- Manila Electric Power Company
MIESCOR	- Meralco Industrial Engineering Services Corporation
MNR	- Ministry of Natural Resources
MW	- megawatt
NDDC	- National Dendro Development Corporation
NEA	- National Electrification Administration
NEDA	- National Economic Development Administration
NEPC	- National Environmental Protection Council
NPC	- National Power Corporation
NPCC	- National Pollution Control Commission
NRECA	- National Rural Electric Cooperative Association
OECF	- Overseas Economic Cooperation Fund
PICOP	- Paper Industries Corporation of the Philippines
psi	- pounds per square inch
REC	- Rural Electric Cooperative
scf	- standard cubic foot
scm	- standard cubic meter
TFA	- Tree Farmers Association
TOC	- total organic carbon
tonnes/hr.	- tonnes per hour
USAID	- United States Agency for Industrial Development
VHF	- very high frequency
WEST JEC	- Western Japan Engineering Consultants, Inc.

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I. SUMMARY

A. OVERVIEW

The Georgia Tech Research Institute (GTRI) of the Georgia Institute of Technology (GIT) has conducted a "...thorough review and evaluation of the National Electrification Administration's (NEA) dendro thermal program with particular regard to its potential and prospects..." called for by its contract (No. 542 PHI, dated June 27, 1983). Each item of the Terms of Reference has been addressed. A package suitable for financing by the Asian Development Bank (ADB) has been identified.

Chapters III-VI of the summary report (Volume I) each contain a separate summary and set of findings and recommendations. Supporting material in the form of consultants' reports and a detailed technical and economic analysis is contained in Volume II.

1. Report Organization

a. Chapter II introduces the report and identifies the framework within which the study was undertaken.

b. Chapter III analyzes the institutions under which the dendro thermal program is being implemented. It identifies the strengths and weaknesses of the institutions and recommends a course of action for the future.

c. Chapter IV analyzes the tree plantations, including the initial concept, evolution of progress, future plans, and harvesting plans. It contains recommendations related to the present sites, future development and forestry research.

d. Chapter V reviews the advantages and disadvantages of the existing power plants from an operational point of view and recommends a model for future power plants.

e. Chapter VI analyzes the financial and economic aspects of the program and notes conclusions resulting from the analysis.

f. Chapter VII contains the ultimate outcome of the study - a recommended package for future financing.

2. Overall Conclusions of the Study

The wood energy program described in this report could have far-reaching significance for rural development in a number of other countries dependent on imported oil. A project has been developed for production of relatively low cost electric power from renewable resources, and its essential technical, economic and institutional features have been identified.

a. NEA's concept of producing electric power from wood-fired steam plants owned and operated by Philippine rural electric cooperatives using fuel wood produced by tree farmer associations appears to be viable, although this conclusion needs to be reinforced by actual operating data.

b. The five-year period from program conception in 1979 through 1984 should be viewed as the learning phase of a major effort by the Philippines to develop alternative and locally renewable sources of energy for generation of electric power and to meet other worthwhile objectives. This effort has been innovative and productive even though it was also accompanied by mistakes and miscalculations. It has also been significantly impacted by the lack of local currency to support and maintain on-going projects.

c. From the lessons learned since 1979, the Philippines should be able to produce electric power from its dendro thermal program at lower costs than oil-fired steam plants; with attendant savings in foreign exchange; with benefits to the environment; and with advantages to the tree farmers in the way of increased rural incomes and secure land tenure. This judgment follows from findings that:

- o Problems of design and operation of most power plants have been recognized and can be resolved. The technology is appropriate and well established, and designs of later power plants will benefit from lessons learned from these early problems.

- o Production from tree farms has been below expectations, and there remain a number of operational problems and unanswered questions. If the lessons learned from experience are properly applied, a sufficient supply of fuel wood can be assured.

- o The three-tiered institutional framework--National Electrification Administration (NEA), Rural Electric Cooperatives (REC), and Tree Farmers Associations (TFA)--while still maturing, is an appropriate management system for the program and its expansion.

d. The Philippines and prospective donors can proceed with confidence that new dendro thermal installations would constitute a sound investment provided that the recommendations made herein are followed.

e. Parallel with further improvement and expansion of its dendro thermal program, the Philippines should undertake a long-term tree farm research activity. The 30,000-70,000 hectares of tree plantations now or planned to be under control of the Dendro Thermal Development Program (DTDP) provide a rare opportunity to undertake on-station and applied research to improve plant growth and yield, to develop alternative plant materials, to conduct soil and provenance tests, and to deal with other research questions.

B. SYNOPSIS OF FINDINGS AND RECOMMENDATIONS

1. Institutional

The institutional framework under which the dendro thermal program is being implemented is appropriate. NEA and the RECs are viable organizations

with experience in developing and implementing similar programs. The Tree Farmer Associations, while established for this specific program, are under the direct guidance of the RECs. Personnel throughout the NEA, RECs, and TFAs are dedicated to the program and its success. The area of weakness observed throughout the program is the lack of experienced technical personnel. The Dendro Thermal Development Office (DTDO) of the NEA lacks experienced, senior foresters and power engineers. The RECs generally do not have experienced foresters, and several RECs do not have qualified dendro thermal coordinators. The GIT team strongly recommends that the required staff of experienced technical personnel be given first priority. Recognizing the importance and difficulty of obtaining experienced personnel, a general recommendation is that any package for financial assistance include provisions for adequate technical assistance. This subject was discussed extensively with all parties, and there is a willingness, at all levels, to accept technical assistance.

2. Wood Energy Plantations

The program to date has produced a wealth of experience related to the development of tree plantations. This was a costly experiment and the lack of anticipated wood yields from the plantations indicates some areas where significant improvement can be made. It is now recognized that each tree farm site must be carefully studied for appropriate selection of tree species, planting and cultivation techniques, and harvesting plan. The feasibility of a particular dendro thermal project critically depends upon the success of the tree farm. The report contains specific recommendations related to site analysis, species selection, plantation size, harvesting plans and forestry research.

3. Power Plants

Generally, power plants of the size and cost of the early designs, or similar plants incorporating many of their features, appear to be capable of producing reliable power at costs competitive with oil. While there is little plant operating experience at the present time the GIT team was able to identify areas that need additional work and to make several recommendations. In

order to facilitate training, maintenance and spare parts, every effort should be made to standardize some aspects of plant design. The standard design should include fuel chipping, centralized controls, communication links with the local NPC grid, and cooling towers rather than stream flow cooling. It should not include fuel dryers. For the existing and future plants, a detailed electrical transmission and distribution analysis must be conducted, including plans for interconnection to avoid costly problems experienced at some early plants.

4. Economic and Financial Viability

For the purpose of the economic and financial analysis, six representative sites were studied. Economic (EIRR) and financial internal rates of return (FIRR) were calculated. Evaluating the FIRRs against the real cost of capital in the Philippine private sector, the dendro projects are marginally viable. However, measured against the rate of return required by international lending agencies for NPC and NEA, they are clearly financially viable. From an economic evaluation, the FIRRs in most cases equal or exceed a social discount rate of 15 percent. The third and significant evaluation of the dendro project is the comparison of cost of power with the alternative generation of oil-based power. In five of the six cases studied, the analysis indicates that the dendro projects can produce cheaper power than oil-based generation. Power plant costs constitute by far the largest component in the cost of power and offer the greatest opportunity for costs savings.

5. Conclusions and Recommendations

The GTRI team finds the Philippine Dendro Thermal Program feasible and, with the implementation of the recommendations contained in this report, recommends that the Asian Development Bank give favorable consideration to a loan package of approximately $37 to $50 million that would stimulate:

- Completion of power plants for which equipment is on hand or partially installed (eight to ten plants, including upgrading of electrical interconnections).

- Completion of tree plantations associated with the incomplete power plants.

- Construction of five new 3-5 MW power plants.

- Development of plantations for the five new power plants.

II. INTRODUCTION

This report presents an extensive evaluation of the Dendro Thermal Development Program (DTDP) currently being implemented by the Government of the Philippines (GOP) and its agency responsible for the electrification of rural areas, the National Electrification Administration (NEA). It is the result of investigations carried out by a team of approximately 22 professionals and additional support personnel, each with a particular expertise in the general fields of forestry, engineering, economics, or institutions. The prime contractor for this study was the Georgia Tech Research Institute, located in Atlanta, Georgia, U.S.A. Subcontractors included the National Rural Electric Cooperative Association of Washington, D.C. (NRECA); Hodam and Associates, Incorporated, of Sacramento, California (HAI); Forest Engineering of Corvallis, Oregon; and the Paper Industries Corporation of the Philippines of Makati, Philippines (PICOP).

GTRI responded to a request for proposals from NEA in September 1982 which presented the terms of reference for the overall evaluation of its Dendro Thermal Development Program. GTRI was selected as the successful proposer, and work was started on the project in January 1984. The project was managed by Mr. William Bulpitt, Project Director. Other personnel included in the project are identified in Figure II.1.

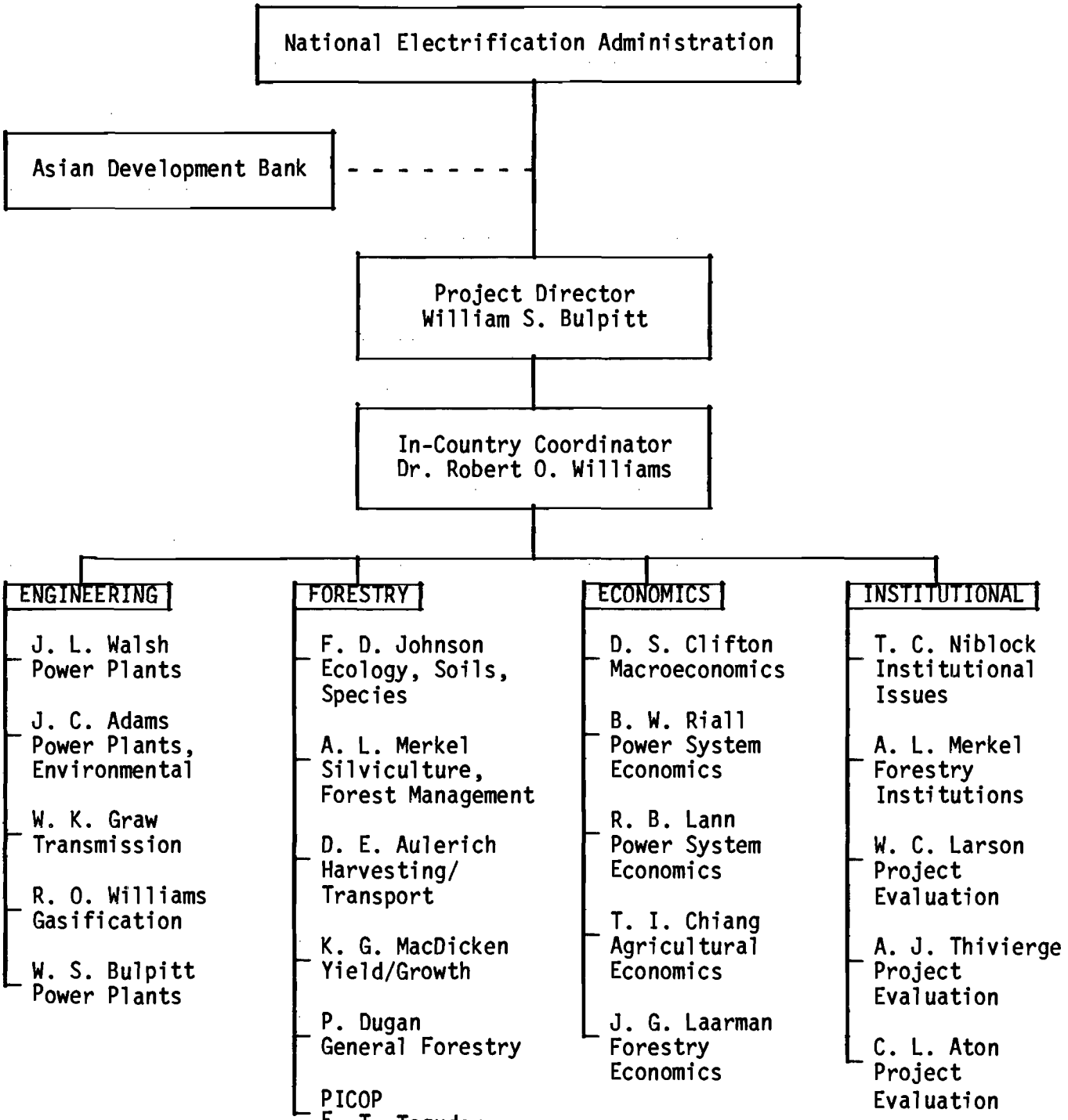
The analyses and conclusions in this report are based upon meetings with personnel of NEA, the Asian Development Bank (ADB), the United States Agency for International Development (USAID), the National Economic Development Administration (NEDA) and other institutions, field trips to power plant and tree plantation project sites, and examination of documents and records at NEA.

The analysis focused on the program's institutional framework, the fuel wood plantations and the wood-fired power plants. A principal purpose was to determine if a replicable model has evolved which is capable of producing electric power at competitive rates, uses locally renewable fuel, is administratively sound, provides increased domestic employment, and is beneficial to the environment.

Two difficulties were common to each element of the analysis. First, the

Figure II.1

PROJECT ORGANIZATION



Philippine DTDP is in many ways a pioneer and demonstration program launched on a learn-as-you-go basis. The prospect for cost effective replication relates, therefore, to the model which evolved from this process rather than to early plans and designs. Second, a more vigorous approach to data gathering, scientific monitoring and applied research would have facilitated this evaluation.

Offsetting these handicaps was the excellent cooperation received by the GIT team and its consultants from all levels within NEA, from the Rural Electric Cooperative (REC) managers and staff, as well as from leaders and members of Tree Farmer Associations (TFAs).

The disruptions to the world oil market during the 1970's and resultant rise in oil prices forced many countries to look at alternative sources of energy. In the Philippines, as in other tropical and semi-tropical nations, a resource that appeared to have potential was biomass energy. Officials of NEA studied the problems and potential and decided to establish the Dendro Thermal Development Program in 1979. This program has three major stated objectives:

1. The reduction of foreign oil imports used to provide fuel for electric power generation.

2. The construction and operation of a network of wood-fired power plants to be constructed in rural areas of the Philippines. These plants would offset the use of oil by the National Power Corporation (NPC), improve the reliability of the electricity supply system, and provide new jobs in rural communities.

3. Establishment of owner-operated tree farms contiguous with the power plants to provide fuel on a continuing basis for the power plants.

The near-term goal of the DTDP is the construction of 200 MW of generating capacity by 1990. To help achieve this end, 40 program sites totalling approximately 45,000 hectares have been identified, and 33 of these sites are being developed. Ultimately, the goal of 200 MW would require development of tree farms at 63 sites totalling more than 70,000 hectares.

III. INSTITUTIONAL

A. BACKGROUND AND SUMMARY

The administrators of the Philippine dendro thermal program are seeking the most efficient wood burning power plants, the most suitable tree species, and the best conditions for the growing of trees. In addition, they are working to develop institutional arrangements for effective administration of the program. This chapter describes the institutional arrangements adopted by the Philippines to carry out its dendro thermal program and appraises these arrangements in relation to possible expansion of the program with funding from the Asian Development Bank.

The Philippine Dendro Thermal Development Program originated from within the National Electrification Administration and is administered by the NEA as a special activity designed to reduce the dependence of the rural electrification system on imported and non-renewable fuels by generation of electricity with fuel from tree farms. A companion program with the same general objective, also administered by NEA, generates electricity from small hydroelectric systems. Both programs are administered by separate offices established within NEA. The Dendro Thermal Development Office was created in 1979 to provide funding, planning and policy guidance, and supervision to the wood-based program. These two programs are designed to meet a significant share of electric power requirements for rural areas.

Execution of both programs was assigned to the locally owned and managed network of 113 Rural Electric Cooperatives. With respect to dendro thermal activities, the RECs were encouraged to acquire land for tree plantations, to take the lead in organizing Tree Farmer Associations, and to make application to NEA for loan funds to establish the tree farms and construct wood-fired power plants. In conjunction with funding, the NEA administers a training program to develop leaders and staff for the dendro thermal program. It also has established procedures and guidelines for administration of the program.

It is significant that the RECs are the owners of the wood-fired power plants. By June 1984, loans had been finalized between the NEA and RECs to establish 40 tree plantations and to fund 17 wood-fired power plants. The

RECs in turn make loans to the Tree Farmer Associations. The NEA's plans provide for eventual development of an additional 30 tree plantations. When fully developed and matched with adjacent wood-fired power plants the system would provide generation capacity for approximately 200 MW of electric power.

Thirty-six RECs had started tree farms by June 1984. As discussed in Chapter IV, some trees were growing well and others not as well, with considerable variation within and between sites. The RECs are cooperating with NEA's research efforts to identify tree varieties suitable to those areas where current varieties are not well suited. The USAID is financing a modest technical assistance program to help test a variety of fast-growing tree species, develop seed orchards, and monitor and evaluate growth.

As of the same date, 3,838 tree farmers had joined 338 Tree Farmers' Associations. Seventy training seminars had been conducted for participants which covered all phases of the dendro thermal program. A listing of training courses with numbers of participants is provided as Annex III.1.

In brief, the institutional framework is in place with initial operations well underway in spite of numerous problems facing this new program.

Philippine oil imports cost $2.3 billion in 1983, nearly 40 percent of foreign exchange earnings. This burden places sharp limits on the ability of the economy to grow and makes it imperative to develop indigenous energy sources. The dendro thermal program reviewed in this study represents one of the several efforts being made by the Government of the Philippines to cope with its fuel import problem. Generally judged the largest program of its kind (growing trees expressly to generate electricity), the program should also be viewed as a massive demonstration project, the results of which will be important to other countries and regions.

This system of producing electricity from tree plantations provides a number of important benefits not ordinarily associated with the electric utility business. Some of these benefits are:

- Marginal land is made productive.

- Foreign exchange is conserved by reducing the import of fuel oil.

- o Landless and/or poor farmers are settled on public lands with long-term tenure.

- o The resulting greening of hillsides could provide important watershed conservation and environmental benefits.

- o The combination of technical, agronomic, and administrative skills involved in this activity could contribute to developing and implementing other rural development programs.

The electric power produced from the wood-fired plants is fed into the existing distribution systems owned by the RECs and, in most cases, displaces power otherwise purchased from the transmission grid of the National Power Corporation. Typically the dendro thermal power plants of 1-5 MW capacity produce only a part of the power requirement of the REC which owns and operates the plant. Nevertheless, during off-peak hours there may be excess power potential. It is planned that any locally excess power will be sold by the RECs to NPC at the same rate the RECs purchase power from NPC (1). The program recognizes that dendro thermal power is not competitive in Mindanao where low cost hydro power continues to be available.

It is clear from the administrative arrangements and the institutions involved that the Philippine dendro thermal program is an integral part of and inseparable from its parent rural electrification program. The following sections deal, therefore, with the dendro thermal program not as a free-standing program but as a specialized add-on to the rural electrification program established in 1969. The institutional strengths and weaknesses of the dendro thermal program are in large measure the same strengths and weaknesses which characterize administration of the basic rural electrification program. Given the decentralized nature of rural electrification in the Philippines, the national authority (NEA) and the local implementing bodies (RECs) are treated in separate sections. There is a separate section also concerning the Tree Farmer Associations as these associations represent a new organizational arm not formally linked to the RECs.

Annexes document the formal status of organizational units (Annex III.2)

and provide detailed data on the status of the program as of June 30, 1984 (Annex III.3).

B. THE DENDRO THERMAL DEVELOPMENT OFFICE UNDER NEA

1. National Electrification Administration

a. Organization

The NEA was formally established as a government corporation on June 26, 1969, by Philippine Republic Act No. 6038. This law was repealed and superseded by Presidential Decree 269 on August 6, 1973. These and related documents provide a clear statement of national priority for rural electrification, particularly for electrification by cooperatives. They constitute a strong institutional base for rural electrification. They authorize capital stock, provide for appropriations from the general revenue, and authorize NEA to contract foreign indebtedness. The NEA is given adequate power to fulfill its mission. Its appointed Administrator and Board of Administrators are respected professionals. Annex III.4 contains a compilation of "Vital Documents on the Philippine Electrification Program." The organization of NEA is shown by Figure III.1. Extensive information on the NEA program is contained in its Annual Reports and other documents available at NEA, Manila. These include detailed information on the accomplishments and status of each individual electric cooperative: "Status of Program Implementation" and "Cooperative Annual Statistical Report." These NEA documents are not included as Annexes but are available for examination at NEA's offices.

b. Assessment of NEA

The physical accomplishments of the Philippine rural electrification program over the past 13 years are well documented and extensive, as shown in the reports mentioned above. Fifteen million of the rural population now receive 24-hour electric service at a price they can afford. Electric power

NATIONAL ELECTRIFICATION ADMINISTRATION
ORGANIZATION CHART

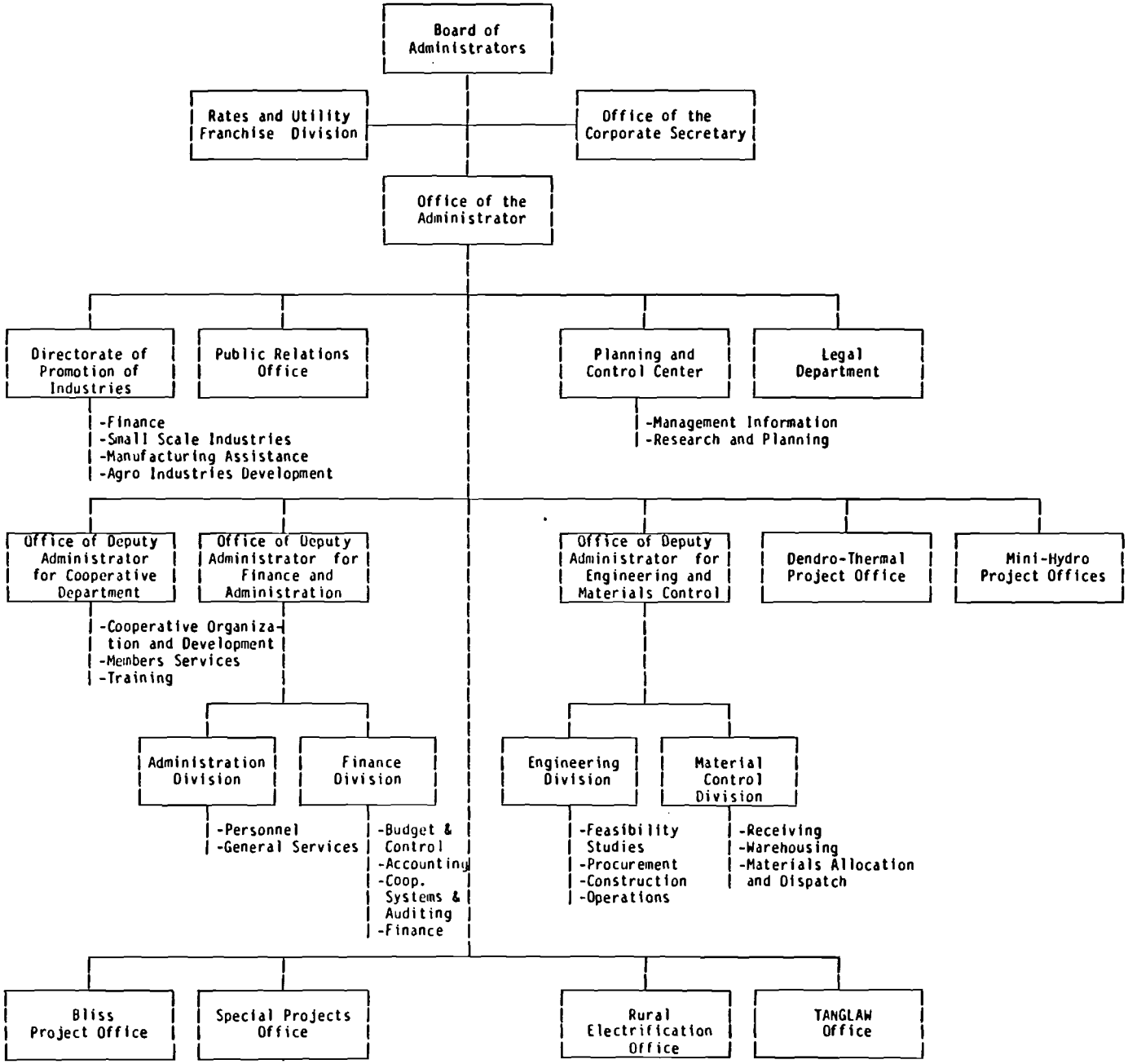


FIGURE III.1

is now available for agriculture, commmerce and industry in all but the most isolated towns and villages of the country. Direct household service is provided to over half of the rural population. While the rate of program expansion has been adversely affected by the current economic situation, total electrification remains a realistic goal for the Philippines. Few, if any, countries have electrified their rural areas at a faster rate.

Various appraisals and evaluations (some conducted for the ADB) have pointed out strengths and shortcomings of the Philippine rural electrification program. These reports bear, of course, on the prospects for the dendro thermal program, given the dependence of the dendro thermal program upon the RECs and NEA. A report prepared for the ADB by Urwich International dated May 25, 1983, is particularly relevant to ADB consideration of participation in the dendro thermal program (2). That report concluded the rural electrification "system as a whole could become financially viable in 3-5 years" and recommended a number of measures designed to bring this about. The report found the financial problem "simplified because gains in a relatively few (RECs) can have a disproportionate effect on the whole." Subsequent to this report the Philippines has experienced severe economic problems which have made achievement of financial viability more difficult. Also, the Urwich report did not take account of the added financial burden assumed by RECs borrowing funds from NEA to establish dendro thermal power plants and tree plantations.

Assessment of NEA's response to the Urwich recommendations and the evolving financial condition of NEA and the RECs is beyond the scope of this report. Such an assessment should, however, be undertaken as part of the loan appraisal process for ADB participation in the dendro thermal program. This assessment should include steps taken to assist RECs to reduce line losses, improve inventory and materials management, strengthen corporate planning, management responsive reporting and other priority measures. It should also assess the significance of the REC network which, in spite of some deficiencies, has a decade of demonstrated performance and considerable administrative strength. The RECs provide ready-made distribution networks for marketing power produced by the dendro thermal plants as well as proven administrative and management capability to take on responsibility for the dendro thermal program.

c. Relationship of NEA to the Power Sector

Primary responsibility for electric power generation rests with the National Power Corporation, a government corporation which operates hydroelectric, geothermal, coal and oil-fired plants. Typically, RECs purchase power from the NPC grid for distribution to customers. Several RECs own and operate oil-fired plants because they cannot be served by NPC.

Imported oil accounts for over 80 percent of commercial energy consumption. Approximately one-fourth of this oil is burned for electric power generation.

The Philippines generates approximately 18,000-20,000 gWh of electricity annually. Of this amount, some 2,500 gWh are distributed through the REC rural network. The 200 MW of power capacity planned for the dendro thermal program would provide a significant share of this rural load. In some REC service areas it would exceed the total demand. The NEA will further reduce dependence upon NPC as small hydroelectric plants are installed. NEA's plans call for installation of 300 MW of small hydro capacity by 1990.

The RECs will continue to rely on NPC for much of their power requirements and will depend on the NPC grid during periods of maintenance. The degree of self-reliance which the RECs achieve in power generation will vary greatly from site to site depending upon local conditions. What is significant is that the Philippines has begun a serious movement to find alternative and renewable sources of electric power for its rural areas and is registering a marked degree of progress in relation to most other countries.

The Manila Electric Power Company (Meralco) distributes power for the metropolitan Manila area. Several RECs have been absorbed into the Meralco system due to urbanization of their areas and inability of the RECs to compete with the more flexible rate structure that Meralco offers small consumers.

The Philippines is currently implementing an energy investment program that is designed to reduce dependence on imported oil. This program includes construction of additional large-capacity hydroelectric plants, geothermal power generation, one nuclear plant, mini-hydros, increased exploitation of local coal deposits, and non-conventional energy from biomass, solar energy, and wind power.

The degree to which savings in foreign exchange can be realized from the DTDP will depend on the pace of program implementation, which has slowed down due to financial limitations. The NEA estimates that savings, had the program been able to proceed at its planned pace, would have replaced 1.6 million barrels of oil by 1990 and 14.5 million barrels by the year 2000. Achievement of such savings depends on receipt of peso financing from domestic or foreign sources to make use of imported equipment, together with resolution of program operational problems described later.

2. The Dendro Thermal Development Office

a. Formation

Following its decision in 1979 to undertake a dendro thermal program to produce electric power, the NEA etablished a separate office to administer this program. The organization, staffing, and activities of that office are described below. These activities are coordinated with a larger tree growing program led by the National Dendro Development Corporation (NDDC). The NDDC coordinates efforts to use fast growing trees for a variety of other purposes. Other purposes include production of fuelwood for household use and charcoal for operation of gasifiers for irrigation pumps, fishing boats, etc.

The Administrator of NEA is responsible for overseeing this broad effort, which includes the Family Forestry (Sariling Sikap) project. The dendro thermal program constitutes but one aspect of the Philippine rural electrification program.

b. Organization and Staffing

The office created to administer the dendro thermal program within NEA, the Dendro Thermal Development Office, is authorized a total personnel complement of 119. As of June 30, 1984, some 68 positions were filled with a trend for a declining number of staff. Financial difficulties facing the NEA and all government corporations in the Philippines in 1984 have mandated austere staffing. The Office is headed by an Executive Director who is one of NEA's

senior officers. The organization of the Office is shown in Figure III.2. Organization charts and functional statements for the six subordinate Divisions appear as Annex III.2. Full staffing may not be justified until the dendro thermal program reaches its planned peak level of operation.

The staff which has been assembled for the dendro thermal program may be characterized as a youthful staff of recent college graduates. The key staff are professionally trained, dedicated, and proud of the innovative and pioneering nature of the program. Until restricted due to budget constraints, the staff traveled frequently to field sites to offer technical guidance and encouragement. This contact and interaction between headquarters staff and the RECs and Farmer Associations was a primary strength in the establishment of the program. The budgetary restrictions on field travel are a setback for the program. A related problem is the low government pay scale which restricts recruitment of experienced engineers, foresters, and agriculturalists. While the program would be strengthened by more senior specialists, there is little doubt that the basis exists for development of a strong and stable organization from the present staff and from others available in the country. Morale and performance should improve as funds become available for travel and other support services.

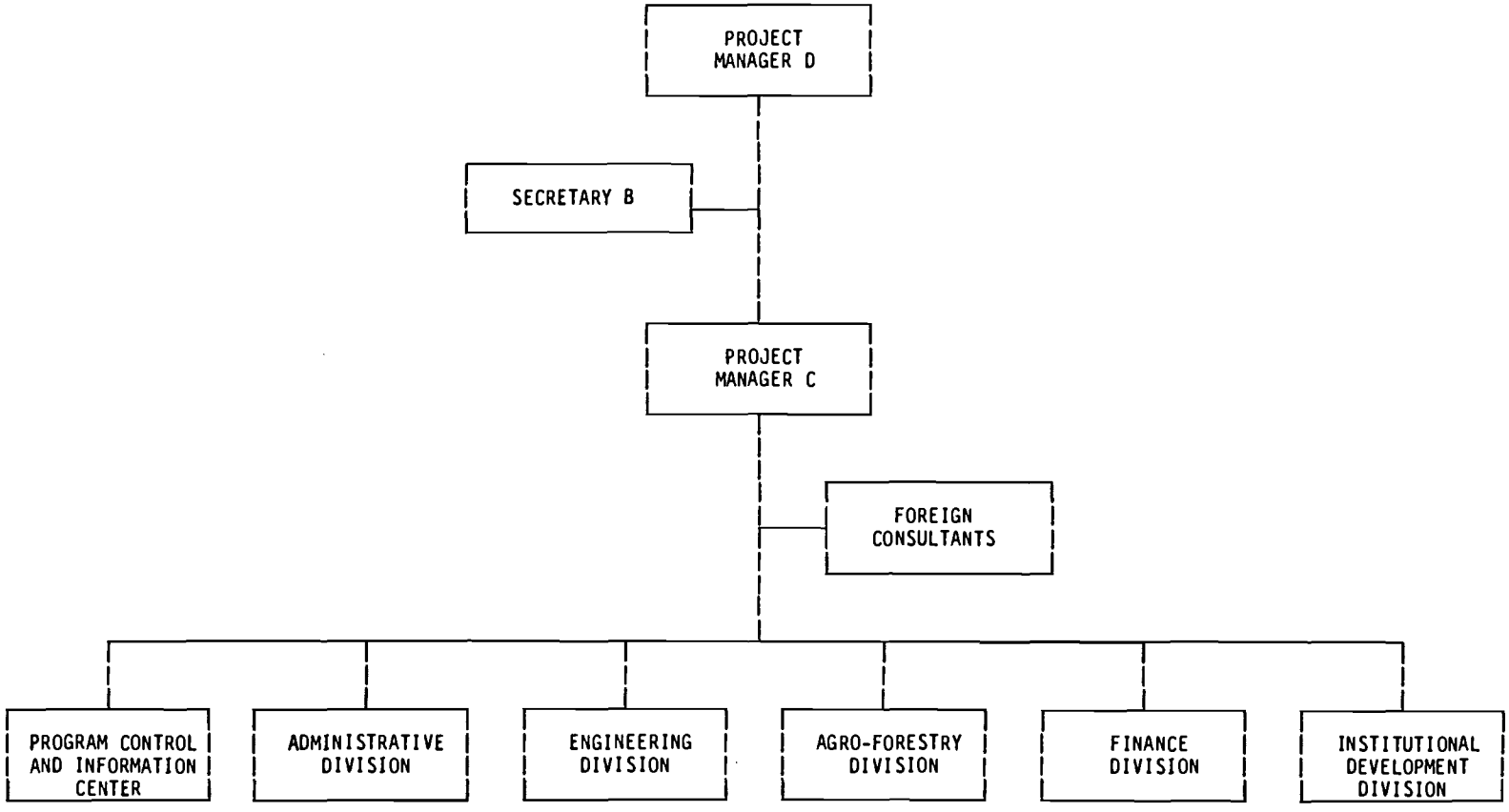
Pending the strengthening and maturing through experience of the staff, the Dendro Thermal Development Office will be hard pressed to provide adequate management services for the large-scale expansion projected over the next five years from the USAID, the Government of Japan, and the funding recommended by GIT for consideration by the ADB. This problem should be addressed at two levels:

- The internal operation of the NEA and its Dendro Thermal Development Office should be reviewed to assure vacant staff positions are filled as the work level expands and that positions are filled with a larger proportion of experienced professionals.

- Contracted technical assistance should be made a part of all major loans to NEA and the RECs to assure that each tree plantation is developed with the on-site services of a professional forester and

DENDRO THERMAL DEVELOPMENT OFFICE

ORGANIZATIONAL CHART



TOTAL PERSONNEL COMPLEMENT = 119
(EXCLUDING FOREIGN CONSULTANTS)

TOTAL FILLED POSITIONS 68

FIGURE III.2

that each power plant is established with the advice and assistance of an experienced architectural/engineering and management team.

3. The Dendro Thermal Program within the Rural Electric Cooperatives

a. The Dendro Thermal Staff

Each REC which undertakes to establish a tree plantation and dendro thermal power plant is itself responsible for implementation of the program, including borrowing the funds needed and providing the necessary staff. The staff is hired as progress of the program warrants. A dendro thermal program coordinator is hired, or assigned from the ranks of the REC, to head the dendro thermal staff unit. The coordinator is typically a person with seniority and status in the REC or community and known to be a good leader.

Selection of dendro coordinators presents special problems for the REC. The same person with technical knowledge to supervise the REC-owned wood-fired power plant may not have the needed skills and personal qualifications to work effectively with tree farmer associations. This is an issue deserving attention from REC Boards of Directors and General Managers as well as the Administrator of NEA. A uniform approach could be counterproductive. Local solutions will need to be tailored to local circumstances. The aim is to find effective leadership for the steam plant and a person with the right personality and skill to work with tree farmers on the site. It is difficult to find individuals possessing both skills.

For management of the tree plantation, the basic staff consists of a forester, an agriculturalist, and a bookkeeper/accountant. For the power plant, staff is recruited to fill the positions called for by the manning chart for operation of the plant, as modified by actual experience during the start-up period. The staff required for management of the tree plantation and operation of the power plant become regular staff of the REC. The typical REC staff, prior to addition of the dendro thermal program, was between 150-300 employees, depending upon the number of customers served.

b. Rural Electric Cooperatives as Owners and Implementors

The RECs are accustomed to management of projects directly or indirectly related to their primary task. Earlier special projects included the promotion of small industries to facilitate application of electric power for productive uses, the electrification of rural schools, assistance with school drinking water systems, administration of rural housing projects, installation and operation of small hydroelectric systems, and help with a family tree farm program and charcoal making. All of these programs involve the management of loan funds made available by NEA for which the RECs are accountable. The RECs are thus prepared to take on responsibility for implementation of the dendro thermal program. The international development community has provided substantial funding for the RECs over the past 10-15 years. The ADB itself has made the largest single loan for electrification through RECs. This loan was based on an analysis of the operating record of NEA and the RECs.

The quality of management of an individual REC is strongly influenced by the abilities of its General Manager and the relationship between the General Manager and the REC Board of Directors. The latter are leaders from towns served by the REC. The NEA rates each REC annually with respect to performance. Special supervision is provided to problem cases. Managers have been changed from time to time at NEA initiative. In general, the RECs are led by able and dedicated persons. The General Managers are viewed in the rural community as local leaders and most of the RECs themselves as successful organizations which are delivering on promises to the rural populace.

4. Tree Farmer Associations

a. Formal Entities

Prior to launching the dendro thermal program, the NEA constructed a theoretical model for the TFAs to follow. The model is described in Dr. Frank H. Denton's book, Wood for Energy and Rural Development, the Philippine Experience, Manila, 1983. Dr. Denton provides considerable commentary on the TFAs--their organization, management, composition, social and economic dimen-

sions, and early operation. The formal standing and guidelines for operation of the TFAs is set forth in an Organization and Operation Manual for Farmer Associations prepared by NEA's Institutional Development Division, Dendro Thermal Development Office, March 1983. The manual is an example of the detailed planning which has gone into the farmer association phase of the program. It is too lengthly to be included as part of this report. However, it is available in the Dendro Thermo Development Office. It is one of the documents prepared by the Philippine dendro thermal program which could have special interest in other countries.

The manual provides a program overview, describes the formation and organization of TFAs, prescribes the conduct of meetings and recordkeeping, and describes how to establish tree plantations, to account for funds and to deal with the distribution of income from the sale of wood.

b. Flexible Implementation

Administrators at NEA and the REC level allow considerable flexibility in implementing the formal plan for the tree growing program. This flexibility has come about as the RECs have conducted information campaigns among prospective farmer members to explain the program and the benefits likely to be reaped from joining the TFA. Adaptation of the tree growing program to fit local conditions was also facilitated by training courses and field monitoring by RECs and NEA. The NEA and REC staff learned, for example, that farmers often preferred to group themselves into TFAs by family or other established personal relationships rather than join an impersonal communal group, even though both would be self-governing. It was found that some farmers were interested in the TFAs if they could use a portion of the plantation land for private food crops and/or could divide time devoted to tree growing with time devoted to their private land. In other cases, farmers were prepared to establish the tree plantings as a group but then wished to maintain the trees on an individual plot basis. The reaction of NEA and the RECs to farmer-proposed modifications has been pragmatic. Financial assistance has been furnished to the farmers, as long as fuel wood trees were planted and maintained.

Many RECs and tree farmers have decided that conditions at their sites

required different spacings from the 1-meter interval prescribed in the model. Some plantation operators have expanded spacings. Others are experimenting with even closer spacings. The result is accumulation of a large body of site specific information. In this sense, the early years of the Philippine dendro energy program could be viewed as a large and decentralized demonstration program providing experience and knowledge which will strengthen subsequent phases. Some might fault the empirical and pragmatic approach followed as being inefficient. Indeed, the GIT report has highlighted the absence of scientific data collection and the limited research built into the program. However that may be, if the focus is on the next phase of the project, these later activities will be able to profit from mistakes and proceed with the assurance that many problems have been resolved. It is not too late to institute improved data collection and research. The DTDP is a long-term program.

Faced with budget constraints and the inability in 1983 and 1984 to proceed with the tree farm and power plant development at the pace earlier planned, the NEA has encouraged the RECs and TFAs to seek interim means to provide income for tree farmers. Pending completion of power plants, there will be a problem in marketing the early fuel wood crops. A number of tree farmers are being given technical assistance by the NEA and RECs in construction of kilns to make charcoal from the tree trunks and animal feed from the tree leaves. Other tree farmers are being allowed to sell wood in the commercial market pending the time the power plants are ready to buy it. In most cases, tree planting goals have been stretched and power plants delayed. While this has no doubt been a disappointment to many tree growers, it does not seem to be destroying the credibility of the NEA tree growing initiatives. Contact with a number of tree farmers suggests that they appear to have absorbed the setback and continue to have confidence in the program.

Indeed, as is described below, the dendro energy program of NEA appears to have inspired a number of private farmers outside the TFA membership to launch tree growing ventures on their own. This is largely an unplanned consequence of the official program and a development which holds promise of assuring a sufficient volume of fuel wood.

c. TFA Outlook

It has been demonstrated that a large number of poor Philippine farmers, including slash and burn farmers whose present farming practice is destructive to the land, are willing to join TFAs and work hard and effectively to plant and nurture a tree crop when a fair market prospect is offered. The farmers have shown initiative and have been the source of learning about the farming of fast growing trees. Given leadership from the RECs, the TFAs are proving to be effective institutions for mobilizing collective efforts. An early example is the Bolinao TFA. The fact that the ipil-ipil plant does not grow well in all locations and under all conditions does not undermine the validity of the TFA institutional concept or its administrative utility. The discovery and development of alternative species of trees for sites unfavorable to ipil-ipil will likely be sufficient incentive to persuade Philippine farmers to carry on with the program. Many Philippine farmers now have experience in adapting to new varieties of rice, for example, and appreciate the need for adapting plants to the environment.

As noted above, the original model for the operation of TFAs has been adapted to local conditions. In practice, the program is dealing with tree growers as subsistence farmers (which many of them are) and does not treat them as regimented members of associations devoted exclusively to a new kind of farming. As local practices evolve and conditions vary, so will individual benefits.

In early years, the cash returns after repayment of loan advances will be modest for many tree farmers in relation to lowland farmers. Combined with the benefits possible from using a portion of the land for other crops (see Chapter IV), the individual farmer should experience a real improvement in material well-being as the result of membership in the TFAs.

Long-term security of land tenure provides strong attraction to landless and/or slash and burn farmers whose livelihood is threatened by government policies which discourage the continuation of past practices. Membership in the TFAs permits 25-year leases on 10 hectares of land, renewable for a second 25 years. This tenure is assured so long as the land is used for the agreed purpose. Death of a member results in land rights going to the spouse or

family member if they continue the agreed land use. If not, the other TFA members can assign the land rights to another farmer. (For further discussion, see Volume II, Considerations of Forestry Management for the Dendro Thermal Project in the Philippines by A. L. Merkel, Section V, "Social Forestry.")

Experience has shown that in order to secure adequate fuel wood for sustained operation of wood-fired power plants, the originally planned 1,000 hectare plantation plots will need to be increased in size. Up to double the originally planned area will be needed depending upon the quality of the particular soils and growing conditions. The NEA will need to have a large supply of loan funds to finance this doubling of area. For their part, the RECs will need to take substantial additional debt if this added area is to be developed entirely from these sources. Fortunately, there is the possibility that farmers outside the TFAs will be interested in using their private lands to produce fuel wood for sale to the dendro thermal power plants. There is evidence that a number of farmers in the vicinity of the tree plantations are already planting fast growing trees with this market in mind. This practice is being encouraged by the NEA and the RECs. Like farmers in most places, the Philippine farmer is sensitive to the marketplace and appears to be responsive to the demand created by the dendro thermal power plants.

The extent of this market response is not yet clear, but it is clear that a variety of programs are underway to encourage the growing of trees and that new ideas are being developed. As mentioned earlier, one plan being stimulated by the NEA is the production of charcoal from ipil-ipil tree trunks and animal feed from the leaves. The growers are primarily private farmers on small plots. It is clear at this stage that future project sites can proceed on the safe assumption that some significant share of fuel wood needs will be available from the private sector without the need for project investments. Site specific planning will be needed to determine the appropriate size of REC-supported plantations and prospects for private plantings. An interesting idea, not yet implemented but illustrative of the thinking on the subject, is for the REC to accept payment of electricity bills with fuel wood stacked in front of the house. One cubic meter of fuel wood per month would roughly equate to average monthly electric bills.

C. PRESENT CONSTRAINTS AND FUTURE PLANS OF THE DTDP

The Dendro Thermal Program, launched in 1979 with the goal of generating 200 MW of electric power from some 70 widely dispersed wood-fired power plants, has been delayed and rescheduled. The delay is due primarily to a shortage of peso funds expected to be provided from the Philippine budget but which have not been forthcoming. The peso shortage itself is the result of severe economic problems faced by the Philippine economy. Also delaying the program are growing pains not unnatural to such a new program for which few precedents exist.

It is, of course, possible to fault the judgment that resulted in six of one type plant and nine of another type being purchased for the learning phase of the dendro thermal program. (This decision was made in response to continually rising oil prices in 1978-79.) As it turns out, due to budgetary constraints, only about 9 of these first 15 wood-fired steam plants are to be worked on and completed during 1984. Whether 9 or 15, the fact is that this initial program launched by NEA is producing a unique body of knowledge with respect to design, construction, and operation of decentralized wood-fired power plants using fast growing tropical trees as the fuel supply. The Philippines will, in the process, have acquired a number of technicians and specialists trained in these plants and a set of national and local level institutions capable of expansion and replication of the process. In addition, there is no reason to think that these plants, designed and operated in line with this experience, will not produce economical electric power from domestic, renewable resources.

As for wood supply, the NEA has moved ambitiously. Thirty-six tree plantations have been started. (A list of the plantation sites, area planted, and other information are shown in Annex III.3.) Chapters IV and V analyze the progress of the tree growing effort with respect to projected yields and estimated cost of wood fuel to the RECs' power plants. As with the power plant, the fuel wood phase of the program has encountered a number of problems. In the process of dealing with these problems, the NEA staff has developed an understanding of the requirements for successful production of fuel wood to meet the demands of the dendro thermal program. This has proven

to be a process related more to farming than traditional forestry. The analysis indicates wood yields (ipil-ipil) on well-chosen plantation sites can provide fuel at prices which will make generation of electric power competitive with large central station plants using imported oil or coal. Expanding the number and/or size of plantations, introducing new tree species and adopting improved practices based on experience should lead to availability of adequate amounts of wood for the overall program.

Recognizing the risks of overdependence on a single tree variety, the NEA is supporting nursery trials to identify other varieties which will produce wood where ipil-ipil does not grow well. This involves a research project (assisted by USAID) in which Philippine foresters and agriculturalists are collaborating with expatriate specialists. Four seed orchards are being established. This research activity (described in Chapter IV) is underway and should produce useful results. At the same time, it is apparent that this effort is being carried out below the minimum level needed, and it is short of the basic and applied research and program monitoring justified by a program of the magnitude and importance being undertaken in the Philippines. This is an unfortunate state of affairs in view of the potential value of this Philippine experience to the broader developing community.

Recognizing that Philippine program administrators are not prepared to use loan funds to carry out research and monitoring, which they view as of primary value to other countries, it appears appropriate that an international donor provide grant technical assistance to the Philippine program to improve the body of knowledge in this important area. International agricultural research centers such as the Internatioanl Rice Research Institute and the Centro Internacional Mejorimiento de Maiz y Trigo have received funding where multicountry benefits were being sought. While the analogy is not complete, comparable funding could be justified for fast growing trees for energy and other uses. GIT understands that the NEA is now seeking grant funding for such a research activity.

There are currently more tree plantations underway with favorable growth prospects than available power plants. Productivity from these tree farms should justify investment in additional power plants, especially if improved tree farm practices are undertaken as described in Chapter IV. The NEA

appears to be in position to invite prospective foreign lenders to fund the plantations and power plants. The program and its implementing institutions have the capacity to support such expansion. Chapter VII of this report recommends that the ADB consider support for completion and expansion of the program.

D. FINDINGS AND RECOMMENDATIONS

1. National Electrification Administration

NEA has provided financial support, policy direction, government supervision and strong leadership for the dendro thermal program, leaving ownership and operations in the hands of the RECs and TFAs. The NEA was able to provide adequate financial support for the program in its early years. Currently, financial support is sharply curtailed due to overall financial conditions in the Philippines. This drop in financial support has adversely affected both headquarter's support for the program and field operations.

As resources become available, the NEA should consider taking the following measures to strengthen its capacity to complete work already begun, and to be in position to expand.

- Renew the active field extension, site visits and motivation work of its present staff which was curtailed due to budget constraints.

- Employ at least one senior, experienced forester to guide the work of the NEA forestry and agriculture staff and assist REC-employed foresters and agriculturists. Employ a senior engineer with experience in power plant construction as a staff consultant.

- Ensure that development of each tree plantation proceeds within the framework of site specific management plans which include topographic maps, soil surveys, and analysis of the social conditions of tree farmers.

- o Develop a complete set of field manuals and training aids for the technical guidance of the program.

- o Continue and expand training programs for power plant and tree farm operators commensurate with progress and expansion of the program.

- o Require RECs to fill a predeveloped staffing plan with individuals meeting professional requirements established by NEA. This should apply both to tree farms and power plants.

- o Seek contracted technical assistance from within and outside the Philippines to the degree needed for the above tasks.

- o Review progress against the recommendations contained in the Urwich report (pp. 71-75) and complete still pending actions.

2. Rural Electric Cooperatives

The RECs provide an adequate management structure for implementation of the dendro thermal program. The addition of wood-fired steam generating plants to the ownership and operation of the RECs is not inconsistent with their purpose and functions or beyond their general technical capabilities. Nor is it beyond the capacity of RECs to take on responsibility for oversight of TFAs. These added duties and financial commitments by the REC require that adequate staff be provided and other arrangements be made. To date, the staff provided for assistance to and oversight of tree plantations has not been adequate. Two measures are recommended to accompany funding of on-going or new dendro sites.

1. Each REC should complete the staffing of its dendro thermal unit to include at least one forester, one agriculturist, one accountant, and support staff for the tree plantation and an appropriate staff for power plant operation.

2. The Board of Directors and General Manager of the REC should assure that the person responsible for working the TFAs (presumably the Dendro Coordinator) has the skills, attributes, and motivation required to work attentively with the tree farmers and that he devotes extensive time and effort to the tree plantation.

3. Tree Farmer Associations

As discussed above, the organization of TFAs has proceeded much as projected by NEA plans. The TFAs appear to be operating satisfactorily even in face of a cutback in planted area and reductions in payments to the TFAs. Apparently the efforts being made by NEA and the RECs to generate new sources of income for the tree farmers pending income from wood sales to the dendro power plant has met with some success. Contacts with tree farmers suggest that they continue to believe the dendro thermal program will benefit them. The NEA continues to have high credibility throughout the rural Philippines based on its performance in developing the RECs and delivering electric service to millions of rural Filipinos. The GIT team concluded that the original concept and institutional arrangements for the TFAs remain valid. The TFAs, like other components of the dendro thermal program, have been characterized by flexibility and innovation in responding to local conditions. No alternative arrangements considered would be more effective than TFAs. The TFA system would appear to have advantages over either contract farming or hired labor.

As more experience is acquired with the TFA system, ways will be found to make improvements. The process of learning and benefiting from this early experience can be strengthened by a more regular and fuller flow of information from the TFAs to the RECs and NEA--and between the TFAs themselves. It is suggested that the NEA encourage and assist with a "TFA Newsletter" to facilitate this exchange of experience. Such a newsletter can also be a mechanism to improve communications between the tree farmers and NEA.

References

1. Personal communication between General Pedro Dumol of NEA and Mr. Thomas Niblock of GTRI Team, September 12, 1984.

2. Urwich International. Financial Study of the Electric Power Cooperative System in the Republic of the Philippines, May 25, 1983.

IV. WOOD ENERGY PLANTATIONS

A. SUMMARY

Tree plantations were not new to the Philippines when the DTDP was launched in 1979. What was new was the growing of trees to produce electric power. The Paper Industries Corporation of the Philippines (PICOP) had considerable experience with company-managed as well as smallholder-managed tree farms. Throughout much of the Philippines, ipil-ipil has long been appreciated as a fast growing tree valued for fuel wood. Foresters at the University of the Philippines were quite familiar with the plant. The so-called "giant" varieties of ipil-ipil had been introduced to the Philippines several years earlier, and their rapid growth had attracted considerable local interest.

It is not surprising that, in the search for a tree to meet the requirements of the newly conceived DTDP, ipil-ipil was chosen. Faced with a policy decision to mount a large-scale wood energy program, ipil-ipil was designated the tree to be grown on all plantations. It was recognized that, in time, other species would be required; but since no good candidates were at hand, the program proceeded based on ipil-ipil. A modest research program was undertaken with USAID support to conduct on-site trials and establish four nurseries to develop alternative species. In addition, the NEA encouraged RECs to undertake field trials of various kinds.

Early planning also anticipated the need for harvesting and transportation systems specially adapted to the DTDP and for special management and institutional arrangements to implement the program. NEA made the decision to promote establishment of private and voluntary associations of tree growers. Members of the Tree Farmers Associations would be mostly landless farm laborers.

This chapter reviews program accomplishments and problems from the forester's perspective, including the growing and harvesting of trees and plantation management. Volume II of this report contains six background papers by consultants, covering these topics in considerable detail.

In brief, the chapter and the supporting papers:

- o Analyze why tree growth and yields have been less than projected.

- o Point out that wood harvesting and transport present special problems and costs not foreseen at the onset of the program.

- o Discuss species selection, soils and site planning and preparation, and plantation management practices that are critical to high and sustained yields.

Each consultant made recommendations to overcome problems observed. A list of key findings and recommendations is found at the end of this chapter.

B. BACKGROUND AND CURRENT STATUS

The Dendro Thermal Development Program currently consists of approximately 30,000 hectares of short-rotation-harvest tree farms which are being planted by approximately 3,000 rural families. At maturity, these tree farms are expected to provide a continuous supply of biomass in amounts sufficient to fuel 30 electric generation plants with an aggregate rated capacity of 90 MW. The overall program is targeted to reforest 70,000 hectares and support the fuel requirements for 200 MW of electric power before the year 2000.

To date, 17,450 hectares have been planted; however, only 7,664 hectares survived. The poor survival rate is partially due to the severe drought experienced throughout most of Southeast Asia during 1982-83 (NEA quarterly report for June 30, 1984). Abnormal climatic conditions, while less serious now than over the past two years, still continue to impair agriculture and forestry production in 1984. However, an assessment of DTDP accomplishments and practices over the past three year indicates that, in order to produce fuel wood on the scale and with the reliability required to support electric power plants, the program needs improvement in the areas of species selection, site identification, silviculture, project planning and management.

Unless such improvements are introduced, wood-fired power plants may not be viable at some of the sites selected for the DTDP where investments have already been made. Three sites have, in fact, been abandoned because initial

tree farm establishment failed. In addition, DTDP activities to date have been set back by the government's current inability to provide funds required for timely maintenance of tree farms already planted but which have not yet reached maturity. Since young trees need tending and care after planting, investments already incurred are now in jeopardy and may be forfeited if tree farm establishment is halted midstream.

Financial constraints have furthermore caused the suspension or delay of power plant construction at eight sites for which equipment has already been purchased. This deprives farmers of the guaranteed market they were promised when the DTDP was launched.

To partially alleviate financing problems for immature plantations, NEA has, on a selective basis, allowed some RECs to roll over periodic amortization payments on loans previously granted for other investments (e.g., distribution lines) and to apply these funds for tree farm development.

Additionally, RECs are being assisted in the construction of low-cost charcoal kilns to process currently harvestable wood. Charcoal sales will help achieve a modest level of self-financing for tree farm maintenance and expansion. Concurrently, farmers are beginning to derive some income from 1981 plantings.

NEA, in coordination with RECs, has further explored other interim marketing/self-financing options. Industrial fuel wood consumers needing fuel and located within economical hauling distance from tree farms have been contacted to begin developing alternate markets. To date, the primary target for these sales promotion efforts has been sugar mills.

The export market for Leucaena products is also being investigated. An NEA sales promotion team returned from Taiwan and Japan in July 1984 with offers from buyers at rates sufficiently attractive to warrant mobilization for export.

Tree farm productivity is central to the issue of power plant viability, and this is still an area of considerable uncertainty. Attempts to measure productivity have yielded mixed results. There is unanimous agreement among mensurationists that growth rates are lower than those anticipated from financial and economic feasibility studies prepared during initial project conception. Unfortunately, there is relatively little data on which to base growth

and yield estimates. This is because the program has only been on stream since 1981 and data has not been collected systematically. Furthermore, the effects of the 1982-83 drought must be considered, and current data may not provide a reliable basis for predicting yields under more normal weather conditions. While several qualified institutions and individuals have been involved in tree farm mensuration, there is still considerable disagreement among these mensurationists in regard to methodology. Each mensurationist who has been commissioned to address the problem has suggested and/or applied different approaches. As a result, conclusions vary considerably. Apparently, professional foresters and the academe are still seeking universally acceptable procedures for measuring and predicting tree growth for fuel wood plantations established on marginal land. This is not surprising, considering the range of biophysical and other variables, plus the fact that commercial-scale fuel wood production is a relatively recent phenomenon in most tropical countries and certainly, in the Philippines.

Given the uncertainty of scientific mensuration attempts to date, an alternative assessment of tree farm viability may be the marketplace, where evidence is encouraging. Commercial fuel wood plantings are apparent, even to the casual observer, throughout most of the countryside except in areas with extensive natural forests (e.g., Mindanao, Samar, Palawan). Numerous wood lots are a comparatively new feature of the rural landscape with visible examples being in Ilocos Sur, Central Luzon, Batangas, Negros Oriental, Negros Occidental, Capiz and Iloilo. Additionally, and readily verifiable, is the large percentage of wood from planted species found in urban and municipal fuel wood dealers' yards and in roadside stores. Clearly, many Filipino farmers have decided that fuel wood production is technically feasible and a profitable enterprise.

While the marketplace provides evidence that tree farms can be profitable for rural producers, the matter of power plant viability needs to be investigated with additional parameters in mind. None of the existing power plants has been operating long enough for investigators to evaluate the feasibility of combining wood production with electric power plant operations, where viability is directly dependent on reliable fuel supplies and relatively constant output at predictable prices.

At one location where tree establishment has been difficult (Solsona, Ilocos Norte), sufficient wood to keep the plant operating has been procured from outside sources. In contrast, at the program's most successful plantation (Bolinao, Pangasinan), harvests have been intentionally delayed or alternatively diverted to charcoal production. Because of technical problems in plant design, the power plant cannot utilize the volume of wood that producers are capable of delivering from their tree farms.

Notwithstanding disagreements between mensurationists in regard to methodology, the unanimous conclusion that growth and yield will be less than earlier predicted is a matter for serious concern. The NEA model, consisting of 1,000 hectares to supply a 3 MW plant, is apparently based on over-optimistic assumptions. Modifications are required in the overall plan with particular emphasis on species selection, plantation size, rotation cycles, harvesting and technology.

C. DEFICIENCIES AND MODIFICATIONS

1. Species Selection

Over-reliance on a single species (Leucaena leucocephala) has been a major weakness of the program. This report recommends several alternative species to match trees selected for planting with the variety of soil existing among and within project sites. GIT recommmendations are generally consistent with suggestions advanced earlier by other experts; both emphasize the need for the diversification which is a characteristic feature of healthy forests in the humid tropics.

NEA has recognized the need to diversify species; field managers initiated experiments in this direction as early as 1982 after some disappointments with Leucaena. Unfortunately, there was lack of clear direction in carrying out these experiments. Furthermore, progress toward more extensive diversification has been curtailed along with all other program activities because of financial constraints. Additionally, lack of sufficient propagation materials, farmers' negative attitudes toward some species and higher cost of production added to the factors that restrict NEA's species diversification scheme.

In October 1983, NEA with USAID assistance employed a U.S. based firm, Hodam and Associates, Inc. (HAI), to carry out systematic diversification experiments through a series of species trials managed by professional foresters. Forestry experts from the Philippines, Taiwan and the United States participated in planning the trials, and 13 promising fuel wood trees were selected for planting. Subsequently, the list was expanded to include other species, especially Eucalyptus. With a few exceptions, species recommended in this report were species included in the trials. However, since the initial plantings only started in July 1984, no conclusions are possible at this writing. Over time, it is planned that trial plantings will evolve into seed orchards after the most promising species are determined and weak specimens are eliminated.

The USAID-assisted trials suffer from two shortcomings:

- Leucaena was not included in the original list; therefore, reliable growth comparisons with alternative species are not possible.

- For 1984, trials are only being carried out at four locations, and these are insufficient to represent all the variables inherent in a nationwide fuel wood program.

NEA has addressed the deficiencies mentioned above as follows:

- The species trial program has been modified to include Leucaena at one site (Leyte) where plant propagation was to begin during August 1984 in time for the planting season (late October) at that particular site. This should ensure uniform silvicultural practices for all species and therefore reliable comparisons.

- Leucaena will be planted at the three other sites, along with all other selected species, during expansion of the trials in 1985.

- Plans have been drawn up to conduct trials over a broader climatic and geographic range and, provided funding can be obtained, new trial sites will be developed.

Concurrently, some RECs which, in 1982, planted species alternative to Leucaena, have continued to maintain their diversified plantings. As expected, several species have surpassed Leucaena's performance on a case-to-case basis, especially in areas characterized by acid soils, degraded land and steep slopes. A few of the more aggressive and more financially capable RECs started modest new diversified plantings in 1984. To some extent these efforts were hindered because seeds and seedlings were not always available.

In general, the need for diversification has been acknowledged by all concerned, but implementation is still at the pilot stage. A concerted effort is needed to emphasize and carry out diversification as the norm rather than the exception. Species selection, systematic seed procurement and appropriate silvicultural training are required.

2. Plantation Size

Given the evidence that growth rates are less than expected, it is apparent that 1,000 hectares of tree farms will not be sufficient to fuel a 3 MW power plant, except under ideal conditions.

With few exceptions, DTDP project sites are located on degraded lands. All evidence to date indicates that average estimated production will probably be in the range of 15 bone-dry tons (BDT)/ha/year, or only about 60 percent of earlier assumptions (25 BDT/ha/year). The implication is that each tree farm should have an average production area of at least 1,600 hectares.

Averaging can lead to serious errors, especially on upland terrain where high variability is normal. To ensure availability of around 1,600 hectares used exclusively for fuel wood production, aggregate plantation areas must be increased to discount for haulage roads or trails, cableways, rocky fields, excessively steep terrain where harvesting costs would be prohibitive and other land uses (e.g., food production). Furthermore, rainfall patterns are not uniform throughout the country, and growth rates will vary accordingly. This has implications for both plantation size and harvest cycles. It is impossible to prescribe a standard model which allows for all these site specific variables.

DTDP managers have accepted the rationale for plantations bigger than

1,000 hectares and, beginning as early as 1982, NEA encouraged the RECs to expand. Many RECs responded and tried to acquire more land by filing applications with the Ministry of Natural Resources (MNR) through the Bureau of Forest Development (BFD).

Unfortunately, expansion areas are not always available on lands adjacent to the original plantations. Since contiguous areas are preferred for efficient wood transport, the lack of options on vacant government lands can be a limiting factor.

One solution to the land availability and plantation size problem is to explore the potential for encouraging fuel wood production on private lands adjacent to DTDP sites. Several RECs are already applying this solution. For example, at Miagao, Iloilo, NEA has initiated contract growing negotiations with 700 farmers occupying 1,000 hectares near a proposed REC power plant. At Ilocos Norte, where serious plantation establishment problems have been encountered, all wood currently being used by the power plant is purchased from private sources outside the REC plantation. To help ensure additional outside wood supplies, procedures are being designed which would give power consumers the option of paying their electricity bills with wood instead of cash. NEA's Tanglaw Project, a voluntary tree planting scheme offering seeds and technical assistance, promotes tree farming in school yards, public plazas and private farms.

While the above described initiatives are commendable, there is a clear need for better organization and a sharper focus. A power plant manager needs to know where fuel will come from, when to expect delivery and what it will cost. The alternatives currently being applied are too general in nature; targets for each alternative are not clear and results are difficult to qualify. GIT recommends synchronization of ongoing DTDP initiatives including the following procedures:

- Detailed mapping and planning at each site to determine the number of hectares suitable for short-rotation tree farms; further quantifying all other land uses and preparing harvest plans. Harvest and plantation development plans should be prepared together because each interacts with the other. Furthermore, road and trail construction should precede planting.

- Exploring options for expansion on adjacent government lands, accompanied by the same level of detailed mapping and planning as stated above to make up for any potential wood supply deficiencies.

- Working with the private sector to further make up for aggregate wood requirement shortfalls indicated above (if these exist) and also for contingencies in the event of unfavorable weather, interrupted deliveries, etc.

- A detailed listing of wood production estimates by tree farm, planting block and private sector supplier along with estimated delivery schedules.

- Preparation of all of the above in direct relation to power plant requirements.

- Development of alternative markets as earlier described to address near term problems (plant construction delay) and the possibility of future oversupply (i.e., more than the power plant requires).

- Negotiation with the Bureau of Forestry Development to acquire plantation sites better suited to tree growing.

To carry out the above-described recommendations, NEA will need to upgrade its field planning capabilities either by employing additional staff qualified to perform the tasks indicated or by employing technical assistance teams to complete this work under contract. Since most of the work would be of temporary duration, technical assistance contractors would seem to be more appropriate and economical. However, NEA staff would still require additional training and personnel in order to supervise contractors.

3. Forestry Technology

a. Tree Farm Establishment

Tree farm establishment has often been characterized by a high degree of trial and error. For instance, when direct seeding proved highly feasible at the DTDP's most successful plantation (Bolinao, Pangasinan), other plantations were encouraged to follow suit.

However, the Pangasinan situation was not typical. Soils there are derived from limestone and therefore highly suitable for Leucaena. The ground cover consisted of second growth trees and brush which, when burned, provided conditions for direct seeding not materially different from the situation slash-and-burn farmers use to their advantage when clearing and planting forested areas. Furthermore, the REC General Manager is an experienced orchardist with a keen sense of timing and is a strict practitioner of timely maintenance.

DTDP planners unfortunately displayed the Pangasinan experience as a model for others to emulate, notwithstanding the biophysical differences between this and other sites, nor perhaps fully appreciative of the importance of timing and maintenance imperatives. Predictably, direct seeding failed in many areas.

More conventional methods were applied before direct seeding became the vogue. Seedlings were raised in plastic bags and outplanted in the normal way. However, the bags were generally quite small and could not accommodate enough potting medium to ensure vigorous early growth after outplanting. The need to sterilize potting medium was not emphasized, and inoculation was rarely practiced. Root pruning and other important procedures were neglected. Again, the results were often disappointing. Bare-root planting was an option applied at many sites, but the mud-puddling and land preparation procedures that are important for successful bare-root planting were often neglected, with predictable results.

In reality, all of the methods described above are applicable if carried out correctly and with due regard for what is suitable at any given location, but none of these methods can be considered universally appropriate. NEA sta-

tistics, quantifying successes and failures, furnish evidence that many mistakes were committed. In this regard, it should be mentioned that NEA has been forthright about acknowledging that problems exist. Success/failure statistics are displayed openly in NEA offices with no attempt to conceal facts.

Almost all of the above-described experiences took place during initial program years when Leucaena was virtually the only species being planted. The lessons learned have strengthened the program. Acknowledgement of problems indicates that NEA is seeking solutions. It is safe to assume that previous mistakes will not be repeated. However, like all trial and error experiences, NEA's lessons were learned at considerable cost. Many disappointments could have been avoided if competent professional foresters had been available to assist the RECs during early phases of the project. An experienced forester would have known what was feasible and what to avoid. Reforestation is an old science, and there was nothing attempted at DTDP sites which had not been tried and either accepted or rejected before.

As the program begins to implement a greater degree of species diversification, upgrading of field level skills will be important because there are differences in the silviculture methods appropriate for many species that will be new to tree farmers and the RECs. To preclude repeating the same costly mistakes, DTDP planners need to ensure that competent professional assistance is available in the field as the program expands. The professional assistance inputs needed are not especially sophisticated, nor should they be unduly expensive, provided careful procurement procedures are followed. The Philippines has many skilled foresters who could provide the necessary assistance. What is important is recognizing the need and being willing to apply tried and tested forestry technology. The recommendations made in this report describe a training program designed to develop in-house expertise and reduce the need for outside technical assistance.

b. Natural Regeneration

Something which has been overlooked in most reforestation projects in the Philippines is the opportunity to convert grasslands into forest at very low cost by simply promoting the growth of naturally seeded indigenous species.

In almost all grasslands, hundreds, often thousands of tree and brush seeds per hectare, sprout and take root each rainy season. The trees that grow naturally in grasslands are normally called "pioneer" or "invasion" species. Most pioneers are characteristically hardy and fast growing. Ecologists would normally classify Leucaena, Gliricidia, Trema and other common fuel wood species as pioneers.

Over time, if pioneers are not disturbed, they grow taller, branches spread, the grass is shaded out and woody perennials (pioneers and bushes), along with vines and bamboo, become the dominant vegetative cover. If no further disturbance occurs, the pioneers are gradually displaced by medium-sized and finally large-sized trees. Eventually, a forest is restored through the natural dynamics of the ecosystem. Scientists call this phenomenon "plant succession." Unfortunately, plant succession in tropical grasslands is usually interrupted by fires nearly every dry season, and the young seedlings are killed.

It has been demonstrated in the Philippines that by simply preventing fire, large grasslands will evolve into areas dominated by pioneers in an estimated 6-8 years. It has further been demonstrated that if, in addition to preventing fire, the pioneers are regularly maintained by ringweeding woody perennials, pioneer trees can become the dominant vegetative cover in approximately 3-4 years. Once this stage of plant succession is reached, a decision can be made to:

- Manage the area as a fuel wood farm
- Interplant with high value hardwoods
- Continue to protect the area, in which case a mature forest will develop over time

or any combination of the above.

Every forester, naturalist, agriculturist or careful observer understands plant succession. The slash-and-burn farmer relies on plant succession to restore fertility between slash-and-burn rotations. However, most managers of

reforestation projects do not take advantage of plant succession because their performance is normally evaluated on the basis of how many trees they plant. Credits are rarely earned for implementing measures, such as those described above, that are consistent with natural ecosystem dynamics and accomplish reforestation at very low cost. Managers are given credit for the number of hectares they clear and convert into tree farms.

The DTDP, in common with most other reforestation projects, has not taken advantage of plant succession. In some cases, second growth forests have even been cut down and burned in order to develop new forests comprised of fuel wood species. This has not always been successful. If planting is delayed after burning because funds are not available or for other reasons, cogon grass (Imperata cylindrica) often invades the area. Lands that were once forested are degraded into grasslands. This has been observed at Palawan and Solsona, Ilocos Norte, and has likely occurred at other sites.

At least one REC is applying the principles of plant succession to good advantage (CASURECO IV, Camarines Sur). GIT suggests that all RECs should be encouraged to consider applying the procedures described above as one of the technologies appropriate for plantation development. These procedures would be particularly appropriate in times of financial stress when low-cost alternatives are crucial. Additionally, this is a very economical way to develop steep slopes and severely degraded areas that would be expensive to reforest using conventional systems.

c. Soil Conservation

Many reforestation projects do not include investments in soil conservation. All too often, it is assumed that soil erosion problems can be solved by simply planting trees. This assumption is erroneous, especially if plantation sites are located on hilly land, and this error becomes even more serious when only one species is planted at high densities, as in a fuel wood plantation. In reality, dense planting of a single species usually creates conditions which lead to increased soil erosion. As trees mature, ground cover is shaded out; the soil underneath is exposed and easily dislodged during heavy rains. Reforestation sites are usually on hilly land and, even

when diversification is practiced, each planting block is normally planted to only one species.

These typical conditions apply to the DTDP and most other reforestation projects, and soil erosion is a problem at many DTDP sites. Loss of soil nutrients because of erosion can reduce production and affect the overall viability of the program. Simple, inexpensive soil conservation measures can and should be implemented.

In order to conserve soil in the plantations, contour lines should be laid out, and hedgerows should be planted along these lines. Hedgerows should be approximately 50 cm wide and should run all the way across the slope. Very dense planting (average 10 x 10 cm) of species that can be kept trimmed to a height of approximately 30-50 cm is recommended. Trimmings should be placed at the base of the hedgerows on the upper side of the slope. Alternatively, some of the trimmings can be used to feed livestock if appropriate species, such as ipil ipil, are selected.

Grass strips or bands of pioneer trees/shrubs/vines can be maintained on contours across the slope, within and between planting blocks. In short, any measure which creates a physical barrier across the slope and arrests downhill movement of rainfall run-off will help prevent erosion. There are many examples already in use throughout the Philippines, and tree farm managers can learn from these examples and should implement soil conservation systems that suit local conditions. Considerations in accomplishing this should include the selection of crops to be planted in those years when the soil is bare and the land requirements necessary to implement these alternatives.

D. HARVESTING AND TRANSPORTATION

1. Evaluation of NEA Status and Plans

The project team began its investigation of the harvesting/transport status by discussing various sites with the NEA and interviewing the project directors of the architect and engineering firms responsible for the design of the transportation systems for each site. Basic questions asked at these interviews centered on the following:

- What investigations and analysis had been conducted to determine harvest system selection?

- When a harvest system was selected, what plans had been developed for the operation of these systems on the sites?

The results of these initial interviews revealed that most harvesting plans were very general in nature. Some plans were quite specific, however, since the sites had been identified as locations for monocable systems, although there was little information available documenting the rationale behind the selection of the monocables. Apparently, substantial sums have been spent to acquire ten monocable transport systems from Lasso of Switzerland. One system has been completely erected, and several others are in the process of being erected at various power plants that are nearing completion. It is unclear where the balance of the systems will be sited.

The Lasso engineers had done a very thorough job of designing the cableways for sites destined to receive them. Unfortunately, very little evidence could be found of adequate plans for feeding the systems from the plantations to ensure a continuous flow of wood fuel to the power plants. The "packaged" approach being used for installation of the monocable systems must be questioned. Site specific variables should be factored into harvesting plans for wood fuel, just as they would be for other agricultural commodities.

NEA has recognized the lack of adequate planning for wood harvesting and has taken some steps to improve the situation. Hodam and Associates has been commissioned by NEA under a USAID program to prepare harvest plans for five DTDP sites. Concurrently, HAI is preparing harvest plans for five other tree plantations managed by the Farm Systems Development Corporation (FSDC), another government corporation. Preparation of these plans began in February 1984, and they were not complete at the time of this report.

2. Design of Harvesting Plans

In addition to the overall evaluation of the dendro thermal concept, the project team was required to develop harvest plans for four selected dendro thermal sites. The sites selected by NEA were as follows:

MARELCO	- Buenavista, Marinduque
FICELCO	- Virac, Catanduanes
ILECO II	- Lambunao, Panay
OMECO	- Magsaysay, Occidental Mindoro

Each site was visited, and ground investigations were made. As much information about previous planning efforts as possible was obtained, along with topographic maps. The preliminary designs were then produced, subject to a number of assumptions given to the project team by NEA. These assumptions stated that a minimum of roads were to be built and that monocable systems were preferred. Monocables had been designed for all four sites, although some did not encompass the total plantation area.

The approach to planning was to design a feeder system for the predesigned monocable locations on three of the sites. These sites were Lambunao, Marinduque, and Catanduanes. Lack of adequate maps restricted efforts to only the monocable analysis for Lambunao. On the other two sites, alternatives to the monocable were developed for comparison. On Catanduanes, two additional plans were developed, and on Marinduque one additional plan was developed. After visiting the Mindoro site and checking the topographic maps of the area, a roading scheme was selected.

Two basic cable systems were used with carrying capacities developed from sample terrain features. No specific equipment brand was identified since numerous manufacturers are available.

The development of the harvest plans required generation of production equations for the different harvesting systems. These were based upon observation, discussion and experience. None were based upon studies conducted in the Philippines. Therefore, the costs generated for the different alternatives as presented in this report should be viewed accordingly.

The costs and man-day requirements presented in Table IV.1 illustrate the fact that costs vary greatly from site to site and among different harvest systems. The results show that if the planner can take advantage of natural conditions, as depicted by the river transport option of Catanduanes, relatively lower costs may be possible. Likewise, it shows that some systems on certain locations are very expensive and may be cost prohibitive for the pro-

Table IV.1
Summation of Costs by Alternative Plans

Project	Dominant System/ Primary Transport	Man-Days	Cost ₱/m^3
Mindoro I	Cable/Truck	39,940	135
Catanduanes I	Cable/Cable	16,668	167
II	Cable/River	9,074	82
III	Cable/Monocable	9,500	133
Marinduque I	Cable/Truck	20,111	181
II	Cable/Monocable	19,843	604
Lambunao I	Cable/Monocable	15,823	130

ject. The most expensive system, with 604 ₱/m^3, is the double monocable system proposed for Marinduque.

The harvest plans prepared should be viewed as options for comparison rather than the optimum technique. The optimum selection can only be made by intensive field study or, at least, by the utilization of accurate topographic maps and aerial photographs. Details of the proposed harvest plans are in the Harvest Systems Evaluation and Design Report in Vol. II. They can be described briefly as follows:

Three plans were prepared for Catanduanes. One plan utilizes a series of cable yarding units with cable swings to a short haul road. It would require many man-days of cable setup and rigging but little initial investment in equipment, and is relatively portable. The second plan is somewhat similar to the first except that it uses the Pajor River as the main transportation mode. A third alternative using a monocable was developed. While it would require little scheduling of the transportation plan, the capital costs are high and it is a permanent installation with somewhat limited access.

One alternative was developed for Lambunao utilizing a monocable with winches and animals to transport the wood to the cableway. It would require careful scheduling.

Two plans were prepared for the Marinduque project. Both entail high cost because of the distance from the plantation to the power plant. One requires construction of a new road and the other a lasso monocable system.

The Mindoro plantation, because of its size and valleys and scattered hills, lends itself to use of roads and yarding by winches.

The wide variation in cost of delivered wood to the power plant indicates that the harvesting system, to be determined by the physical characteristics of the site, should be studied before any investment is made in the power plant. Even though the greater part of the total project cost is in the power plant, the viability of the overall project is greatly dependent on the availability of the fuel wood in the required quantities and at a reasonable cost.

E. FINDINGS AND RECOMMENDATIONS

1. Development Strategy

A primary objective of the DTDP is the large-scale production of fuel wood. An underlying planning assumption has been that potential cash income opportunities resulting from future fuel wood sales will provide adequate incentives for small-scale tree farmers to give priority to wood production. This assumption, while perhaps correct in some instances, should be examined.

The small-scale Filipino producer occupying hilly uplands is, first and foremost, a subsistence farmer. Ability to survive on marginal lands is due in large measure to a strategy predicated on diversifying sources of income, whether these be in cash or in kind. DTDP implementation procedures tend to overlook this important sociological consideration.

It is perhaps prudent to assume that the diversified survival tactics of upland rural dwellers would be a constraint to achieving the DTDP's wood production targets because the program has adopted a single-commodity oriented development strategy foreign to a subsistence farmer. Easy financing and especially secure land tenure, both of which are positive features of the program, are powerful incentives to change centuries-old lifestyles. However, it is doubtful whether a farmer should be expected to rely completely on an entirely new occupation to support a family until there is evidence that it is also reliable and sustainable. The recent abrupt slow-down in tree farm financing and development, due to financial constraints, can be expected to erode the farmers' confidence in the program and reinforce their confidence in a diversified survival strategy.

The issue of sustained confidence is relevant to tree farm establishment. Without regular and effective maintenance, newly planted trees will either die, become overrun by weeds or grow at less than desired rates. Effective maintenance is directly related to a farmer's enthusiasm for whatever crop he is growing and confidence that harvests will support his basic needs. Without some modification in the single-commodity oriented aproach implicit in the DTDP strategy, confidence and enthusiasm may be extremely difficult to develop and sustain.

Specifically, GIT recommmends a greater emphasis on activities the typical upland farmer feels are essential for his security, especially food production and backyard animal husbandry. GIT suggests that the DTDP should, at a minimum, include assistance in soil conservation techniques that would stabilize hilly land, so a farmer may grow a significant amount of his daily food requirements on the tree farm. Additionally, follow-up assistance in crop production and, eventually, backyard animal husbandry would help promote a feeling of security and thereby build enthusiasm and develop confidence in the program. In effect, it is suggested that the DTDP should take on many of the features of a traditional agro-forestry project, still giving priority to wood production but simultaneously incorporating a farming systems approach.

The recommendations summarized above would be one way of responding to the abrupt curtailment of plantation financing and address the basic issues of food security and developing confidence in the overall program. Farmer interviews conducted during this consultancy indicate the need to improve credibility. Investments in what farmers perceive to be important should help address this issue.

Models incorporating agro-forestry features already exist. Virtually all hilly land development programs currently being implemented in the Philippines emphasize a systems approach, not a commodity approach. The recently launched national livelihood program (Sariling Sikap, or People's Forests) is one example. Earlier examples include the well-documented PICOP experience (which incorporates food, animal and wood production in a comprehensive package), the World Neighbors Soil Conservation Project in Cebu, the Rainfed Agriculture Project of the Ministries of Agriculture and National Resources, the World Bank-assisted Central Visayas Regional Project-I in Region VII and others. These examples demonstrate the concept of a farming systems approach that would strengthen the DTDP.

It should be mentioned that some DTDP managers have already implemented many of the modifications suggested above. Intercropping of annuals has been encouraged during the early stages of tree farm development. One REC (CENECO, Negros Occidental) is pursuing an integrated production strategy with individual farmers apportioning their land into wood and food production lots. However, these scattered efforts have not been deliberately incorporated into

the overall program. While simultaneous production of wood and food has been announced at the highest levels as a program objective, much needs to be done to achieve that objective.

Broadening the scope of land development activities has implications for the amount of land required for each site. The illustrative figure of 1,600 hectares mentioned earlier for wood production for a 3 MW power plant would need to remain relatively constant because of power plant requirements. Naturally, expanding the size of the power plants requires a corresponding increase in the size of tree plantations. Additional activities would therefore mean even larger overall plantation areas. Furthermore, to pursue a farming systems approach effectively, the program will need to develop an agricultural extension capability and to allocate funds for material and technical support. The economic and financial feasibility of these additional inputs will need to be evaluated as part of the overall program. However, similar evaluations for other projects, including those mentioned earlier, have been favorable; there are ample grounds for predicting a favorable determination for the same type of investments as one component of the DTDP.

2. Pre-Investment Studies

Each DTDP project site has unique features. Pre-investment feasibility studies should be conducted to:

- Categorize sites and determine those with the best potential for development, using a matrix which identifies constraints and opportunities, and measures investment options on a weighted value scale.

- Select promising areas for investment, giving priority (whenever it is prudent) to RECs needing funds to complete ongoing plant construction or to resume construction that has been suspended because of financial constraints.

- Refine the proposed investment list, giving due consideration to special NEA priorities which may not emerge during conventional feasibility analyses.

3. Detailed Project Planning

Project sites should be studied in detail and a comprehensive development plan prepared for each site. Specific activities would include:

- o Preparation of contour, soil, vegetation and land use maps (this should be done to the maximum extent by REC local personnel assisted as needed by NEA or outside consultants).

- o Delineation of tree farm areas, subdividing these into planting blocks and identifying the appropriate species for each block; preparation of nursery, outplanting and maintenance procedures by block and species, activity schedules and cost estimates.

- o Preparation of harvest plans including road and trail alignments, cableways, equipment requirements and all other components, plus cost estimates for construction, equipment procurement and operations.

- o Planning for support activities such as soil conservation, fire prevention, pest/disease control and, when necessary, developing outside wood suppliers and/or acquiring more land; applying the above-described planning procedures on expansion areas and potential outside wood suppliers' farms.

- o Delineation of agricultural development areas sufficient in size to grow most of the farmers' basic food needs on site.

- o Preparation of cost/benefit studies for each site selected for investment.

4. Institution Strengthening

The capability to manage field operations and the required technical skills need to be in place by the time any ADB-assisted implementation begins.

GIT suggests implementation of a carefully planned recruitment and training program designed to strengthen in-house expertise. Personnel selection criteria should be prepared for dendro thermal coordinators, tree farm field managers, field foremen and plant propagators. Such criteria include physical fitness, stamina, an aptitude for management, willingness to perform manual work, a rural background, technical ability, honesty, the personality traits of a team player, and the determination needed to accomplish difficult tasks. Under a recruitment effort, job opportunities would be advertised, and applicants would be thoroughly screened to select the most capable people. Recruitment, screening and selection of trainees would take place at sites identified for assistance during the investment study phase. To qualify for assistance during implementation, RECs would be required to pay trainees' salaries during training and, subject to their successful completion of the curriculum, employ the graduates in the positions for which they were trained. Broad geographical representation would be emphasized to help ensure the eventual deployment of personnel who are familiar with local conditions at their future assignments.

Trainees would attend approximately one week of orientation briefings, after which they would be deployed for on-the-job training at selected tree farm sites. They would work under the supervision of experienced plantation managers for one complete cycle of seedling production, land preparation, outplanting and maintenance (estimated 9-10 months). Trainees would apply all the field skills that would be required during implementation. Training on propagation of alternate species would be included. This deployment stage would be treated as an extension of earlier screening, and a failure/dropout rate as high as 50 percent would be anticipated. The objective would be to train one dendro thermal coordinator, one field manager, three field foremen and two plant propagators, or seven individuals for each of ten DTDP sites. Including provision for failures/dropouts, a total of approximately 100 trainees would be required.

Training for coordinators, field managers and field foremen would be synchronized with detailed project planning so that trainees would receive on-the-job experience in plantation layout, harvest plan design and other project planning tasks.

Recruitment and training would be designed to evolve into a permanent, year-round, in-house skills development program that would prepare future staff needed to manage new tree farm sites and/or upgrade implementation at ongoing sites in need of special assistance.

5. Tree Farm Development

Financial and technical assistance are proposed to support the establishment of approximately 16,000 hectares of tree farms or roughly 1,600 hectares for each of 10 sites. For every 10 hectares of tree farm, two hectares would be developed for food production and animal husbandry--i.e., an additional 3,200 hectares or a grand total of 19,200 hectares. Food production/animal husbandry investments along with roads, cableways, equipment and other harvesting requirements would be included in the tree farm development budget.

6. Species Trial Expansion/Growth and Yield Studies

As mentioned earlier, the program now includes USAID-assisted species trials and NEA-financed diversification experiments at some project sites; both are designed to identify trees appropriate for a wide range of biophysical variables. This research activity should be expanded. Wider geographic distribution is needed to test promising species under different edaphic and climatic conditions. Furthermore, planting at USAID-assisted trials only started in July 1984, and funding is assured only until October 1985. This will not provide sufficient time to compare performance between species. GIT understands that the NEA plans to seek USAID participation in a comprehensive dendro research program.

All dendro thermal plantations have set aside 100-hectare modules for development under administration by the REC. The rest of the plantation areas are for development by the farmers. REC modules were intended to serve as back-up sources of fuel wood in the event that farmer deliveries are interrupted because of bad weather or for other reasons. These modules were also to be used for training. Tree farmers were to be hired to plant the modules under REC supervision. This was expected to facilitate technology

transfer and help ensure that tree farmers were trained in the skills required to develop their own farms.

This plan was an innovative, practical and cost-effective training approach. In effect, farmer training costs would eventually be recovered when trees planted during training were harvested as fuel for the power plant. Unfortunately, the plan was not always implemented in the intended manner. GIT recommends reviving the concept and combining it with species trial activities, perhaps in conjunction with the expanded research program NEA is considering. Applied research trials could be expanded to cover the 100-hectare modules so that the trial sites could also serve as demonstration/training farms. Competent private tree farm development contractors could be hired to manage the trials. Contractors could also be expected to implement soil conservation, food production and animal husbandry activities. Tree farmers could be hired as laborers and could receive on-the-job training working under the direction of contractors.

Species trial specialists will be needed to carry out periodic growth/yield measurements over a number of years. This would build a fairly long-term data base and help resolve the discrepancies which have emerged from previous mensuration efforts.

V. POWER PLANT TECHNICAL ANALYSIS

A. SUMMARY

The use of wood as fuel for a steam electric power plant is not a new technology, nor is it technically difficult. It is commonly used throughout the world, including the Philippines. However, it is usually utilized in conjunction with forest products industries, a particular processing industry that generates a combustible waste product. What is unique about the Philippine Dendro Thermal Development Program is that its primary purpose is to generate electricity on a relatively large scale. Also, it is the largest program known to exist.

Currently 29 generating plants are in various stages of operation, construction or planning under the program, for a total capacity of 92.3 MW. These plants will be provided through a variety of financial schemes but generally on a concessionary basis.

Six 3.1 MW steam plants are of British design. Five of these are either in operation or in the final stages of construction, while one plant has been suspended. All are basically the same design. Fuel wood in log form is fed into the furnace/boiler by a conveyor. The boiler is a standard marine type horizontal drum watertube model, and the turbine is a seven-stage, single extraction condensing unit. The units are rated to have a net power output of 2.97 MW and an efficiency rating of approximately 16 percent.

Seven 3.4 MW and two 1.2 MW steam plants are of French design. They have all been manufactured. Two are in the final stages of construction. Seven are in various storage locations. Design details of the 1.2 MW French designed steam plants were not available. The 3.4 MW French design utilizes a fuel wood crusher, wood dryer, covered storage building with automatic loading and retrieval and pneumatic conveyor. The furnace/boiler input is a two-drum watertube boiler with superheater, economizer and air heater. The turbine is a three-stage, single extraction condensing unit. The units are rated to have a net power output of 2.91 MW and an efficiency rating of approximately 15.6 percent.

Two 0.96 MW gasifier plants are of French design. Both are in final

stages of construction. Both consist of two 600 KVA gasifier-engine-generator systems. The gasifiers convert wood fuel to a gas which is used in reciprocating diesel engines. The fuel wood is cut into blocks, dried and fed into the gasifiers by a semi-automatic loader. The units are rated to have a net power output of 0.66 MW and an efficiency rating of approximately 20 percent.

Nine 3.4 MW steam plants of Japanese design are planned. The basic design of the units and the implementation plan have recently been completed. A construction schedule has not yet been established. The preliminary design calls for chipped, dried and stored fuel wood, automatically fed to the furnace/boiler. The specifications of the boilers and turbines have not yet been determined.

Three 5 MW steam plants of U.S. design are planned. The design, construction and implementation schedules for these units have not yet been determined.

Since, with few exceptions, the dendro thermal power plants will be interconnected to the NPC power grid, each project must be engineered to ensure compatibility. If the power plant's net output is greater than can be utilized by the REC, power will be sold to NPC. Likewise, if the power plant's net output is less than the REC requirements, power will be purchased from NPC. This interconnection requires detailed engineering.

Dendro thermal power plants do not present any unusual environmental problems. However, by Philippine law, each project must be studied, environmental aspects considered and an Environmental Compliance Certificate obtained from the National Pollution Control Commission.

The overall conclusion reached by the GTRI team is that the dendro thermal program of the Philippines is technically feasible and that the implementing agencies, with technical assistance, could implement the program. This chapter contains a number of recommendations related to the continuation and expansion of the program. It is the GTRI team recommendation that the Philippine Dendro Thermal Development Program standardize to the extent possible on a single plant design. This standard design should have the following characteristics: 3-5 MW in size, utilization of chipped wood fuel, non-utilization of dryers, use of enclosed control rooms and cooling towers, and maximum use of packaged, off-the-shelf equipment.

B. INTRODUCTION

The utilization of wood as fuel for steam electric power plants is common practice in the United States and throughout the world; however, most of these wood-fired power plants are located at forest products industries where the wood fuel is produced as a waste product. The firing of this wood fuel is as much a method of waste disposal as it is a means of producing energy. In recent years, a number of non-forest products industries have converted to wood fuels as a source of energy for production of electricity and process heat, but only a small number of plants have been designed to burn wood fuel exclusively for the production of electricity. Even fewer plants use wood grown exclusively to produce electricity, and there are no plants in the United States which utilize a plantation exclusively for the production of wood fuel.

The Dendro Thermal Development Program of the National Electrification Administration is the largest program in existence where the objective is the production of electrical power exclusively from wood. The overall Philippines program plan is to construct 72 power plants capable of producing approximately 200 MW of power.

This engineering analysis of the power plants addresses primarily the 29 plants listed in Table V.1. Currently 29 plants are in various stages of construction or planning. The table lists the NEA Co-op, the location of the plant by town and province, the plant gross output and the equipment supplier. The table also provides some details as to the current status of plant construction and indicates plants inspected by the engineering team. Figure V.1 shows the approximate location of these plants on a map of the Philippines.

See the consultants' reports, Volume II, for a detailed analysis of the power plants.

Table V.1
Power Plant Summary

Plant No.	Site Name	Province	Town	Equipment Supplier	Capacity (MW)	Status	Inspection
1	PANELCO I	Pangasinan	Bolinao	Alsthom-Atlantique	3.40	C	X
2	INEC	Ilocos Norte	Solsona	Balfour Beatty	3.10	BI	X
3	ANTECO	Antique	Hamtic	Moteurs Duvant	0.96	96%	X
4	ISECO	Ilocos Sur	Burgos	Alsthom-Atlantique	3.40	80%	X
5	ISELCO II	Isabela	Ilagan	Balfour Beatty	3.10	BI	X
6	ZAMECO	Zambales	Palauig	Balfour Beatty	3.10	95%	X
7	CASURECO IV-A	Camarines Sur	Caramoan	Balfour Beatty	3.10	80%	X
8	ISELCO I	Isabela	Jones	Balfour Beatty	3.10	75%	
9	OMECO	Occidental-Mindoro	Magsaysay	Moteurs Duvant	0.96	88%	X
10	ABRECO	Abra	San Juan	Alsthom-Atlantique	3.40	S	
11	NUVELCO	Nueva Vizcaya	Dupax del Norte	Balfour Beatty	3.10	T	
12	PALECO (A)	Palawan	Aborlan	Alsthom-Atlantique	1.20	S	
13	MARELCO	Marinduque	Buenavista	Alsthom-Atlantique	3.40	S	
14	AKELCO	Aklan	Nabas	Alsthom-Atlantique	3.40	T	
15	FICELCO	Catanduanes	Virac	Alsthom-Atlantique	1.20	S	
16	PALECO (A)	Palawan	Puerto Princesa	Alsthom-Atlantique	3.40	S	
17	ILECO II-A	Iloilo	Lambunao (A)	Alsthom-Atlantique	3.40	T	X
18	CAPELCO	Capiz	Tapaz	WEST JEC	3.40	ND	
19	BOHECO I	Bohol	Inabanga	Stone and Webster	5.00	NN	
20	ILECO I	Iloilo	Miag-ao	WEST JEC	3.40	ND	
21	LUELCO	La Union	Arningay	WEST JEC	3.40	ND	
22	CASURECO III	Camarines Sur	Balatan	WEST JEC	3.40	ND	
23	CAGELCO II	Cagayan	Lallo/Lasam	WEST JEC	3.40	ND	
24	CASURECO II	Camarines Sur	Pili	WEST JEC	3.40	ND	
25	CASURECO IV-B	Camarines Sur	Garchitorena	WEST JEC	3.40	ND	
26	CENECO	Negros Occidental	Murlia	Stone and Webster	5.00	NN	
27	QUEZELCO	Quezon	Macalolon	WEST JEC	3.40	ND	
28	MASELCO	Masbate	Mabo	WEST JEC	3.40	ND	
29	ILECO II-B	Iloilo	Lambunao (B)	Stone and Webster	5.00	NN	

C - Complete
BI - Break In
T - Terminated
S - Suspended

% - Percent Complete
ND - Not Designed
NN - Contract Not Negotiated

X - Indicates Inspection Made

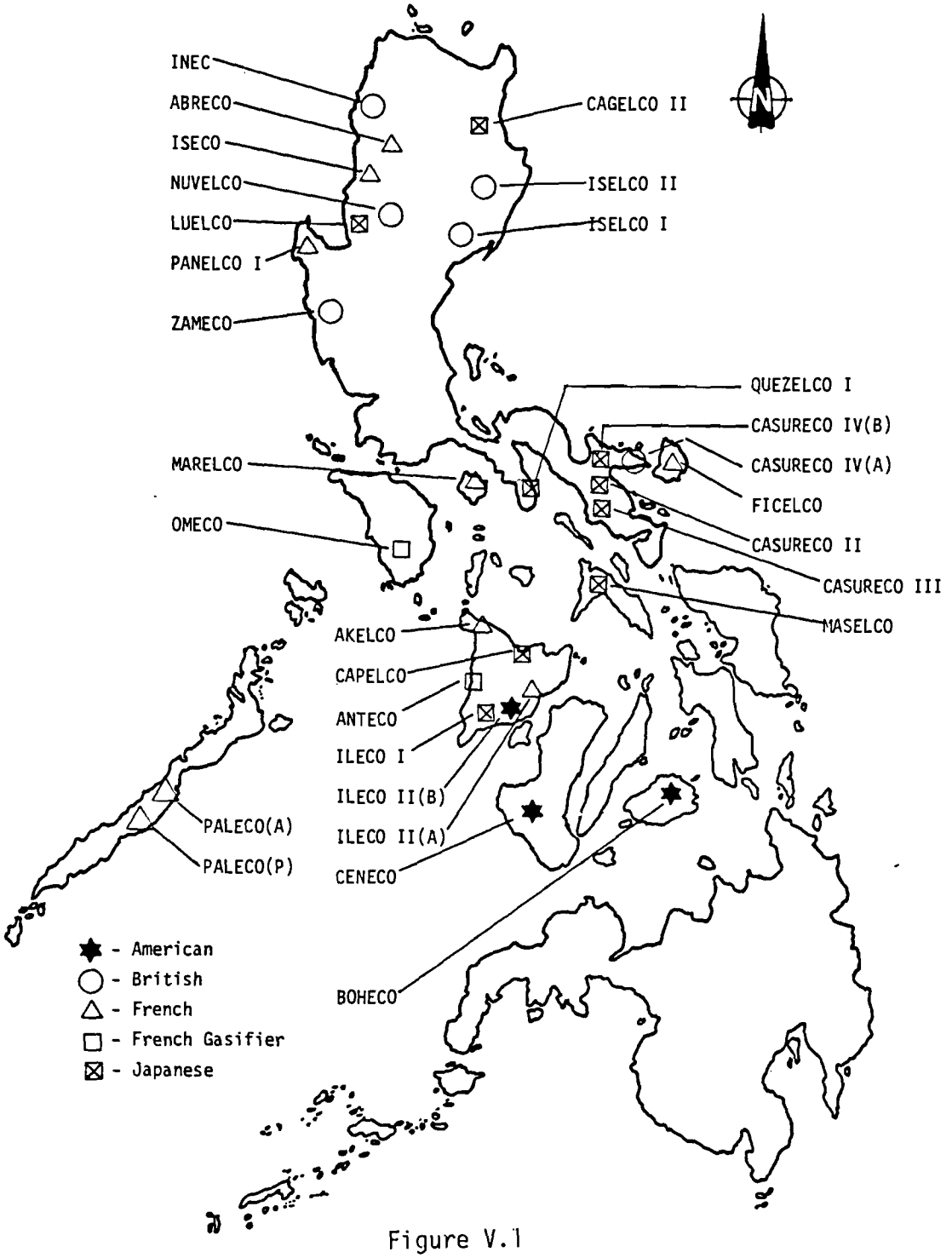


Figure V.1

Plant Location

C. GENERAL RESPONSIBILITIES OF CONTRACTORS

The construction of the dendro thermal plants involves three contractors: the equipment supplier, the architect engineer (A & E) and the construction contractor. Each interfaces directly with NEA on technical and administrative matters.

The equipment supplier is responsible for the design, selection and shipment of the major plant process equipment, supervision of start-up and training of operators. To date, the equipment has been funded through loans and grants from the equipment suppliers' respective governments.

The A & E is responsible for design of support equipment, foundations, buildings and other site works, and for supervision of construction. All A & E's are Philippine companies. A & E's responsible for specific sites will be identified later. Funding for the A & E has been provided by NEA.

The construction contractor is responsible for installation of equipment designed by the A & E and the equipment supplier. These contractors are also Philippine companies and have been funded through NEA.

D. DESCRIPTION OF POWER PLANTS CURRENTLY UNDER CONSTRUCTION OR PLANNED

1. British Balfour Beatty Design (3.1 MW)

a. Description and Status of Plants

The British power plants were designed by Balfour Beatty Engineering Limited of Kent, England, and financed by British sources. Each of the plants is designed to have a nominal gross output of 3.1 MW. Five British plants currently under construction are planned for start-up in 1984. A typical Balfour Beatty plant is shown in Figure V.2.

Numerous factors have caused delays in the completion of the plants, but the most significant factor appears to be the lack of local currency funding by NEA. This lack of funding has resulted in delays in equipment deliveries and payment of subcontractors, and other problems which have impacted the start-up of all plants. Additionally, some problems were noted with the determination of responsibility for overall site operations.

Figure V.2

Typical British Balfour Beatty Plant

b. General Technical Details

All of the British plants employ the same basic design with the exception of the condenser cooling water system. A typical layout is shown in Figure V.3. The INEC, ISELCO I and ISELCO II plants utilize river water cooling, while the ZAMECO, CASURECO IV and NUVELCO plants have cooling towers. There are also some minor differences in the support systems and equipment that were designed by the different A & E's involved.

Raw wood fuel in the form of logs is received at the plant from the Lasso cable transport system (in most instances). The fuel is transported by hand-cart to the fuel sizing stations. A chainsaw sizing system has been added to the plant due to the non-uniform size of the fuel currently being received at the plants.

The bulk storage area at these plants consists of uncovered stacks of logs, with transportation to and from storage by cart. The size and configuration of the bulk storage area varies from plant to plant.

Swing blade sizing is required to reduce the length of the logs to less than 0.3 meters before feeding to the boiler. There are usually four or more swing blade saws at each plant, which are manually operated by woodyard personnel.

The surge storage at the plant consists of stacks of completely sized wood (length and diameter) located on the two sides of the boiler feed conveyor. Logs are manually loaded into the boiler feed conveyor from the surge storage. This storage area is being covered at some sites to facilitate operations during the rainy season.

The boiler for the British plants is a Fraser horizontal drum watertube model manufactured by Towler and Son Limited of Essex, England. The boiler is designed to burn logs which are fed through a slot on the front side of the boiler. The hot gases make three passes through the boiler, a single pass through an economizer, and are exhausted to atmosphere through a 40-foot steel chimney. Feedwater from the deaerator storage tank enters the boiler through the economizer, is heated in tubes and vaporized in the steam drum, and superheated in the horizontal superheater.

The boiler has no cyclones for particulate emission control, as the manu-

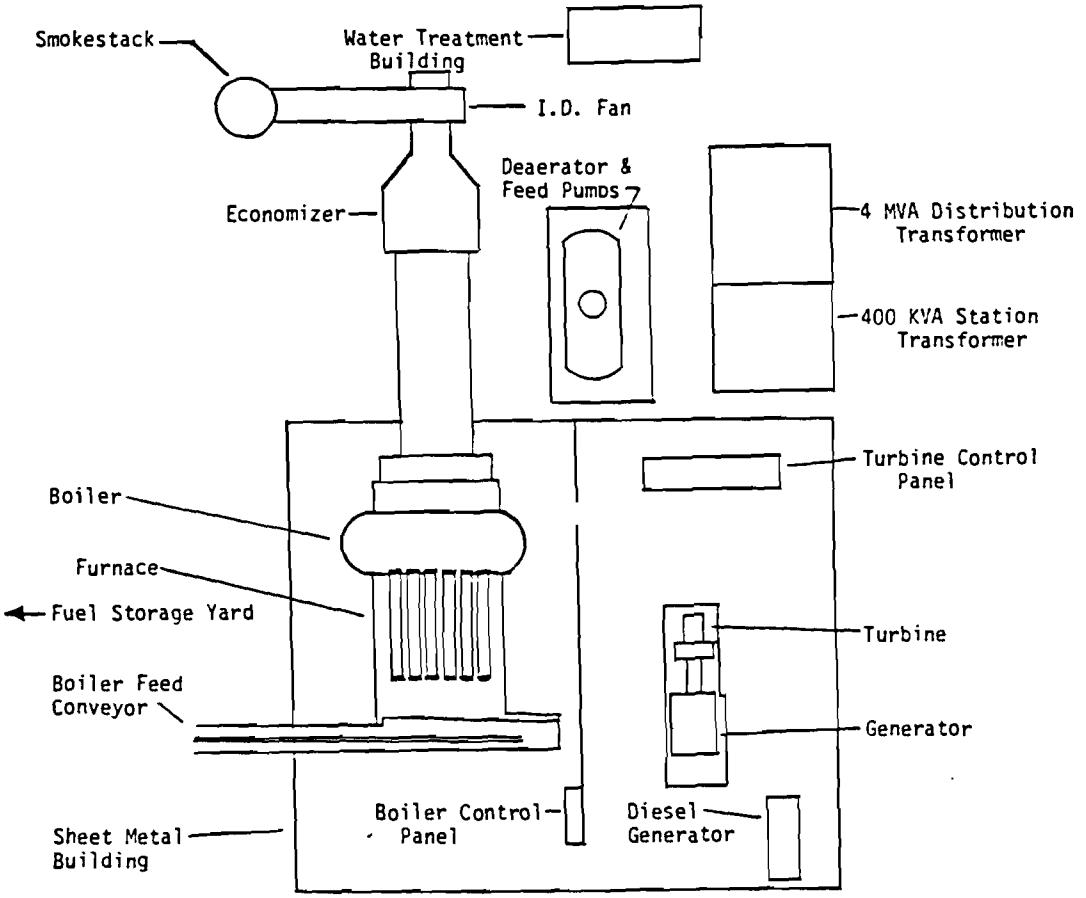


Figure V.3

Balfour Beatty Plant Layout

facturer claims that the three passes are sufficient to remove particulates. Ash is manually removed from the furnace section of the boiler through access hatches on the front side of the boiler.

The turbine is a seven-stage, single extraction condensing unit manufactured by Peter Brotherhood Limited of Peterborough, England. The unit was originally designed for marine applications. Steam from the boiler superheater is expanded in the turbine to generate shaft power and is then exhausted to the condenser. The turbine is connected to the generator through a gearbox.

The boiler and turbine are enclosed in the same metal-sided building with an internal partition separating the two major equipment items. The British plants do not have a central control room but have the boiler and turbine controls located near their respective pieces of equipment. The switchpanel controls are located in the turbine section of the building.

c. Heat Balance

The net output of the plant is 2.97 MW, the net plant thermal efficiency is 16 percent and the net plant heat rate is 5368 kcal/kWh (21,300 Btu/kWh).

d. Operation, Maintenance and Training

As of the publication of this report, only limited plant operation data was available, mostly from start-up and commissioning of the plants. A large number of handlers are required to manually feed the boiler and to reduce the size of the non-ipil-ipil wood fuel required for the log-burning boiler.

Each plant has a full-time maintenance engineer who is responsible for general equipment servicing. In addition, all operators are trained in troubleshooting equipment problems and identifying items for repair or replacement.

Training is provided through sponsorship of a training engineer by the Overseas Development Authority of the British government. A copy of the general training course outline is included in Annex V.1. The general training course requires approximately 6 weeks--2 weeks at an operating plant and 4 weeks at the plant where the operators are assigned.

e. Spare Parts

Spare parts are included in the scope of supply from Balfour Beatty; however, during the initial start-up of the plants, some parts from the NUVELCO plant were being used as temporary replacements at the other plants. A system for central location, inventory control and distribution of spare parts has not yet been established.

2. French Alsthom-Atlantique Design (3.4 MW)

a. Description and Status of Plants

The French steam power plants were designed by Alsthom-Atlantique of Paris, France, and financed by French sources. Seven of the plants are designed to have a nominal gross output of 3.4 MW, and two of the plants are designed to have a capacity of 1.2 MW. A typical French plant is shown in Figure V.4. The initial purchase order with Alsthom-Atlantique was signed on December 19, 1979. Currently the only plants planned for initial completion are PANELCO I and ISECO.

The PANELCO I plant is listed as operational but, as of June 1984, Alsthom-Atlantique was making major modifications to the fuel system. The ISECO plant is scheduled for commissioning during 1984, but significant work is still to be accomplished, and the fuel system modifications have yet to be initiated.

The contractual responsibilities for the design, construction and start-up of the Alsthom-Atlantique plants are similar to those of the British plants. As is the case with the British plants, the reasons for delays are varied, but inadequate local funding appears to be the primary problem.

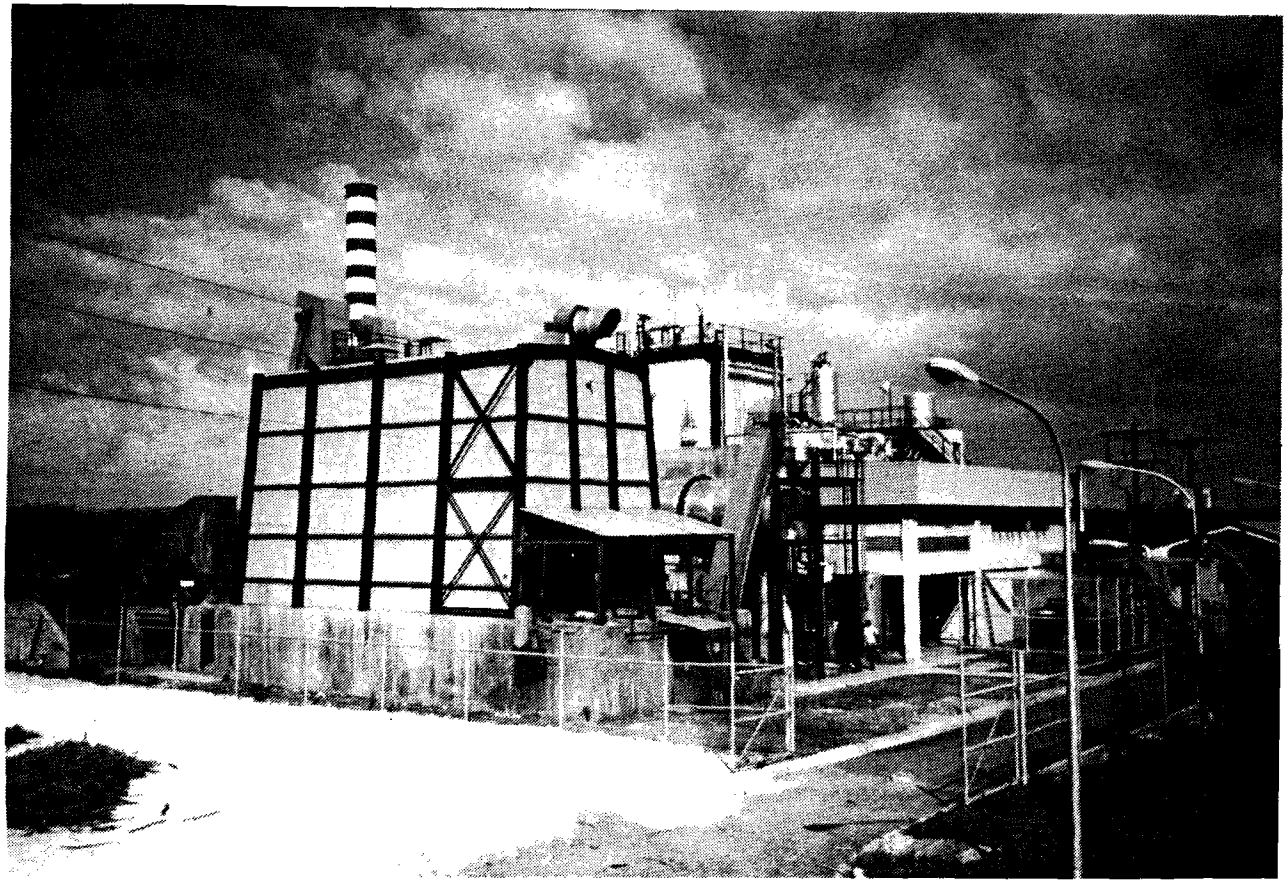


Figure V.4

Typical French Alsthom-Atlantique Plant

b. General Technical Details

The remainder of the discussion of the Alsthom-Atlantique plants will address only the 3.4 MW plants, as neither of the 1.2 MW plants has been constructed, and design details were not available. All of the Alsthom-Atlantique 3.4 MW plants are identical in design, and all utilize cooling towers for condenser cooling. As with the British plants, there are minor differences in the support systems and equipment that were designed by the different A & E's involved. A typical Alsthom-Atlantique plant layout is shown in Figure V.5.

The Lasso wood conveyor system from the tree farms, outside storage, woodyard handling and preliminary sizing are similar to the British system. However, the plant fuel handling system is much more complex, involving two crushers, a wood dryer, a covered storage building with automatic loading and retrieval and pneumatic conveyors. The system supplies a fine wood fuel, having ten percent moisture content, to the suspension burning boiler.

The boiler for the Alsthom-Atlantique plants is manufactured by ADF in France. The unit is a two-drum watertube boiler with superheater, economizer and air heater. Hot gases pass through the main boiler, the pendant superheater, to the economizer, and finally, to the air heater. A forced draft fan supplies air to the air heater. Hot exhaust gases pass through one of three parallel cyclone separators before flowing to the dryer. The boiler is tangentially fired with two fuel and four secondary air nozzles. Feedwater enters the boiler through the economizer, is heated in tubes, vaporized in the steam drum and superheated in the pendant type superheater. Ash is automatically removed from the boiler by a screw conveyor.

The turbine is a three-stage, single extraction condensing unit manufactured by Rateau of France. Steam from the boiler is expanded in the turbine to generate shaft power and is exhausted to the condenser. The turbine is connected to the generator through a gearbox.

The boiler at the Alsthom-Atlantique plant is completely uncovered, while the turbine is located under a metal roof building with partial siding. There is a building on the Alsthom-Atlantique site which houses the central control room where all plant operations can be controlled and monitored. The

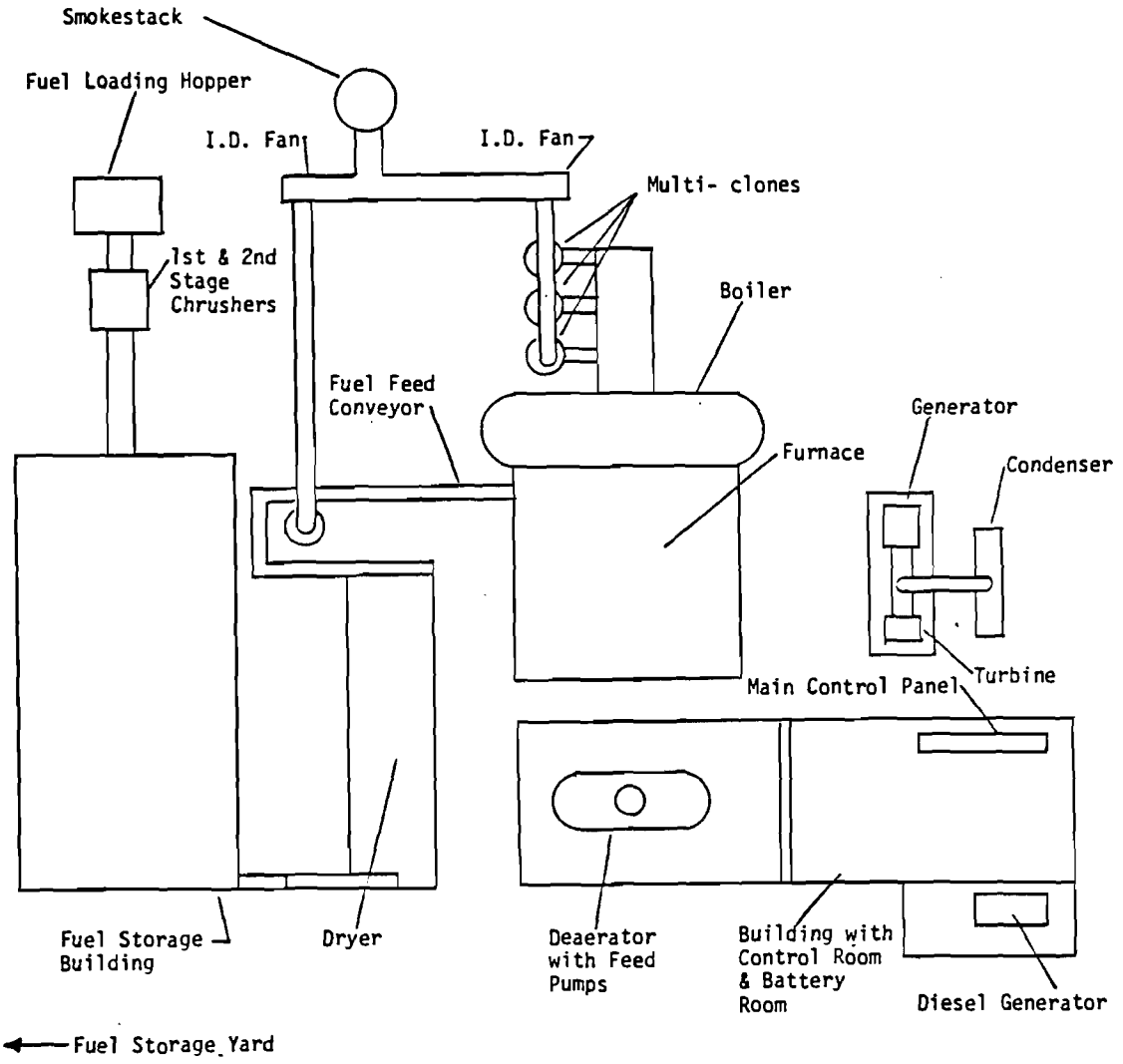


Figure V.5

Alsthom-Atlantique Plant Layout

deaerator and feedwater storage tank are located on top of this building, and the boiler feed pumps, compressor, and diesel are located in a bay in this building. The building also contains the emergency storage batteries and sleeping quarters for operators.

c. Heat Balance

The plant has a large parasitic load resulting from the complex fuel feed system. Based on the heat balance and auxiliary load tables, it is concluded that the Alsthom-Atlantique 3.4 MW plant will have a net power output of 2.91 MW, a net plant thermal efficiency of 15.6 percent and a net plant heat rate of 5526 kcal/kWh (21,927 Btu/kWh).

d. Operation, Maintenance and Training

As of the publication of this report, only limited plant operation data was available, most of this data from start-up and commissioning of the plant. Plant personnel requirements are similar to the British plants. Alsthom-Atlantique is responsible for training plant operators through their local agent.

e. Spare Parts

Spare parts are included in the scope of supply from Alsthom-Atlantique. However, during the initial start-up of the PANELCO I and ISECO plants, some replacement parts were obtained from the plants not under construction. A system for central location, inventory control and distribution of spare parts has not yet been established.

3. French Duvant Gasifier Design (0.96 MW Plants)

a. Description and Status of Plants

Two gasifier-based power stations, each of capacity 0.96 MW, have been supplied by Moteurs Duvant of Valenciennes, France. A typical plant is shown

in Figure V.6.

One of the stations is owned by the Occidental Mindoro Electric Cooperative (OMECO) and is located in the municipality of Magsaysay. The other station is owned by the Antique Electric Cooperative (ANTECO) and is located in the municipality of Hamtic.

The gasifier plants were broken down to major roll-ups (for the reactors) and individual components of the gas processing train for shipping. The Duvant diesel sets were shipped as complete units.

According to the NEA Dendro Thermal Development Office report of June 30, 1984, the OMECO site is 88.35 percent complete with a target completion time of 699 days. The ANTECO site is 96.41 percent complete with a target completion time of 604 days. At both sites, the major reasons for delay are lack of funds due to the current financial crisis within the Philippines and NEA, and delay with the shipping of refractory cement used to install the firebrick in the gasifier and combustion chamber.

b. General Technical Details

Each power station consists of a pair of 600 kVA gasifier-engine-generator systems. The gasifier converts wood fuel to a low-Btu fuel gas (about 135 kcal/scm or 150 Btu/scf), which is used as fuel in a reciprocating diesel engine. A small quantity (usually 10 to 20 percent of total energy input) of diesel fuel is required by the engine for ignition purposes.

The main features of the gasifier--a Duvant model GA20--are its fixed bed and separate combustion chamber. Fuel wood, received at the station from the plantation, is broken into 7.62 cm x 12.70 cm (maximum) size pieces, dried using engine exhaust gas, and conveyed to the top of the gasifier reactor by a semi-automatic skip loader. The reactor fuel port is sealed by a horizontal sliding plate. Static pressure inside the top of the reactor is claimed to be zero, so gas does not escape during fuel loading, i.e., with the sliding plate in the open position.

A layout of the system is shown in Figure V.7. Gas, exiting the main reactor at the two levels, is combined and delivered to a wet scrubber consisting of a vertical, baffled spray tower. Scrubber water is circulated

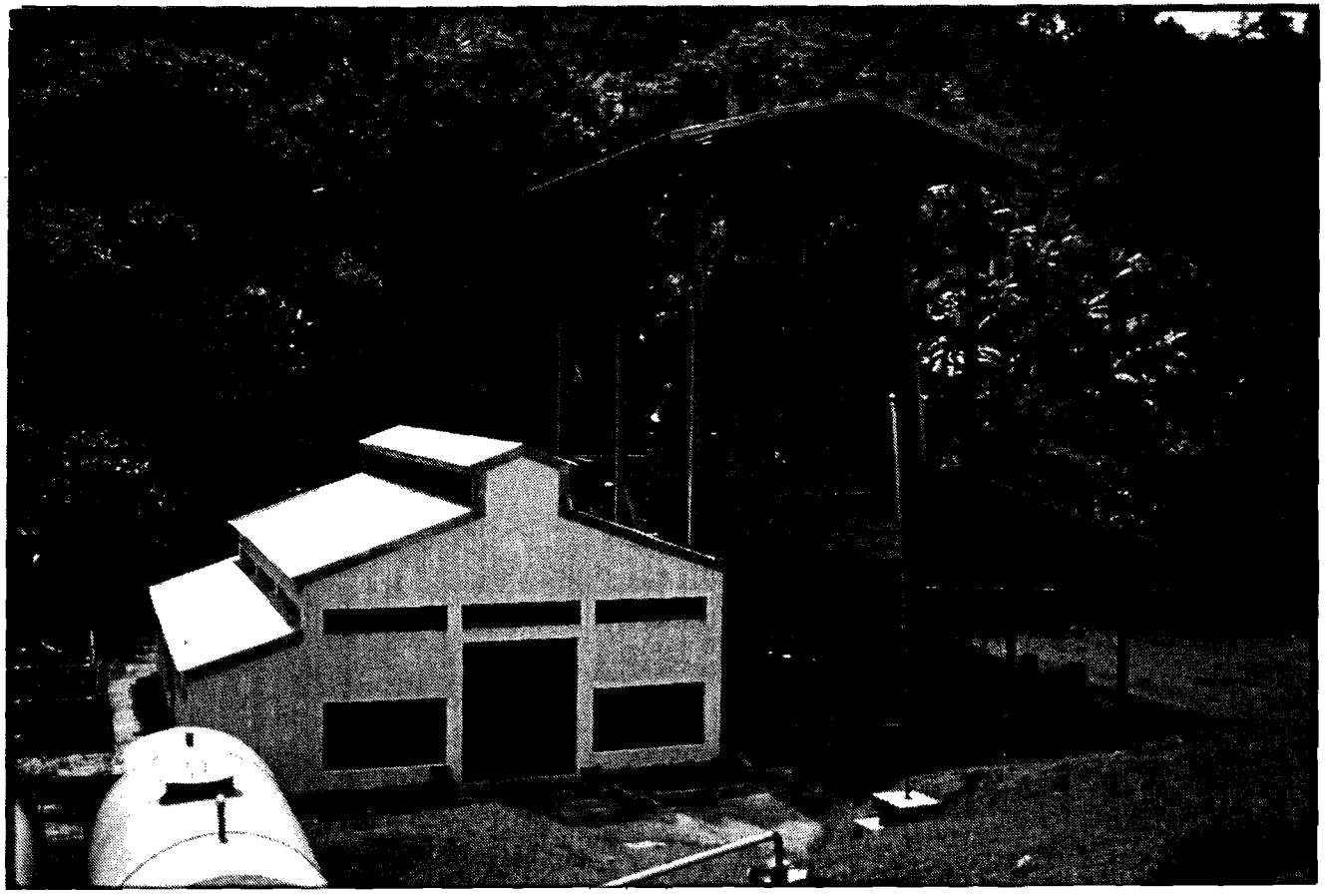


Figure V.6

Typical French Moteurs Duvant Plant

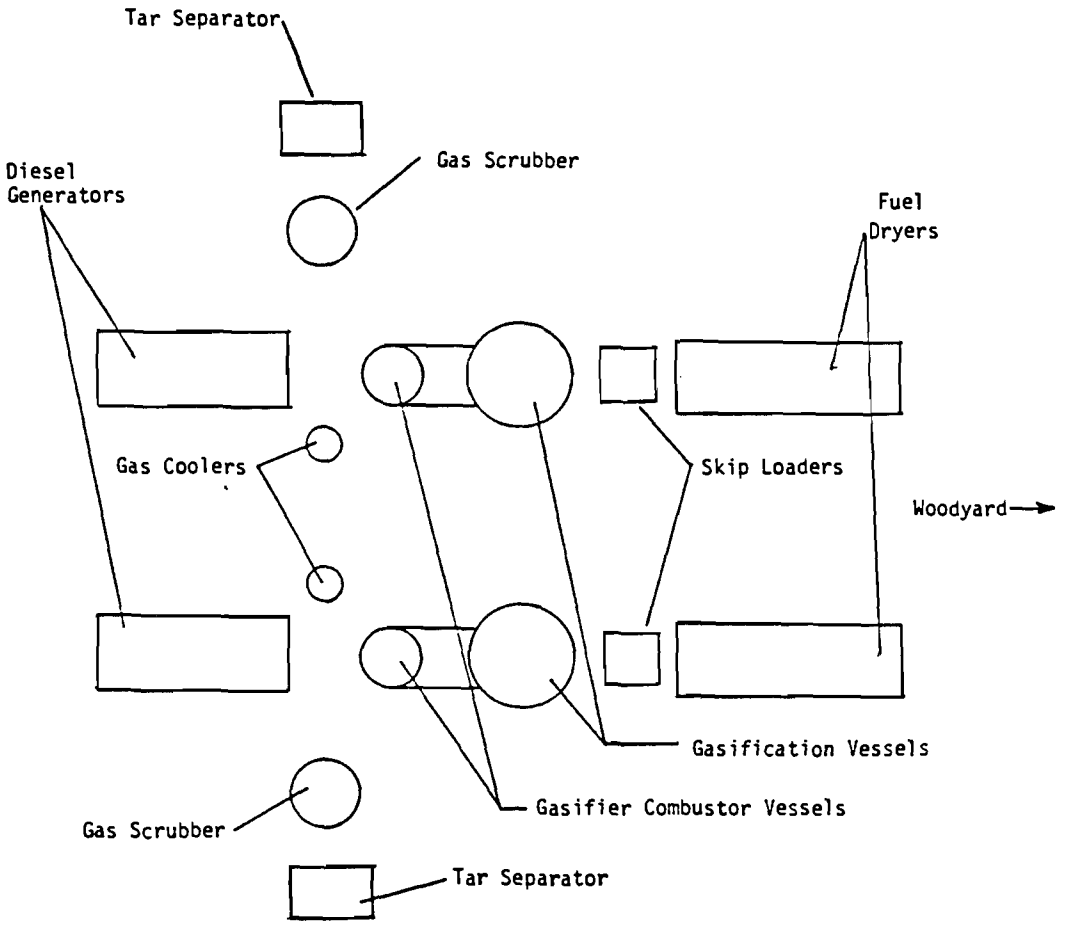


Figure V.7

Moteurs Duvant Plant Layout

through cooling towers and filters. Suction is applied to the scrubber by a 7.5 kW centrifugal fan. Leaving the fan, gas is passed through safety cartridge filters and delivered to the inlet side of a 50 kW Roots type compressor to increase gas pressure prior to delivery to the engine. Heat of compression is removed in a second spray tower. The system is piped so that gas can recirculate around the gas compressor. The engine draws gas as required by station electrical load; surplus gas is flared.

The Duvant-supplied dual-fuel engine is a standard diesel with modifications to accommodate operation in dual-fuel mode. In particular, gas and air are compressed separately and introduced into the cylinder head through separate valves. Gas flow is controlled by a butterfly valve in the gas header driven by the engine governor. Diesel fuel injection flow rate is set at the minimum required for ignition of the gas.

The engine is started with compressed air and cooled with water which is circulated through two cooling towers at the back of the engine house. Engine exhaust is used for drying the gasifier fuel. Air supply to the engine is supercharged. Air pressure is increased automatically with load. Gas pressure is corrected to remain above air pressure, regardless of load, to ensure adequate fuel mixing in the cylinders.

The two engine-generator sets, electrical control panel, compressors for engine start-up and compressed air control systems, and fuel oil delivery system (for dual-fuel operation) are located inside the engine house. The two gasifiers, combustion chambers and gas conditioning plant are located adjacent to the engine house. Fuel drying and storage facilities are under a covered enclosure next to the gasifiers. Four cooling towers, two for the engine coolant and two for the gas cleaning plant scrubbing liquor, are located to one side of the station.

c. Heat Balance

Gross electrical output for one station (two gasifier systems) is 0.96 MWe. Total station load--blowers, pumps, etc.--is equivalent to 0.30 MWe. Net station output is 0.66 MWe or 0.58 million kcal/hr (2.25 million Btu/hr). Allowing for the efficiency of conversion of wood to low-Btu gas, the diesel

consumption will be 10 to 15 percent of total fuel energy input to the engines. Overall station thermal efficiency will be about 20 percent.

d. Operation, Maintenance and Training

Since neither of the two stations has been commissioned or started up, no experience with plant operation or maintenance requirements currently exists. Training for proposed operating personnel has yet to be undertaken. Maintenance schedules for gasifier systems and engines are available, but as yet there is no actual experience with its implementation.

e. Spare Parts

Spare parts were not available at the NEA warehouse nor visible at the OMECO site. There were some spares on hand at ANTECO.

Replacements for fabricated parts of the gasifier plant could be manufactured locally. The usual inventory of spares for engine parts could be maintained on site; large components would need to be replaced from France.

4. Japanese Design (3.4 MW)

a. Description and Status of Plants

A commitment has been made to NEA by the Overseas Economic Cooperation Fund (OECF) to build nine dendro thermal plants of Japanese design. The first phase of this process involved producing a basic design and an implementation plan for the Japanese projects. Funds for these activities were provided to NEA through a low-interest loan of approximately ₱14 million from OECF. The duration of these activities was for a nominal 14 months, consisting of activity both in the Philippines and in Japan.

The work on this phase of the project was carried out by a team comprised of West Japan Engineering Consultants, Inc. (WEST JEC) of Fukuoka, Japan, and Meralco Engineering Services Corporation (MIESCOR) of Manila. At the time of this writing, the basic design and the implementation plan have just been

completed. Therefore, there has been no actual construction done on the power plants. The next phase of activity under this project will involve detailed design and then construction of some of the plants. It appears now that there will be at least a one-year delay on any further funding from the Japanese government to start construction of the plants.

b. General Technical Details

All of the Japanese plants will employ the same basic design, including the use of a cooling tower for condenser cooling. There will be minor differences in plant layout due to site-specific details. Figure V.8 shows the overall planned layout of a typical Japanese plant.

The design calls for a large log storage yard neatly laid out in rows with room for access by carts, forklifts or simple manpower. Delivery to the unloading area may be by truck, cableway or other means, depending on the specific characteristics of the site.

The logs will be transferred to the log handling platform where they will be conveyed to one of two log chippers. Normal storage in the wood yard is planned for one month (approximately 7000 tonnes).

Two chippers of the rotary disc type will be installed with a capacity of 20 tonnes/hr each. These chips will have a nominal chip size of 30 mm (1.18") per side.

After chipping, the wood chips are to be stored in an enclosed chip storage house having a capacity of about 1600 tonnes, which, according to the designers, will be enough for one week's operation of the power plant. The chip pile in the fuel house will be managed by a tractor with a front end loader, and the chips will be loaded onto a supply conveyor for conveying to a two-hour surge hopper adjacent to the boiler.

The designers have chosen 30 kg/cm^2 (425 psi) as the boiler operating pressure. Size of the plant output will be 3.4 MW (gross). Steam conditions will be 30 kg/cm^2 and 350°C at boiler outlet and 29.5 kg/cm^2 and 345°C at turbine inlet. Steam flow of the boiler will be approximately 20 tonnes/hr (45,000 lb/hr). The boiler type has not been finalized. The designers are considering pile burners, thin bed burners (with spreader stokers) and sus-

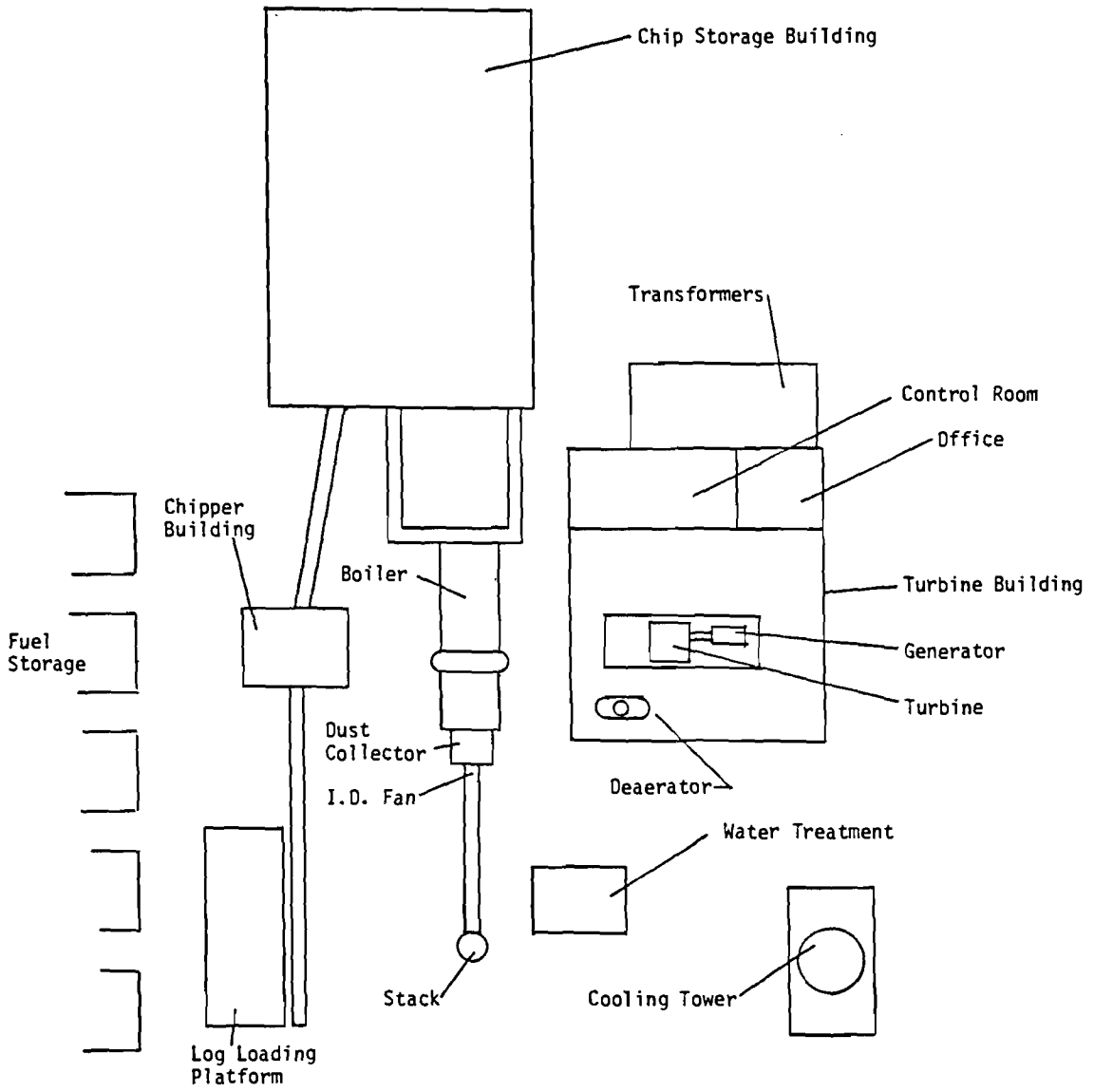


Figure V.8

WEST JEC Plant Layout

pension burners. During the detailed design phase the boiler design will be finalized.

Discharge of the boiler will probably be into a mechanical dust collector of the cyclone variety to control particulate emissions. The stack will be a steel stack approximately 30 meters in height.

The steam turbine design has not been finalized, but plans call for a synchronous generator driven by a high-speed turbine with gear reducers, similar to the French and British designs.

c. Heat Balance

Since the final designs for the boiler and turbine have not been determined, no heat balance can be performed. The designers claim that the overall station efficiency will be 18.5 percent, which seems somewhat optimistic.

d. Manufacture and Construction

No comments can be made on these subjects, since equipment suppliers for the various power plant components have not yet been identified.

e. Operation, Maintenance and Training

No definite plans have yet been formulated for the training of operators.

f. Spare Parts

A schedule of spare parts inventory for the power plants has been outlined.

5. American Design (5 MW Steam Plants)

USAID and NEA have a long record of cooperation on rural electrification projects. Thus, when NEA began to formulate its plan for the dendro thermal program, it requested assistance from USAID. Early investigations resulted in

a USAID project paper entitled "Philippines Rural Energy Development (492-0375)," published in April 1982. The particular portion of the project paper dealing with dendro thermal is "Annex I: Wood-Fired Power Plants Sub-Project."

This project paper describes in detail the basis for the construction of three 5 MW power plants in the Visayas region of the Philippines. The locations were agreed upon mutually by USAID and NEA.

The USAID approach to its power plant projects differs somewhat from the approaches by the British and French as previously described. For these projects a consultant in the U.S. will be hired as designer of the three plants. This architect/engineering firm will also be responsible for project management and will actually run the job sites. No Filipino A & E firms will be directly involved as has been the case with the British and French plants. The A & E firm of Stone and Webster, headquartered in Boston, Massachusetts, has been selected to perform the A & E functions.

Stone and Webster will be responsible for preparing all plans, specifications and bidding documents, and will supervise the activities of the other contractors for the USAID project. These contractors will include the U.S. equipment supplier or suppliers and the civil works construction firm (a Philippine construction contractor).

The USAID project is still in the review process, with no definite implementation schedule.

E. ADVANTAGES AND DISADVANTAGES OF THE POWER PLANT DESIGN

1. General Techniques Used for the Analysis

In order to accomplish an analysis of the plants, a number of site visits, interviews and investigations were made by the various members of the engineering team. Specific aspects of this analysis include the following:

- o Dendro thermal plant sites listed in Table V.1 were visited.
- o The feasibility studies for all nine plants scheduled for early completion were reviewed.

- The Outline Engineering Reports for several plants were reviewed.

- All operating documentation available on the Balfour Beatty, Alsthom-Atlantique and Moteurs Duvant plants were reviewed.

- Contracts with equipment suppliers, A & E's and construction contractors were reviewed.

- Interviews were conducted with AWIA, DCCD and MIESCOR to discuss experiences in plant design and construction and to solicit recommendations for future plants.

Data gathered from these various sources was then examined by the engineering team to produce a comprehensive analysis.

2. Specific Advantages and Disadvantages of the British Design

a. Advantages

- Simple design. The simple design of the British plant not only facilitates installation, but also should result in higher availability for the plant. The design allows for easy transportation of equipment. In addition, the plant is easily assembled once the equipment is delivered to the site.

  The simple design will also result in fewer maintenance and operating problems, and thus the availability of these plants will be greater. Boiler tubes are not welded and thus can be easily replaced. The design should also permit plant personnel to accomplish many repairs.

- Training. The training program for operators of the British plants is excellent and should help produce a high level of plant availability with a minimum of unscheduled outages. The outline of training is well organized and covers all major aspects of plant operation.

b. Disadvantages

- Fuel feed system. The fuel feed system of the British plants has several major problems. In order to operate the boiler, three wood handlers are required to distribute the fuel manually across the grates. As of the writing of this report, the boiler manufacturer had completed a design of an automatic fuel distribution system. This system was installed on at least one of the power plants being commissioned.

  The firing of fuel other than ipil-ipil has caused problems in boiler subsystems. The chainsaw and swingsaw sizing system has been incorporated at the Balfour Beatty plants, and, as a consequence, additional personnel are required for plant operation.

  Another problem with the fuel feed system is the lack of any automatic surge capacity on the boiler, and thus plant personnel are continuously required to feed the boiler.

- Plant control. There are several problems associated with the control system. The primary problem is the absence of a central air-conditioned control room with a communications system to other areas of the plant and the National Power Corporation central controllers. The simplicity of the control system is advantageous from the standpoint of ease of operation and maintenance.

- River water cooling at some plants. The INEC, ISELCO I and ISELCO II plants are designed with river water cooling systems and have already encountered problems with silt being sucked into the condenser cooling water system during the rainy season. Silt cleanout systems have been retrofitted, but these systems have yet to be checked out during operation.

- Ash removal system. The ash removal system has been a problem at some plants, where operators have experienced difficulties in removing ash.

- o Maintenance and spares. The contract for purchase of the power plants specified spare parts for the plants. However, problems exist with obtaining replacement parts. The current problem is obtaining these spare parts from bonded storage due to the lack of funds to pay shipping and storage charges. However, once this problem is resolved, there is still difficulty in supplying spare parts in the event of failure of a critical component on a plant.

3. Specific Advantages and Disadvantages of the Alsthom-Atlantique Design

a. Advantages

- o Central control scheme. The central control room used on the Alsthom-Atlantique design is an excellent concept and should provide smooth control for the plant. It is important that the chief operator of a plant be able to function in an environment where there is access to data on the status of all system operations and to the mechanism for control of all processes. The Alsthom-Atlantique design provides all of these features.

- o Maximum efficiency design. The use of suspension burning and waste exhaust heat for fuel drying maximizes the overall plant efficiency. The Balfour Beatty design recovers some of the exhaust heat in the economizer; however, a significant quantity of the energy in the exhaust gases is wasted to the atmosphere. The Alsthom-Atlantique design recovers some of the exhaust gas energy in the air heater but also incorporates the dryer to reduce the exhaust temperature to the lowest point possible.

b. Disadvantages

- o Fuel feed system. Alsthom-Atlantique is in the process of making significant modifications to the original design of the fuel feed system. These modifications include relocation of the second

stage crushers, redesign of the fuel nozzles to the boiler, and installation of two additional cyclones to prevent carryover of "sparklers" to the dryer. The fuel feed system is very complex and has no bypasses for major pieces of equipment. Therefore, the failure of a single equipment item will shut the plant down. Although the complex fuel feed system improves efficiency, it incorporates the potential for numerous single-point failures.

The current system is not adequately designed for dryer fire problems. It is recommended that the recirculation system to the storage bin be disconnected and a "fire dump" be located between the primary air fans and the surge storage feed conveyor. The extensive dusting created by the fuel feed system poses a potential explosion problem. The crushers are the primary cause of the dusting problem, although conveyors contribute somewhat.

- o Control system complexity. The centralized monitoring system of the Alsthom-Atlantique design is a plus, but the complexity of some instrumentation may cause problems. Repair and replacement of this equipment at the remote plant sites may cause problems. Simple gauges with data recorded manually by the operator might have been more appropriate.

- o Lack of communications to NPC. The only major item lacking from the control room on the Alsthom-Atlantique plants is a communication link to the local NPC load control center.

- o Maintenance and spares. The problems associated with maintenance and spares are the same as those for the British plants. There is a current problem of obtaining replacement parts from bonded storage due to the lack of funds to pay shipping and storage charges. Even with this resolved, however, there will still be difficulty in supplying spare parts in the event of failure of a critical component on a plant.

4. Specific Advantages and Disadvantages of the Duvant Design (Gasifier)

a. Advantages

- o Efficiency. Theoretically, in the size range being considered (1 MW), a biomass gasification system should have a higher thermal efficiency for electricity production than a steam cycle plant. This possibility will not be known until post-startup testing.

- o Design. The Duvant gasifier design uses a unique two-stage combustion arrangement which should be helpful in producing clean gas.

- o Gas Cleanup. The extensive gas processing system should ensure clean gas for the engines.

- o Complete Instrumentation. The instrumentation supplied by Duvant includes adequate measurement of gas temperatures, pressures and flow rates.

- o Engine Configuration. The dual-fuel engine design ensures an engine of proven performance on low-Btu gas.

- o Gas Flow Circuits. The separation of gas flows in the gasifier and engine circuits enables the engine to draw gas as necessary from the gasifier.

- o Quality. A high level of workmanship was observed in examining the products of the equipment suppliers and the contractors, particularly at the ANTECO site.

b. Disadvantages

- o History. Experience with this new generation of highly automated gasifier plants is very limited.

- o Control Reliability. The Duvant gasifier system has complicated monitoring and control systems which may be difficult to maintain at remote power stations.

- o Procedures. The gasifier system requires elaborate startup and shutdown procedures which may make operator training difficult.

- o Parasitic Load. The gasifier stations have a high parasitic load (approximately 30 percent).

5. Specific Advantages and Disadvantages of the Japanese and American Designs

At this point, no analysis can be done on the Japanese and American plants based on final design and operational experience since the final designs have not yet been completed.

6. Standardization of Plant Designs

Standardization of plants is important for a number of reasons. The primary reason is that spare parts are easier to store and distribute if only a limited number of items is required. Replication of a proven standard component or complete system will increase reliability. Procurement of new plants or replacement parts is simplified.

The current program has achieved a degree of standardization in that several plants built incorporated the same design. Most of these designs use standard off-the-shelf components such as pumps, compressors and turbines. The Balfour Beatty design maximizes standardization--the boiler is essentially a "packaged" model shipped in pieces and assembled in the field.

It is not advisable to standardize future plants to the extent that only one supplier is used for all plants. Such a practice tends to discourage competition that is beneficial in optimizing design and obtaining competitive prices. However, consideration should be given to some component standardization, such as electric motors, belt drive systems and instrumentation.

F. POWER PLANT SIZE SELECTION

1. Size Relative to Demand

The first consideration is the selection of plant size relative to the demand of the local cooperative grid. Currently the capacity of most plants is larger than the current peak REC demand and the load factor for most of the RECs is very low. This will result in most of the power produced by the plant being sold to the NPC grid.

This situation is not considered to be a problem for several reasons. At some future date all power produced by the plant will be sold within the REC. In addition, the power sold to NPC from the dendro may replace power generated from imported oil. Thus, the national balance of trade is improved. However, the sale to NPC will benefit the REC only if NPC has a real demand and pays an equitable price for the power.

2. Availability of Fuel Supply

The second consideration is that an adequate fuel supply is available for the plant. Typically, fuel must be available within 80 km (50 miles) or less to keep the cost of transportation down. Based on preliminary investigation by the engineering team, securing an adequate fuel supply should not be a problem.

3. Economics of Scale

The final consideration in plant size selection is the economy of scale which can be achieved with larger plants. The average plant cost is approximately $1700 per kW. A 50 MW plant was recently constructed in the United States for a cost of $1600 per kW using new equipment. Construction of a 50 MW plant will be more expensive in the Philippines due to the cost of shipping and the difficulty in construction of large plants in very remote areas. It can therefore be concluded that significant economies of scale could not be realized on the dendro project.

The general selection of plant size based on REC load, fuel transportation distance and economies-of-scale is acceptable. The exact size of a specific plant should be such that existing packaged equipment can be utilized to the maximum extent possible.

G. DENDRO PROJECT TECHNICAL PERSONNEL

During the course of the engineering review, meetings and discussions were held with engineers from NEA, numerous RECs, equipment suppliers, A & E's and construction contractors. In general, these individuals were knowledgeable, capable and very enthusiastic about the project. Thus, a strong engineering nucleus exists on the project.

The areas where additional support would be beneficial are the addition of a senior staff engineer for technical support to the NEA engineering staff and outside technical assistance if a new major program is undertaken.

The addition of a senior staff engineer with extensive experience in wood-fired power plants would significantly help the current staff. The current staff is knowledgeable and capable, but also quite young and without extensive experience. This individual should not be placed in the line staff, but should be used as a resource available to all engineers. This assistance would be of particular value in the resolution of specific problems such as the ISELCO II grid connection.

Outside technical assistance would provide support if a new program is undertaken. This assistance would be used for the evaluation of technical details of a project as well as the preparation of specifications, contracts, schedules and funding. Those providing this assistance would preferably report to the agency providing funding for the project.

H. ENVIRONMENTAL ANALYSIS

1. Introduction

The dendro thermal project utilizes two basic power generation processes, steam turbine/generator systems and wood gas/diesel engine generators. Each

of the processes, typified by low and medium pressure solid (wood) fueled boiler-turbine-generator and gasifier-engine-generator power systems, have fundamental differences in environmental impact. Both processes produce somewhat similar waste streams composed of solid, gaseous and liquid components. In addition, the gasifier system produces pyrolytic tars. The environmental impacts of these wastes are a function of the quantities, compositions and disposal options available for each of these waste streams.

2. Solid Wastes

The solid wastes produced by the two power plant processes are charcoal and ash. If the power plants are operated correctly, a minimum of charcoal will be produced. The final ash production is expected to be 2449 kg per MWh (5400 lb/MWh) for steam systems and 1723 kg per MWh (3800 lb/MWh) for wood gas systems. This equates to approximately 1 percent by weight of the fuel wood input.

Ash wastes from wood combustion are considered less detrimental than solid residues from coal and other fuels. Only trace amounts of heavy metals, phosphorus and nitrogen are present; thus, hazards to the environment are limited. The ash is a chemical base made up primarily of potassium, silica, sodium hydroxide and calcium carbonate. Protective measures can prevent surface runoff (containing ash) from contaminating streams due to high alkalinity and turbidity which can harm aquatic life.

The ash disposal systems at all plants currently under construction utilize a dry storage at the plant site for temporary storage of ash removed from the combustion system. Ash removal may be either a manual or a mechanized operation depending on the design of the equipment supplier. The actual transporting of the ash to the plant storage area is usually a manual operation.

A preliminary investigation of the plant sites indicates that the problem of runoff has not been addressed. The grading at most sites is designed to allow water to drain into the local stream. It is suggested that sites be regraded as required to retain water in the ash storage area. It is recognized that, due to the large quantity of rain at the plant during the

summer, containment of all water is not possible. It is recommended that drainage be routed to mix with the acidic runoff from the wood storage pile so that both streams are neutralized.

Wood ash is frequently used as an alkalinity builder in pulp and paper forestry operations in the United States similar to current practices of slash-and-burn techniques in agriculture common in the Philippines. It is desirable to utilize the ash products of the power plants to return nutrients and to adjust soil acidity of the fuel wood plantations.

Transportation of ash throughout the plantation will be difficult due to the poor road system, although the Lasso cable system might be used to distribute the ash. Correct application to supply the proper dosage of nutrients to the soil and to prevent runoff should be determined with the REC dendro coordinator.

It is anticipated that some combination of landfill and soil treatment will be employed at all sites depending primarily on soil conditions of the fuel wood plantations. The small quantity of ash produced at the power plant sites coupled with the remote locations should cause ash disposal to have minimal effect on the environment.

3. Liquid Wastes

One source of liquid waste that is common to both power plant processes is rainfall runoff from wood storage piles. This leachate is primarily composed of turpentines. The environmental hazard of this leachate is reduced, however, due to several factors. First, the wood used for fuel in the power plants is primarily composed of low resinous woods which have a much lower turpentine content than other softwoods. Second, the wood will be stored as logs, which reduces the ability of rainfall to leach turpentines from the wood. Third, many turpentines are volatile and released to the atmosphere. Thus, the major hazard would be the contamination of ground waters with turpentines which are not toxic, but impart objectionable taste and odor.

The proposed design of the Japanese plants will incorporate outside chip storage, which will increase the amount of turpentines leached from the wood. The design of the open chip storage area should assure that drainage does not

run directly to a stream. As discussed earlier, mixing of drainage from the ash and wood storage areas could be used to neutralize the waste stream.

The wastewater from the gasifier power plant process presents serious environmental problems. As reported by J. V. Maxham, the wastewater from a similar fixed bed updraft gasifier located at Texas Tech University (Lubbock, Texas) includes a very high chemical oxygen demand (in the range of 50,000 to 70,000), high total organic carbon (in the range of 11,000 to 18,000) and a very high color. In addition, the wastewater is acidic (due mostly to acetic and proprionic acids) and fairly toxic, probably due to the phenols and creosols. The available treatment alternatives fall into three basic categories: physical/chemical, biological and pretreatment prior to discharge into a municipal biological system.

An inspection of the gasifier sites by the engineering team has indicated that there is a potential for contamination of the nearby streams. The water from the gas scrubbers is discharged directly into these streams at a flow rate of 75 liters per hour (20 gallons per hour). While this flow rate is small compared to the river flow rates of 719,778 liters per hour (190,166 gallons per hour) at OMECO and 359,889 liters per hour (95,083 gallons per hour) at ANTECO, a problem does exist.

The liquid discharge from the gasifiers requires a thorough investigation, including sampling to determine the specific pollutants being dumped into the nearby water. Additional pollution control equipment may be required to reduce BOD and COD levels.

4. Gaseous Wastes

All of the gaseous wastes will result from the direct combustion of wood in the steam power plants and of wood gas and diesel in the gasifier-engine power plants. The qualitative combustion products of the wood fuel, similar for both processes, are water vapor, carbon dioxide and traces of nitrogen oxide. Carbon monoxide will also be present in very low levels depending on the trim of the boilers and tune of the wood gas/diesel engines. Sulfur compounds are negligible since wood is naturally low in these compounds. However, if high sulfur diesel is used in the gasifier-engine-generator sets,

some traces will be present even with small quantities of the fuel.

Overall, the emissions from these power plants will be less than the current emissions produced to generate the power that is to be displaced in the dendro thermal program.

5. Particulates

All boiler systems without particulate cleanup like the Balfour Beatty designs are expected to emit approximately 5 kg of particulates per MW-hr of power produced. Systems with cyclone collectors (Alsthom-Atlantique) will produce about half that quantity. The characteristics of the particulates are the same as those for the solid wastes. Environmental hazards are quite small for the power plants with their low levels of emissions and rural locations.

6. Environmental Regulatory Compliance

In accordance with Presidential Decree No. 1586, all projects and project proposals, whether public or private, must be reviewed so that socio-economic undertakings are reconciled with the goals of maintaining environmental quality. Under Section 4 of the Decree, all projects or areas in which projects are undertaken that are deemed critical to the environment must obtain an Environmental Compliance Certificate (ECC) to construct and operate such a project. Projects and areas in which projects are to be undertaken are determined critical by the President of the Philippines by his own initiative or upon the recommendation of the National Environmental Protection Council (NEPC).

The dendro thermal power plants are not on the list of environmentally critical sectors; only those power plants located in environmentally critical areas must obtain an ECC.

At present, the 11 plants under construction are not known to be located in environmentally critical areas, and an ECC should not be necessary. However, the National Pollution Control Commission (NPCC), which certifies pollution abatement equipment, and the NEPC should be consulted on each plant system and plant site for any special environmental problems that might arise.

I. ELECTRICAL INTERCONNECTION AND TRANSMISSION

1. Overview

The most effective utilization of wood-fired power plants requires that the plants be operated at a base load. The REC loads are generally low during the late night and daytime hours and peak in the early evening. If the power plant net output is higher than the REC load, then power should be sold to NPC during off-peak hours. Likewise, if the power plant net output is less than the REC load, power must be purchased from the NPC. Either situation requires the establishment of an acceptable technical electrical interface with NPC as well as power exchange and pricing agreements.

Additionally, the complete REC dendro transmission system must be integrated to maximize power distribution. This integration requires an analysis of the complete system including loads, impedances and other losses.

2. Need for Detailed Engineering

Ideally, proper consideration for electrical proximity to load and NPC factors above will result in minimum transmission investment and line losses. In addition, it will result in maximum power transfer capability between the dendro unit and the NPC system, permitting full power interchange between the REC and NPC. A lesser, but still important benefit will be a reliable outside source of power for the necessary auxiliaries to avoid using the diesels for a "black start," after a plant outage.

Figure V.9 shows the relative location of the power plants in relation to the nearest NPC 69 kV or higher transmission in the Luzon grid. Figure V.10 presents the same data for the Visayas grid. The figures indicate both existing and proposed transmission lines.

It is clear from the figures that most of the power plants are located relatively near an NPC high voltage transmission line. The only exceptions to this situation are the CASURECO IV-A and IV-B plants.

Proximity to NPC is only a part of the problem, as a substation must exist for connection to NPC. Table V.2 lists the distances from the power

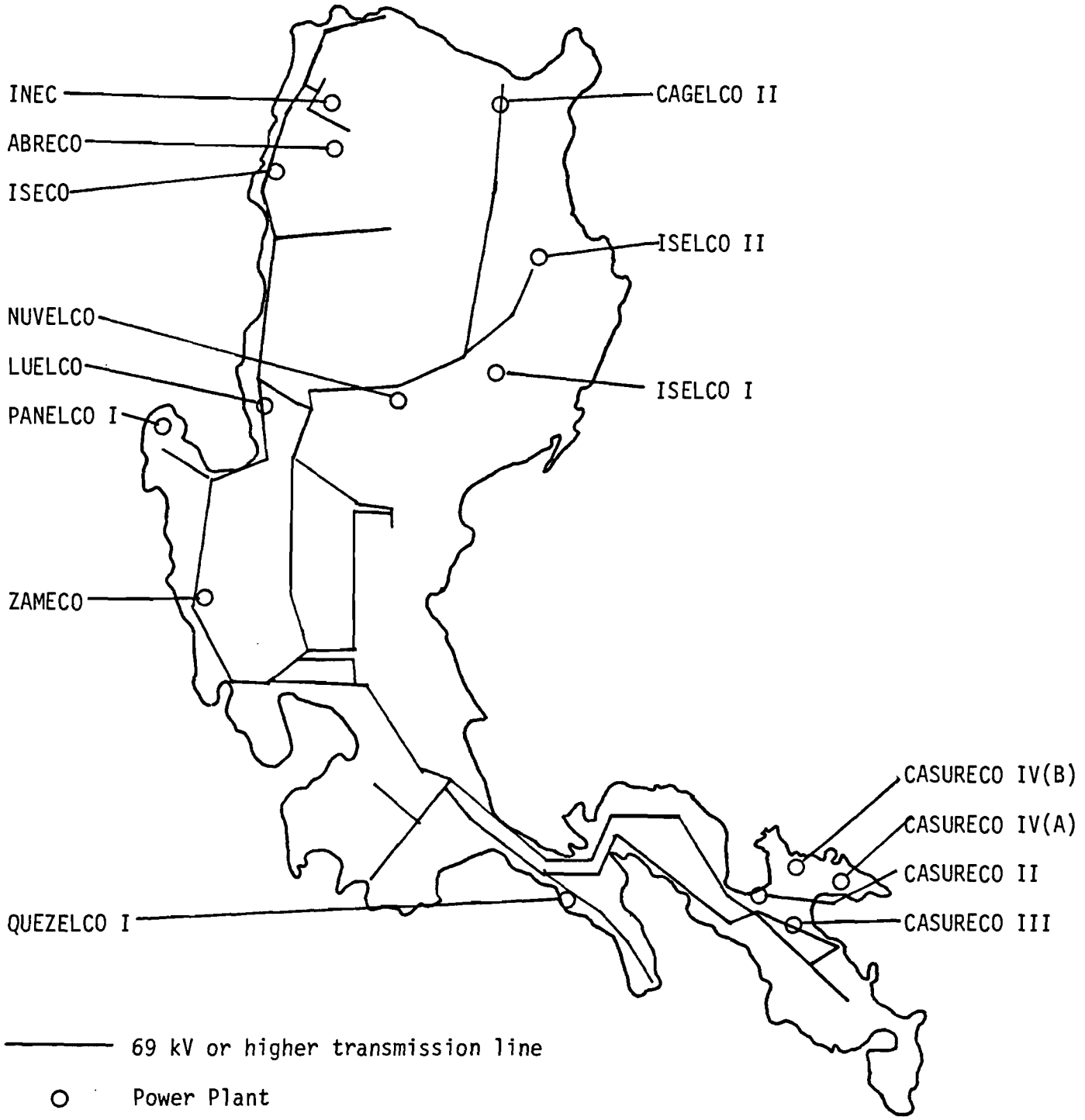


Figure V.9

Relative Location of Power Plants and NPC Transmission Lines
Luzon Grid

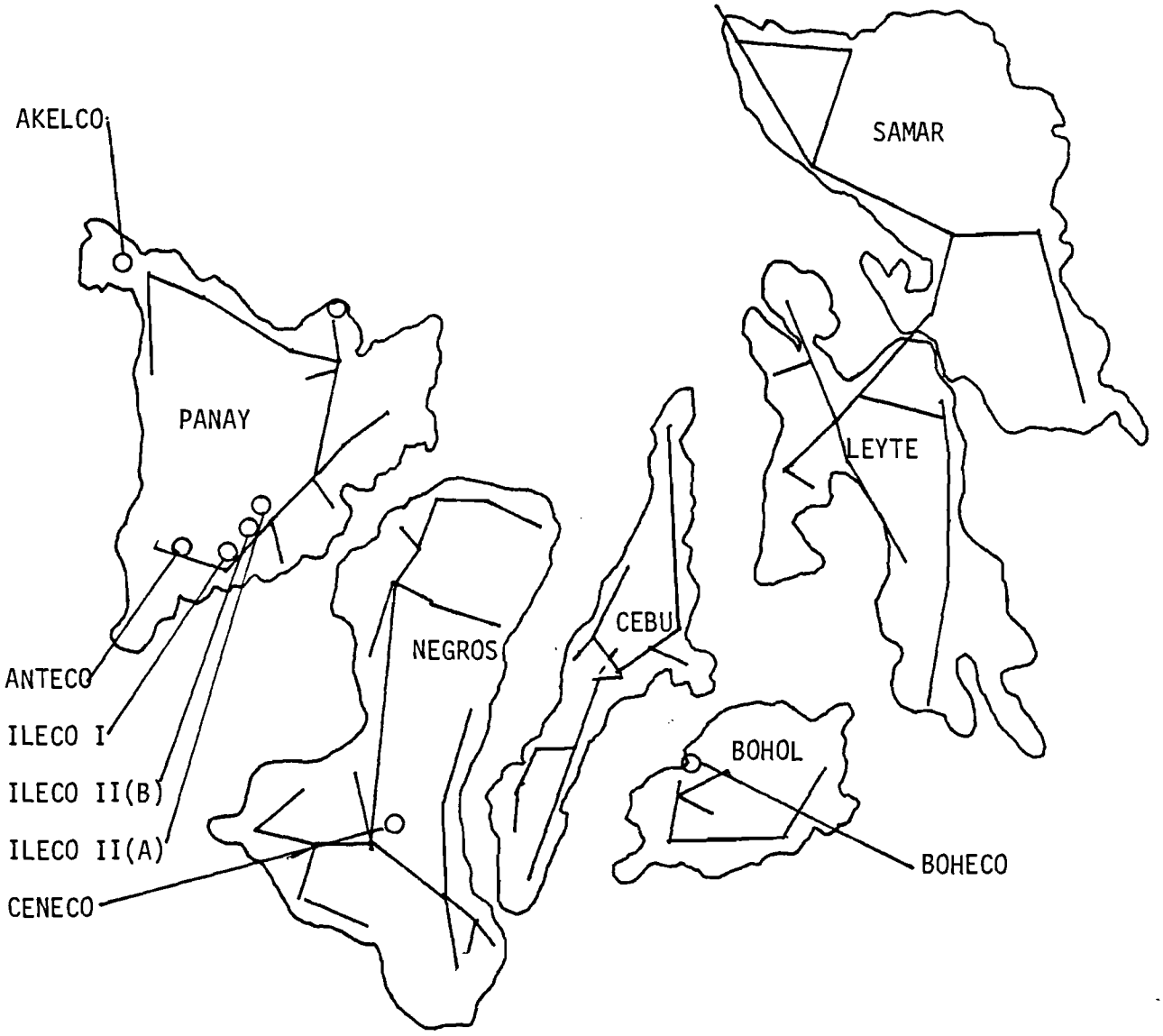


Figure V.10

Relative Location of Power Plants and NPC Transmission Lines
Visayas Grid

Table V.2

Plant Locations Relative to REC Grid and NPC Substation

Plant	Distance to REC Grid (km)	Distance to NPC Substation
INEC	0.5	44.0
ZAMECO	10.0	37.0
CASURECO IV	8.0	74.0
ISELCO I	22.0	35.0
ISELCO II	19.0	DNA
PANELCO I	4.0	DNA
ISECO	0.3	13.0
ANTECO	10.0	DNA
OMECO	0.5	No NPC

DNA - Data not available

No NPC - No NPC grid exists on Occidental Mindoro

plant to the REC grid and the nearest NPC substation for the 9 plants scheduled for initial completion. The table confirms the problem of CASURECO IV-A as the plant is 74 kilometers from the substation. There are problems at several plants where transmission losses to the high voltage NPC lines will be significant.

A detailed analysis of the transmission and distribution system must be conducted to optimize the complete system. This analysis must consider not only the physical distance to substations, but also factors such as frequency and synchronization, generator impedances, and other factors. This analysis is usually performed before generation and transmission equipment is purchased.

In the dendro project, no detailed transmission/distribution studies were conducted; the original feasibility studies considered only the costs associated with the plants. Transmission/distribution deficiencies could result in excessive voltage drop, frequency and synchronization difficulties, and inability to attain full plant output. However, the extent of these deficiencies has not been quantified nor is there a plan to address these deficiencies if they arise.

The corrective measures to be implemented are as follows:

1. Undertake the necessary engineering studies for each dendro site to determine any weaknesses in the existing system.

2. For those systems found to be inadequate, design and contract the system additions to provide adequate capacity. Such additions will generally consist of lines, substations and associated equipment. They will probably have to be reviewed jointly with NPC.

3. Where possible, the high side voltage of each dendro plant main power transformer should not be specified until the abovementioned engineering studies are complete.

The implementation of steps 1 and 2 is an undertaking of substantial magnitude and will require time and funds. It should move in parallel with

the construction schedule of the dendro units, so that when the units go into full load production, the transmission system will be adequate to deliver all the power.

3. Interconnected Operation NEA/NPC

In its negotiations with NPC, NEA should attempt to obtain a standard interconnection agreement applicable to all dendro installations. This is preferable to piecemeal negotiations on a case-by-case basis.

a. Metering

A standard "out" kWh meter with detents is adequate to measure power into the NPC system. The meter should have a demand drag needle. If finances permit, a digital meter would be worth the expense because it permits detailed analysis of load patterns.

If a distinction is made between "on-peak" and "off-peak" energy, the meter will have to be time calibrated. The surplus output of the dendro units fed back to NPC may have to be broken down into these two components for pricing purposes. If so, a metering set-up which distinguishes between on-peak and off-peak utilization is required. Two kilowatt-hour meters with separate clock systems are sufficient.

b. Switching Procedures

The importance of coordinating switching procedures cannot be overemphasized. The three out-of-phase closures at Ilagan highlight the improvements that must be made in this area.

c. Communications

Most dendro plants have VHF base station equipment. This permits their communicating to the REC headquarters. The individual REC headquarters in turn are linked to the NEA office in Manila. A channel may have to be pro-

vided so that each NEA office can communicate with the NPC dispatch permit proper control of switching and restoration procedures after outages.

d. Wheeling of Power for NEA by NPC

This will allow dendro units to secure a transmission path to feed other neighboring RECs and thus extend benefits. It is feasible for a dendro unit to be utilized to serve an adjacent REC. A wheeling agreement is needed under which power can be delivered over the intervening NPC facilities. Normally such arrangements are handled by designing a "contract path" between the point of generation and the point of delivery and charging a flat wheeling charge of so many mills per kilowatt hour plus a loss allowance.

e. Backup and Reserve

Backup and reserve power are required if the power plant is not operating due to scheduled maintenance or breakdown of equipment. The two principal types of reserve are spinning and ready reserve. Spinning reserve is in the form of unused electrical generating capacity already synchronized and ready for instant use in the event of loss of other units. It is a most valuable form of reserve. Ready reserve, less valuable, assumes that the plant can be started up and brought on the line usually within some specified period of time.

Preferably, an interconnection agreement can be negotiated which covers all dendro units collectively. If negotiations are conducted for a single dendro (or one at a time in piecemeal fashion), reserve and backup will probably have to be supplied by NPC and there may be a cost for this service. If, on the other hand, ten dendro units are assumed to be interconnected, the dendros can furnish their own reserve. Specifically, loss of one unit can be covered by the overload capacity of the remaining nine with little, if any, reliance on NPC.

Reserve is frequently reviewed as to its acceptability to the overall integrated pool by an operating committee which investigates the quality of the units to assure that they fulfill suitable availability criteria. For

scheduled maintenance outages of the dendro units, an interchange or banking account can be set up into which the dendro unit can put a portion of their surplus. They can then draw against this surplus during periods of scheduled maintenance.

Such banking arrangements are very common in the industry and are usually possible where one of the parties to the agreement has hydro power. A possible means of storing electricity is with hydro units. Power is storable in the form of unused water flow and can be made available upon immediate demand. The fact that the NPC does have hydro facilities makes this arrangement feasible.

4. Conclusion

Prior to any further work being done at the dendro sites, the entire site selection process should be reviewed with appropriate input from an electrical consultant who can assess such factors as economic conductor size, economic transmission voltage, voltage drop, losses, coordination of the protective devices and transfer capability. This is a vital step in engineering that has not been done.

Some site changes may be necessary for plants not yet constructed. Detailed estimates for transmission or distribution facility changes must be made. The transmission or distribution work must proceed so as to be in place when the dendro plant is ready for commercial operation.

Necessary changes in the transmission/ distribution system must be determined for the plants that have been constructed and are operating. If costs are prohibitively high, operating limitations may be necessary. First priority should be given to completing work on transmission or distribution systems for plants presently installed and operable to realize economic benefits as soon as possible.

In all cases, NPC should be kept aware of what is planned. NPC will require certain equipment (e.g., protective relays) prior to allowing hookup to their system.

J. LOCAL MANUFACTURE OF FUTURE POWER PLANTS

All of the power plants discussed in the previous sections were purchased from foreign manufacturers on loans or credit provided by the governments' manufacturers. These loans must be repaid in the currency of the foreign supplier. Economically, it would be desirable on future projects to manufacture as much of the equipment and replacement parts as possible in the Philippines.

To assess the possibility and desirability of local manufacture of future power plants, the engineering team conducted a number of investigations. Interviews were conducted with the AWIA, DCCD and MIESCOR architect and engineering firms to discuss their capabilities and the resources available in the country. The local representatives of Balfour Beatty and Alsthom-Atlantique were interviewed to determine their assessment of the local manufacturing question. Additional data was obtained from NEA personnel, field engineers and REC personnel.

Based on information obtained during these interviews, the manufacturing firm of Atlantic, Gulf and Pacific (AG&P) was identified as having the capacity for manufacture of a large amount of power plant equipment. AG&P was then interviewed by the engineering team. The company is certified by the American Society of Mechanical Engineers for manufacture of pressure vessels. They represent Riley Stoker, Cleaver Brooks and Combustion Engineering of the United States, and NEI and Towler of Great Britain. The company manufactures some of the equipment for these suppliers. In addition, the company manufactures their own design of packed firetube, oil-fired boilers. AG&P has worked extensively with the Philippines sugar industry.

Table V.3 presents a matrix that identifies the equipment which can be manufactured in the Philippines and that which must be purchased from foreign sources. Most of the raw materials used for Philippine manufacturing must be imported.

Additionally, MIESCOR, AWIA and DCCD are well qualified for plant design, as evidenced by their performance on this and other projects. It is, therefore, recommended that future dendro project design be contracted directly with the local A & E's.

Table V.3

Sources of Power Plant Equipment

Equipment	Local Manufacture	Foreign Manufacture
Concrete	X	
Structural Steel and Buildings	X	
Low Pressure Boilers	X	
High Pressure Boilers		X
Pumps		X
Fans		X
Large Motors		X
Small Motors	X	
Low Pressure Piping	X	
High Pressure Piping		X
Turbines Generator		X
Controls	X	
Condensers	X	
Electrical	X	

However, it is recognized that local A & E's have not had total responsibilities for design of the plants to date. Thus it is further recommended that any new major program include assistance in the areas of technical assessment of plants as well as scheduling, contracting and funding allocations. This assistance should be under the direct control of the funding agency.

It is concluded that approximately 50 percent of the power plant could be manufactured in the Philippines, and further concluded that the complete plant design could be accomplished by local architect and engineering firms.

K. WOOD FUEL PROCESSING

The discussion of the power plants currently under construction or planned has addressed the various biomass fuel forms including logs, chips, crushed and gasified. The advantages and disadvantages of each form were examined. In addition to the fuel forms previously discussed, the use of charcoal and densified fuel must also be considered.

The use of charcoal for power generation is not recommended. Biomass is essentially 20 percent charcoal and 80 percent volatile fuel on a dry basis. Production of charcoal utilizes the 80 percent volatile fuel for process heat. This loss of fuel to produce charcoal for the boiler would make the economics of the dendro plant prohibitive. The savings which could be realized in the cost of production equipment would not be sufficient to make the concept viable.

Densification is also not recommended for the dendro project. Densification at the plant would permit a smaller boiler size, but the capital and operating costs of the equipment make the concept economically infeasible. Densification at a central plantation would optimize tree growth through species selection and ideal soil conditions. However, the operating cost of the system and the problems of transportation would make the concept infeasible.

L. SPECIFIC PROGRAM RECOMMENDATIONS

The detailed analysis of the plants has identified a number of recommendations which should be incorporated in the program. Some of these are

applicable only to new plants, with equipment suppliers yet to be identified. Others should be incorporated in the Japanese and American designs before the final designs are completed. These recommendations are as follows:

1. The overall dendro plant design concept is technically viable, and use of general design features should be continued.

   The analysis of the plants under construction and planned has indicated that there are no major design problems which make the concept technically infeasible.

2. A senior staff engineer is needed at NEA.

   This senior engineer should have extensive experience in both power generation and wood energy systems. This engineer would provide support to the capable but inexperienced NEA staff.

3. Comprehensive training programs are needed for operators.

   The training program being conducted by the British is the only comprehensive program currently in place. A similar program with qualified instructors is needed for all present and future plants. The outline for the British program (copy provided in Annex V.1) is suggested as a guideline for all future training programs.

4. Adequate spares and a system for distribution are needed.

   The contracts for the British and French plants included provisions for spares, but these spares are not always available due to a number of reasons. An adequate supply of spares must be available for all systems. Additionally, a distribution system for the spares, particularly during the rainy season, must be provided. Storage of spares at a centrally located plant is suggested.

5. A detailed electrical transmission distribution analysis must be conducted.

A technically viable design of the integrated REC/NPC power network requires a detailed analysis of power transmission and distribution. Such an analysis has not been conducted but is needed as soon as possible to optimize the system.

6. Communication links to the local NPC controller should be provided at all plants.

A VHF radio link to the local NPC controller should be installed at all plants. As discussed above, the link should be located in the control room.

7. Additional technical assistance should be provided with any new major program.

The assistance would provide support in the areas of technical assessment of plants as well as scheduling, contracting and funding allocations. This assistance should be under the direct control of the funding agency.

8. Philippine contractors should be used as much as possible for design and construction of all new plants.

Inspection of plant sites, discussions with A & E's, and review of in-country manufacturing industries have indicated that Philippine contractors are capable of 100 percent of plant design, 50 percent of equipment manufacture and 100 percent of construction. Assistance from outside specialists in the areas of turbines, controls and fuel handling may be required initially.

Maximum economic utilization of in-country manufacturing should be made, but specialized equipment such as turbines, where only a limited number will be required on the dendro or other projects, should be imported. Capabilities for manufacture of equipment such as pumps, fans, and pressure piping should be established. This establishment may require the licensing of some foreign technology.

9. Wood chippers should be used for fuel sizing at all plants.

The difficulties at the Balfour Beatty plants have shown that some sort of fuel sizing is required, especially where fuel other than ipil-ipil is fired. The difficulties at the Alsthom-Atlantique plant have shown that grinding the fuel to a size suitable for suspension burning is not advisable. A system which simply reduces the fuel to chip size would permit combustion of the fuel on a grate type boiler. It is further recommended that two chippers, each with full boiler fuel feed capacity, be provided and the system configured such that either unit can be utilized if the other breaks.

10. A detailed analysis of the liquid effluent from the two gasifiers currently in place is required.

Liquid effluents from gasifier scrubbers have known carcinogens which have the potential for severe pollution problems. A thorough analysis including sampling is needed to determine the types of pollutants and requirements for control equipment.

11. Central air conditioned control rooms should be used for each plant.

The controls for the plant boiler, turbine and switch panel should be located in a control room. The room should be air conditioned and isolated from plant noise to allow the shift supervisor to operate in an environment free from distraction. Communication links to NPC should be located in this control room.

12. Cooling towers should be used on all plants.

The intense summer rains make silt a major problem if river water is used for condenser cooling. It is recommended that only cooling towers be used on all future plants.

13. Dryers should not be utilized on future plant designs.

Due to the difficulties of operating dryers, particularly in remote locations, it is recommended that dryers not be used on future plants. This restriction will require boilers with grate rather than suspension burning.

14. Gasifiers should not be used on systems in the near future.

The use of gasifiers on future plants is not recommended until the technology is further developed. Numerous difficulties have been experienced in the United States with gasification systems, and thus similar difficulties are anticipated in the Philippines. The severity of the problem will be increased due to the remote location of the sites. The further installation of gasifiers is not suggested until this equipment has established a better record of reliable service.

15. Standardization should be practiced on future projects.

Design standardization such as the use of chippers, cooling towers and central control rooms, and the elimination of dryers should be implemented.

VI. FINANCIAL AND ECONOMIC ANALYSIS

A. SUMMARY

Six representative sites (CASURECO IV-A, ZAMECO, OMECO, ANTECO, PANELCO I, and ISECO) within the Philippine Dendro Thermal Development Program were studied intensively from a financial and economic (societal) perspective.

The two major components of the dendro thermal concept, i.e., tree farm plantations and power plants, were evaluated both separately and together. The data base for the plantations was developed from a survey supplemented by secondary data; the power plant data base was developed from the National Electrification Administration's (NEA) reports supplemented by reviews of the various contracts and interviews with project participants. These data were developed to address three primary questions:

- How effective has the implemented concept been? (**Baseline Case**)
- How effective can the concept be, if implemented with the benefit of hindsight? (**Replication Case**)
- What is the cost of power per kilowatt-hour under the baseline and replication cases?

Answers to these questions were to be the basis of a judgement as to the readiness of a financially and economically sound production model for future dendro thermal projects. The baseline case examines the historical record and attempts to evaluate how well the concept worked. The replication case recreates the project with the benefit of hindsight. It assumes that deficiencies were corrected and recommendations for improvement were implemented successfully.

For both cases (baseline and replication), a financial and an economic analysis was performed. The key financial indicator of effectiveness and commercial profitability used in the evaluation was the financial internal rate of return (FIRR), excluding the specific financing structure employed. The economic analysis took the

financial analysis as a starting point and adjusted the costs and revenues to reflect the real costs and benefits of using these resources to the Philippines. The economic internal rate of return (EIRR) was calculated for the consolidated system of each site, as well as the plantations and power plants separately.

An indicator of viability used in addition to the FIRR and the EIRR was the average cost of power as compared to alternative methods of production. The dendro thermal program provides a variety of economic, social, and ecological benefits not included in a cost of power estimate, as well as not including a comprehensive valuation of the output. It is therefore not the preferred yardstick for evaluating these projects, but it does provide an additional dimension of comparability. A summary of the financial and economic internal rate of returns (FIRRs and EIRRs, respectively) and the cost of power is given in Table VI.1.

Table VI.1

Summary of FIRR, EIRR, and Cost per Kilowatt-hour
Consolidation of Plantation and Power Plant

	Financial Internal Rate of Return		Economic Internal Rate of Return		Pesos Per* Kilowatt Hour	
	B	R	B	R	B	R
CASURECO IV-A	10.6%	11.9%	14.7%	15.6%	1.09	1.09
ZAMECO	12.5%	13.8%	13.2%	14.6%	1.14	1.09
OMECO	15.8%	17.1%	6.4%	9.3%	1.97	2.10
ANTECO	11.9%	12.6%	13.2%	13.7%	1.21	1.24
PANELCO I	14.0%	14.9%	21.0%	21.0%	.83	.81
ISECO	17.4%	18.3%	23.1%	24.0%	.76	.74

*Investment annualized at 15%.
B = Baseline Case; R = Replication Case

There are several yardsticks by which the FIRRs may be evaluated. The most stringent would be the real cost of capital in the private

sector of the Philippines which, though not strictly definable, is probably in the range of 15% to 25%. By this yardstick, therefore, the dendro projects are only marginally viable. Another yardstick is the required real rate of return on projects of this type by major international funding agencies (such as the World Bank). This required real rate is reported to be 8%. By this yardstick, all of the projects are financially viable.

The yardstick to evaluate the EIRRs would be the social discount rate which is generally accepted to be 15% for the Philippines. Only two sites (PANELCO I and ISECO) exceed this rate for the baseline case and three exceed it for the replication case, although ZAMECO and ANTECO are very close. OMECO remains the lowest due to the relatively low utilization level caused by a low local demand and non-interconnection with a grid system.

The cost of power could be evaluated in comparison with alternative production methods presently used. The 1983 oil-based generation cost on Luzon (adjusted to 1984 pesos) was ₱1.51 per kilowatt-hour (kWh), while hydroelectric and geothermal were ₱.27 per kWh and ₱.52 per kWh, respectively. All of the dendro projects are lower than the Luzon oil-based cost with the exception of OMECO, which has a low output. Oil-based costs for a power demand situation seen at OMECO are not available for comparison. While the dendro projects compare well with oil-based alternatives, they are all higher than either hydroelectric or geothermal costs.

A result of the cost of power analysis was that the power plant represented by far the largest component of total costs under the replication case assumptions. The risk analysis, however, demonstrated that one of the greatest risks to the dendro concept resides in potentially inadequate fuel wood production from the tree farms and the effect this may have on local fuel wood markets. The implication of these two factors taken together is that project risks can be reduced by allocating additional planning and development

resources to the tree plantation without seriously adversely affecting the overall financial performance of the dendro concept.

The results of the economic/financial analysis viewed from these three perspectives indicate that the dendro thermal concept is a viable one though not one that could be applied to all places at all times. Hydroelectric and geothermal sources should be investigated first and, as discussed in the more detailed comparison (see Volume II) extensive forestry and power evaluation analyses must precede the application of the dendro thermal concept. All of these factors underscore the need for coordination of the power production aspects of these projects with the National Power Corporation and the economic development aspects with the appropriate planning agencies. It should also be noted that all of these conclusions are based upon project costs which are not yet final and upon operational data that are estimated. It is strongly recommended that these project sites be reevaluated following a one- to two-year operational period to verify the data used in this analysis.

B. OBJECTIVES

The Dendro Thermal Development Program is a large and complex undertaking that presents many questions. The following discussion is a very brief summary of the financial and economic analysis conducted to address these questions, and the interested reader is urged to consult Volume II for a full explanation of the data sources, methodology and results of the analysis.

This study first analyzes what has occurred, by collecting and interpreting data from representative sites for which enough information exists to evaluate how well the concept has worked over the past four years -- whether the historical record stands up to the original feasibility assessments from a financial and an economic standpoint. The analysis of the historical record is referred to as the "**baseline case.**"

Other project members examined the tree farm operation, the harvesting system and the power plant operation from a technical,

engineering and agricultural standpoints. Their recommendations were used to develop what we term a **"replication case,"** that aims to reassess the financial and economic feasibility of replicating each site with the advantage of hindsight. The analysis provides an assessment of how well a site, similar to any analyzed in this study, will do if it takes the recommendations into account.

C. METHODOLOGY

For both cases (baseline and replication), a financial and an economic analysis was conducted for each site. The economic analysis was based on recent National Economic Development Administration (NEDA) estimates for shadow prices of unskilled labor and foreign exchange of 60% of administered wages and 120% of official rates, respectively.

The plantations and the power plants are analyzed separately. A consolidated cash flow table is also shown which aggregates the results from each to provide a total project assessment. A "representative" project approach was used because the dendro thermal program is, in its conception, a very large project consisting of dozens of sites, and our resources for this analysis were limited. Table VI.2 depicts the project sites selected that meet the requirements established to ensure adequate representation. The selection criteria are specified in Volume II. At the time of project selection, the 1982 area surviving data were the most recent available for use as one of the selection criteria.

The steps in the methodology followed for the tree plantations could be summarized as follows:

- Survey data for the plantation were collected at the module level including hectares planted, hectares surviving, annual development costs by cost category and expected operation and maintenance costs.

- The module level data were aggregated to plantation level.

Table VI.2

Characteristics of Project Sites Selected for Analysis

	Town	Province	Region	Power Plant Type	1982 Plantation Area Surviving (Hectares)	Number of Farmers Associations /Members
CASURECO IV-A	Caramoan	Caramines Sur	V	Balfour-Beatty	126	10/121
ZAMECO	Palauig	Zambales	III	Balfour-Beatty	146	10/99
OMECO	Magsaysay	Occidental Mindoro	IV	Moteur-Duvant	120	4/31
ANTECO	Hamtic	Antique	VI	Moteur-Duvant	30	3/57
PANELCO I	Bolinao	Pangasinan	I	Alsthom-Atlantique	1,100	10/101
ISECO	Burgos	Ilocos Sur	I	Alsthom-Atlantique	311	10/96

- Initial investment, projected income and cash flow statements were prepared from these data representing the financial baseline case.

- Assumptions were developed (as specified in a later section) to represent the potential the tree plantation could achieve under ideal conditions. These assumptions formed the basis for the replication case analysis.

- The effect of the replication case assumptions on the financial parameters were calculated and the replication case cash flows were prepared.

- The financial internal rate of return (FIRR) implied by the cash flows for the baseline and replication cases were calculated.

- The pesos per metric ton costs for wood produced were estimated by annualizing the initial investment costs at 15%, 20% and 25% discount rate factors, adding these costs to the annual operating costs and dividing by production.

- The economic analysis used the baseline and replication case financial data as a base from which social costs and benefits were estimated as described in a later section.

The steps in the methodology followed for the power plants could be summarized as follows:

- Initial investment cost data by functional category were secured from NEA summary reports.

- A temporal disaggregation of these costs was estimated from previous NEA reports.

- A disaggregation of these initial costs into more detailed cost components (such as unskilled labor and foreign exchange) was estimated using factors derived from interviews.

- Adjustments to these costs due to construction contract change orders were made.

- Operating costs were estimated from expected staffing, repair and maintenance, and estimated wood consumption. This included estimating the quantity of plantation supplied fuel and open market purchases.

- Revenues were estimated considering transmission losses, internal loads and the split between sales to co-op customers and the National Power Corporation based on the estimated local loads assuming an average of 6,000 hours of operation per year.

- The initial investment, operating costs and revenues were used to prepare the financial statements for the baseline case.

- The power plant replication case cash flow statements were prepared based on the replication case plantation fuel wood production.

- The FIRRs for the baseline and replication case implied by the cash flows were calculated.

- The cost of power was estimated by annualizing the initial investment costs at 15%, 20% and 25% discount rate factors, adding these to the annual operating costs and dividing by gross output.

Additional analyses provided the estimated employment impacts, the labor intensity of these projects and the foreign exchange impacts.

As stated above, the primary data source for the plantation analyses was a survey conducted at the module level supplemented by field visits while the power plant data was collected from the National Electrification Administration project summary reports and various contracts for the initial investment costs. It must be noted that no actual operating data are available for either the power plants or tree plantations and construction costs are not yet final.

These costs must, therefore, be considered speculative and subject to revision. Two indicators of viability are used in this analysis. The internal rate of return is considered the more comprehensive, but the average costs of production are also provided to allow an additional dimension for comparison.

D. FINANCIAL ANALYSIS

This section presents the results, in summary format, of the financial and economic analysis. Results for the baseline case, covering both power plants and plantations will be presented first, followed by the replication case and cost analysis. Some additional analysis on the employment impacts and foreign currency flows will be presented following these components.

1. Baseline Case

Although the six projects did not all start their development in the same year, the timing incongruities were not severe enough to warrant using different time periods for each. The analysis that follows will use the years 1981 to 1984 as the development period for both plantations and power plants, and 1985 as the first operational year for both.

a. Investment Costs

Table VI.3 contains the estimated investment costs totaled over the four-year development period for plantations and power plants. Because each plantation differs in hectares planted and survived and the power plants differ in capacity, columns are included which normalize each investment cost by hectares planted for plantations and megawatt capacity for power plants.

b. Production Costs

For the plantations, annual production costs reflect harvest costs which in turn are a function of the number of surviving hectares and yields realized. The plantation wood is priced at 65 pesos per

wet ton (the NEA recommended price). The wood bought from the local market, required to supplement the plantation output per the power plant fuel requirements, is priced at local market rates as reported in the surveys per metric ton: ₱60 for CASURECO IV-A; ₱98 for ZAMECO; ₱90 for OMECO; ₱39 for ANTECO; ₱90 for PANELCO I; and ₱80 for ISECO.

Table VI.4 contains the wood production estimates for each plantation, wood requirements for each power plant and the resulting shortfall which must be supplied from local wood sources.

Table VI.3

Initial Investment Costs for the Plantation and Power Plant in Baseline Case

	Plantation		Power Plant	
	Total Investment (thousands of 1984 pesos)	Per Hectare Planted	Total Investment (thousands of 1984 pesos)	Per Megawatt Capacity (1,000s)
CASURECO IV-A	945	2,220	95,466	30,795
ZAMECO	3,062	4,730	95,404	30,755
OMECO	348	2,280	21,596	22,495
ANTECO	1,441	3,660	36,008	37,508
PANELCO I	4,479	4,080	74,279	21,847
ISECO	1,692	2,800	65,950	19,397

Table VI.4

Plantation Wood Production and Power Plant Requirements in Baseline Case

	Power Plant Requirements (metric ton)	Plantation Production (metric ton)	Plantation Percent (%)	Local Purchases (metric ton)
CASURECO IV-A	43,041	8,259	19.2	34,782
ZAMECO	43,041	4,235	9.8	38,806
OMECO	9,218	2,640	28.6	6,578
ANTECO	9,218	2,404	26.1	6,814
PANELCO I	43,414	24,960	57.5	18,454
ISECO	43,414	11,577	26.7	31,837

These figures and wood prices discussed above, along with labor costs, administrative costs and production materials, provide the

power plants' operating costs which appear in Table VI.5. Full production costs are operating costs plus depreciation and interest.

Table VI.5 also shows the operating costs for the plantations. The figures are primarily made up of labor costs for harvesting, with the remainder attributed to maintenance costs. The harvesting costs were calculated for each site using relative labor costs per hectare in the development period.

Table VI.5

Plantation and Power Plant Annual Operating Costs for the Period 1985-2009 in Baseline Case
(in thousands of 1984 pesos)

	Plantation		Power Plant	
	Operating Costs	Depreciation	Operating Costs	Depreciation
CASURECO IV-A	113	19	5,587	2,764
ZAMECO	143	21	7,041	2,711
OMECO	62	4	1,410	646
ANTECO	90	*	1,552	1,034
PANELCO I	943	70	5,379	2,134
ISECO	382	15	5,234	1,986

*Less than one thousand.

On a per hectare harvested basis, the plantation operating costs vary quite markedly. It is assumed that these differences between areas primarily reflect differences in the cost of living and the difficulty of the terrain. (Complete projected income statements and cash flow statements and their derivation are included in Volume II.) This presentation is limited to those data used to calculate the internal rates of return (FIRR), which do not include the debt service component. The FIRR is the maximum interest rate the project could pay for the resources used if the project is to recover its investment and operating costs and still break even. We show the cash flow summary without financing for both plantations, power plants, and the two components consolidated in Table VI.6. The financial internal rate of returns for each case are also presented. The "residual

Table VI.6

Plantation, Power Plant, Consolidated Cash Flow, and
Financial Internal Rate of Return Without Financing in Baseline Case
(in thousands of 1984 pesos)

	Investment Period				Production Period	Residual	Financial Internal Rate of
	1981	1982	1983	1984	1985-2009	Value	Return
CASURECO IV-A							
Plantation	(404)	(322)	(195)	(23)	538	1,048	31.0%
Power Plant	(4,620)	(66,583)	(10,307)	(13,957)	12,586	0	10.2%
Consolidated	(5,024)	(66,905)	(10,502)	(13,980)	13,124	1,048	10.6%
ZAMECO							
Plantation	(1,936)	(575)	(521)	(30)	136	406	1.4%
Power Plant	(6,167)	(65,134)	(14,309)	(9,794)	15,797	0	12.8%
Consolidated	(8,103)	(65,709)	(14,830)	(9,824)	15,933	406	12.5%
OMECO							
Plantation	(225)	(103)	(16)	(4)	110	119	19.6%
Power Plant	0	(12,513)	(4,837)	(4,246)	4,284	0	15.7%
Consolidated	(225)	(12,616)	(4,853)	(4,250)	4,394	119	15.8%
ANTECO							
Plantation	(432)	(525)	(417)	(66)	66	191	1.6%
Power Plant	(2,986)	(22,898)	(5,477)	(4,647)	5,666	0	12.2%
Consolidated	(3,418)	(23,423)	(5,894)	(4,713)	5,732	191	11.9%
PANELCO I							
Plantation	(845)	(1,844)	(1,233)	(557)	688	1,699	12.1%
Power Plant	(8,814)	(43,160)	(12,248)	(10,058)	13,729	0	14.2%
Consolidated	(9,659)	(45,004)	(13,481)	(10,615)	14,417	1,699	14.0%
ISECO							
Plantation	(499)	(609)	(481)	(104)	379	1,263	16.4%
Power Plant	(5,006)	(31,836)	(14,083)	(15,025)	14,850	0	17.5%
Consolidated	(5,505)	(32,445)	(14,564)	(15,129)	15,229	1,263	17.4%

NOTE: Some elements of some sites were begun prior to 1981. The year 1981 was chosen as starting year for all sites to increase readability and consistency.

value" column is an estimate of the value of wood fuel located on the plantation land at the end of the 25-year period.

Because investment costs, operating costs, and revenues are dominated by the power plant, the consolidated results do not differ much from the power plant results. A few comments on each site's results might be useful.

The required return on private investment in the Philippines is probably greater than all the financial internal rate of returns shown in Table VI.6, with the exception of CASURECO IV-A. All other financial internal rate of returns (FIRRs) are really too low to be judged good investments by private sector investors. By that criteria, all but one are not financially viable projects. But this is only an evaluation from a private sector investor's viewpoint. The real rate of return required by major financial supporters of power plant projects (such as the World Bank) is generally in the neighborhood of 8%. By this yardstick, all of the projects would be considered viable. Society's criteria for viability is different, as shown in the economic analysis. It is the social perspective that is really important in evaluating these projects.

- o CASURECO IV-A. The plantation FIRR is very high because investment costs were kept down at this plantation. The reported investment costs (from the survey) per planted hectare were the lowest among all the sites. The survival rate averaged about 59%, so that most of the trees planted were harvested and generated income. As we saw The co-op cannot support more than a third of the power to be generated, which lowers the power plant revenues.

- o ZAMECO. ZAMECO's plantation results are very poor. They had one of the highest investment costs per hectare and one of the lowest survival rates at 22%. These factors resulted in the low level of profit and low FIRR shown for the plantation. The power plant investment costs are comparable to CASURECO's but ZAMECO's revenues are much higher because a much higher portion of total sales go to the co-op at a higher rate than the National Power Corporation (NPC) rate. This is why the FIRR for the power plant is higher.

- o OMECO. OMECO's plantation results are good because of low investment cost per hectare planted (Table VI.3) and a high

survival rate (78%). The power plant results are fair. Investment costs are on the low side per megawatt of capacity, but fuel costs are a bit high due to relatively greater dependence on outside sources of fuel wood at a higher price. Because OMECO has the highest electricity price, at 3.70 pesos a kilowatt-hour, the financial internal rate of return (FIRR) came out relatively high even though the local demand for power is low and there are no sales to the National Power Corporation (NPC) due to the absence of interconnection.

- o ANTECO. ANTECO is a gasifier like OMECO, so some comparisons can be made. For the plantation, the results are very poor, because of high investment costs per hectare planted and high operating costs compared to all sites. For the power plant, comparisons to OMECO show very high investment costs per megawatt of capacity. ANTECO's lower electricity price (relative to OMECO) results in lower revenues. These problems combine to result in the low FIRR shown for ANTECO.

- o PANELCO I. PANELCO I planted more hectares than any other plantation (with comparable fuel wood requirements) and had the highest survival rate of all the sites (97%). Unfortunately, PANELCO I also had the second highest development costs per hectare planted, so that the plantation FIRR is lower than it could have been if development costs had been lower. The power plant results are fair, and could be improved if more power could be sold to co-op members.

- o ISECO. Generally, ISECO had the best results among the six sites. Development costs for both the plantation and power plant were relatively low. The plantation survival rate was very high (92%), and almost all of the power generated can be sold to co-op members. These figures result in relatively high revenues for the plantation and the power plant.

c. Cost of Energy and Wood

Table VI.7 shows the estimated energy and fuel wood costs resulting from the investment and operating costs for the plantations and power plants. An estimate of total annualized cost is calculated by annualizing the investment costs and adding this to annual operating costs. Dividing these results by metric tons of wood produced (for the plantations) and by gross energy produced (for the power plants) determines the cost of wood and cost of energy

estimates, respectively. For the details of these calculations, see Volume II.

Table VI.7

Wood and Energy Costs for the Baseline Case
(in 1984 pesos)

	Wood Cost Per Metric Ton With Investment Annualized at			Energy Cost Per Kilowatt Hour With Investment Annualized at		
	15%	20%	25%	15%	20%	25%
CASURECO IV-A	31	37	42	1.09	1.34	1.59
ZAMECO	146	180	215	1.14	1.38	1.63
OMECO	44	50	56	1.97	2.40	2.83
ANTECO	130	159	188	1.21	1.50	1.81
PANELCO I	66	74	83	.83	1.00	1.18
ISECO	56	63	70	.76	.91	1.07

We do not know the acceptable return on investment in the private sector of the Philippines, but we do know that it is greater than the 15% social discount rate used in this analysis. The costs in Table VI.7 were estimates for three different rates of capital recovery: 15%, 20% and 25%. The resulting wood and energy reflect the expected differences across sites.

2. Replication Case

a. Financial Analysis

For the replication case, the following adjustments to the baseline results were performed.

For the plantation, we assumed:

- A 100% survival rate.

- An increase in yield equal to 80%, 40%, and 20% for poor, good, and excellent baseline yields, respectively.

For the power plants:

- An increase in fuel wood from the plantations equal to that resulting from the assumptions above.

These adjustments result in new investment costs, new operating costs, and new revenues for the plantations, and new operating costs for the power plants. The new operating costs are shown in Table VI.8; and the new plantation investment costs, and resulting cash balances and financial internal rate of returns (FIRRs) are shown in Table VI.9. Debt service is not included to eliminate bias resulting from assuming a particular financing structure. These adjustments significantly affect the FIRRs.

Table VI.8

Annual Operating Costs for Plantations and Power Plants in Replication Case (in thousands of 1984 pesos)

	Plantation Operating Costs	Power Plant Operating Costs
CASURECO IV-A	454	5,430
ZAMECO	753	5,531
OMECO	207	1,729
ANTECO	275	1,564
PANELCO I	961	5,123
ISECO	688	4,970

All the plantation results are greatly improved over the baseline case, and for the most part the power plant results are better. Only CASURECO IV-A and ANTECO show slightly lower power plant FIRRs because of the replacement of lower cost outside wood is replaced with higher cost plantation wood (see baseline case section on Production Costs). Besides indicating how well a plantation/power plant could do on a site similar to the six studied, these results also reveal how well the sites can do with proper silvicultural practices, improved sites,

Table VI.9

Plantation, Power Plant and Consolidated Cash Flow and
Financial Internal Rate of Return Without Financing in Replication Case
(in thousands of 1984 pesos)

	Investment Period				Production Period	Residual	Financial Internal Rate of
	1981	1982	1983	1984	1985-2009	Value	Return
CASURECO IV-A							
Plantation	(555)	(555)	(555)	(555)	2,517	5,098	53.4%
Power Plant	(4,620)	(66,583)	(10,307)	(13,957)	12,429	0	10.1%
Consolidated	(5,175)	(67,138)	(10,862)	(14,512)	14,946	5,098	11.9%
ZAMECO							
Plantation	(1,182)	(1,182)	(1,182)	(1,182)	1,280	3,777	20.1%
Power Plant	(6,167)	(65,134)	(14,309)	(9,794)	16,687	0	13.4%
Consolidated	(7,349)	(66,316)	(15,491)	(10,976)	17,967	3,777	13.8%
OMECO							
Plantation	(228)	(228)	(228)	(228)	594	972	37.8%
Power Plant	0	(12,513)	(4,837)	(4,246)	4,314	0	15.8%
Consolidated	(228)	(12,741)	(5,065)	(4,474)	4,908	972	17.1%
ANTECO							
Plantation	(366)	(366)	(366)	(366)	584	1,471	26.9%
Power Plant	(2,986)	(22,898)	(5,477)	(4,647)	5,489	0	11.8%
Consolidated	(3,352)	(23,264)	(5,843)	(5,013)	6,073	1,471	12.6%
PANELCO I							
Plantation	(1,019)	(1,019)	(1,019)	(1,019)	1,336	3,430	23.2%
Power Plant	(8,814)	(43,160)	(12,248)	(10,058)	13,985	0	14.4%
Consolidated	(9,833)	(44,179)	(13,267)	(11,077)	15,321	3,430	14.9%
ISECO							
Plantation	(701)	(701)	(701)	(701)	1,218	3,884	28.6%
Power Plant	(5,006)	(31,836)	(14,083)	(15,025)	15,114	0	17.7%
Consolidated	(5,707)	(32,537)	(14,784)	(15,726)	16,332	3,884	18.3%

and species diversification. We will examine the sensitivity of these results to changes in uncertain elements of the analysis in a later section.

b. Cost of Energy and Wood

It is also instructive to examine the results of the replication case assumptions in terms of energy and wood costs. Table VI.10 gives these estimates.

These power costs compare favorably with the 1983 National Power Corporation's costs (adjusted to 1984 pesos) of ₱1.51 per kilowatt-hour for oil-based power production (with the exception of OMECO), but are significantly above the hydroelectric or geothermal costs of ₱.27 and ₱.52 per kilowatt-hour, respectively. OMECO's high cost is due to its relatively low output due to a low load factor. This low load factor reduces the comparability between OMECO's cost of power with that of Luzon. The higher residential rates at OMECO indicate that the costs, under the demand conditions present, will be considerably higher than high base-load systems such as found on Luzon. Alternative production methods under demand conditions found at OMECO are not available for comparison.

Table VI.10

Wood and Energy Costs in Replication Case
(1984 pesos)

	Wood Cost Per Metric Ton With Investment Annualized at			Energy Cost Per Kilowatt Hour With Investment Annualized at		
	15%	20%	25%	15%	20%	25%
CASURECO IV-A	20	23	25	1.09	1.33	1.58
ZAMECO	48	55	62	1.09	1.33	1.58
OMECO	28	32	35	2.10	2.53	2.97
ANTECO	38	43	49	1.24	1.54	1.84
PANELCO I	45	51	56	.81	.99	1.16
ISECO	38	43	48	.74	.90	1.05

Another use of the cost of power estimates is to demonstrate the relative contribution represented by the power plants and tree plantations in the cost of production. Table VI.11 provides a disaggregation of the total cost of production for the replication case costs evaluted at a 20% discount rate factor. The three components isolated are the power plants, the tree plantations, and the cost of fuel wood purchased on the open market. The power plants represent 83.3% (ISECO) to 96.0% (OMECO) of the total costs while the tree plantations represent 4% (OMECO) to 11.2% (PANELCO I), which includes the farmers' margin. It is clear from these data that the power plant costs represent by far the largest component. This implies that small percentage savings in power plant costs can provide large percentage increases to funds for the planning and development of the tree plantations with no overall increase in costs.

Table VI.11

Relative Costs of Power in Replication Case
Evaluated at a 20% Discount Rate Factor
(pesos per kilowatt-hour)

	Total	Power Plant	Tree Plantation	Market Purchased Fuel Wood
CASURECO IV-A				
Cost	1.33	1.18	.14	.01
% of Cost	100	88.70	10.50	.80
ZAMECO				
Cost	1.34	1.17	.11	.06
% of Cost	100	87.30	8.20	4.50
OMECO				
Cost	2.53	2.43	.10	0.00
% of Cost	100	96.00	4.00	0.00
ANTECO				
Cost	1.54	1.44	.10	0.00
% of Cost	100	93.50	6.50	0.00
PANELCO I				
Cost	.99	.84	.11	.04
% of Cost	100	84.80	11.20	4.00
ISECO				
Cost	.90	.75	.09	.06
% of Cost	100	83.3	10.00	6.70

E. ECONOMIC ANALYSIS

The economic analysis takes the financial analysis results as a starting point and adjusts costs and revenues to reflect the real costs and benefits of using these resources to the Philippines.

The objective of the economic analyses is to derive an estimate of the net benefits to the nation as a result of the implementation of these six projects. In addition to shadow pricing, unskilled labor and foreign exchange, it was also necessary to adjust the price of fuel wood and value of power production to reflect their economic value.

1. Benefits and Costs

Benefits are identified as wood production, oil import reduction as a result of the dendro plants, and the increased value of the previously denuded and unproductive land on which the plantations are developed. The benefits from wood production are valued using the market price of wood in the area. The value of the electricity generated is not determined from the sale of the electricity to local consumers, but rather, from the import substitution of oil, which is the highest cost fuel used for electricity generation in the Philippines, and therefore the first to be replaced. It also represents a large drain on foreign currency. The electricity will be valued as if it were generated using imported oil, at the world oil price. The net effect of the oil substitution is to release a sum of foreign currency for alternate use by the economy, equal to the foreign currency cost of the imported oil. The increased value of the plantation land, the residual value, is estimated as the present value of the perpetual stream of income which the land could provide as a result of the project.

On the cost side only one adjustment to the financial analysis results is made. The benefits to the farmers from wood sales are, of course, a cost to the rural electric cooperatives (co-ops) that buy the wood for use in the power plants. Because we are valuing this

benefit to the farmers using the prevailing market price in each area, the cost of the wood to the power plant is changed. This change in power plant operating costs is illustrated in Table VI.12. The benefit calculations result in the figures shown in Table VI.13 for the plantation and Table VI.14 for the power plant, from the wood sales adjustment and the oil import substitution effect, respectively.

Table VI.12

Power Plant Annual Fuel Requirements at Market Prices in Baseline and Replication Cases

	Wood Requirements (metric ton)	Wood Cost (thousands of 1984 pesos)	Operating Costs Local Currency Component* (thousands of 1984 pesos)
CASURECO IV-A	43,041	2,582	4,288
ZAMECO	43,041	4,218	5,924
OMECO	3,845	346	1,204
ANTECO	9,218	360	1,218
PANELCO I	43,414	3,907	5,257
ISECO	43,414	3,473	4,732

*Excludes unskilled labor.

Table VI.13

Tree Plantation Benefits

	1984 Local Wood Prices (pesos/ (metric ton)	Baseline Case		Replication Case	
		Wood Produced (metric ton)	Benefits (1984 pesos)	Wood Produced (metric ton)	Benefits (1984 pesos)
CASURECO IV-A	60	8,259	495,540	39,800	2,388,000
ZAMECO	98	4,235	415,030	31,210	3,058,580
OMECO	90	2,640	237,600	12,320	1,108,800
ANTECO	39	2,404	93,756	13,212	515,268
PANELCO I	90	24,960	2,246,400	35,200	3,168,000
ISECO	80	11,577	926,160	29,204	2,336,320

Table VI.14

Power Plant Benefits for Baseline and Replication Cases

	Gross Electricity Produced (megawatt hour)	Foreign Currency Value	
		Dollars	Pesos (P18 to $1)
CASURECO IV-A	18,600	1,194,120	21,494,160
ZAMECO	18,600	1,194,120	21,494,160
OMECO	2,409	154,658	2,783,844
ANTECO	5,760	369,792	6,656,256
PANELCO I	20,400	1,309,680	23,574,240
ISECO	20,400	1,309,680	23,574,240

2. Net Benefits

Debt service is not included in the net benefits figures since in the economic analysis, it is treated as a transfer within the Philippine economy. This separates the decision of how good a project is from the decision of how to finance it.

Table VI.15 summarizes the net benefits for each plantation and power plant for both the baseline and replication cases. In both tables the economic internal rate of return (EIRR) is also shown. For details of the adjusted costs and benefits, see Volume II.

Table VI.16 contains the consolidated results of the net benefit calculations. Because the power plant dominates the benefits and costs in sheer size of numbers, the consolidated results closely resemble the power plant results.

Using the social discount rate of 15% as the cutoff rate for the economic rate of return, the consolidated net benefits from the plantations and power plants can be evaluated with respect to their social profitability. In the baseline case, PANELCO I (21.0%) and ISECO (23.1%) would be implemented, and CASURECO IV-A (14.7%), ZAMECO (13.2%), OMECO (6.4%) and ANTECO (13.2%) rejected. In the replication case, ZAMECO (14.6%), OMECO (9.3%) and ANTECO (13.7%) would be rejected.

Table VI.15

Plantations and Power Plants Net Benefits and Economic Internal Rate of Return in Baseline and Replication Cases (in thousands of 1984 pesos)

	Plantations		Power Plants
	Baseline Case	Replication Case	Baseline/Replication
CASURECO IV-A			
1981	(330)	(413)	(5,544)
1982	(224)	(413)	(78,955)
1983	(127)	(413)	(9,762)
1984	(23)	(413)	(13, 247)
1985-2009	417	2,071	20,479
Economic Internal Rate of Return	24.7%	56.6%	14.5%
ZAMECO			
1981	(1,310)	(808)	(7,400)
1982	(404)	(808)	(77,723)
1983	(349)	(808)	(13,891)
1984	(30)	(808)	(9,588)
1985-2009	323	2,567	18,483
Economic Internal Rate of Return	11.5%	43.1%	13.3%
OMECO			
1981	(161)	(170)	0
1982	(79)	(170)	(15,016)
1983	(16)	(170)	(4,820)
1984	(4)	(170)	(4,207)
1985-2009	211	958	1,920
Economic Internal Rate of Return	36.3%	60.5%	5.4%
ANTECO			
1981	(286)	(245)	(3,583)
1982	(354)	(245)	(24,371)
1983	(284)	(245)	(5,095)
1984	(41)	(245)	(4,436)
1985-2009	38	344	6,552
Economic Internal Rate of Return	1.3%	24.5%	13.5%
PANELCO I			
1981	(530)	(656)	(9,737)
1982	(1,137)	(656)	(49,935)
1983	(829)	(656)	(12,524)
1984	(391)	(656)	(10,210)
1985-2009	1,676	2,587	23,669
Economic Internal Rate of Return	34.5%	49.1%	20.4%
ISECO			
1981	(361)	(461)	(6,002)
1982	(377)	(461)	(38,200)
1983	(304)	(461)	(13,243)
1984	(70)	(461)	(15,596)
1985-2009	673	1,880	23,009
Economic Internal Rate of Return	33.5%	50.1%	22.8%

Table VI.16

Plantations and Power Plants Consolidated Net Benefits and Economic Internal Rate of Return in Baseline and Replication Cases (in thousands of 1984 pesos)

	Baseline Case	Replication Case
CASURECO IV-A		
1981	(5,874)	(5,957)
1982	(79,179)	(79,368)
1983	(9,889)	(10,175)
1984	(13,270)	(13,660)
1985-2009	20,896	22,550
Economic Internal Rate of Return	14.7%	15.6%
ZAMECO		
1981	(8,710)	(8,280)
1982	(78,127)	(78,531)
1983	(14,240)	(14,699)
1984	(9,618)	(10,396)
1985-2009	19,166	21,419
Economic Internal Rate of Return	13.2%	14.6%
OMECO		
1981	(161)	(170)
1982	(15,095)	(15,186)
1983	(4,836)	(4,990)
1984	(4,211)	(4,377)
1985-2009	2,131	2,878
Economic Internal Rate of Return	6.4%	9.3%
ANTECO		
1981	(3,869)	(3,828)
1982	(24,725)	(24,616)
1983	(5,379)	(5,340)
1984	(4,477)	(4,681)
1985-2009	6,590	6,896
Economic Internal Rate of Return	13.2%	13.7%
PANELCO I		
1981	(10,267)	(10,393)
1982	(51,072)	(50,591)
1983	(13,353)	(13,180)
1984	(10,601)	(10,866)
1985-2009	25,245	26,286
Economic Internal Rate of Return	21.0%	21.8%
ISECO		
1981	(6,368)	(6,468)
1982	(38,577)	(38,661)
1983	(12,939)	(13,704)
1984	(15,665)	(15,057)
1985-2009	23,682	25,237
Economic Internal Rate of Return	23.1%	24.0%

An important objective of the Dendro Thermal Development Program is to generate employment, especially in the rural areas. Table VI.17 presents an estimate of the employment impact of the projects over their life in person-years and a measure of the degree of labor intensiveness.

Table VI.17

Employment Implications of the Plantations and Power Plants in the Baseline and Replication Cases Over 25 Year Project Life

	Total Labor (person-years)		Person-Years per Million of 1984 Pesos of Investment	
	Baseline Case	Replication Case	Baseline Case	Replication Case
CASURECO IV-A	3,104	3,661	32	38
ZAMECO	3,427	4,578	36	48
OMECO	1,376	1,592	64	74
ANTECO	1,772	2,110	49	59
PANELCO I	4,444	4,451	60	60
ISECO	2,713	3,312	41	50

Another important objective of the program is the foreign currency generated by the substitution of wood-produced electricity for oil-produced electricity. The foreign exchange earning capacity rates are the discount rates that equalize the foreign exchange costs and net foreign exchange benefits over the life of the projects. These were CASURECO IV-A (19.9%), ZAMECO (19.2%), OMECO (14.2%), ANTECO (22.9%), PANELCO I (28.3%) and ISECO (31.9%). With a social discount rate of 15%, the foreign exchange impact for all the projects is positive with the exception of OMECO, which is quite close.

F. SENSITIVITY ANALYSIS

The use of sensitivity analysis in this type of project is confined to quantifying the impact of changes in uncertain elements of the analysis, in order to assess the risk to the project's viability.

For example, if the price of excess power purchased by the National Power Corporation from the co-ops was uncertain, and the sensitivity analysis showed that variation in this price significantly changes the profitability of the project, then the success of the project is uncertain.

Specific elements of the plantation and power plant analysis, which are uncertain, have been identified. These should, therefore, be tested through sensitivity analysis to ascertain the project's vulnerability to changes in these elements. We will use the replication case results and assumptions as the departure point for the sensitivity analysis.

The replication case represents the hypothetical potential of replicating any of the six sites with the changes in development and operation noted earlier. Therefore, it is important to assess the risks that another co-op would face if it were to follow the path of implementation described by the replication case.

For the tree farm plantations, the following sensitivities have been identified:

Case	Description
TF1	Increase yields by 20%
TF2	Decrease yields by 20%
TF3	Increase operating costs by 100%

For this type of analysis it is not necessary to analyze every site. The results can be obtained by bracketing the analysis using the best and worst case. Based on the financial internal rate of returns (FIRRs), these sites are CASURECO IV-A (best) and ZAMECO (worst). The results of the analysis are shown in Table VI.18.

ZAMECO's large drop in FIRR for the operating cost sensitivity results from an operating cost much larger than CASURECO's which does not show the same degree of sensitivity. A 100% increase in operating cost was used rather than something more moderate because the harvesting methods have been identified as questionable.

Table VI.18

Plantation Sensitivity Analysis - Impact on Annual Cash Flow
(in thousands of 1984 pesos)

	1981	1982	1983	1984	1985-2009	Residual	Financial Internal Rate of Return
CASURECO IV-A							
Replication	(555)	(555)	(555)	(555)	2,517	5,098	53.4%
TF1	(555)	(555)	(555)	(555)	3,088	6,118	60.1%
TF2	(555)	(555)	(555)	(555)	1,946	4,078	45.7%
TF3	(555)	(555)	(555)	(555)	2,063	4,644	47.4%
ZAMECO							
Replication	(1,182)	(1,182)	(1,182)	(1,182)	1,280	3,727	20.1%
TF1	(1,182)	(1,182)	(1,182)	(1,182)	1,686	4,472	24.8%
TF2	(1,182)	(1,182)	(1,182)	(1,182)	874	2,982	14.6%
TF3	(1,182)	(1,182)	(1,182)	(1,182)	572	2,974	9.2%

On a percentage basis, the low yield sensitivity results in a larger drop in FIRR for ZAMECO (27%) than for CASURECO (14%). Lower-than-projected yields will affect the viability of the relatively worse sites more than the more successful sites. Although the drop is not as severe as shown for the operating cost sensitivity, the drop is significant, especially since the drop in yield was only 20%. Larger drops, which are more in line with what has actually occurred at the plantations relative to the replication case assumptions, imply a degree of risk that is worth noting. The high yield sensitivity is not designed to investigate risk but instead, to help measure the symmetry of the yield sensitivity test.

For the power plants, five sensitivities on the financial analysis have been tested based on changes in electricity price the co-ops receive from the National Power Corporation, the level of local demand affecting the amount of energy co-ops have in excess, and investment costs. These are listed below.

Case	Description
PP1	Zero price from the National Power Corporation, no sales to the Corporation.
PP2	A price of .35 pesos/kilowatt-hour instead of 1.10 pesos per kilowatt-hour used in the replication case.
PP3	A 5% growth in local demand up to the point where all output is sold locally.
PP4	All power sold locally at the outset.
PP5	A 20% higher investment cost.
PP6	A 20% lower investment cost.

In addition to these, we have included one sensitivity on the economic analysis results. For this test we examined the impact on net benefits from a drop in forecasted oil price. These results will be presented after the financial analysis sensitivities.

Only PP1, PP2 and PP5 will be used to assess project risk. The others illustrate the sensitivity to key assumptions, and how these changes improve the financial viability of the power plants. Cases PP1 through PP4 are shown in Table VI.19, with ISECO and PANELCO I used for the analysis. These two were chosen for these sensitivities because ISECO had the best power plant financial internal rate of return (FIRR), and PANELCO I had the lowest proportion of local sales for a site interconnected to the National Power Corporation grid. For cases PP5 and PP6, the choice was based on the best and worst FIRRs which resulted in ISECO (best) and CASURECO IV-A (worst). Table VI.20 shows these results.

As with the plantation sensitivities, the best site shows very little sensitivity to changes and the alternate site shows a great deal of sensitivity to changes. The zero price sensitivity (PP1) in which no power can be sold to the National Power Corporation, results in a severe drop in FIRR for PANELCO I, but very little change for ISECO. The same is true for the lower price sensitivity (PP2). These results indicate that sites similar to PANELCO I run the risk of project failure if either the price they receive for their excess

Table VI.19

Power Plant Sensitivity Analysis - Impact on Annual Cash Flows
Cases PP1 to PP4
(in thousands of 1984 pesos)

	1981	1982	1983	1984	1985-2009	Financial Internal Rate of Return
ISECO						
Replication	(5,006)	(31,836)	(14,003)	(15,025)	15,144	17.7%
PP1	(5,006)	(31,836)	(14,003)	(15,025)	14,421	17.0%
PP2	(5,006)	(31,836)	(14,003)	(15,025)	14,642	17.2%
PP3	(5,006)	(31,836)	(14,003)	(15,025)	16,610	17.9%
PP4	(5,006)	(31,836)	(14,003)	(15,025)	15,227	17.8%
PANELCO I						
Replication	(8,814)	(43,160)	(12,248)	(10,057)	13,985	14.4%
PP1	(8,814)	(43,160)	(12,248)	(10,057)	2,927	4.6%
PP2	(8,814)	(43,160)	(12,248)	(10,057)	6,564	6.2%
PP3	(8,814)	(43,160)	(12,248)	(10,057)	15,267	15.3%
PP4	(8,814)	(43,160)	(12,248)	(10,057)	20,034	19.5%

Table VI.20

Power Plant Sensitivity Analysis - Impact on Annual Cash Flows
Cases PP5 to PP6
(in thousands of 1984 pesos)

	1981	1982	1983	1984	1985-2009	Financial Internal Rate of Return
ISECO						
Replication	(5,006)	(31,836)	(14,003)	(15,025)	15,144	17.7%
PP5	(6,007)	(38,203)	(16,900)	(18,030)	15,144	15.1%
PP6	(4,005)	(25,469)	(11,266)	(12,020)	15,144	21.3%
CASURECO IV-A						
Replication	(4,620)	(66,583)	(10,306)	(13,957)	12,429	10.1%
PP5	(5,544)	(79,900)	(12,367)	(16,748)	12,429	8.2%
PP6	(3,696)	(53,266)	(8,245)	(11,166)	12,429	12.6%

energy sales to the Corporation is in the neighborhood of .35 pesos/kilowatt-hour, or if they cannot sell any excess power to the Corporation because it lacks an available transmission line.

In the economic analysis presented earlier, benefits from the power plants were defined as the amount of foreign exchange the power plants release from import substitution of foreign oil. Using oil substitution and, hence foreign exchange release as the benefits accrued by the wood fired power plant projects, ties benefits to the price of world oil over the time horizon used in the analysis. Although forecasting the world price of oil is well beyond the scope of this analysis, we can illustrate the sensitivity of our baseline/replication case results for the economic analysis using an alternate oil price in all years (no increase in the real price of oil). Based on current prices, we decided to use a price of $24/bbl for this sensitivity.

A summary of these results is presented in Table VI.21, which shows the change in net benefits and EIRR for each site. The benefits are shown in thousands of pesos, converted from dollars at 18 pesos to the dollar. Because the alternate price is 63% of the former price of $38/bbl, the benefits and resulting EIRRs are signficiantly reduced.

Table VI.21

Comparison of Power PlanT Economic Benefits and EIRR from a Change in World Oil Price

Site	Benefits (in 1,000s of Pesos) at $38/bbl	Benefits (in 1,000s of Pesos) at $24/bbl	Economic Internal Rate of Return at $38/bbl	Economic Internal Rate of Return at $24/bbl
1. CASURECO IV-A	21,494	13,575	14.5%	7.5%
2. ZAMECO	21,494	13,575	13.3%	5.9%
3. OMECO	2,784	1,758	5.4%	0.0%
4. ANTECO	6,656	4,204	13.4%	7.0%
5. PANELCO I	23,575	14,889	20.4%	12.4%
6. ISECO	23,575	14,889	22.8%	13.6%

G. PROJECT RISKS

The purposes of project risk analysis are to isolate those factors which could prevent the project from not reaching its potential. The project risks associated with the power plants are greatest in the area of the NPC buy-back price and the level of local demand. A substantial differential exists between the value of power consumed locally and the off-peak power sold to the National Power Corporation (NPC) grid. This differential arises due to the transmission losses associated with moving the power from one co-op grid to another as well as the relatively lower cost of off-peak power production which would be saved by NPC by purchasing this power from the dendro plants. The buy-back price should be established to reflect the actual cost savings accruing to NPC through the availability of dendro power, perhaps on a site-specific basis. A price which does not reflect those cost savings will introduce distortions into the electric power production resource allocation mechanism and result in inefficiencies. The derivation of this price is an extremely complex task as well beyond the scope of the present analysis, but it is unlikely that the parity between buy and sell rates accurately reflects cost savings. The co-ops are buying power at peak and selling it off-peak, the latter almost certainly having a lower value. The net result of all these factors is that project risks increase as the level of local demand decreases.

Another potential risk relates to the expected shortfall in fuel wood supply from the tree farm plantations. Any shortfall must be made up through purchases on the fuel wood markets. If the demand for domestic and industrial fuel wood is increasing due to high fossil fuel prices, dendro plants which have significant shortfalls in plantation fuel wood supply could experience large price increases in market purchased fuel wood as well as restricted availability. This is especially true of markets near metropolitan areas. This potential problem could be ameliorated by ensuring adequate plantation supplied fuel prior to construction of the power plant.

The greatest sensitivities in the farm viabilities are revealed both in the sensitivity analysis and in the differences between baseline and replication cases. The improvement areas addressed in developing the replication case were site and species selection to increase survival and yield, and development conducted on a regular and consistent timetable. The increase in returns resulting from these improvements were quite significant indicating that proper planning, consistent financing and in-depth site-specific forestry analysis are all necessary to reduce project risks.

Another area where project risks were revealed relates to harvesting costs. Should those costs be significantly higher than expected, the rate of return to the tree farms is greatly reduced. This risk can only be resolved by site-specific harvesting planning activities conducted prior to tree farm development with this factor incorporated into the site selection process.

The nature of the tree farm project also opens up another, unquantifiable area of risks associated with natural disasters. The greatest risk seems to be fire, but risks also are present from storm or insect damage. These risks, particularly fire, can be reduced but only at the expense of productivity. For example, land devoted to fire breaks is not available for tree plantings and must be cleared on a regular basis. There is also a question regarding the productivity of the trees following several coppice cycles. The extent and timing of replantings are not known at present and can only be resolved with further research and experience at each site.

In summary, the dendro thermal concept appears to be a viable alternative to conventional power production methods, but only if potential risks are reduced. The concept is not appropriate for all places at all times; the land must be suitable for the fuel wood species selected, and the level of local power demand as well as the value of power produced in excess of local demands must be carefully evaluated. Other power production methods such as hydroelectric and geothermal should be investigated where site characteristics are technically appropriate.

VII. RECOMMENDED INVESTMENT PACKAGE

The Georgia Tech Research Institute, finding the Philippine Dendro Thermal Development Program feasible, recommends that the Asian Development Bank give favorable consideration to the loan package outlined below. This recommendation follows from the investigations and findings summarized earlier in this volume of the study, as substantiated by the detailed economic and technical findings and consultants' reports contained in Volume II. They support the conclusion that electric power can be generated in the Philippines by wood-fired steam plants at a price competitive with power produced from oil-fired steam plants. The fuel wood plantations can also provide other valuable economic and social benefits for the rural community.

Overall, investment in the dendro thermal program offers an attractive prospect for providing a locally renewable source of energy while contributing to the objective of rural development.

The investment recommended below represents an order of magnitude only. It is not based on detailed cost estimates. It does conform to what is believed to be a prudent next phase in the program, considering the local currency shortage in the Philippines and GTRI's confirmation of the essential soundness of the program.

1. The partially completed wood-fired power plants (eight to ten plants) and their associated tree plantations could be economically sound investments if completed in line with the recommendations contained in this report. The decisions on which particular recommendations apply to each incomplete power plant and partially established tree plantation must be based on an examination of each site and the status of the power plant. Nine power plants are under construction and eight are in storage. Of those in storage, some parts have already been used as spares and some have detoriated from exposure to weather. The amount of funds needed will need to be determined for each plant. This estimate includes funds to complete the interconnections to the NPC grid.

   Estimated range of investment $12 to $15 million

2. Completion of tree plantations associated with the incomplete power plants. The tree plantations are in various stages of development. Like the power plants, each site must be studied individually. In all cases, funds will be needed to ensure the required yields and to provide for the harvesting systems.

Estimated range of investment	$2 to $3 million

3. Construction of five new 3-5 MW power plants - next phase of expansion. New projects should be based on site-specific feasibility studies for 3-5 MW power plants and associated tree plantations following the recommendations which emerged from the GIT study. The essential characteristics of a successful dendro energy project are contained in the recommendations of Chapters IV and V.

Estimated range of investment	$22 to $30 million

4. Development of plantations for the five new power plants.

Estimated range of investment	$ 1 to $2 million
Total estimated range of investment	$37 to $50 million

These amounts should provide adequate funds for internationally awarded contracts for power plant equipment and supervision of installation, for Philippine general contractors for civil works, and for Philippine technical assistance for tree plantations. Because of the lack of local currency available from the Government of the Philippines for the program, any investment package should make provision for the local currency as well as the foreign exchange expenditures. If grant technical assistance is not provided from other sources for applied research and improved monitoring of program results, then the ADB should provide or arrange for such assistance as part of the investment package. Investment in research and data gathering would not

only benefit the Philippine long-range dendro thermal program but would assist other of the Bank's member countries make decisions with respect to this type of project.

Annex III.1

Status of Dendro Training Activities Conducted

STATUS OF DENDRO TRAINING ACTIVITIES CONDUCTED*

COURSES	CY 1981		CY 1982		CY 1983		TOTAL	
	# of Courses	Number of Participants	# of Courses	Number of Participants	# of Courses	Number of Participants	# of Courses	Number of Participants
A. INSTITUTIONAL DEVELOPMENT								
1. Seminar on the Organization and Supervision of Farmers Association (Participants - Dendro Coordinators or Project Specialists)	-	-	1	25	2	33	3	58
2. Orientation Seminar for Farmers Associations on Dendro Power Projects (Participants - Registered members of the FA's)	9	756	21	1,813	8	500	38	3,069
B. TREE PLANTATION MANAGEMENT (AGRO-FORESTRY)								
1. Seminar on Energy Plantation (Ipil-Ipil) Development & Management (Participants - Co-op Agriculturists/Aides or Foresters)	2	84	1	17	1	34	4	135
2. Seminar-Workshop on Advanced Plantation Development & Management (Participants - Co-op Agriculturists/Aides or Foresters who have attended Basic Energy Plantation Seminar)	-	-	2	59	-	-	2	59
3. Conference-Workshop on Dendro Power Project Implementation (Participants - Elect. Co-op Board President, General Manager, Dendro Coordinator, Accountant Agriculturist/Forester Representative - FA)	6	260	5	151	-	-	11	411
4. Conference-Workshop on Ipil-Ipil Experience (Participants - Co-op General Managers)	-	-	1	35	-	-	1	35
5. Seminar on Forest Fire Control (Participants - Agriculturists or Foresters)	-	-	-	-	1	38	1	38

STATUS OF DENDRO TRAINING ACTIVITIES CONDUCTED (CONTINUED)

COURSES	CY 1981		CY 1982		CY 1983		TOTAL	
	# of Courses	Number of Participants	# of Courses	Number of Participants	# of Courses	Number of Participants	# of Courses	Number of Participants
C. FINANCIAL ASPECT:								
1. Dendro Power Project Accounting Course I (Participants - Dendro Accountants/Bookkeepers)	-	-	3	74	-	-	3	74
D. TECHNICAL OPERATIONS (POWER PLANT)								
1. Seminar on Dendro Power Plant Technology (Participants - Plant Engineers)	1	36	-	-	-	-	1	36
2. On-the-Job Training on Dendro Power Plant (550 kW) Operations and Maintenance Korean Designed (Participants - Power Plant Engineers)	-	-	4	56	-	-	4	56
3. Seminar on Water Treatment (Participants - Power Plant Engineers)	-	-	1	29	-	-	1	29
	18	1,136	39	2,259	12	605	69	4,000

NOTE: As of 1st Quarter 1984:

1. On-the-Job Training on Dendro Power Plant Operations and Maintenance French-Designed (Participants - Plant Engineers & Operators: Turbine/Boiler/Switchboard)	1	21

* Due to severe budget constraints in CY 1984, training during the first three months of the year was limited to one course for 21 participants trained in dendro power plant operation and maintenance.

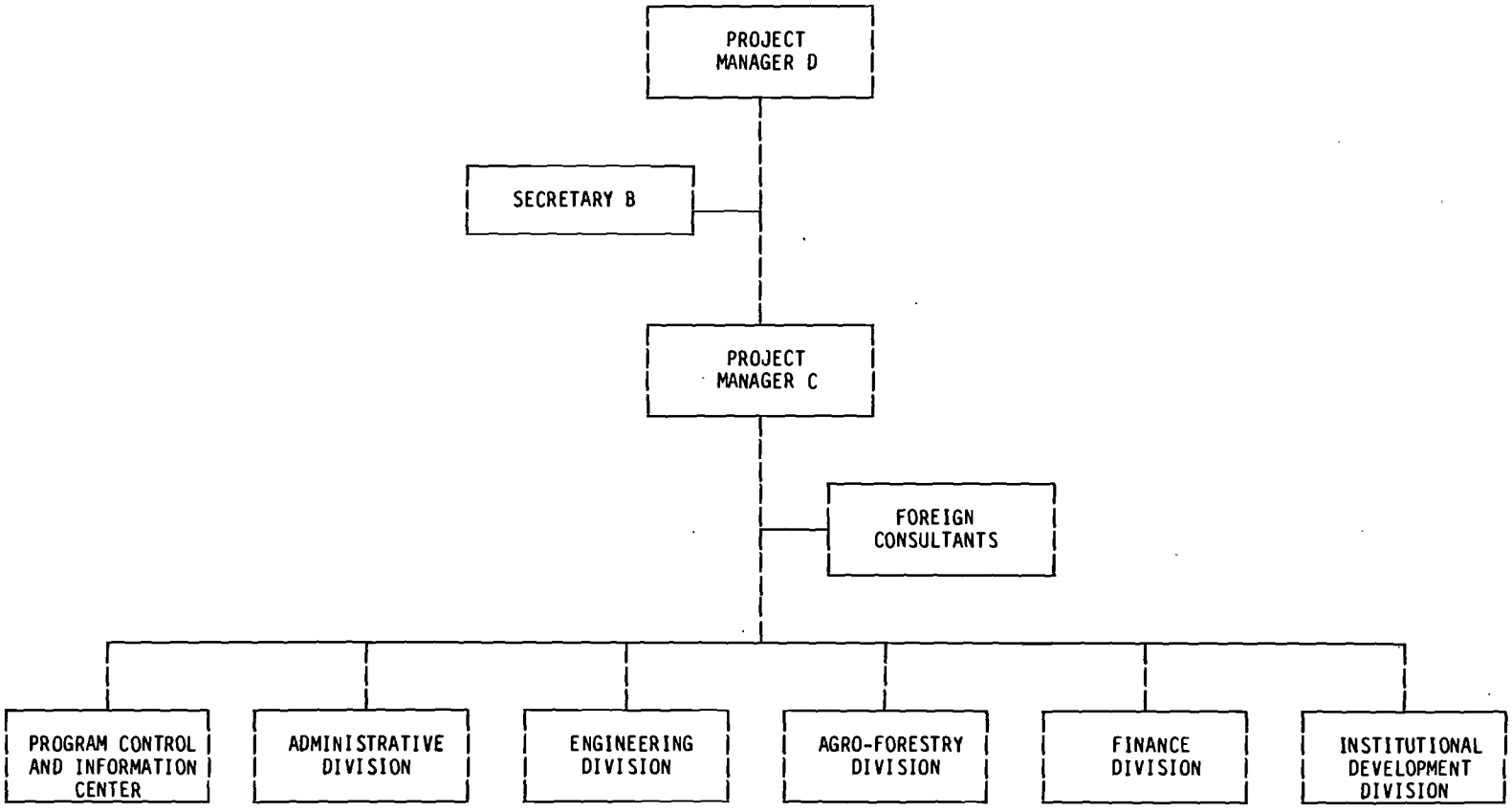
Annex III.2

Dendro Thermal Development Office

Organizational Charts and Function Lists

DENDRO THERMAL DEVELOPMENT OFFICE

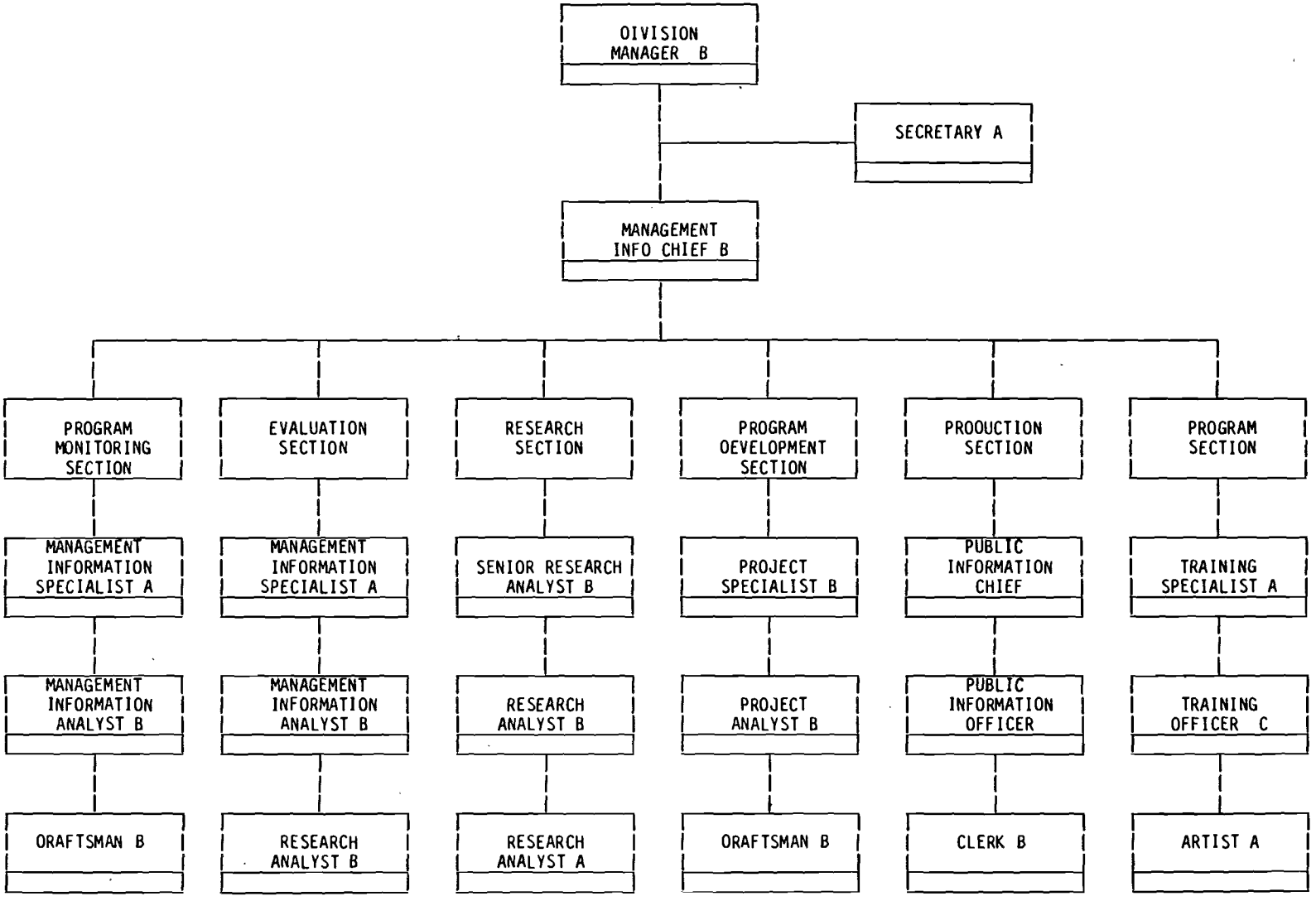
ORGANIZATIONAL CHART



TOTAL PERSONNEL COMPLEMENT = 119
(EXCLUDING FOREIGN CONSULTANTS)

TOTAL FILLED POSITIONS 68

DENDRO THERMAL DEVELOPMENT OFFICE
PROGRAM CONTROL AND INFORMATION CENTER
ORGANIZATIONAL CHART



TOTAL PERSONNEL COMPLEMENT = 21

F U N C T I O N S

PROGRAM CONTROL AND INFORMATION CENTER

1. Monitors and evaluates the extent of implementation of dendro thermal projects vis-a-vis plans and schedules through the operation of a data bank, and provides NEA management with regular progress reports.

2. Prepares project proposals for funding purposes and conducts researches/special studies on the impact of the dendro thermal projects in the rural areas.

3. Sets up an effective system of disseminating information such as the quarterly publication "Information Service," slide presentations, lectures, organizational briefings, and meetings, among others leading to the promotion of the dendro-thermal program.

4. Conducts necessary studies, prepares proposals, and assists in the negotiations for foreign loans requirements or acquisition of grants for the dendro thermal program.

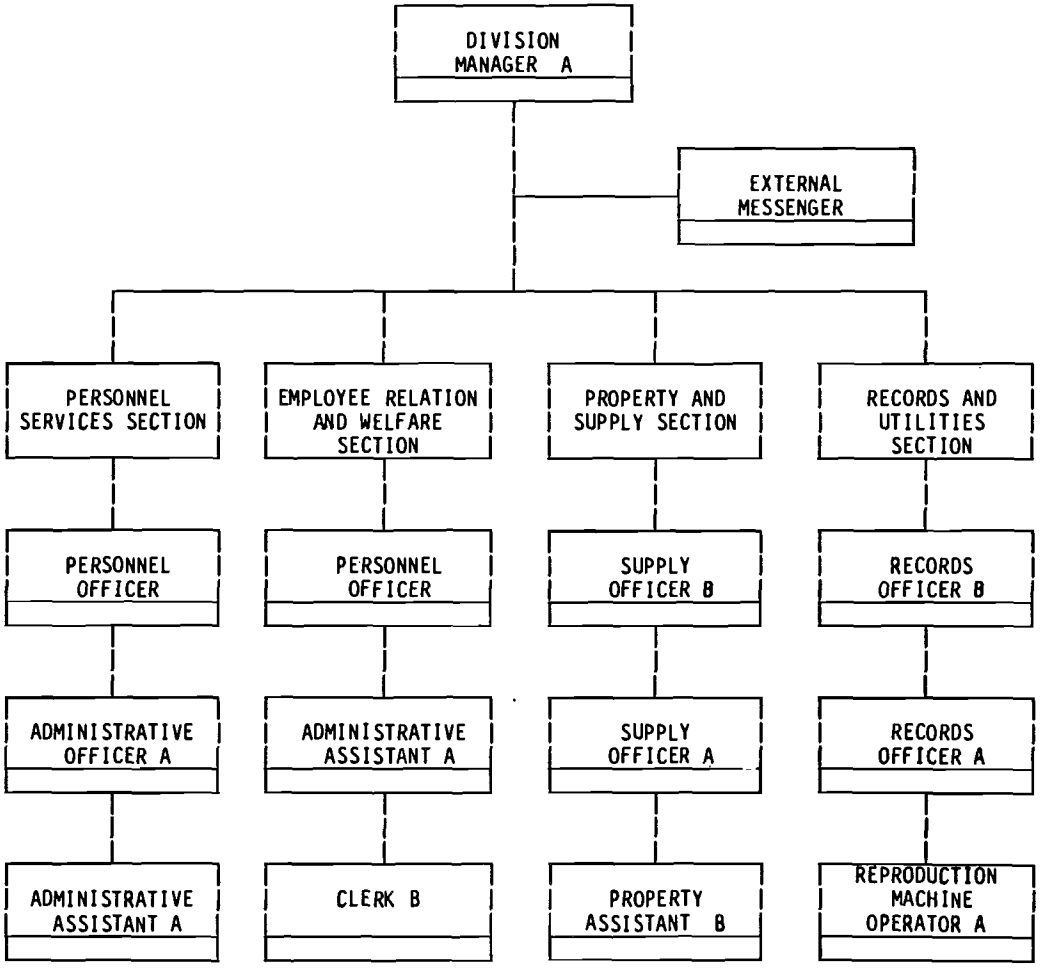
5. Undertakes organizational evaluation/audits of the farmers associations and their relationship to the electric cooperatives power plan set-ups.

6. Functions as the public relations office of the Dendro Thermal Development Office locally (at the rural areas and/or national government level) and internationally (with foreign governments and their instrumentalities and/or other foreign lending institutions).

DENDRO THERMAL DEVELOPMENT OFFICE

ADMINISTRATIVE DIVISION

ORGANIZATIONAL CHART



TOTAL PERSONNEL COMPLEMENT = 14

F U N C T I O N S

ADMINISTRATIVE DIVISION

1. Conducts continuing studies related to the formulation and implementation of procedures and guidelines in the recruitment, testing, selection, and placement of qualified personnel in the office.

2. Assists line offices in maximizing utilization of human resources through timing of hiring schedules, implementation of agency policies on personnel management, monitoring of the observance of proper office decorum, conducting thorough orientation sessions on the dendro thermal program, organization/maintenance of a complaints and grievance machinery and guidance and counselling program, and periodic evaluation of employee morale, discipline, and wholesome working inter-relationships.

3. Provides advisory assistance to the line departments in drawing up the administrative portions of the dendro thermal project studies such as position classification, wage and salary administration, hiring schemes, setting up of qualification standards, and other related matters.

4. Initiates positive steps to recruit the best qualified personnel; establishes/maintains a Register of Qualified Applicants and a filing system for same.

5. Performs research studies on the In-Service Training needs for the office personnel, develops training programs, coordinates with the proper line offices in conducting these, and undertakes periodic evaluation of said training programs.

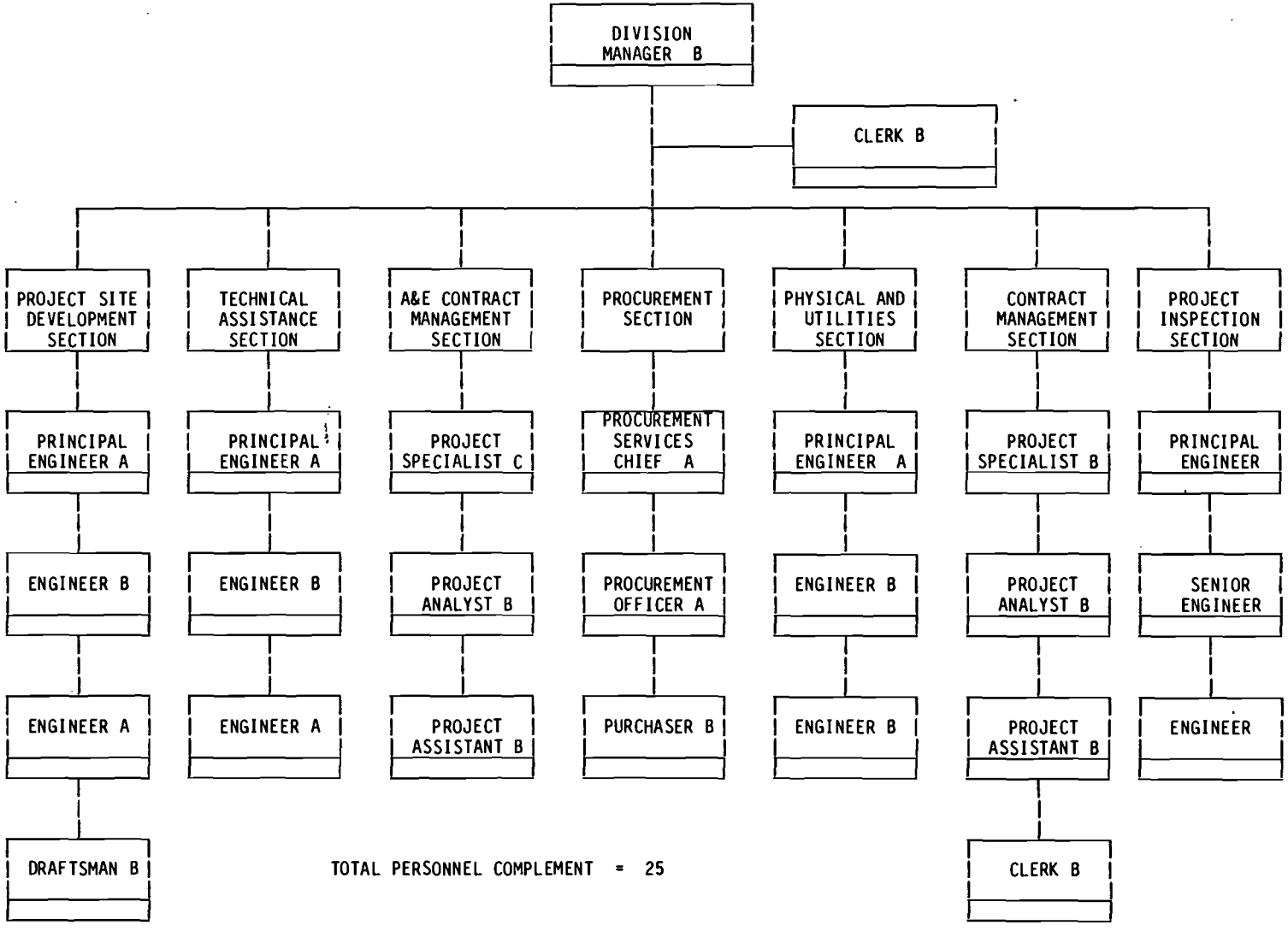
6. Designs/prepares forms/charts/graphs pertaining to personnel administration; renders periodic statistical status reports.

7. Assumes responsibility for personnel matters at the office level which includes timekeeping, leaves, drawing-up of job specifications/descriptions, performance appraisal system, maintaining personnel files, undertaking special programs (sports/cultural, etc.), and others.

DENDRO THERMAL DEVELOPMENT OFFICE

ENGINEERING DIVISION

ORGANIZATIONAL CHART



F U N C T I O N S

ENGINEERING DIVISION

1. Establishes procedures and guidelines in extending assistance to electric cooperatives dendro thermal project in the areas of economics and technical research, feasibility studies, site evaluation/identification, technical design, construction contract bidding, negotiation and award, and others.

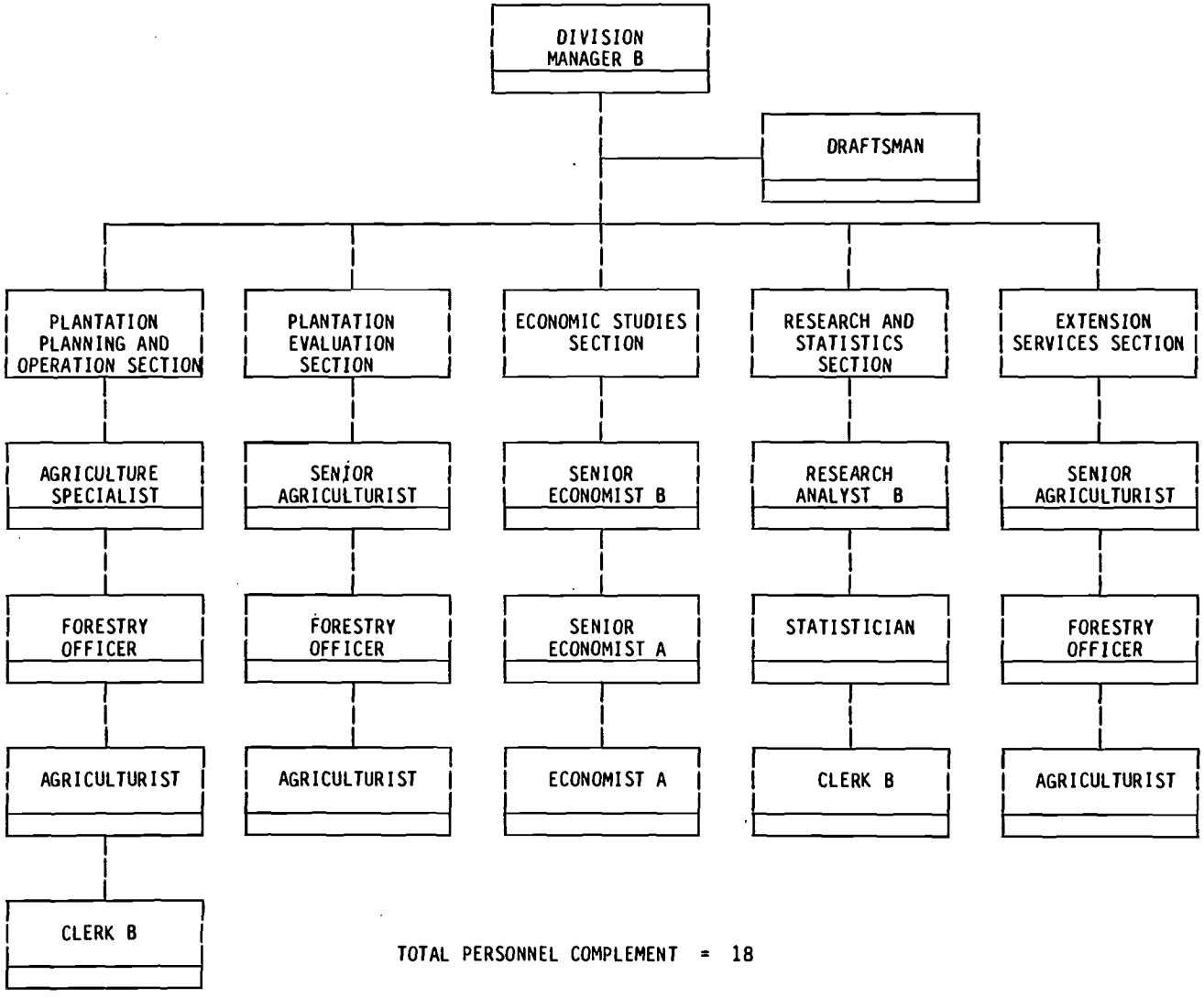
2. Formulates policies and guidelines, undertakes evaluation and review of foreign loan fund/equipment proposals, conducts actual review and recommendations of architecture and engineering proposals covering plans, specifications and estimates, and procurement of physical systems for dendro thermal projects.

3. Supervises the construction of the physical systems of the projects, monitors its operation, and provides continuous technical assistance to electric cooperatives.

DENDRO THERMAL DEVELOPMENT OFFICE

AGRO-FORESTRY DIVISION

ORGANIZATIONAL CHART



TOTAL PERSONNEL COMPLEMENT = 18

F U N C T I O N S

AGRO-FORESTRY DIVISION

1. Prepares overall energy tree plantation program and undertakes the evaluation of plantation development plans of various electric cooperatives engaged in the dendro thermal projects.

2. Formulates, plans, and implements guidelines and procedures in farm operations and management to achieve maximum yields in the tree plantations to be able to support the dendro thermal program execution on a national scale.

3. Identifies, evaluates, and recommends sites for tree plantation in coordination with the Dendro Thermal Engineering Division, the electric cooperatives, and the duly authorized government offices/bureaus.

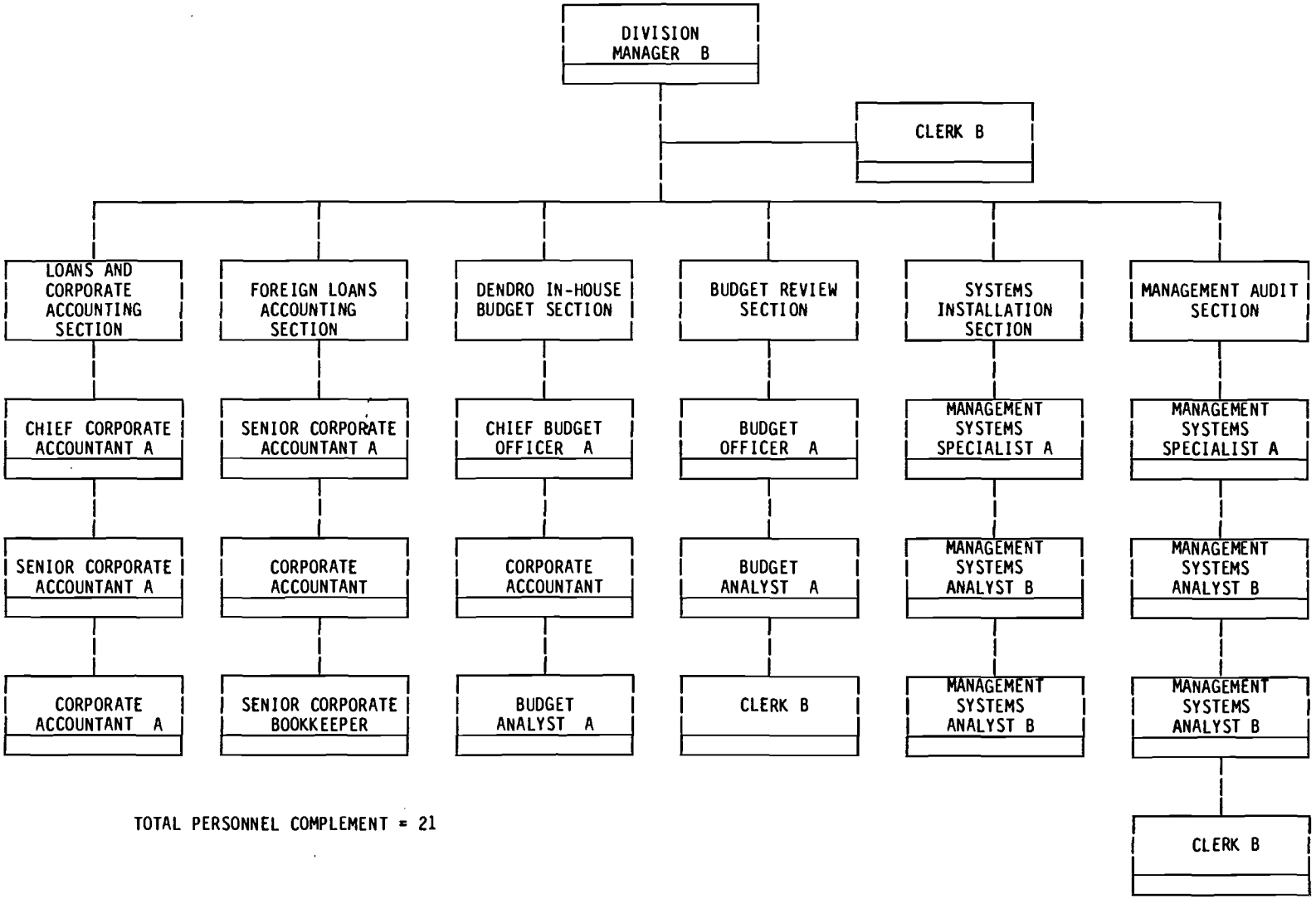
4. Provides continuous research/studies and technical extension services to farm technicians and farmers associations nationwide to develop and improve farm operations and management.

5. Installs systems and undertakes the regular monitoring and evaluation of plantation establishment, development, and operations and management to ensure the effective utilization of plantation funds and assure the availability of wood supply for the power plant.

DENDRO THERMAL DEVELOPMENT OFFICE

FINANCE DIVISION

ORGANIZATIONAL CHART



TOTAL PERSONNEL COMPLEMENT = 21

F U N C T I O N S

FINANCE DIVISION

1. Supervises the accounting, budgeting, and auditing functions of the Dendro Thermal Development Office.

2. Reviews and checks regular reports and the status of loan contracts and actual amounts released to the Dendro Thermal Project.

3. Supervises the regular audits of dendro thermal projects.

4. Oversees budgeting procedures and the amounts to be released for dendro thermal projects.

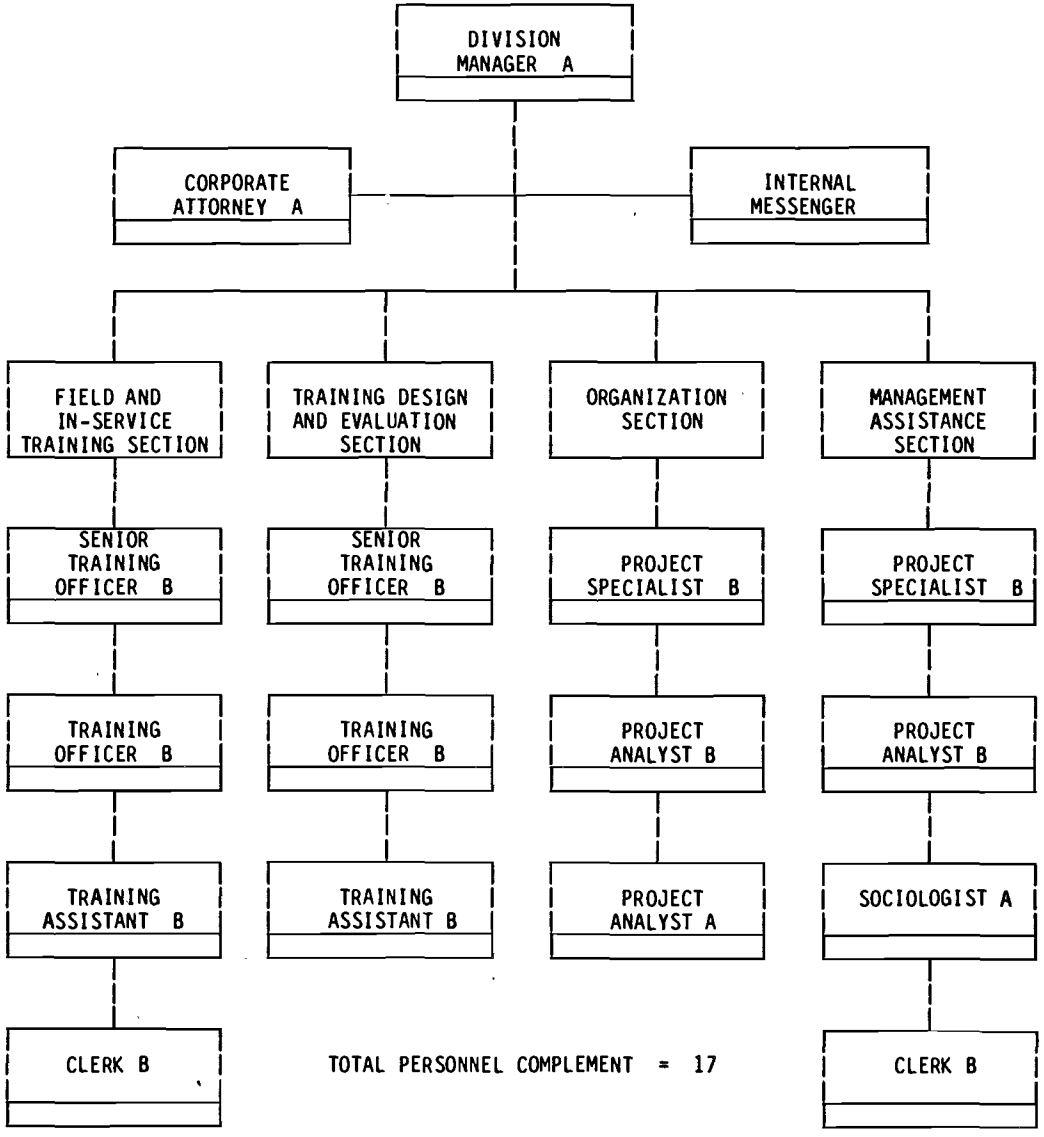
5. Reviews annual budgetary requirements of dendro thermal projects and prepares funding requirements.

6. Coordinates with other divisions concerned with regards to the relationship of the financial requirements of the Dendro Thermal Project to overall program objectives.

DENDRO THERMAL DEVELOPMENT OFFICE

INSTITUTIONAL DEVELOPMENT DIVISION

ORGANIZATIONAL CHART



F U N C T I O N S

INSTITUTIONAL DEVELOPMENT DIVISION

1. Plans and implements a total scheme for the organization, development, and promotion of dendro thermal projects.

2. Undertakes training for individuals and groups of government and private sectors involved in the program, as well as in-service training of dendro thermal personnel.

3. Organizes, coordinates, and supervises the activities of the different divisions within the Institutional Division.

4. Coordinates with other directorates, government offices, and other organizations.

5. Assists the Administrator in the formulation of sound written policies.

6. Submits a consolidated budget of the fund requirements of the different divisions of the Department for the approval of the Administrator.

Annex III.3

Dendro Thermal Development Office Progress Report

DENDRO THERMAL DEVELOPMENT OFFICE
SUMMARY OF PROGRESS REPORT AS OF JUNE 30, 1984

	LAST REPORT	THIS REPORT	TOTAL TO DATE
I. INSTITUTIONAL DEVELOPMENT			
A. Organization Development			
a. Plantation Organized	37	-	37
b. Farmers Association Registered	338	-	338
c. Total Number of Members	3 838	10	3 848
B. Dendro Thermal Seminars			
a. Training Activities Conducted	70	-	70
b. Total Number of Participants	4 021	-	4 021
C. Management Assistance Services			
a. Medical Services	38	-	38
b. Insurance	4	-	4
II. A. LOAN AGREEMENTS			
1. Plantation Development			
a. Number of Loan Agreements	40	-	40
b. Amount of Approved Loan	175.93 M	-	175.93 M
c. Amount of Released Loan	54.32 M	0.49 M	54.81 M
2. Power Plant			
a. Number of Loan Agreements	17	-	17
b. Amount of Approved Loan	642.28 M	-	642.28 M
c. Amount of Released Loan	394.75 M	6.74 M	401.49 M
B. PROGRAM FUNDING AND AVAILMENTS			
1. Local Funding			
a. Project Cost	757.00 M*	-	757.00 M
b. Availments	198.21 M	7.27 M	205.48 M
2. Foreign Funding			
a. Project Cost	638.99 M*	-	638.99 M
b. Availments	469.77 M	119.60 M	589.37 M
III. PLANTATION DEVELOPMENT			
a. Number of Plantation Sites Identified	40*	-	40
b. Feasibility Studies Approved	40	-	40
c. Total Land Area Covered (Has.)	63 059	-	63 059
d. Area Planted (Has.)	17 450	277	17 727
e. Area Surviving (Has.)	7 664	288	7 952
IV. POWER PLANT FACILITIES			
a. Number of Power Plant Sites Identified	36	-	36
b. Equipment Ordered	17	-	17
c. Feasibility Studies Approved	17	-	17
d. A & E Services Contracts	17*	-	17
e. Construction Contracts	14	-	14
f. No. of Power Plant Commissioned	1	-	1

*Adjusted

STATUS OF CONSTRUCTION CONTRACTS
AS OF JUNE 30, 1984

	PROJECT	CONTRACTOR	CONTRACT AMOUNT	DATE AWARDED	TARGET COMPLETION TIME(DAYS)	% OF COMPLETION
1.	INEC Solsona	Pacific Asia Builders and Development, Inc.	₱ 7 777 099	21 Jan. 1982	550	In operation. Power plant modification in process.
2.	PANELCO I Bolinao	Eng'g. Construction Corp.-ASIA	14 000 000	05 Feb. 1982	343	Power plant modification in process.
3.	ISELCO II Ilagan	Engineering Equipment, Inc.	8 246 209	28 Jan. 1982	626	95.5
4.	ANTECO Hamtic	F.F. Cruz and Co.	8 823 675	17 Feb. 1982	604	96.41
5.	ISELCO I Jones	Eng'g. Construction Corp.-ASIA	9 560 000	24 Feb. 1982	815	73.23
6.	ABRECO San Juan	S.D. Flores Construction	11 111 111	23 Apr. 1982	575	Contract suspended indefinitely
7.	ZAMECO Palauig	RIMCO Construction	11 451 000	18 May 1982	690	98.51
8.	AKELCO Nabas	Eng'g. Construction Corp.-ASIA	11 751 000	02 Sept. 1982	510	Termination of contract in process.
9.	NUVELCO Dupax del Norte	WGS Construction Specialists	10 507 603	11 June 1982	300	Contract terminated.
10.	CASURECO IV Caramoan	Bicol Woodworks Industries, Co.	10 849 660	08 July 1982	609	82.0
11.	OMECO Magsaysay	Power Consultants, Inc./ Isabelo Ong Construction Co., Inc.	3 920 000	13 July 1982	699	88.35
12.	ILECO II Lambuano	Engineering Equipment, Inc.	14 700 000	25 Oct. 1982	390	Termination of contract in process.
13.	ISECO Burgos	C.R. Baluyot Construction	13 718 730	03 Nov. 1982	529	77.42
14.	MARELCO Buenavista	Phil. Const. Consortium Corp.	11 200 000	11 July 1982	321	Contract suspended indefinitely

REGISTERED FARMERS ASSOCIATION
AS OF JUNE 30, 1984

PROJECT	NAME OF FARMERS ASSOCIATION	NUMBER OF FARMERS ASSOCIATION	NUMBER OF MEMBER	DATE OF INCORPORATION AND REGISTRATION
PANELCO I	Cape Bolinao	10	100 *	May 1, 1980
CENPELCO	Aguilar	10	100	May 24, 1980
INEC	First Ilocos Norte	10	93	June 7, 1980
AKELCO	Havana	10	130	August 13, 1980
ANTECO	Hamtic	3	57 *	August 17, 1980
ABRECO	San Juan	12	173	August 23, 1980
ISECO	Padre Burgos	10	96 *	August 23, 1980
ISELCO II	Ilagan	10	73 *	September 28, 1980
PALECO A	Aborlan	10	92	November 29, 1980
BATELCO	Bataan	10	107	November 30, 1980
PANELCO III	San Manuel	10	100	December 1, 1980
ZAMECO	Palauig	10	99	January 16, 1981
CAPELCO	Tapaz	10	135	January 16, 1981
CASURECO IV-A	Caramoan/Presentacion	10	121	February 14, 1981
ISELCO I	Jones	9	129 *	March 26, 1981
FICELCO	Virac	5	53	March 28, 1981
OMECO	Occidental Mindoro	4	31	April 22, 1981
NUVELCO	Dupax	10	100	May 16, 1981
MARELCO	Marinduque	10	148	May 29, 1981
PELCO II	Pasbol	10	99	June 11, 1981
BOHECO I	Dagohoy	10	138 *	June 26, 1981
ILECO II	Lambunao	10	127	July 24, 1981
NEECO II	Pantabangan	10	110	July 31, 1981
ILECO I	Miagao	10	114	October 23, 1981
TAWELCO	Balimbing	5	72	January 23, 1982
LUELCO	Aringay	10	100 *	February 19, 1982
NOCECO	Biao	10	81	February 23, 1982
BECO I	Doña Remedios Trinidad	10	96	March 17, 1982
CASURECO III	Balatan	10	145	May 10, 1982
CAGELCO II	Lallo-Lasam	10	134 *	June 10, 1982
BOHECO II	Duero	10	98	June 10, 1982
CASURECO II	Balatan	10	142	June 24, 1982
PALECO B	Sta. Lourdes	10	85	September 10, 1982
CASURECO IV-B	Garchitorena	10	116 *	September 16, 1982
CENECO*	Ceneco	6	72	October 29, 1982
CENECO	Ceneco	4	52	March 1, 1983
AKELCO	Pawa	5	60	February 8, 1983
QUEZELCO I	San Vicente	5	70 *	May 26, 1983
	TOTAL	338	3 848	

*Adjusted

STATUS OF PROGRAM FUNDING AND AVAILMENTS
(IN THOUSAND PESOS)
AS OF JUNE 30, 1984

SOURCE	PROJECT COST *	AVAILMENT THIS REPORT	BALANCE
LOCAL FUNDING			
Tree Plantation	288 500	54 807	233 693
Dendro Power Plants **	423 458	136 249	287 209
Wood Gasifier	35 385	14 153	21 232
Engineering Services	9 657	266	9 391
TOTAL	757 000	205 475	551 525
FOREIGN FUNDING			
Dendro Power Plants **			
United Kingdom	340 100	339 398	702
France	230 670	216 572	14 098
Wood Gasifier			
France	20 970	20 970	-
Engineering Services			
OECF - Japan	17 550	9 729	7 821
ESF-USAID	18 000	-	18 000
ADB	11 700	2 700	9 000
TOTAL	638 990	589 369	49 621

* Adjusted

** For 15 Dendro Power Plants

TREE PLANTATION LOAN RELEASES
AS OF JUNE 30, 1984

PROJECT	LOAN NO.	DATE OF LOAN CONTRACT	APPROVED LOAN (P M)	AMOUNT RELEASED (P M) LAST REPORT	THIS REPORT	TOTAL TO DATE
1. ABRECO	267	12-17-80	4.39	4.39		4.39
2. INEC	239	12-03-80	4.74	3.12		3.12
3. ISECO	297	12-17-80	4.39	1.73		1.73
4. LUELCO	82	03-10-82	4.39	0.87		0.87
5. PANELCO I	215	12-01-80	4.50	4.50		4.50
6. CENPELCO	238	12-01-80	4.39	1.48		1.48
7. PANELCO III	269	12-01-80	4.39	1.34		1.34
8. CAGELCO II	253	08-28-82	4.39	0.55		0.55
9. ISELCO I	100	07-15-81	4.04	1.82		1.82
10. ISELCO II	330	01-14-81	4.39	1.37		1.37
11. NUVELCO	147	07-15-81	4.39	0.62		0.62
12. BATELCO	292	11-30-80	4.39	2.10		2.10
13. BECO I	236	02-03-82	4.39	0.56		0.56
14. NEECO I				0.16		0.16
15. NEECO II	206	08-22-81	4.39	1.58		1.58
16. PELCO I				0.15		0.15
17. PELCO II	171	07-15-81	4.39	0.78		0.78
18. TARELCO	101	07-15-81	4.04	2.07		2.07
19. ZAMECO	283	01-28-81	4.39	2.43		2.43
20. MARELCO	170	07-15-81	4.39	1.53		1.53
21. OMECO	136	09-02-81	2.10	0.84		0.84
22. PALECO (A)	282	12-17-81	4.04	2.27		2.27
23. PALECO (PP)	193	07-28-82	4.39	0.75	0.19	0.94
24. QUEZELCO I	255	07-28-82	4.39	0.30		0.30
25. LUBELCO I				0.10		0.10
26. CASURECO I				0.15		0.15
27. CASURECO II	254	07-28-82	4.39	1.15		1.15
28. CASURECO III	183	05-19-82	4.39	0.95		0.95
29. CASURECO IV-A	329	05-16-81	4.39	1.43		1.43
30. CASURECO IV (Garchitorena)	076	06-03-83	4.39	0.15		0.15
31. FICELCO	270	05-16-81	2.45	1.32		1.32
32. MASELCO	376	12-15-82	4.39	0.30		0.30
33. AKELCO	268	12-17-80	4.39	2.10		2.10
34. ANTECO	083	07-15-81	1.75	1.12		1.12
35. CAPELCO	099	06-22-81	4.39	2.75	0.30	3.05
36. CENECO	312	09-01-82	7.75	0.47		0.47
37. ILECO I	097	03-17-82	4.39	0.93		0.93
38. ILECO II-A	220	09-02-81	4.39	1.11		1.11
39. ILECO II-B	371	01-07-83	7.75	0.15		0.15
40. NOCECO	279	02-03-82	4.39	1.27		1.27
41. BOHECO I	155/305	08-05-81/09-02-81	7.75	0.80		0.80
42. BOHECO II	108	04-21-82	4.39	0.30		0.30
43. CEBECO I	278	02-03-82	4.39	0.15		0.15
44. TAWELCO	143	04-21-82	2.10	0.31		0.31
T O T A L			175.93	54.32	0.49	54.81

POWER PLANT LOAN RELEASES
AS OF JUNE 30, 1984

	PROJECT	LOAN NO.	DATE OF LOAN CONTRACT	APPROVED LOAN (P M)	AMOUNT RELEASED (P M) LAST REPORT	THIS REPORT	TOTAL TO DATE
1.	ABRECO	263	10-14-81	41.76	27.46		27.46
2.	INEC	219	09-02-81	42.39	37.60	0.27	37.87
3.	ISECO	375	12-15-81	42.92	31.36	2.18	33.54
4.	PANELCO I	200	09-02-81	41.90	37.64	0.10	37.74
5.	ISELCO I	310	11-04-81	41.20	38.65	0.16	38.81
6.	ISELCO II	266	10-18-81	41.20	40.82	0.38	41.20
7.	NUVELCO	311	10-04-81	41.20	31.75		31.75
8.	ZAMECO	375	01-06-82	41.20	43.41	1.64	45.05
9.	OMECO	280	10-07-81	16.80	11.08	0.17	11.25
10.	MARELCO	373	01-13-82	41.86	02.72	0.57	3.29
11.	PALECO (A)	374	01-13-82	41.86			
12.	PALECO (PP)	313	09-01-82	42.75	02.36	0.01	2.37
13.	CASURECO IV	372	01-13-82	41.30	40.93	0.36	41.29
14.	FICELCO	265	10-14-81	23.07	0.47		0.47
15.	ANTECO	264	10-07-81	16.80	18.24		18.24
16.	AKELCO	057	02-10-82	41.86	20.41	0.06	20.47
17.	ILECO II	204	05-16-82	42.21	09.85	0.84	10.69
	T O T A L			642.28	394.75	6.74	401.49

STATUS OF PLANTATION DEVELOPMENT
AS OF JUNE 30, 1984

		AREA PLANTED (HAS.)						AREA SURVIVING (HAS.)					
		1980	1981	1982	1983	1984	TOTAL	1980	1981	1982	1983	1984	TOTAL
1.	INEC	406	571	303	266	-	1 546	74	91	257	89	-	511
2.	ISECO	8	164	259	144	145	720	7	164	140	133	145	589
3.	ABRECO	200	700	368	118	-	1 386	-	243	344	110	-	697
4.	LUELCO	-	-	135	61	11	207	-	-	62	36	11	109
5.	PANELCO I	310	500	300	-	-	1 110	300	500	300	-	-	1 100
6.	PANELCO III	60	376	16	*	-	452	-	13	-	-	-	13
7.	ISELCO I	28	110	182	179	-	499	-	69	144	164	-	377
8.	ISELCO II	20	145	146	109	-	420	2	27	37	97	-	163
9.	NUVELCO	-	-	-	12	*	12	-	-	-	10	-	10
10.	CAGELCO II	-	-	88	77	8	173	-	-	50	91	8	149
11.	ZAMECO	20	450	155	146	-	771	-	82	79	65	-	226
12.	BATELCO	250	511	125	145	*	1 031	-	-	3	7	-	10
13.	PELCO II	-	109	136	40	*	285	-	-	3	20	-	23
14.	BECO I	-	26	168	*	-	194	-	13	22	-	-	35
15.	NEECO II	-	252	244	251	*	747	-	-	10	-	-	10
16.	QUEZELCO I	-	-	8	70	-	78	-	-	8	62	-	70
17.	OMECO	-	25	128	*	-	153	-	18	102	-	-	120
18.	MARELCO	-	259	227	98	-	584	-	68	33	81	-	182
19.	PALECO (A)	63	521	279	15	*	878	2	34	35	10	-	81
20.	PALECO (PP)	-	-	142	150	-	292	-	-	85	46	-	131
21.	CASURECO II	-	-	350	207	-	557	-	-	236	180	-	416
22.	CASURECO III	-	-	352	87	12	451	-	-	239	80	12	331
23.	CASURECO IV-C	55	300	104	151	-	610	-	39	87	139	-	265
24.	CASURECO IV-G	-	-	-	58	-	58	-	-	-	47	-	47
25.	FICELCO	18	176	145	76	-	415	15	154	130	66	-	365
26.	MASELCO	-	-	-	2	-	2	-	-	-	2	-	2
27.	AKELCO	90	260	99	54	19	522	5	101	18	50	19	193
28.	CAPELCO	6	340	293	260	-	899	-	107	111	220	-	438
29.	ANTECO	10	160	111	88	-	369	-	23	7	80	-	110
30.	ILECO I	-	-	270	254**	42**	566	-	-	29	216	42	287
31.	ILECO II-A	-	15	300	140	-	455	-	5	57	122	-	184
32.	CENECO	-	-	76	194	-	270	-	-	67	156	-	223
33.	NOCECO	-	30	250	126	5	411	-	10	102	22	5	139
34.	BOHECO I	-	50	285	163	-	498	-	43	182	94	-	319
35.	BOHECO II	-	-	44	40*	-	84	-	-	25	-	-	25
36.	TAWELCO	-	-	2	20	-	22	-	-	2	-	-	2
	TOTAL	1544	6050	6090	3801	242	17 727	405	1804	3006	2495	242	7 952

* Suspended

** New Site

STUDY CONTRACTS
AS OF JUNE 30, 1984

CONSULTING FIRM	PURPOSE	PROJECT COST ('000) FOREX	PROJECT COST ('000) LOCAL	SOURCE OF FUNDING	DATE STARTED	DURATION OF SERVICE
West Japan Engineering Consultants, Inc. and Meralco Industrial Eng'g. Services Corp.	Detailed eng'g. services for 11 dendro thermal power projects	¥231 835	P 1 611	OECF Loan GOP	1-20-83	14 months
Georgia Tech Research Institute	Dendro thermal power generation program evaluation study	$621	P 134	ADB Loan/ Grant GOP	1-20-84	6 months

STATUS OF A & E CONTRACTS
AS OF JUNE 30, 1984

	PROJECT	A & E FIRM	DATE OF APPROVAL	AMOUNT APPROVED
1.	PANELCO I	MIESCOR	18 June 1980	₱ 969 220
2.	ISELCO I	AWIA	10 Dec. 1980	984 000
3.	ISELCO II	AWIA	10 Dec. 1980	984 000
			7 June 1984	150 000 *
4.	NUVELCO	AWIA	10 Dec. 1980	984 000
5.	AKELCO	AWIA	10 Dec. 1980	1 074 000
6.	FICELCO	TAP	25 Mar. 1981	985 000
7.	MARELCO	MIESCOR	19 Aug. 1981	772 000
8.	CASURECO IV	EDCOP	06 Jan. 1982	758 000 ***
		AWIA	11 May 1983	370 000
9.	ABRECO	AWIA	20 Jan. 1982	984 000
10.	ANTECO	AWIA	14 Oct. 1981	451 000
		AWIA	04 Aug. 1982	246 000 *
11.	ZAMECO	MIESCOR	02 Aug. 1981	855 000
		MIESCOR	06 Oct. 1982	515 000 *
12.	ISECO	DCCD	02 Feb. 1983	815 000
		DCCD	11 May 1983	15 000 *
13.	ILECO II	DCCD	01 June 1983	1 215 000
14.	CENPELCO	MIESCOR	18 June 1980	969 220 **
15.	TARELCO	EDCOP	02 Aug. 1981	730 000 **
16.	INEC	DCCD	20 July 1983	1 050 000
17.	OMECO	DCCD	13 July 1983	790 000

* Amendment to the original contract
** Deferred projects
*** Terminated

DENDRO THERMAL DEVELOPMENT OFFICE

PROJECT SITE LOCATION

AS OF June 30, 1984

ELECTRIC COOP	MUNICIPALITY	SITE	LAND AREA AVAILABLE (Has)
REGION I			
1. INEC	Solsona/Dingras	Maananteng	2 700
2. ISECO	Burgos	Lubing	1 125
3. ABRECO	San Juan	Alimusgan	1 468
4. LUELCO	Aringay/Tubao	Macabato	1 668
5. PANELCO III	San Manuel *	San Roque	1 304
6. CENPELCO	Mangatarem *	:	1 500
7. PANELCO	Bolinao	Ilog-Malino	1 255
REGION II			
8. ISELCO I	Jones	Minuri	1 088
9. ISELCO II	Ilagan	Batong-Labang	1 145
10. NUVELCO	Dupax del Norte *	Belance	1 673
11. CAGELCO II	Lallo/Lasam	Minanga	1 595
REGION III			
12. ZAMECO	Palauig	Bulawen	1 290
13. PELCO II	Porac *	Pasbol	2 500
14. BATELCO	Morong *	Nagbalayong	1 200
15. BECO I	Remedios Trinidad*	Camaching	1 350
16. NEECO III	Gen. Tinio	Rio Chico	1 300
17. NEECO II	Pantabangan *	Tanauan	1 500
REGION IV			
18. QUEZELCO	Macalelon	San Vicente	1 850
19. OMECO	Magsaysay	Paclolo	2 600
20. MARELCO	Buenavista	Tungib	813
21. PALECO (A)	Aborlan *	Sagpangan	2 180
22. PALECO (PP)	Puerto Princesa	Irawan	1 565
REGION V			
23. CANORECO	Sta. Elena/Capalonga	Bulala and Villa Aurora	3 000
24. CASURECO II	Pili	Guinaban	1 800
25. CASURECO III	Balatan		1 500
26. CASURECO IV	Caramoan	Hanopol	1 285
27. CASURECO IV	Garchitorena	Ason/Salvacion	1 813
28. FICELCO	Virac	Buyo	1 000
29. MASELCO	Uson	San Jose	1 510
REGION VI			
30. AKELCO	Nabas	Pawa	624

DENDRO THERMAL DEVELOPMENT OFFICE

PROJECT SITE LOCATION

AS OF June 30, 1984

ELECTRIC COOP	MUNICIPALITY	SITE	LAND AREA AVAILABLE (Has)
REGION VI			
31. CAPELCO	Tapaz	San Julian	1 300
32. ANTECO	Hamtic	Casalngan	503
33. ILECO I	Miag-ao/Igbaros**	Durog, Tiglawan, Sta. Barbara	965
34. ILECO II-A	Lambunao A	Tagbacan	1 200
35. ILECO II-B	Lambunao B	Agsirab Cabatangan	2 500
36. CENECO	Murcia/San Carlos	Minoyan/Cudcod	4 020
37. NOCECO	Binalbagan	Bi-ao	1 575
REGION VII			
38. BOHECO I	Inabanga	Ilaya	2 150
39. BOHECO II	Duero *	Cansuhay	1 145
REGION IX			
40. TAWELCO	Balimbing	Balimbing	500
		T O T A L	63 059
	* Suspended		
	** New Site		

DENDRO THERMAL DEVELOPMENT OFFICE

STATUS OF FARMERS ASSOCIATION

AS OF June 30, 1984

PROJECT	NO. OF FA's	MEMBERS	STATUS						REMARKS
			1	2	3	4	5	6	
REGION I									
INEC	10	93	X	X	X	X		X	
ISECO	10	96	X	X	X	X	X	X	
ABRECO	12	173	X	X	X	X			
LUELCO	10	100	X	X	X	X	X		
PANELCO I	10	100	X	X	X	X	X	X	
CENPELCO	10	100	X	X	X				Inactive
PANELCO III	10	100	X	X	X				To be transferred to TANGLAW Proj.
REGION II									
ISELCO I	9	129	X	X	X	X	X		
ISELCO II	10	73	X	X	X	X	X		
NUVELCO	10	100	X	X	X				Inactive
CAGELCO II	10	134	X	X	X	X	X	X	For reorganization three modules
REGION III									
ZAMECO	10	99	X	X	X	X	X	X	
PELCO II	10	99	X	X	X	X	X		Inactive
BATELCO	10	107	X	X	X	X	X	X	
BECO I	10	96	X	X	X	X	X		To be transferred to TANGLAW Proj.
NEECO II	10	110	X	X	X	X	X		
REGION IV									
QUEZELCO I	5	70	X	X	X	X	X		
OMECO	4	31	X	X	X	X	X	X	
MARELCO	10	148	X	X	X	X	X		
PALECO A	10	92	X	X	X	X	X	X	Suspended
PALECO B	10	85	X	X	X	X	X		
REGION V									
CANORECO			X						
CASURECO I			X						
CASURECO II	10	142	X	X	X	X	X		

LEGEND

1. PRE-ORGANIZATION
2. ORGANIZATION
3. INCORPORATION & REGISTRATION
4. RELENDING
5. TRAINING
6. EVALUATION

/ - IN PROGRESS
X - COMPLETED

DENDRO THERMAL DEVELOPMENT OFFICE

STATUS OF FARMERS ASSOCIATION

AS OF June 30, 1984

PROJECT	NO. OF FA's	MEMBERS	STATUS						REMARKS
			1	2	3	4	5	6	
CASURECO III	10	145	X	X	X	X	X		
CASURECO IV-A	10	121	X	X	X	X	X		
CASURECO IV-B	10	116	X	X	X	X	X		
MASELCO			X						
FICELCO	5	53	X	X	X	X	X	X	
REGION VI									
ANTECO	3	57	X	X	X	X	X	X	
AKELCO (HAVANA)	10	130	X	X	X	X	X	X	CLOSED
AKELCO (PAWA)	5	60	X	X	X	X	X		
ILECO I	10	114	X	X	X	X	X		CLOSED
ILECO II	10	127	X	X	X	X	X		
CAPELCO	10	135	X	X	X	X	X	X	
CENECO	10	124	X	X	X	X	X		
NOCECO	10	81	X	X	X	X	X		Inactive/no activity
REGION VII									
BOHECO I	10	138	X	X	X	X	X		Additional 6 module for registration
BOHECO II	10	98	X	X	X	X	X		To be transferred to TANGLAW Proj.
REGION IX									
TAWELCO	5	72	X	X	X	X			

LEGEND

1. PRE-ORGANIZATION
2. ORGANIZATION
3. INCORPORATION & REGISTRATION
4. RELENDING
5. TRAINING
6. EVALUATION

/ - IN PROGRESS
X - COMPLETED

DENDRO THERMAL DEVELOPMENT OFFICE

STATUS OF PLANTATION DEVELOPMENT

As of June 30, 1984

PROJECT	LAND AREA (Has)		
	(FOR DEV.) (TOTAL)	SURVIVING UP TO 1983	FOR PLANTING 1984
REGION I			
1. INEC	1 200	511	300
2. ISECO	1 100	444	275
3. ABRECO	1 100	697	300
4. LUELCO	1 100	109	275
5. PANELCO I	1 100	1 100	
6. CENPELCO	1 100		
7. PANELCO III *	1 100	13	
REGION II			
8. ISELCO I	1 000	377	250
9. ISELCO II	1 100	163	275
10. NUVELCO *	1 100	10	
11. CAGELCO II	1 100	141	275
REGION III			
12. ZAMECO	1 100	226	275
13. BATELCO *	1 100	10	
14. PELCO II *	1 100	23	
15. BECO I *	1 100	35	
16. NEECO II	1 100	10	
REGION IV			
17. QUEZELCO I	1 100	70	250
18. OMECO	500	120	125
19. MARELCO	1 100	182	150
20. PALECO (Aborlan) *	1 000	81	
21. PALECO (Puerto Princesa)	1 100	131	275
REGION V			
22. CANORECO	1 100		
23. CASURECO II	1 100	416	275
24. CASURECO III	1 100	331	275
25. CASURECO IV (Caramoan)	1 100	265	275
26. CASURECO IV (Garchitorena)	1 100	47	250
27. FICELCO	600	365	150
28. MASELCO	1 100	2	100
REGION VI			
29. AKELCO	1 100	174	150

DENDRO THERMAL DEVELOPMENT OFFICE

STATUS OF PLANTATION DEVELOPMENT

As of June 30, 1984

PROJECT	LAND AREA (Has)		
	(FOR DEV.) (TOTAL)	SURVIVING UP TO 1983	FOR PLANTING 1984
REGION VI			
30. CAPELCO	1 100	438	275
31. ANTECO	400	110	100
32. ILECO I	1 100	245	275
33. ILECO II - Lambunao A	1 100	184	250
34. ILECO II - Lambunao B	2 000		100
35. CENECO	2 000	223	275
36. NOCECO	1 100	134	200
REGION VII			
37. BOHECO I	2 000	319	275
38. BOHECO II *	1 100	25	
REGION IX			
39. TAWELCO	500	2	75
T O T A L	43 100	7 733	6 325

* Suspended

DENDRO THERMAL DEVELOPMENT OFFICE

STATUS OF POWER PLANT FACILITIES

AS OF June 30, 1984

PROJECT	CAPACITY	EQPT SUPPLIER	A&E	CONTRACTOR	CONSTRUCTION STARTED	COMPLETION TIME (days)	DATE OF COMMISSIONING
REGION I							
1. ABRECO	3.4	FR-AA	AWIA	S.D.Flores	23 Apr. '82	575	*
2. CENPELCO	3		MIESCOR				1988
3. INEC	3.1	UK-BBEL	DCCD	PACORP	18 Jan. '82	550	1984
4. ISECO	3.4	FR-AA	DCCD	BALUYOT CONST.	17 Jan. '83	529	1985
5. LUELCO	3	J	EDCOP				1987
6. PANELCO I	3.4	FR-AA	MIESCOR	ECCO-ASIA	20 Jan. '82	343	COMMISSIONE
REGION II							
7. ISELCO I	3.1	UK-BBEL	AWIA	ECCO-ASIA	24 Feb. '82	815	1987
8. ISELCO II	3.1	UK-BBEL	AWIA	ECCO-ASIA	28 Jan. '82	626	1984
9. CAGELCO II	3	J	MIESCOR				1987
10. NUVELCO	3.1	UK-BBEL	AWIA	WGS Const.	15 Jun. '82	300	**
REGION III							
11. BATELCO	3		MIESCOR				1988
12. NEECO II	3		TAP				1988
13. ZAMECO	3.1	UK-BBEL	MIESCOR	RIMCO	18 May '82	690	1984
REGION IV							
14. MARELCO	3.4	FR-AA	MIESCOR	PCCC	11 Aug. '83	321	*
15. OMECO	.96	FR-MD	DCCD	POWER CONSULTANTS, INC.	2 Aug. '82	699	1984
16. PALECO (PP)	3.4	FR-AA	DCCD				1986
17. PALECO (A)	1.2	FR-AA					1986
18. QUEZELCO I	3		MIESCOR				198 7
REGION V							
19. CANORECO	3		MIESCOR				1988
20. CASURECO I	3		MIESCOR				1988
21. CASURECO II	3		MIESCOR				1987
22. CASURECO III	3		MIESCOR				1987
23. CASURECO IV-A	3.1	UK-BBEL	AWIA	BICOL WOOD-WORKS	8 July '82	609	1984
24. CASURECO IV-B	3	J	MIESCOR				1987
25. FICELCO	1.2	FR-AA	TAP				1985
26. MASELCO	3	J	MIESCOR				1987

DENDRO THERMAL DEVELOPMENT OFFICE

STATUS OF POWER PLANT FACILITIES

AS OF June 30, 1984

PROJECT	CAPACITY	EQPT SUPPLIER	A&E	CONTRACTOR	CONSTRUCTION STARTED	COMPLETION TIME (days)	DATE OF COMMISSIONING
REGION VI							
27. ANTECO	.96	FR-MD	AWIA	FIL.-SYSTEMS INC.	17 Feb. '82	604	1984
28. AKELCO	3.4	FR-AA	AWIA	ECCO-ASIA	2 Sept.'82	510	**
29. CAPELCO	3	J	MIESCOR				1987
30. CENECO	5	USA					1986
31. ILECO I	3	J	MIESCOR				1987
32. ILECO II-A	3.4	FR-AA	DCCD	EEI	25 Oct. '82	390	**
33. IELCO II-B	5	USA					1986
34. NOCECO	3		DCCD				1988
REGION VII							
35. BOHECO I	5	USA					1986
REGION IX							
36. TAWELCO	1						1988

* Contract suspended indefinitely

** Contract terminated

Annex III.4

Vital Documents on the Philippine Rural Electrification Program

FOREWORD

Eleven years after the issuance of Republic Act No. 6038 creating the National Electrification Administration (NEA) and establishing a nationwide electrification program, the role of electrification as a catalyst in rural development has been definitely proven.

In the words of President Ferdinand E. Marcos himself, "In addition to the expected profit and fruits in the economic and infrastructure sides of our society, the social and political effects of rural electrification have been beyond our wildest dreams."

The initial success of this program can be traced to the all out support of President Marcos and the First Lady Imelda Romualdez Marcos, presently the Chairman of the NEA Board of Administrators. President Marcos has issued several presidential decrees and orders strengthening the program. These documents are as follows:

Presidential Decree No. 1645
Letter of Implementation No. 80
Presidential Decree No. 269
Presidential Decree No. 501
Presidential Decree No. 1370
Presidential Decree No. 40
Letter of Instruction No. 38
Memorandum Order No. 395

This publication is a compilation of all documents relevant to the Philippine rural electrification program as implemented by the NEA.

Our target is total electrification by 1987. Toward this goal, all our concerted efforts are being directed.

(Sgd.) PEDRO G. DUMOL
Administrator

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Presidential Decree No. 1206 (Excerpts)

Presidential Decree No. 175 (Excerpts)

Republic Act No. 6038 (Excerpts)

Republic Act No. 2717

PRESIDENTIAL DECREE NO. 1645

AMENDING PRESIDENTIAL DECREE NO. 269, INCREASING THE CAPITALIZATION AND BROADENING THE LENDING AND REGULATORY POWERS OF THE NATIONAL ELECTRIFICATION ADMINISTRATION AND FOR OTHER PURPOSES.

WHEREAS, under Presidential Decree No. 269, the National Electrification Administration (NEA) is charged with the responsibility of organizing, financing and regulating electric cooperatives throughout the country;

WHEREAS, the total electrification of all municipalities by the year 1987 is a declared goal of the government;

WHEREAS, the international energy crisis may seriously delay the attainment of electrification goals unless indigenous and renewable energy resources are immediately developed to supplement existing power systems;

WHEREAS, the development of systems powered by indigenous and renewable energy resources will require funding support beyond the capability of existing NEA capitalization and may require NEA equity investments in the said systems;

WHEREAS, there is a distinct need to provide NEA with additional authority to take measures that will better safeguard government inputs in electric cooperatives and other entities that are or will be related to the total electrification effort;

NOW, THEREFORE, I, FERDINAND E. MARCOS, President and Prime Minister of the Republic of the Philippines, by virtue of the powers vested in me by the Constitution, do hereby order and decree:

Section 1. Section 6 of Presidential Decree No. 269 (as amended) is hereby further amended to read as follows:

> "Sec. 6. Capital Stock. The authorized capital of NEA shall be five billion pesos, divided into fifty (50) million shares with a par value of one hundred pesos (₱100.00) each, which shares shall not be transferred, negotiated, pledged, mortgaged, or otherwise given as security for the payment of any obligation.
>
> The sum of not less than five hundred million pesos shall be earmarked out of the corporate equity investment funds contained in Batas Pambansa Blg. 40 and the same amount is hereby appropriated out of the funds in the National Treasury not otherwise appropriated, for the payment of subscription to NEA capital stock, for each year beginning with fiscal year 1981 until the unpaid subscription of the government to the capital stock of the corporation shall have been paid in full: Provided, That additional amounts as may be needed shall be included in the annual General Appropriations Acts."

Sec. 2. Section 4, Chapter II of Presidential Decree No. 269 is hereby amended by deleting the word "and" at the end of subsection "(n)", modifying subsection (l) and adding new subsections (p), (q) and (r) to read as follows:

"(l) To require the submission of Articles of Incorporation, by-laws, and documents relating to consolidation, merger, conversion, dissolution, change in the location of principal offices, and election to dissolve, from all recipients of loans and/or equity investments and upon determination that such are in conformity with this Decree, to certify the same, to file in the records of the NEA and to maintain a registry of such filings the provisions of Act No. 1459, as amended, to the contrary notwithstanding."

"(p) To invest and/or grant loans for the development of power generation industries or companies, including dendrothermal and mini-hydro power plants and associated facilities such as alcogas and tree plantations, water impounding reservoirs and feeder roads: Provided, That such investment and loans shall be limited to a specific percentage of total requirements as may be determined by the NEA Board of Administrators."

"(q) To organize wholly or partly owned companies and subsidiaries for the purpose of operating power generating and distribution systems and other related activities; and

"(r) To organize wholly or partly owned subsidiaries for the purpose of manufacturing materials and equipment for power generating systems."

Sec. 3. Section 5(a), Chapter II of Presidential Decree No. 269 is hereby amended by adding sub-paragraph (6) to read as follows:

"(6) To authorize the NEA Administrator to designate, subject to the confirmation of the Board of Administrators, an Acting General Manager and/or Project Supervisor for a Cooperative where vacancies in the said positions occur and/or when the interest of the Cooperative and the program so requires, and to prescribe the functions of said Acting General Manager and/or Project Supervisor, which powers shall not be nullified, altered or diminished by any policy or resolution of the Board of Directors of the Cooperative concerned."

Section. 4. Section 8(b), Chapter II of Presidential Decree No. 269 is hereby amended to read as follows:

"(b) With respect to foreign indebtedness to be incurred by the NEA, such may be contracted, in form of loans, credits convertible to foreign currencies, or other forms of indebtedness, from foreign governments, or any international financial institution or fund source, including foreign private lenders. The total outstanding amount of such indebtedness exclusive of interest, shall not exceed eight hundred million United States dollars or the equivalent thereof in other currencies. The President of the Philippines by himself or through his duly authorized representative, is hereby authorized to negotiate and to contract with foreign governments or any international financial institution or fund source in the name and on behalf of

NEA and is further authorized to guarantee, absolutely and unconditionally, as primary obligor and not merely as a surety, in the name and on behalf of the Republic of the Philippines, the repayment of any indebtedness thereby contracted and the payment thereof of any due interest charge, up to the limited amount authorized by the foregoing, which shall be over and above the amounts which the President is authorized to guarantee under R.A. 6142, as amended, and also to guarantee the performance of all or any of the obligations undertaken by the NEA in the territory of the Republic of the Philippines pursuant to this subparagraph (b). Any indebtedness contracted under this subparagraph (b) and the payment of the principal thereof and of any interest charges thereon, as well as the importation of machinery, equipment, materials, supplies and services by the NEA, paid from the proceeds of any such contracted indebtedness, shall also be exempted from all direct and indirect taxes, fees, imposts, other charges and restrictions, including import restrictions by the Republic of the Philippines or by any authority, branch, division or political subdivision thereof."

Sec. 5. Section 10, Chapter II of Presidential Decree No. 269 is hereby amended to read as follows:

"Section 10. Enforcement Powers and Remedies. In the exercise of its power of supervision and control over electric cooperatives and other borrower, supervised or controlled entities, the NEA is empowered to issue orders, rules and regulations and motu-propio or upon petition of third parties, to conduct investigations, referenda and other similar actions in all matters affecting said electric cooperatives and other borrowers, or supervised or controlled entities.

If the electric cooperative concerned or other similar entity fails after due notice to comply with NEA orders, rules and regulations and/or decisions, or with any of the terms of the Loan Agreement, the NEA Board of Administrators may avail of any or all of the following remedies:

(a) Refuse to make or approve any new loan to the borrower or to release funds to implement loans that are otherwise already approved;

(b) Withhold NEA advances, or withhold approval of advances or fund releases in behalf of any other lender with respect to which the NEA has such power relative to loans made;

(c) Withhold any technical or professional assistance otherwise being furnished or that might be furnished to the borrower;

(d) Foreclose any mortgage or deed of trust or other security held by the NEA on the properties of such borrower, in connection with which the NEA may, subject to any superior or co-equal rights in such lien held by any other lender, (1) bid for and purchase or otherwise acquire such properties; (2) pay the purchase

price thereof and any costs and expenses incurred in connection therewith out of the revolving fund; (3) accept title to such properties in the name of the Republic of the Philippines; and (4) even prior to the institution of foreclosure proceedings, operate or lease such properties for such period, and in such manner as may be deemed necessary or advisable to protect the investment therein, including the improvement, maintenance and rehabilitation of systems to be foreclosed, but the NEA may, within five years after acquiring such properties in foreclosure proceedings, sell the same for such consideration as it determines to be reasonable and upon such terms and conditions as it determines most conducive to the achievement of the purposes of this Decree; or

(e) Take preventive and/or disciplinary measures including suspension and/or removal and replacement of any or all of the members of the Board of Directors, officers of employees of the Cooperative, other borrowing institutions or supervised or controlled entitles as the NEA Board of Administrators may deem fit and necessary and to take any other remedial measures as the Law or the Loan Agreement may provide."

No Cooperative shall borrow money from any source without the Board of Administrators' prior approval: Provided, That the NEA Board of Administrators may, by appropriate rule or regulation, grant general permission to Cooperatives to secure short-term loans not requiring the encumbrance of their real properties or of a substantial portion of their other properties or assets.

Sec. 6. The provisions of Section 15 to 40, Chapter III of Presidential Decree No. 269, governing cooperatives shall be also applicable to mini-hydro and dendro-thermal power plants, alcogas and tree plantation and other power generating entities supported by NEA.

Sec. 7. Subsection (a), Section 24, Chapter III of Presidential Decree No. 269 is hereby amended to read as follows:

"Section 24. **Board of Directors.** (a) The Management of a Cooperative shall be vested in its Board, subject to the supervision and control of NEA which shall have the right to be represented and to participate in all Board meetings and deliberations and to approve all policies and resolutions of the Board.

The composition, qualifications, the manner of elections and filling of vacancies, the procedures for holding meetings and other similar provisions shall be defined in the by-laws of the Cooperative subject to NEA policies, rules and regulations.

No member of the Board shall receive any salary for his service as Director nor for services rendered in any other capacity. However, reasonable per diems for every Board meeting

actually attended and reimbursement of actual expenses incurred in the performance of the duties of a member of the Board may be allowed as specified in NEA policies, rules and regulations."

Sec. 8. Section 26, Chapter III of Presidential Decree No. 269 is hereby amended to read as follows:

"Section 26. **Officers.** The officers of a cooperative shall consist of a President, Vice-President, Secretary and Treasurer, who shall be elected annually by and from the Board. When a person holding such office ceases to be a director, he shall ipso facto cease to hold such office. The offices of Secretary and of Treasurer may be held concurrently by one person. The Board may also elect or appoint such other officers, agents or employees as it deems necessary or advisable and shall prescribe their powers and duties, subject to the pertinent provisions of this Decree, the Loan Agreement, and NEA policies, rules and regulations."

Sec. 9. **Effectivity.** This Decree shall take effect immediately.

Done in the City of Manila, this 8th day of October, in the year of Our Lord, nineteen hundred and seventy-nine.

(Sgd.) FERDINAND E. MARCOS
President & Prime Minister
Republic of the Philippines

By the President:
(Sgd.) JACOBO C. CLAVE
Presidential Executive Assistant

LETTER OF IMPLEMENTATION NO. 80

TO: The Minister of Human Settlements
The Minister of Energy

Pursuant to the provisions of Presidential Decree No. 830, dated November 27, 1975, and in order to implement immediately the mini-hydro and dendro-thermal projects under the Bagong Lipunan Sites and Services (BLISS) Program, the National Electrification Administration (NEA) is hereby transferred from the Ministry of Energy to the Office of the President with the Minister of Human Settlements as ex-officio Chairman of the Board of Administrators.

Such transfer shall include applicable appropriation, records, equipment, property and such personnel as may be necessary.

This Order shall take effect immediately.

DONE in the City of Manila, this 9th day of February, in the year of Our Lord, nineteen hundred and seventy-nine.

(Sgd.) FERDINAND E. MARCOS
President
Republic of the Philippines

The First Lady, Imelda Romualdez Marcos is presently the Minister of Human Settlements.

PRESIDENTIAL DECREE NO. 269

CREATING THE "NATIONAL ELECTRIFICATION ADMINISTRATION" AS A CORPORATION, PRESCRIBING ITS POWERS AND ACTIVITIES, APPROPRIATING THE NECESSARY FUNDS THEREFORE AND DECLARING A NATIONAL POLICY OBJECTIVE FOR THE TOTAL ELECTRIFICATION OF THE PHILIPPINES ON AN AREA COVERAGE SERVICE BASIS, THE ORGANIZATION, PROMOTION AND DEVELOPMENT OF ELECTRIC COOPERATIVES TO ATTAIN THE SAID OBJECTIVE, PRESCRIBING TERMS AND CONDITIONS FOR THEIR OPERATIONS, THE REPEAL OF REPUBLIC ACT NO. 6038, AND FOR OTHER PURPOSES.

WHEREAS, it is the desire of the government to effect changes and reforms in the social, economic, and political structure of our society;

WHEREAS, detailed studies have clearly emphasized the very close correlation between consumption of energy and gross national product. Electric power, wherever introduced, stimulates the growth of industry and the economy in general;

WHEREAS, electrification of the entire country, one of the primary concerns of the government in order to bring about the desired changes and reforms, can be hastened by rationalizing the distribution of electricity;

WHEREAS, rationalization which implies the adoption of all measures necessary to obtain the maximum expense, can be achieved by:

1. Establishing island grids and integrating power generating systems.

2. Consolidating electric distribution franchise systems. The existence of small franchise systems impede the progress of total electrification, as such small and isolated systems are antithetical to the economies of scale.

3. Implementing the area coverage concept, which will allow the construction of lines to thinly settled areas which are most costly to electrify, provided that the losses from these lines can be reasonably absorbed by the more profitable lines.

WHEREAS, under Republic Act No. 6038, dated August 4, 1969, Presidential Decree No. 40 and Letter of Instruction No. 38, both dated November 7, 1972, the National Electrification Administration was given certain powers, duties, and functions to attain total electrification on an area coverage basis, to set up cooperatives for the distribution of power; and to determine privately-owned public utilities which should be permitted to remain in operation;

WHEREAS, to attain total electrification in the most effective and efficient manner, there is a need to further strengthen and make more flexible the organizational structure of the National Electrification Administration by converting it into a corporation, wholly-owned and controlled by the government, possessed with borrowing authority and corporate powers;

NOW, THEREFORE, I, FERDINAND E. MARCOS, President of the Republic of the Philippines, by virtue of the powers vested in me by the Constitution as Commander-in-Chief of the Armed Forces of the Philippines, and pursuant to Proclamation No. 1081, dated September 21, 1972, and General Order No. 1, dated September 22, 1972, as amended, do hereby repeal Republic Act No. 6038 and to hereby decree, order and make as part of the law of the land the Charter of the National Electrification Administration, which read as follows:

CHAPTER I – POLICY AND DEFINITIONS

SEC. 1. Title. – This Decree shall be referred to as the "National Electrification Administration Decree".

SEC. 2. Declaration of National Policy. – The total electrification of the Philippines on an area coverage basis being vital to the welfare of its people and the sound development of the Nation, it is hereby declared to be the policy of the State to pursue and foster, in an orderly and vigorous manner, the attainment of this objective. For this purpose, the State shall promote, encourage and assist all public service entities engaged in supplying electric service, particularly electric cooperatives, which are willing to pursue diligently this objective.

Because of their non-profit nature, cooperative character and the heavy financial burdens that they must sustain to become effectively established and operationally viable, electric cooperatives, particularly, shall be given every tenable support and assistance by the National Government, its instrumentalities and agencies to the fullest extent of which they are capable; and, being by their nature substantially self-regulating and Congress having, by the enactment of this Decree, substantially covered all phases of their organization and operating requiring or justifying regulation, and in order to further encourage and promote their development, they should be subject to minimal regulation by other administrative agencies.

Area coverage electrification cannot be achieved unless service to the more thinly settled areas and therefore more costly to electrify is combined with service to the most densely settled areas and therefore less costly to electrify. Every public service entity should thereafter cooperate in a national program of electrification on an area coverage basis, or else surrender its franchise in favor of those public service entities which will. It is hereby found that the total electrification of the Nation requires that the laws and administrative practices relating to franchise electric service areas be revised and made more effective, as herein provided. It is therefore hereby declared to be the policy of the State that franchises for electric service areas shall hereafter be so issued, conditioned, altered or repealed, and shall be subject to such continuing regulatory surveillance, that the same shall conduce to the most expeditious electrification of the entire Nation on an area coverage basis.

SEC. 3. Definitions. – As used in this Decree, the following words or terms shall have the following meanings, unless a different meaning clearly appears from the context;

(a) "NEA" shall mean the National Electrification Administration, "Board of Administrators" shall mean the Board of Administrators, and

"Administrator" shall mean the Administer, all as provided for in this Decree.

(b) "Cooperative" shall mean a corporation organized under Republic Act No. 6038 or this Decree or a cooperative supplying or empowered to supply service which has heretofore been organized under the Philippine Non-Agricultural Cooperative Act, whether converted under this Decree or not.

(c) "Public service entities" shall mean (1) a cooperative, (2) the NPC, and (3) local governments and privately-owned public service entities in operation which furnish and are empowered to furnish retail electric service.

(d) "Person" shall mean any natural person, firm, association, cooperative, corporation, business trust, partnership, the National Government or any political sub-division, agency or instrumentality thereof.

(e) "Service" shall mean electric service, either at wholesale or retail, including the furnishing of any auxiliary or related service;

(f) "Dependable and adequate service" shall mean service that, consistent with normal standards and levels of service based upon good utility management and operating practices, is sufficient in quantity, having regard for the demands for service currently existing and reasonably anticipated within the foreseeable future, that is accessible on a constant and continuous basis except for outages occasioned by the need for normal repair, maintenance, construction or renovation work or by acts beyond the reasonable ability of the public service entity to prevent or control.

(g) "Area" shall mean (1) the geographic area franchised to a public service entity or (2) any lesser geographic area for the furnishing of retail service to which a public service entity pursuant to this Decree borrows, or may apply to borrow, funds from the NEA, or may otherwise secure loans with the approval of the NEA, to finance the acquisition or construction and operation, maintenance or renovation of service facilities.

(h) "Area coverage" shall mean dependable and adequate service that, on the basis of reasonable and standard extension and service policies, rates, charges and other terms and conditions, will be or is being made available to all persons within the affected area as above defined who request such service and are able and willing to abide by and comply with all reasonable and standard terms and conditions, regardless of the relative location of such persons within the affected area or of their proximity to existing or proposed service facilities: Provided, that the financial feasibility of the public service entity's entire operation is not thereby impaired.

(i) "Interest rate per centum per annum" shall mean an interest rate that is accrued solely upon the unpaid balance of any loan principal which has actually been advanced to a borrower and upon any interest payment which has become due or been deferred and has not been paid by the borrower, computed on an annual basis.

(j) "Loan" shall mean a loan the total principal amount of which, as and when required for application to the purposes thereof, is, at the time of the making thereof, assured from funds that are or will become available therefor.

(k) "NEDA" shall mean National Economic and Development

Authority or any successor instrumentality that may hereafter be established to perform the same or substantially similar function; "NPC" shall mean National Power Corporation; and "NEDA-FS" shall mean National Economic and Development Authority-Foreign Source.

(l) "Board of Power and Waterworks" shall mean Board of Power and Waterworks or any successor board, agency or instrumentality that may hereafter be established to perform the same or substantially similar functions.

(m) "Franchise" shall mean the privilege extended to a person to operate an electric system for service to the public at retail within a described geographic area, whether such privilege had been granted by the Congress, by a municipal, city or provincial government or, as herein provided, by the NEA.

(n) "Non-profit" shall mean that a cooperative shall not engage in business for the purpose of making a profit for itself or its patrons, but it shall not mean that a cooperative may not account on a patronage basis to its patrons for any receipts in excess of its expenses in relation to its operations in service such patrons or in to investment of any of its surplus funds pending their use by the cooperative or their refund to patrons; nor shall it mean that such excess receipts may not be refunded to its patrons, or may not be converted into patron-furnished capital subject to later redemption and retirement by the cooperative.

(o) "Board" shall mean the board of directors of a cooperative.

(p) "Household" shall mean a non-seasonal dwelling capable of receiving service safely, including apartments and other dwelling combinations.

(q) "Congress" shall mean the President during his exercise of Martial Law, or the National Assembly under the new Constitution of 1973, whichever is the case at any given time.

(r) "President" shall mean the President of the Philippines during the existence of Martial Law, or the Prime Minister when the National Assembly comes into existence.

CHAPTER II – THE NATIONAL ELECTRIFICATION ADMINISTRATION

SEC. 4. **NEA Authorities, Powers and Directives.** – The NEA is hereby authorized, empowered and directed to promote, encourage and assist public service entities, particularly cooperatives, to the end of achieving the objective of making service available throughout the nation on an area coverage basis as rapidly as possible; and for such purpose it is hereby, without limiting the generality of the foregoing and in addition to other authorizations, powers and directives established by this Decree, specifically authorized, empowered and directed;

(a) To have a continuous succession under its corporate name until otherwise provided by law;

(b) To prescribe and thereafter to amend and repeal its by-laws not inconsistent with this Decree;

(c) To adopt and use a seal and alter it at its pleasure;

(d) To sue and be sued in any court, Provided, that NEA shall, unless its consents otherwise, be immune to suits for acts ex delicti;

(e) To make contract of every name and nature and to execute all instruments necessary or convenient for the carrying on of its business;

(f) To make loans to public service entities, with preference to cooperatives, for the construction or acquisition, operation and maintenance of generation, transmission and distribution facilities and all related properties, equipment, machinery, fixtures, and materials for the purpose of supplying area coverage service, and thereafter to make loans for the restoration, improvement or enlargement of such facilities: Provided, that the public service entity applying for a loan, if neither a cooperative nor a local government, must be in operation at the time of application;

(g) To promote, encourage and assist public service entities and government agencies and corporations having related functions and purposes, with preference to cooperatives, in planning, developing, coordinating, establishing, operating, maintaining, repairing and renovating facilites and systems to supply area coverage service, and for such purposes to furnish, to the extent possible and without charge therefore, technical and professional assistance and guidance, information, data and the results of any investigation, study, or report conducted or made by the NEA;

(h) To approve or disapprove any loan from other lenders to public service entities which at the time are borrowers from NEA under subparagraphs (f) or (i) of this section, and thereafter, pursuant to Section 10(b) to disapprove advances of loans from other lenders;

(i) To make loans for the purpose of financing the wiring of premises of persons served or to be served as a result of loans made under sub-paragraph (f) of this Section, and for the acquisition and installation by such persons of electrically-powered appliances, equipment; fixtures and machinery of all kinds for residential, recreational, commercial, agricultural and industrial uses, such loans to be made directly (1) to public service entities which have received loans under sub-paragraph (f) of this section, which entities shall in turn relend such funds to persons served or to be served by them, or (2) to any person served or to be served by public service entities which have received loans under subparagraph (f) of this section: Provided, that at no time shall the total loans made under this sub-paragraph (i) to a public service entity and/or to persons served or to be served by such entity exceed twenty-five (25%) per centum of the outstanding loans to such entity made under sub-paragraph (f) of this section;

(j) To so cooperate, coordinate and exchange such information, studies and reports with, and to seek such cooperation and coordination from, other departments, agencies and instrumentalities of the National Government, including the NPC, as will most effectively conduce to the achievement of the purposes of this Decree;

(k) To borrow funds from any source, private or government, foreign or domestic, and not inconsistently with Section 8, to issue bonds or other evidences of indebtedness therefor and to secure the lenders thereof by pledging, sharing or subordinating one or more of the NEA's own loan securities;

(l) To receive from cooperatives all articles of incorporation, amendments, consolidation, merger, conversion and dissolution, and all certificates of changes in the location of principal offices and of elections to dissolve, and, upon determining that such are in conformity with this

Decree, to certify the same, to file them in the records of the NEA, and to maintain a registry of such filings the provisions of Act No. 1459, as amended, to the contrary notwithstanding;

(m) To acquire, by purchase or otherwise (including the right of eminent domain, which is hereby granted to the NEA, to be exercised in the manner provided by law for the institution and completion of expropriation proceedings by the National and local governments), real and physical properties, together with all appurtenant rights, easements, licenses and privileges, whether or not the same be already devoted to the public use of generating, transmitting or distributing electric power and energy, upon NEA's determination that such acquisition is necessary to accomplish to purposes of this Decree and, if such properties be already devoted to the public use described in the foregoing, that such use will be better served and accomplished by such acquisition; Provided, that the power herein granted shall be exercised by the NEA solely as agent for and on behalf of one or more public service entities which shall timely receive, own and utilize or replace such properties for the purpose of furnishing adequate and dependable service on an area coverage basis, which entity or entities shall then be or in connection with the acquisition shall become, borrowers from the NEA under sub-paragraph (f) of this section, and Provided, Further, that the costs of such acquisition, including the cost of any eminent domain proceedings, shall be borne, either directly or by reimbursement to the NEA, whichever the NEA shall elect, by the public service entity or entities on whose behalf the acquisition is undertaken; and otherwise to acquire, improve, hold, transfer, sell, lease, rent, mortgage, incumber and otherwise dispose of property incident to, or necessary, convenient or proper to carry out, the purposes for which NEA was created;

(n) At least annually, not later than June 30th, to report to the President and when the same comes into existence, the Prime Minister and the National Assembly, on the status of electrification of the Philippines, including a comprehensive reporting of loans made, loan funds advanced, loans secured from other sources and the advances thereof, the names and locations of the borrowers, the number of services, contemplated by such loans, the number actually receiving service as a result of such loans, the number of electrified and remaining number of unelectrified households throughout the Nation, the amounts of usage by consumers, loans and other activities programmed for the ensuing year, and all such other information and data as will accurately reveal the progress being made toward the achievement of the purposes of this Decree; and to publish such report for dissemination to and use by other interested departments, agencies and instrumentalities of the National Government and by borrowers under this Decree; and

(o) To exercise such powers and do such things as may be necessary to carry out the business and purposes for which the NEA was established, or which from time to time may be declared by the Board of Administrators to be necessary, useful, incidental or auxillary to accomplish such purposes; and, generally, to exercise all the powers of a corporation under the Corporation Law insofar as they are not inconsistent with the provisions of this Decree.

SEC. 5. National Electrification Administration; Board of Administrators; Administrator. (a) For the purpose of administering the provisions of this Decree, here is hereby established a public corporation to be known as the National Electrification Administration. All of the powers of the corporation shall be vested in and exercised by a Board of Administrators, which shall be composed of a Chairman and four (4) members, one of whom shall be the Administrator as ex-officio member. The Chairman and the three other members shall be appointed by the President of the Philippines to serve for a term of six years. Provided, that the terms of the first appointees shall be six years for the Chairman and one member and three years for the two other members, respectively, and that the term of the ex-officio member shall be co-terminous with his term as the Administrator. All vacancies, except through expiration of the terms, shall be filled for the unexpired term only. The Chairman and every member of the Board of Administrators shall be entitled to a per diem of not more than three hundred pesos for each meeting actually attended by them: Provided, that the total of such per diems shall not exceed one thousand five hundred pesos per month per member.

The Board of Administrators shall meet regularly at least twice a month and as often as the exigencies of the agency's affairs demand.

The presence of at least three members shall constitute a quorum which shall be necessary for the transaction of any business. The affirmative vote of a majority of the members present shall be necessary for the approval of any resolution, decision or order, except when a greater vote is required as sometimes hereinafter provided. In the absence of the Chairman at a Board meeting duly called, the Administrator as ex-officio member shall preside.

The Board shall, without limiting the generality of the foregoing have following specific powers and duties.

(1) To implement the provisions and purposes of this Decree;

(2) To formulate and adopt policies and plans, and to promulgate rules and regulations, for the management, operation and conduct of the NEA;

(3) To adopt and, as may be necessary from time to time, to amend annual budgets for the NEA's borrowing and lending programs and for the agency's administration, Provided, that copies of such budgets shall be submitted to the President or the appropriate committee of and as determined by the National Assembly, when it comes into existence, within fifteen (15) days from the transmission thereof to the NEDA; and Provided, Further, that the administrative budget and any amendments thereto shall be subject to the approval of NEDA;

(4) To fix the compensation of the Administrator and of the Deputy Administrators, subject to the approval of the President of the Philippines; and

(5) To establish policies and guidelines for employment on the basis of merit, technical competence and moral character, and, upon the recommendation of the Administrator to organize or reorganize NEA's staffing structure, to fix the salaries of personnel and to define their powers and duties.

(b) The management of the NEA shall be vested in the Administra-

tor, who shall be a person of known integrity, competence and experience in technical and executive fields related to the purposes of this Decree. He shall be appointed by the President of the Philippines and shall not be removed except for cause.

The administrator shall have the following powers and duties:

(1) To execute and administer policies, plans and programs, and the rules and regulations, approved or promulgated by the Board of Administrators;

(2) To submit for the consideration of the Board of Administrators such policies, plans and programs as he deems necessary to carry out the provisions and purposes of this Decree;

(3) To direct and supervise the operation and internal administration of the NEA and, for this purpose, to delegate same of any of this powers and duties to subordinate officials of the NEA;

(4) Subject to the guidelines and policies established by the Board of Administrators, to appoint and fix the number and compensation of subordinate officials and employees of the NEA: Provided, however, the provisions of the Civil Service Law and the Wage and Position, Classification Law shall not apply to the appointment and compensation of any such subordinate official or employee; compensation of any such subordinate officials or employees.

(5) For cause, to remove, suspend, or otherwise discipline any subordinate official or employee;

(6) To prepare an annual report on the activities of the NEA at the close of each fiscal year and to submit a copy thereof to the President of the Philippines and when it comes into existence, the Prime Minister and the appropriate committee of, and as determined by, the National Assembly; and

(7) To exercise such other powers and duties as may be vested in him by the Board of Administrators.

In case of absence or disability of the Administrator, he shall designate any of the Deputy Administrators who shall act in his place.

(c) The Auditor General shall be ex-officio Auditor of the NEA. The provisions of Section 584 of the Revised Administrative Code, as amended by Republic Act numbered 2266 and 2716, shall apply to the Office of the Representative of the Auditor General in the NEA.

SEC. 6. Capital Stock.* The authorized capital stock of NEA is one billion pesos (₱1B) divided into ten (10) million shares having a par value of one hundred (100.00) pesos each, which shares are not to be transferred, negotiated, pledged, mortgaged or otherwise given as security for the payment of any obligation. The sum of fifty million pesos (₱50M) of the capital stock has been subscribed and paid wholly by the Government of the Philippines in accordance with the provisions of Republic Act numbered Twenty-seven hundred seventeen and Republic Act numbered Sixty Hundred Thirty-eight.

The remaining nine hundred fifty million pesos (₱950M) shall be wholly subscribed by the Government of the Philippines and shall be paid as follows:

(a) The sum of one hundred ninety-five million pesos (₱195M) worth of goods and services from Japanese Reparations for the eighteenth, nineteenth, and twentieth year schedule, which is hereby allocated to NEA;

(b) The sum of ten million pesos (₱10M) of the fiscal year 1973 and the same amount each year for the next two fiscal year making a total sum of thirty million pesos (₱30M) representing proceeds of the sale of reparation goods, which are hereby allocated to NEA;

(c) The sum of fifty-three million five hundred thousand pesos (₱53.5M) for the fiscal year 1973 and the same amount each year for the next nine (9) fiscal years from the general revenue, which are hereby appropriated;

(d) The sum of one hundred thirty million pesos (₱130M) representing fund or physical assets which NEDA-FS may make available to the NEA for loan purposes;

(e) The sum of sixty million pesos (₱60M) representing proceeds corresponding to the share of the National Government in all franchise taxes paid by electric service and entities; and

(f) Such sums as may be appropriated and/or allocated by the President or the National Assembly when it comes into existence, from time to time as the financial needs of the NEA and require until the authorized capital stock is fully paid up.

SEC. 7. Loan Standards. – In making a loan authorized in Section 4, the Board of Administrators is hereby authorized, empowered and directed:

(a) Before making such loan, to determine and certify that (1) the project or projects being financed thereby are financially feasible for the purpose or, and will result in, area coverage in the area or areas to be affected thereby; (2) funds are or will be available for the total advance of such loans to the borrower on the schedule contemplated by the loan agreement; and (3) in the NEA's judgment the security for such loan is reasonably adequate and the principal of and interest upon such loan will be repaid on schedule and within the time agreed;

(b) To require that such loan be self-liquidating within a term to be fixed by the NEA;

(c) To impose upon the loan principal and interest charge to be fixed by the NEA;

(d) To fix the schedule for repayment of the principal of and the interest upon such loan in installments recurring not more than every quarter, which installments may be made in unequal amounts and larger in the later years of the loan term than in the earlier years;

(e) To require in the loan agreement that the borrower's rates, charges, rules and regulations, policies and all other terms and conditions affecting its extension and furnishing of service shall be such as to assure achievement of the loan purposes, and that the same shall be field with and for such purpose approved by the Board of Administrators before being put into effect or changed by the borrower; and

(f) Subject to the foregoing, to establish and require compliance with such procedures, rules and regulations as the Board of Administrators may determine to be necessary or appropriate to assure that the purposes of such loan will be timely achieved and that the loan agreement and the provisions of this Decree will be complied with.

*Amended by Presidential Decree No. 1370 issued May 2, 1978.

SEC. 8. Contracting Indebtedness: Conditions, Privileges, Exemptions, Sinking Fund, Guarantees. – Whenever the Board of Admininistrators determines that to accomplish the purposes of Chapter II of this Decree it is necessary to contract indebtedness, it shall by a resolution adopted by the affirmative votes of at least three members, so declare and authorize the NEA's execution or issuance of and establish the terms and conditions to be contained in, such bonds, loan agreements or other evidences of indebtedness necessary therefor. Such resolution shall become valid and effective upon approval by the President of the Philippines upon recommendation of the Secretary of Finance.

(a) With respect to domestic indebtedness to be incurred by the NEA, the terms and conditions to be contained in such bonds or other evidences of indebtedness, and other conditions, privileges, exemptions and guarantees attaching thereto, shall include the following:

(1) Such bonds or other evidences of indebtedness (A) shall be in registered form and transferable at the Central Bank of the Philippines; (B) shall not be sold at less than par; (C) shall be payable ten years or more from date of issue, as may be determined by the Secretary of Finance before their issuance, but shall be redeemable, upon the election of the Board of Administrators, after five years from such date of issue; and (D) shall bear interest at an annual rate to be determined before their issuance by the Secretary of Finance in consultation with the Monetary Board of the Central Bank of the Philippines before date of issuance and both the principal and interest shall be payable in legal tender of the Philippines.

(2) The bonds or other evidences of indebtedness shall be exempt from the payment of all taxes by the Republic of the Philippines, or by any authority, branch, division or political subdivision thereof, which facts shall be stated upon their face; and they shall be receivable as security in any transaction with the National Government or any of its branches, subdivisions, instrumentalities and its owned or controlled corporations in which a security is required.

(3) The sinking fund shall be established by the National Electrification Administration in such manner that the total annual contributions thereto, accrued at such rate of interest as may be determined by the Secretary of Finance in consultation with the Monetary Board, shall be sufficient to redeem at maturity the bonds issued under this sub-section. This sinking fund shall be under the custody of the Central Bank of the Philippines, which shall invest the same, subject to the approval of the Board of Administrators and the Secretary of Finance in consultation with the Monetary Board: Provided, that the proceeds thereof shall accrue to the NEA.

(4) The Republic of the Philippines hereby guarantees the payment by the NEA of both the principal and the interest of the bonds or other evidences of indebtedness, and shall pay such principal and interest in case the NEA fails to do so; and there are hereby appropriated out of the general funds in the National Treasury not otherwise appropriated, the sums necessary to make the payments so guaranteed: Provided, that the sums so paid by the Republic of the Philippines shall be refunded by the NEA, and Provided, Further, that the NEA, to assure such refunding shall establish such reserves or sinking funds and comply with such other

restrictions and conditions as the Secretary of Finance may prescribe and establish for that purpose.

(b) With respect to foreign indebtedness to be incurred by the NEA, such may be contracted, in the form of loans, credits convertible to foreign currencies, or other forms of indebtedness, from foreign governments or any international financial institution or fund source, including foreign private lenders. The total outstanding amount of such indebtedness, exclusive of interest, shall not exceed five hundred million United States dollars (U.S. $500M) or the equivalent thereof in other currencies. The President of the Philippines, by himself or through his duly authorized representative, is hereby authorized to negotiate and to so contract with foreign governments or any international financial institution or fund source in the name and on behalf of the NEA; and is further authorized to guarantee, absolutely and unconditionally, as primary obligor and not merely as a surety, in the name and on bel lf of the Republic of the Philippines, the repayment of any indebtedness thereby contracted and the payment thereon of any due interest charge, up to the limited amount authorized by the foregoing, which shall be over and above the amounts which the President is authorized to guarantee under R.A. 6152, and also to guarantee the performance of all or any of the obligations under taken by the NEA in the territory of the Republic of the Philippines pursuant to loan agreements entered into pursuant to this sub-paragraph (b). Any indebtedness, contracted under this sub-paragraph (b) and the payment of the principal thereof and of any interest or other charges thereon, as well as the importationf of machinery, equipment, materials, supplies and services by the NEA, paid from the proceeds of any such contracted indebtedness, shall also be exempt from all direct and indirect taxes, fees, imposts, other charges and restrictions, including import restrictions, by the Republic of the Philippines, or by any authority, branch, division or political subdivision thereof.

SEC. 9. Authority to Extend Loans and Release or Subordinate Securities. – Whenever in its judgment such is necessary or desirable to achieve the purposes of this Decree, and particularly if such is necessary to make or keep a project operationally viable, the Board of Administrators is hereby authorized and empowered (a) by agreement with the borrower, to extend the time of payment of principal or interest, or both, beyond the loan agreement term of any loan made by the NEA under this Decree, or to defer, for not in excess of seven years, the time when the repayment schedule for principal or interest, or both, shall begin, or to reschedule payments of principal or interest, or both, or when none of the foregoing is sufficient, to compromise any amount owing by a borrower to the NEA subject to provisions of existing laws; and (b) upon the NEA's determination that such is necessary or desirable for the purpose of enabling a borrower to accomplish the purposes for which it has already received a NEA loan and that such will not result in any diminution of the security of, or of the ability of the borrower to repay, any outstanding indebtedness of the borrower below the level of such security and ability were additional borrowings from another lender not undertaken, to release any after-acquired property clause contained in any lien the NEA holds on a borrower's properties to, or to share any such lien on a co-equal basis in proportion to their respective loans with, or to subor-

dinate any such lien in favor of, any other lender of funds to a public service entity or to the NEA for relending to public service entities for the purposes for which loans are authorized under this Decree.

SEC. 10. Enforcement Powers. – If any public service entity which has borrowed funds from the NEA, or from any other lender with the NEA's lawfully required prior approval, shall default in its principal or interest payments, or shall fail, after notice from the NEA to comply with any other term or condition of a loan agreement or of any rule or regulation promulgated by the NEA in administering the provisions of this Decree, the Board of Administrators is hereby authorized and empowered in its discretion to do any or any combination of the following:

(a) Refuse to make, or give any required approval, to any new loan to the borrower;

(b) Withhold without limitation the NEA's advancement, or withhold its approval for any other lender with respect to which the NEA has such approving power to make advancement, of funds pursuant to any loan already made to the borrower;

(c) Withhold any technical or professional assistance otherwise being furnished or that might be furnished to the borrower;

(d) Foreclose any mortgage or deed of trust or other security held by the NEA on the properties of such borrower, in connection with which the NEA, may, subject to any superior or co-equal rights in such lien held by any other lender, (1) bid for and purchase or otherwise acquire such properties, (2) pay the purchase price thereof and any costs and expenses incurred in connection therewith out of the revolving fund, (3) accept title to such properties in the name of the Republic of the Philippines; and (4) even prior to the institution of foreclosure proceedings, operate or lease such properties for such period, and in such manner as may be deemed necessary or advisable to protect the investment therein, including the improvement, maintenance and rehabilitation of systems to be foreclosed, but the NEA shall, within five years after acquiring such properties in foreclosure proceedings, sell the same for such consideration as it determines to be reasonable and upon such terms and conditions as it determines most conducive to the achievement of the purposes of this Decree; or

(e) Take any other remedial measure for which the loan agreement may provide.

In addition to the foregoing, the Board of Administrators may, at its own instance and in the name of the NEA, petition any court having jurisdiction for such purpose or any administrative agency possessing regulatory powers for such purpose (including the Board of Power and Waterworks) to issue such order and afford such lawful relief as may be necessary.

No borrower shall, without the approval of the Board of Administrators and of any other lender holding or sharing a lien on such borrower's properties, sell or dispose of the property, rights, franchises, permits or any other assets acquired and/or mortgaged pursuant to the provisions of this Decree until all outstanding indebtedness to the NEA and any other such lender, including all interest owing thereon, shall have been repaid, Provided, that the NEA may, by appropriate rule or regulation, grant general permission to borrowers to dispose of incidental properties

(excluding real property), rights, franchises, permits or other assets no longer deemed necessary or useful in conducting the borrower's operations.

No cooperative shall borrow money from any source without the Board of Administrator's prior approval; Provided, that the Board of Administrators may, by appropriate rule or regulation, grant general permission to cooperatives to secure short-term loans not requiring the encumbering of their real properties or of a substantial portion of their other properties or assets.

SEC. 11. Execution of Public Works Act. – The NEA shall execute all electrification projects that may be authorized in any Public Works Acts; and for this purpose it may call for assistance and cooperation consistently with Section 4(j).

SEC. 12. Conflict of Interest. – (a) No member, officer, attorney, agent, or employee of the NEA shall in any manner, directly or indirectly, participate in the determination of any question affecting any public service entity or other entity in which he is directly or indirectly interested or any person to whom he is related within the third degre of affinity or consanguinity. Any person violating the provisions of this sub-section shall be removed from office and shall upon conviction be punished by a fine not to exceed ten thousand (₱10,000.00) pesos or imprisonment not to exceed five years, or both.

(b) No officer or employee of the NEA or any governnment official who may excercise any executive or supervisory authority over the NEA, either directly, for himself or as the representative or agent of others, shall become a guarantor, endorser, surety for loans from the NEA to others, or in any manner be an obligor for money borrowed from the NEA. Any such officer or employee who violates the provisions of this sub-section shall be punished by a fine of not less than one thousand pesos (₱1,000.00) pesos, not more than five thousand (₱5,000.00) pesos or imprisonment for not less than one year nor more than five years, or both.

(c) No loan shall be granted by the NEA to any person related to any member of the Board of Administrators or to the Administrator within the third degree of consanguinity or affinity, or to any corporation, partnership, or company wherein any member of the Board of Administrators or the Administrator is a shareholder, Provided, that the foregoing prohibition shall not apply to a member cooperative of which any member of the board of Administrators or the Administrator or any such relative is a member. Violation by any member of the Board of Administrators or the Administrator of the provisions of this sub-section is sufficient cause for his removal by the President of the Philippines, and the violator shall furthermore be punished as provided in sub-section (b).

(d) No fee, commission, gift, or charge of any kind shall be exacted, demanded, or paid for obtaining loans from the NEA. Any officer, employee or agent of the NEA or the government exacting, demanding or receiving any fee, commission, gift or charge of any kind for service in obtaining a loan shall be punished by a fine of not less than one thousand nor more than three thousand pesos, or imprisonment for not less than one year nor more than three years, or both.

(e) Any person who, for the purpose of obtaining, renewing, or increasing a loan or the extension of the period thereof, on his own or another's behalf, shall give any false information or cause through his

intrigue or machination the existence and production of any false information with regard to the identity, situation, productivity or value of security, or with regard to a point which might affect the granting or denial of the loan, whether the latter has been consummated or not, and any officer or employee of the NEA who through connivance shall allow by action or omission such false information to pass unnoticed, thereby causing damage to the NEA or exposing the latter to the danger of suffering such damage shall be punished by a fine of not less than the amount of the loan obtained or applied for nor more than three times such amount, or imprisonment for not less than three months nor more than three years, or both.

(f) Any officer or employee of the NEA who violates, or causes or permits another person to violate, and any other person who violates or aids or abets the violation of, any provision of this Decree not specifically punishable in the preceding sub-section shall be punished by a fine not exceeding two thousand (₱2,000.00) pesos, or imprisonment not exceeding one year, or both.

SEC. 13. **Supervision over NEA; Power Development Council**; – The NEA shall be under the supervision of the Office of the President of the Philippines. All orders, rules and regulations promulgated, and all appointments made by the NEA as well as transaction subject to the authority and jurisdiction of the NEA involving more than five hundred thousand (₱500,000.00) pesos shall be subject to the approval of the Office of the President of the Philippines.

In order to achieve coordination and cooperation among different agencies and sectors having to do with electrification and power development, there is hereby created a Power Development Council whose Chairman shall be a person or official designated by the President of the Philippines, and its members shall be the manager of the NPC, the NEA Administrator, the Director General of the NEDA, the Chairman of the Board of Power and Waterworks, a representative of electric cooperatives to be chosen by a national association of electric cooperatives, and a representative of the Private sector.

The Council shall have a Secretariat to be headed by an Executive Secretary and staffed by such number of personnel as may be determined by the Council. In order to augment the expertise necessary in the performance of its functions, the council may secure the detail of personnel, either on a part-time or full-time basis, as well as other forms of assistance from other government offices and agencies, including government-owned or controlled corporations. The qualifications and compensation of the personnel of the Secretariat shall be determined by the Council, but their appointment shall be made by the Chairman.

The salaries, expenses, operating expenses and such other necessary financial outlays for PDC shall be provided for from a special annual assessment to be determined by the Chairman of PDC and paid by the NEA and NPC.

The Council shall adopt an integrated plan of electrification and power development, coordinate the activities and operations of all sectors involved in electrification, and recommend such policies and measures to the power authorities and parties concerned as it may deem necessary to achieve the total electrification objective declared in this Decree.

SEC. 14. **Exemption From All Taxes, Duties, Fees, Imposts and Other Charges by Government and Government Instrumentalities.** – The NEA shall devote all its returns from its capital investments as well as excess revenues from its operation to attain its objectives. To enable the NEA to pay its indebtedness and obligations and in furtherance and effective implementation of the policy enunciated in this Decree, the NEA is hereby declared exempt:

(a) From the payment of all taxes, duties, fess imposts, charges, costs and restrictions to the Republic of the Philippines, its provinces, cities, municipalities, and other charges provided for under the Tariff and Customs Code of the Philippines, R.A. 1937, as amended by Presidential Decree No. 34 dated October 27, 1972, and Presidential Decree No. 69 dated November 24, 1972, and filing and service fees and other charges or costs in any court or administrative proceedings in which it may be a party;

(b) From all income taxes, franchise taxes and realty taxes to be paid to the National Government, its provinces, cities, municipalities and other government agencies and instrumentalities;

(c) From all import duties, compensating taxes and advance sales tax, wharfage fees on import of foreign goods and required for its operations and projects; and

(d) From all taxes, duties, fees, imposts, and all other charges imposed direct or indirectly by the Republic of the Philippines, its provinces, cities, municipalities and other government agencies and instrumentalities, on all petroleum products used by the NEA in the generation, transmission, utilization and sale of electric power.

CHAPTER II – ELECTRIC COOPERATIVES

SEC. 15. **Organization and Purpose.** – Cooperative non-stock, non-profit membership corporations may be organized, and electric cooperative corporations heretofore formed or registered under the Philippine non-Agricultural Co-operative Act may as hereinafter provided be converted, under this Decree for the purpose of supplying, and of promoting and encouraging the fullest use of, service on area coverage basis at the lowest cost consistent with sound economy and the prudent management of the business of such corporations.

SEC. 16. **Powers.** – A cooperative is hereby vested with all powers necessary or convenient for the accomplishment of its corporate purpose and capable of being delegated by the President or the National Assembly when it comes into existence; and no enumeration of particular powers hereby granted shall be construed to impair any general grant of power herein contained, nor to limit any such grant to a power or powers of the same class as those so enumerated. Such powers shall include, but not be limited to, the power:

(a) To sue and be sued in its corporate name;

(b) To have existence for a period of fifty years;

(c) To adopt a corporate seal and alter the same;

(d) To generate, manufacture, purchase, acquire, accumulate and transmit electric power and energy, and to distribute, sell supply and dispose of electric energy to persons who are its members and to other

persons not in excess of ten per centum of the number of its members; Provided, however, that a cooperative may furnish electric cold storage or processing plant service to non-members without limitation; and Provided, further, that a cooperative which acquires existing electric facilities may continue service from such facilities without requiring such persons to become members, but such persons may become members upon such terms as may be prescribed in the cooperative's by-laws;

(e) To assist persons to whom service is or will be supplied by the cooperative in wiring their premises and in acquiring and installing electrically powered appliances, equipment, fixtures and machinery for agricultural, commercial and industrial uses by the financing thereof otherwise, and in connection therewith to wire, or cause to be wired, such premises, and to purchase, acquire, lease as lessor or lessee, sell, distribute, install and repair such electrically-powered appliances, equipment, fixtures and machinery;

(f) To assist persons to whom service is or will be supplied by the cooperative in constructing, equipping, maintaining and operating electric cold storage or processing plants, by the financing thereof or otherwise;

(g) To construct, purchase, lease as lessee, or otherwise acquire, and to equip, maintain, and operate, and to sell, assign, convey, lease as lessor, mortgage, pledge, or otherwise dispose of or encumber, electric transmission and distribution lines or systems, electric generating plants, lands, buildings, structures, dams, plants and equipment, and any other real or personal property, tangible or intangible, which shall be deemed necessary, convenient or appropriate to accomplish the purpose for which the cooperative is organized;

(h) To purchase, lease as lessee, or otherwise acquire, and to use, and exercise and to sell, assign, convey, mortgage, pledge or otherwise dispose of or encumber franchises, rights, privileges, licenses and easements;

(i) To borrow money and otherwise contract indebtedness, and to issue notes, bonds, and other evidence and indebtedness, and to secure payment thereof by mortgage, pledge, or deed of trust of, or any other encumbrances upon, any or all of its then owned or after-acquired real or personal property, assets, franchises, or revenues; Provided, That any borrowing from, or any encumbering of properties as security in favor of, any lending sources other than the NEA shall require the prior approval of the NEA Administrator and has certification that such is in furtherance of the purposes and is consistent with the provisions of this Decree, and that such borrowing and/or encumbering will not diminish the security of or of the ability of the cooperative to repay, any then-outstanding indebtedness of the cooperative to the NEA or any other lending source below the level of such security and ability were such additional borrowing not being undertaken;

(j) To construct, maintain and operate electric transmission and distribution lines along, upon, under and across publicly owned lands and public thoroughfares, including, without limitation, all roads, highways, streets, alleys, bridges and causeways; Provided, that such shall not prevent or unduly impair the primary public uses to which such lands and thoroughfares are otherwise devoted;

(k) To exercise the power of eminent domain in the manner provided by law for the exercise of such power by other corporations con-

and distribution lines or systems;

(l) To become a member of other cooperatives or Corporation or to own stock therein, provided such cooperatives or corporation are engaged in a business or activities of the cooperative, its members, its directors, or its employees;

(m) To conduct its business and exercise its powers within or without the province or provinces in which it supplies service;

(n) To adopt, amend and repeal by-laws;

(o) To fix, maintain, implement and collect rates, fees, rents, tolls and other charges and terms and conditions for service; Provided, that by appropriate rules and regulations the NEA shall require that such shall be in furtherance of the purpose and in conformity with the provisions of this Decree; and

(p) To do and perform any other acts and things, and to have and exercise any other powers which may be necessary, convenient or appropriate to accomplish the purpose for which the cooperative is organized.

SEC. 17. Name. – The name of a cooperative shall include the words "Electric" and "Cooperative", and the abbreviation "Inc.". The name of a cooperative organized under this Decree shall be distinct from the name of any other cooperative already organized or converted under this Decree. The foregoing requirement shall not apply to any cooperative which becomes subject to this Decree by complying with the provisions of Section 31.

SEC. 18. Incorporators. – Five or more persons, including cooperatives, may organize a cooperative in the manner hereinafter provided.

SEC. 19. Articles of Incorporation. – The articles of incorporation of a cooperative shall recite that they are executed pursuant to this Decree and shall state: (a) the name of the cooperative; (b) the address of its principal office; (c) the names and addresses of the incorporators; and (d) the names and addresses of its original directors, who shall constitute the board until the first election of the board by the members; and may contain any other provisionss not inconsistent with this Decree that are deemed necessary or advisable for the conduct of its business. Such articles shall be signed by each incorporator and acknowledged by at least two of the incorporators (or on their behalf, if they are cooperatives). It shall not be necessary to recite in the articles of incorporation the purpose for which the cooperative is organized or any of its corporate powers.

SEC. 20. By-laws. – Unless reserved to the members in the articles of incorporation, the power to adopt and thereafter to amend or repeal by-laws, shall vest in and be exercised by the board, the affirmative votes of a clear majority of all directors in office, after due notice to all directors, being requisite for such purpose. The by-laws shall set forth the basic rights and duties of member and directors and may contain any other provisions for the regulation and management of the affairs of the cooperative not inconsistent with its articles of incorporation or this Decree.

SEC. 21. Members. – Each incorporator of a cooperative shall be a member thereof, but other persons may become members thereof unless

such other persons agree to use services furnished by the cooperative when made available by it. Membership in a cooperative shall not be transferable, except as provided in the by-laws. The by-laws may prescribe additional qualifications and limitations with respect to membership.

The provision of any law or regulation to the contrary notwithstanding, an officer employee of the government shall be eligible for membership in any cooperative if he meets the qualifications therefore and he shall not be precluded from being elected to or holding any position therein, or from receiving such compensation or fee in relation thereto as may be authorized by-laws; **Provided**, that elective officers of the government, except barrio captains and councilors, shall be ineligible to become officers and/or directors of any cooperative. For this purpose, individual permission need not be obtained from the proper head of office; **Provided, however**, that this authority shall not be considered as a permit to the government officer or employee concerned to devote official time to the affairs of the cooperative.

SEC. 22. **Meetings of Members.** (a) An annual meeting of the members of a cooperative shall be held at such time and place as shall be provided in the by-laws.

(b) Special meetings of the members may be called by the President, by the board, by any three directors, or, unless a smaller number or percentage be prescribed in the by-laws, by not less than 100 members or five per centum of all members, whichever shall be the lesser.

(c) Except as otherwise provided in this Decree and unless otherwise provided for in the by-laws, written or printed notice stating the time and place of each meeting of the members and, in the case of special meeting, the purpose or purposes for which the meeting is called, shall be given to each member, either personally or by mail, not less than ten days nor more than twenty-five days before the date of the meeting. If mailed, such notice shall be deemed to be given when deposited in the Philippine mail with postage prepared, addressed to the member at his address as it appears on the records of the cooperative.

(d) Unless the by-laws prescribed the presence of a greater or lesser percentage or number of the members for such purpose, a quorum for the transaction of business at all meetings of the members of a cooperative having not more than 1,000 members shall be five per centum of all members, present in person, and of a cooperative having more than 1,000 members shall be five per centum of all members or 100, whichever is lesser, present in person. If less than a quorum is present at any meeting, a majority of those present in person may adjourn the meeting from time to time without further notice.

(e) Each member shall be entitled to one vote of each matter submitted to a vote at a meeting of the members. Voting shall be noncumulative and in person, but if the by-laws so provide, may also be by mail or by proxy.

SEC. 23. **Waiver of Notice.** – Any person entitled to notice of a meeting may waive notice in writing either before or after such meeting; however, his attendance shall constitute a waiver of notice of such meeting, unless such person participates therein solely to object to the

transaction of any business because the meeting has not been legally called or convened.

SEC. 24. **Board of Directors.** – (a) The business of a cooperative shall be managed by a board of not less than five directors, each of whom shall be a member of the cooperative or of another which is a member thereof. The by-laws shall prescribe the number of directors, their qualifications other than those prescribed in this Decree, the manner of holding meetings of the Board and of electing successors to directors who shall resign, die or otherwise be incapable of acting. The by-laws may also provide, for the removal of directors from office and for the election of their successors. Directors shall not receive any salaries for their services as such and, except in emergencies, shall not receive any salaries for their services to the cooperative in any other capacity without the approval of the members. The by-laws may, however, prescribe a fixed fee for attendance at each meeting of the board and may provide for reimbursement of actual expenses of such attendance of any other actual expenses incurred in the due performance of a director's duties.

(b) The directors of a cooperative named in any articles of incorporation, consolidation, merger or conversion shall hold office until the next annual meeting of the members and until their successors are elected and qualify. At each annual meeting of, in case of failure to hold the annual meeting as specified in the by-laws, at a special meeting called for that purpose, the members shall elect directors to hold office until the next annual meeting of the members, except as otherwise provided in this Decree. Each director shall hold office for the term for which he is elected and until his successor is elected and qualifies.

(c) Instead of electing all the directors annually, the by-laws may provide that each year half of them or one-third of them, or a number as near thereto as possible, shall be elected on a staggered term basis to serve two-year terms or three-year terms, as the case may be.

(d) A majority of the board of directors in office shall constitute a quorum.

(e) The board shall exercise all of the powers of a cooperative not conferred upon or reserved to the members by this Decree or by its articles of incorporation or by-laws.

SEC. 25. **Districts.** – The by-laws may provide for the division of the territory served or to be served by a cooperative into two or more districts for any purpose, including, without limitation, the nomination and election of directors. The by-laws shall prescribe the boundaries of the districts, or the manner establishing such boundaries, the manner of changing such boundaries, and the manner in which such districts shall function.

SEC. 26. **Officers.** – The officers of a cooperative shall consist of a president, vice-president, secretary and treasurer, who shall be elected annually by and from the board. When a person holding any such office ceases to be a director, he shall ipso facto cease to hold such office. The offices of secretary and of treasurer may be held by the same person. The board may also elect or appoint such other officers, agents, or employees as it deems necessary or advisable and shall prescribe their powers and duties. Any officer may be removed from office and his successor elected in the manner prescribed in the by-laws.

SEC. 27. **Amendment of Articles of Incorporation.** A cooperative may amend its articles of incorporation by complying with the following requirements; **Provided**, however, that a change of location of principal office may be effected in the manner set forth in Section 28. The proposed amendment shall be presented to a meeting of the members, the notice of which shall set forth or have attached thereto the proposed amendment or an accurate summary thereof. If the proposed amendment, with any changes, is approved by the affirmative vote of not less than two-thirds of the total votes cast thereon at such meeting, articles of amendment shall be executed and acknowledged on behalf of the cooperative by its president or vice-president and its seal be affixed thereto and attested by its secretary. The articles of amendment shall recite that they are executed pursuant to this Decree and shall state: (1) the name of the cooperative; (2) the address of its principal office; and (3) the amendment to its articles of incorporation.

The president or vice-president executing such articles of amendment shall make the annex thereto an affidavit stating that the provisions of this section with respect to the amendment set forth in such articles were duly compiled with.

SEC. 28. **Change of Location of Principal Office.** – A cooperative may, upon authorization of its board or members, change the location of its principal office by filling a certificate reciting such change of principal office, executed and acknowledged by its president or vice-president under its seal attested by its secretary, in the place provided for in Section 34.

SEC. 29. **Consolidation.** – Any two or more cooperatives (each of which is hereinafter designated a "consolidating cooperative") may consolidate into a new cooperative (hereinafter designated the "new cooperative"), by complying with the following requirements:

(a) The proposition for the consolidation of the consolidating cooperatives into the new cooperative and proposed articles of consolidation to give effect thereto shall be submitted to a meeting of the members of each consolidating cooperative, the notice of which shall have attached thereto a copy of the proposed articles or consolidation or an accurate summary thereof.

(b) If the proposed consolidation and the proposed articles of consolidation, with any amendments, are approved by the affirmative vote of not less than two-thirds of the total votes cast thereon by each consolidating cooperative voting thereon at each such meeting, articles of consolidation in the form approved shall be executed and acknowledged on behalf of each consolidating cooperative by its president or vice-president and its seal shall be affixed thereto and attested by its secretary. The articles of consolidation shall recit that they are executed pursuant to this Decree and shall state: (1) the name of each consolidating cooperative and the address of its principal office; (2) the name of the new cooperative and the address of its principal office; (3) a statement that each consolidating cooperative agrees to the consolidation; (4) the names and addresses of the directors of the new cooperative; and (5) the terms and conditions of the consolidation and the mode of carrying the same into effect, including the manner in which members of the consolidating cooperatives may or shall become members of the new cooperative; and

may contain any other provisions not inconsistent with this Decree that are deemed necessary or advisable for the conduct of the business of the new cooperative. The president or vice-president of each consolidating cooperative executing such articles of consolidation shall make and annex thereto an affidavit stating that the provisions of this section with respect to such articles were duly complied with by such cooperative.

SEC, 30. **Merger.** – Any one or more cooperatives 9each of which is hereinafter designated a "merging cooperative") may merge with one or more other cooperatives by complying with the following requirements:

(a) The proposition for the merger of the merging cooperatives into the surviving cooperative and proposed articles or merger to give effect thereto shall be submitted to a meeting of the members of each merging cooperative and of the surviving cooperative, the notice of which shall have attached thereto a copy of the proposed articles of merger or an accurate summary thereof.

(b) If the proposed merger and the proposed articles of merger, with any amendments, are approved by the affirmative vote of not less than two-thirds of the total votes cast thereon by each cooperative voting thereon at each such meeting, articles of merger in the form approved shall be executed and acknowledged on behalf of each such cooperative by its president or vice president and its seal affixed thereto and attested by its secretary. The articles of merger shall recite that they are executed pursuant to this Decree and shall state: (1) the name of each merging cooperative and the address of its principal office; (3) a statement that each merging cooperative and the surviving cooperative agree to the merger; (4) the names andaddresses of the directors of the surviving cooperative, and (5) the terms and conditions of the merger and the mode of carrying the same into effect, including the manner in which members of the merging cooperatives may or shall become members of the surviving cooperative and may contain any other provisions not inconsistent with this Decree that are deemed necessary or advisable for the conduct of the business of the surviving cooperative. The president or vice-president or each cooperative executing such articles of merger shall make and annex thereto an affidavit stating that the provisions of this section with respect to such articles were duly complied with by such cooperative.

SEC. 31. **Effect of Consolidation or Merger.** – (a) In the case of consolidation, the existence of the consolidating cooperative shall cease and the articles of consolidation shall be deemed to be the articles of incorporation of the new cooperative; and in the case of merger, the separate existence of the merging cooperatives shall cease and the articles of incorporation of the surviving cooperative shall be deemed to be amended to the extent, if any, that changes therein are provided for in the articles of merger;

(b) All rights, privileges, immunities and franchises and all property, real and personal, including without limitation applications for membership, all debts due on whatever account and all other choses in action of each of the consolidating or merging cooperatives shall be deemed to be transferred to and vested in the new or surviving cooperative without further act or deed.

(c) The new or surviving cooperative shall be responsible and liable for all the liabilities and obligations of each of the consolidating or merging cooperatives, and any claim existing or action or proceeding pending by or against any of the consolidating or merging cooperatives, be prosecuted as if the consolidation or merger had not taken place, but the new or surviving cooperatives shall be constituted in its place; and

(d) Neither the rights of creditors nor any liens upon the property of any such cooperatives shall be impaired by such consolidation or merger.

SEC. 32. Conversion of Existing Corporation. – Any corporation heretofore organized or registered under the Philippine Non-Agricultural Co-operative Act and supplying or having the corporate power to supply electric energy may convert itself into a cooperative under this Decree by complying with the following requirements, and shall thereupon become subject to this Decree with the same effect as if originally organized hereunder:

(a) The proposition for the conversion of such corporation and proposed articles of conversion to give effect thereto shall be submitted to a meeting of the members or stockholders of such corporation, the notice of which shall have attached thereto a copy of the proposed articles of conversion or an accurate summary thereof.

(b) If the proposition for the conversion and the proposed articles of conversion, with any amendments, are approved by the affirmative vote of not less than two-thirds of the total votes cast thereon by members a such meeting, and/or, if such corporation, is a stock corporation or has both members, and voting stockholders, by the affirmative vote of the holders of not less than two-thirds of those shares of the capital stock of such corporation represented at such meeting and voting thereon, articles of conversion in the form approved shall be executed and acknowledged on behalf of such corporation by its president or vice-president and its seal shall be affixed thereto and attested by its secretary. The articles of conversion shall recite that they are executed pursuant to this Decree and shall state: (1) the name of the corporation and the address of its principal office prior to the conversion into a cooperative; (2) a statement that such corporation elects to become a cooperative, non-profit, membership corporation subject to this Decree; (3) its name as a cooperative; (4) the address of the directors of the cooperative, and (6) the manner in which members or stockholders of such corporation may or shall become members of the cooperative; and may contain any other provisions not inconsistent with this Decree that are deemed necessary or advisable for the conduct of the business of the cooperative. The president or vice-president executing such articles of conversion shall make and annex thereto and affidavit stating that the provisions of this section were duly complied with in respect to such articles. The articles of conversion shall be deemed to be the articles of incorporation of the cooperative.

SEC. 33. Dissolution. – A cooperative may be dissolved in the following manner: The proposition to dissolve shall be submitted to the members of the cooperative at any annual or special meeting, the notice of which shall set forth such proposition. The members at any such meeting shall approve, by the affirmative vote of not less than a majority of all members of the cooperative, the proposition that the cooperative

be dissolved (hereinafter designated the "certificate") shall be executed and acknowledged on behalf of the cooperative by its president or vice-president under its seal, attested by its secretary, stating; (1) the name of the cooperative; (2) the address of its principal office; and (3) that the members of the cooperative have only voted that the cooperative be dissolved. Also, an affidavit, made by its president or vice-president executing the certificate, shall state that the statements in the certificate are true. Upon the filing of the certificate and affidavit as provided for in Section 34, the cooperative shall cease to carry on its business except to the extent necessary for the winding up thereof, but its corporate existence shall continue until articles of dissolution shall have been filed. The board shall immediately cause notice of the dissolution proceedings to be mailed to each known creditor of and claimant against the cooperative and to be published once a week for two successive weeks in a newspaper of general circulation in the territory in which the principal office of the cooperative is located. The board shall wind up and settle the affairs of the cooperative, collect sum owing to it, liquidate its property and assets, pay and discharge its debts, obligations and liabilities, other than those to patrons arising by reason of their patronage and do all other things required to wind up its business, and, after paying or discharging or adequately providing for the payment or discharge of all its debts, obligations and liabilities, other than those to patrons arising by reason of their patronage, shall distribute any remaining sums and/or unliquidated assets, first, to patrons for the pro rata return of all amounts standing to their credit by reason of their patronage; second, to members for the pro rata repayment of membership fees; and third, to patrons for the amounts of any outstanding contributions in aid of construction they have made. Any sums and/or unliquidated assets then remaining shall be distributed in such manner as provide in the cooperative's articles of incorporation or by-laws, which may provide for distribution of such sums or assets on a patronage basis to persons who were members in one or more prior years or for transfer thereof to a new cooperative to succeed the one being dissolved. The board shall thereupon authorize the execution of articles of dissolution, which shall be executed and acknowledged on behalf of the cooperative by its president or vice-president, and its seal shall be affixed thereto and attested by its secretary. The articles of dissolution shall recite that they are executed pursuant to this Decree and shall state: (1) the name of the cooperative; (2) the address of its principal office; (3) the date on which the certificate of election to dissolve was filed; (4) that there are no actions or suits pending against the cooperative; (5) that all debts, obligations and liabilities of the cooperative have been paid and disregard or that provision to the extent possible has been made therefor; and (6) that the provisions of this section have been duly complied with. The president or vice-president executing the articles of dissolution shall make the annex thereto an affidavit stating that the statements made therein are true.

SEC. 34. Filing of Articles and Certificates. – Articles of incorporations, amendment, consolidation, merger, conversion, or dissolution and certificates of changes in the location of principal offices and of elections to dissolve, when executed and acknowledged and accompanied by such affidavits as may be required by applicable provisions of this Decree,

shall be presented to the Administrator for filing in the records of his office. If he shall find that such conform to the requirements of this Decree, he shall so certify and shall file such in the records of his office. Upon such certification and filing, the incorporation, amendment, consolidation, merger, conversion, dissolution or certificate provided for therein shall be in effect.

SEC. 35. **Non-profit, Non-discriminatory, Area Coverage Operation and Service.** A cooperative shall be operated on a non-profit basis for the mutual benefit of its members and patrons, shall, as to rates and services make or grant no unreasonable preference or advantage to any member or patron nor subject any member or patron to any unreasonable prejudice or disadvantage; shall not establish or maintain any unreasonable difference as to rates or services either as between localities or as between classes or service; shall not give, pay or receive any rebate or bonus, directly or indirectly, or mislead its members in any manner as to rates charged for its services; and shall furnish service on an area coverage basis, **Provided**, that, for any extension of service which if treated on the basis of standard terms and conditions is so costly as to jeopardize the financial feasibility of the cooperative's entire operation, the cooperative may require such contribution in aid of construction, such facilities extension deposit, such guarantee of minimum usage for a minimum term or such other reasonable commitment on the part of the person to be served as may be necessary and appropriate to remove such jeopardy, but no difference in standard rates of use of service shall be imposed for such purpose.

The by-laws of a cooperative or its contracts with members and patrons shall contain such reasonable terms and conditions respecting membership, the furnishing of service and the disposition of revenues and receipts as may be necessary and appropriate to establish and maintain its non-profit, cooperative character and to assure compliance with this section. No bona fide applicant for membership on non-member patronage who is able and willing to satisfy and abide by all such terms and conditions shall be denied arbitrarily, capriciously or without good cause.

SEC. 36. **Disposition of Property.** – (a) The board of a cooperative shall have full power and authority, without authorization by the members thereof, to authorize the execution and delivery of a mortgage or a deed of trust, or the pledging or encumbering otherwise, of any or all of the property, assets, rights, privileges, licenses, franchises and permits of the cooperative, whether acquired or to be acquired, and wherever situated, as well as the revenues therefrom, all upon such terms and conditions as the board shall determine, to secure any borrowing by or indebtedness of the cooperative.

(b) A cooperative may not otherwise sell, lease, or except by consolidation or merger, otherwise dispose of the property (other than merchandise and property which shall represent not in excess of ten per centum of the value of the cooperative's total assets, or which in the judgement of the board are not necessary or useful in operating the cooperative) unless such sale, lease, or except in the case of consolidation or merger, other disposition is (1) authorized by the affirmative vote of not less than a majority of all members of the cooperative and (2) consented to

by the NEA and any other lending source which then holds a lien on any of the cooperative's properties.

SEC. 37. **Non-Liability of Members for Debts of Cooperative.** – No member shall be liable or responsible for any debts of the cooperative and the property of the members shall not be subject to execution therefor.

SEC. 38. **Limitation of Actions.** – No action or suit may be brought against any agent, servant or employee thereof, by reason of the maintenance of electric transmission or distribution lines, or real property after the expiration of a period of five (5) years of continuous maintenance of such lines or related equipment facilities or machinery.

SEC. 39. **Assistance to Cooperative; Exemption from Taxes, Imposts, Duties, Fees; Assistance from the National Power Corporation.** – Pursuant to the national policy declared in section 2, the Congress hereby finds and declares that the following assistance to cooperatives is necessary and appropriate:

(a) Provided that it operates in conformity with the purposes and provision of this Decree, a cooperative (1) shall be permanently exempt from paying income taxes, and (2) for a period ending on December 31; of the thirtieth full calendar year after the date of a cooperative's organization or conversion hereunder, or until it shall become completely free of indebtedness incurred by borrowing, whichever event first occurs, shall be exempt from the payment (A) of all National Government, local government and municipal taxes and fees, including any franchise filing, recordation, license or permit fees or taxes and any fees, charges, or costs involved in any court or administrative proceeding in which it may be a party, and (B) of all duties or imposts on foreign goods acquired for its operations, the period of such exemption for a new cooperative formed by consolidation, as provided for in section 29, to begin from as of the date of the beginning of such period for the constituent consolidating cooperative which was most recently organized or converted under this Decree; **Provided**, that the Board of Administrators shall after consultation with the Bureau of Internal Revenue, promulgate rules and regulations for the proper implementation of the tax exemption provided for in this Decree.

(b) The National Power Corporation shall, except with respect to the National Government, give preference in the sale of its power and energy to cooperatives, and shall otherwise provide the maximum support of and assistance to cooperatives of which it is capable, including assistance in developing dependable and reliable arrangements for their supplies of bulk power, either from itself, or from other sources. In pursuance of the foregoing policy, the National Power Corporation shall not, except upon prior written agreement approved by the cooperative's board, compete in the sale of power and energy which without regard to the location of the point of delivery thereof, will be utilized and consumed within any area franchised to a cooperative.

SEC. 40. **Exemption from Board of Power and Waterworks and Securities and Exchange Commission.** – (a) Cooperatives shall be exempt from regulation by the Board of Power and Waterworks.

(b) The provisions of the Securities Act shall not apply to any note, bond or other evidence of indebtedness issued by any cooperative or to any mortgage, deed of trust, indenture or other instrument executed to secure the same. The provisions of said Act shall not apply to the is-

suance of membership certificates or any other evidence of member or patron interest by a cooperative.

CHAPTER IV. – FRANCHISES; REGULATION OF COOPERATIVES

SEC. 41. **Applicability.** – This Chapter shall apply only to electric franchises as in Section 3 defined. It shall not be applicable to franchises for any other utility service or to those separable portions of franchises covering any other type of utility service though such franchises may also cover electric service. The Board of Administrators shall hear and determine all questions which may arise under this section.

SEC. 42. **Repeal of Franchise Powers of Municipal, City and Provincial Governments.** – The powers of municipal, city and provincial governments to grant franchises, as provided for in Title 34 of the Philippines Statutes or in any special law, are hereby repealed: PROVIDED, that this section shall not impair or invalidate any franchise heretofore lawfully granted by such a government or repeal any other subsisting power of such governments to require that electric facilities and related properties be so located, constructed, operated and maintained as to be safe to the public and not to unduly interfere with the primary use of streets, roads, alleys and other public ways, buildings and grounds over, upon or under which they may be built.

SEC. 43. **Franchising Powers Delegated to the NEA.** – The power hereafter to grant and thereafter to repeal, alter or amend new franchises, or repeal, alter or amend all franchises heretofore granted by the Congress (or by the President, or by the National Assembly after it comes into existence), and repeal, alter or amend all franchises heretofore granted by any municipal, city or provincial government, is hereby delegated to the NEA, whose Board of Administrators shall, acting as a Commission, administer the provisions of this Chapter. Provisions of Republic Act 2677 to the contrary notwithstanding, no municipality shall hereafter initiate the operation or after December 31, 1973, continue any operation heretofore initiated, of any service for sale at retail unless it shall first obtain a franchise from the NEA in accordance with the provisions of this Chapter. In exercising the powers herein delegated, the NEA shall at all times seek to serve the National objective of the most rapid total electrification of the Philippines on an area coverage basis. Without limiting the generality of the foregoing sentence, the NEA is hereby authorized, empowered and directed:

(a) Within one hundred eighty days after the effective date of this Chapter (and periodically thereafter, at least once annually) to notify and require every person holding a franchise to report to it, within not less than ninety days after such notice, an accurate description of the geographic area encompassed in such franchise, the number of households therein receiving service which is not adequate and dependable, the number and type of other retail customers therein receiving adequate and dependable service or service which is not adequate and dependable, the approximate total numbers of households therein, the date such franchise

was granted and such other information and date as the NEA for the purpose of implementing this section may require, and, on the basis of such reports and otherwise, including complaints:

(1) to review such franchises to determine whether the holders thereof are furnishing service on an area coverage basis or are engaged in effective measures to furnish such service within a reasonable time;

(2) to repeal and cancel any franchise if the NEA finds that the holder thereof is no then furnishing, and is unable or unwilling within a reasonable time to furnish, adequate and dependable service on an area coverage basis within such area; and

(3) to alter and condition such or other existing franchises and to issue new franchises to the end of assuring area coverage service throughout the Nation as in this Decree contemplated: Provided, That no franchise shall be altered, conditioned, repealed or cancelled, and no franchise shall be granted, without first affording the holder thereof, or the contending applicants therefor, if such be the case, and any other interested parties opportunity for hearing; and

(b) Upon determining, after affording opportunity for hearing to all interested parties, that such is necessary or appropriate to assure or expedite the furnishing of service on an area coverage basis, to require any public service entity to interconnect its generation, transmission or distribution facilities with, and through such interconnection to exchange, sell or purchase power and energy with, to or from or to transmit power and energy on behalf of, any other public service entity or, if it so requires or consents, the NPC; and, if such public service entities (and, if such be the case, the NPC) are unable between or among themselves to agree upon such, to establish the manner and degree, to fix and apportion the financial responsibility and sharing of costs, and to determine the other terms and conditions of such interconnection, exchange, sale purchase or transmission: Provided, however, that the provisions of Section 45 to the contrary notwithstanding, the provisions of this paragraph shall apply to industrial plants, factories, mills, mines and similar or other generating entities in which case they shall qualify as public service entities for purposes of Section 4(f).

SEC. 44. **Preference to Cooperatives.** – Whenever two or more public service entities are affected by and have competing or conflicting interests with respect to the granting, repeal, alteration or conditioning of the same franchise or franchises, and one or more of such entities are cooperatives, the NEA shall accord preference to a cooperative over any other type of public service entity (and shall prefer one cooperative over another) unless and except to the extent that an order in favor of another type of public service entity (or of another cooperative) will, as found by the NEA, result both earlier and ultimately in the furnishing and extending of area coverage service (1) to a greater number of households, (2) over a larger geographic area, and (3) on the basis of the same or lower rates, charges and fees.

SEC. 45. **Furnishing Service Without a Franchise Prohibited.** – No person shall furnish or extend service to the public within any area for which person has not been granted a franchise or after such a franchise has been repealed and cancelled or so conditioned or altered as to prohibit service therein: Provided, that such service may be continued and ex-

tended herein, and the NEA, after affording opportunity for hearing to any interested party, may by order require that it be so continued and extended, until service to the customers of such person is made available by a public service entity lawfully authorized to service therein.

SEC. 46. **Additional Regulation of Cooperatives by the NEA.** – In addition to the other ways in which cooperatives are subject to regulation by the NEA as provided in this Decree, the NEA, on its own motion or upon complaint but only after affording opportunity for hearing to all interested parties, is empowered to and shall (1) require a cooperative to extend or improve service upon the NEA's determination that such should be done in furtherance of the purposes of this Decree and that such may reasonably be done without undue impairment of the feasibility of the cooperative's operations and financial condition; and (2) require a cooperative to cease and correct any practice or act which the NEA determines to be in violation of the provisions of Section 35, and in connection with such authority it may require a cooperative to file with the NEA, and to make accessible to any person upon request therefor, copies of all rates, charges, contract forms, fee or deposit schedules, by-laws, and service rules and regulations.

SEC. 47. **Hearings and Investigations.** – The NEA is empowered to conduct such hearings and investigations and to issue such orders as are necessary for it to implement the provisions of this Chapter, and in connection therewith, without necessity of previous hearing, to require any public service entity or the officials thereof to furnish to it such information and data, including statements of account, schedules of rates, fees and charges, contracts, service rules and regulations, articles of incorporation, by-laws, audit reports and other internal records, documents, policies and procedures, as will enable the NEA to be sufficiently informed in exercising its powers and authorities: **Provided**, that no order shall issue finally determining and substantially affecting any right of any person subject to the NEA's jurisdiction without first affording such person and any other interested person opportunity for hearing as a party in the hearing proceeding.

SEC. 48. **Parties and Intervenors in NEA's Proceedings.** – Public service entities or any other interested person may invoke the NEA's exercise of its powers and authorities provided for in Sections 43, 44, 45, 46 and 47 by filing verified applications or complaints with the NEA, and the NEA, on its own motion solely, may institute proceedings in connection with all matters coming under its jurisdiction as provided for in said sections. In any proceeding conducted by the NEA, including proceedings to establish NEA rules and regulations, all persons having a substantial interest therein shall, upon petition therefor, be permitted by the NEA to intervene as full parties, and the NEA, in its discretion, may permit persons having an insubstantial interest therein to intervene as a full party or on such limited basis as the NEA may prescribe.

SEC. 49. **NEA Rules and Regulations.** – The NEA shall establish appropriate rules and regulations to carry out the provisions of this chapter IV, including rules for the conduct of NEA investigations, proceedings and hearings, and shall timely publish the same when adopted

or amended to the end that all persons affected thereby shall be given reasonable notice thereof.

SEC. 50. **Notice.** – (a) With respect to any NEA proceeding, investigation or hearing (including such as are for the purpose of establishing NEA rules and regulations) which may substantially affect the rights or interests of any person or persons (including the general public or the National Government or any department, agency, instrumentality or political subdivision thereof, if such be the case), the NEA shall cause timely notice in writing to be furnished to, or served upon or approximately published to such person or persons to the end of affording them reasonable opportunity, as a party or otherwise, directly to participate, or otherwise to have their positions, views and inter sts adequately presented to or represented, in such proceeding, investigation or hearing.

(b) Upon the completion of any such processing, investigation or hearing, the NEA shall cause timely notice of any other issuing thereupon to be furnished to, or served upon, or appropriately published to any person or persons (including the general public or the National Government or any department, agency, instrumentality or political subdivision thereof, if such be the case) who will be directly affected thereby. Such notice shall be supplementary to, not in conflict with or in lieu of, the notices and services otherwise provided for in this Chapter.

SEC. 51. **Hearings Conducted by Board of Administrators or any Member Thereof.** – NEA hearings pursuant to this chapter may be conducted by the Board of Administrators en banc or by any one or more members thereof, as the Board of Administrators may decide: **Provided**, that the Administrator shall preside when the Board of Administrators sits en banc; **Provided, Further**, that all hearings shall be of record; **And Provided Finally**, that findings, determinations, orders and rulings based upon such hearings shall require the affirmative majority of all the members of the Board of Administrators upon the certification, to become a part of such findings, determinations and orders, on the part of any member of the Board who was absent from the hearings that he has read the record of the same.

SEC. 52. **Compensation.** – The members of the Board of Administrators and other hearing officers as the Board of Administrators may designate shall be entitled to per diem for each hearing actually conducted or attended by them in such amount as may be fixed by the President of the Philippines.

SEC. 53. **Hearing Rules; Contempt.** – All hearings and investigations conducted by the NEA shall be governed by rules adopted by the NEA, and in the conduct thereof the NEA shall not be bound by the technical rules of legal evidence; **Provided**, that the NEA or such member of the Board of Administrators when conducting a hearing, may summarily punish for contempt by a fine not exceeding two hundred pesos (₱200.00) or by imprisonment not exceeding ten (10) days, or both, any person guilty of misconduct in the presence of the hearing or so near the same as to interrupt the hearing, proceed, session or investigation refuses to be sworn as a witness or to answer as such when lawfully required to do so. To enforce the provisions of this section, the NEA, or such member thereof, may, in necessary, request the assistance of the municipal police

for the execution or any order made for said purpose.

SEC. 54. Subpoenas; Contempt. – (a) The NEA may issue subpoenas and subpoenas duces tecum, for witnesses in any matter of inquiry pending before it, and require the production of all books, papers, traffics, contracts, agreements, and all other documents which it may deem necessary in any proceeding. Such process shall be issued under the seal of the NEA, signed by one of the members of the NEA Board of Administrators and may be served by any person of full age or by registered mail. In case of disobedience to such subpoena, the NEA may invoke the aid of the Supreme Court, or any Court of First Instance of the Philippines in requring the attendance and testimony of witnesses and the production of books, papers and documents under the provision of this Chapter, and the Supreme Court, or any Court of First Instance of the Philippines within the jurisdiction of which such inquiry is carried on, may, in case of contumacy or refusal to obey a subpoena, issue to any public service entity subject to the provisions of this Decree, or to any person, an order requiring such public service entity or person to appear before the NEA and produce books and papers if so ordered and give evidence touching the matter in question; and any failure to obey such order of the Court may be punished by such court as a contempt thereof;

(b) Any person who shall neglect or refuse to answer any lawful inquiry or produce before the NEA books, papers, tariffs, contracts, agreements, and documents, or other things called for by the NEA if in his power to do so, in obedience to the subpoena or lawful inquiry of the NEA upon conviction thereof by a court of competent jurisdiction, shall be punished by a fine not exceeding five thousands pesos (₱5,000.00) or by imprisonment not exceeding one year, or both in the discretion of the court;

(c) Any NEA Board Member shall have the power to administer oaths in all matters under the jurisdiction of the NEA.

(d) Any person who shall testify falsely or make any false affidavit or oath before the NEA or before any of its members shall be guilty of perjury, and, upon conviction thereof in a court of competent jurisdiction, shall be punished as provided by law;

(e) Witnesses appearing before the NEA in obedience to subpoena or subpoena duces tecum shall be entitled to receive the same fees and mileage allowance as witnesses attending courts of First Instance in civil cases;

(f) Any person who shall obstruct the NEA or any member of the NEA Board while engaged in the discharge of official duties, or who shall conduct himself in a rude, disrespectful or disorderly manner before the NEA or any NEA Board Member while engaged in the discharge of official duties, or shall orally or in writing be disrespectful to, offend or insult any of the NEA Board Members on occasion or by reason of the performance of official duties, upon conviction thereof by a court of competent jurisdiction, shall be punished for each offense by a fine not exceeding one thousand pesos (₱1,000), or by imprisonment not exceeding six months, or both in the discretion of the court.

SEC. 55. Testifying. – No person shall be excused from testifying or from producing any book, document, or paper in any investigation or

inquiry by or upon the hearing before the NEA when ordered to do so by the NEA, except when the testimony or evidence required of him may tend to incriminate him. Without the consent of the interested party, no member or employee of the NEA shall be compelled or permitted to give testimony in any civil suit to which the NEA is not a party, with regard to secrets obtained by him in the discharge of his official duty.

SEC. 56. Depositions. – The NEA may, in any investigation, proceeding or hearing, by its order in writing, cause the deposition of witnesses residing within or without the Philippines to be taken in the manner prescribed by the Rules of Court. Where witnesses reside in places distant from Manila and it would be inconvenient and expensive for them to appear personally before the NEA, the NEA may, by proper order, commission any clerk of the Court of First Instance, municipal judge or justice of the peace of the Philippines to take the deposition of witnesses in any case pending before the NEA. It shall be the duty of the official so commissioned to designate promptly a date or dates for the taking of such deposition, giving timely notice to the parties, and on said date to proceed to take the deposition, reducing it to writing. After the depositions have been taken, the official so commissioned shall certify to the depositions taken and forward them as soon as possible to the NEA. It shall be the duty of the respective parties to furnish stenographers for taking and transcribing the testimony taken. In case there are no stenographers available, the testimony shall be taken in long hand by such person as the clerk of court, the municipal judge or justice of the peace may designate. The NEA may also commission a notary public to take the depositions in the same manner herein provided.

The Board may also, by proper order, authorize any of the attorneys of the legal division or division chiefs of the NEA to hear and investigate any case filed with the NEA or any matter within the jurisdiction of the NEA and in connection therewith to receive such evidence as maybe material thereto. At the conclusion of the hearing or investigation, the attorney or division chief so authorized shall submit the evidence received by him for the Board of Administrators to enable the latter to render its decision.

SEC. 57. Service. – Every order made by the NEA shall be served upon the person or public service entity affected thereby within ten (10) days from the time said order is filed, by personal delivery or by ordinary mail, upon the attorney of record or, in case there be no attorney of record, upon the party interested; and in case a certified copy is sent by registerd mail, the registry mail receipt shall be prima facie evidence of the receipt of such order by the public service entity in due course of mail.

SEC. 58. Reconsideration. – Any interested party may request the reconsideration of any order, ruling, or decision of the NEA by means of a petition filed not later than fifteen (15) days after the date of the notice of the order, ruling, or decision in question. The grounds on which the request for reconsideration is based shall be clearly and specifically stated in the petition. Copies of said petition shall be served on all parties interested in the matter. It shall be the duty of the NEA to decide the same within thirty (30) days, either denying the petition or

revoking the modifying order, ruling, or decision under consideration. If no petition for reconsideration is filed, no review by the Supreme Court as hereinafter provided shall be allowed.

SEC. 59. **Court Review.** – The Supreme Court is hereby given jurisdiction to review any order, ruling, or decision of the NEA and to modify or set aside such order, ruling, or decision when it clearly appears that there was no evidence before the NEA to support reasonably such order, ruling, or decision, or that the same is contrary to law, or that it was without the jurisdiction of the NEA. The evidence presented to the NEA, together with the record of the proceedings before the NEA, shall be certified by the NEA to the Supreme Court. Any order, ruling, or decision of the NEA may likewise be reviewed by the Supreme Court upon a writ of certiorari in proper cases. The procedure for review, except as herein provided, shall be prescribed by rules of the Supreme Court. Any order, or decision of the NEA may be reviewed on the application of any person or public service entity aggrieved thereby and who was a party in the subject proceeding, by certiorari in appropriate cases or by a petition for review, which shall be filed within thirty (30) days from the notification of the NEA order, decision, or ruling on reconsideration. Said petition shall be placed on file in the office of the Clerk of the Supreme Court who shall furnish copies thereof to the NEA and other interested parties.

SEC. 60. **No Stay.** – The institition of a writ of certiorari or other special remedies in the Supreme Court shall in no case supersede or stay any order, ruling, or decision of the NEA unless the Court shall so direct, and the appellant may be required by the Court to give bond in such form and of such amount as may be deemed proper.

SEC. 61. **NEA Counsel.** – The chief of the legal division or any other attorney of the NEA shall represent the same in all judicial proceedings. It shall be the duty of the Solicitor General to represent the NEA in any judicial proceeding if, for special reasons, the Administrator shall request his intervention.

CHAPTER V – TRANSITORY PROVISIONS

SEC. 62. **Existing NEA Continued.** – (a) The existing Board of Administrators of the NEA and the Administrator provided for under this Decree, and their respective terms shall be and continue as already established;

(b) Any reference to the NEA in any existing law or in any executive order or proclamation of the President shall, with respect to any duty or function assumed by the NEA pursuant to said Decree, be deemed hereafter to have reference to the NEA established under this Decree;

(c) The properties, assets, rights, choses in action, obligations, liabilities, records and contracts of the NEA are hereby transferred to and are vested in, and assumed by the NEA established under this Decree;

(d) All personnel of the NEA shall be absorbed and transferred to the NEA established under this Decree without demotion in rank nor reduction in salary; and

(e) All on-going projects and/or approved loans of the NEA established under Republic Act No. 6038 shall be reviewed by the NEA established under this Decree and, insofar as found to be economically feasible in accordance with sound management, engineering and technological standards, shall be continued and completed on a priority basis.

SEC. 63. **Separability of Provisions.** – If any provision of this Decree, or the application of such provision to any person or circumstance, is declared invalid, the remainder of the Decree or the application of such provision to other persons or circumstances shall not be affected by such declration.

SEC. 64. **Effect on Other Acts.** – All Acts inconsistent herewith are repealed or modified accordingly.

SEC. 65. **Effectivity.** – This Decree shall take effect immediately.

Done in the City of Manila, this 6th day of August in the year of Our Lord, nineteen hundred and seventy-three.

(Sgd.) FERDINAND E. MARCOS
President
Republic of the Philippines

By the President:
(Sgd.) ALEJANDRO MELCHOR
Executive Secretary

PRESIDENTIAL DECREE NO. 501
Excerpts)

AMENDING CERTAIN PROVISIONS OF PRESIDENTIAL DECREE NUMBER ONE HUNDRED SEVENTY-FIVE, ENTITLED "STRENGTHENING THE COOPERATIVE MOVEMENT", RELATING TO THE REGULATORY POWERS OF THE DEPARTMENT OF LOCAL GOVERNMENT AND COMMUNITY DEVELOPMENT OVER COOPERATIVES.

Section 1. Section 8 of the Presidential Decree No. 175 is hereby amended to read as follows:

"Section 8. Powers of Regulatory Agency. – The Department of Local Government and Community Development through the Bureau of Cooperatives Development is vested with full authority to promulgate rules and regulations to govern the promotion, organization, registration, regulation and supervision of all types of cooperative except electric cooperatives which shall remain under the regulation and supervision of the National Electrification Administration under the provisions of Republic Act No. 6038 in conjunction with Presidential Decree No. 40 and Letter of Instruction No. 38. x x x

Section 2. This Decree shall take effect immediately.

Done in the City of Manila, this 28th day of June, in the year of Our Lord, nineteen hundred and seventy-four.

(Sgd.) FERDINAND E. MARCOS
President
Republic of the Philippines

By the President:
(Sgd.) ALEJANDRO MELCHOR
Executive Secretary

PRESIDENTIAL DECREE NO. 1370

AMENDING SECTION 6 OF CHAPTER II OF PRESIDENTIAL DECREE NO. 269 IN ORDER TO INCREASE THE CAPITALIZATION OF THE NATIONAL ELECTRIFICATION ADMINISTRATION.

WHEREAS, under the basic policies for the rationalization of the electric power industry established under Presidential Decree No. 269, the NEA was given the responsibility of setting up electric cooperatives for the generation, transmission, and distribution of electric power, and to determine privately-owned public utilities which should be permitted to remain in operation in order to attain total electrification on an area coverage basis;

WHEREAS, the magnitude of the electrification program envisioned under said decree requires the infusion of massive governmental support and financial assistance in order to achieve the ultimate objective of total electrification;

WHEREAS, the financial resources of NEA, although supplemented by foreign borrowings, are still deemed insufficient to finance and accelerate the rapid implementation of the national commitment of total electrification;

WHEREAS, it is necessary to appropriate additional funds for the immediate realization of this objective.

NOW, THEREFORE, I, FERDINAND E. MARCOS, President of the Philippines, by virtue of the powers vested in me by the Constitution, do hereby order and decree as follows:

SECTION 1. Section 6 of Presidential Decree No. 269 is hereby amended to read as follows:

"Section 6. – Capital Stock* – The authorized Capital Stock of NEA is Two Billion Pesos divided into Twenty (20) Million shares with a par value of One Hundred Pesos (₱100) each, which shares are not to be transferred, negotiated, pledged, mortgaged, or otherwise given as security for the payment of any obligation. Beginning with the Fiscal Year 1978, the sum of Two Hundred Million Pesos is hereby appropriated out of the funds in the National Treasury not otherwise appropriated and the same amount annually thereafter until the balance of the unpaid subscription of the government to the capital stock of the corporation shall have been paid in full. Such annual appropriation shall be programmed and released by the Budget Commission in accordance with the schedule of cash requirements to be submitted by the NEA; provided that this annual appropriation of Two Hundred Million Pesos and the programming and release thereof shall remain in force until the entire capital stock of the NEA is paid in full."

SECTION 2. This Decree shall take effect immediately.

Done in the City of Manila, this 2nd day of May, in the year of Our Lord, nineteen hundred and seventy-eight.

(Sgd.) FERDINAND E. MARCOS
President
Republic of the Philippines

By the President:
(Sgd.) JUAN C. TUVERA
Presidential Assistant

*Further amended by Presidential Decree No. 1645 issued on October 8, 1979.

PRESIDENTIAL DECREE NO. 40

ESTABLISHING BASIC POLICIES FOR THE ELECTRIC POWER INDUSTRY.

WHEREAS, one of the primary concerns of the Government in promoting the economic welfare of the people is to hasten the electrification of the entire country, more particularly the rural areas; and

WHEREAS, it is necessary to establish certain basic policies for the attainment of said objective.

NOW, THEREFORE, I, FERDINAND E. MARCOS, President of the Philippines, by virtue of the powers vested in me by the Constitution as Commander-in-Chief of all Armed Forces of the Philippines, and pursuant to Proclamation No. 1081, dated September 21, 1972, and General Order No. 1, dated September 22, 1972, do hereby order and decree as part of the law of the land the following basic policies for the electric power industry:

1. The attainment of total electrification on an area coverage basis, which is a declared policy of the State, shall be effected primarily through:

(a) The setting up of island grids with central/linked-up generation facilities; and
(b) The setting up of cooperatives for distribution of power.

2. The setting up of transmission line grids and the construction of associated generation facilities in Luzon, Mindanao and major islands of the country, including the Visayas, shall be the responsibility of the National Power Corporation (NPC) as the authorized implementing agency of the State.

(a) Plant additions necessary to meet the increase in power demand of the area embraced by any grid set up by the NPC shall be constructed and owned by NPC.

(b) In areas not embraced by the NPC grid, the State shall permit cooperatives, private utilities, and local governments to own and operate isolated grids and generation facilities, subject to State regulation.

3. The distribution of electric power generated by the NPC shall be undertaken by:

(a) Cooperatives;
(b) Private utilities;
(c) Local government; and
(d) Other entities duly authorized subject to State regulation.

4. With the area embraced by a grid set up by the NPC, the State shall determine privately-owned generating facilities which should be permitted to remain in operation.

5. It is the ultimate objective of the State for the NPC to own and operate as a single integrated system all generating facilities supplying electric power to the entire area embraced by any grid set up by the NPC.

6. The Power Development Council shall be expanded and strengthened to make it more effective in the planning and implementation of power and electrification projects and in the re-direction and re-orientation of the various sectors of the industry towards national development goals.

Done in the City of Manila, this 7th day of November, in the year of Our Lord, nineteen hundred and seventy-two.

(Sgd.) FERDINAND E. MARCOS
President
Republic of the Philippines

By the President:
(Sgd.) ALEJANDRO MELCHOR
Executive Secretary

LETTER OF INSTRUCTION NO. 38

To: The National Electrification Administration

In view of the desire to effect changes and reforms in the social, economic and political structure of our society, and with the promulgation of Presidential Decree No. 40, dated November 7, 1972, as a means of converting small private/municipal systems to electric cooperatives with Republic Act No. 6038, the National Electrification Administration (NEA) is hereby directed to immediately implement and enforce strictly the provisions of Presidential Decree No. 40.

The NEA is hereby directed to establish procedures, systems and organizations with defined functions for the prompt implementation of said Decree:

The NEA, as the implementing agency, shall determine which systems should be converted or integrated in accordance with the following criteria:

(1) Systems with exhorbitant rates and notoriously poor service.
(2) Systems which are delinquent in their amortization payments to NEA and other banking institutions and/or payments to NPC of their power bills.
(3) Systems connected to NPC or MERALCO and therefore do not have generating plants.
(4) Systems within the proposed 36 cooperative areas.

The following shall be the priority list of municipalities of the seven (7) provinces considered as pilot projects:

(1) Pampanga
   a. Arayat
   b. Sta. Ana
   c. Candaba
   d. San Luis
   e. San Simon
   f. Mexico

(2) Laguna
   a. Pagsanjan
   b. Cavinti
   c. Kalayaan
   d. Lumban
   e. Paete
   f. Sta. Maria
   g. Pakil
   h. Pangil
   i. Siniloan
   j. Famy
   k. Mabitac

(3) Bulacan
   a. Hagonoy
   b. Malolos
   c. Paombong
   d. Calumpit
   e. Pulilan
   f. Plaridel

(4) Pangasinan
   a. Sual
   b. Lingayen
   c. Binmaley
   d. Mangatarem
   e. Labrador
   f. Bugallon
   g. Urbiztondo
   h. Aguilar

(5) Tarlac
   a. San Manuel
   b. Moncada
   c. Anao
   d. Paniqui
   e. Ramos
   f. Gerona
   g. Pura
   h. Victoria

(6) Nueva Ecija
   a. Lupao
   b. San Jose
   c. Lucena
   d. Caranglan
   e. Rizal
   f. Pantabangan

(7) Rizal
   a. Binangonan
   b. Cardona

Done in the City of Manila, this 7th day of November, in the year or Our Lord, nineteen hundred and seventy-two.

(Sgd.) FERDINAND E. MARCOS
President
Republic of the Philippines

MEMORANDUM ORDER NO. 395
ORGANIZING THE PROVINCIAL ELECTRIC COOPERATIVES TEAM (PECT)

WHEREAS, under Republic Act No. 6038, approved on August 4, 1969, total electrification of the country on an area coverage basis has been adopted as the national policy objective;

WHEREAS, in the light of that policy objective, it is conceived that the benefits of electricity will be brought to all areas of the country by means of electric cooperatives organized by the electric consumers themselves with technical and financial assistance of the government through the National Electrification Administration (NEA) as the implementing agency of the government;

WHEREAS, the organization of electric cooperatives by the people themselves should be encouraged, promoted, and developed through a program of continuous educational campaign on the meaning, philosophy, and benefits thereof, and through actual assistance more particularly in the mechanics of establishing the cooperative;

WHEREAS, the promotional campaign envisaged would require the cooperation of and coordination between the government agencies and instrumentalities involved and the private sector, and the best way this could be realized would be to form an organization wherein the civic religious organizations would be represented;

NOW, THEREFORE, there is hereby organized and established the Provincial Electric Cooperatives Team (PECT) which shall be charged with the main function of promoting and assisting in the organization and development of electric cooperatives.

There shall be one PECT for each province and each and every PECT shall be composed of representatives each from the NEA, Presidential Arm on Community Development (PACD), Department of Education, Cooperatives Development Office (CAO), Office of the Provincial Governor, League of Municipal Mayors in the province concerned, active civic organization, and religious organization in the province concerned.

It is hereby directed that all departments, bureaus, offices and agencies of the government, including government-owned or controlled corporations as well as local govenment entities, shall extend assistance and Cooperation to the PECT.

By order of the President:

(Sgd.) ALEJANDRO MELCHOR
Executive Secretary

Manila, September 1970

APPENDICES

PRESIDENTIAL DECREE NO. 1206*
(Excerpts)

CREATING THE DEPARTMENT OF ENERGY

SECTION 10. Attached Agencies. – The following government corporations are attached to the Department for purposes of policy coordination and integration with sectoral program Philippine National Oil Company, National Power Corporation, and National Electrification Administration. Such attachment shall be in accordance with the applicable provisions of Article III, Chapter IV, Part II and of Article III, Chapter I, Part XI of the integral Reorganization Plan.

Done in the City of Manila, this 6th day of October, in the year of Our Lord, nineteen hundred and seventy-seven.

(Sgd.) FERDINAND E. MARCOS
President
Republic of the Philippines

By the President:

(Sgd.) JACOBO C. CLAVE
Presidential Executive Assistant

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*Amended by Letter of Implementation No. 80.

PRESIDENTIAL DECREE NO. 175*
(Excerpts)

STRENGTHENING THE COOPERATIVE MOVEMENT

Section 8. **Powers of Regulatory Agency.** – The Department of Local Government and Community Development through the Bureau of Cooperatives Development is vested with full authority to promulgate rules and regulations to govern the promotion, organization, registration, regulation and supervision of all types of cooperatives. x x x

Done in the City of Manila, this 14th day of April in the year of Our Lord, nineteen hundred and seventy-three.

(Sgd.) FERDINAND E. MARCOS
President
Republic of the Philippines

By the President:

(Sgd.) ALEJANDRO MELCHOR
Executive Secretary

*Amended by Presidential Decree No. 501.

S. No. 1136
H. No. 17025

Sixth Congress
of the
Republic of the Philippines
Ninth Special Session

Begun and held in the City of Manila on Monday, the second day of June, nineteen hundred and sixty-one.

REPUBLIC ACT NO. 6038*

AN ACT DECLARING A NATIONAL POLICY OBJECTIVE FOR THE TOTAL ELECTRIFICATION OF THE PHILIPPINES ON AN AREA COVERAGE SERVICE BASIS, PROVIDING FOR THE ORGANIZATION OF THE NATIONAL ELECTRIFICATION ADMINISTRATION, THE ORGANIZATION, PROMOTION AND DEVELOPMENT OF ELECTRIC COOPERATIVES TO ATTAIN THE OBJECTIVE, PRESCRIBING THE TERMS AND CONDITIONS FOR THEIR OPERATION, THE REPEAL OF R.A. NO. 2717, AND FOR OTHER PURPOSES.

Be it enacted by the Senate and House of Representatives of the Philippines in Congress assembled:

Chapter I. – POLICY AND DEFINITIONS

SECTION 1. Title. – This Act shall be referred to as the "National Electrification Administration Act."

Chapter II. – THE NATIONAL ELECTRIFICATION ADMINISTRATION

SECTION 6. Loans from GSIS, SSS, and DBP. – The GSIS, SSS and DBP are hereby authorized, empowered and directed to make loans directly to public service entities for the same purposes for which NEA loans are authorized in sub-paragraph (a) of section five. Any other provision of law to the contrary notwithstanding, such a loan shall be made by any of the foregoing three whenever:

(a) Application for such loan has been made to it on behalf of such entity by the Administrator, accompanied by his determination and certification that (1) sufficient funds for such loan are not available out of the revolving fund hereinafter established; (2) such loan is necessary to enable the borrower to accomplish the loan purposes established in sub-paragraph (a) of section five; (3) in his judgment the loan will be repaid with interest on schedule and will not result in any diminution of the security of, or of the ability of the borrower to repay, any outstanding

Repealed by Presidential Decree No. 269 signed on August 6, 1973.
Contained herein are the provisions which were not included in Presidential Decree No. 269.

indebtedness of the borrower to the NEA or any other lending source below the level of such security and ability were such additional borrowing not being undertaken: (4) no lender other than the NEA or if such be the case the lender being applied to, then holds or has the right to secure a first lien on the properties of the borrower to be financed by such loan, and (5) his willingness in relation to the properties to be financed by such loan, (A) to release any after-acquired property clause in any lien the NEA already has on the borrower's properties to, or (B) to share any such lien on a co-equal basis in proportion to their respective loans with, or (C) to subordinate any such lien in favor of, the lender; and

(b) The NEC determines and certifies to the lender; (1) that the funds of such lender, having regard for the amount, term, interest charge, repayment schedule and security of such loan, are sufficient and available for such purpose; (1) that such loan will not impair or unduly deter the achievement of the primary purposes for which the lender has accumulated such funds; (3) the loan term, which shall not exceed thirty-five years; (4) the repayment schedule, which shall not cause payments of principal or interest to come due more often than every quarter; (5) the interest rate, which shall not exceed (A) the lowest interest rate being then received by the lender on loans of ten-or-more year terms made by the lender during the preceding twelve months (or, if no such loans have been made during the preceding twelve months (or, if no such loans by the lender during the preceding five years; or, if no such loans have been made during the preceding five years; on the longest-term loan made by the lender during the preceding three years), or (B) six per centum per annum, whichever is the lesser: Provided, that if six per centum per annum is lesser, the NEC may, but shall not be required to, fix the interest rate to be not in excess of (i) such higher rate as will result in an average interest rate to the borrower of not in excess of six per centum per annum or (ii) the lowest interest rate determined under (A) above, whichever is the lesser; and (B) the other terms and conditions of the loan;

(c) Such loan when added to the outstanding principal indebtedness to such lender for any other loans made pursuant to this section, will not aggregate in excess of one hundred million pesos; and

(d) The borrower executes such documents as shall be necessary to effectuate such borrowing and give the lender as security therefor an exclusive or shared first lien on the properties being financed by the loan, and the Administrator executes such instruments as shall be necessary to release to the lender any after-acquired property clause of, or to share with our subordinate in favor of the lender, any such lien the NEA then already has upon such borrower's properties, whichever the NEC shall require.

The beginning schedule of repayment of the principal of such loans of the interest charges thereon, or both, may be deferred for a period not to exceed seven years from the advance of such principal, upon the Administrator's request and if the NEC certifies to the lender its approval thereof, in which event provision for such deferment shall be incorporated into the loan agreement and interest shall accrue and be payable on any interest payment so deferred.

Advances to the borrower of loans made pursuant to this section, and advances to a cooperative borrower from any other non-NEA source, shall be made directly to the borrower by the lender at such time or times in such amount or amounts as the Administrator approves; and the Administrator, with respect to such loans, advances, application by the borrower of such advances to their purposes, repayments by the borrower of the principal of the interest upon such loans, and all operations of the borrower affecting the loan security and the borrower's conformity with loan agreements, shall establish and implement the same procedures and requirements affecting the borrower as though such loan had been made by the NEA. Annually, and at any time a borrower's condition indicates that it may default in its loan agreement, or whenever so requested by such a lender or by the NEC, the NEA shall furnish a current and comprehensive report of the status and operations of the borrower relating to its financial and operating conditions in general. To the extent that a loan made pursuant to this section has not been advanced to the borrower within five years after the effective date of the loan agreement, the same shall be rescinded unless the lender and borrower, upon the NEA's approval, agree otherwise, which agreement shall be executed by all three in writing and become a part of the loan agreement.

This section shall not constitute a limitation on the right and ability otherwise lawfully possessed by such a lender to make such loans to such public service entities on terms and conditions more favorable to such entities than herein prescribed.

SECTION 7. Revolving Fund. A revolving fund, out of which the Board of Administrators is hereby authorized, empowered and directed to make loans to public service entities for the purposes set forth in subparagraph (a) of section 5, is hereby established to consist of the following:

(a) Any portion of the twenty-five million pesos heretofore appropriated pursuant to Section 6 of Republic Act 2717 that has not already been advanced and for lawful reason will no be advanced;

(b) The following sums, which are hereby appropriated: twenty million pesos for the fiscal year 1970 and the same amount each year for the next nine fiscal years. Provided, That the Congress shall not be limited as to the amount it may further appropriate in any year for the purpose;

(c) Any fund or physical asset which NEA-FS may make available to the NEA for such loan purposes;

(d) Any fund or physical asset which the President, pursuant to Section 6 of Republic Act Numbered Twenty-seven hundred seventeen, may have already made, or, as he is hereby authorized and empowered so to do, may hereafter make available to the NEA for such loan purposes from any sum or assets received from or out of Japanese reparations including proceeds from the sale thereof or loans obtains under the Japanese Reparations Treaty;

(e) All moneys not already expended which have heretofore been received by the Electrification Administration from payments to it of the

principal of and interest upon any loans it has heretofore made pursuant to Republic Act numbered Twenty-seven hundred seventeen, except to the extent such moneys may have already been allocated to the EA for administrative or other purposes, and all moneys hereafter received by the NEA from payments to it of the principal of and interest upon any loans heretofore made under Republic Act numbered Twenty-seven hundred seventeen or hereafter made under this Act;

(f) The sum of two million dollars worth of goods and services from Japanese Reparations for the fourteenth year schedule and the same amount each year for the next four year schedules, which are hereby allocated to the revolving fund of the NEA;

(g) The sum of two million pesos for the fiscal year 1970 and the same amount each year for the next four fiscal years which are hereby allocated to the revolving fund of the NEA out of the proceeds of the sale of Japanese Reparations Goods; and

(h) The proceeds corresponding to the share of the National Government in all franchise taxes paid by electric service entities, which are hereby appropriated for the purpose of augmenting the revolving fund.

No portion of the revolving fund shall, without the prior approval of the Congress, be expended by the NEA for any purpose other than the loans herein and in section nine authorized and the acquisition authorized in section eleven. The Board of Administrators shall annually, not later than January thirty-first, report to the Congress and the President the current status and amount of the revolving fund and the anticipated status and amount thereof in the ensuing year.

SECTION 8. **Loan Standards.**

Notwithstanding the foregoing provisions of this section, The Board of Administrators may fix any higher interest rate or any shorter or longer term for loans made from funds or physical assets made available from sources stated in subparagraphs (c) and (d) of section 7, but only if and not to exceed the extent to which such is required by, or otherwise is made a condition of the availability of such funds or assets from, such sources: Provided, That the Board of Administrators may, unless the conditions attaching to the availability of such funds require otherwise, combine such funds with the other funds in the revolving fund and fix a blended interest charge on loans made generally repayment to the revolving fund of interest of three per centum per annum on that portion of funds not derived from such sources and of such higher interest per centum per annum as is required on that portion of funds that is derived from such sources.

SECTION 9. **Loans for Electric-Related Purposes.** – The Board of Administrators is hereby authorized, empowered and directed to make loans, out of the revolving fund, for the purpose of financing the wiring of premises of persons served or to be served as a result of loans made under Section 7, and for the acquisition and installation by such persons of

electrically-powered appliances, equipment, fixtures and machinery of all kinds of commercial, agricultural and industrial uses. Such loans may be made directly (a) to public service entities which have received loans under Section 7, which entities shall relend such funds to persons served or to be served by such an entity. Such loans shall be made for such items, shall bear interest at such rate not to exceed six per centum per annum, and shall be subject to such other terms and conditions as the Board of Administrators shall determine to be necessary and appropriate to assure repayment thereof within the time agreed: Provided, however, That at no time shall the total loans made for the purpose stated under this section exceed ten per centum of the total of the revolving fund nor shall any such loan to any borrower exceed ten per centum of the total loan to such borrower from the revolving fund.

SECTION 14. **Administrative Expenses.** – The NEA's administrative expenses shall be appropriated annually by the Congress.

SECTION 42. **Regulation by the Public Service Commission and Securities and Exchange Commission.** – Pursuant to the national policy declaration in section 2, the Congress hereby establishes that:

(a) To the extent that the Public Service Commission now is or may hereafter be authorized and empowered to do so with respect to other electric public services, the Commission is hereby authorized and empowered:

(1) To grant, condition, restrict or cancel a cooperative's franchise, or to determine whether a cooperative is qualified to receive a franchise;

(2) To require a cooperative to extend or improve service upon the Commission's determination that such should be done in furtherance of the public convenience and necessity and that such may reasonably be done consistently with the purposes and provisions of this Act;

(3) To require a cooperative to cease any discriminatory practice which the Commission finds to be in effect in violation of section 37; and, in connection with such authority, to require a cooperative to file with the Commission for information purposes, and to make accessible to any person upon request therefor, copies of all rates, charges, contract forms, fee or deposit schedules, by-laws, rules and regulations; and

(4) To require a cooperative to interconnect its facilities with, and through such interconnection to sell or exchange electric energy to or with, other electric public services or the National Power Corporation if the National Power Corporation so requests or consents thereto.

Other than an order to require information filings, as provided in (3) of this subsection, the Commission shall issue no order in the exercise of the foregoing power without affording the cooperative and any other interested person who requests it any opportunity to be heard. Except as provided in this subsection, a cooperative shall be exempt from regulation or control by the Public Service Commission.

(b) The provisions of the Securities Act shall not apply to any note, bond or other evidence of indebtedness issued by any cooperative or to any mortgage, deed of trust or other instrument executed to secure the same, The provisions of said Act shall not apply to the issuance of membership certificates or any other evidence of member or patron interested by a cooperative.

This Act, which originated in the Senate, was finally passed by the same on June 26, 1969.

Finally passed by the House of Representatives on June 26, 1969.

ELISEO M. TENZA
Secretary of the Senate

INOCENCIO B. PAREJA
Secretary of the
House of Representatives

APPROVED: August 4, 1969

FERDINAND E. MARCOS
President of the Philippines

REPUBLIC ACT NO. 2717

AN ACT TO CREATE THE ELECTRIFICATION ADMINISTRATION AND FOR OTHER PURPOSES

Be it enacted by the Senate and House of Representatives of the Philippines in Congress assembled:

SECTION 1. This Act shall be known as the "Electrification Administration Act."

SECTION 2. It is declared to be the policy of the Republic of the Philippines to furnish cheap and dependable electric power and facilities in order to promote and accelerate the agricultural and industrial development of the country.

SECTION 3. For the purpose of carrying out the policy enunciated in this Act, specially in the rural areas, there is hereby created and established an agency to be known as the "Electrification Administration", all the powers of which shall be exercised by an Administrator, who shall be appointed by the President, with the consent of the Commission on Appointments, for a term of ten years and who shall receive an annual compensation of twelve thousand pesos, which may be increased to not more than twenty-five thousand pesos as the President may deem proper.

SECTION 4. The Administrator is authorized (a) to make loans for the electrification and the furnishing of electric energy, particularly in the rural reas; (b) to plan, coordinate program and supervise comprehensive, efficient and dependable producing, transmitting and distributing systems for electric power; (c) to make, or cause to be made, studies, investigations and reports concerning the condition and progress of electrification of any region of the country, prin( )ally the furnishing of electric power to ultimate consumers; (d) to encourage and aid local governments and cooperative electric power, heat and light systems; and (e) to publish and disseminate information with respect thereto.

SECTION 5. The Government Service Insurance System, the Social Security System and the Development Bank of the Philippines are hereby authorized and directed to make loans not exceeding in aggregate the amount of fifty million pesos with interest at a rate not exceeding five per cent per annum to local governments, electric consumers cooperative associations duly organized under the laws of the Philippines, and to Filipino electric franchise holders now operating, upon recommendation of the Administrator and with the approval of the National Economic Council, for the purpose of constructing, operating, maintaining and administering electric power, heat and light system for service to the public and/or for the purpose of purchasing any existing electric public service.

SECTION 6. As a revolving fund of the Electrification Administration, there is hereby appropriated the sum of five million pesos for the

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Repealed by Republic Act 6038.
Enacted without Executive approved June 19, 1960.

fiscal year nineteen hundred sixty-one, subject to availability of funds, and the same amount each year for the next four fiscal years. Any sum as assets which NEC-ICA may assign to the Electrification Administration shall form part of this revolving fund, except when it is expressly set aside for research or operating expenses. The President of the Philippines is empowered to allocate and transfer to the Electrification Administration any sums or assets received from or our of a Japanese reparations and loans obtained under the Japanese Reparations Treaty which shall also form part of the revolving fund, except when it is expressly set aside for research or operating expenses.

SECTION 7. Out of the revolving fund, the Administration is authorized and empowered to make loans to local governments, electric consumers cooperative associations duly organized under the laws of the Philippines and to Filipino electric franchise holders now operating, for the purpose of financing the construction and operation of generating plants, electric transmission and distribution lines or systems for the furnishing of electric energy, particularly in rural areas. Such loans shall be on such terms and conditions relating to the expenditure of the moneys loaned and the security therefor as the Administrator shall determine, and may be payable in whole or in part out of the borrower's income; Provided, That all such loans shall be self-liquidating within a period of not less than twenty-five years, and shall bear interest at a rate not to exceed three per centum per annum, except loans from funds taken from Japanese loans under the Japanese Reparations Treaty, in which case the interest shall not exceed the interest on Japanese loans: Provided, furthere, That loans shall not be made unless the Administrator finds and certifies that in his judgment the security therefore is reasonably adequate and such loans will be repaid within the time agreed: Provided, further, That the contract of loan shall contain a stipulation that the rates of any borrowing electric public service shall be fiveld so that its profit shall not exceed six per cent per annum of the rate base, notwithstanding any provision of law providing higher rate of profit.

SECTION 8. The Administrator is authorized and empowered to make loans for the purpose of financing the wiring of premises of persons in rural areas and the acquisition and installation of electrical plumbing appliances and equipment. Such loans may be made to any Filipino citizen or to any borrower of funds under Section seven hereof, or to any person, association or corporation supplying or installing said wiring, appliances or equipment. Such loans shall be for such terms, subject to such conditions, and so secured as reasonably to assure repayment thereof, and shall be at a rate of interest not to exceed five per centum per annum.

SECTION 9. The Administrator is authorized and empowered to extend the time of payment of interest or principal of any loan made by him or pursuant to this Act.

SECTION 10. The Administrator is authorized and empowered to (a) bid for and purchase of any foreclosure or other sale, or otherwise to require property pledged or mortgaged to secure any loan made pursuant to this Act; (b) pay the purchase price and any costs and expenses incurred in connection therewith; (c) accept title to any property so purchased or acquired in the name of the Republic of the Philippines; (d) operate or lease such property for such period as may be deemed necessary or advisable to protect the investment therein; and (e) sell such property so purchased or acquired upon such terms and for such consideration as the Administrator shall determine to be reasonable.

No borrower of funds shall, without the approval of the Administrator, sell or dispose of the property, rights or franchises acquired under the provisions of this Act, until any loan obtained from the Electrification Administration, including all interest and charges, shall have been repaid.

SECTION 11. To enable the Electrification Administration to implement more effectively the provisions of this Act, the Administrator shall have a technical staff and such other staffs or personnel as he may deem proper. The Administrator shall appoint, fix the compensation and determine the duties of such staff, officials and employees as the exigencies of service may require.

SECTION 12. The Administrator may call upon any department or agency of the Government for assistance or cooperation on any matter connected with the functions and powers of the Electrification Administration.

The Administrator shall execute all electrification projects that may be authorized in any Public Works Acts; and for this purpose, he may call for assistance and cooperation from the National Power Corporation and the Mechanical and Electrical Division of the Bureau of Public works.

SECTION 13. The Administrator shall present annually to the Congress not later than the last day of January in each year the full report of its activities under this Act.

SECTION 14. No member, officer, attorney, agent, or employee of the Electrification Administration shall in any manner, directly or indirectly, participate in the determination of any question affecting any corporation or association in which he is directly or indirectly interested. Any person violating the provisions of this section shall be removed from office and shall upon conviction be punished by a fine not to exceed ten thousand pesos or imprisonment not to exceed five years, or both.

SECTION 15. No officer or employee of the Electrification Administration nor any government officials who may exercise execute or supervisory authority over the Electrification Administration, either directly or indirectly, for himself or as representative or agent of others, shall become a guarantor, indorser, or surety for loans from the Electrification Administration to others, or in any manner be an obligor for money borrowed from the Electrification Administration. Any such officer or employee who violates the provisions of this section shall be punished by a fine of not less than one thousand pesos nor more than five thousand pesos, or imprisonment for not less than one year nor more than five years, or both.

SECTION 16. No loan shall be granted by the Electrification Administration to any person related to the Administrator within the third

degree of consanguinity or affinity, or to any corporation, partnership, or company wherein the Administrator is a shareholder. Violation by the Administrator of the provisions of this section is a sufficient cause for his removal by the President of the Philippines and the Administrator shall furthermore, be punished as provided in the next preceding section.

SECTION 17. No fee, commission, gift, or charge of any kind shall be exacted, demanded, or paid for obtaining loans from the Electrification Administration, any officer, employee or agent of the Administration exacting, demanding or receiving any fee, commission, gift or charge of any kind of service in obtaining a loan, shall be punished by a fine of not less than one thousand nor more than three thousand pesos, or imprisonment for not less than one year nor more than three years or both.

SECTION 18. Any person who, for the purpose of obtaining, renewing or increasing a loan or the extension of the period thereof, on his own or another's behalf, shall give any false information or cause through his intrigue or machination the existence and production of any false information with regard to the identity, situation, productivity, or value of security, or with regard to a point which may affect the granting or denial of the loan, whether the latter has been consummated or not, and every officer or employee of the Electrification Administration who, through connivance or negligence, shall allow by action or omission such false information to pass unnoticed, thereby causing damage to the Electrification Administration or exposing the latter to the danger of suffering such damage, shall be punished by a fine of not less than the amount of the loan obtained or applied for, nor more than three times such amount, or imprisonment for not less than three months nor more than three years, or both.

SECTION 19. Any officer or employee of the Electrification Administration who violates or permits any agent or any other officer or employee of the Administration or any other person to violate any of the provisions of this Act not specifically punished in the preceding sections, and any person violating any provisions of this Act or aiding and abetting the violation thereof, shall be punished by a fine not to exceed ten thousand pesos, or imprisonment for not more than five years.

SECTION 20. If any provision of this Act, or the application of such provision to any person or circumstance is declared invalid, the remainder of the Act or the application of such provision to other persons or circumstances shall not be affected by such declaration.

SECTION 21. All Acts or parts of Acts inconsistent herewith are repealed or modified accordingly.

SECTION 22. This Act shall take effect upon its approval.

Annex V.1

Balfour Beatty Training Plan

BRITISH DENDRO THERMAL POWER PLANTS

OPERATOR TRAINING

Introduction

The training programme for operators at British Dendros started officially on February 5 and is due to continue to January 1985. To date two power plants have had operators trained. In these notes the background and purpose of the training programme are set out.

Background

At the stage when BBEL/NEA were formulating the contract for the six British Dendro the NEA did not want training to be included in BBEL's contract. Therefore, provision of skilled engineers and operators to assist BBEL during commissioning and then take over the plant became an NEA/Coop responsibility. During the latter stages of construction BBEL commenced planning for commissioning. Advice was given to the NEA on the type, numbers and likely source of skilled power plant staff.

When BBEL's engineers came closer to commissioning the coops had been unable to engage experienced staff thus BBEL recommended that NEA set up a training programme, possibly engaging the services of a local consultant. BBEL have prepared a very comprehensive operating and maintenance manual so it was considered that an engineer with experience of thermal power plants could train others, it would not be essential to use a BBEL engineer. At the same time BBEL submitted a commercial offer to NEA for training by BBEL. It appeared to BBEL that little progress was being made with either a BBEL or local A & E training arrangement thus a further option was considered.

BBEL prepared a case and made submission to the British Government, Overseas Development Administration for a grant to fund training. On behalf of NEA, BBEL were successful in securing an ODA grant for UK costs of a training engineer. NEA had to fund day to day Peso expenses. This is the basis of the training programme that is in progress.

Training

By the time the training programme started BBEL had already commissioned two plants and thus got to know the type of engineers that needed training. Based upon the type of engineers that coops could engage and the programme of construction foreseen by NEA BBEL formulated a training programme that would progress through the constructed sites. It was originally anticipated that once the

first site was operational and training nearly complete then the staff from the second site would visit the first site to be given training on a working plant prior to starting their own plant.

This cascade with overlap programme has not proven practical and currently the training engineer spends approximately eight weeks at each site training the operators.

The training is carried out mainly on the plant and by physical demonstration of how to operate the equipment, some classroom training is given. Training follow the training programme attached.

Progress to Date

The operators of the Solsona Dendro and Ilagan Dendro have been trained and are now able to operate the power plant without assistance. There could be incidents of an abnormal nature arising which require a greater depth of knowledge that it is possible to achieve in a training programme then the power plant operators will have to call for the assistance of the A & E or BBEL. By mid June training should be in progress at the third site, Caramoan and within 1984 it is hoped that the staff at four sites will have been trained.

Attachments:-

1. Training Programme Dendro Contract.

2. Letter sent to all coops advising arrangements for power plant staff training.

3. Report on training at Solson in which it is noted that INEC have worked hard to achieve maximum benefit from the training and trainees have worked hard.

4. Training agreement between BBEL and ODA.

TRAINING PROGRAMME - DENDRO CONTRACT

1.0 Object

To train the Coop engineers and operators to run and maintain the Dendro plants in a safe and efficient manner.

2.0 Level of Training

The level of training is to be carried out in 3 distinct stages viz

Stage (1) To train the 3 shifts at a station to be capable of operating without full time supervision of the training officer so that the plant can run 24 hours per day 7 days per week. This will enable the plant to be generating electricity and earning money for the coop as soon as possible. The training officer will be still stationed at the site during this period working a normal 40/50 hours per week but not necessarily on call at site all the time.

Stage (11) To improve stage (1) training with particular attention to the shift charge engineers and station manager to a level such that the plant can be safely run while the training officer is absent at another site. It is not expected that a full understanding of the theory of the plant operation will have been grasped in stage (1) and stage (11) training.

Stage (111) The third stage, after some weeks of being left to run on their own will consist of more advanced training in efficiency of operation including theoretical work. The establishment of a routine maintenance system. Review of overall operation.

3.0 Type of Training for the 3 Stages

Stage (1) This will consist of basic training, mostly by example and direction, of the engineers and operators in the areas of: -

- Start up of plant
- Water treatment plant operation
- Feed water system operation
- Boiler stoking and firing
- Running of turbine
- Synchronizing to NPC

- Emergency shut down procedures

- Keeping records of operation

Training at this level should be kept to the minimum basic practical knowledge to get the plant running and earning money for the Coops.

Stage (11) This should concentrate on training of the station manager and engineers to ensure that they reach a level of competence to issue instructions to operators, etc. to run the station safely. At this stage it should be largely practical instruction with a minimum of theoretical knowledge. Particular reference should be made to use of the Operating and Maintenance Manuals for general instruction and problem solving. The aim being to enable them to be left to run the station while the training officer is absent at another station.

Stage (111) This should take place on a return visit of the training officer after some weeks of running. It should consist of: -

- Review of efficiency of operation to date

- Training necessary to improve thermal efficiency of station

- Training on maintenance and the implementation of a maintenance schedule

- Theoretical training needed to enable engineers and manager to have a better grasp of overall operating parameters.

Balfour Beatty

Your ref

Our ref 40052/019/PJT/moa

Date 19th March 1984

Balfour Beatty Engineering Limited
Suite 402 JEG Building
150 Legaspi Street
Legaspi Village
Makati Metro Manila

Telephone 89 11 3
89 14 9
Telex 66086 BBEL P
64138 BB PHIL P

Mr. Simon Alberto
General Manager
Isabela II Electric Cooperative
Ilagan, Isabela

Dear Sir:

Re: Dendro Power Plant Operator Training

We are writing to advise you of the arrangements that have been made for training of Dendro Power plant engineers.

An aid grant has been obtained from the British Government which enables us to provide the training engineer. The grant pays the engineer's UK salary, international air fares and cost of training materials.

The NEA is responsible for providing a Landrover, a driver and daily expenses. A Landrover is being provided by allocating one of the three Landrovers currently used by supervising engineers to the training engineer. An existing Balfour Beatty driver has been assigned to the training engineer. Food and other expenses are processed by BBEL and NEA.

The Coops are responsible for providing a house at site, fully equipped and a cook/house keeper. This being the house that was used by BB engineers during construction.

The training engineer is Mr. R. Elstow who has many years experience with power plant and similar equipment operation. Mr. Elstow is British but has previously worked in the Philippines. All trainees should find Mr. Elstow an approachable person and should not hesitate to ask any questions.

The programme of training is as shown on attached notes. The actual date upon which training will start at a particular power plant will depend upon when the plant is commissioned and will be coordinated with the coop. The first training will take place in advance of stage one when a selected few persons will visit an already operational power plant for about two weeks. For example Solsona is operational so Caramoan staff will visit. Later when Caramoan is operational and the training engineer is there the Palauig engineers will visit.

The training can only be fully effective if the power plant has a proper supply of wood, chemicals and is properly equipped with tools, etc. etc. Coops should ensure that all items on the check list of preparation for operation, as issued by Balfour Beatty are completed.

Should you have any questions regarding the training please do not hesitate to ask Mr. Elstow or write to us in Manila.

Very truly yours,

PETER J. TOTTMAN
Manager - Dendro Thermal Project

cc: Col. F. T. San Miguel
BBEL Sidcup

Training Report : Dendro Thermal Units (Solsona)

Period Covered : February 6th - March 6th

A joint training programme for both disciplines of mechanical and electrical engineering has been constructed and implemented during this month. The training programme has been disigned to cover the practical aspects of the operation and maintenance of Dendro Thermal Units.

The programme is prepared such that three stages of training will be covered viz.

Stage I Cover the training of both mechanical and electrical disciplines to the point of plant operation without full time supervision.

The areas covered in this phase are:-

a) A general understanding of what equipment has been provided and its place in the overall station design concept.

b) The operation of each piece of equipment and the likely effect of failure both to itself and the plant.

c) With particular reference to the mechanical engineers, the theory, and more particularly the practice of combustion. The principles of safe operation of boiler plant and the study of grate management.

d) For the electrical trainees, the circuitry and switching of 4.16kV power, the practice and logic of circuit investigation, the practical aspects of electrical fault finding.

e) The application of boiler feedwater treatment and the practical aspect of de-mineralized water plant operation (mechanicals).

f) The physical determination of gas passage and feed water system in the boiler (mechanicals).

g) The operation of the turbine as a heat engine with the additional consideration of wet, saturated and super-heated steam, their formation and uses (mechanical).

h) Consideration of the oil, cooling water and vacuum systems on the turbine (mechanical and electrical).

i) The combined work force to consider the needs and practical problems of communication with each other and the intercourse between sections ie. Boiler House, Turbine House, Switchgear, external Switchgear and the various levels of management.

j) The combined work force to consider their efforts to be part of a National Resource with responsibilities of efficiency and their contribution to the National Effort.

k) The needs and provisions for breakdown, preventive and scheduled maintenance of plant. Also to engender logical through the implementation of such a maintenance programme, and its association with Management, customer, Accounting Dept. Stores and lead time for purchase of spares and consumables.

l) The other man's job - where the electrical engineers operate the boiler and turbine under the supervision of the mechanical engineers and the mechanical engineers operate the switchgear and gain some understanding of the electrical system under the supervision of their electrical colleagues.

Stage I has been generally completed although it has only been possible to run the plant on infrequent occasions. This has been wholly due to the absence of chemicals for feed water treatment and the paucity of tools and test instrumentation for the maintenance and general running of the plant. Since there is no sharp delineation between stages part of Stage II has also been covered during the month.

Stage II This section seeks to involve the Station Manager and Shift Charge Engineers in the paths of suitable management in the light of operating experience gained. It is also designed to improve the understanding of the trainees and to induce confidence and precision into the Station operation. With the additional aim of high lighting the needs of self discipline and dedication to their particular jobs.

a) The operation of the station carrying its own internal load, punctuated by unexpected trips, faults and shut downs and the implementation of remedial and emergency procedures.

b) The design and implementation of set shifts procedures e.g. as a new shift takes over, the outgoing and incoming engineer should inspect their section of the plant together and note any problems which has occured or can be predicted for the future.

c) Observation by the Station Manager & Shift Charge Engineers of the operation of the shift work, the fuel supply and the availability of labour.

d) Design and implementation of reporting procedures both up and down the management chain the design and implementation of programmes to improve the efficiency of the station, with particular regard to the keeping of logs and the extraction of data from the sheets. This data will figure in future management policy.

e) The design and implementation of manning levels and systems for outlying switching and sub-stations together with communication facilities for emergency conditions.

f) The trainees to become familiar with the O&M Manuals their contents and advise back of shortcomings they find.

Some stage II work has already been completed because the non availability at the station for operation has caused a blurring of the interface between stages. In order to obtain continuity some work has been taken out of context and applied at a date earlier than intended.

Stage III Will take place as a review content for the programme, return visits will be made to ensure that there are no gaps in the coverage of the previous stages. During this stage more emphasis will be placed on the practical aspects of maintenance.

General appreciation of the programme so far and the means by which the effects have been measured.

Mechanical

It must be said of INEC Management that every effort has been made to facilitate the training programme. No effort has been spared to ensure that men and materials within their authority and supply have been available.

Moreover the dedication and application of the trainees to their appointed tasks, assignments and studies has been excellent.

Where sins of omission and comission have been commited they have been wholly due to small problems in communication. However, repetition of theory and "by example" in practice have cured the outstanding problems. Repetition has been appreciated by those

who did not understand and has been endured with goodwill by those who did which makes the training enigneers task much easier.

In order to assess the level of understanding of the course a 4 hour examination paper was set, the results from this are that of 7 engineers who completed the course 6 passed, 3 with distinction and 3 with varying levels of competance, the last engineer who failed is actually the storekeeper who sat the examination but did not attend the lectures and programmes, nor did he take part in the set assignments or emergency procedures. Examination papaer is Appendix I.

Electrical

There the story is very different. Of 5 available trainees only one made a concerted effort to attend lectures and assignments and in the final examination the results he produced were excellent and correct in every particular. The other 4 engineers were reluctant to attend at the site and their showing in the examination was abysmal. An investigation into their reasons for lateness and non-attendance reveals that a considerable salary difference between their attendance at headquarters, for work there, and their attendance at site for instruction reduced their enthusiasm for site attendance. This has now been resolved by the good offices of the Station Manager and 5 days of intensive training have ensued, a further examination has been prepared and the results will be appended to this report. The original examination has been added as Appendix II the additional paper is accorded as Appendix III.

Recommendations as to the fitness of various personnel for duty as Shift Charge Engineers or operators is offered as Appendix IV.

Solsona Dendro Thermal Unit is now ready for operation without prejudice to any outstanding remedial or completion work which may still be outstanding for BBEL.

The personnel are ready to undertake their duties and their understanding of those duties is such that there is no hindrance to the plant operation. Indeed it is desirable that continuous operation be undertaken to improve their confidence in their own abilities.

However it is essential that availability of chemical and engineering consumables is assured and continous, also that transport is at site to move the fuel wood in an adequate quantity to sustain the plant operation.

Mechanical Questions

1. The wood handler who empties the ash skip draws your attention to unburnt carbon in the ash. Give the causes for this.

2. What are the main losses on a boiler, state in a few words how to keep them as low as possible.

3. Describe in your own words:

   a. What is saturated steam and how does it differ from wet steam?

   b. What is superheated steam and how is it produced?

   c. Why do we superheat steam?

4. Describe briefly, the various stage which occur in a power station during the conversion of the chemical energy in wood into electrical energy.

5. The boiler you are steaming has a CO_2 indicator but you have not been given CO_2 figure to work to and the analysis of the fuel you are burning is not known. How would you set about getting the highest CO_2 for good combustion.

6. Describe the procedure for the start up of the turbine up to and including synchronizing with INEC supply, include the people with whom you would communicate your actions.

7. Describe how you would induce the suction on a cooling water pump after it has been shut down, stripped and reassembled after overhaul.

8. Draw a sketch of the layout of the Turbine indicator panel, name the instruments and state the approximate readings you would expect to have when running on load.

9. In planning the shut down of the power station for general maintenance, which authorities would you agree your plan with, what procedure would you adopt to ensure that the overhaul was completed on time. Explain how you would establish the most suitable time of year for an overhaul to take place.

10. State in a <u>few words</u> what is meant by the following terms:

    a. Corrosion
    b. CArry over or priming
    c. Hardwater
    d. De-aerated water
    e. Conductivity meter
    f. Blowdown

11. Show by calculation how the setting on the thermal overloads on an electric motor are established, the overloads are there to protect the motor from damage.

- O -

From the 11 questions which have been set, select 8. Your answers together with my comments will be forwarded to INEC Management before return to the trainees.

Time Limit : 4 Hours-split 2 Hours 10:00-12:00 & 14:00-16:00

Appendix II

Electrical Questions

1. Explain the function of the excitation control and the governor control when:

   a. in parellel with INEC
   b. in parallel with NPC

2. Explain in detail the synchronizing procedure aligning the generator with NPC from the time the turbine operator advises you he is ready to accept station load.

3. A motor breakdown has been reported to you, actually the motor has an open circuit winding, describe what procedure you would adopt to locate the fault.

4. Describe what you think are the most important functions of the 110 volt DC battery supply and charger.

5. It is necessary to synchronize the blackstart genertor with the turbo-alternator - describe how this should be done.

6. Describe the action you would take in the event of the following faults occuring on the main transformers:

   a. Buckholz alaram
   b. Winding temperature alarm
   c. Oil temperature alarm

7. What would be the effect of our power station generating in parallel with NPC but having a higher power factor.

8. Describe the procedure for setting the "NORMAL" and "FIRST LOW LEVEL ALARAM" and the opening and closing functions of the boiler feed water valve modulating system, using the electrical/ electronic control boards.

- O -

Please attempt all 8 questions. Your answers together with my comments will be forwarded to INEC management before return to trainees.

Time limit: 4 Hours - split 2 hours 10:00-12:00 & 14:00-16:00

cc J Masterson
M Smith - Accts
D Jarrold - Cost Cont
P. Tottman - Mnl
R Elstow

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ATTENTION MR P A DUCKWORTH
Balfour Beatty Engineering Limited
Marlowe House
SIDCUP
Kent
DA15 7AU

Your reference 40052/845/VRT/JB

Our reference CON 517/138/01

Date 20 February 1984

Gentlemen

I am directed by the Secretary of State for Foreign and Commonwealth Affairs to refer to recent discussions and correspondence between Balfour Beatty Engineering Limited ("the Consultants") and the Overseas Development Administration ("ODA") and to confirm that, in response to a request from the Government of the Philippines under British technical cooperation arrangements, the British Government wishes to engage the Consultants on the terms set out in this letter and its Appendix to provide the services of a Training Engineer to train local engineers and operators of Dendro Thermal (Woodburning) Power Stations, the Philippines.

2. Terms of Reference

The Consultants' terms of reference for this engagement are as set out in the Appendix to this letter.

3. Period of Engagement and Staffing

In order to fulfil this engagement which shall be for a period of twelve (12) months residential service in the Philippines with effect from about 2 February 1984, the Consultants shall arrange for Mr W R B Elstow to travel to the Philippines on or about 2 February 1984 for the purposes of this engagement. Mr P A Duckworth will be responsible for the overall supervision and coordination of this engagement.

4. Provision of Substitutes

If, owing to death, illness or other circumstances beyond the control of the Consultants, Mr Elstow should be unable to carry out his duties under this engagement the Consultants shall, if requested by the ODA, provide a substitute acceptable to the ODA. Provided Mr Elstow was certified as being medically fit within one month prior to travelling to the Philippines in respect of this engagement the British Government shall reimburse the Consultants for such additional cost, including air fares and other incidental expenses, as may be agreed between the Consultants and the ODA as having been reasonably incurred in providing such a substitute. If, for any other reason, Mr Elstow does not carry out his duties under this engagement the Consultants shall be responsible for providing without delay a substitute acceptable to the ODA without further cost to the British Government.

/5.

5. British Carrier

The Consultants shall, when it is reasonable and practicable to do so, travel by a British Carrier.

6. Reports

In addition to the reports required by the terms of reference the Consultants, in respect of this engagement, shall submit reports as follows:

Date due	Nature of Report	No of copies required by a. ODA	b. Government of Philippines
Each quarter, 1st due 14 May 1984	Progress report	10	10
February 1985	Final Report, outlining inputs made, results achieved and any recommendations the Consultants may wish to make	10	10

The Consultants' final report shall be submitted in accordance with the note of the presentation of reports enclosed with this letter.

7. Fees and Expenses

In consideration of the satisfactory performance by the Consultants of this engagement and subject to paragraphs 8 and 9 the British Government shall make the following payments to the Consultants:

i. fees for the time, including travelling time, necessarily spent by Mr Elstow for the purpose of this engagement at the periodic rate of [redacted] per quarter (which rate shall apply pro-rata for part periods);

ii. reimbursement of reasonable out-of-pocket expenses necessarily incurred by the Consultants in carrying out this engagement, including the items set out below:-

a. economy class return airfares and associated travel expenses up to an overall total cost of [redacted]; and

b. training materials etc up to an overall cost of [redacted] provided ODA has first agreed in writing to the purchase of any training materials recommended by the Consultants,

but excluding expenses for the items mentioned in paragraph 17 below.

8. Fees: Definition

The fees payable to the Consultants are deemed to cover the cost of salary, overseas inducements and leave allowances, bonuses, profit, insurances, superannuat and all other costs, overheads and expenses of whatsoever nature that the Consultan may incur except those specifically otherwise provided for in the terms of this engagement.

9. Financial Limit

The financial limit of the British Government's liability to the Consultants under this engagement shall not exceed a total sum of £38,000 (thirty-eight thousand pounds) unless the amount of any such excess has first been agreed by the ODA in writing before the Consultants have taken any action which might result in the financial limit for this engagement being exceeded.

10. Payments

The sums due to the Consultants under the terms of this engagement shall, subject to the ODA being satisfied that this engagement is being or has been carried out to its satisfaction, be paid in sterling in London quarterly in arrear on the receipt and approval by the ODA of the Consultants' statement of account which should be submitted in accordance with the enclosed note on submission of statements of account.

11. Value Added Tax

Although the Consultants are being engaged by the British Government and payments under this engagement will be made from aid funds, the services of the Consultants will be supplied to the Government of Philippines. In accordance with the provisions of Item 6 of Group 9 in Schedule 5 to the Value Added Tax Act 1983, VAT will not be payable on the Consultants' fees and expenses. Services supplied to the Consultants by sub-contractors cannot, however, be zero-rated under the aforementioned provisions of the Value Added Tax Act 1983. Accordingly it will be for the Consultants to recover any VAT paid in respect of such services from HM Customs and Excise in accordance with the normal rules, and any such VAT payment shall not be eligible for reimbursement to the Consultants under the terms of this engagement.

12. Currency

If it is necessary for the Consultants to purchase foreign exchange for the purpose of this engagement, for the purpose of evaluating one currency in terms of the other the conversion shall be made at the purchasing rate legally applicable at the time and place of, and to the currency utilised in, the underlying expenditure or transaction.

13. Indemnity

The Consultants shall indemnify and keep indemnified the British Government in respect of any claims arising out of, or related to, this engagement howsoever they may arise.

14. Assignment to Others

The Consultants shall not, without the consent in writing of the ODA, assign or transfer or cause to be assigned or transferred, whether actually or as the result of takeover, merger or other change in identity or character of the Consultants, this engagement or any part, share or interest therein. Upon any such assignment or transfer this engagement may forthwith be terminated by the ODA.

15. Termination

i. If in the opinion of the ODA it appears desirable that this engagement should be terminated, the ODA may at any time give the Consultants written notice of

/three

three months, or such other period as may be agreed between the Consultants and the ODA, of their intention to terminate this engagement and this engagement shall be deemed to terminate on the expiry of such notice. Reports due in accordance with the terms of this engagement during the period of the notice shall be furnished but, unless so agreed between the parties, no final report or draft thereof. Payments due to the Consultants under this engagement shall be made for services rendered up to the date of termination less any unrecovered or balance of advances made. No other payments shall be due to the Consultants.

ii. If the Consultants should at any time during this engagement go into liquidation or enter into any arrangement with their creditors the ODA may forthwith terminate this engagement. In that case payments due to the Consultants under this engagement shall be made for services rendered up to the date of termination, less any unrecovered or balance of advances made. No other payments shall be due to the Consultants.

16. Force Majeure: Cessation of Obligations

If the rights of the Consultants or of the British Government under this engagement are wholly or substantially diminished or the performance of this engagement rendered wholly or substantially impossible by reason of force majeure, then the party so affected shall promptly notify the other party in writing and as from the date of that notification the obligations of both parties shall cease forthwith except that the British Government shall pay the Consultants:

i. all fees, expenses and other sums due and outstanding under the terms of this engagement up to and including the date the obligations so ceased ("the relevant date");

ii. in respect of each person who, in accordance with the terms of this engagement, was employed by the Consultants in order to fulfil this engagement on the relevant date, or who was due to be so employed during the following two months, a fee at the rates provided for by this engagement for such period, not exceeding two months from the relevant date, as such person was due to work under this engagement;

iii. reimbursement of reasonable expenses necessarily incurred by the Consultants after the relevant date in winding up this engagement.

17. Local Services and Facilities

The Consultants shall provide the following:-

a. Accommodation in the Philippines (engineer and driver/assistant)

b. Land Rover (LWB) and VHF radio

c. Salary of Driver/Assistant

d. Land Rover Maintenance and Fuel

e. Incidental expenses

The British Government shall not be responsible for the provision of, or cost of, and shall accept no liability in connection with, such services and facilities.

18. Settlement of Disputes: Arbitration

Should the Consultants and the ODA be unable to reach agreement on the meaning or interpretation of any of the terms of this engagement, any matters in dispute shall

be referred to an arbitrator to be agreed between the parties or failing such agreement to be nominated by the President of the Law Society of England and Wales on the application of either party, and the decision of the arbitrator shall be final and binding on both parties.

19. I should be grateful if you would confirm in writing that you accept this engagement on the terms set out in this letter and its Appendix.

I am, Gentlemen,
Your obedient Servant

J W Last
Consultancies Section

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APPENDIX

Woodburning Power Stations - Philippines

Terms of Reference

Object

- To train the operating staff of the six stations situated at Solsona, Iligon, Palavig, Jones, Caramoon and Dupax in Luzon to enable them to operate and maintain the stations efficiently and safely.

Type and Extent of Training

- All training will be at the power plant sites (although it is possible that at times operating staff from a yet to be commissioned station, will be transferred for training purposes to the running station where the training engineer is located), as decided by and for such periods as the National Electrification Administration (NEA) shall determine.

- Training shall be largely practical but shall also cover the minimum theoretical knowledge necessary.

- Training shall cover two separate aspects viz:-

    Station Operation
    Station Maintenance

- Training shall emphasise the use of and reference to, the comprehensive operating and maintenance manuals provided

- It shall include the setting up of routine records, shift logs, maintenance logs etc, initiation and recording of maintenance work

- It shall instill an awareness of possible dangers and attention to safety and safe working practices

Items of Plant to be covered

Boiler Plant including economiser, fans, sootblowers and auxiliaries. Particular attention shall be paid to training the engineers and operators in maintaining correct firing conditions. Regular use of sootblowers to keep the gas passes clean and correct operation of fans to maintain efficient combustion and control of smoke.

Instruction in the correct operation of the water treatment plant to provide boiler feed water. Chemical dosing and regular water testing shall be stressed.

Instruction in the correct operation of the deaerator and feed water system including blowdown regimes. Emergency shut down procedures shall be included.

Turbine Plant

Instruction in the running up of the turbine and its normal and emergency shut down. The routine logging and the necessity to observe the readings to detect any change in operation. Routine changing of oil filters and oil coalescer filters shall be included.

Instruction in the correct operation of vacuum pumps, condensate pumps and main

Electrical

(Note - The Training Engineer will be assisted by the Consultants' Electrical Engineers, whenever available.)

480V Auxiliary System

Training shall include the start up and running of the black start diesel generator set together with its emergency use for the safe shut down of the station. Instruction in the starting of motor drives and the setting of auto changeover systems for standby drives shall be given.

4.16kV Main Generation System

Instruction in the correct operation of the generator excitation controls including adjusting voltage and power factors as necessary. Synchronization with the grid system shall be demonstrated. The operation of the main switchboard and the main auxiliary transformers shall be included.

General

Emphasis shall be placed on the regular routine recording of information together with its interpretation. This shall include setting up systems for such things as:-

- Regular logging of plant operating conditions
- Analysis of operating log sheets to detect deviations from normal
- Initiation of periodic maintenance to plant items and the recording of work carried out
- Recording and ordering of consumable stores and spare parts

Support in the field

The Consultants' office in Manila shall provide support in the field for the training engineer. This shall cover such aspects as -

- Communication back to UK and elsewhere
- Vehicle maintenance arrangements
- Arrangements to draw money in the field (to be covered by an expense sheet)
- Act as link to NEA Manila Headquarters

Reporting

The engineer must complete daily record sheets to show where he is located and what training has been carried out. He is also required to produce approx monthly reports covering such items as -

- Training carried out
- Recommendations as to competence of engineers trained
- Recommendations to the Co-operative owners of the plant as to any extra staff, improvement in shift arrangements, maintenance etc

Such reports should be written at the end of a spell at any one station and handed to the General Manager of the Co-operative, and the NEA. The reports should be incorporated in the quarterly reports required by ODA under the terms of paragraph 6 of the contract. Where a spell at a station is to cover a two month period an interim report must be provided to the General Manager of the Co-perative and the NEA after one month.

DENDRO THERMAL POWER GENERATION PROGRAM EVALUATION STUDY

Volume II

Consultants' Reports

GEORGIA INSTITUTE OF TECHNOLOGY

A Unit of the University System of Georgia
Georgia Tech Research Institute
Atlanta, Georgia 30332

GTRI

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PREFACE

The full text of individual consultants' reports is included in this volume. This is done to accommodate the reader who wishes to explore, in more detail, the analysis stated in Volume I. The substance of each consultant's report was considered in formulating the analysis and conclusions presented in Volume I. The opinions expressed in the consultants' reports are those of the individual authors and not necessarily held by the Georgia Institute of Technology.

HARVEST SYSTEMS EVALUATION AND DESIGN

Presented to

Georgia Institute of Technology
Atlanta, Georgia

by

Forest Engineering Incorporated
Corvallis, Oregon

October 1984

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SYMBOLS FOR TABLES
2, 5, 8, 11, 14, 17 and 20

UC	Uphill Cable
DC	Downhill Cable
UDC	Downhill and Uphill Cable
UA	Uphill Animal
DA	Downhill Animal
A	Flat Animal
DUA	Downhill-Uphill Animal
*	Larger swing winch used
1C	1 Cable swing
2A/1C	2 Animal swings followed by 1 Cable swing
240/560	1st swing 240 meters, next 560 meters
10C/88A	swing days required for a unit: 10 by Cable 88 by Animal

CONTRACT BACKGROUND

Forest Engineering Incorporated entered into a contractual agreement with Georgia Institute of Technology March 1, 1984. Consulting Agreement No. C4-A-3717 (FEI 72.01) started on March 12, when D.E. Aulerich left for the Philippines on the first of two trips to the country.

The contract has six tasks, but two primary functions. The first function is to evaluate past and present activities pertaining to the harvesting and transport of forest material (ipil-ipil) from the plantations to the plant site. The second primary function is to examine, in detail, four dendro sites selected by NEA. The outcome of this examination will be one or more harvest designs with accompanying costs and manpower requirements.

Harvest Planning

A considerable amount of work of a general nature has been done in the past. An overall scheme of harvesting and transport planning with some intense efforts were made on specific points of monocable installations. However, at no point during our investigation did we find that any analysis was made as to what system would be the most applicable.

It seems that the monocable system was selected with inadequate thought given to alternatives, and there is little evidence that much thought went into the problems of feeding the monocable. In a study on the Catanduanes site [2/] a statement was made that the monocable would be the most economical and efficient, but would require foregoing the use of 100+ hectares of plantation east of the Pajo River. This study goes on to state that the Pajo River would be used to transport the wood from this difficult area. Elaborate designs of the monocable accompany this report (Figures 1 and 2), but very general statements about feeder winches are given. The report goes on to state that one each of a 550 meter and 250 meter feeder winch will be necessary, and what cannot be reached will be harvested with carabao-drawn sleds. It is extremely doubtful whether this is physically possible let alone economically feasible. We found no evidence to refute or support these statements; however, in my opinion the production is unrealistic.

In the initial stages of the development there was a tendency to stay away from any roading whatsoever. There may be a valid reason such as keeping settlers from moving in; however, we failed to find cost

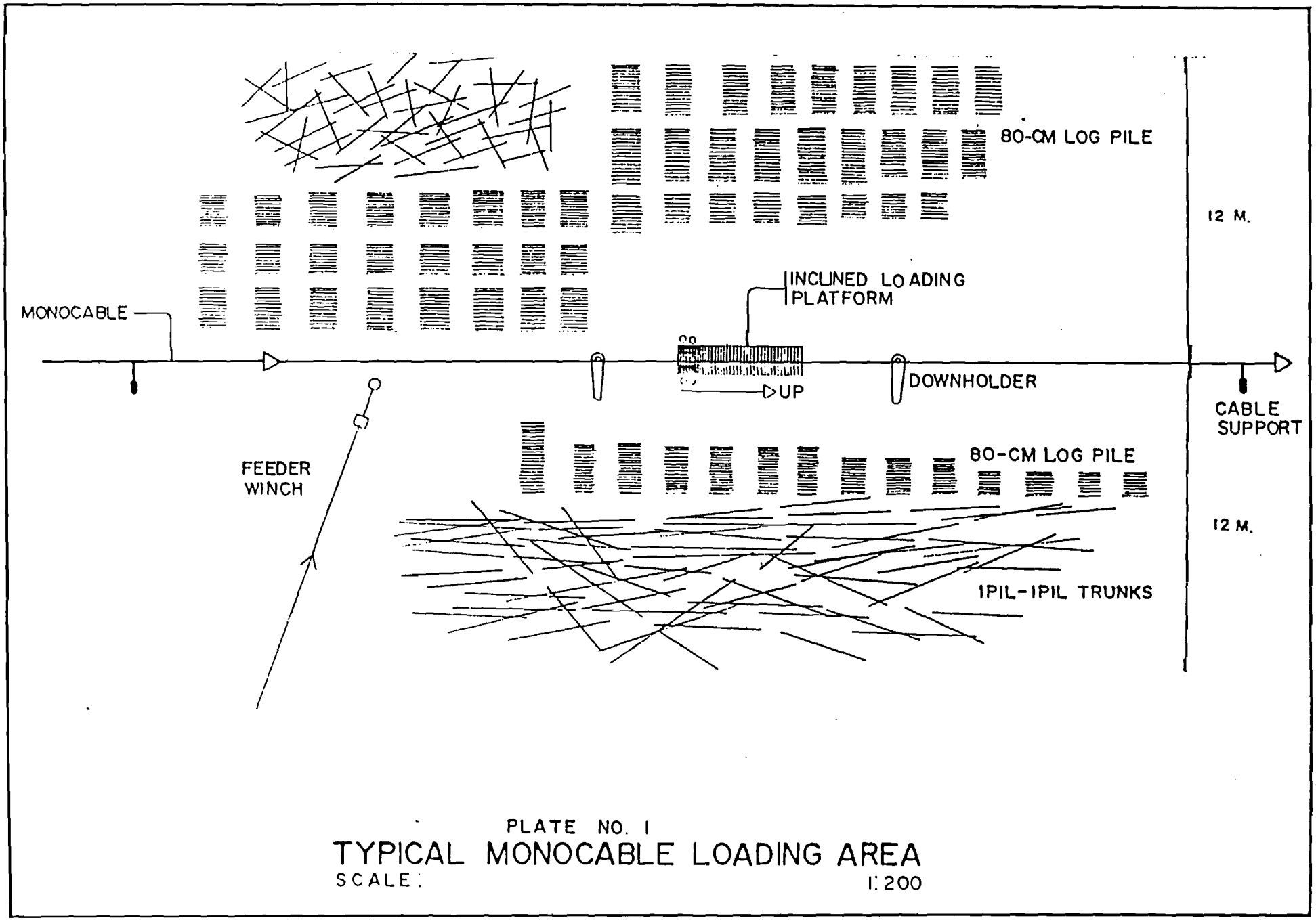


Figure 1. Typical monocable loading area. Source: Catanduanes Dendro-Thermal Outline Engineering Report. Trans Asia Engineering (Philippines) December 1982.

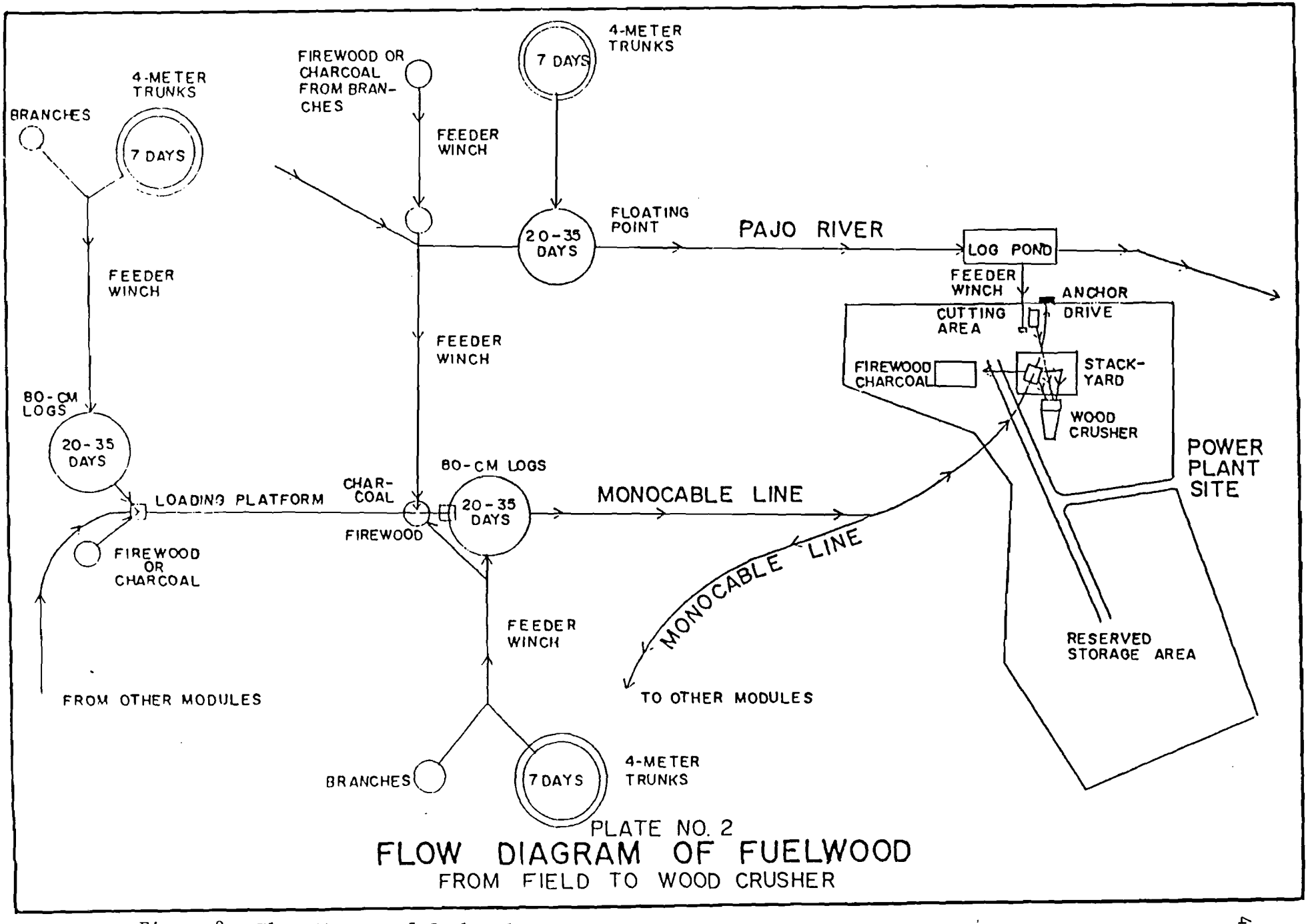


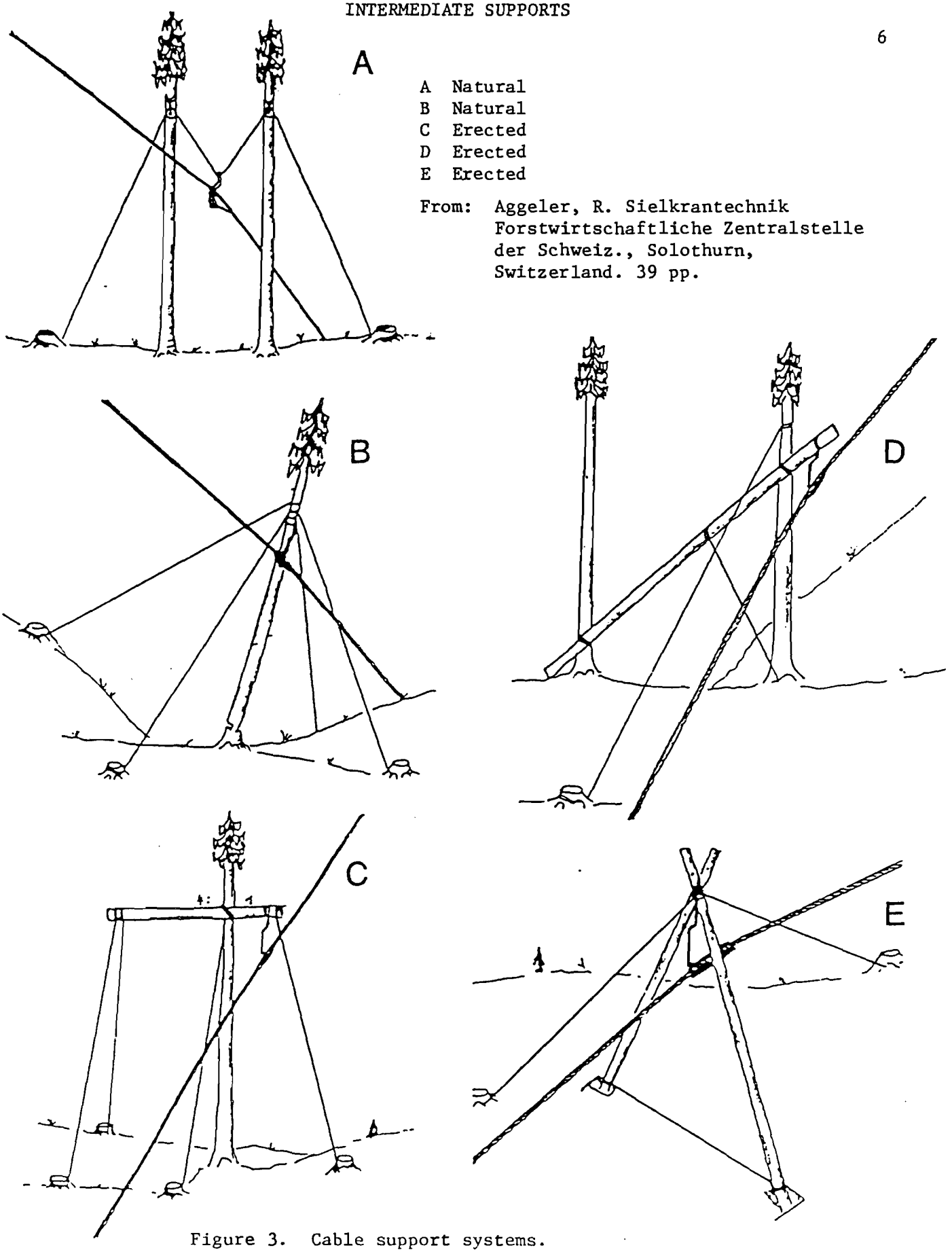
Figure 2. Flow diagram of fuelwood.

data that would support the monocable over roading. This is not to say roading would be better, it's just that we found no evidence to support going to the monocable system on so many sites.

In addition to the high cost and limited application of the monocable system, we think the major obstacle is the general lack of planning as to how the feeder winches are actually going to be utilized. The basic activities of moving and installing the units can be formidable especially with untrained crews. There seems to be a lack of understanding of the difficulties associated with cable harvesting on difficult terrain by designers of the project. The very presence of adequate anchors and support structures for the cables will require careful planning to take advantage of the sparse conditions that are available. Nearly all feeder winch installations will require the erection of support sturctures if the yarding distance is greater than 100 meters (Figure 3).

The lack of planning that fails to take advantage of terrain features will further increase the harvesting difficulty. Ground winching is not an acceptable method, especially at distances of 200 to 500 meters.

Since the monocable location is very critical to enable the system to work, much care was taken in the placement of these sytems (Figure 4). Elaborate surveys were conducted so that the monocable could physically operate. The problem we see is that the monocable in some cases fell short of meeting the needs of the site. Such a case has already been recognized at Catanduanes.



A Natural
B Natural
C Erected
D Erected
E Erected

From: Aggeler, R. Sielkrantechnik
Forstwirtschaftliche Zentralstelle
der Schweiz., Solothurn,
Switzerland. 39 pp.

Figure 3. Cable support systems.

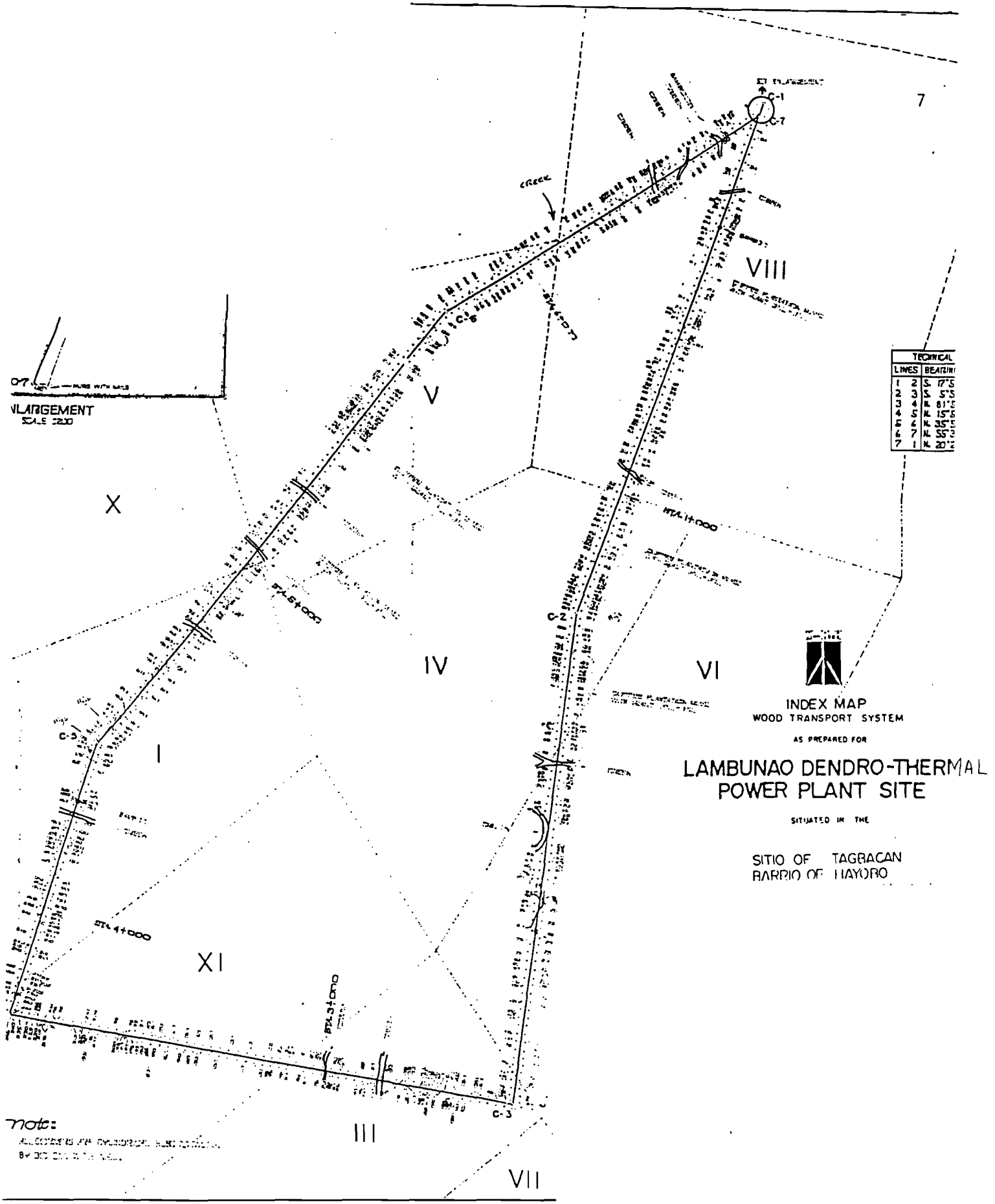


Figure 4. Wood transport system, Lambunao Dendro-Thermal Power Plant site.

The success of cable harvest operations is dependent upon the correct placement of the yarders to take advantage of the terrain. A cableway's productive capacity depends upon the amount of deflection the cable can have and still be above the ground. If the profile of the ground rises instead of dropping, intermediate support structures are necessary or yarding distances are very short.

A section of the harvest area on Marinduque is illustrated in Figure 5. Swing skyline 096 is necessary to move the wood from units 17 and 18 to the haul road. The efficiency of the operation is influenced by the load this cableway can carry. Since small cable systems are being used, five support structures are necessary to carry .75 cubic meters of ipil ipil (Figure 6). The limiting net load for the cableway 235.7 meters from the landing is 596 kilograms. Another limit point is 361.4 meters from the landing with a carrying capacity of 579 kilograms. Assume one cubic meter weighs 800 kilograms.

Another profile that takes better advantage of the terrain is profile 067 (Figure 7) with a resulting payload capacity of two or more cubic meters (Figure 8). Only end supports are necessary rather than the five supports required for profile 096. These two examples illustrate the advantages of planning, especially when cable systems are required.

The computer analysis of skylines (cableways) 096 and 067 presented here illustrate the load carrying capacities of cableways under different ground conditions (Figures 6 and 8). The analyses shows that the tensions in the cables and thus the payload capacities vary depending upon the location of the load along the skyline. These calculations

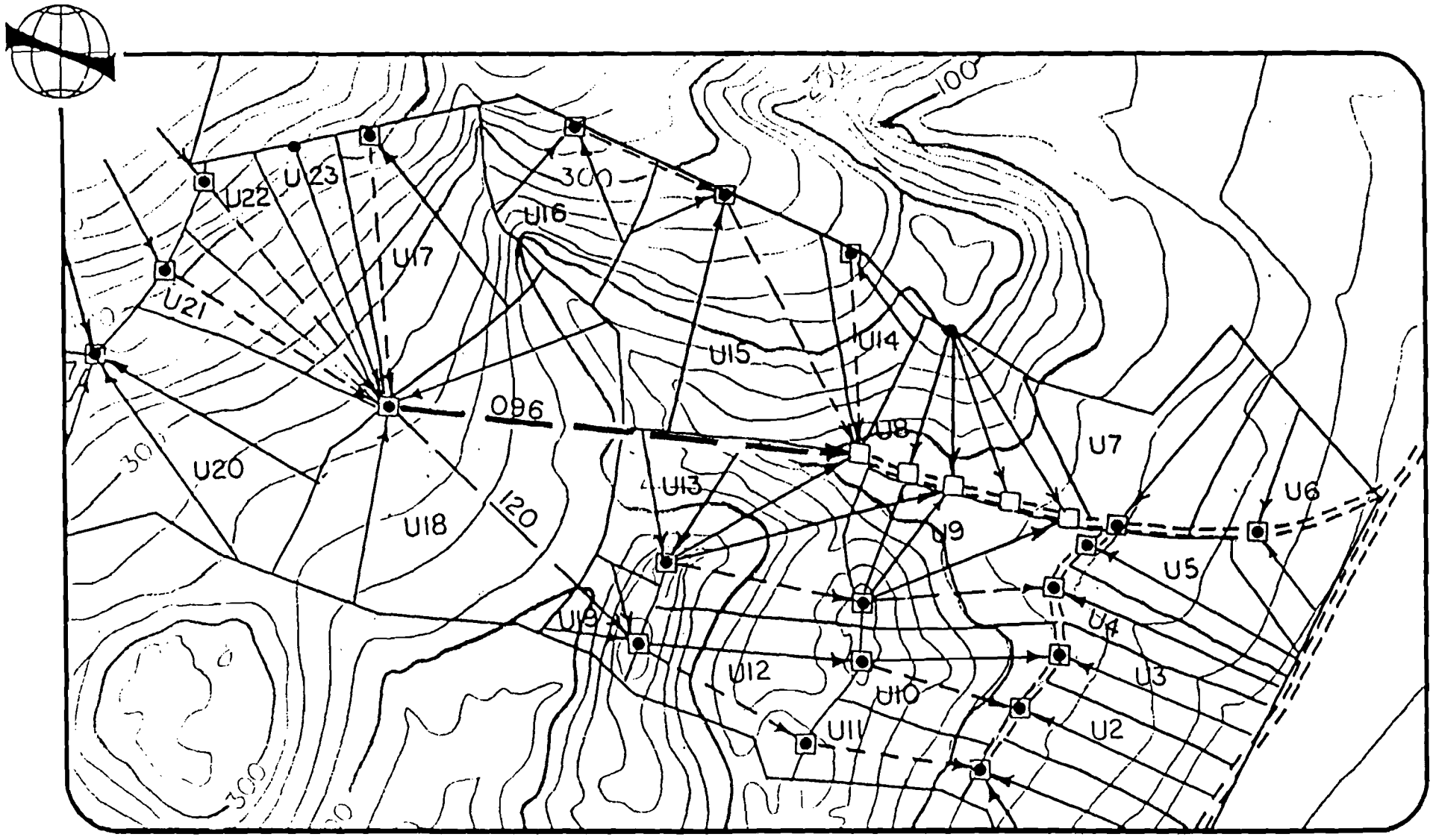


Figure 5. Topographic location, Skyline 096, Marinduque.

MULTISPAN ANALYSIS FOR PROFILE 72.01-MARINDUQUE-096

*****SUPPORT INFORMATION*****

*****LOAD PATH ANALYSIS*****

SUPPORT	1	D	0.0	H	0.0	CHORD SLOPE -19.0 PERCENT
SUPPORT	2	D	105.9	H	19.6	CHORD SLOPE -25.0 PERCENT
SUPPORT	3	D	242.6	H	53.0	CHORD SLOPE -23.0 PERCENT
SUPPORT	4	D	401.1	H	89.0	CHORD SLOPE -24.0 PERCENT
SUPPORT	5	D	843.6	H	191.0	

LOAD PATH BEING COMPUTED FOR LINE LENGTH OF 865.09 m AND LOAD OF 771.57 kg

LOAD STATION M	ELEV DIFF M	SPAN NO	SKYLINE TENSION Kg	MAINLINE TENSION Kg	NET LOAD	COMMENTS
5.3	3.4	1	2205	357	803	
26.5	12.0	1	2622	227	700	
52.9	18.3	1	2741	143	646	
79.4	21.3	1	2586	73	621	
100.6	20.6	1	2175	HAULBACK REQ	613	
112.7	24.5	2	2308	361	661	
140.1	37.1	2	2824	259	653	
174.2	47.2	2	2958	195	677	
208.4	53.0	2	2760	117	627	
235.7	53.9	2	2211	39	596	
250.5	58.5	3	2362	347	657	
282.2	72.2	3	2967	245	657	
321.8	83.2	3	3095	197	710	
361.4	89.6	3	2874	105	579	
393.1	90.3	3	2262	29	591	
423.2	103.5	4	3028	362	694	
511.7	138.0	4	4203	247	670	
622.3	167.9	4	4490	179	650	
733.0	187.9	4	4086	111	604	
821.5	194.0	4	2874	65	546	

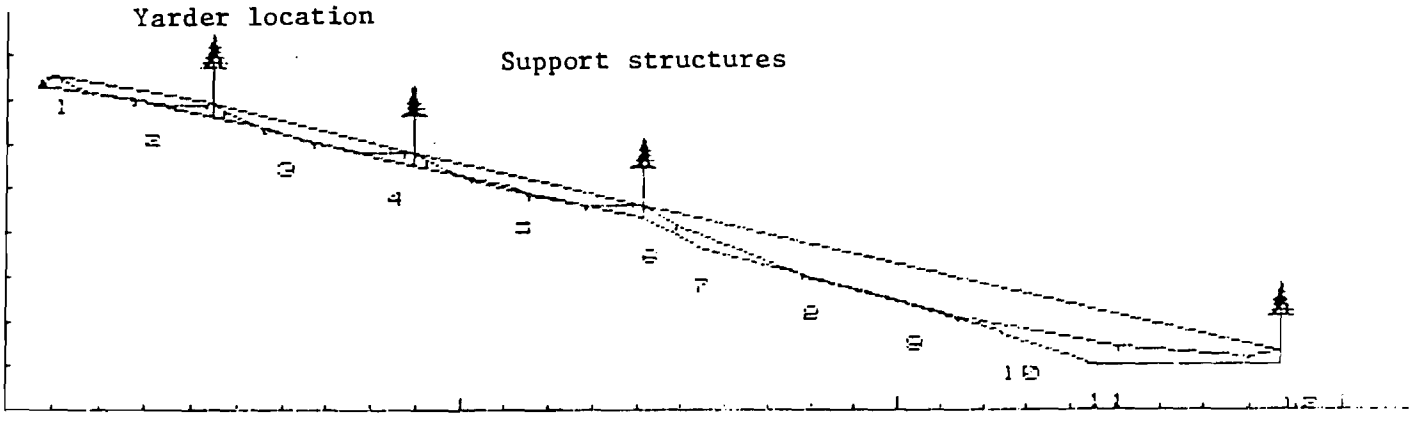


Figure 6. Load path analysis, Profile 72.01, Marinduque 096.

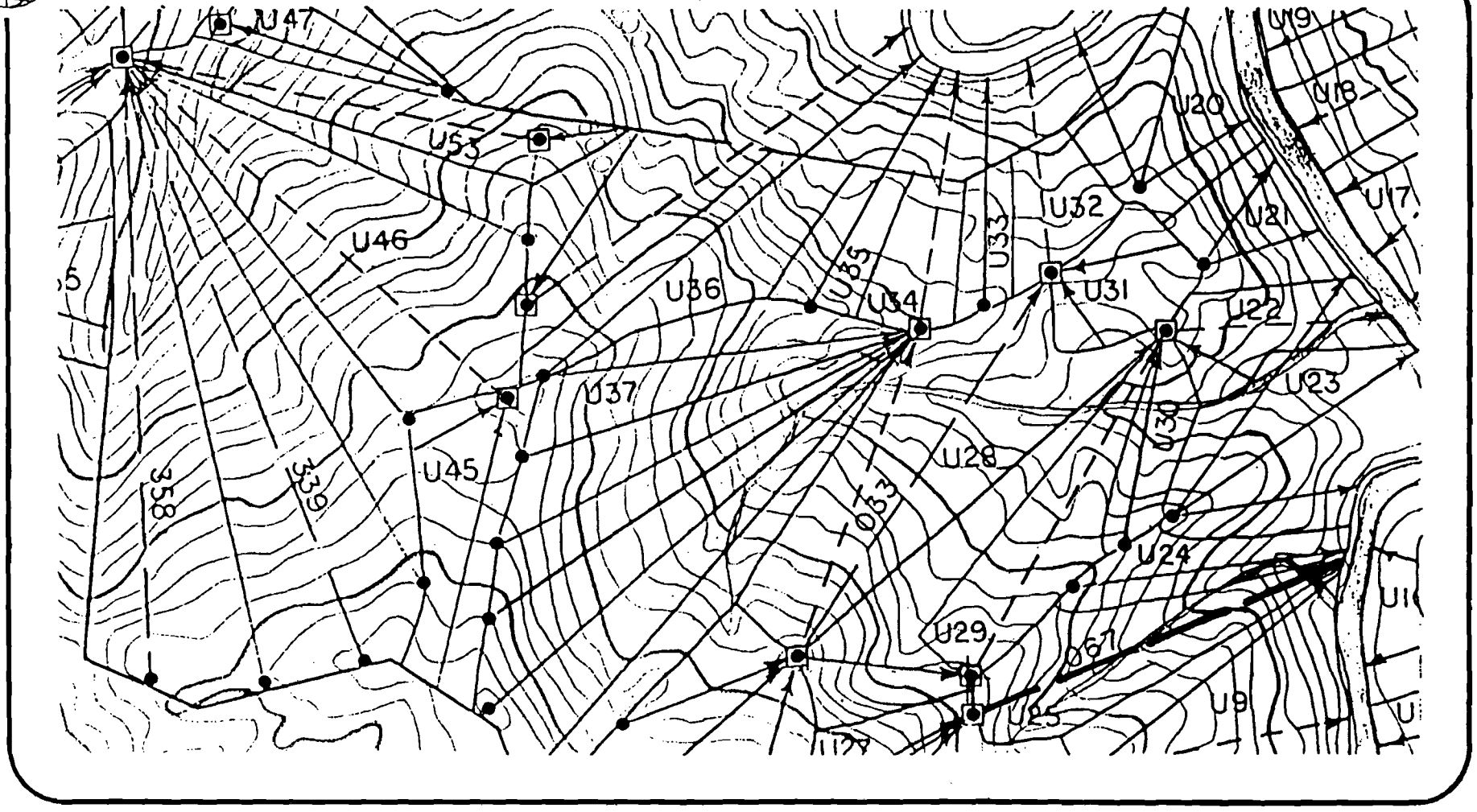


Figure 7. Topographic location, Skyline 067, Catanduanes.

SKYLINE ANALYSIS

PROFILE 72.01 -CATANDUANES -067 (FILE 47)

STANDING SKYLINE LOAD PATH FOR PROFILE 72.01-CATANDUANES-067

TERRAIN POINT	FLYING PAYLOAD Kg	DRAGGING PAYLOAD Kg	MAINLINE TENSION Kg	CARRIAGE TO GROUND CLRC M	SKYLINE LENGTH M
3	0	12035	3820	14.9	907.1
4	4953	0	2142	20.6	907.1
5	4101	0	1725	32.9	907.1
6	3082	0	1259	38.4	907.1
7	2749	0	1115	51.4	907.1
8	2215	0	896	56.2	907.1
9	1820	0	746	59.4	907.1
10	1435	0	611	51.5	907.1
11	1283	0	565	47.6	907.1
MIDSPAN	1269	0	561	48.1	907.1
12	1263	0	558	49.6	907.1
13	1276	0	560	63.8	907.1
14	1301	0	565	77.8	907.1
15	1642	0	618	70.0	907.1
16	1713	0	627	67.0	907.1
17	2004	0	660	58.1	907.1

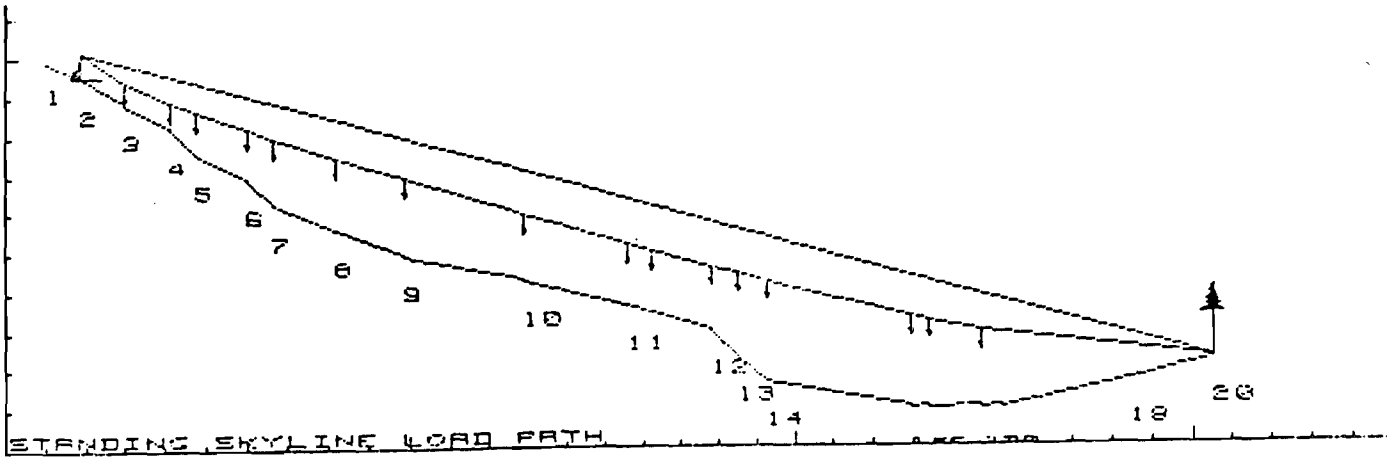


Figure 8. Load path analysis, Profile 72.01, Catanduanes 067.

show the importance of correct planning in advance of operations. Planning the location of the cables increases in system capability while staying within the tension constraints of the cable system. These factors are necessary to first determine if the plantation could physically be cable harvested and secondly what level of production is possible.

As we can see by the two diagrams, one requires the errecting of three support structures (Figure 6) whereas profile 067 requires none and still results in twice the carrying capacity being obtained (Figure 8).

As previsouly mentioned, little evidence was found of planning efforts to feed the Lasso monocable systems. Two profiles were analyzed based upon the designed location for Catanduanes. Profiles A and B, Figure 9, both required structures to carry the wood to the monocable (Figures 10 and 11). The installation of support structures are costly and time consuming and should be avoided if possible. Designing to reduce the number of structures will help reduce the cost. In this case, if some structures were not present it would be impossible to move the wood uphill with the light cables programmed for this project.

Module Locations

The location of farm modules along straight lines rather than along potential harvest opportunities is going to continue to disrupt the successful operation of the project. Initial requirements that the monocable had to touch every module, even when it was not practical, is only a forerunner to problems yet to come (Linsangan, Opolento, 1984).

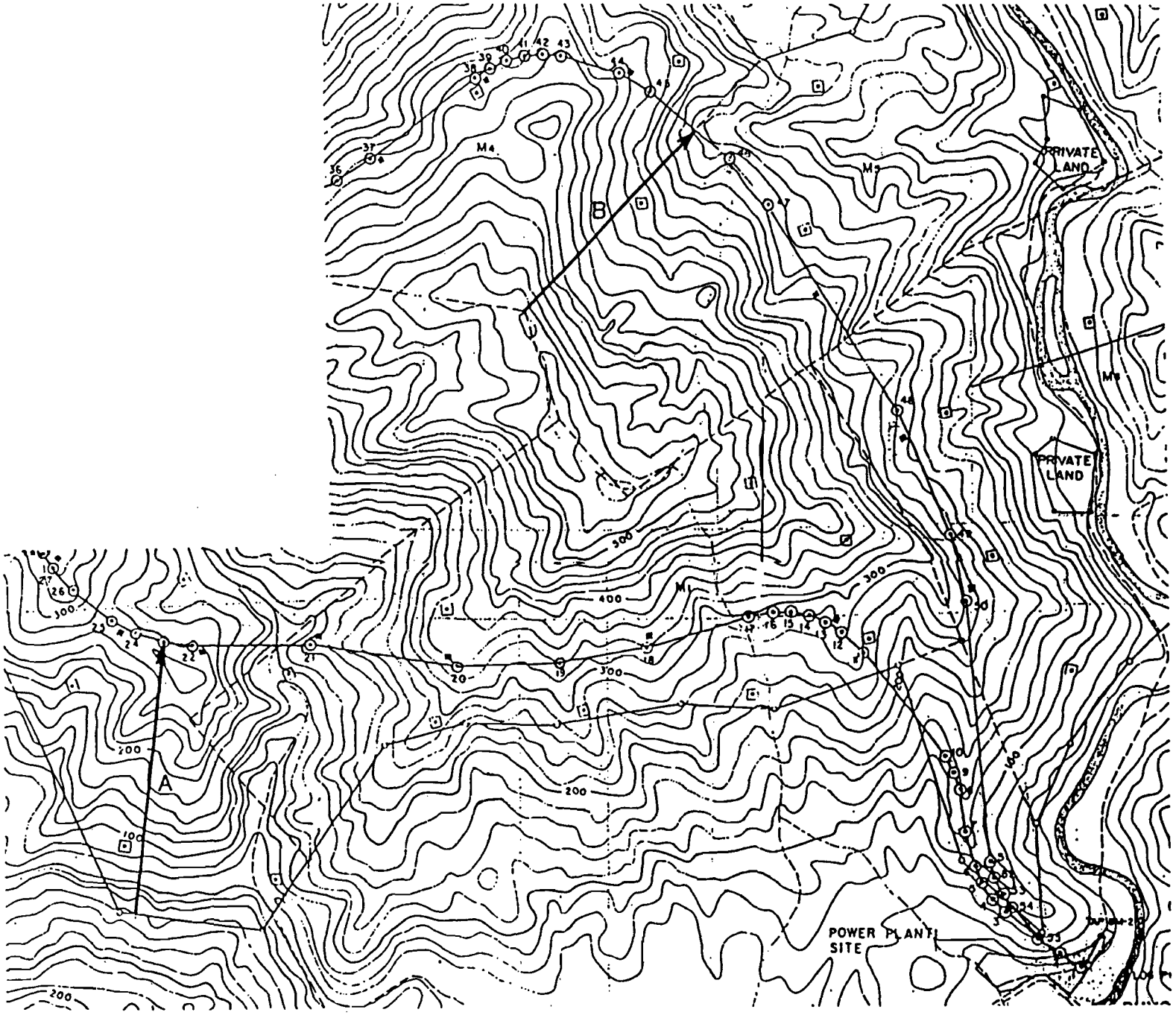
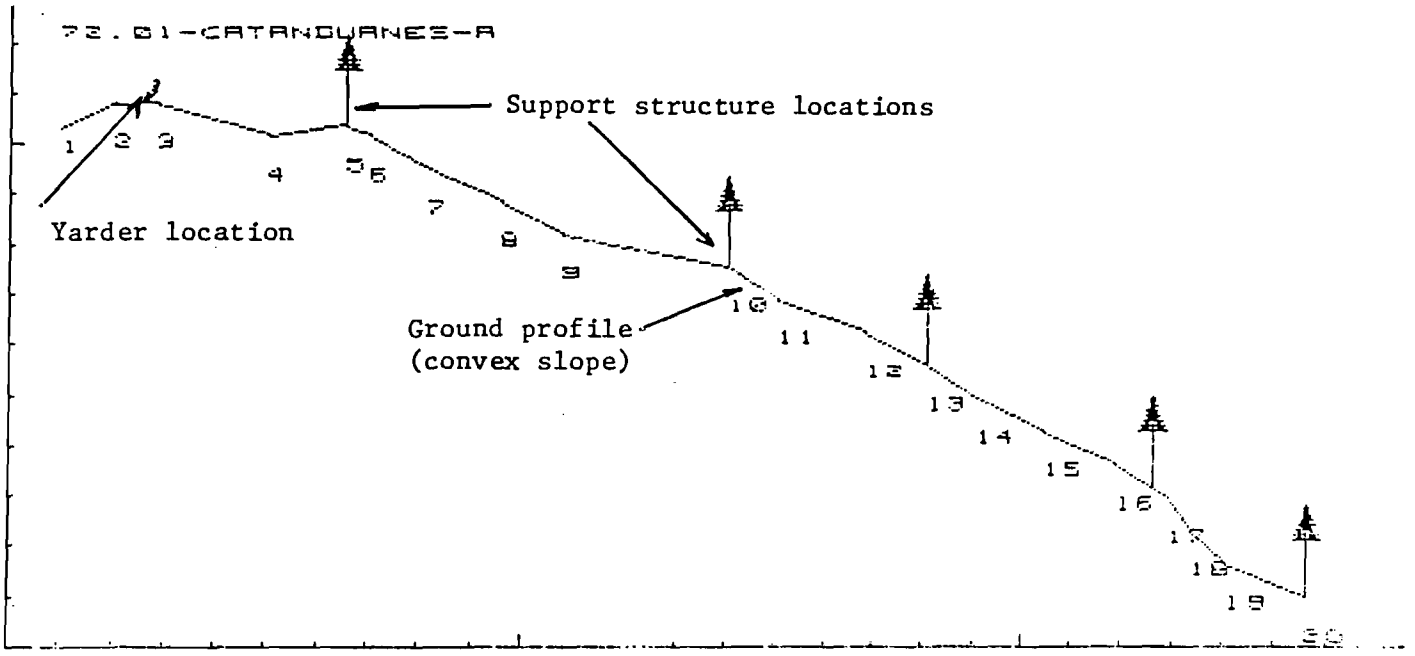


Figure 9. Feeder skylines for monocable installations - Catanduanes.

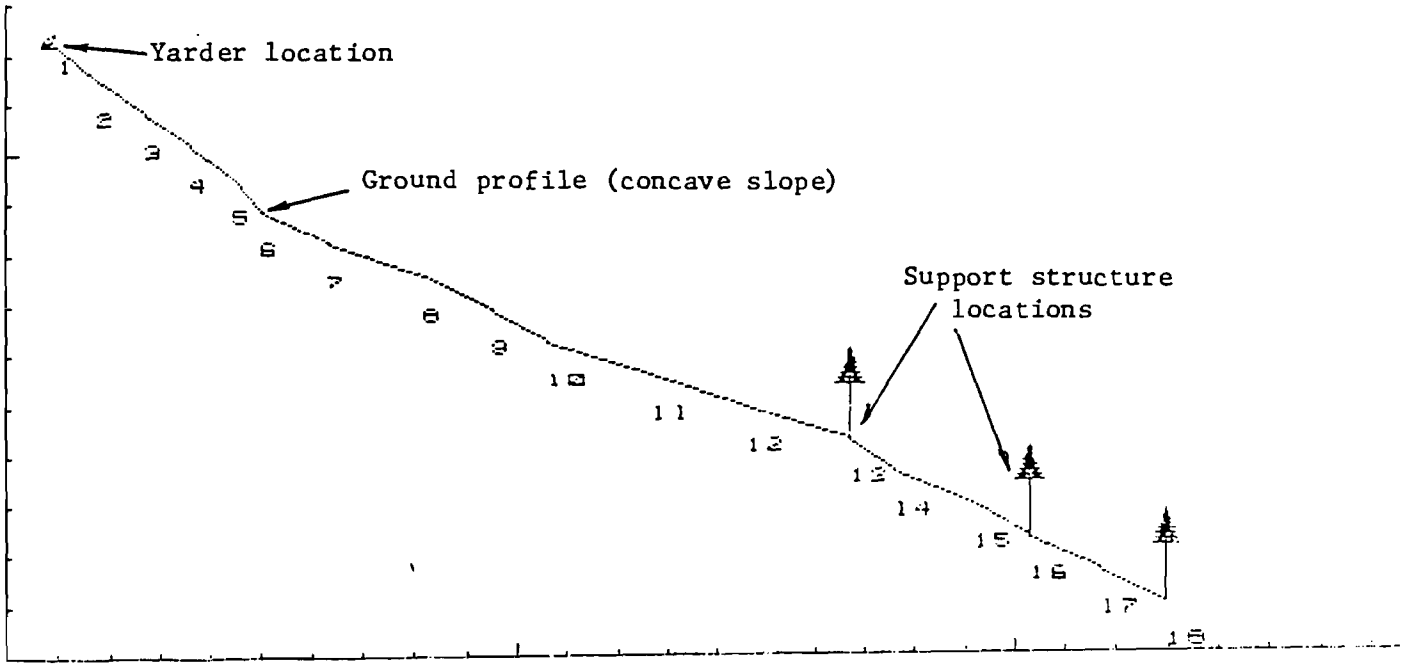
MULTISPAN ANALYSIS for profile 72.01-CATANDUANES-A
*****SUPPORT INFORMATION*****



REQUIRED GROUND CLEARANCE = 10 FT

Figure 10. Support structures required for feeder winch A - Catanduranes.

MULTISPAN ANALYSIS for profile 72.01-CATANDUANES-B
*****SUPPORT INFORMATION*****



REQUIRED GROUND CLEARANCE = 10 FT

Figure 11. Support structures required for feeder winch B - Catanduranes.

As has already been stressed, the most successful cable operations take advantage of the terrain and natural support structures. When obstacles, be they physical, political or administrative, constrict activities, the rate of success diminishes. An example is where a unit is planted near the monocable first. This would mean that any area behind it would be yarded through the new plantation. Planting and harvest units should be the same units.

PLANNING FOR CABLE OPERATIONS

Paper Plan

Cable operations are similar to all harvesting systems in that they should be environmentally acceptable, economically feasible, and physically possible.

If the maps are used correctly by a qualified forest engineer, different alternative designs can be evaluated prior to constructing roads or cableways.

During the paper planning stage it is desirable to have the planner visit the sites, at least at some stage, to reconnoiter the area. The more reconnaisance that is economically feasible the better. Ground checking is desirable especially if the maps are suspect.

A paper plan in itself is usually not sufficient for construction or installation, but should be followed up with intensive ground verification. Minor changes can then be made as needed, but the plan will generally remain the same. The paper plan is a basis for further refinement.

The basic difference from ground systems is that cables are extremely sensitive to terrain because of the cable hanging. Another difference is that a poor plan may produce conditions that are not only more expensive, but are impossible to recover from. Herein lies the danger of not planning. A case in point is the Catanduanes plantation where the area east of the Pajo River is ignored because the wood could not be carried to the monocable.

The harvest plan should be developed PRIOR to planting unless the harvest operation is confirmed as feasible. Only an adequate harvest can do this. It appears that the plans developed for the dendro-thermal sites are inadequate or non-existent.

The minimum planning effort that should be made on difficult terrain, such as found on the dendro-thermal sites, are paper plans based upon the best topographic maps available. Examples are provided in this report.

Requirements for Proper Planning

An understanding of harvesting techniques is essential to adequate planning, even at the paper planning level. Recognition of topographic features, and therefore deflection opportunities, is vital. Also an understanding of anchoring requirements is essential. Too often, technical foresters or engineers with little or no training in harvesting are expected to fill the harvesting void and are unable to do so. We suspect this is the case in this project.

Adequate maps are very helpful since they will reduce the amount of field time required. Topographic maps of Scale 1:10,000 with 10 meter contour intervals are preferred. Maps that are enlarged from 1:60,000 usually are not adequate but were used for these preliminary plans.

Present mapping techniques are available that can use aerial photographs and produce exceptional products of scale 1:4,800 and with 5 meter contour intervals. These would be preferable for the dendro sites. The costs of such maps given the photography and control if available would be approximately ₱21 per hectare (₱14/$1).

Some calculator or computer facilities are desirable, but with proper training, manual techniques are adequate. Planners must be very familiar with topographic maps and the different logging systems.

Training

Proper training of planners is important, but so is the proper training of operational personnel. Cable systems, when used correctly, can be highly productive and therefore relatively economical. However, if they are not planned, poorly installed, and improperly manned they can be very inefficient and extremely dangerous.

A training effort for the operators, farmers and foresters of the proper installation and use of small cableways is necessary to assure success of this project.

The successful flow of wood from the plantations to the boilers is dependent upon the proper planning and training in harvest techniques. Carabaos alone are not an adequate solution to the requirements of this operation. Basic low production free descent gravity systems are not an adequate solution (Hawkes, 1979). These systems may have a place in the overall operation because of limited use in certain locales, but are insufficient in producing adequate fuel in the short run. Very intense detailed investigations are necessary to assure that these systems are applicable.

Fuel Form

Present operations such as found in Bolinao, cut the wood to short lengths (80 cm) for hauling on the Lasso monocable. An attempt should be made to keep the pieces as large as possible for as long a period of time through the system as possible. This will reduce the handling of so many pieces.

If the system requires size reduction it should only be made at the point of necessity. Therefore, wood should be transported to the monocable in the biggest piece possible.

For hand-logging I have estimated an individual maximum-piece size of 10 cm x 2.7 m or approximately .02 m^3. The estimated load for a carabao is 10 pieces, 10 cm x 8.1 m or .8 m^3. Such a piece would be considered tree length. Loading of the feeder winches will be dependent upon the situation. Total tree harvesting should be attempted whenever possible to reduce handling costs and wood loss during transport.

The swing operations should be moving whole stems whenever possible. Carabao swings will limit production because of speed and load.

Plant Location

The location of the plants has been primarily identified from available water sources. We think it was wise to locate the plants downhill from the plantations where possible. This allows gravity cable systems to be used in some cases; thus, keeping equipment costs down.

HARVEST PLANS FOR SELECTED SITES

General Comments

Four sites were selected by NEA for relatively intense planning efforts. These sites were:

Catanduanes (FICELCO), Virac

Panay (ILECO II), Lambunao

Marinduque (MARELCO), Buena Vista

Mindoro (OMECO), Magsaysay

(Figure 12)

The plans were developed primarily from topographic maps after an on-the-ground reconnaissance visit had been made to the area. Computer profile analysis was used selectively to indicate loading since most of the maps were inadequate for more refined payload analysis. The maps available were 1:10,000 enlarged from 1:50,000. The contour interval was 20 meters.

Previous planning efforts were restricted to plantation boundary identification and location of Lasso monocable installations on some sites. Lasso locations were identified for the Catanduanes, Marinduque, and Lambunao sites (Lasso, Yang, 1984).

Harvest plans were developed for feeder winches in each of the monocable locations. In addition to these three options, comparison plans were developed for

Catanduanes -

1) Cable swing to the plant site

2) Cable swing to the Pajo River for river transport to the plant site

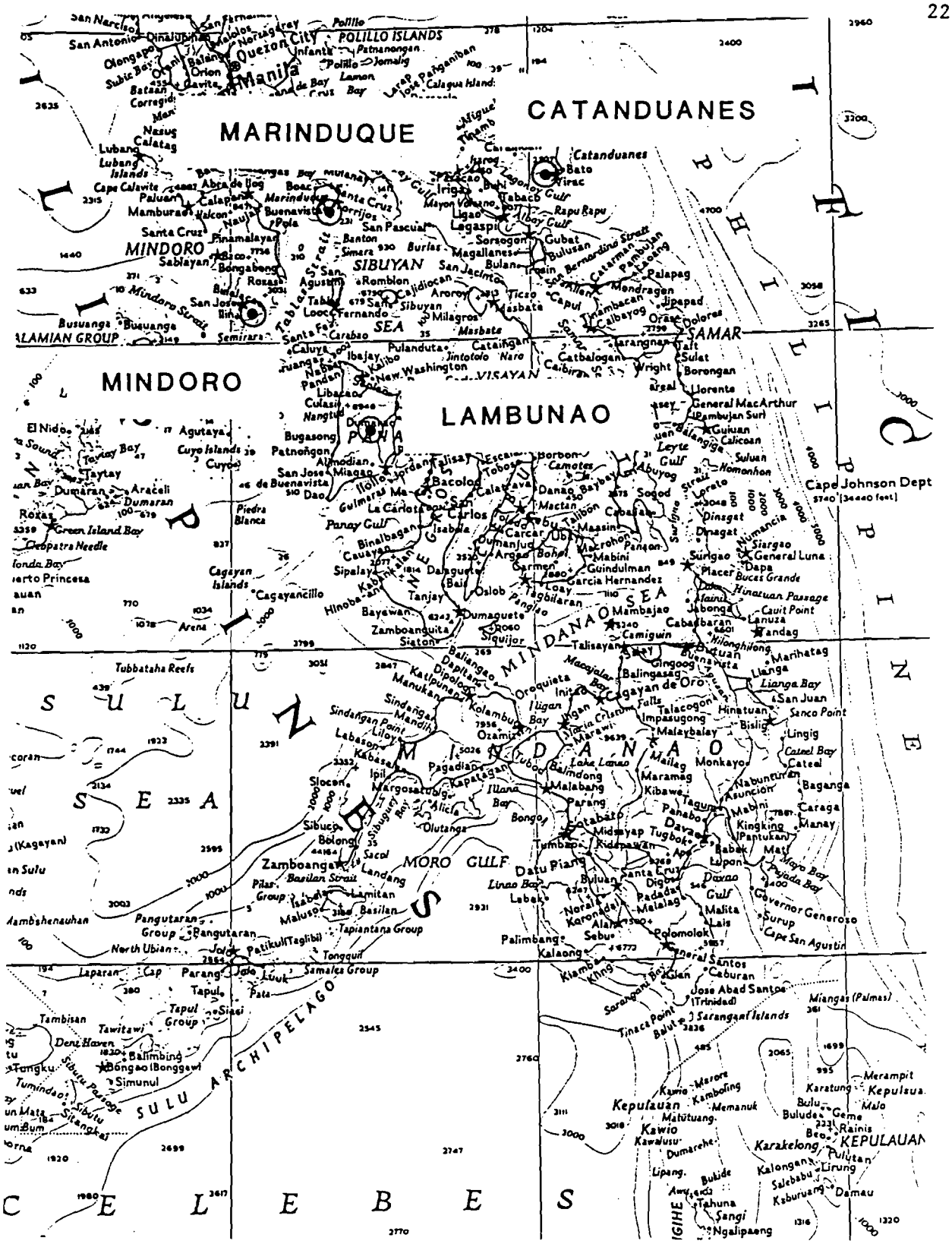


Figure 12. Harvest plan sites.

Marinduque -

1) Cable swing to a constructed road network for truck haul to the plant site.

Also, because of the relatively gentle access and isolated steep areas encountered on Mindoro, a roaded plan was designed for this site.

Costs and manpower requirements were generated for each option. These costs and production rates were developed from information gathered from field sources, literature, and personal experience, and are subject to discussion and revision if necessary. Consistency of application should allow the readers to compare harvest techniques even if some of the production rates or costs are questionable.

Equipment costs are subject to change, but in every case the value used in the analysis has been stated. The monocable costs were gathered from invoices supplied by Lasso or NEA. The Hinteregger feeder winches previously recommended were not used in the analysis primarily because the prices for comparable Japanese winches were much less (Nagaoka, 1984). All cost analysis was done using Iwafuji winches, although a wide range of winches and carriages is available on the market even in the Philippines. These include Koller, Gantner, and Hinteregger (see Machine Costs, Appendix).

The purpose of the harvest plans is more one of presenting some options for comparison rather than selection of the optimum technique. The optimum selection cannot be made without an intensive field study or at least without the availability of accurate topographic maps and aerial photographs.

Scheduling of operations is going to be a major task. That is why all costs and production requirements are based on the assumption that any one unit can be harvested individually and not in conjunction with another unit. Operationally this is not a desirable action; however, due to the random planting and module design, uniform coordination of operation may not be possible.

Because of these conditions, cost may be unnecessarily higher. An example can be illustrated by looking at Catanduanes II (Figure 13). Assume the trees in Unit 37 were ready to harvest, but the stand in Unit 34 had just been planted. To harvest U37 the skyline across U34 would be needed to swing the U37 wood to the Pajo River. At a later date, this skyline would need to be re-installed to harvest U34. Sequential planting and harvesting would greatly reduce costs. In this analysis a "worst case" condition is predicted.

Catanduanes I, II, III

Three distinctly different plans were generated for the FICELCO site (Figure 14). Two were based upon cable winch yarding and swings and one was based on the monocable system with feeder winches.

Alternative I (Figure 15) was a series of cable yarding units with cable swings to a short haul road. The system required many man-days of cable setup and rigging (Table 1), primarily due to the erection of the numerous swings, 6536 man-days.

The advantages presented by this alternative is that there is relatively little initial investment in equipment. The portable sled winches can be moved about to wherever there is available wood, on or

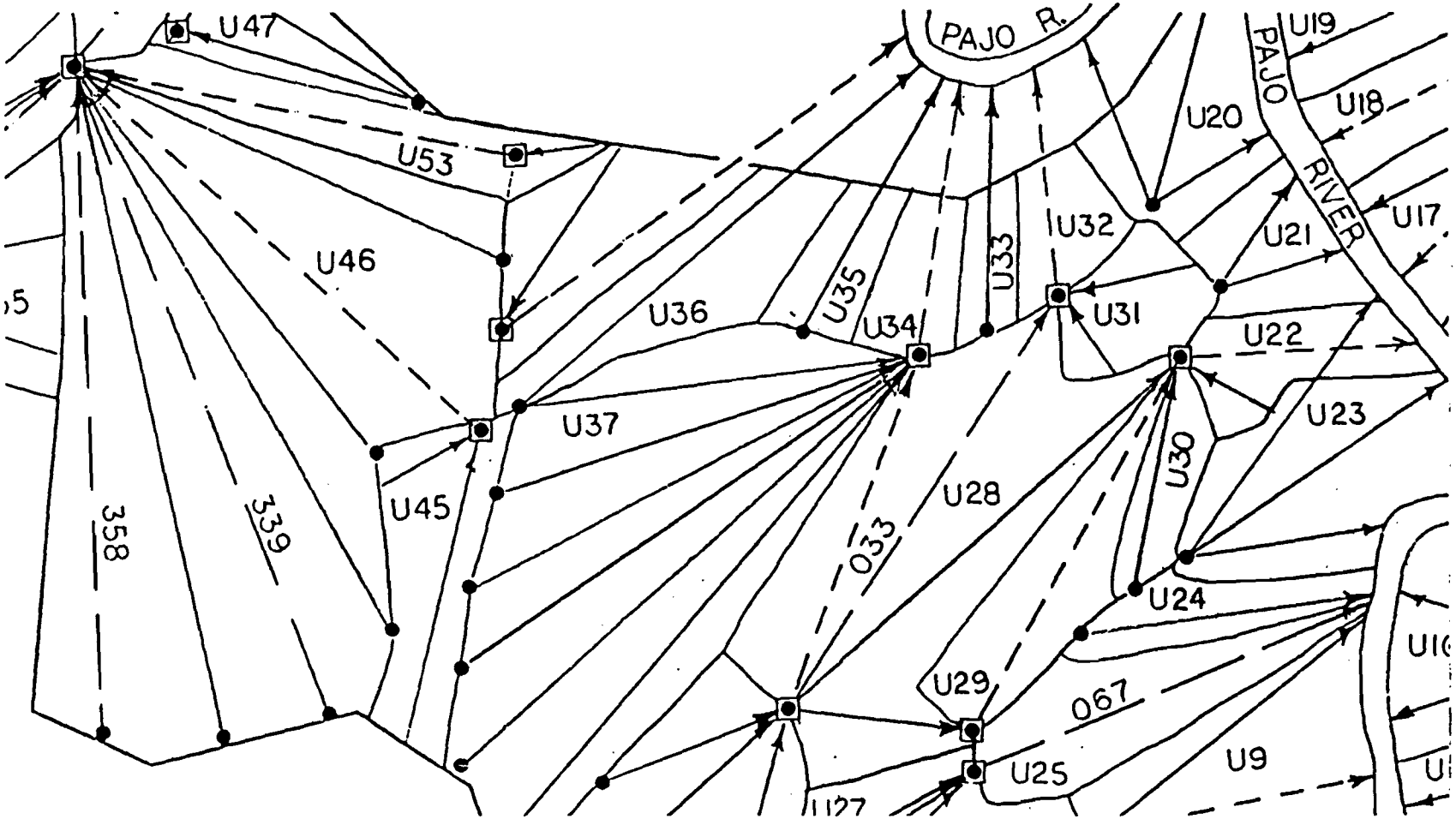


Figure 13. Sequential harvesting, Catanduanes II, Units 37 and 34.

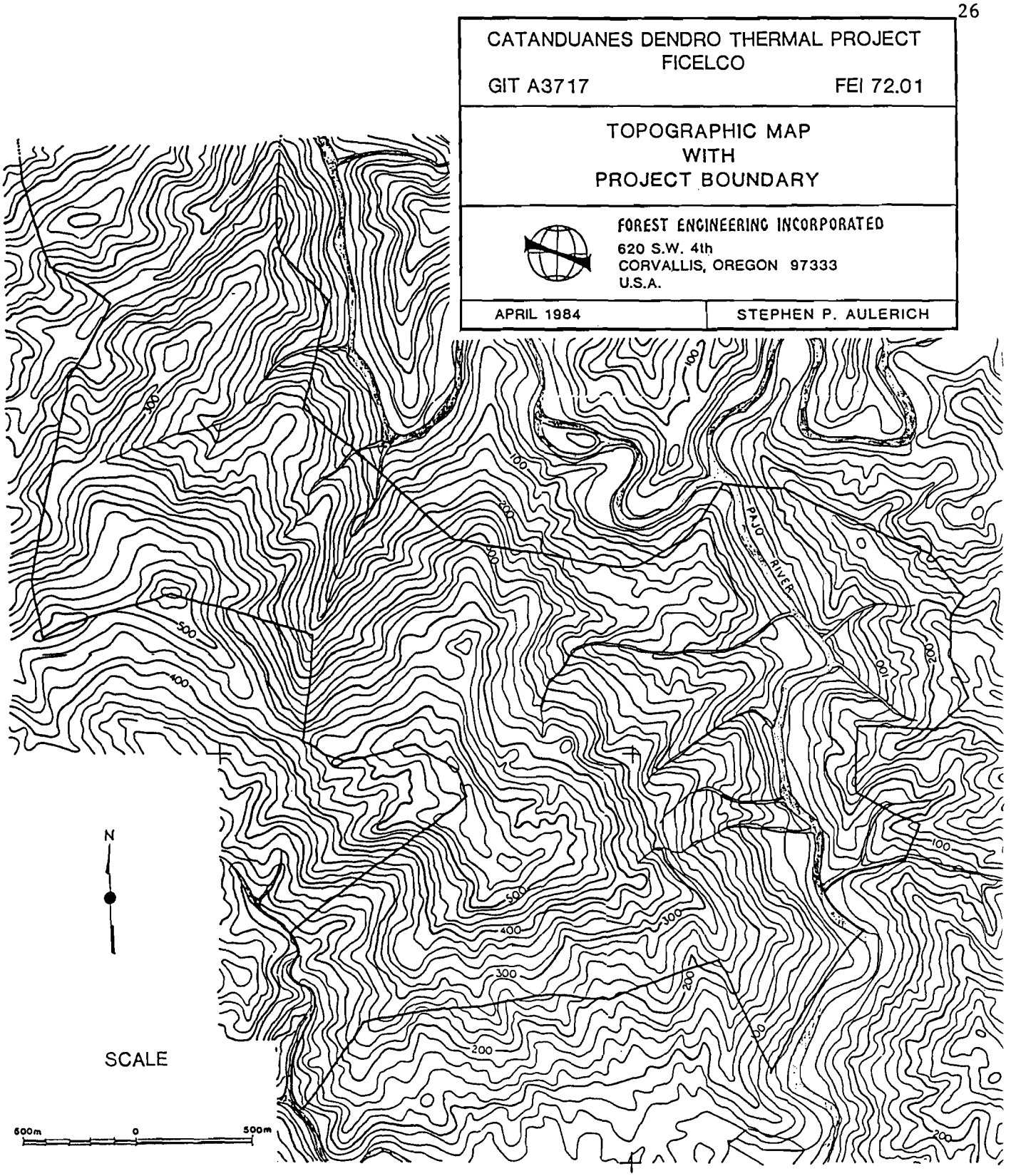


Figure 14. Topographic map, Catanduanes FICELCO Project.

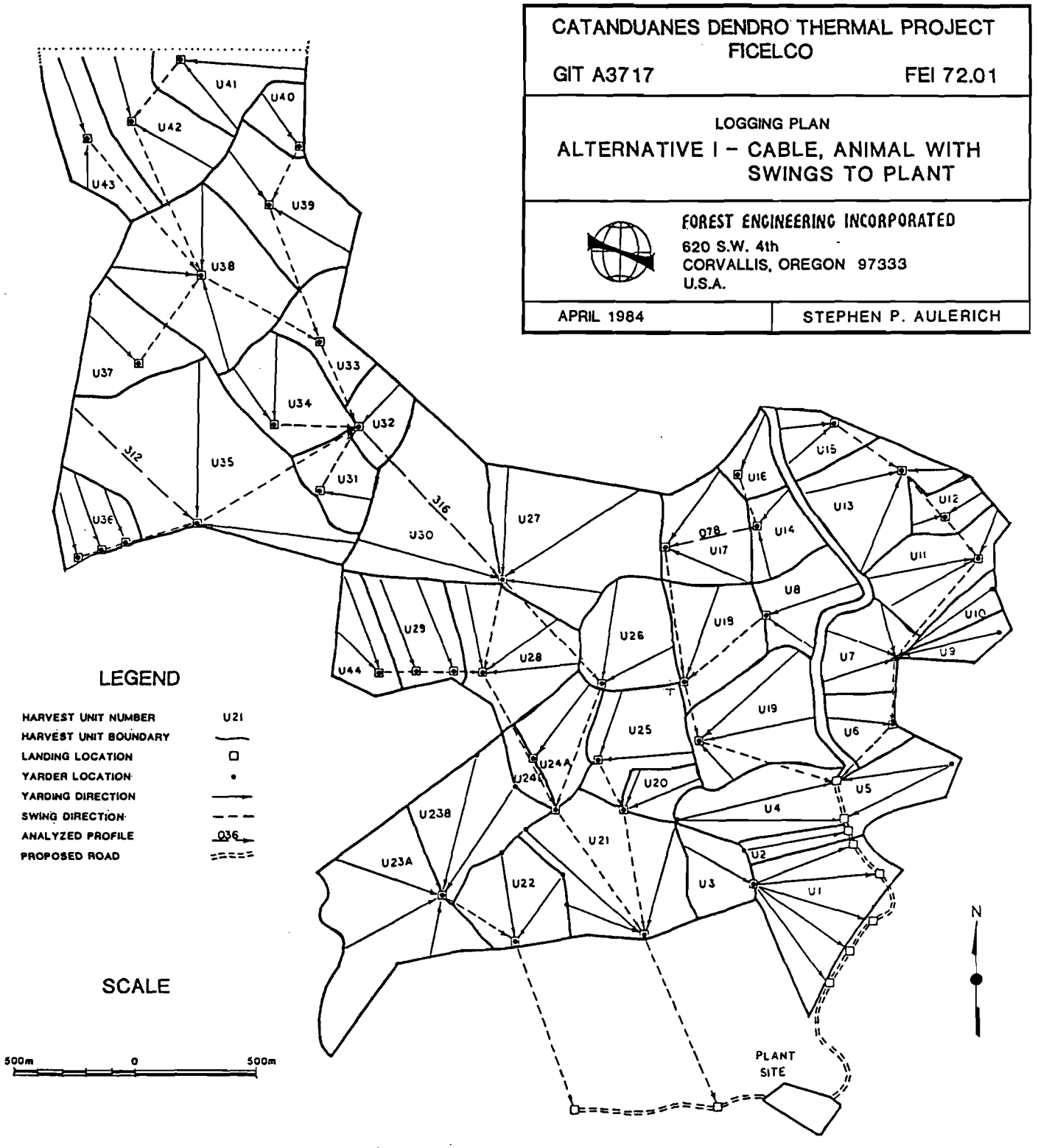


Figure 15. Harvest Plan, Alternative I, Catanduanes.

Table 1. HARVEST PLAN SUMMATION

LOCATION CATANDUANES ALTERNATIVE I

Area 743.06 hectares

Harvest Units:	46	Hectares
Hand	-	-
Animal	6	61.81
Cable	40	681.25

ROADS: 2.75 km

SWINGS:	Number	Distance (meters)
Animal	-	-
Cable	179	100,480

Yarder Setups 187

LABOR:	Crew-days [1/]	Man-days
Cutting	1,952	1,952
Yarding		
Hand	-	-
Animal	289	289
Cable	1,108	4,432
Swinging		
Animal	-	-
Cable	1,634	6,536
Hauling		
Truck	1,153	1,153
Monocable	-	-
Loading	1,153	2,306
TOTAL		16,668

[1/]
Cutting	1-man crew	
Yarders	4-man crew	
Animal	1-man crew	
Trucking	1 man	2 loaders
Monocable	1 man	2 loaders

Table 2. Unit Statistics, Catanduanes I

LOCATION CATANDUANES I, Virac SYSTEM Cable, Animal with swings to plant

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
1	23.86	5	190	DC[a]	5			1.00	63	38		
2	4.27	62	265	DC[a]	1			1.50	11	7		
3	8.84	38	218	DC	3			1.00	23	15		
4	17.67	54	213	DC[a]	2			1.65	46	26		
5	12.39	25	142	DA	2			1.65	33	30		
6	8.21	50	175	UC	3	1C	340	1.75	22	14	6	13
7	11.90	47	199	UC	4	2C	340/280	1.75	31	20	11	19
8	12.01	35	221	UC	6	3C	480/270/600	1.75	32	11	19	19
9	4.63	18	311	DA	1	2C	340/280	1.75	12	25	7	7
10	4.69	20	368	DA	1	2C	340/280	1.75	12	30	7	8
11	16.10	53	358	UC[a]	7	3C	340/280/550	1.75	42	31	21	26
12	5.60	30	107	UC	4	4C	480/280/550/220	1.75	15	11	15	9
13	19.77	45	249	UC[a]	7	5C	340/280/550/220/260	1.75	52	34	34	32
14	8.51	60	184	UC	5	4C	400/500/270/600	1.75	22	16	20	14
15	7.52	56	180	UC	3	6C	340/280/550/220/260/350	1.75	20	13	23	12
16	5.84	43	132	UC	3	5C	220/400/480/270/600	1.75	15	10	19	9
17	16.27	10	224	DA	7	3C	480/270/600	1.75	43	62	23	26
18	17.33	36	287	UC[a]	6	2C	270/600	1.75	46	31	18	28
19	23.57	44	334	UC[a]	7	1C	600	1.75	62	41	17	38
20	5.41	56	206	UC	2	2C	550/790	.35	14	9	11	8
21	31.16	51	411	DC[a]	6	1C	790	.35	82	51	24	47
22	15.88	40	237	DC	5	1C	750	1.00	42	27	14	25
23A	34.89	33	368	UC[a]	7	2C	370/750	1.00	92	57	35	55
23B	20.64	25	382	DC[a]	4	2C	370/750	1.00	54	135	23	32
24A	12.33	38	204	UC	2	3C	250/660/800	.35	32	19	23	19
24B	3.19	0	120	DA		3C	250/660/800	.35	8	7	12	5
25	16.65	30	237	UC	4	3C	240/550/800	.35	44	27	27	26
26	16.85	54	298	UC[a]	4	3C	570/660/800	.35	44	28	32	26
27	37.62	41	430	UC[a]	6	5C	400/430/240/660/800	.35	99	60	74	57
28	22.71	16	240	UC	6	4C	430/240/660/800	.35	60	37	43	35
29	14.16	52	237	UC	2	5C	200/430/240/660/800	.35	37	22	34	22
30	32.23	44	495	UC[a]	6	5C	400/430/240/660/800	.35	85	54	65	49
31	9.17	70	184	UC	3	6C	300/890/640/570/660/800	.35	24	15	39	14
32	7.67	61	166	UC	3	5C	890/640/570/660/800	.35	20	13	32	12
33	10.78	40	167	UC	3	6C	890/640/570/660/800/400	.35	28	17	43	16
34	17.20	33	211	UC	5	6C	890/640/570/800/340	.35	45	28	59	26

Table 2. - continued

LOCATION CATANDUANES I, Virac SYSTEM Cable, Animal with swings to plant 2 OF 2

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
35	55.59	44	434	UC[A]	7	6C	890/640/570/660/800/790	.35	146	87	166	83
36	9.75	40	215	UC	3	7C	890/640/570/660/800/790/400	.35	26	16	48	13
37	15.11	21	179	UC	4	8C	460/570/400/890/640/570/660/800	.35	40	24	68	23
38	35.53	30	240	UC	8	7C	570/400/890/640/570/660/800	.35	93	57	118	54
39	23.71	45	226	UC	7	7C	610/400/890/640/570/660/800	.35	62	40	86	36
40	5.41	30	195	UC	2	8C	270/610/400/890/640/570/660/800	.35	14	9	38	8
41	14.64	38	267	UC[A]	2	9C	330/710/570/400/890/640/570/660/800	.35	38	22	74	22
42	20.55	40	232	UC	4	8C	710/570/400/890/640/570/660/800	.35	54	32	88	31
43	16.22	43	221	UC	3	8C	760/570/400/890/640/570/660/800	.35	43	25	75	25
44	9.03	38	200	UC	2	5C	440/430/240/660/800	.35	24	14	27	14

1/ See page iii for symbol description.

Table 3. ESTIMATED HARVEST COSTS

LOCATION CATANDUANES ALTERNATIVE I

CUTTING

44,584 m^3 @ ₱ 5 /m^3 = ₱ [1/] 222,920

ROADS

Low standard:	-	km	@ ₱	-	/km	= ₱	-
High standard:	2.75	km	@ ₱	250,000	/km	= ₱	687,500

YARDING

Hand:	₱ -	/day x	-	days	= ₱	-
Animal [2/]:	₱ 122	/day x	289	days	= ₱	35,258
Small winch:	₱ 696	/day x	406	days	= ₱	282,576
Large winch:	₱ 1,816	/day x	702	days	= ₱	1,274,832
Crew:	3 men x ₱ 72	/day x	1,108	days	= ₱	239,328

SWINGING

Animal:	₱ -	/day x	-	days	= ₱	-
Large winch:	₱ 1,816	/day x	1,634	days	= ₱	2,967,344
Crew:	3 men x ₱ 72	/day x	1634	days	= ₱	352,944

LOADING

2 men x ₱ 72 /day x 1,153 days = ₱ 166,032

HAULING

Truck:	₱ 1,072	/day x	1,153	days	= ₱	1,236,016
Monocable:	₱ -	/day x	-	days	= ₱	-

Total Estimated Cost	= ₱	7,464,750	
Volume Harvested	=	44,584	m^3
Cost/m^3	= ₱	167.43	/m^3
Cost/tonne	= ₱	209.29	/ton

[1/] ₱14 = $1 (US)

[2/] ₱50/day Carabao, ₱72/day man

[3/] 1 m^3 = .80 tonnes

off the site. Stockpiling of resource can be done prior to completion of the power plant. Above all, flexibility of the operation is possible. The yarding operation can take advantage of different maturity levels of the different stands. Also, if fire or other events change the availability of wood fiber the yarding system can adjust.

Alternative II (Figure 16) is similar to I in that swings are used with small yarding winches. The primary difference is that the Pajo River is the main transportation mode. Verification of the floatability of ipil ipil was not done nor was the navigability of the river investigated, but rainfall rates are sufficient to consider this method as an alternative (Molina, Dugan, 1984).

Initial studies conducted early in the project (author unknown) suggested that this technique be used especially for the remote areas east of the river (Trans Asia Engineering, 1982).

The major disadvantage of both Alternatives I and II are the necessity of the operators to know cable logging techniques. A training program in the use of simple cable systems will need to be developed to provide safe and efficient operations. Both alternatives require high man-power rates (Tables 1 and 4).

As in the case of Alternative I, Alternative II offers a flexible system that can be moved to where the wood is available. Another advantage is that cable winches can be used for jobs other than just transporting fuel wood.

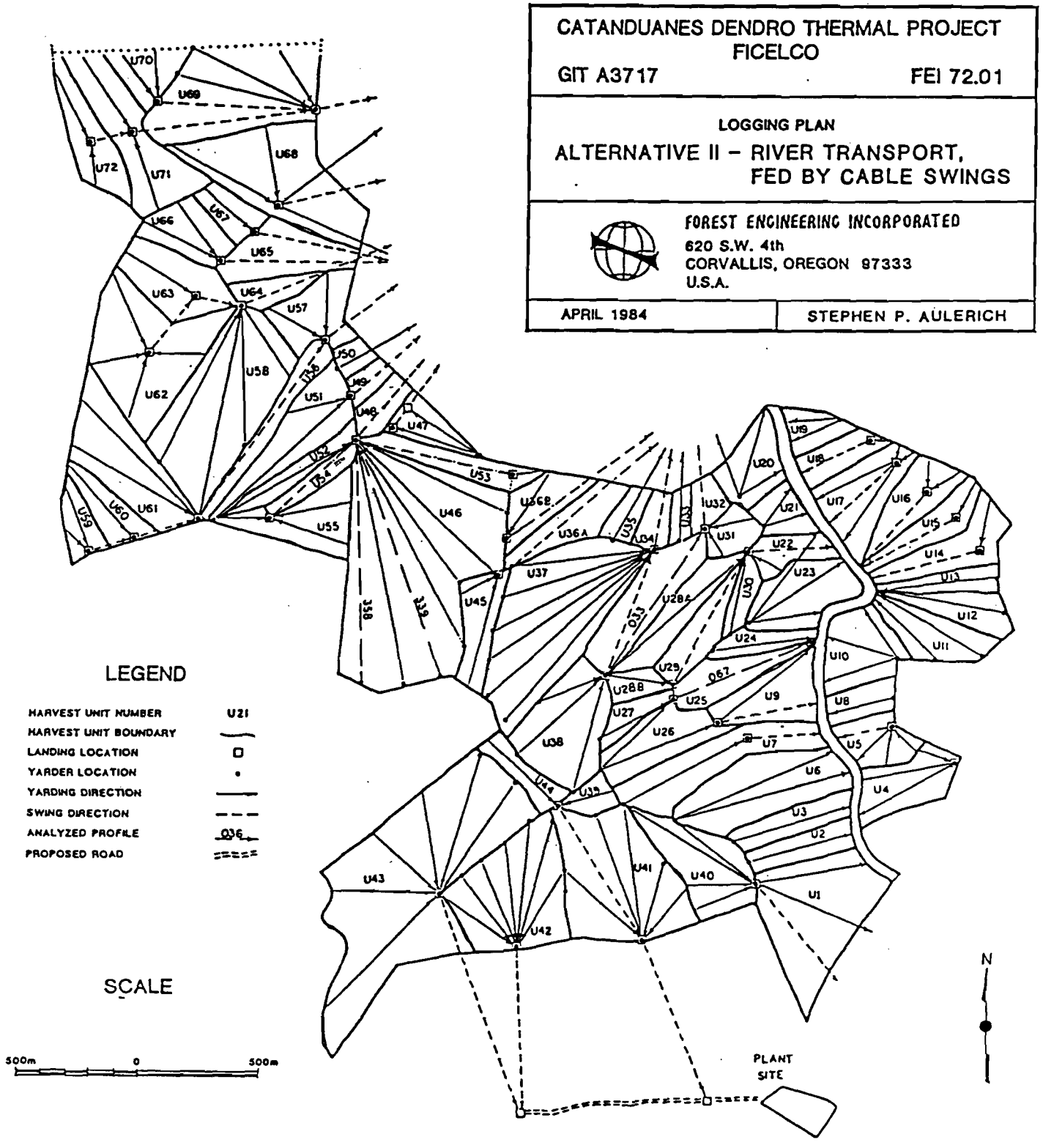


Figure 16. Harvest Plan, Alternative II, Catanduanes.

Table 4. HARVEST PLAN SUMMATION

LOCATION CATANDUANES ALTERNATIVE II

Area 727.78 hectares

Harvest Units:	74	Hectares
Hand	-	-
Animal	-	-
Cable	74	727.78

ROADS: 1.15 km

SWINGS:	Number	Distance (meters)
Animal	-	-
Cable	60	31,170

Yarder Setups 174

LABOR:	Crew-days [1/]	Man-days
Cutting	1,880	1,880
Yarding		
Hand	-	-
Animal	-	-
Cable	1,191	4,764
Swinging		
Animal	-	-
Cable	483	1,932
Hauling		
Truck	166	166
Monocable	-	-
Loading	166	332
TOTAL		9,074

1/
Cutting	1-man crew	
Yarders	4-man crew	
Animal	1-man crew	
Trucking	1 man	2 loaders
Monocable	1 man	2 loaders

Table 5. Unit Statistics, Catanduanes II

LOCATION CATANDUANES II SYSTEM River transport, fed by cable swings

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	PRODUCTION REQUIREMENTS			
									CUTTING (man-days)	YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
1	21.31	52	181	DC	4				56	33		
2	5.21	62	259	DC*	1				14	8		
3	5.93	64	297	DC*	1				16	9		
4	8.55	30	134	DC	3				22	14		
5	5.85	70	81	UC	2	1C	220		15	9	4	
6	16.35	53	226	DC	2				43	25		
7	13.20	53	340	DC*	2	1C	300		35	21	8	
8	4.29	48	155	DC	1				11	7		
9	9.20	53	154	DC	3				24	15		
10	9.80	47	105	DC	3				26	16		
11	7.78	32	308	DC*	1				20	12		
12	4.09	49	295	DC*	1				11	7		
13	3.97	48	277	DC*	1				10	7		
14	8.46	53	255	DUC*	2	1C	450		22	14	6	
15	5.68	42	228	DUC	2	1C	440		15	10	5	
16	6.88	43	139	DUC	3	1C	420		18	12	5	
17	9.88	47	115	DUC	5	1C	380		26	17	7	
18	4.63	48	177	DC	2	1C	320		12	8	4	
19	3.88	64	78	DC	2				10	7		
20	7.31	35	141	DC	3				19	12		
21	4.25	70	70	DC	2				11	7		
22	4.51	38	199	UC	2	1C			12	8		
23	10.74	33	148	DC	3				28	17		
24	3.47	43	245	DC	1				9	6		
25	7.29	36	433	DC*	1				19	11		
26	9.64	49	154	DC	2	1C			25	15		
27	3.27	83	261	DC*	2	1C	670		9	7	5	
28A	8.45	25	416	DC*	1	1C	370		22	13	6	
28B	2.72	80	192	DC	1	2C	650/370		7	5	7	
29	6.24	22	422	DC*	1	1C	370		16	10	5	
30	3.07	11	194	UC	1	1C	370		8	5	3	
31	3.74	9	130	UC	2	1C	350		10	7	4	
32	2.77	73	210	DC	1				7	5		
33	2.28	82	233	DC	1				6	4		
34	3.14	69	255	DC*	1				8	5		
35	2.76	38	235	DC	1				7	5		
36A	7.46	48	444	DC*	1				20	12		
36B	6.64	40	237	UC	2	1C	790		17	11		
37	30.99	28	527	DC*	6	1C	420		81	52	17	
38	15.54	40	313	DC*	3	2C	580/420		41	25	18	
39	2.79	17	154	UC	1	2C	680/720	.35	7	5	9	4
40	12.50	37	275	DC*	4	1C	500		33	22	10	
41	25.42	52	365	DC*	6	1C	720	.35	67	43	20	39
42	21.39	44	312	DC*	8	1C	700	1.15	56	39	17	34
43	51.31	65	317	UC*	7	1C	1000	1.15	135	81	44	81
44	5.08	0	200	UC	1	2C	680/720	.35	13	8	11	8
45	6.76	20	229	DC	2	1C	820		18	11	8	
46	55.77	22	649	DC*	7	1C	450		146	90	30	
47	5.15	35	146	DC	2	1C	330		14	9	4	
48	3.68	31	230	DC	1				10	6	14	

Table 5. - continued

LOCATION CATANDUANES II SYSTEM River transport, fed by cable swings 2 OF 2

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	PRODUCTION REQUIREMENTS			
									CUTTING (man-days)	YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
49	2.26	40	215	DC	1				6	4		
50	1.72	50	212	DC	1				5	3		
51	11.59	16	290	DC[A]	3	1C	390		30	19	7	
52	4.38	49	379	DC[A]	1	1C	450		12	7	4	
53	6.67	16	432	DC	2	1C	700		18	12	7	
54	3.36	42	260	DC[A]	1	1C	450		9	6	4	
55	9.55	63	234	UC	3	2C	500/450		25	16	12	
56	6.75	33	474	DC[A]	1	1C	400		18	11	5	
57	9.11	14	166	UC	2	1C	400		24	14	6	
58	26.50	33	458	DC[A]	5	1C	700		70	44	20	
59	3.82	48	145	UC	2	3C	480/920/400		10	7	12	
60	5.08	45	178	UC	1	3C	270/920/400		13	8	13	
61	15.32	40	430	UC[A]	2	3C	920/400		40	24	20	
62	21.98	34	200	UC	6	3C	310/200/700		58	36	27	
63	9.85	51	176	UC	2	2C	200/700		26	15	12	
64	3.72	40	171	DC	1				10	6		
65	10.64	36	358	DC[A]	2				28	17		
66	7.40	46	217	UC	2	1C	700		19	12	8	
67	3.83	61	164	UC	1	1C	580		10	6	.5	
68	22.49	53	265	UC[A]	1	1C	470		59	37	13	
69	23.44	12	370	UC[A]	5	1C	270		62	39	11	
70	5.43	48	171	UC	2	2C	670/270		14	9	9	
71	13.70	47	239	UC	2	2C	780		36	21	12	
72	8.17	50	166	UC	2	3C	180/780		21	13	11	

1/ See page iii for symbol description.

Table 6. ESTIMATED HARVEST COSTS

LOCATION CATANDUANES ALTERNATIVE II

CUTTING

43,667 m^3 @ ₱ 5 /m^3 = ₱ [1/] 218,335

ROADS

Low standard:	-	km	@ ₱	-	/km	= ₱ -
High standard:	1.15	km	@ ₱	250,000	/km	= ₱ 287,500

YARDING

Hand:	₱	-	/day x	-	days	= ₱	-
Animal [2/]:	₱	-	/day x	-	days	= ₱	-
Small winch:	₱	696	/day x	487	days	= ₱	338,952
Large winch:	₱	1,816	/day x	704	days	= ₱	1,278,464
Crew:	3 men x ₱	72	/day x	1,191	days	= ₱	257,256

SWINGING

Animal:	₱	-	/day x	-	days	= ₱	-
Large winch:	₱	1,816	/day x	483	days	= ₱	877,128
Crew:	3 men x ₱	72	/day x	483	days	= ₱	104,328

LOADING

2 men x ₱ 72 /day x 166 days = ₱ 23,904

HAULING

Truck:	₱	1,072	/day x	166	days	= ₱	177,952
Monocable:	₱	-	/day x	-	days	= ₱	-
Retaining boom:						₱	14,000
			Total Estimated Cost			= ₱	3,577,819
			Volume Harvested			=	43,667 m^3
			Cost/m^3			= ₱	81.93 /m^3
			Cost/tonne			= ₱	102.41 /ton

[1/] ₱14 = $1 (US)

[2/] ₱50/day Carabao, ₱72/day man

[3/] 1 m^3 = .80 tonnes

The third alternative, Alternative III (Figure 18), is a basic monocable installation powered by the dendro plant. The location of the proposed monocable would allow the farmers to attach bundles at any point in the system (Lasso, 1984).

The advantage of this system is that little scheduling of the transportation phase is required. The cableway can move in either direction.

The disadvantages of the monocable system are primarily threefold. First, the initial capital costs for equipment and installation can be high. The estimated price for the Catanduanes installation is ₱4,005,000.

The second disadvantage, and I feel this is the most important, is the permanency of the installation. If something, such as a fire, destroys part or all of the plantation, not only is the cableway in jeopardy, but it could not be quickly moved to another wood source. I feel that the plantation stability is enough in doubt that such an investment is questionable.

A third disadvantage is the limitations of the system. Much of the area cannot be accessed as noted earlier. High costs associated with feeding the cable may be incurred, although in this situation it was less expensive than the total swing system.

Lambunao I

Only one alternative was developed for the Lambunao site (Figure 20). This alternative was to use a monocable with winches and animals being the primary technique to get the wood to the cableway. The terrain had some relatively gentle ridges where animals could be used.

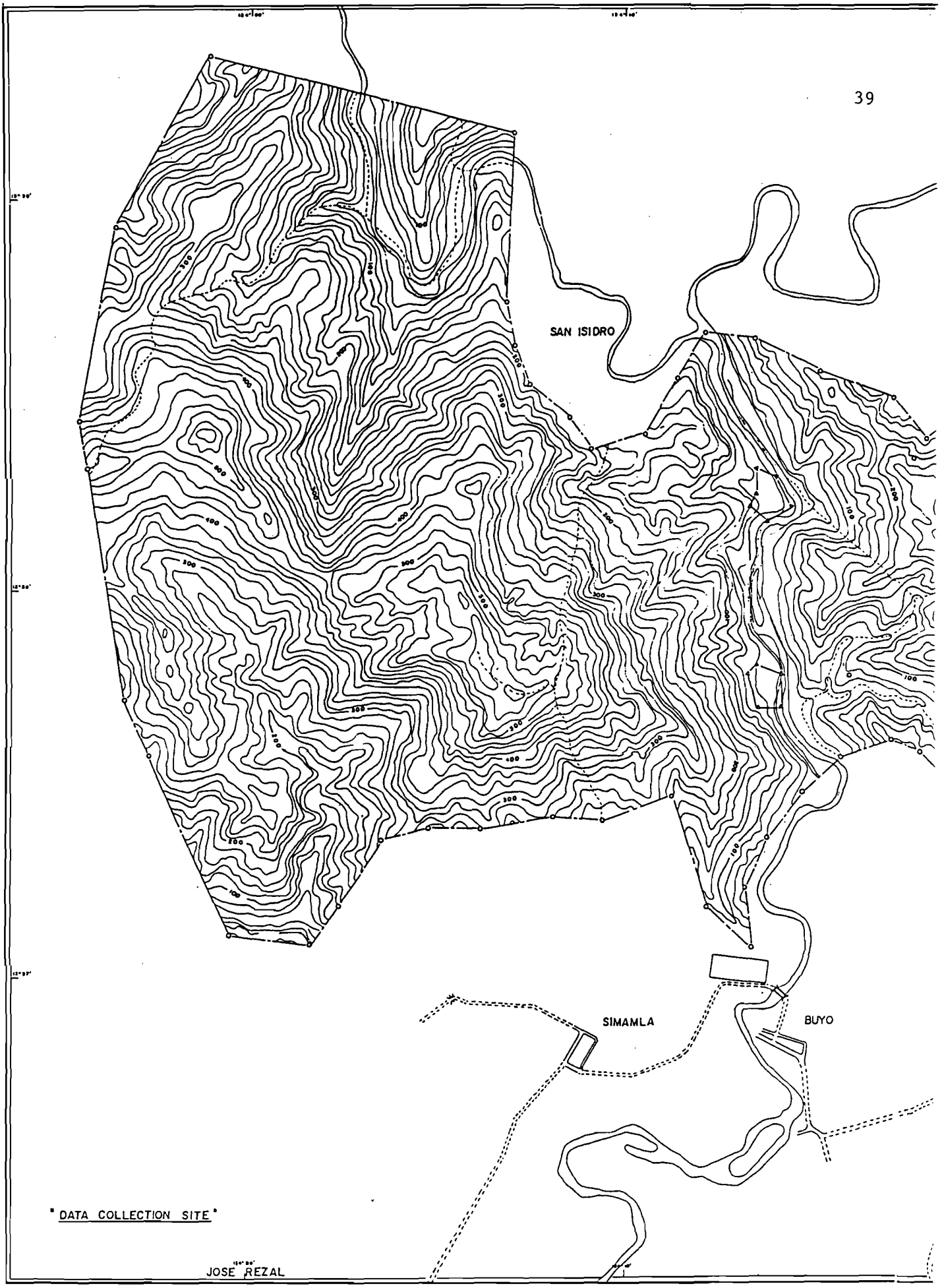


Figure 17. Topographic map, Alternative III, Catanduanes.

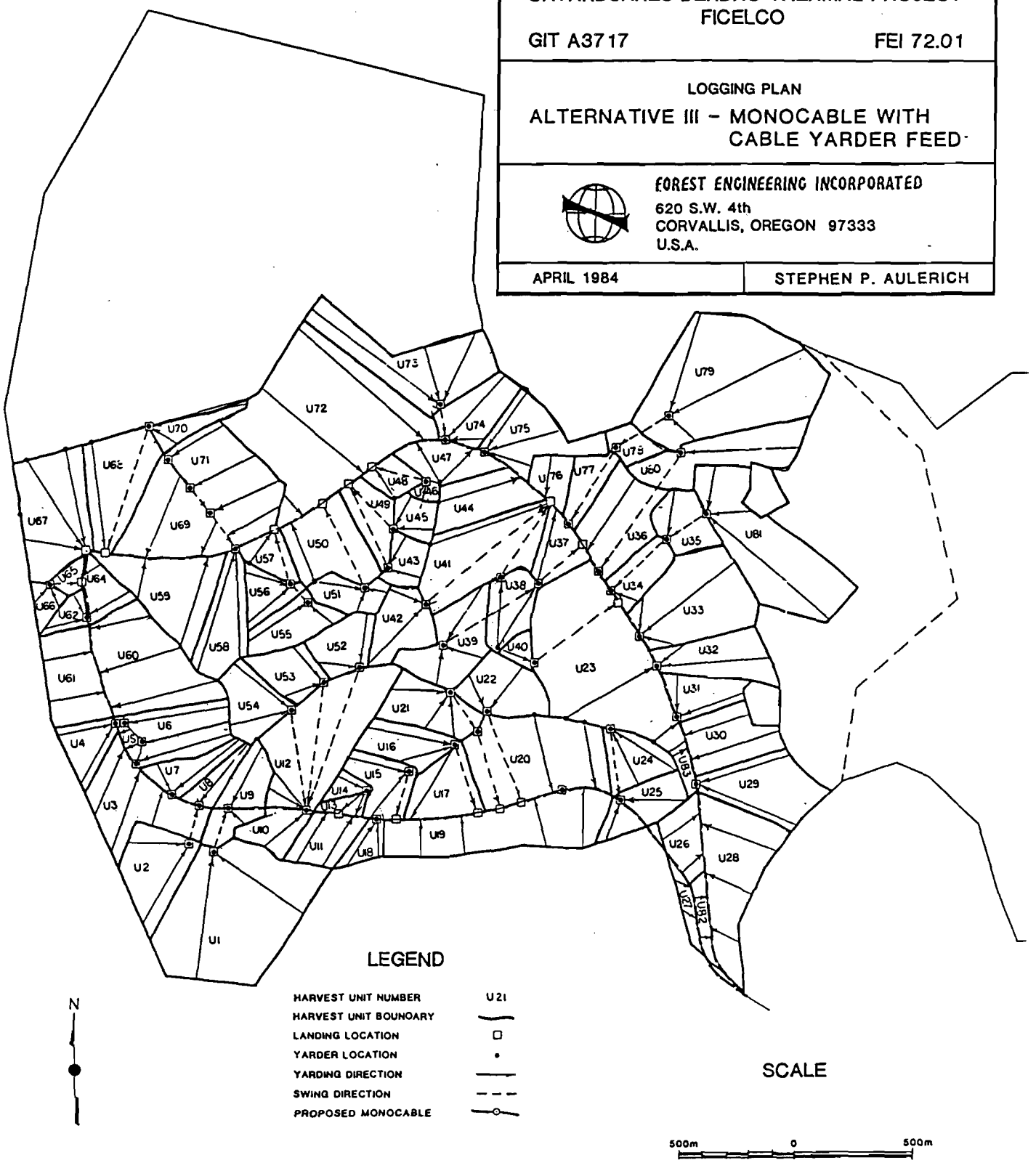


Figure 18. Harvest Plan, Alternative III, Catanduanes.

Table 7. HARVEST PLAN SUMMATION

LOCATION CATANDUANES ALTERNATIVE III

Area 708.4 hectares

Harvest Units:	82	Hectares
Hand	-	-
Animal	-	8.83
Cable	-	699.57

ROADS: 8.4 km (Monocable)

SWINGS:	Number	Distance (meters)
Animal	-	-
Cable	37	11,395

Yarder Setups _____

LABOR:	Crew-days [1/]	Man-days
Cutting	1,858	1,858
Yarding		
Hand	121	121
Animal	-	-
Cable	1,175	4,700
Swinging		
Animal	-	-
Cable	202	808
Hauling		
Truck	-	-
Monocable	671	671
Loading	671	1,342
TOTAL		9,500

[1/]
Cutting	1-man crew	
Yarders	4-man crew	
Animal	1-man crew	
Trucking	1 man	2 loaders
Monocable	1 man	2 loaders

Table 8. Unit Statistics, Catanduanes III

LOCATION CATANDUANES III SYSTEM Monocable with cable yarder feed

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
1	30.98	36	357	UC*	7	1C	180	2.7	81	52	13	31
2	9.99	42	230	UC	4	1C	180	3.0	26	18	6	11
3	12.50	35	132	UC	4			3.3	33	20		15
4	4.62	40	181	UC	2			3.6	12	8		6
5	1.43	14	35	DH	0			3.4	4	14		2
6	8.95	26	201	UC	2	/1C	80	3.4	24	14	5	11
7	4.28	14	152	UC	2			3.1	11	8		5
8	2.96	6	175	UC	1			3.0	8	5		3
9	6.80	13	134	UC	4			2.9	18	13		7
10	5.75	24	166	UC	3			2.5	15	10		5
11	5.63	32	131	UC	2			2.4	15	9		5
12	18.80	40	396	DC*	5			2.5	49	33		18
13	1.43	50	41	DH	0			2.4	4	18		1
14	1.42	80	119	UC	1	1C	140	2.3	4	3	3	1
15	5.93	52	173	UC	2	1C	200	2.1	16	10	5	4
16	6.02	56	258	UC*	2	1C	300	1.7	16	10	5	4
17	7.17	55	137	DC	3			1.8	19	12		5
18	2.65	40	138	UC	2			2.2	7	5		2
19	18.91	42	121	UC	6			1.6	50	31		11
20	19.77	63	414	DC	4			1.4	52	33		10
21	7.51	56	183	UC	4	2C	200/350	1.6	20	14	8	5
22	7.83	21	162	UC	4	1C	400	1.5	21	14	6	4
23	31.34	54	233	DC*	6			1.7	82	49		20
24	5.84	50	204	UC	2	1C	120	1.0	15	10	4	2
25	5.95	25	142	UC	3			1.0	16	11		2
26	4.33	32	95	UC	2			.7	11	7		1
27	2.31	27	57	UH	0			.3	6	49		1
28	15.93	50	307	UC	4			.5	42	27		3
29	11.48	57	356	UC*	3			1.0	30	20		4
30	8.63	60	204	UC	2			1.1	23	14		4
31	5.20	52	186	UC	2			1.3	14	9		3
32	8.35	49	312	UC*	2			1.5	22	14		5
33	15.96	43	323	UC*	4			1.7	42	27		10
34	4.59	33	158	UC	1			2.0	12	7		3
35	5.87	43	144	UC	3	1C	300	2.0	15	11	5	4
36	10.65	24	206	UC	2			2.0	28	17		8
37	5.01	44	99	DC	2			2.2	13	8		4
38	5.77	36	98	DC	2	1C	250	2.2	15	9	4	5
						2C	500/240	2.1	25	17	11	7
40	1.65	29	96	UC	1	1C	450	1.9	4	3	3	1
41	14.85	49	434	DC*	3			2.3	39	25		13
42	6.66	14	160	UC	4	1C	700	2.3	17	13	6	6
43	3.50	35	111	UC	2	1C	400	3.3	9	6	4	4
44	9.23	52	232	DC*	2			2.4	24	15		8
45	3.14	18	123	UC	2	1C	250	3.3	8	6	3	4
46	0.91	25	61	UC	1	1C	240	3.2	2	2	3	1
47	5.94	54	80	DC	3			2.9	16	10		6
48	2.84	26	114	DC	2			3.2	7	5		4
49	5.10	53	204	DC	2			3.3	13	9		6
50	10.24	46	167	DC	2			3.6	27	16		14

Table 8. - continued

LOCATION CATANDUANES III SYSTEM Monocable with cable yarder feed 2 OF 2

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
51	4.02	18	109	UC	3	1C	400	3.5	11	8	4	5
52	5.32	11	143	UC	2	1C	650	2.5	14	9	6	5
53	5.28	27	167	UC	3	1C	550	2.5	14	10	6	5
54	6.52	28	198	UC	3	1C	425	2.5	17	12	5	6
55	6.18	45	165	UC	3	2C	100/240	3.7	16	11	7	9
56	3.87	54	143	UC	2	1C	240	3.7	10	7	3	5
57	3.32	58	144	DC	2			3.7	9	6		5
58	8.35	41	347	UC*	2			3.9	22	14		12
59	12.68	41	162	UC	3			4.2	33	20		20
60	16.88	54	239	UC*	3			3.6	44	26		23
61	9.05	61	135	UC	3			3.6	24	15		12
62	1.93	32	92	UC	2			3.8	5	4		3
63	No unit											
64	3.99	50	93	UC	2			3.9	10	7		6
65	1.32	38	71	UC	1			4.0	3	2		2
66	2.00	48	111	UC	1	1C	130	4.0	5	3	3	3
67	14.41	42	268	DC*	5			4.1	38	25		22
68	11.86	35	332	DC*	2			4.2	31	19		19
69	12.71	43	190	DC*	3			4.3	33	20		20
70	3.21	56	221	UC*	2	1C	560	4.1	8	6	5	5
71	15.54	75	200	UC	4	2C	120/200	3.9	41	25	11	23
72	38.77	25	289	UC*	5			3.2	102	59		47
73	15.36	45	300	UC*	4	1C	160	2.9	40	26	7	17
74	6.52	48	208	UC	2			2.9	17	11		7
75	9.36	55	282	UC*	3			2.7	25	16		9
76	3.19	17	91	DC	1			2.3	8	5		3
77	3.74	13	156	UC	1			2.2	10	6		3
78	2.44	17	87	UC	2	1C	370	2.2	6	5	3	2
79	32.69	12	346	UC*	8	2C	300/370	2.2	86	55	24	27
80	11.56	14	225	UC*	3	1C	600	2.0	30	19	10	9
81	20.57	10	346	UC*	5	2C	200/300	1.9	54	35	15	15
82	2.26	55	40	DH				.3	6	25		1
83	1.40	83	39	DH				1.1	4	15		1

1/ See page iii for symbol description.

Table 9. ESTIMATED HARVEST COSTS

LOCATION CATANDUANES ALTERNATIVE III

CUTTING

42,504 m^3 @ ₱ 5 /m^3 = ₱ 1/ 212,520

ROADS

Low standard: - km @ ₱ - /km = ₱ -

High standard: - km @ ₱ - /km = ₱ -

YARDING

Hand:	₱	72	/day x	121	days =	₱	8,712
Animal 2/:	₱	-	/day x	-	days =	₱	-
Small winch:	₱	696	/day x	610	days =	₱	424,560
Large winch:	₱	1,816	/day x	565	days =	₱	1,026,040
Crew:	3 men x ₱	72	/day x	1,175	days =	₱	253,800

SWINGING

Animal:	₱	-	/day x	-	days =	₱	-
Large winch:	₱	1,816	/day x	202	days =	₱	366,832
Crew:	3 men x ₱	72	/day x	202	days =	₱	43,632

LOADING

2 men x ₱ 72 /day x 671 days = ₱ 96,624

HAULING

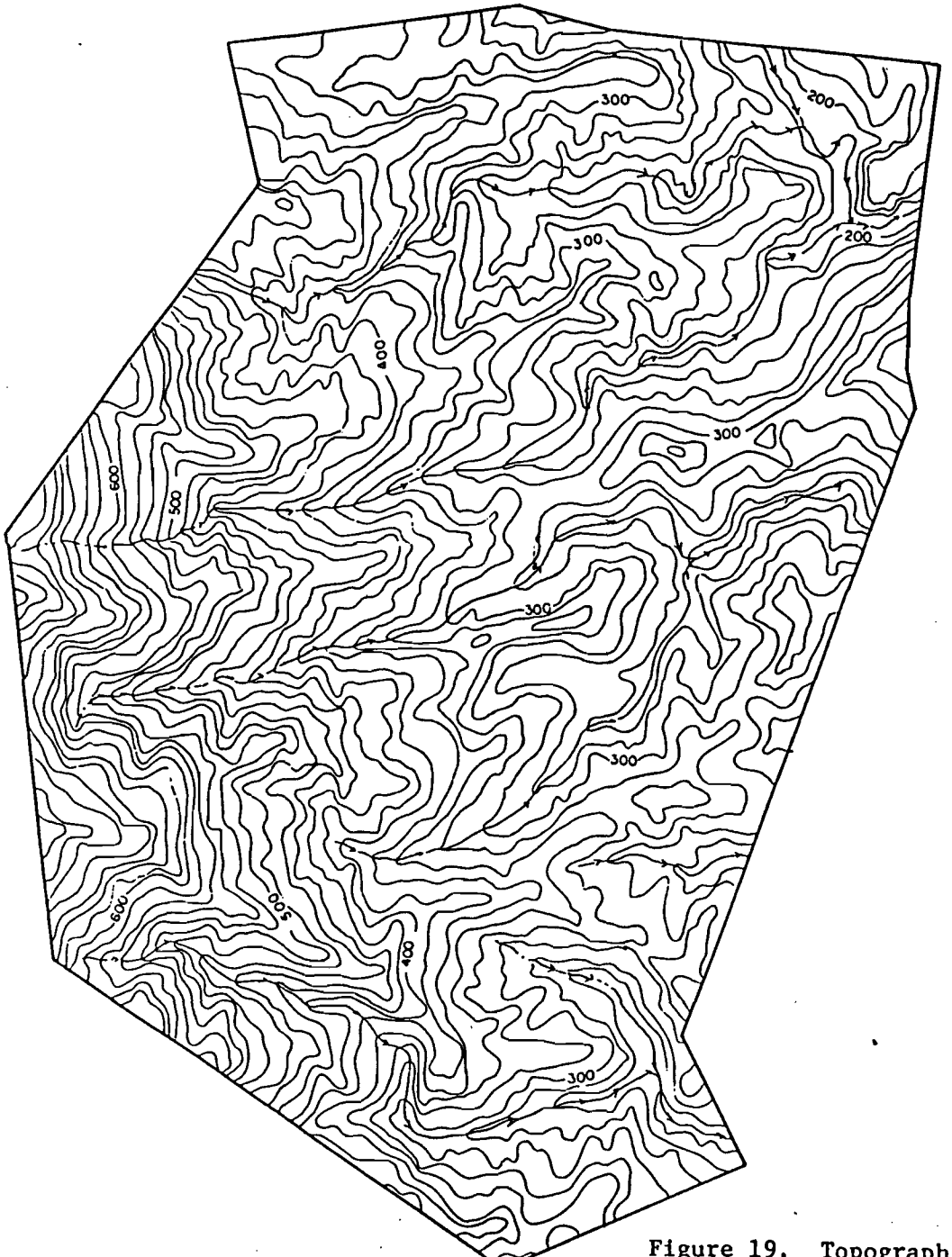
Truck:	₱	-	/day x	-	days =	₱	-
Monocable:	₱	4,808	/day x	671	days =	₱	3,226,168

Total Estimated Cost	=	₱	5,658,888
Volume Harvested	=		42,504 m^3
Cost/m^3	=	₱	133.14 /m^3
Cost/tonne	=	₱	166.43 /ton

1/ ₱14 = $1 (US)

2/ ₱50/day Carabao, ₱72/day man

3/ 1 m^3 = .80 tonnes



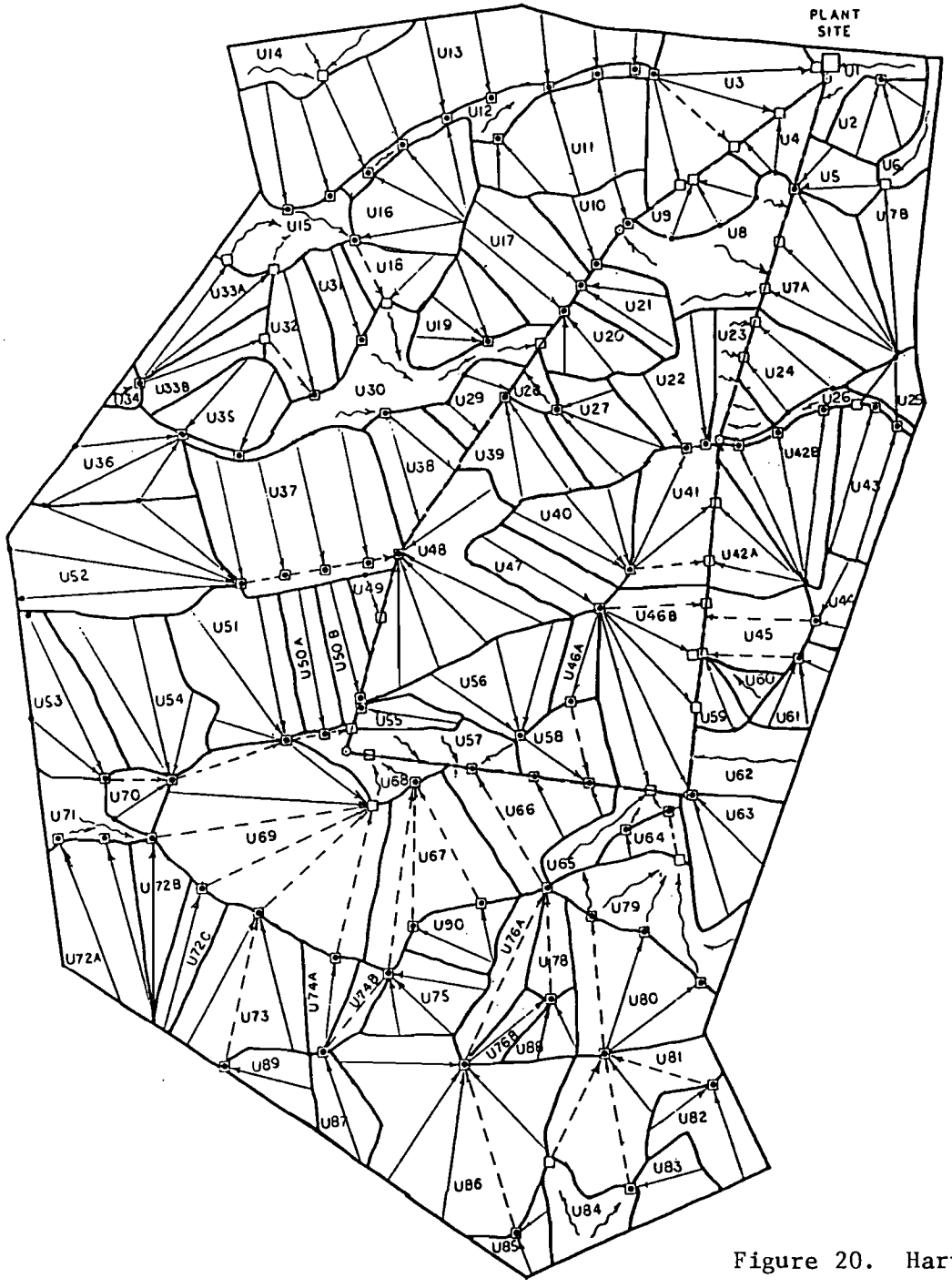
LAMBUNAO DENDRO THERMAL PROJECT IELCO II	
GIT A3717	FEI 72.01
TOPOGRAPHIC MAP WITH PROJECT BOUNDARY	
FOREST ENGINEERING INCORPORATED 620 S.W. 4th CORVALLIS, OREGON 97333 U.S.A.	
APRIL 1984	STEPHEN P. AULERICH

N

SCALE

500m 0 500m

Figure 19. Topographic map, Alternative I, Lambunao



LAMBUNAO DENDRO THERMAL PROJECT
IELCO II

GIT A3717 FEI 72.01

LOGGING PLAN

ALTERNATIVE I - MONOCABLE WITH CABLE AND ANIMAL FEEDING

FOREST ENGINEERING INCORPORATED
620 S.W. 4th
CORVALLIS, OREGON 97333
U.S.A.

APRIL 1984 | STEPHEN P. AULERICH

LEGEND

HARVEST UNIT NUMBER	U21
HARVEST UNIT BOUNDARY	
LANDING LOCATION	
YARDER LOCATION	
YARDING DIRECTION	
SWING DIRECTION	
PROPOSED MONOCABLE	

SCALE

500m 0 500m

Figure 20. Harvest Plan, Alternative I, Lambunao.

Table 10. HARVEST PLAN SUMMATION

LOCATION LAMBUNAO ALTERNATIVE I

Area 984.79 hectares

Harvest Units:	98	Hectares
Hand	-	-
Animal	19	129.65
Cable	79	855.14

ROADS: - km

SWINGS:	Number	Distance (meters)
Animal	43	17,940
Cable	61	25,080

Yarder Setups 194

LABOR:	Crew-days [1]	Man-days
Cutting	2,589	2,589
Yarding		
Hand	-	-
Animal	535	535
Cable	1,368	5,472
Swinging		
Animal	3,320	3,320
Cable	424	1,696
Hauling		
Truck	-	-
Monocable	737	737
Loading	737	1,474
TOTAL		15,823

[1] Cutting 1-man crew
Yarders 4-man crew
Animal 1-man crew
Trucking 1 man 2 loaders
Monocable 1 man 2 loaders

Table 11. Unit Statistics, Lambunao I

LOCATION LAMBUNAO I SYSTEM Monocable with cable and animal feeding

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
1	5.19	7	110	DA	0			.00	14	10		0
2	7.10	14	158	UC	3	1A	190	.00	19	12	23	0
3	21.25	22	152	DC*	4			.38	56	33		3
4	4.97	20	72	DC	2			.30	13	8		1
5	4.96	0	174	UC	2			.43	13	9		1
6	3.30	0	150	A	0	1C	310	.43	9	8	3	1
7A	17.63	26	192	DC*	3			.65	46	27		4
7B	9.00	19	189	DC*	1	1C	310	.43	24	13	6	1
8	15.40	16	125	DA	0			.62	40	33		4
9	6.29	20	135	UC	3			.62	17	11		1
10	6.69	32	105	UC	2			1.01	18	11		3
11	17.72	25	155	UC	4	1A/1C	290/350	.43	47	28	10C/88A	3
12	6.51	7	580	DA	0	1C	350	.43	17	65	5	1
13	40.74	13	151	UC	9	1A/1C	800/350	.43	107	64	20C/559A	7
14	8.03	0	100	A	0	1C/1A/1C	330/1030/350	.43	21	14	11C/142A	1
15	8.34	7	230	DA	0	1C/1A	230/700	1.40	22	33	5C/100A	4
16	14.10	26	112	UC	4	1A/1C	800/350	.43	37	22	8C/193A	2
17	12.76	4	240	UC*	2			1.21	34	20		6
18	5.83	23	139	UC	2	1A	700	1.40	15	10	70	3
19	9.11	17	172	UC	3	1A	190	1.40	24	15	30	5
20	6.97	16	188	UC	2			1.26	18	11		3
21	6.50	23	208	UC	2			1.15	17	11		3
22	10.26	20	240	UC*	2	1A	50	1.33	27	16	9	5
23	5.95	0	60	A	0			1.06	16	6		2
24	8.96	33	158	DC	2			.98	24	14		3
25	3.79	25	61	DC	2	1A	600	1.31	10	7	39	2
26	2.64	0	380	A	0			1.31	7	17		1
27	9.57	3	191	DC	3	1A	180	1.52	25	16	30	5
28	2.18	0	50	A	0			1.52	6	2		1
29	4.95	38	75	DC	2			1.69	13	8		3
30	17.12	20	612	DA	0			1.40	45	180		9
31	5.56	9	201	UC	1	1A	680	1.40	15	9	65	3
32	8.86	0	223	UC*	2	1A	830	1.40	23	14	126	5
33A	8.36	27	170	DC*	2	1A/1C/1A	380/230/700	1.40	22	13	5C/154A	4
33B	5.95	40	237	DC*	1	1C/1A	250/810	1.40	16	9	4C/83A	3
34	1.19	0	40	A	0	2C/1A	450/250/810	1.40	3	1	5C/17A	1
35	9.29	30	156	UC	2	1A	1300	1.40	24	15	207	5
36	12.71	36	268	DC*	3	1A	1400	1.40	33	21	305	7
37	31.00	9	205	DC*	4	1C	300	2.28	81	47	15	27
38	9.40	11	110	DC	2			2.04	25	14		7
39	9.78	6	236	UC	3			1.64	26	16		6
40	10.46	13	241	UC*	3	1C	270	1.72	27	17	6	7
41	13.29	2	131	DC*	3			1.53	35	21		8
42A	8.20	21	131	DC	2			1.63	22	13		5
42B	15.17	4	171	UC*	3	1A	220	1.31	40	24	57	7
43	10.23	6	250	UC*	2	1A	630	1.31	27	16	110	5
44	4.53	17	132	UC	2	1C	400	1.92	12	8	4	3
45	9.34	27	186	DC	2			1.96	25	15		7
46A	3.59	36	175	DC	5	1C	280	2.87	9	9	3	4
46B	22.57	33	182	DC*	1			2.22	59	32		19

Table 11. - continued

LOCATION LAMBUNAO I SYSTEM Monocable with cable and animal feeding 2 OF 2

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
47	8.09	4	240	UC*	1	1C	370	1.88	21	12	6	6
48	25.67	24	310	UC*	5			2.28	67	41		22
49	2.54	43	75	DC	1			2.51	7	4		2
50A	6.57	6	240	UC*	1	1C	90	2.90	17	10	4	7
50B	5.32	6	200	UC	1			2.79	14	8		6
51	17.62	6	320	UC*	3	1C	220	2.90	46	28	9	19
52	25.57	25	472	DC*	4	1C	550	2.28	67	41	17	22
53	12.00	12	288	DC*	2	3C	220/420/230	2.90	32	19	21	13
54	18.34	9	347	UC*	3	2C	420/230	2.90	48	29	20	20
55	3.44	26	140	UC	1			2.79	9	6		4
56	13.21	0	241	UC	3	1A	150	3.29	35	21	34	16
57	7.06	0	70	DA	0			3.33	35	19	8	9
58	7.42	29	174	DC	2			2.87	19	12		8
59	2.83	15	140	DC	1			2.05	7	5		2
60	2.10	15	200	DA	0			2.05	6	7		2
61	5.04	16	142	UC	3	1C	330	2.05	13	9	4	4
62	8.86	11	185	DA	0			2.40	23	28		8
63	11.15	11	249	UC	3			2.53	29	18		11
64	3.32	40	59	UC	2	1A	100	2.66	9	6	6	3
65	5.17	0	250	DA	0			2.66	14	22		5
66	13.17	2	330	DC*	3			3.14	35	22		16
67	18.15	0	318	DC*	3	1A	90	3.09	48	29	28	21
68	4.89	0	60	DA	0			3.09	13	5		6
69	41.42	31	417	DC*	7	1A	180	3.09	109	67	128	48
70	3.99	32	156	DC	2	2C	420/230	2.90	10	7	8	4
71	5.76	5	100	DA	0			3.09	15	10		7
72A	14.75	29	275	UC*	2	1A/1C/1A	230/760/180	3.09	39	23	13C/104A	17
72B	6.25	16	200	UC*	1	1C/1A	760/180	3.09	16	10	7C/19A	7
72C	5.26	2	250	UC*	1	1C/1A	650/180	3.09	14	8	6C/16A	6
73	17.74	2	295	DC*	3	1C/1A	530/180	3.09	47	28	13C/55A	21
74A	4.51	19	163	UC	1	1C/1A	520/180	3.09	12	7	5C/14A	5
74B	2.75	11	176	UC	1	1C/1A	650/90	3.09	7	5	5C/4A	3
75	8.47	39	196	UC	3	1C/1A	670/90	3.09	22	14	8C/13A	10
76A	6.94	3	300	DC*	1	1C	480	3.29	18	11	6	9
76B	2.71	21	180	DC	1	2C	370/480	3.29	7	5	6	3
77												
78	4.14	16	223	UC	1	1C	480	3.29	11	7	4	5
79	13.75	15	280	DA	0	1C/1A	150/80	2.66	36	66	7C/19A	14
80	17.10	4	135	UC*	3	1A/1C/1A	320/150/80	2.66	45	26	8C/117A	17
81	17.81	0	254	UC*	4	1C/1A	480/500	2.66	47	29	11C/153A	18
82	8.72	9	186	UC	2	2C/1A	380/480/500	2.66	23	14	13C/75A	9
83	5.08	24	160	UC	2	2C/1A	450/480/500	2.66	13	9	10C/44A	5
84	6.21	12	189	DA	0	2C/1A	450/480/500	2.66	16	20	10C/53A	6
85	3.84	43	105	UC	2	3C	590/650/480	3.14	10	7	14	5
86	36.46	0	308	UC*	7	2C	650/480	3.14	96	58	46	43
87	5.51	18	220	UC	1	2C/1A	350/650/80	3.09	14	9	10C/8A	6
88	3.67	15	133	DC	2	2C	370/480	3.29	10	7	8	5
89	4.94	40	220	UC	1	2C/1A	430/530/180	3.09	13	8	10C/15A	6
90	6.19	32	137	UC	2	1C/1A	480/80	3.09	16	10	5C/8A	7

1/ See page iii for symbol description.

Table 12. ESTIMATED HARVEST COSTS

LOCATION LAMBUNAO ALTERNATIVE I

CUTTING

59,087 m^3 @ ₱ 5 /m^3 = ₱ 1/ 295,435

ROADS

Low standard: - km @ ₱ - /km = ₱ -

High standard: - km @ ₱ - /km = ₱ -

YARDING

Hand:	₱	-	/day x	-	days =	₱	-
Animal 2/:	₱	122	/day x	535	days =	₱	65,270
Small winch:	₱	696	/day x	554	days =	₱	385,584
Large winch:	₱	1816	/day x	814	days =	₱	1,478,224
Crew:	3 men x ₱	72	/day x	1368	days =	₱	295,488

SWINGING

Animal:	₱	122	/day x	3320	days =	₱	405,040
Large winch:	₱	1816	/day x	424	days =	₱	769,984
Crew:	3 men x ₱	72	/day x	424	days =	₱	91,584

LOADING

2 men x ₱ 72 /day x 737 days = ₱ 106,128

HAULING

Truck:	₱	-	/day x	-	days =	₱	-
Monocable:	₱	5136	/day x	737	days =	₱	3,785,232

Total Estimated Cost	=	₱	7,677,969
Volume Harvested	=		59087 m^3
Cost/m^3	=	₱	129.94 /m^3
Cost/tonne	=	₱	162.43 /ton

1/ ₱14 = $1 (US)

2/ ₱50/day Carabao, ₱72/day man

3/ 1 m^3 = .80 tonnes

Many of the cableways were downhill which can cause some problems, but fuel usage should be less.

Much of the swings were done by animal with lower productivity, so scheduling will need to be carefully monitored.

Marinduque I, II

Two plans were developed for the MERELCO project on Marinduque (Figure 21). One alternative was designed to use a lower road network (Figure 22), whereas the second was a design to cable yard the wood to a Lasso monocable (Figure 23).

Alternative I required the construction of 7.8 kilometers of new road to tie together a network of access roads already in existence. The existing roads would require some reconstruction however, before being available for truck hauling.

One major cost associated with the Marinduque site is that the power plant is approximately 6 kilometers away from the plantation. Once the plantation has been harvested this extended haul is an additional burden (Losbaños, 1984) (Lasso, 1984).

The downhill nature of Alternative I would allow the maximum use of gravity. It would also facilitate using the gentle ground of the lower slopes for landings and roading.

These advantages, as well as offering additional access to the island, are major cost savings.

The disadvantages of Alternative I are the large number of swings required to get the wood from the remote units such as U64, 65, and 66 (Figure 22, Table 14) and the additional roading. The

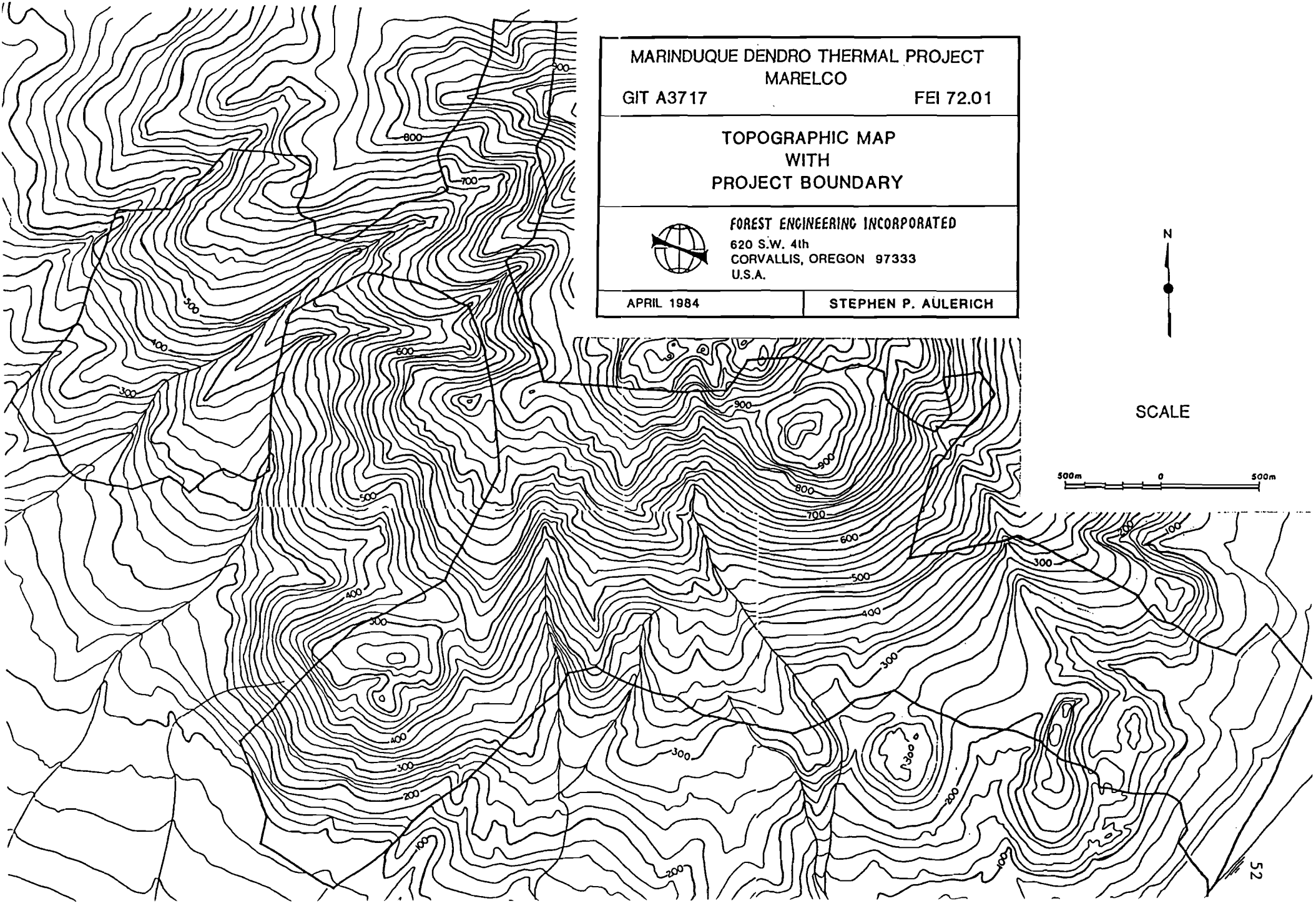


Figure 21. Topographic map, Marinduque, MARELCO project.

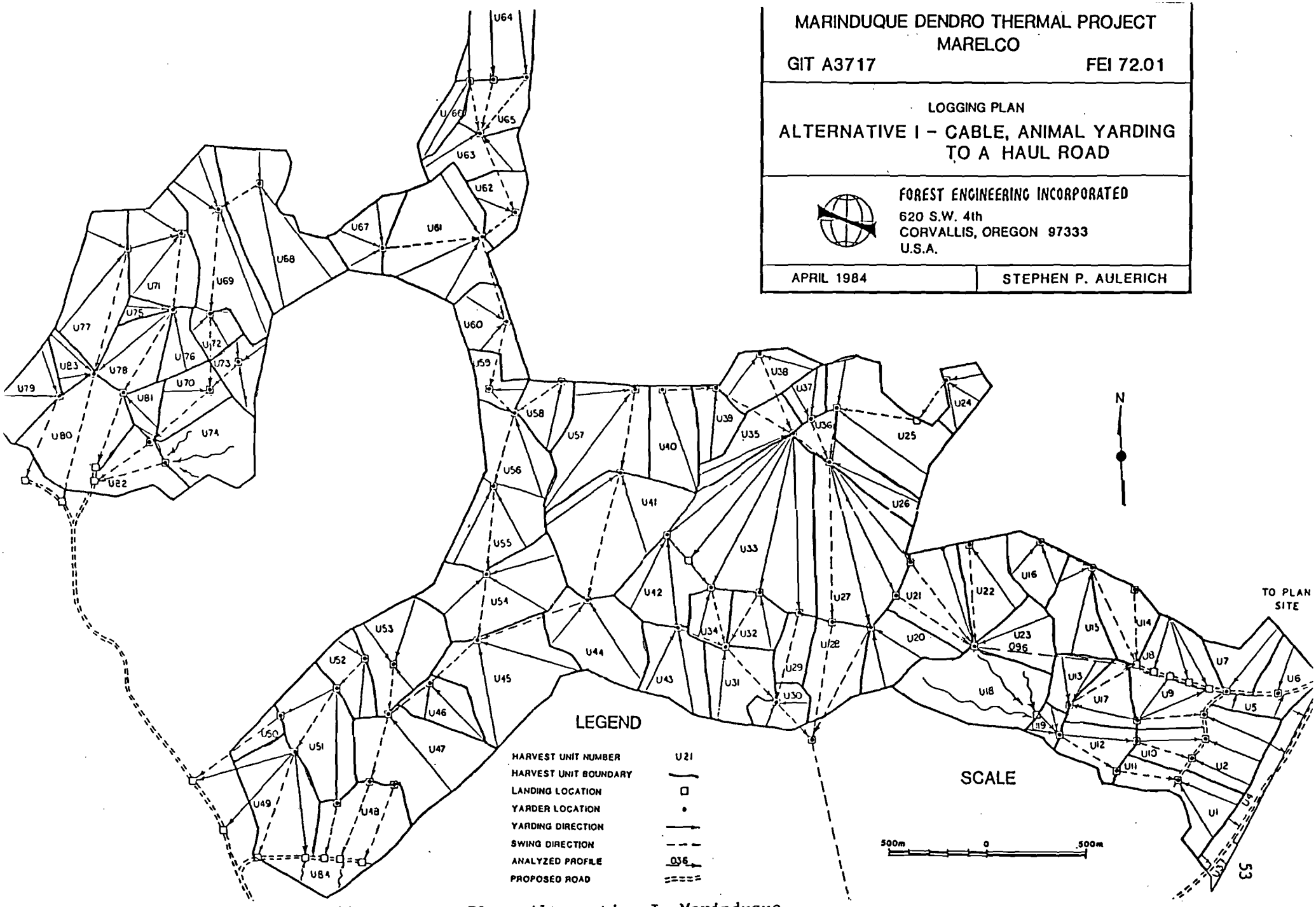


Figure 22. Harvest Plan, Alternative I, Marinduque.

Table 13. HARVEST PLAN SUMMATION

LOCATION MARINDUQUE ALTERNATIVE I

Area 923.39 hectares

Harvest Units:	84	Hectares
Hand	3	13.41
Animal	3	42.08
Cable	78	867.90

ROADS: 17.3 km (7.8 new) (9.5 existing)

SWINGS:	Number	Distance (meters)
Animal	-	-
Cable	283	115,934

(Note: This reflects requirements if units are harvested separately with no scheduling)

Yarder Setups _____

LABOR:	Crew-days [1/]	Man-days
Cutting	2,423	2,423
Yarding		
Hand	235	235
Animal	183	183
Cable	1,430	5,720
Swinging		
Animal	-	-
Cable	1,617	6,468
Hauling		
Truck	1,694	1,694
Monocable	-	-
Loading	1,694	3,388
TOTAL		20,111

[1/]

Cutting	1-man crew	
Yarders	4-man crew	
Animal	1-man crew	
Trucking	1 man	2 loaders
Monocable	1 man	2 loaders

Table 14. Unit Statistics, Marinduque I

LOCATION MARINDUQUE I, Marelco SYSTEM Cable, animal yarding to a constructed haul road 1 OF 1

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
1	7.48	24	211	UC	3			7.90	20	13		12
2	11.68	24	195	UC	3			7.80	31	19		18
3	1.64	2	40	UH				7.80	4	38		3
4	7.79	13	40	DH				7.50	20	122		12
5	3.98	0	40	DH				7.40	10	75		6
6	4.77	5	135	UC	2			7.20	13	8		7
7	7.38	3	205	UC	2			7.40	19	12		11
8	8.87	33	110	DC*	3			7.60	23	14		14
9	9.77	29	106	DC*	3			7.70	26	16		15
10	5.70	31	91	DC	2			7.70	15	9		9
11	3.65	33	163	DC	1			7.90	10	6		6
12	7.48	26	110	DC	2	1C	300	7.90	20	12	5	12
13	5.20	44	165	UC	2	1C	400	7.90	14	9	4	8
14	9.48	38	272	DC*	2			7.90	25	15		15
15	10.63	27	268	UC*	3	1C	500	7.90	28	18	9	17
16	6.98	45	162	UC	2	2C	300/500	7.90	18	14	10	11
17	7.73	38	109	UC	2	1C	400	7.90	20	12	6	12
18	21.04	15	287	DA		3C	150/330/300	7.90	55	103	20	33
19	2.44	56	106	UC	1	2C	300/310	7.90	6	4	4	4
20	10.19	26	224	UC*	3	2C	610/860	10.00	27	17	17	17
21	13.97	38	341	DC*	3	1C	830	7.90	37	23	13	22
22	11.23	45	255	UC*	3	2C	500/830	7.90	29	19	17	18
23	8.76	29	281	UC	2	1C	830	7.90	23	14	9	14
24	5.24	50	149	UC	3	6C	230/400/270/790/580/850	10.00	14	10	25	9
25	22.27	60	335	UC*	5	4C	270/790/580/850	10.00	58	37	47	38
26	5.82	65	310	UC*	1	3C	790/580/850	10.00	15	9	18	10
27	28.85	63	276	DC*	4	2C/2C	620/850/450/830	10.00/7.90	76	44	62	25/23
28	11.08	12	383	DC*	2	1C	850	10.00	29	18	11	19
29	5.38	16	281	DC*	1	2C	240/850	10.00	14	9	10	9
30	4.93	30	101	UC	3	2C	240/850	10.00	13	9	9	8
31	10.54	13	213	UC	3	3C	340/240/850	10.00	28	17	18	18
32	6.36	41	174	UC	2	3C	340/240/850	10.00	17	11	14	11
33	42.44	54	303	DC*	5	4C/5C	320/340/240/850/320/300/340/240/850	10.50	111	64	120	72
34	5.46	36	164	UC	2	4C	340/240/300/850	10.50	14	9	16	9
35	8.65	55	268	UC*	3	4C	230/790/580/850	10.50	23	15	25	15
36	3.45	30	158	DC	3	3C	790/580/850	10.50	9	7	14	6
37	4.05	44	149	UC	2	4C	280/790/580/850	10.00	11	7	18	7
38	9.33	64	190	UC	4	5C	400/280/790/580/850	10.00	24	16	30	16
39	6.44	72	224	UC	2	5C	440/280/790/580/850	10.00	17	11	25	11
40	11.95	62	298	UC*	2	6C	280/440/280/790/580/850	10.00	31	19	39	20
41	28.66	54	380	UC*	9	6C	640/580/300/250/320/400	14.10	75	51	61	56

Table 14. - continued

LOCATION MARINDUQUE I, Mareico SYSTEM Cable, animal yarding to a constructed haul road 2 OF 3

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	PRODUCTION REQUIREMENTS CUTTING (man-days)	YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
42	11.87	55	312	UC*	3	5C	320/300/340/240/850	10.00	31	19	39	20
43	11.71	21	229	UC*	3	4C	230/340/240/850	10.00	31	19	23	20
44	17.17	43	248	UC*	5	5C	580/300/250/320/400	14.10	45	29	33	34
45	23.95	38	300	UC*	6	4C	300/250/320/400	14.10	63	40	31	47
46	7.09	50	182	UC	2	3C	250/320/400	14.10	19	12	12	14
47	22.25	52	333	UC*	5	2C	320/400	14.10	58	37	18	44
48	14.67	41	200	DC	3			14.10	39	23		29
49	17.60	41	155	DC*	4			13.80	46	28		34
50	3.10	41	454	DC*	1			14.20	8	6		6
51	17.04	57	154	DC*	3	1C	540	13.70	45	26	12	33
52	7.05	25	154	UC	3	3C	200/370/540	13.70	19	12	13	14
53	16.52	32	182	UC	6	3C	240/320/400	14.10	43	28	19	32
54	21.37	47	246	UC	7	5C	300/300/250/320/400	14.10	56	37	34	42
55	14.54	50	261	UC	4	6C	430/300/300/250/320/400 - 2000	14.10	38	24	32	29
56	11.73	34	238	UC	3	7C	370/430/300/300/250/320/400-2370	14.10	31	19	32	23
57	20.96	41	340	UC*	4	7C	400/640/580/300/250/320/400-2890	14.10	55	34	55	41
58	7.01	36	188	UC	2	8C	280/370/430/300/300/240/320/400 - 2650	14.10	18	11	28	14
59	4.81	43	109	UC	2	8C	180/370/430/300/300/250/320/400 - 2550	14.10	13	8	24	9
60	9.26	67	186	UC	4	9C	320/180/370/430/300/300/250/320/400 - 2870	14.10	24	16	33	18
61	24.86	44	293	UC*	6	10C	420/320/180/370/430/300/300/250/320/400 - 3290	14.10	65	41	70	49
62	6.96	71	156	UC	3	11C	200/420/320/180 370/430/300/300 250/320/400 - 3490	14.10	18	12	35	14
63	8.94	38	172	UC	3	12C	400/200/420/320/180/370/430/300/300/250/320/400 - 3890	14.10	23	15	44	18
64	11.66	52	197	UC	3	13C	280/400/200/420/320/180/370/430/300/300/250/320/400 - 4190	14.10	31	19	54	23
65	7.56	37	192	DC	3	12C	400/200/420/320/180/370/430/300/300/250/320/400 - 3890	14.10	20	13	40	15

Table 14. - continued

LOCATION MARINDUQUE I, Marelco SYSTEM Cable, animal yarding to a constructed haul road 3 OF 3

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
66	4.65	45	250	UC*	1	13C	250/400/200/420/320/180/370/430/300/300/250/320/400 = 4140	14.10	12	7	36	9
67	8.43	23	156	UC	3	11C	500/420/320/180/370/430/300/300/250/320/400 = 3790	14.10	22	14	41	17
68	25.88	40	321	UC*	5	5C	220/500/370/400/320	15.90	68	42	43	52
69	22.32	28	292	UC*	4	4C	500/370/400/320	15.90	59	35	34	45
70	8.18	35	155	UC	2	2C	400/320	15.90	21	13	9	17
71	15.97	43	217	UC	4	3C	270/480/380	15.90	42	26	21	32
72	4.40	53	129	UC	2	3C	370/400/320	15.90	12	8	10	9
73	6.23	30	114	UC	4	3C	200/400/320	15.90	16	12	11	13
74	14.84	12	287	DA		1C	380	15.90	39	73	9	30
75	1.81	38	185	UC	1	2C	480/380	15.90	5	3	5	4
76	4.77	40	213	UC	1	2C	480/380	15.90	13	8	7	10
77	17.13	37	292	UC*	4	2C	620/640	15.80	45	28	22	35
78	9.71	34	152	DC*	2	1C	640	15.80	25	15	9	20
79	8.61	37	203	UC	3	1C	420	16.10	23	15	6	17
80	19.15	26	250	DC*	3			15.80	50	30		39
81	3.48	1	147	UC	2	1C	380	15.90	9	6	4	7
82	9.58	30	251	DC*	2			15.90	25	15		19
83	3.63	11	151	UC	2	1C	640	15.90	10	7	5	7
84	6.20	10	63	UA				14.00	16	7		12

1/ See page iii for symbol description.

Table 15. ESTIMATED HARVEST COSTS

LOCATION MARINDUQUE ALTERNATIVE I

CUTTING

55,403 m^3 @ ₱ 5 /m^3 = ₱ [1/] 277,015

ROADS

Low standard:	9.5	km	@ ₱	20,000	/km	= ₱	190,000
High standard:	7.8	km	@ ₱	250,000	/km	= ₱	1,950,000

YARDING

Hand:	₱	72	/day x	235	days	= ₱	16,920
Animal [2/]:	₱	122	/day x	183	days	= ₱	22,326
Small winch:	₱	696	/day x	590	days	= ₱	410,640
Large winch:	₱	1,816	/day x	840	days	= ₱	1,525,440
Crew:	3 men x ₱	72	/day x	1430	days	= ₱	308,880

SWINGING

Animal:	₱	-	/day x	-	days	= ₱	-
Large winch:	₱	1,816	/day x	1,617	days	= ₱	2,936,472
Crew:	3 men x ₱	72	/day x	1617	days	= ₱	349,272

LOADING

2 men x ₱ 72 /day x 1694 days = ₱ 243,936

HAULING

Truck:	₱	1,072	/day x	1,694	days	= ₱	1,815,968
Monocable:	₱	-	/day x	-	days	= ₱	-

Total Estimated Cost	= ₱	10,046,869
Volume Harvested	=	55,403 m^3
Cost/m^3	= ₱	181.34 /m^3
Cost/tonne	= ₱	226.68 /ton

[1/] ₱14 = $1 (US)

[2/] ₱50/day Carabao, ₱72/day man

[3/] 1 m^3 = .80 tonnes

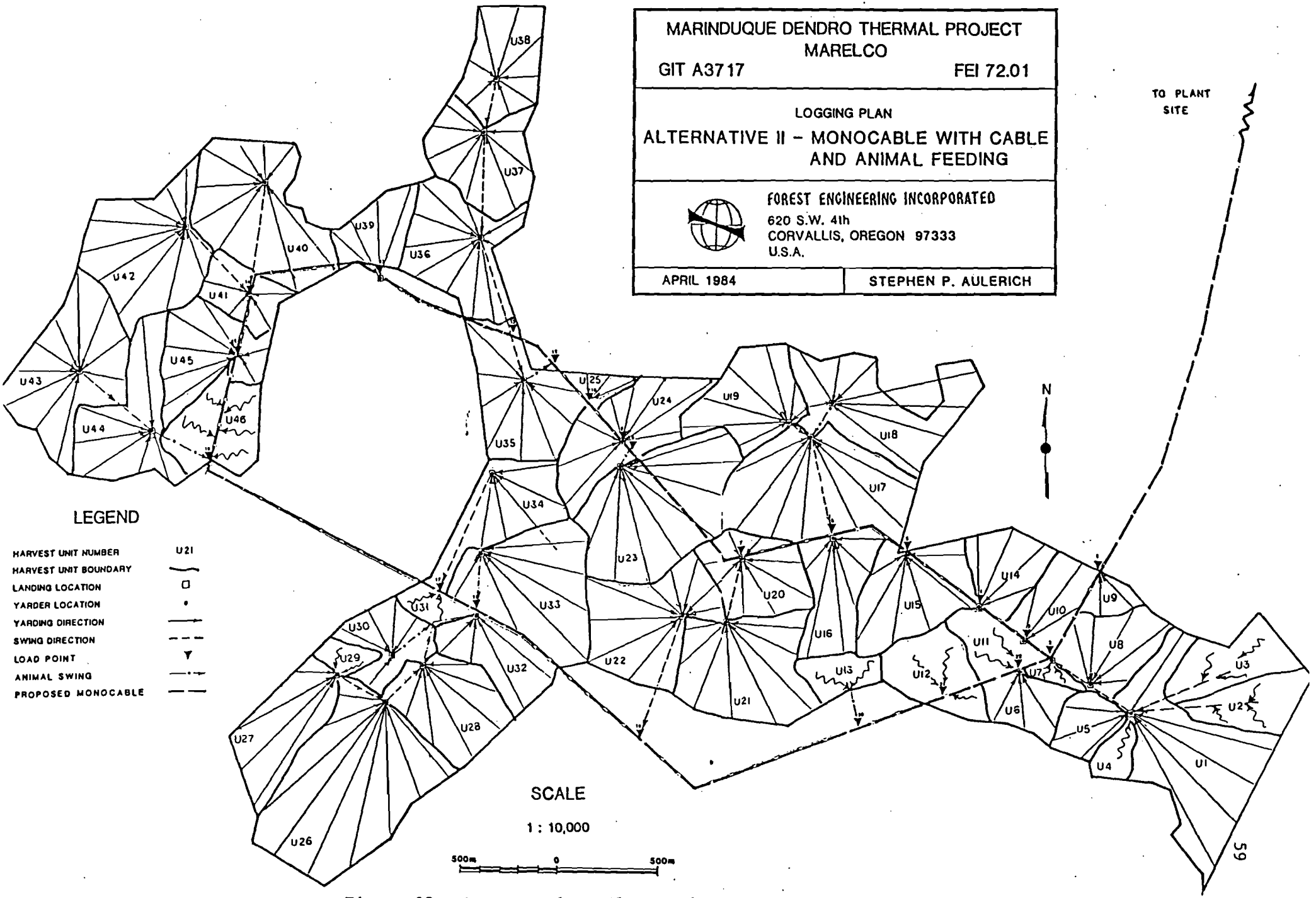


Figure 23. Harvest Plan, Alternative II, Marinduque.

Table 16. HARVEST PLAN SUMMATION

LOCATION MARINDUQUE ALTERNATIVE II

Area 926.27 hectares

Harvest Units:	46	Hectares
Hand	-	-
Animal	10	93.07
Cable	36	833.20

ROADS: 1.5 km (Carabao swing roads)

SWINGS:	Number	Distance (meters)
Animal	7	1,460
Cable	18	7,630

Yarder Setups 226

LABOR:	Crew-days [1]	Man-days
Cutting	2,435	2,435
Yarding		
Hand	-	-
Animal	-	-
Cable	1,404	5,616
Swinging		
Animal	1,361	1,361
Cable	384	1,536
Hauling		
Truck	-	-
Monocable	2,965	2,965
Loading	2,965	5,930
TOTAL		19,843

[1] Cutting 1-man crew
Yarders 4-man crew
Animal 1-man crew
Trucking 1 man 2 loaders
Monocable 1 man 2 loaders

Table 17. Unit Statistics, Marinduque II

LOCATION MARINDUQUE II SYSTEM Monocable with cable and animal feeding

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
1	41.54	27	461	UC*	6	1C	580	6.00	109	66	27	93
2	12.41	14	121	DUA		2C	580/580	6.00	33	26	17	28
3	14.63	13	121	DUA		2C	480/580	6.00	38	30	17	33
4	4.25	3	150	DUA		1C	580	6.00	11	11	5	10
5	8.46	23	234	DC*	3	1C	580	6.00	22	15	8	19
6	10.34	14	205	DC	3			6.10	27	17		24
7	2.27	0	104	DA				6.00	6	4		5
8	16.84	67	292	UC	5	1C	230	6.00	44	29	8	38
9	4.21	36	157	UC	2			5.50	11	7		9
10	12.59	47	278	UC*	3			6.10	33	21		29
11	10.25	18	218	DA				6.10	27	38		23
12	16.47	11	194	DUA				6.55	43	55		40
13	7.16	30	155	DA		A	200	7.00	19	19	25	19
14	13.58	40	269	DUC*	4			6.40	36	23		33
15	24.04	40	282	UC*	5			6.80	63	39		61
16	17.77	45	313	UC*	6			7.25	47	31		48
17	41.03	63	420	UC*	7	1C	480	7.25	108	66	23	112
18	30.21	60	379	UC*	8	2C	200/480	7.25	79	52	23	82
19	20.64	13	283	UC	6	2C	130/480	7.25	54	35	16	56
20	19.26	33	206	UDC	8			7.70	51	34		56
21	32.44	29	335	UC*	8	1C	320	7.70	85	54	16	94
22	28.57	38	283	UDC*	9	1C	630	8.30	75	49	20	89
23	40.12	52	414	UC	8	1A	90	8.50	105	66	62	128
24	24.23	42	247	UDC	8			8.60	64	42		78
25	3.54	60	148	DC	3			8.85	9	7		12
26	55.49	59	582	UC*	9	1C/1A	260/440	9.30	146	92	24/418	194
27	20.46	61	454	UC*	4	2C/1A	270/260/440	9.30	54	34	15/154	71
28	22.70	58	330	UC*	6	1A	440	9.30	60	38	171	79
29	3.78	20	129	A		2C/1A	270/260/440	9.30	10	8	6/29	13
30	12.95	36	168	UDC	5	1A	490	9.30	34	22	109	45
31	4.93	0	121	A				9.50	13	10		18
32	15.81	38	291	UC*	4			9.30	42	26		55
33	33.25	50	418	UC*	6	1C	300	9.30	87	54	16	116
34	19.85	66	313	UC	5	1C	630	9.50	52	33	15	71
35	26.47	33	239	UC	8	1A	160	9.10	70	45	73	90
36	26.33	42	258	UC	9	1C	520	9.35	69	46	17	92
37	21.90	57	248	UC	9	2C	510/520	9.35	58	39	24	77
38	19.31	42	202	UC	8	3C	270/510/520	9.35	51	34	27	68
39	11.51	11	266	UC	4			10.10	30	20		44
40	36.12	40	300	UC*	10	1C	500	10.85	95	61	23	147
41	10.59	28	141	UDC	5			10.85	28	19		43
42	32.59	46	327	UC*	9	1C	460	10.85	86	56	18	133
43	34.47	30	258	UC*	10	1C/1A	460/320	10.85	91	58	19/189	140
44	23.92	31	269	UDC	6	1A	320	10.85	63	39	131	97
45	20.07	28	228	UDC	7			11.20	53	35		84
46	16.92	30	221	A				10.85	44	64		69

1/ See page iii for symbol description.

Table 18. ESTIMATED HARVEST COSTS

LOCATION MARINDUQUE ALTERNATIVE II

CUTTING

55,576 m^3 @ ₱ 5 /m^3 = ₱ [1/] 277,880

ROADS

Low standard:	1.5	km @ ₱	20,000	/km = ₱	30,000
High standard:	-	km @ ₱	-	/km = ₱	-

YARDING

Hand:	₱	-	/day x	-	days = ₱	-
Animal [2/]:	₱	-	/day x	-	days = ₱	-
Small winch:	₱	696	/day x	503	days = ₱	350,088
Large winch:	₱	1,816	/day x	901	days = ₱	1,636,216
Crew:	3 men x ₱	72	/day x	1404	days = ₱	303,264

SWINGING

Animal:	₱	122	/day x	1,361	days = ₱	166,042
Large winch:	₱	1,816	/day x	384	days = ₱	697,344
Crew:	3 men x ₱	72	/day x	384	days = ₱	82,944

LOADING

4 men x ₱ 72 /day x 2965 days = ₱ 853,920

HAULING

Truck:	₱	-	/day x	-	days = ₱	-
Monocable:	₱	9,840	/day x	2,965	days = ₱	29,175,600

Total Estimated Cost	= ₱	33,573,298	
Volume Harvested	=	55,576	m^3
Cost/m^3	= ₱	604.10	/m^3
Cost/tonne	= ₱	755.13	/ton

[1/] ₱14 = $1 (US)

[2/] ₱50/day Carabao, ₱72/day man

[3/] 1 m^3 = .80 tonnes

new road will need to be constructed across Patay Na Ilog Creek, which could be a relatively major project.

The number of swings, as reported in Table 14, required to harvest this plantation depict a "worst case" situation where only one unit is harvested at a time. Such a plan requires duplication of rigging if undertaken. Careful scheduling of planting and harvesting could greatly reduce the number of installations required.

Alternative II is based upon the designed Lasso monocable system (Figure 23). This system required two monocable loops, one of 10.75 kilometers to access the plantation and one of 12.0 kilometers to transfer the material to the remotely located power plant (Figure 24A). Such a system will require a transfer station as shown in Figure 24B.

The advantage of the monocable system is that wood can be placed into the system at any time. The major disadvantage, however, is the extremely high cost of the installation of two cableways.

Mindoro I

The Mindoro, Magsaysay plantation is the largest area planned. It is also the most conducive to roading with its valleys and scattered hills (Figure 25).

The presence of large native trees scattered throughout the stand offers opportunities not available at other sites. If planned properly, these trees can be used for rigging supports in place of the erected supports necessary on the uniform ipil ipil plantations of Marinduque and Catanduanes.

The ability to construct roads offers many advantages to the plantation other than harvesting. Access for planting, maintenance,

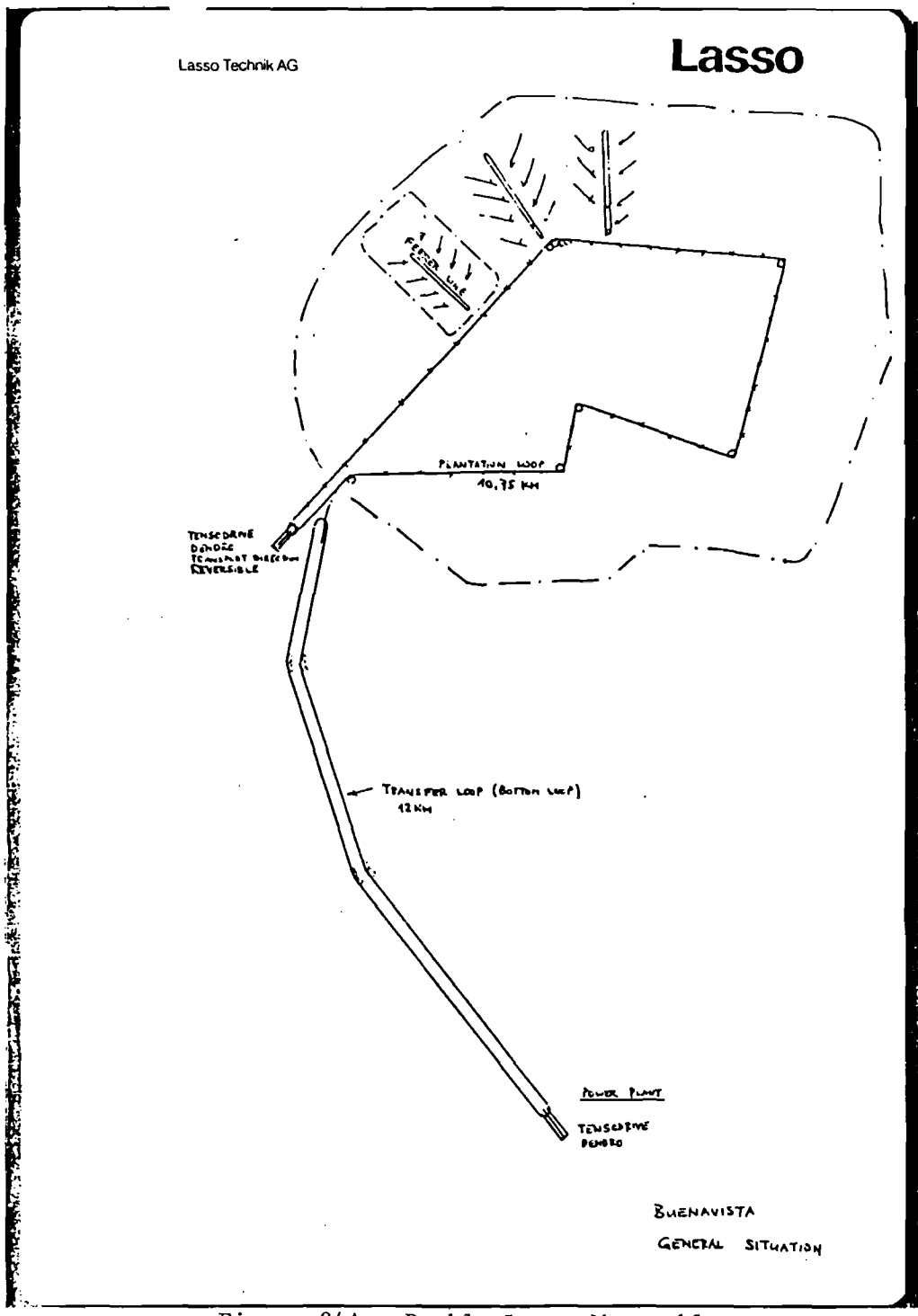


Figure 24A. Double Lasso Monocable, Alternative II, Marinduque.

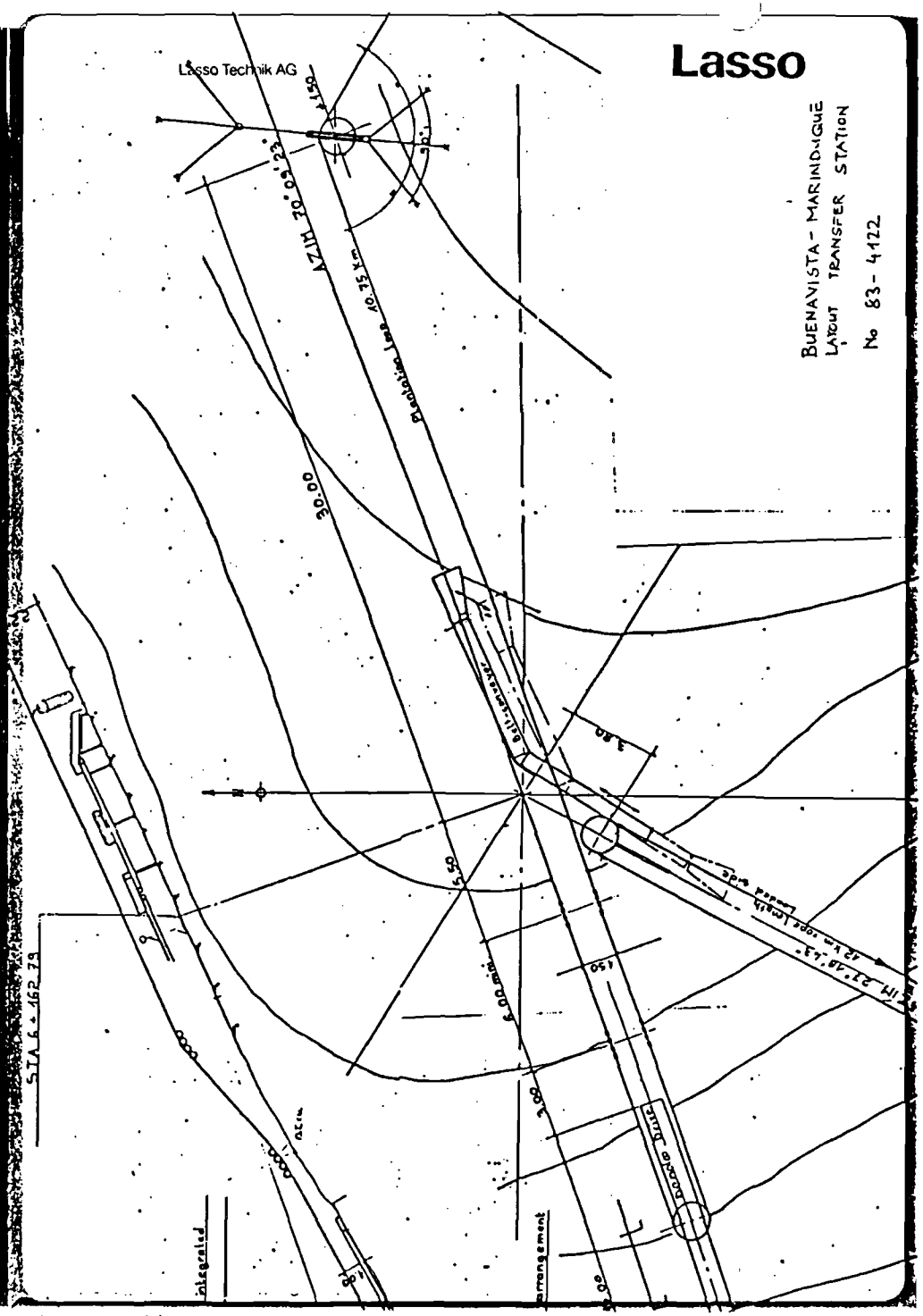


Figure 24B. Transfer station layout - Lasso Monocable, Marinduque.

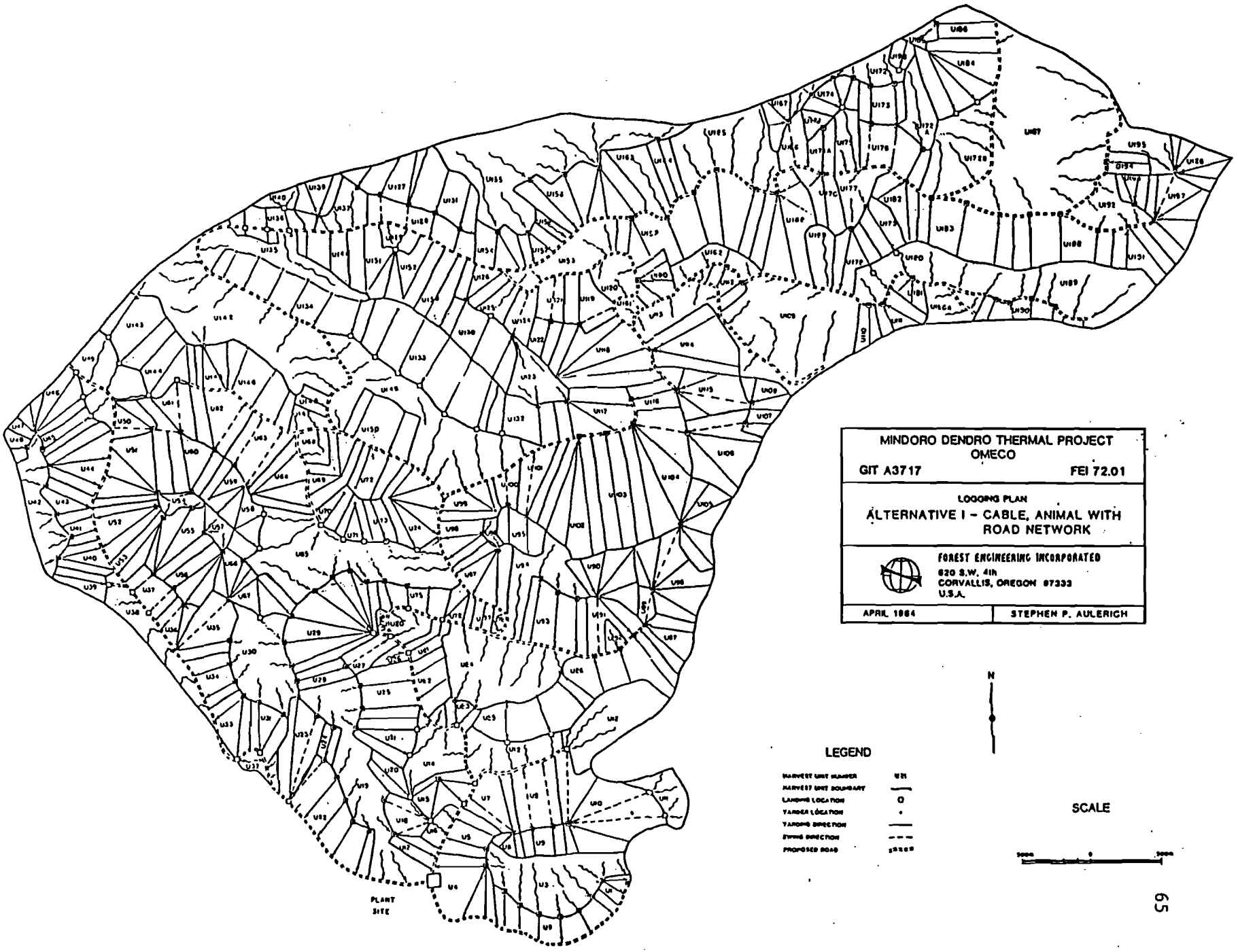


Figure 25. Harvest Plan, Alternative I, Mindoro OMECO Project, Magsaysay.

Table 19. HARVEST PLAN SUMMATION

LOCATION MINDORO, Magsaysay ALTERNATIVE I

Area 2704.52 hectares

Harvest Units:	202	Hectares
Hand	1	4.35
Animal	57	1030.12
Cable	144	1670.05

ROADS: 38.7 km

SWINGS:	Number	Distance (meters)
Animal	22	5,300
Cable	82	20,640

Yarder Setups 372

LABOR:	Crew-days [1/]	Man-days
Cutting	7,361	7,361
Yarding		
Hand	51	51
Animal	3,555	3,555
Cable	2,756	11,024
Swinging		
Animal	789	789
Cable	375	375
Hauling		
Truck	5,220	5,220
Monocable		
Loading	5,220	10,440
TOTAL		39,940

[1/]
Cutting	1-man crew	
Yarders	4-man crew	
Animal	1-man crew	
Trucking	1 man	2 loaders
Monocable	1 man	2 loaders

Table 20. Unit Statistics, Mindoro I

LOCATION MINDORO I, Magsaysay SYSTEM Cable, Animal with road network

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
1	3.03	28	61	DC	2			1.90	8	5		5
2	17.28	33	100	DC	6			1.00	45	28		27
3	31.84	8	231	DA	0			1.00	84	126		50
4	18.37	14	135	DC	4			.20	48	29		28
5	9.43	35	164	DC	2			.30	25	15		14
6	2.97	28	108	UC	2	1C	400	.60	8	6	3	5
7	11.35	34	142	DC	2			.70	30	17		18
8	14.70	27	238	DC	2			1.15	39	22		23
9	6.21	34	106	UC	2	1C	450	1.15	16	10	5	10
10	34.56	29	342	UC	6	1C	500	1.45	91	55	21	55
11	8.98	10	126	UA	0	2C	700/500	1.45	24	19	14	14
12	22.96	5	401	UA	0			1.45	60	158		37
13	14.88	11	101	DA	0			1.10	39	26		23
14	14.63	10	126	UA	0			1.15	38	32		23
15	10.27	25	80	DC	4	1A	150	.50	27	17	5	16
16	4.33	3	60	UA	0			.30	11	4		7
17	4.16	18	168	DC	1			.20	11	7		6
18	6.81	22	206	DC	2	1A	150	.30	18	11	4	10
19	38.98	14	219	DA	0	/1C	300	.90	102	146	18	61
20	5.11	31	188	DC	1	2A	210/150	.30	13	8	32	8
21	11.07	24	267	DC	2	1A	100	1.30	29	17	5	17
22	25.04	32	168	DC	5			.90	66	39		39
23	14.56	29	419	DC	2			1.30	38	23		23
24	3.06	23	118	DC	1	1C	400	1.30	8	5	3	5
25	15.01	24	206	DC	2			1.60	39	23		24
26	2.13	14	101	DA	0			1.80	6	4		3
27	5.72	18	198	DC	1			1.90	15	9		9
28	5.44	23	185	DC	1	1C	380	1.90	14	8	5	9
29	33.42	32	381	DC	6			2.00	88	54		50
30	26.16	17	122	DA	0	1C/1C	250/650	2.10	69	55	7/11	21/21
31	8.32	51	215	DC	2			1.50	22	13		13
32	4.35	28	31	UH	0			1.80	11	51		7
33	9.45	41	119	DC	2			1.80	25	15		15
34	8.84	65	155	DC	2			2.30	23	14		15
35	13.40	30	318	DC	2			2.60	35	21		22
36	5.51	28	77	DC	2			2.90	14	9		9
37	7.20	30	120	DC	2			3.20	19	11		12
38	15.58	5	100	UA	0			2.80	41	27		26
39	5.34	22	174	DC	1			3.45	14	8		9
40	6.78	31	110	DC	2			3.60	18	11		12
41	3.36	47	99	DC	1			5.20	9	5		6
42	15.97	10	101	DA	0	1C	200	5.40	42	28	8	29
43	7.86	41	203	DC	2			4.00	21	13		14
44	15.65	41	147	DC	3			4.20	41	24		28
45	5.22	34	217	DC	1			4.80	14	8		9
46	10.01	34	152	DC	2	/1A	100	5.00	26	16	9	18
47	3.65	40	143	UC	2	1C/1A	500/100	4.90	10	7	5	7
48	2.54	38	93	UC	1	2A/1C	240/500	4.90	7	4	4/4	5
49	19.55	18	135	DA	0			5.00	51	45		35
50	6.34	25	90	DC	2			4.70	17	10		11

Table 20. - continued

LOCATION MINDORO I, Magsaysay SYSTEM Cable, Animal with road network

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
51	22.40	50	150	DC	4	/1C	280	4.40	59	34	4	40
52	11.65	53	158	DC	2			3.80	31	18		20
53	6.51	46	253	DC	1			3.40	17	10		11
54	3.57	25	41	DA	0	1C	500	3.40	9	3	4	6
55	14.87	42	326	DC	3	1C	200	3.30	39	24	7	25
56	10.02	42	141	DC	2	1C	220	3.05	25	15	6	17
57	3.71	18	102	DA	0	2C	240/450	3.30	10	6	6	6
58	9.82	22	75	DC	3	1C/1A	470/370	6.20	26	16	8	19
59	6.78	1	77	DC	2	1C	400	5.70	18	11	5	13
60	11.95	26	115	DC	2	1C	400/360	6.25	31	18	5/5	23
61	9.69	28	99	DC	2	1A	250	4.80/6.00	25	15	21	9/9
62	14.47	28	132	DC	2	/1C		5.80	38	22		27
63	13.55	30	224	DC	2			5.80	36	21		25
64	14.99	24	136	DC	3			5.30	39	23		27
65	51.48	13	277	DA	0	/1C/1A	500/150	2.05/6.20	135	244		48/42
66	5.52	39	211	DC	2	1C	500	2.80	14	10	6	9
67	9.39	32	89	DC	3	1C/1A	600/230	2.60/2.05	25	15	8	8/7
68	5.12	20	112	DA	0			5.50	13	10		9
69	11.73	26	85	DC	4			5.30	31	19		21
70	4.27	24	123	DC	1			6.20	11	7		8
71	5.49	37	79	DC	2	1A	300	6.20	14	9	28	10
72	10.05	32	178	DC	2			4.80	26	16		18
73	4.80	47	171	DC	1	1A	400	3.80	13	8	33	8
74	18.00	40	125	DC	5	/1A	150	4.10	47	29	9	32
75	9.32	85	125	DC	3			2.40	24	15		15
76	4.56	30	70	DC	2			2.80	12	8		8
77	2.75	26	93	DC	1			2.90	7	5		5
78	1.53	10	50	DA	0			3.10	4	1		3
79	1.46	5	30	DA	0			2.20	4	1		2
80	6.16	29	104	DA	0			2.20	16	11		10
81	4.65	30	123	DC	2			1.90	12	8		8
82	9.19	28	130	DC	2			1.70	24	14		15
83	4.00	35	113	DC	2			1.15	11	7		6
84	36.31	12	181	DA	0	/1C	180	1.15/3.10	96	113		17/43
85	19.21	29	135	DC	4	1A	150	1.10	50	30	49	30
86	23.43	32	199	UC	4	/1A	180	3.80	62	36		41
87	9.66	38	241	UC	2			4.10	25	15		17
88	23.10	17	247	UC	5	1C	280	4.10	61	37	11	41
89	2.67	0	130	UC	1			4.10	7	4		5
90	15.15	26	231	UC	4	1C	400	3.70	40	25	9	26
91	10.09	29	119	DC	2			3.90	26	15		18
92	2.23	15	81	DA	0			3.90	6	3		4
93	19.08	31	209	DC	3			3.40	50	29		33
94	18.01	18	266	DA	0			3.40/3.10	47	82		16/15
95	7.92	32	131	UC	2	1C	220/450	4.70/5.00	21	13	3/4	7/7
96	1.73	20	51	DA	0	1C	300	3.50	5	2	3	3
97	13.70	30	124	DC	3			3.50	36	21		24
98	8.02	27	94	DC	2			3.90	21	13		14
99	9.01	30	120	DC	3			4.30	24	15		16
100	4.23	31	131	DC	1			4.60	11	7		8

Table 20. - continued

LOCATION MINDORO I, Magsaysay SYSTEM Cable, Animal with road network 3 OF 4

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
101	11.59	8	144	DC	2			5.00	30	18		21
102	27.65	6	378	UC	3			5.30	73	42		51
103	18.72	16	415	UC	1			5.50	49	27		34
104	35.73	29	454	UC	4			5.70	94	55		66
105	14.89	37	239	UC	4	2C	260/500	4.10	39	25	15	22
106	21.90	36	329	UC	3	1C	400	5.70	58	34	57	33
107	3.25	47	105	UC	1	2C	400/420	5.70	9	5	6	6
108	5.04	30	157	UC	2	1C	550	11.80	13	9	6	11
109	56.36	12	201	DA	0			12.60	148	194		129
110	4.64	26	155	UC	1			13.10	12	7		11
111	6.78	31	162	UC	2			13.20	18	11		16
112	4.71	22	90	UC	2			12.00	12	8		11
113	13.32	0	100	UA	0			11.50	35	23		29
114	21.41	24	342	UC	3			11.50	56	33		47
115	15.78	28	258	UC	4			11.80	41	26		35
116	5.81	28	166	UC	1			6.00	15	9		11
117	16.74	26	126	DC	3			5.60	44	26		31
118	29.29	43	214	DC	4	/1C	280	11.40	77	44		65
119	11.02	29	101	DC	2			10.00	29	17	100	23
120	7.74	10	90	DA	0			10.50	20	12		17
121	11.94	23	159	DC	1			9.90	31	17		25
122	8.49	29	146	DC	1	1C	300	9.90	22	13	6	18
123	17.57	17	101	DA	0	1C	300	9.70/5.10	46	9	7	18/16
124	6.21	31	168	DC	1			9.70	16	18		13
125	4.28	20	143	DA	0			9.60	11	10		9
126	7.61	30	90	DC	2			9.40	20	12		16
127	12.03	31	183	UC	3	1C/1A	200/300	8.50	32	19	4/31	24
128	13.55	35	106	UC	5			8.80	36	22		28
129	3.90	20	76	DA	0			8.60	10	5		8
130	18.73	36	175	DC	4	1C/1A	300/280	9.60	49	29	9/30	39
131	16.23	3	160	DC	3	1C	190	9.00	43	25	8	33
132	13.46	43	163	DC	3	1A	200	4.80	35	21	23	24
133	44.11	43	218	DC	7	2A	400/300	4.40/5.70	116	68	151/113	39/41
134	29.88	32	147	DC	7			6.50	78	47		57
135	19.35	13	202	DA	0			7.20/7.80	51	67		19/19
136	9.07	27	78	UC	4			7.70	24	15		18
137	8.24	7	150	DA	0			8.20	22	21		17
138	9.68	40	264	DC	1			9.10	25	14		20
139	7.60	17	152	UC	3	1A	100	8.10	20	13	13	15
140	3.25	7	105	DA	0	1C	150	7.90	9	6	3	6
141	9.20	15	137	DC	3			8.00	24	15		18
142	61.28	5	200	DA	0	/1C	300	6.65	161	210	7	117
143	18.67	7	225	DC	3	1A	200	5.00	49	29	64	34
144	11.61	49	294	DC	3	1A	200	4.80/6.50	30	19	46	10/11
145	6.92	32	94	DC	2			5.70	18	11		13
146	17.49	34	169	DC	4			6.00	46	28		33
147	3.50	0	100	DA	0			5.50	9	6		6
148	3.13	35	106	DC	1			5.40	8	5		6
149	52.17	13	227	DA	0			4.40/5.70	137	203		46/48
150	15.92	20	127	DC	3			4.80	42	24		29

Table 20. - continued

LOCATION MINDORO I, Magsaysay SYSTEM Cable, Animal with road network 4 OF 4

UNIT	AREA (Hectares)	SLOPE %	AVERAGE SLOPE YARDING DISTANCE (Meters)	YARDING[1] SYSTEM	NUMBER OF SETUPS	NUMBER[1] OF SWINGS	SWING DISTANCE (Meters)	HAUL DISTANCE (Km)	CUTTING (man-days)	PRODUCTION REQUIREMENTS YARDING (crew days)	SWINGING (crew days)	HAULING (crew days)
151	13.17	18	123	DC	2	/1A	150	8.30	35	20	17	27
152	12.19	30	129	DC	2	/1A	150	8.70/8.90	32	18	16	25
153	16.68	20	127	DA	0			10.00	44	36		35
154	9.09	40	92	DC	3			9.50	24	15		19
155	61.60	16	253	DA	0	1C	350	9.70/10.40	162	267	29	65/66
156	26.93	23	150	DC	5			10.20/10.40	71	41		58
157	5.51	35	71	DC	2			9.80	14	9		12
158	2.20	21	143	DA	0			10.00	6	5		5
159	41.20	35	212	UC	7			10.80/11.40	108	64		45/45
160	7.30	32	161	UC	3			10.70	19	13		16
161	2.44	20	102	DA	0			11.20	6	20		5
162	8.45	27	78	DA	0			12.00	22	4		19
163	10.45	40	269	DA	0			10.80	27	48		23
164	7.16	47	260	DC	1			10.90	19	11		16
165	31.25	21	194	DA	0			11.40	82	104		69
166	6.34	40	162	DC	1			12.10	17	10		14
167	4.73	40	129	UC	3	1C	300	12.10	12	9		11
168	24.55	35	330	UC	5			11.80	64	40		55
169	7.16	23	125	DA	0			12.90	19	15		16
170	8.93	30	214	UC	3			12.30	23	15		20
171	7.55	30	100	DA	0	1C	220	12.30	7	4	3	6
171A	2.95	27	187	DC	1			12.30	16	9		13
172	10.09	0	100	DA	0	2C	250/300	12.70	26	17	10	23
172A	9.66	15	329	DA	0	1C	280	12.90	25	54		22
172B	24.03	13	777	DA	0			13.80	63	93		57
173	8.58	24	129	DC	3	1C	300	12.70	23	14	6	20
174	7.53	26	160	DC	3	1A	400	12.60	20	13		17
175	7.38	18	229	DA	0			12.60	19	29		17
176	14.59	27	155	DC	4			12.80	38	24		33
177	8.31	53	170	DA	0	/1C/1A	350/200	12.80	22	24	4/14	19
178	10.30	31	116	DC	2	/1A	120	13.20	27	16	11	24
179	8.06	42	213	DC	2	1A	110	13.40	21	13	15	19
180	30.17	17	152	DA	0			13.90	79	79		71
180A	8.69	23	128	UA	0			13.90	23	19		21
181	3.86	23	123	UC	3			13.50	10	8		9
182	9.16	39	202	UC	3			12.90	24	15		21
183	25.62	49	206	UC	5			13.40	67	40		60
184	24.67	34	161	DC	5			14.20	65	38		59
185	2.52	27	114	DA	0	1C	420	14.60	7	5	3	6
186	7.51	33	221	DC	2			14.60	20	12		18
187	94.03	11	428	DA	0			14.00/14.60	247	690		156/68
188	22.61	37	187	UC	5			14.10	59	36		54
189	28.58	20	204	DA	0			14.80	75	100		69
190	7.65	50	67	UC	4			14.50	20	13		18
191	11.54	33	244	UC	3			14.60	30	19		28
192	12.08	10	100	DA	0			14.30	32	21		29
193	4.32	10	124	UC	2	1A	150	14.70	11	7	11	10
194	4.35	13	151	UC	1			14.60	11	7		10
195	9.53	8	293	DA	0	/1C	350	14.80	25	48	4	23
196	10.08	30	221	UC	4	1C	350	14.80	26	18	6	24
197	18.79	42	233	UC	5			14.80	49	31		45
198	2.60	27	114	UC	1	1A/1C	600/250	13.00	7	5	6/2	6

1/ See page iii for symbol description.

and fire control is a very large benefit, especially when the terrain makes it possible. Another advantage is the ability to hand or animal yard because of the shorter yarding distances (Tables 21 and 22).

It is important to recognize the disadvantages of roading a plantation. Access for settlement may be a problem, or it could be a solution. Also, continued maintenance of the road system is necessary.

Only one design was developed for this site. However, a portion of this area would be conducive to monocable use. Such a design should be developed for comparison with the roading method.

Table 21. ESTIMATED HARVEST COSTS

LOCATION MINDORO ALTERNATIVE I

CUTTING

162,271 m^3 @ ₱ 5 /m^3 = ₱ [1/] 811,355

ROADS

Low standard:	-	km	@ ₱	-	/km	= ₱ -
High standard:	38.7	km	@ ₱	250,000	/km	= ₱ 9,675,000

YARDING

Hand:	₱ 72	/day x	51	days	= ₱	3,672
Animal [2/]:	₱ 122	/day x	3,555	days	= ₱	433,710
Small winch:	₱ 696	/day x	1,583	days	= ₱	1,101,768
Large winch:	₱ 1,816	/day x	1,173	days	= ₱	2,130,168
Crew:	3 men x ₱ 72	/day x	2756	days	= ₱	595,296

SWINGING

Animal:	₱ -	/day x	-	days	= ₱	-
Large winch:	₱ 1,816	/day x	375	days	= ₱	681,000
Crew:	3 men x ₱ 72	/day x	375	days	= ₱	81,000

LOADING

2 men x ₱ 72 /day x 5,220 days = ₱ 751,680

HAULING

Truck:	₱ 1,072	/day x	5,220	days	= ₱	5,595,840
Monocable:	₱ -	/day x	-	days	= ₱	-

Total Estimated Cost	= ₱	21,860,489
Volume Harvested	=	162,271 m^3
Cost/m^3	= ₱	134.72 /m^3
Cost/tonne	= ₱	168.40 /ton

[1/] ₱14 = $1 (US)

[2/] ₱50/day Carabao, ₱72/day man

[3/] 1 m^3 = .80 tonnes

Table 22. Summation of Costs by Alternative Plans

Project	Area (Hectares)	Dominant System/ Primary Transport	Man-days	Cost ₱/m³
Mindoro I	2704.52	Cable/Truck	39,940	135
Catanduanes I	743.06 1/	Cable/Cable	16,668	167
II	727.78	Cable/River	9,074	82
III	708.40	Cable/Monocable	9,500	133
Marinduque I	923.39	Cable/Truck	20,111	181
II	926.27	Cable/Monocable	19,843	604
Lambunao I	984.79	Cable/Monocable	15,823	130

1/ Some differences in area between Catanduanes I and II are a result of digitizing error. Differences between I, II and III are due to the fact that III had different boundaries. See maps Figures 14 and 17.

CONCLUSIONS

The most important finding of our investigation is the lack of comparative analysis of harvest systems that could be applied to the sites. In no case did we find that alternatives to the monocable were even considered. Also, there is an apparent lack of understanding of the difficulties of harvesting small stems on rough terrain. Statements made in reference to feeding the monocable were very general and consisted of "... small feeder winches will be used" (Trans Asia Engineering, 1982).

With the large investment that has or will be made in plant and plantation, there has been too little done to plan the harvesting. We see little evidence that the harvesting could maintain a steady flow of wood to the dendro plants.

The cost of wood to the plants needs to be determined before a decision can be made as to the feasibility of such a project. A major component of the real cost of wood is the cost of harvesting. These costs have not been generated except in this report, and as can be seen by the results (Table 22) vary with the situation. Let it be understood that these plans are "first run - minimum effort" approach. All sites should be anlayzed, at a minimum, in this manner before selection of harvesting equipment and MOST CERTAINLY before investing millions of pesos in power plants.

The selection of monocable systems is not necessarily wrong, because we feel there are places where they may be the best alterna-

tive (Table 22). We do, however, question whether these places have been determined as yet. The extreme costs and relative permanency of the system at many of the sites makes the selection of such a system questionable, especially in the early stages of the project. Once permanent, on-going plantations are established, and the plant is running smoothly, an upgrading of harvesting techniques to a monocable may be warranted.

We have attempted to use basic proven systems to initially start the harvesting process. Man-power and animal power has been brought into the plan where feasible. This is not to say that more could not be used, but we also feel that such a project cannot or should not rely on homemade winches that may or may not work. A project of this magnitude and importance must be planned realistically using available equipment by knowledgeable people. Haphazard wood supply is not acceptable when running a dendro plant.

Two areas of further effort will be necessary to make this project a success. First will be a serious effort in planning the harvesting for each site. This has already been stressed. It is our understanding that some of this has been done by Hodam and Associates (Dugan, 1984).

The second effort will be that once a plan has been developed, verified, and decided upon, a training effort will be necessary to train planners, operators, and investigators in the applications of the harvesting methods.

Without these to efforts the success of the project will be uncertain as to whether it will work and no large expenditure of monies for sophisticated systems will solve the problem

The purpose of these plans was to illustrate more than give a solution. It was to illustrate the differences and problems of harvesting difficult terrain, especially small stems. Before these plans could be put to use, an intensive field verification should be done. It should be understood that some changes in the plan may then be necessary.

The production rates that were generated in an attempt to determine manpower requirements may be questioned (see Appendix, Production Estimations). However, the approach and logic is sound even though the values may be different. Values will need to be determined for the operators as they develop skills in the different harvest techniques.

Equipment selection is not as critical as system or technique selection. There are many manufacturers of similar units; therefore, selection should be based upon price, dependability, and service.

We feel that the dendro-thermal project is possible on selected sites. We do not feel that sufficient study has been given to determining the harvest costs of the sites. On some sites the cost of harvesting will make the project uneconomical no matter what system is applied and should therefore not be attempted. Others may be harvested economically with several systems and enough planning should be conducted to select the best.

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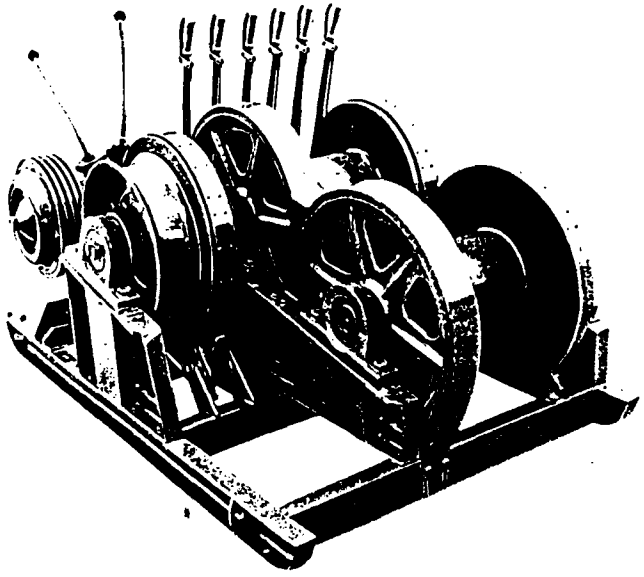
APPENDIX

Y形集材機シリーズ

Y12E

小形３胴集材機

信頼のマーク



巻上力：2080kg　重　量：825kg

中小規模の集材作業，土木建設作業にピッタリの軽量タイプ

- 集材作業はもちろん，先山での木寄せ，トラックへの積み卸しや，土木建設作業などにも広く利用できます。
- 正逆転各４段の変速段により，作業に合わせて適正な巻上力とスピードが選べ，エンジン出力にムダがなく，効果的です。
- 独創的な構造により分解搬送も可能。どなたにも簡単に分解，組付ができます。しかも，軽量で移動も容易です。
- 主要部分には密閉形のベアリングを採用していますので給油は不要。日常の点検整備が簡単です。

イワフジ工業株式会社

SPECIFICATIONS

IWAFUJI INDUSTRIAL CO., LTD.

Model		Y-12EC type 3 Drum Yarder							
Dimensions Overall length Overall width Overall height		2600 mm 1080 mm 1000 mm							
Drum		1st Drum		2nd Drum		Endless Drum			
Number of drums Spool diameter Width Frange diameter		1 228 mm 310 mm 550 mm		1 228 mm 310 mm 500 mm		1 360 mm 120 mm —			
Engine Model Type Number of cylinder Piston displacement Max. flywheel horeepower		YANMER NS-130C Water-cooled, diesel engine 1 751 cc 12 ps/2200rpm							
Main clutch		Dry type, single-disk type							
Drum clutch		Friction type, corn type							
Transmission		Gear shifting for 4 speeds forward and reverse, sliding mesh type							
Power drive system		V-belt and gear							
Cable capacity	Rope dia.	8 mm		10 mm		12 mm			
	1st drum	970 m		620 m		430 m			
	2nd drum	770 m		490 m		340 m			
Performance		Forward				Reverse			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th
Max. line pull (kg)	1st drum	1650	935	535	290	1385	780	450	245
	2nd drum	1640	935	535	290	1385	780	450	245
	Endless	1050	590	340	185	880	495	285	155
Max. line speed (m/min)	1st drum	30	50	85	160	35	60	105	190
	2nd drum	30	50	85	160	35	60	105	190
	Endless	45	80	135	250	55	95	160	250
Weight		approx. 1190 kg							

*Max. line pull: At engine max. torque & the mean diameter between full and bare drum.

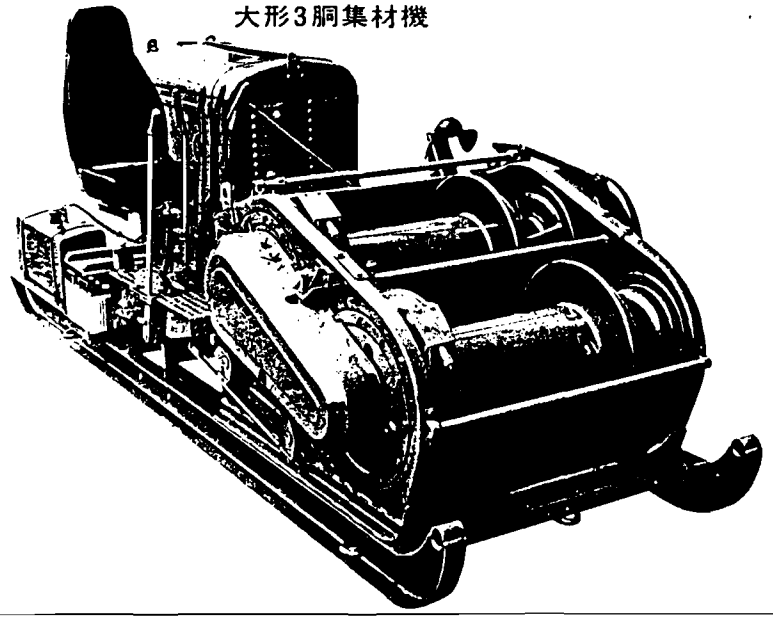
*Max. line speed: As above.

Y形集材機シリーズ

Y-32E

大形3胴集材機

信頼のマーク



■ ■ : 2550kg

幅広い集材と，高速，高能率を誇る強力機！

- どのドラムも操作の軽いドラムクラッチと強力なブレーキ付，2個のドラムのほかにエンドレスドラムを備え，あらゆる架線方式に使用出来ます。
- 1胴を横取りにあてることができるので，幅広い集材が出来ます。
- 余裕のあるエンジン，充分な速度段のトランスミッションと正逆転機の組合わせは，高能率を発揮します。
- セミモノコック構造のフレームは，外観もコンパクト，重量も軽く，現場の移動もスムーズです。
- エンジンクラッチは，単板油圧操作式で，エンジンブレーキも可能。また，操作も軽く疲労の軽減，安全の確保など万全の注意が払われています。

イワフジ工業株式会社

SPECIFICATICNS

IWAFUJI INDUSTRIAL CO., LTD.

Model		Y-32E Yarder								
Operating weight		255C kg								
Dimensions Overall length Overall width Overall height		42CC mm 165C mm 1650 mm								
Drum		1st Drum		2nd Drum		Endless drum				
Number of drums		1		1		1				
Spool diameter		32C mm		32C mm		443 mm				
Flange diameter		623 mm		623 mm		—				
Spool length		637 mm		637 mm		156 mm				
Engine Model Type Number of cylinders Piston displacement Max. horse power		ISUZU 6BD1PD-S 4 cycle, Water-cooled, Diesel engine 6 5785 c.c. 98 PS/2CCC r.p.m.								
Clutch	Engine	Dry, single-disc type ; Hydraulic control ; Hand operated								
	Drum	Internally expanding type ; Mechanical linkage control ; Hand operated								
Brake	1st, 2nd Drum	Band type ; Mechanical linkage control ; Foot operated								
	Endless Drum	Externally contracting type ; Mechanical linkage control ; Hand operated								
Transmission		5 speeds ; Constant-mesh in 1st Cynchro-mesh in 2nd, 3rd, 4th, 5th								
Reversing mission		Selective sliding gear type								
Cable capacity (m.)	Rope dia.	10 mm		12 mm		14 mm		16 mm		
	1st, 2nd Drum	1320		915		675		515		
Performance		Forward					Reverse			
	Speed	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
(1) Max. line pull (kg)	1st, 2nd Drum	3710	2110	1040	580	460	3090	1760	660	480	380
	Endless Drum	3950	2240	1100	620	490	3290	1870	920	520	410
(2) Max. line speed (m/min.)	1st, 2nd Drum	95	170	340	(500)	(500)	115	200	410	(500)	(500)
	Endless Drum	90	160	320	(500)	(500)	110	190	385	(500)	(500)
Fueltank capacity		55 ltr.								

(1) Max. line pull ; At engine max. torque & half drum
(2) Max. line speed ; At engine max. speed & half drum

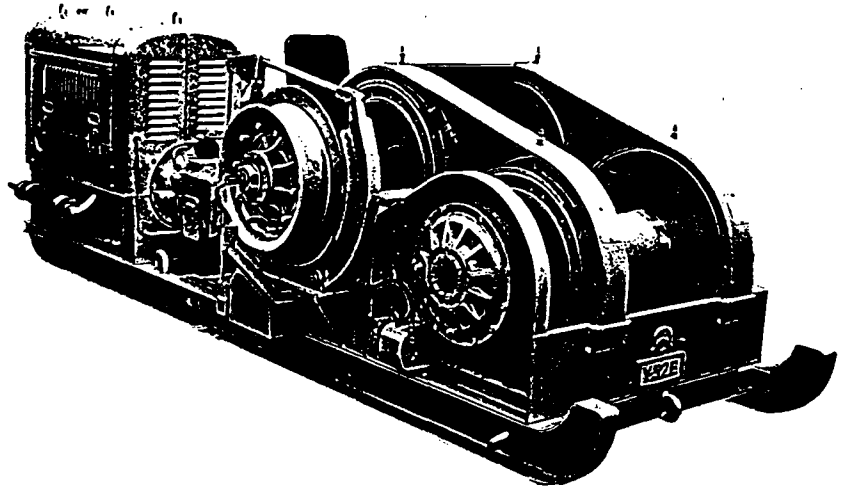
Oct. 30, 1982

Y形集材機シリーズ

Y52E

大形３胴集材機

信頼のマーク



巻上力：8620㎏　　重　量：5000㎏

超大型集材機の傑作機

- 巻込容量12㎜ロープで2.05km、大型機に比べ約約２倍の能力と容量を有しています。
- 普通ドラム２個と，サイドエンドレスドラム１個を装備していますので，あらゆる架線方式で使用できます。
- シンクロメッシュ付トランスミッションのため，ギヤの切換が迅速に行え，正逆４段の変速により高能率の作業ができます。
- ドラムクラッチ，ブレーキ，パーキングは空圧式を採用，操作は軽く，機能は確実，空圧が低下した場合，自動的に非常ブレーキが作動します。
- 高速回転部は，すべてケース内に納めるか，カバーでおゝわれているので低騒音型，安全性にも優れています。

イワフジ工業株式会社

SPECIFICATIONS

IWAFUJI INDUSTRIAL CO., LTD.

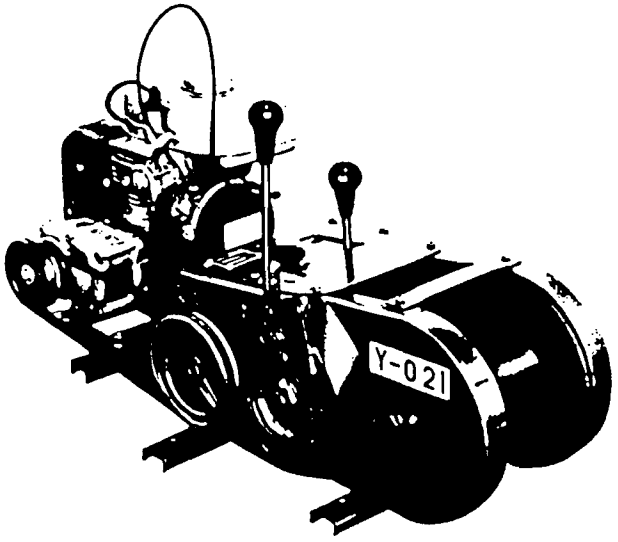
Model		Y-52E Yarder							
Operating weight		5000 Kg							
Dimensions Overall length Overall width Overall height		4670 mm 2245 mm 1525 mm							
Drum		1st Drum				2nd Drum			Endless Drum
Number of drums		1				1			1
Spool diameter		320 mm				320 mm			540 mm
Flange diameter		860 mm				760 mm			-
Spool length		640 mm				640 mm			150 mm
Engine Model Type Number of cylinders Piston displacement Max. horse power		ISUZU DA120P Diesel Engine 4 cycle, watercooled 6 6126 cc 92 PS/1950 rpm							
Engine clutch		Dry, single disc type with coil spring damper, Hydraulic control type, hand operated							
Drum clutch		Internal expanding type, Pneumatic control, hand operated							
Brake	1st, 2nd Drum	2 Band type, pneumatic control, Foot operated							
	Endless Drum	External contracting type, Pneumatic control, Foot operated							
Transmission		4 speeds ; Selective sliding type in 1st, 2nd Cynchro-mesh in 3rd, 4th							
Reversing mission		Selective sliding gear type							
Cable Capacity (m)		12 mm				14 mm			16 mm
	1st Drum	2050				1500			1150
	2nd Drum	1530				1120			860
Performance		Forward				Reverse			
		1st	2nd	3rd	4th	1st	2nd	3rd	4th
(1) Max. line pull (Kg)	1st Drum	4060	2270	1210	630	3470	1950	1030	540
	2nd Drum	5110	2860	1520	790	4370	2460	1300	680
	Endless Drum	5110	2860	1520	790	4370	2460	1300	680
(2) Max. line speed (m/min)	1st Drum	85	150	285	550	100	180	335	645
	2nd Drum	70	120	225	440	80	140	265	515
	Endless Drum	70	120	225	440	80	140	265	515
Fuel tank Capacity		94 ltr.							

(1) Max. Line pull; At engine max. torque & half drum
(2) Max. Line speed; At engine max. speed & half drum

フジパワーウインチシリーズ

Y-021

小形１胴ウインチ



信頼のマーク

間伐集材作業、土木建設作業に最適。

- 間伐集材作業はもちろん、先山での木寄せ、軽架線集材、トラクタウインチラインの引きもどし、積込作業、土木作業、荷揚運搬作業等、幅広い用途に利用できる多目的向きウインチです。
- 重量35kgと軽量、小型で現場移動も容易です。
- スレッド、スプリットエンドレスドラムはオプションで用意しております。

イワフジ工業株式会社

SPECIFICATIONS　　Y-021A MINI-WINCH

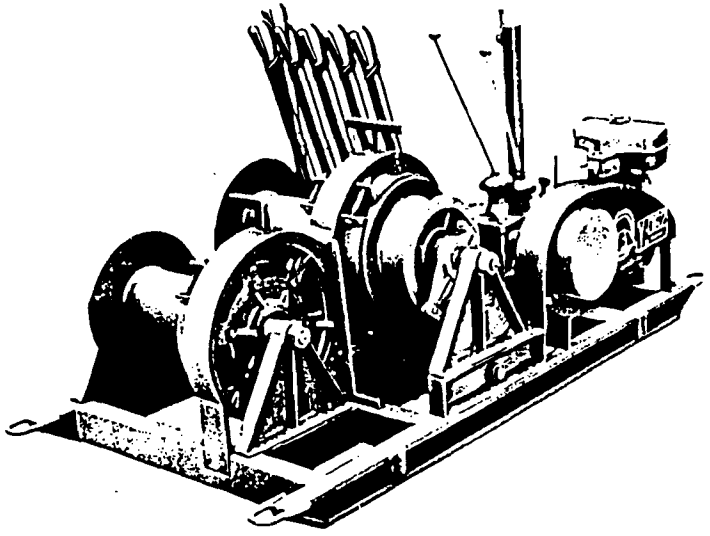
IWAFUJI INDUSTRIAL CO., LTD.

ITEMS		SPECIFICATIONS	
Dimensions			
Overall length		750 mm	
Overall width		380 mm	
Overall height		380 mm	
Drum			
Spool dia.		77 mm	
Spool length		130 mm	
Flange dia.		205 mm	
Engine			
Model		Fuji Robin EC06BC	
Type		Air cooled, 2 cycle, Gasolin engine	
Displacement		60.8 c.c.	
Max. horsepower		2.5 ps/2000 rpm	
Brake		Band type	
Transmission		Gear shifting, 1 speed for each forward & reverse	
Rope capacity	Rope dia.	6 mm	8 mm
		81 m	46 m
Line pull (mean)		200 kg	
Line speed (mean)		44 m/min	
Weight		35 kg	

Y形集材機シリーズ

Y-062E

小形3胴集材機



間伐集材作業、土木建設作業に最適。

- 間伐集材作業はもちろん、先山での木寄せ、土木建設作業等、幅広い用途に利用でき、多用途向ウインチです。
- 正逆転各3段の変速機を搭載、作業に合わせた適正な巻上力やスピードが選べ、エンジン出力を効率良く利用できます。
- 重量460kgと軽量、小型で現場移動も容易です。
- お客様のご希望により、各種エンジン搭載可能です。
- シートクッションはオプションで用意しております。

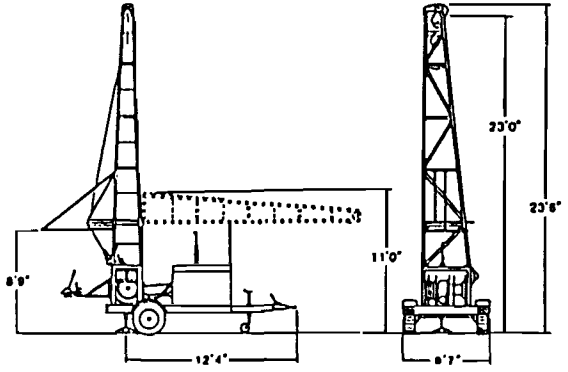
イワフジ工業株式会社

SPECIFICATIONS　　Y-062E MINI-WINCH

IWAFUJI INDUSTRIAL CO., LTD.

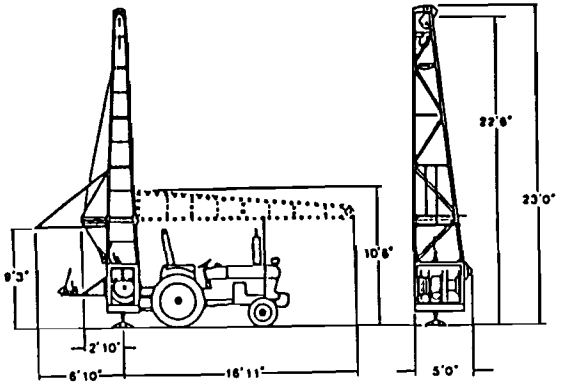
ITEMS		SPECIFICATIONS					
Dimensions Overall length Overall width Overall height		1797 mm 1045 mm 985 mm					
Drum		1st drum		2nd drum		Endless drum	
Spool diameter (mm) Spool length (mm) Flange diameter (mm)		161 300 355		161 300 355		243 --- 88	
Engine Model Type Displacement Max. horsepower		Fuji Robin EC17B Air cooled, 2 cycle, Gasoline engine 175 c.c. 6.5 ps/2000 rpm					
Engine clutch		Dry, Single disc type, Friction clutch					
Drum clutch		Cone type, Friction clutch					
Drum brake		Band type					
Transmission		Gear shifting, Sliding mesh, 3 speeds for each forward & reverse					
Rope capacity	Rope dia.	6 mm			8 mm		
	1st drum	600 m			340 m		
	2nd drum	〃			〃		
Performance		Forward			Reverse		
		1st	2nd	3rd	1st	2nd	3rd
Max. line pull (kg)	1st drum	465	305	200			
	2nd drum	〃	〃	〃			
	Endless drum	420	275	180	500	330	215
Max. line speed (m/min)	1st drum	73	110	168			
	2nd drum	〃	〃	〃			
	Endless drum	68	100	160	56	85	130
Weight		approx. 460 kg					

Koller K 300 YARDER SPECIFICATIONS



TRAILER-MOUNTED

Power source	Trailer's engine
Engine	Perkins 4.236 85.5 hp. at 2250 rpm.
Approx. weight	7,100 lbs.
Ave. mainline speed	885 ft./min.



TRACTOR-MOUNTED

Power source	Agricultural tractor
Engine	Minimum of 40 hp.
Approx. weight (without tractor)	3,500 lbs.
Ave. mainline speed (input 1000 rev./min.)	630 ft./min.

CAPACITIES AND PERFORMANCE			
	MAINLINE	SKYLINE	GUYLINE
CABLE CAPACITY	1150' of 3/8"	1150' of 5/8"	100' of 9/16"
MAXIMUM LINE PULL Bare Drum Average Drum	3,940 lbs.	9,900 lbs.	N/A

Koller CARRIAGE SPECIFICATIONS

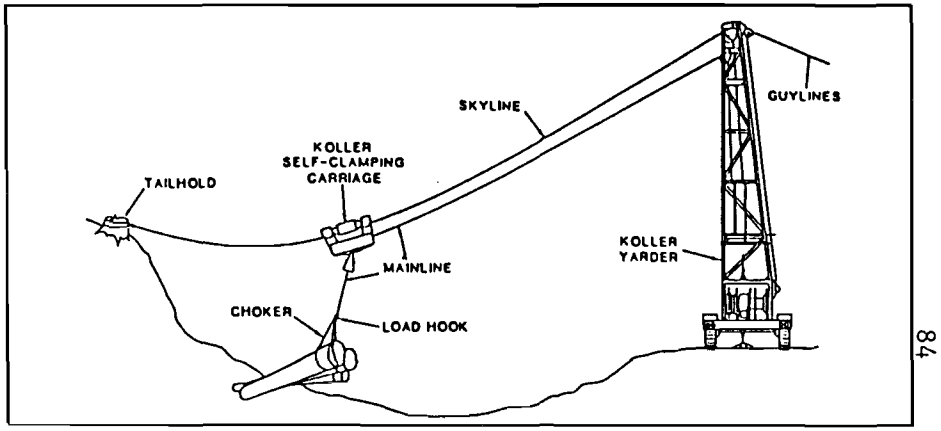
	SKA 1	SKA 2.5	SKA 5
LENGTH	38"	44"	55"
WIDTH	11"	12"	13"
HEIGHT	46"	54"	70"
WEIGHT (Approx.)	330 lbs.	550 lbs.	925 lbs.
SKYLINE	9/16"-5/8"	3/4"-1 1/4"	1 1/4"-2"
MAINLINE	5/18"-3/8"	1/2"-9/18"	5/8"-3/4"

CARRIAGE OPERATIONS:

SETTING THE CARRIAGE -- Roll the carriage down the skyline a little past the desired clamping position. Pull the carriage back to a point three feet uphill from the desired clamping position. Roll carriage back. In about three feet, the carriage will clamp automatically to the skyline and release the mainline and loadhook.

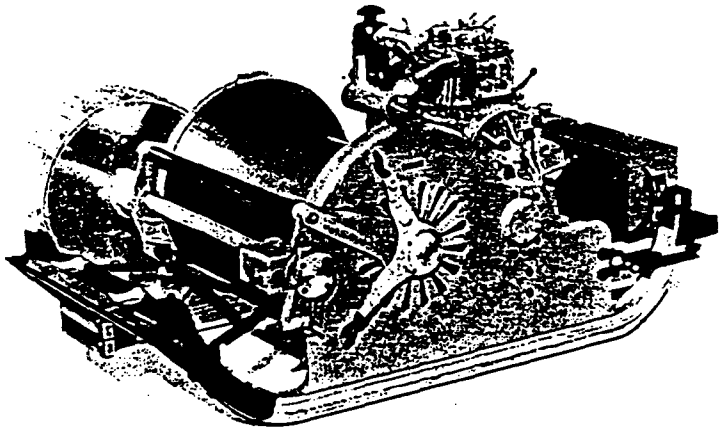
YARDING THE TURN -- Pull out the mainline and set the turn. Haul in the mainline. When the turn snugs up to the carriage the skyline clamp automatically releases, and the carriage clamps to the loadhook for yarding to the landing.

UNHOOKING -- At the landing, let the carriage roll back down the skyline about three feet. The carriage will clamp automatically to the skyline and release the loadhook.



Specifications may change. Check with your dealer.

- built in 5 standard sizes; W-20, W-30, W-60, W-90, W-200
- driven by air-cooled diesel engines with electric starter (by special order also equipped with gasoline or electric engines)
- special spur-gear system with 6 and 8 speeds. Teeth and shafts case-hardened and most of them ground
- big, smooth-working shoe-brake inside the cable drum
- adjustable air-brake (each brake is able to hold the heaviest load independently of the other brake)
- very strongly built of best material with a minimum of weight
- able to drive by its own power, cable and winch up to 100 % slope, straight and zig-zag
- compact, safe and well constructed
- can be equipped to drive pendulum as well as circular cableways

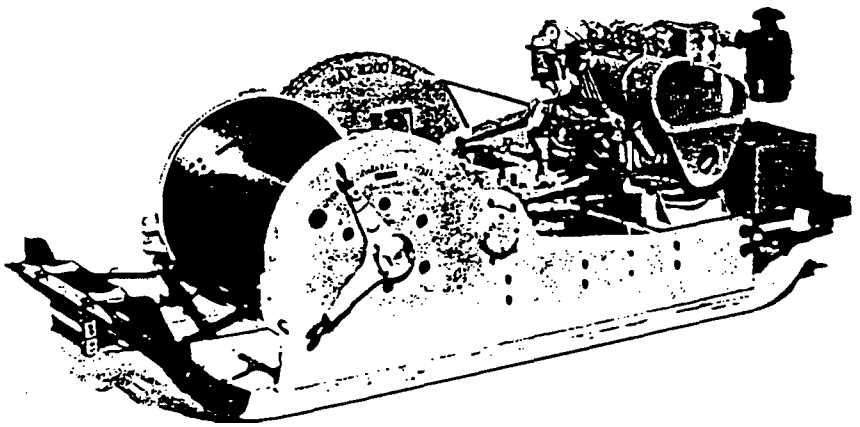


Yarder Type W-20

Diesel Engine 15.5 H. P.

Cable Ø	Drum capacity	Load capacity
3/8 inch	5900 feet	3300 lbs
7/16 inch	4900 feet	4400 lbs
1/2 inch	3900 feet	5500 lbs

6 speeds from 0.7 to 14.5 feet per sec.
pulling power; 440 to 9680 lbs
weight: 1900 lbs



Yarder Type W-30

Diesel Engine 35 H. P.

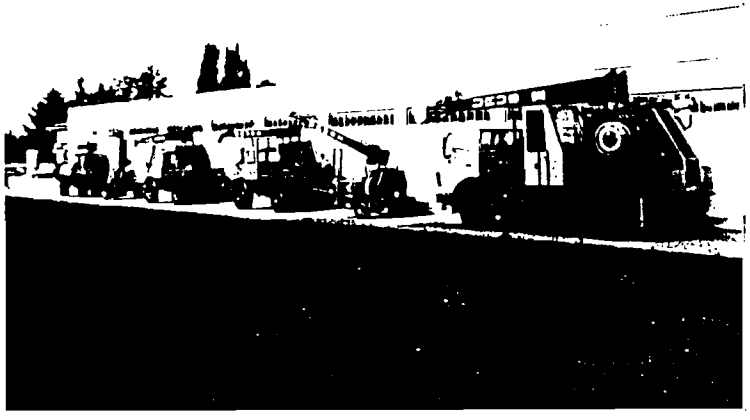
Cable Ø	Drum capacity	Load capacity
3/8 inch	6400 feet	3300 lbs
7/16 inch	5400 feet	4400 lbs
1/2 inch	4300 feet	5500 lbs

6 speeds forward and 6 reverse from 1,65 to 22 feet per sec.
pulling power: 770 to 8140 lbs
weight: 2700 lbs

REINHOLD HINTEREGGER
MASCHINEN- UND SEILBAHNBAU
KÄRNTEN · VILLACH · AUSTRIA

HOLZMESSE 1983 Klagenfurt

1 + 2 - Eine URUS-Kolonne auf Mercedes Trucs montiert, vor der Fabrik, Abfahrt zur Holzmesse
A column of URUS Tower Yarders fitted on Mercedes Trucs in front of the plant, starting to the WOOD FAIR



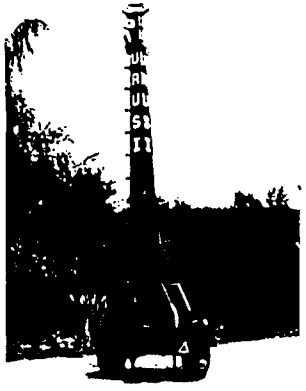
URUS

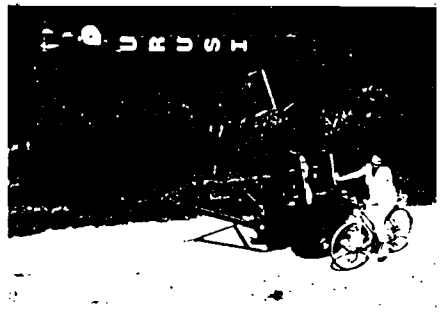
URUS I - UNIVERSAL TOWER YARDER
in high quality and best design, suitable for uphill and downhill logging and side skidding of landed logs.
Equipment: Skyline winch, Mainline winch, Haulback line winch and 2 Rigging winches

Tractor with URUS I on three-point hitch with tower down for road transport

Tractor with URUS I on three-point hitch with hydraulically lifted tower

URUS I, tractor-driven, fitted on trailer, with tower down for road transport





URUS I, tractor-driven, fitted on trailer can anywhere put down, with tower lifted or lowered. See advantages back!

Reinhold Hinteregger
Maschinen- und Seilbahnbau
9500 Villach
Zehenthofstraße 33
Postfach 42 · Telefon 24258

Production equations were developed for each activity based upon the following primary assumptions:

1) Volume/hectare at time of harvest = 60 m^3
2) Productive day = 8 hours

Cutting (with Bowsaw)

$$\text{Production/man-day } (m^3) = \frac{SH}{FT\ (1 + \Sigma\ TA)}$$ [1/]

$$= \frac{8\ h}{.29\ (1 + .20)} = 22.85\ m^3/\text{man-day}$$

SH = shift hours
FT = felling time in man-hours/m^3 = .29 bowsaw
TA = temperature adjustment
temperature 30°C, humidity 80%

$$\text{Felling costs/m}^3 = \frac{\text{Wages/day (1 + Fringe) + Owning Costs}}{\text{Production/man-day}}$$

$$= \frac{₱50\ (1 + 1.2) + 0\ \text{man-day}}{22.85\ m^3\ \text{man-day}} = ₱4.81/m^3$$

$$= \underline{\underline{₱5/m^3}}$$

where:

wages/man-day = ₱50
fringe benefits = 120%
owning costs = not calculated since bolo or saw would be locally produced

Yarding

A. Hand carrying assumptions:

1) One man can carry a piece 10 cm x 2.7 m or .02 m^3
2) Base daily production @ 50 m = 4 m^3/man-day
3) Production reduced 20% for uphill
increased 10% for downhill

B. Carabao yarding assumptions:

1) One team = 1 man, 1 carabao
2) Volume per turn = .8 m^3 maximum
3) Speed uphill or downhill, loaded or unloaded = 1094 m/h
4) Turn time round trip

1/ FAO Forestry Paper 2, Planning forest roads and harvesting systems. Food and Agriculture Organization of the United Nations, Rome 1977.

$$\text{Turn time (hours)} = \frac{\text{AYDS x 2}}{\text{1094 m/h}}$$

AYDS = Average yarding distance (slope)

$$\text{Turns/day} = \frac{\text{8 h/day}}{\text{turn time}}$$

Volume Yarded/day = Turns/day x Volume/turn

$$\text{Days required to harvest unit} = \frac{\text{Volume available}}{\text{Volume production/day}}$$

$$\text{Days Required} = \frac{\text{(Unit Area) AYDS}}{58.3467}$$

C. Cable yarding assumptions:

1) Unit production is a function of the number of setups of the cableway
2) Setup time is a function of the supports required
3) Required support structures are based on AYDS and not on the total span length in this analysis. Final planning will require field verification and support design before implemetation. The distance between supports is estimated as 125 meters.
4) Erection time for constructed supports = .25 crew days
5) 50% of required supports will be erected
6) Crew size for cable yarders = 1 operator and 3 workers
7) Setup time for yarding = .5 crew days
8) Two different yarders will be necessary. For this analysis, the IWAFUJI Y-12E and Y-52E have been used (see specifications page). Other yarders are applicable but lack of data was a guide
9) Estimated paylaod (designed) = .6 m^3
   10 pieces (10 cm x 8.1m)
10) Average turn time = 6.6 minutes
11) 9.1 turns/hour @ .6 m^3/turn = 5.45 m^3/hour production
12) Lateral yarding distance = 100 meters

Area Harvested/day = .73 hectares

Therefore,

Harvest Time Required/Unit (HTR)

$$\text{HTR} = .5 \text{ days (NOS)} + \frac{\text{AYDS}}{125} \text{(NOS)(.25)}$$

where

NOS = Number of Setups
AYDS = Average yarding distance (slope)

Swinging

Swinging is the transfer of yarded wood to a point of loading either into a truck, river or monocable. Several swings may be necessary for remote units.

Assumptions:

1) Swings are designed for each unit although careful planning can utilize a swing for many units
2) Swing production and costs are a function of
   a. swing distance
   b. rigging requirements
   c. payload capacity
3) Designed paylaod = 1 m^3/turn
4) Hook and unhook time = 2 minutes/turn
5) Line speed = 225 meters/minute
   based on mainline winch of IWAFUJI Y-52E in 3rd gear
6) Rigup time is a function of skyline
   (swing distance, horizontal)
   0-499 meters = 2 days
   500 + meters = 3 days
7) Animal swings are the same as for carabao yarding

$$\text{Turn time (minutes)} = 2 \text{ minutes} + \frac{\text{Swing Distance (m)}}{225\text{m/min}}$$

Days Required/Units = (Area Volume) Cycle time + Rigup

Hauling

A. Truck hauling assumptions:

1) Load size = 10 m^3
2) Loading time = 2 hours
3) Hauling speed = 24.14 km/hour
4) Production on round trip

Days Required/Harvest Unit =

$$\frac{\text{AREA (HD)}}{16093.3} + 1.5 \text{ (AREA)}$$

HD = haul distance in meters
AREA = unit area in hectares

B. Monocable hauling assumptions:

1) Speed of monocable = 4320 m/h
2) Loading = 3.3 m^3/man-hour
3) Production for a 3-man crew loading, unloading, and transport = 10 m^3/h/2 km

Days Required/Harvest Unit = 3.75 (AREA)(HDIST)

MACHINE OPERATING COST ESTIMATE [1/]

Machine LASSO MONOCABLE (Catanduanes)

Delivered Cost ₱4,005,000

Life in Years 15 Hours per year 2,000 life 30,000

Fuel: Type Diesel Price per litre ₱ 7

Operator: Rate per hour ₱10 Fringe benefits 120%

Cost Component

(a) Depreciation = $\frac{\text{Delivered Cost x .90}}{\text{life in hours}}$ = ₱ 120

(b) Interest = $\frac{\text{Delivered Cost x .60 x Interst Rate}}{\text{Average hours per year}}$ = 180

(c) Insurance = $\frac{\text{Delivered Cost x .60 x .03}}{\text{Average hours per year}}$ = 36

(d) Taxes = $\frac{\text{Annual Tax Amount}}{\text{Average hours per year}}$ = -

(e) Operating Labor = $\frac{\text{Labor Cost per period x (1 x f)}}{\text{Machine hours in period}}$ = 22

where f = cost of labor fringe benefits expressed as % of direct labor cost

(f) Fuel = GHP x X x CL = 42

where GHP = gross engine horsepower
CL = fuel cost per litre
X = .12 for diesel, .175 for gasoline

(g) Oils & Grease = $\frac{\text{GHP x .20}}{100}$ = 1

(h) Servicing and Repairs [2/] = $\frac{\text{Delivered Costs}}{\text{Life in hours}}$ = 200

Total = ₱601 per hour

1/ FAO Forest Paper 2, Planning forest roads and harvesting systems Food and Agriculture Organization of the United Nations, Rome, 1977

2/ Maunder, Keith "The Lasso Cable System" supplied by Lasso Technik AG.

MACHINE OPERATING COST ESTIMATE [1/]

Machine LASSO MONOCABLE (Lambunao)

Delivered Cost ₱4,309,000

Life in Years 15 Hours per year 2,000 life 30,000

Fuel: Type Diesel Price per litre ₱ 7

Operator: Rate per hour ₱10 Fringe benefits 120%

Cost Component

(a)	Depreciation = $\frac{\text{Delivered Cost x .90}}{\text{life in hours}}$	= ₱	129
(b)	Interest = $\frac{\text{Delivered Cost x .60 x Interst Rate}}{\text{Average hours per year}}$	=	194
(c)	Insurance = $\frac{\text{Delivered Cost x .60 x .03}}{\text{Average hours per year}}$	=	39
(d)	Taxes = $\frac{\text{Annual Tax Amount}}{\text{Average hours per year}}$	=	-
(e)	Operating Labor = $\frac{\text{Labor Cost per period x (1 x f)}}{\text{Machine hours in period}}$	=	22
	where f = cost of labor fringe benefits expressed as % of direct labor cost		
(f)	Fuel = GHP x X x CL	=	42
	where GHP = gross engine horsepower CL = fuel cost per litre X = .12 for diesel, .175 for gasoline		
(g)	Oils & Grease = $\frac{\text{GHP x .20}}{100}$	=	1
(h)	Servicing and Repairs [2/] = $\frac{\text{Delivered Costs}}{\text{Life in hours}}$	=	215
	Total	=	₱642 per hour

1/ FAO Forest Paper 2, Planning forest roads and harvesting systems Food and Agriculture Organization of the United Nations, Rome, 1977

2/ Maunder, Keith "The Lasso Cable System" supplied by Lasso Technik AG.

MACHINE OPERATING COST ESTIMATE [1]

Machine 2 LASSO MONOCABLES (Marinduque)

Delivered Cost ₱8,234,417

Life in Years 15 Hours per year 2,000 life 30,000

Fuel: Type Diesel Price per litre ₱ 7

Operator: Rate per hour ₱10 Fringe benefits 120%

Cost Component

(a) Depreciation = $\frac{\text{Delivered Cost x .90}}{\text{life in hours}}$ = ₱ 247

(b) Interest = $\frac{\text{Delivered Cost x .60 x Interst Rate}}{\text{Average hours per year}}$ = 371

(c) Insurance = $\frac{\text{Delivered Cost x .60 x .03}}{\text{Average hours per year}}$ = 74

(d) Taxes = $\frac{\text{Annual Tax Amount}}{\text{Average hours per year}}$ = -

(e) Operating Labor = $\frac{\text{Labor Cost per period x (1 x f)}}{\text{Machine hours in period}}$ = 44

where f = cost of labor fringe benefits expressed as % of direct labor cost

(f) Fuel = GHP x X x CL = 84

where GHP = gross engine horsepower
CL = fuel cost per litre
X = .12 for diesel, .175 for gasoline

(g) Oils & Grease = $\frac{\text{GHP x .20}}{100}$ = 2

(h) Servicing and Repairs [2] = $\frac{\text{Delivered Costs}}{\text{Life in hours}}$ = 412

Total = ₱1234 per hour for system

[1] FAO Forest Paper 2, Planning forest roads and harvesting systems Food and Agriculture Organization of the United Nations, Rome, 1977

[2] Maunder, Keith "The Lasso Cable System" supplied by Lasso Technik AG.

MACHINE OPERATING COST ESTIMATE [1/]

Machine TRUCK

Delivered Cost ₱420,000

Life in Years 10 Hours per year 2400 life 24,000

Fuel: Type Diesel Price per litre ₱ 7

Operator: Rate per hour ₱6 Fringe benefits 120%

Cost Component

(a) Depreciation = $\frac{\text{Delivered Cost x .90}}{\text{life in hours}}$ = ₱ 16

(b) Interest = $\frac{\text{Delivered Cost x .60 x Interst Rate}}{\text{Average hours per year}}$ = 16

(c) Insurance = $\frac{\text{Delivered Cost x .60 x .03}}{\text{Average hours per year}}$ = 3

(d) Taxes = $\frac{\text{Annual Tax Amount}}{\text{Average hours per year}}$ = -

(e) Operating Labor = $\frac{\text{Labor Cost per period x (1 x f)}}{\text{Machine hours in period}}$ = 13

where f = cost of labor fringe benefits expressed as % of direct labor cost

(f) Fuel = GHP x X x CL = 59

where GHP = gross engine horsepower
CL = fuel cost per litre
X = .12 for diesel, .175 for gasoline

(g) Oils & Grease = $\frac{\text{GHP x .20}}{100}$ = 1

(h) Servicing and Repairs [2/] = $\frac{\text{Delivered Costs}}{\text{Life in hours}}$ = 18

(i) Tires = .006 x Cost of Replacement
.006 x 14,000 = 8

TOTAL = ₱134 per hour

1/ FAO Forest Paper 2, Planning forest roads and harvesting systems Food and Agriculture Organization of the United Nations, Rome, 1977

2/ Maunder, Keith "The Lasso Cable System" supplied by Lasso Technik AG.

MACHINE OPERATING COST ESTIMATE [1/]

Machine IWAFUJI Y-12E Feeder Winch

Delivered Cost ₱140,000

Life in Years 5 Hours per year 2400 life 12,000

Fuel: Type Diesel Price per litre ₱ 7

Operator: Rate per hour ₱10 Fringe benefits 120%

Cost Component

(a) Depreciation = $\frac{\text{Delivered Cost x .90}}{\text{life in hours}}$ = ₱ 11

(b) Interest = $\frac{\text{Delivered Cost x .60 x Interst Rate}}{\text{Average hours per year}}$ = 5

(c) Insurance = $\frac{\text{Delivered Cost x .60 x .03}}{\text{Average hours per year}}$ = 1

(d) Taxes = $\frac{\text{Annual Tax Amount}}{\text{Average hours per year}}$ = -

(e) Operating Labor = $\frac{\text{Labor Cost per period x (1 x f)}}{\text{Machine hours in period}}$ = 22

where f = cost of labor fringe benefits expressed as % of direct labor cost

(f) Fuel = GHP x X x CL = 10

where GHP = gross engine horsepower
CL = fuel cost per litre
X = .12 for diesel, .175 for gasoline

(g) Oils & Grease = $\frac{\text{GHP x .20}}{100}$ = 1

(h) Servicing and Repairs [2/] = $\frac{\text{Delivered Costs}}{\text{Life in hours}}$ = 37

Total = ₱ 87 per hour

1/ FAO Forest Paper 2, Planning forest roads and harvesting systems Food and Agriculture Organization of the United Nations, Rome, 1977

2/ Maunder, Keith "The Lasso Cable System" supplied by Lasso Technik AG.

MACHINE OPERATING COST ESTIMATE [1]

Machine IWAFUJI Y-52E Yarder

Delivered Cost ₱420,000

Life in Years 10 Hours per year 2400 life 24,000

Fuel: Type Diesel Price per litre ₱ 7

Operator: Rate per hour ₱10 Fringe benefits 120%

Cost Component

(a) Depreciation = $\frac{\text{Delivered Cost x .90}}{\text{life in hours}}$ = ₱ 16

(b) Interest = $\frac{\text{Delivered Cost x .60 x Interst Rate}}{\text{Average hours per year}}$ = 16

(c) Insurance = $\frac{\text{Delivered Cost x .60 x .03}}{\text{Average hours per year}}$ = 3

(d) Taxes = $\frac{\text{Annual Tax Amount}}{\text{Average hours per year}}$ = -

(e) Operating Labor = $\frac{\text{Labor Cost per period x (1 x f)}}{\text{Machine hours in period}}$ = 22

where f = cost of labor fringe benefits expressed as % of direct labor cost

(f) Fuel = GHP x X x CL = 77

where GHP = gross engine horsepower
CL = fuel cost per litre
X = .12 for diesel, .175 for gasoline

(g) Oils & Grease = $\frac{\text{GHP x .20}}{100}$ = 1

(h) Servicing and Repairs [2] + Cable replacement = $\frac{\text{Delivered Costs}}{\text{Life in hours}}$ = 92

Total = 227 per hour

[1] FAO Forest Paper 2, Planning forest roads and harvesting systems Food and Agriculture Organization of the United Nations, Rome, 1977

[2] Maunder, Keith "The Lasso Cable System" supplied by Lasso Technik AG.

EVALUATION OF ELECTRICAL INTERCONNECTION ASPECTS OF DENDRO THERMAL PROJECT FOR THE NATIONAL ELECTRIFICATION AGENCY (N.E.A.) GOVERNMENT OF THE PHILIPPINES

September 1984

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I. INTRODUCTION

The National Power Corporation (NPC) had available 4324 MW of generation capacity in 1982. The mix among the different fuel sources is shown below:

Generation Type	% of Total
Oil Based	57.6
Hydro	21.5
Geothermal	20.6
Coal	0.3

Since 1977, NPC has been engaged in an all out effort to reduce the dependency on oil based plants. The decline of the share of oil based plants was brought about by a 29% growth in production of geothermal plants in 1982. Output of oil based and hydropowered plants increased by less than 6% and 1%, respectively. The two primary objectives of NPC are reduction of imported oil and bringing the benefits of electricity to the nonelectrified parts of the country.

The objectives of NEA coincide closely with those of NPC. NEA is fulfilling the historical REA role of bringing power to nonelectrified areas.

The dendro concept, which is being sponsored largely under the auspices of NEA, grew out of the need for displacing oil fired generation. The concept consists of utilizing small wood burning power plants delivering power to local cooperatives and feeding surplus back into the NPC system.

Among the additional benefits realized are furnishing aid to the local economy through employment, conservation, and forestation.

The concept behind the dendro program is sound and it necessitates close coordination among a number of different entities. The concept of reforestation and the growing of the fuel obviously must be coordinated with the production needs of the dendro plants. There must be coordination between NEA and NPC because of the technical questions associated with interconnection.

This report will focus on the technical details associated with this enterprise, particularly the facilities for interconnection of power from the dendro thermal power plants to the NPC transmission grid.

II. SUMMARY AND CONCLUSION

The original feasibility studies for dendro thermal power in the Philippines did not include detail plans for interconnection of the power output from dendro thermal plants to the NPC transmission grid or to the REC distribution system. The result has been the series of deficiencies described in the report (excessive voltage drop, frequency and synchronization difficulty, etc.).

It is my recommendation that, prior to any further work being done at the dendro sites, the entire site selection process be reviewed with appropriate input from an electrical consultant who can assess such factors as economic conductor size, economic transmission voltage, voltage drop, losses, coordination of the protective devices, and transfer capability. This is a vital step in engineering that has not been done. This will require detailed engineering studies for each site.

1. For the plants not yet constructed: Some site changes may be necessary. Detailed estimates for transmission or distribution facility changes must be made. The transmission or distribution work must proceed so as to be in place when the dendro plant is ready for commercial operation.

2. For the plants that have been constructed and are operating: Determine what changes (if any) are necessary in the transmission/distribution system. If costs are prohibitively high, it may be necessary to live with some operating limitations. First priority should be given to completing work on transmission or distribution systems for plants presently installed and operable so as to realize economic benefit as soon as possible.

   In all cases, NPC should be kept aware as to what is planned. NPC will require certain equipment (e.g., protective relays) prior to allowing hookup to their system.

Chapter IV.D contains a list of miscellaneous recommendations.

III. DENDRO THERMAL PLANTS

A. BRITISH POWER PLANTS

The British systems have been engineered by Balfour Beatty Engineering Ltd. and are nominally sized at 3.1 MW. The boiler is of the "Fraser" design and supplies steam at 327 psi (22.2 bar) with a superheater outlet temperature at 559°F (239°C) and a full load steam flow at 45,980 lb/hr (20,400 kg/hr). Steam is fed to a Brotherhood 7-stage marine type turbine which drives a Parsons-Peebles generator. All major systems are "off-the-shelf" British items. Fuel is fed to the boiler in log form, fed into the negative draft furnace through a slot in the boiler front.

B. FRENCH STEAM PLANTS

The French steam plants have been engineered by Alsthom Atlantique and are nominally sized at 3.4 MW. The boiler is of a water tube design with an operating pressure at 605 psi (41 bar). Steam is fed to a 3-stage Rateau turbine at a final temperature of 700°F. Fuel is fed to the furnace in a pulverized form after two stages of crushing.

C. FRENCH GASIFIER PLANTS

The French gasifier plants are being built by Moteurs Duvant and consist of downdraft wood gasifiers powering dual fuel diesel engines.

D. JAPANESE STEAM PLANTS

Japan has tentatively agreed to supply ten nominally 3 MW steam plants starting in 1986. The designs are being produced with the Manila based A/E firm of MIESCOR.

E. AMERICAN STEAM PLANTS

The U.S. has tentatively agreed to supply three nominally 5.0 MW steam plants to be built in 1985. These plants are to be designed by Stone and Webster.

Table 1 lists the 10 sites presently completed or being completed, and 4 sites for which equipment is on hand but not installed.

Two of the sites (at OMECO and ANTECO) utilize two 480 kW units each.

The small size of these units is such that no distribution line problems will be encountered.

In its final form, a total of 70 sites may be developed.

TABLE 1

DENDRO THERMAL PLANTS

Project			
Cooperative	Designation	Capacity (MW)	Nationality
1. Abreco	San Juan	3.4 *	French
2. Inec	Solsona	3.1	British
3. Iseco	Burgos	3.4	French
4. Panelco I	Bolinao	3.4	French
5. Iselco I	Jones	3.1	British
6. Iselco II	Ilagan	3.1	British
7. Nuvelco	Dupax	3.1 *	British
8. Zameco	Palauig	3.1	British
9. Omeco	Magsaysay	0.96 **	French
10. Marelco	Buena Vista	3.4 *	French
11. Casureco IV	Caramoan	3.1	British
12. Anteco	Hamtic	0.96 **	French
13. Akelco	Nabas	3.4 *	French
14. Ileco II	Lambunao	3.4	French

* Equipment on hand.

** French Gasifier Units - two @ 480 kW each. Because of small size, no transmission problems are anticipated.

IV. ANALYSIS

A. NEED FOR DETAILED ENGINEERING (Electrical Considerations)

Factors which enter into dendro site selection are:

1. Proximity to fuel and water.
2. Environmental restrictions including land use.
3. Electrical proximity to load.
4. Electrical proximity to NPC facilities.

Ideally, proper consideration for factors 3 and 4 above will result in minimum transmission investment and line losses. In addition, it will result in maximum power transfer capability between the dendro unit and the NPC system, thus permitting full power interchange between the Cooperative and NPC.* A lesser, but nevertheless important, benefit will be a reliable outside source of power for the necessary auxiliaries so as to enable avoiding using the diesels for a "black start," after a plant outage.

Final site selection represents a compromise among these criteria.

Normally when generation facilities are under study, a major area of concurrent study is the transmission and distribution system to insure that it possesses sufficient capacity to accept the full plant output and transmit it to the point of use.

If these studies reveal shortcomings in the transmission/distribution system, then the necessary upgrading of this system is designed and constructed so as to be in place when the new generation facilities are operable.

In the case of the dendro project, no detailed transmission distribution studies were conducted. The original feasibility studies considered only the costs associated with the plants. As a result, as the dendro plants near their completion dates, transmission/distribution deficiencies take the form

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*See discussion "Power Transfer Capability" in the Appendix.

of excessive voltage drop, frequency and synchronization difficulties, and inability to attain full plant output.

The corrective measures to be implemented are as follows:

1. Undertake the necessary engineering studies for each dendro site to determine any weaknesses in the existing system.

2. For those systems found to be inadequate, design and contract the system additions to provide adequate capacity. Such additions will generally consist of lines, substations, and associated equipment and will probably have to be reviewed jointly with NPC.

3. Where possible, the high side voltage of each dendro plant main power transformer should not be specified until the above mentioned engineering studies are complete.

The implementation of steps 1 and 2 above is an undertaking of substantial magnitude and will require time and funds. It should move in parallel with the construction schedule of the dendro units, so that when the units go into full load production, the transmission system will be adequate to deliver all the power.

Because of their small size (480 kW), the French gasifier units should not be a problem. However, because of their larger size (3 to 5 MW), the French, British, Japanese, and American units should be investigated as stipulated under steps 1 and 2 above.

In conclusion, it should be noted that the studies referred to herein will have to be performed and any facilities prescribed by the studies will have to be constructed in any event (because the work has not been done). The important thing is to pick up this neglected phase of the work and accelerate the studies with all speed.

B. ISOLATED VERSUS INTERCONNECTED OPERATION

Two modes of operation are possible for the dendro units:

1. Isolated Operation: Where the dendro unit separately supplies power to an isolated portion of the Cooperative system with the remainder of the system still supplied by NPC.

2. Interconnected Operation: Where the dendro unit supplies power to the entire contiguous Cooperative system in parallel with the NPC supply.

Isolated generation does not allow the sale of surplus energy to NPC as well as economic loading of generation. Unquestionably, interconnected operation is far more preferable to isolated operation from the point of view of economics, satisfactory customer service, and efficient equipment utilization.

C. INTERCONNECTED OPERATION NEA/NPC

The general subject of interconnected operation covers:

1. Metering.
2. Switching procedures.
3. Communications.
4. Sale of surplus power to NPC.
5. Wheeling of power for NEA by NPC.
6. Backup.

In its negotiations with NPC, NEA should attempt to obtain a standard interconnection agreement applicable to all dendro installations. This is preferable to piecemeal negotiations on a case-by-case basis.

1. Metering

A standard "out" kWh meter with detents is adequate to measure power into the NPC system. The meter should have a demand drag needle. If finances permit, a digital meter would probably be worth the expense because it permits detailed analysis of load patterns.

If a distinction is made between "on-peak" and "off-peak" energy, the meter will have to be time calibrated. The former is the more valuable commodity. A kilowatt of capacity when the electrical system is operating near peak is more valuable than a kilowatt at 2:00 a.m. in the extreme light load period. The surplus output of the dendro units fed back to NPC may have to be broken down into these two components for pricing purposes. If so, a metering setup which distinguishes between on-peak and off-peak utilization is required. Two kilowatt hour meters with separate clock systems are sufficient.

2. Switching Procedures

The importance of coordinating switching procedures cannot be overemphasized. The three out-of-phase closures at Ilagan highlight the improvements that must be made in this area.

3. Communications

Most dendro plants have VHF base station equipment. This permits their communicating to the Cooperative headquarters. The individual Cooperative headquarters in turn are linked to the NEA office in Manila. A channel may have to be provided so that each NEA office can communicate with the NPC dispatch so as to permit proper control of switching and restoration procedures after outages.

4. Sale of Surplus Power to NPC

This is vital to the economic viability of the Cooperative. In addition, it is of help to NPC in avoidance of capital constructions, as well as oil consumption. Price should be the "avoided cost."

5. Wheeling of Power for NEA by NPC

This will allow dendro units to secure a transmission path to feed other neighboring Cooperatives and thus extend benefits. It is feasible for a

dendro unit to be utilized to serve an adjacent Cooperative. A wheeling agreement is needed under which power can be delivered over the intervening NPC facilities. Normally such arrangements are handled by designing a "contract path" between the point of generation and the point of delivery and charging a flat wheeling charge of so many mills per kilowatt hour plus a loss allowance.

6. Backup and Reserve

This covers the subject of reserve (spinning and ready) and the related subject of backup.

There are two principle types of reserve:

1. Spinning Reserve: Is in the form of unused electrical generating capacity already synchronized and ready for instant use in the event of loss of other units. This is a most valuable form of reserve.

2. Ready Reserve: A second type of reserve of lesser value. This assumes that the plant can be started up and brought on line usually within some specified period of time. This latter type reserve is not immediately available for the system, but must be started up after an outage. If there is a widespread power outage, this may have to be done from a black start.

Preferably, an interconnection agreement can be negotiated which covers all dendro units collectively. If negotiations are conducted for one single dendro (or one at a time in piecemeal fashion), reserve and backup will probably have to be supplied by NPC and there may be a cost for this service.

If, on the other hand, 10 dendro units are assumed to be interconnected, the dendros can furnish their own reserve. Specifically, loss of one unit can be covered by the overload capacity of the remaining nine with little, if any, reliance on NPC.

Unloaded or excess thermal capacity, spinning and synchronized to the system, can be self-furnished. The units must, however, have a proven satis-

factory record of reliable operation.

Reserve is frequently reviewed as to its acceptability to the overall integrated pool by an operating committee which investigates the quality of the units to assure that they fulfill suitable availability criteria.

For scheduled maintenance outages of the dendro units, an interchange or banking account can be set up into which the dendro units can put a portion of their surplus, which can be drawn against during periods of scheduled maintenance.

Such banking arrangements are very common in the industry and are usually possible where one of the parties to the agreement has hydro power. A possible means of storing electricity is with hydro units. Power is storable in the form of unused water flow and can be made available upon immediate demand. The fact that NPC does have hydro facilities makes this arrangement feasible.

D. MISCELLANEOUS RECOMMENDATIONS AND COMMENTS

In the course of the investigation of the dendro project, a number of peripheral areas were looked into. The various comments, issues, and suggestions gleaned from these areas are summarized in this section.

1. Protective Devices

Many of the plant protective devices (alarms and protective relays) have been set by the vendor. Actual operation may reveal settings too heavy, too light, or miscoordinated with line relays. If these settings prove improper, changes should be made only after discussion with the vendor. Such information should be kept as part of permanent plant records.

2. Special Generator Information

It is advisable to obtain information from the equipment vendors relating to governor and exciter response characteristics, as well as short term overload characteristics of the generator.

The ability of the units to remain on the system and to override system

disturbances is dependent upon the rapidity with which the exciter and the governor respond to emergency conditions. If there should be an operating history of an excessive number of trip-offs or system separations, one of the areas to look at for remedial action is the characteristics of the excitation and governor systems.

The reason for ascertaining the overload capacity of the machine is because of the fact that the overload capacity enters into the pool spinning reserve capability. A statement from the manufacturer certifying the machine's overload capacity will be useful in reserve negotiations.

3. Inventory Control

Because of the physical isolation of the dendro plants and also the variety of the equipment, consideration should be given to a centralized inventory control system for maintenance and spare parts.

Eventually there will be a large number of dendro units installed (up to 70 potential sites). Because of the limited number of vendors, i.e., French, British, Japanese, and American, there is an opportunity for some standardization and for cutting down on the overall spare parts inventory. Maintenance people like to keep a large parts inventory in stock, but such a concept usually goes to excessive lengths and can be costly. From the outset, the spare part administration should be taken over by a central authority (NEA) to keep this matter under control.

Such a system has the following advantages:

1. Minimum investment in inventory.

2. Control of purchasing for maintenance parts with opportunity for most favorable price, delivery, and minimum chance for specification error.

3. Correct price data for accurate maintenance records.

4. Minimum lost time in locating required spare parts in emergency situations.

It would be uneconomical for each plant to stock its own spare parts (except for very commonly used items).

A centralized inventory control system would list full spare part nomenclature identification, vendor drawing reference, current inventory cost, and place of storage.

Updated inventory lists can be made monthly and furnished to each plant via regular mail. Central inventory would be responsible for maintaining and circulating master lists and maintaining minimum stock.

4. Comments on NPC Rate

The Appendix shows the NPC rate in force as of January 26, 1984. There are differences among the grids. In many cases, there is an inverted rate with increasing demand and energy blocks. This provides a further incentive to operate the dendro generation at full load connected to the NPC system. In addition, there is a fuel cost adder, as well as a correction for the foreign exchange rate.

5. Tender Documents

A review was made of the "Tender Documents." This is the construction contract and is similar to United States construction contracts. The "Engineer" who prepares the document is charged with overall supervision and administration. The document seemed adequate from the technical point of view as regards such items as grounding, wiring, electrical testing, etc.

There are two areas worthy of comment:

1. The contractor was charged with the responsibility of furnishing an Operations and Maintenance manual. The contractor is not particularly well suited to perform this job. It might better be the responsibility of the Engineer.

2. The documents also stipulate "tropicalization" of equipment, i.e., special safeguarding to prolong life in a high-temperature, high-

humidity climate. This is a wise precaution; however, the proviso should be more specific. The document made no mention of environmental protection.

I had an opportunity to meet with representatives of two engineering firms: DCCD Engineering Corporation and Meralco Industrial Engineering Services Corporation.

6. Operator Training

(I had an opportunity to review and observe training at a session at the plant at Ilagan. The notes below are based on this visit.)

When the contracts were let, no provisions were included for operator training. Training is supplied and financed under a separate grant. The British provide operator and maintenance training under a structured program conducted by a training specialist.

The staff for the plant has been selected and are employed by the Cooperative. Some of the personnel were drawn from Philippine engineering and technical schools. Staffing will be a problem because of money. Many Philippine technicians and engineers go overseas for better paying jobs.

The need for continuous on-going training and supervision and backup programs is obvious. The recommendation is for a continuation of the training program that was started by the British plus having an operations and maintenance expert available on a call-up basis until such time as the units have gone through that first major overhaul.

V. DETAILED DISCUSSION (AKELCO)

In order to illustrate some of the problems that may be encountered in the area of transmission and distribution, a detailed examination was made of the Akelco installation in the province of Aklan at the town of Nabas. The present feed is from the 69/13.2 kV stepdown station on the easterly side. The dendro plant is to be installed on the westerly end of the system. The main radial feeder going through the Cooperative system was a 13.2 kV - 3/0-100 kM in length. Losses in excess of 100% would be realized during light load period when it was necessary for the output of the dendro plant to flow back into the NPC system. The Nabas system had recloser and fuse sectionalizing. Although the fusing would coordinate properly when the plant was not in operation, proper fuse coordination will be impossible when the plant is on line.

It is inconceivable that the system will function properly because of the above difficulties.

There are certain general guidelines for the selection of the site for the dendro plants.

The preferred location for the dendro plant is at or near the present NPC delivery substation. This location will permit power to come from both the dendro units and the NPC delivery point in parallel and flow over the system with the volt drop and the losses and the fuse coordination unchanged from when the unit is off the line. In addition, should the unit trip-off the line, the nearby presence of the NPC substation will help supply power for a restart. During the light load period when excess power from the dendro plant flows into NPC, there is minimum limiting reactance between the dendro and the NPC system.

Another major problem which is avoided by adhering to the above criteria is the avoidance of out-of-phase operation of breakers. In the case where the NPC feed is at one end of the system and the dendro unit is at the other end of the system, there is always the high probability that during storms and fault conditions, the intervening breakers and reclosers will operate. And since they are timed to reclose with no regard for synchronism, it is a certainty that there will be out-of-phase operations.

A second major consideration in site selection is that it is not necessary for the dendro unit to feed power directly into the Cooperative distribution system. If the location of the plant is in proximity to an NPC substation, perhaps entirely out of the Cooperative service area, it is entirely feasible to connect the plant to the NPC system at transmission voltage such as 69 kV, and completely bypass the distribution system 13.2 kV. From the electrical point of view, this is far cleaner and easier to operate and less prone to operating errors and voltage fluctuations. The Cooperative can still obtain the full economic benefits by having the metered demand and energy from the dendro plant subtracted from the main NPC meter which meters power into the system and by paying for power on the difference.

VI. COST ESTIMATES

Except for the two gasifier units, budget $250,000 per dendro site as itemized below:

Engineering	$ 10,000
Transmission/Distribution Changes	190,000
Protective Equipment Relaying, Synchronizing, etc.	50,000
	$250,000

Costs are difficult to estimate because available information is incomplete on many sites. Engineering has not been done. Corrective measures may range from minor changes to major reconductoring or circuit rebuilding.

Above estimate of $15,000 per mile of line is based on current construction costs (labor and material) adjusted to official rate of exchange.

APPENDIX
POWER TRANSFER CAPABILITY

A. BACKGROUND

This section provides a brief technical explanation of the concept of "power transfer capability."

B. EXPLANATION

Classical power transfer analysis makes use of the "two machine" concept. All problems relating to the concept of power transfer between synchronous machines may be illustrated and simplified to Diagram No. 1.

The left hand portion represents the Dendro generator with its synchronous reactance X_S. E_1 is the voltage "ahead of the synchronous reactance." The center portion of the diagram represents the reactance of all transmission and distribution lines and transformers.

The right hand portion of the diagram represents the composite generations equivalent of the NPC (National Power Council) system as seen at the point of interconnection, in series with its positive sequence reactance, X_1. E_2 is the "voltage ahead of the synchronous reactance."

Diagram 2 is a plot of power transfer for two synchronous machines interconnected.

For power angle up to 90^o between E_1 and E_2, transmitted power increases with increasing angle. For angles between 90^o and 180^o, increasing angle means decreasing power transfer, and instability results.

The equation shows that increased voltage helps maintain power transfer capability; increased reactance reduces power transfer capability. To relate this problem to the Dendro units, lengthy low voltage lines between the Dendro units and the point of interconnection to the NPC, with their relatively high impedance, will reduce transfer capability.

The solution to this problem is to increase this capacity through higher voltage lines, larger conductors, etc.

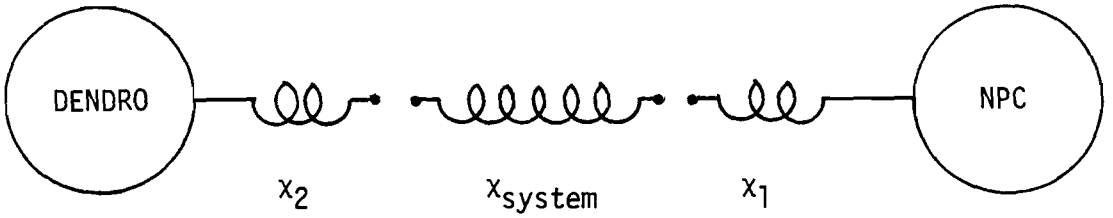

Diagram No 1

Electrical Representation
Two Synchronous Machines
Interconnected

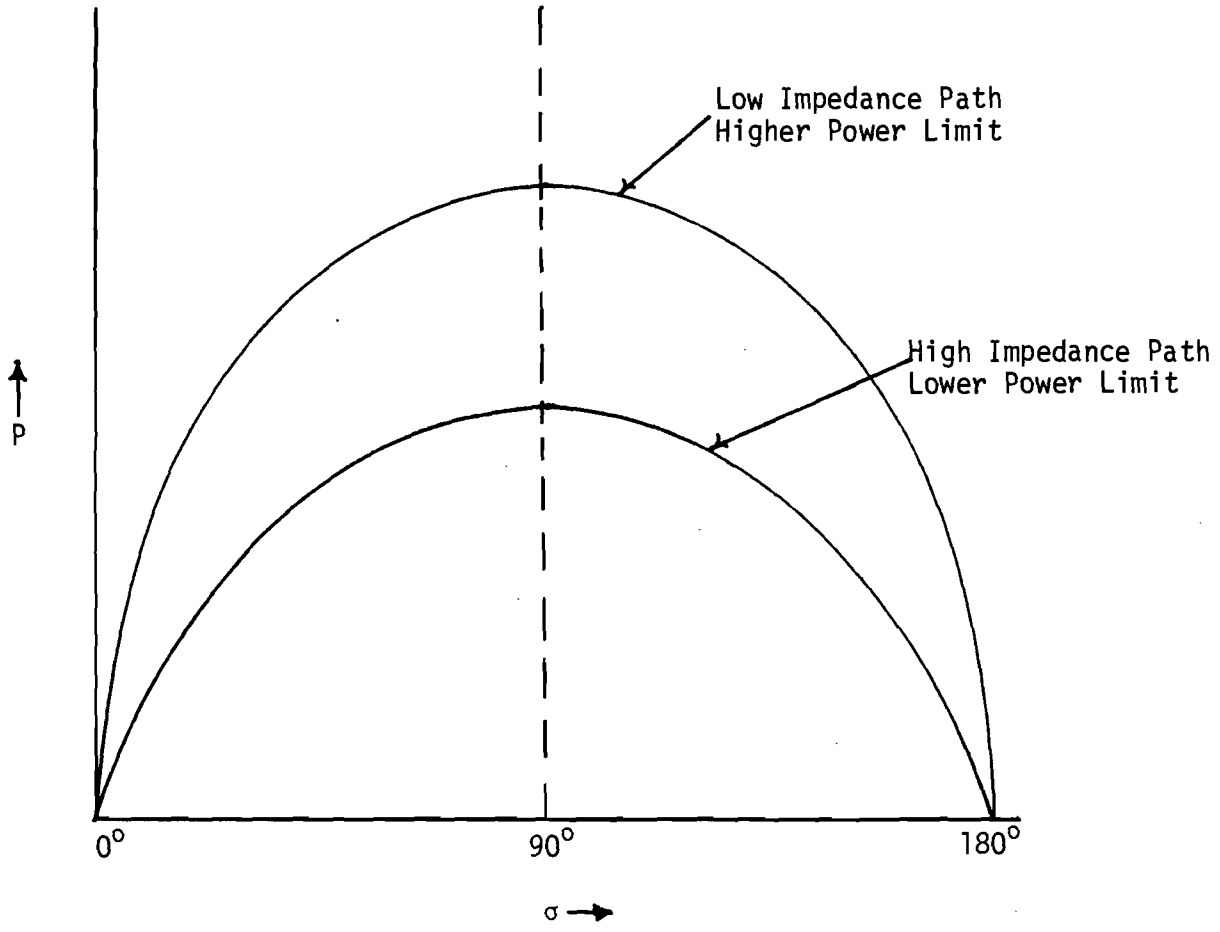

Diagram No 2
Power Transfer For
Two Synchronous Machines
Interconnected

DENDRO THERMAL PLANTATION DEVELOPMENT AND MANAGEMENT

Presented to

Georgia Institute of Technology
Atlanta, Georgia

by

Frederick D. Johnson
University of Idaho
Moscow, Idaho

June 2, 1984

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I. INTRODUCTION

The purpose of this consultancy was to make recommendations on the development and management of dendro-thermal plantations of rural electric cooperatives in numerous locations in the Republic of the Philippines. Specifically, recommendations were to be made on soils and on species selection. As a member of a four-man forestry team, the author was also to make recommendations on various other aspects of the plantations.

Seven weeks were spent in the Philippines, interacting throughout that period with team member Albert Merkel. With team member Ken McDicken, the author overlapped for three weeks, and with Jan Laarman, a total of several days. During this period, the most productive discussions by the forestry team were during field trips to various dendro-thermal plantations.

During the visit in the Philippines the folowing dendro-thermal plantation sites were visited:

1. INEC
2. ISECO
3. ABRECO
4. PANELCO
5. ISELCO II
6. PALECO (PP)
7. ANTECO
8. BOHECO I.

Two and one-half days were also spent at the PICOP operation at Bislig Bay, Mindanao. Map 1 locates the plantations visited in relation to other dendro-thermal sites.

At each of the sites visited, interviews were arranged and questions asked of the co-op general manager, dendro-coordinator, foresters and agriculturists. In addition, data from 33 feasibility studies (remainder not available) and three USAID sites, where more complete reports are available, were examined.

Assumptions and Alternatives

The main thrust of this report is based on a number of assumptions:

1. Plantation site selection will not materially improve toward selection by NEA of only high quality, easy access sites for plantation development.
2. Plantation size remains essentially the same as now planned.
3. Rotations are to remain short--with an objective of four years as the usual rotation.
4. Co-op power plants will not be sited which are entirely dependent upon outside wood (wood grown outside co-op plantations by independent producers).

While the impact of these assumptions is touched upon in a number of places within this report, it is nonetheless important to stress the rationale behind these restrictions.

1. Plantations are not all sited based on either optimizing growth of trees or upon reasonable access. Choosing only plantation areas with high growth potential and with easy access to the power plant is the easiest and most reliable

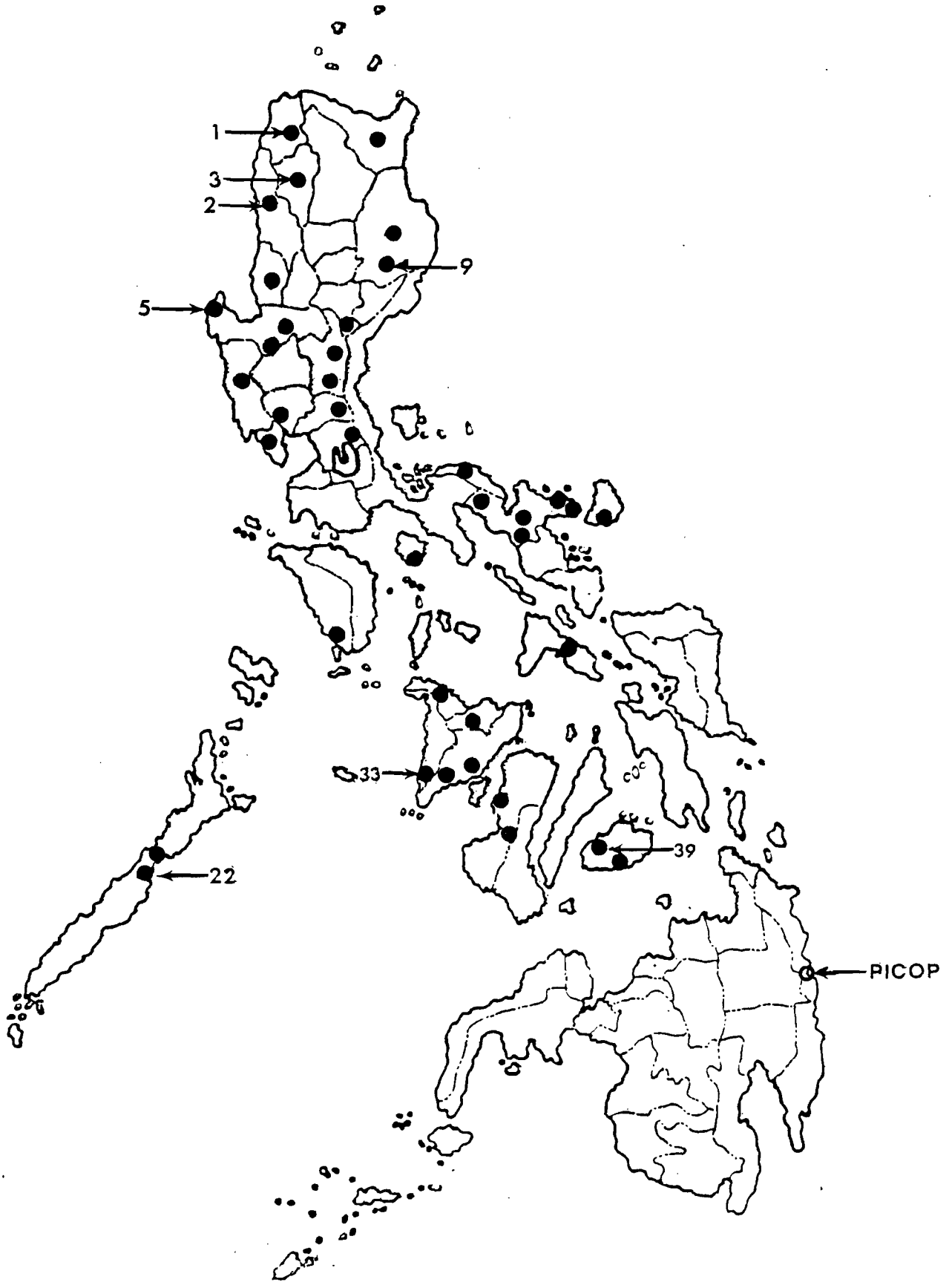
means of producing wood at the lowest cost in the shortest time.

2. Another alternative to increasing production of wood is by an increase in plantation size. While 100 hectares (ha) seems a reasonable size for 10 farmers to maintain for wood production, there is nothing magical in 10 modules of 100 ha each. The limit is reached by projected wood demands and transportation costs. Since initial wood production figures are falling short of estimates, increasing plantation size, both for existing sites and future sites (based on site quality) is another alternative.

3. There seems no strong reason for a 4-year growth-harvest rotation except that it was based on overly optimistic yield predictions. A combination of increased plantation size and longer rotations will combine to meet wood yield demands on any site, no matter how poor.

4. Some co-ops without power plants could right now begin dendro-thermal operations with the purchase of outside wood. Such is the case with Puerto Princessa (PALECO) on Palawan. While this is one of the few such cases visited, there may be more. Co-ops should evaluate the supply and costs of outside wood before deciding on plantations directed by the co-ops as the most feasible (and inexpensive) means of assuring a constant supply of wood.

Map 1. Thirty-nine dendro-thermal sites. Arrows indicate sites visited, numbers are co-op numbers (see Table 1).



II. SOILS

Preliminary soils data presented in the feasibility studies are inadequate for species selection. A summary of the total soils data from the feasibility studies is presented in Table 1. Two facts are evident: 1) there is very little specific data: no soil depth, no nutrient analysis, etc., and 2) there is great variability; for example, in co-op #38, soil pH ranges from 3.7 to 7.7; this is only 0.2 pH less than the range for the entire 33 sites!

Soils and climate are the basic resources which are responsible for tree growth. Soils are complex entities, having great variation in many attributes over an area as great as the 1000 hectares considered average for a dendro-thermal plantation.

Some co-ops have had further soils surveys done by local agriculture schools or by the national soils agency. Results of these surveys are disparate.

Contradictions in Soils Information

Seven dendro-thermal plantations were visited. At each of these, spot examinations of the soils were made and co-op personnel were asked about soils on their areas.

No soil maps are available for any site. While national soils maps may be available for some sites, these are not usually at a scale which has any value to plantation management or species choice. Not only is there too little soils data, but what is available is inconsistent. For the most part, it appears too few samples were taken but the data base is rarely explained, nor are the methods, depths taken, or locations plotted.

Table 1. Electric co-ops, climate, area, soils and species recommendations. Climate, soils and species recommendations are from NEA feasibility studies. Map 2 should be consulted to visualize climatic types.

ELECTRIC CO-OP	MUNICIPALITY	SITE	CLIMATE		LAND AREA AVAILABLE	NEA FEASIBILITY STUDIES DATA		
			M.A. PPT (mm)	CLIMATIC TYPE	(Has)	SOIL TEXTURE	pH	OTHER SPECIES RECOMMENDED
Region I								
1. INEC	Solsona/Dingras	**Maananteng (2952)	2294	I	2,700	silty clay, clay loam	5.0	missing
2. ISECO	Burgos	**Lubing	1891	I	1,125	silty clay,sandy loam,silty clay loam	5.9-6.6	Gliricidia
3. ABRECO	San Juan ABRA	Alimusgan	2568	I	1,468	sandy clay loam	5-7.5	Gmelina,Acacia auric.
4. LUELCO	Aringay/Tubao	Macabato	2481	I	1,668	clay loam, clay		Gmelina,Acacia auric.
5. PANELCO	Bolinao	Ilog-Maline	2551	I	1,255	clay loam	Basic	Gmelina, Gliricidia
6. CENPELCO	Mangatarem*				1,500			
7. PANELCO II	San Manuel*	San Roque			1,304			
Region II								
8. ISELCO I	Jones	Minuri	1902	III-IV	1,088	clay loam, clay	3.8-7.0	Acacia auric., Gmelina
9. ISELCO II	Ilagan	Batong-Labang	1885	IV	1,145	clayey		Acacia auric., Gmelina
10. NUVELCO	Dupax del Norte	Belance	1540?	IV	1,673	clay loam, clay	3.9-7.0	Gmelina, Gliricidia
11. CAGELCO II	Lallo/Lasam	Minanga	1834	III	1,595	sandy loam,clay loam	Alkaline	Casaurina equisetifolia, Gmelina
Region III								
12. ZAMECO	Palauig	Bulawen	3674	I	1,290	clay loam	4.9-6.4	Acacia auric., Gmelina
13. PELCO II	Porac	Pasbol	2500	I	2,500	clay loam	5.3-5.7	Gmelina, Acacia
14. BATELCO	Morong	Nagbalayong	2640	I	1,200	clay loam,clay	4.7-5.8	Gmelina, Gliricidia
15. BECO I	Remedies Trinidad	* Camaching	2277	II-IV	1,350	sandy loam	5.1-6.6	Gmelina, Acacia auric.
16. NEECO III	Gen. Tinio	Rio Chico			1,300			
17. NEECO II	Pantabangan	Tanauan	1780	III-IV	1,500	clay loam,silty clay loam	5.4-6.7	Gmelina, Gliricidia
None TARELCO I	Bamban	San Vincente,Macapagal	2459	I		silty loam	Basic	Gmelina
Region IV								
18. QUEZELCO	Macalelon	San Vincente	3602	II	1,850	clay loam		Gmelina, Trema
19. OMECO	Magsaysay	Paclolo	2713	I	2,600	sandy,sand-loam	5.6-6.4	Albizzia procera, Trema orientalis
20. MARELCO	Buenavista/Torrijos	Tungib	2088	IV	813	sandy,sand-loam		Gmelina, Gliricidia

Table 1 (cont.).

ELECTRIC CO-OP	MUNICIPALITY	SITE	CLIMATE		LAND AREA AVAILABLE	NEA FEASIBILITY STUDIES DATA		
			M.A. PPT. (mm)	CLIMATIC	(Has)	SOIL TEXTURE	pH	OTHER SPECIES RECOMMENDED
Region IV (cont.)								
21. PALECO (A)	Aborlan	Sagpangan			2,180			
22. PALECO (PP)	Puerto Princesa	Irawan	1567	III	1,565		5-7	Trema orientalis, Bouhinia malabar
Region V								
23. CANORECO	Sta. Elena/Capalonga	Bulala & Villa Aurora			3,000			
24. CASURECO I	Lupi	Napolindan			785			
25. CASURECO II	Pili	Guinaban	2269	II	1,800	clay loam	Alkaline	Gmelina, Trema orientalis
26. CASURECO III	Balatan		2100	IV	1,500	clay to silty clay	5.5/7.9	
27. CASURECO IV	Caramoan	Hanopol	2268	II	1,285	clay to sandy clay		Gliricidia, Gmelina
28. CASURECO IV	Garchitorena	Ason/Salvacion	2268	II	1,813	clay loam		Gmelina, Gliricidia
29. FICELCO	Virac	Buyo		II	1,000	clay loam		Gmelina, Gliricidia
30. MASELCO	Uson	San Jose	1857	III	1,510	clay loam		Gmelina, Gliricidia
Region VI								
31. AKELCO	Nabas	Pawa			624			
32. CAPELCO	Tapaz	San Julian	2927	III	1,300	clay	5.8	Gmelina, Acacia auric.
33. ANTECO	Hamtic	Casalngan	2933	I	503	clay, clay/loam	5.2-6.5	Albizzia procera, Acacia auric.
34. ILECO I	Miag-ao/Igbaros	**Durog,Tiglawan,Sta.Barbara			965			
35. ILECO II-A	Lambunao A	Tagbacan	2244	I	1,200	sandy loam, clay loam	4.4-6.7	Gmelina, Acacia auric.
36. ILECO II-B	Lambunao B	Agsirab Cabatangan	2244	III	2,500	clay	5.8	Gmelina, Gliricidia
37. CENECO	Murcia/San Carlos	Minoyan/Cudcod	2690	III	4,020	clay loam, clay	5.1-5.9	Gliricidia, Gmelina
38. NOCECO	Binalbagan	Bi-ao	2193	I-III	1,575	clay	3.7-7.5	Gmelina,Acacia auric. (Fertility low)
Region VII								
39. BOHECO I	Inabanga	Ilaya	1650	IV	2,150	clay-loam,clay	5.5-7.7	Gmelina, Trema, Gliricidia
40. BOHECO II	Duero*	Cansuhay			1,145			
Region IX								
41. TAWELCO	Balimbing	Balimbing			500			
				TOTAL	63,844			

* Suspended
**New Site

Total 42 sites
Missing 9 /3 of these suspended
1 of these new site
* 33 summarized - 2 without alternate species data

Table 1 - Summary
Ranges in Habitat Characters per Climatic Type

Climatic Type n =	M.A. Ppt.(mm) Mean (")		Soil Texture	pH
Type I -12 sites	2193	3674	clay to sandy loam	3.7-7.5
2 seasons - wet.dry	58"			
Type II - 6 sites	2268	2602	clay to sandy loam	5.1-6.6
no dry - wet winter	13"			
Type III- 8 sites	1567	2927	clay to sandy loam	3.8-7.0
relatively even, drier winter	54"			
Type IV - 4 sites	1650	2100	clay to sandy	3.9-7.9
even entire year	18"			
TOTAL RANGE	62" (85")	147"		3.7-7.9
(climatic ecotones tallied as first listed)			Greatest range pH 1 site	3.7-7.5

**Co-ops #1&2 - Data from ADB project profile

The following examples illustrate some of the inconsistencies or conflicting soils information.

Co-op #1 Solsona--Feasibility study: pH 5.0.

At Solsona the co-op decided that soils data was needed as well as other recommendations. A consultant was hired, spent one day on site, and the report (dated April 4, 1984) was examined. Some contradictory highlights between that report and field observations: Report: Soil is thin (under 6 cm); Observed: In a day of looking at several modules, no soils under 30 cm depth were observed. Report: One pH sample was taken, pH 5.4; Observed: The soils observed in the morning of 5/10/84 were of granitic origin--likely diorites, granodiorites, and similar acidic granitic-related rocks. That afternoon we crossed the river to another set of modules (the river may follow a fault line, separating parent materials or basement rocks)--the soils here were apparently derived of metamorphosed sedimentary rock, probably of marine origin. There was also some evidence of pyroclastics (tufa) from volcanic action. The significance here is considerable since texture, pH, nutrients and depth, to mention a few important characteristics, are dependent on parent material. For example, the granitic soils were more sandy (higher quartzite) and should be acidic in pH. The (marine?) metasediments-derived soils had higher clay and loam fractions, and should be higher (more basic) in pH values. While some of this discussion is conjecture (lacking better data), the fact of two or three parent materials is real. The one day's consultancy, if the recommendations are followed, may result in considerable revenue and wood yield losses.

Co-op #2 Burgos--Feasibility study: pH 5.9-6.6.

Here considerable additional soils data is present. Before planting, 150 samples were taken on 2 modules and analyzed at the U. of N. Philippines. Later the National Bureau of Soils took 79 samples on the same 2 modules. Here are the results of pH analysis:

U.N. Philippines	pH 6.0-8.0
N.B. of Soils	pH 5.0-6.9.

This represents a significant disparity. Soil with pH 8.0 is very basic and is a higher pH value than any of the 33 sites for which feasibility study data is available. Lacking other soils data, plantation species should be shifted on the basis of this information. Soils below pH 5.5 should be considered acid and ipil ipil should not be planted. Also at Burgos, Olsen's phosphorus values were derived by the N.B.S. and given by co-op people at 5-28 ppm. This is a 600% variation. Yet fertilization was recommended using N:P:K, 12:12:12. If the P (phosphorus values) of 5 ppm are to be raised significantly, then rock phosphate (cheaper per unit of P) or triple superphosphate is indicated. Cheaper, perhaps, would be to switch to a plantation tree less demanding in phosphorus. Either way, it would be money well spent to know where the soils are deficient in whatever nutrient, rather than fertilizing the whole plantation whether needed or not.

Co-Op #3 San Juan (ABRA). Feasibility pH: 5.0-7.5

Co-op personnel: Modules 1-5 = 5.7, modules 6-12 = 6.7. Significance pH 5 is too low of ipil ipil, while 5.7 is marginal. Module 4 was clearly with a limestone parent material and yet 5.7 is usually too acid for a lime-derived soil. The questions raised

are clear, what are the pHs, and what species are appropriate to plant?

Co-op #5 Bolinao--Feasibility study merely says the soil is "basic," co-op personnel stated pH 6.4-7.2. Feasibility texture clay loam, while on the site sandy loam was found in some areas.

Co-op #22 Puerto Princessa--Feasibility pH: 5-7. Co-op personnel 4.8-6.0. The feasibility texture class was missing, while the observed majority of spot samples were clay loam. This discrepancy, if present throughout, would cause me to shift from ipil ipil to Acacia auriculiformis on shallow or moderately deep soils.

Co-op #33 Hamtik--Feasibility pH: 5.2-6.5, while co-op personnel quoted 5.2-5.9--more acid on average. Feasibility texture: clay to clay loam, while part of the plantation visited was sandy clay loam.

Co-op #36 Cabatangan--Feasibility pH: 5.8; USAID study: 9 of 12 samples were under pH 5.8, range 4.5 to 6.2. Feasibility: Precipitation 2244 mm; USAID 2057 mm (clearly not all agree on data sources). Feasibility: texture, clay; USAID: all 12 samples were sandy--from sandy loam to sandy clay loam. Sandiness affects soil water percolation, movement of nutrients, erosion rates, rooting depth and other features of importance to tree growth.

Co-op #39 Ilaya--Feasibility pH: 5.5-7.7; USAID--40 samples were taken, scattered over the entire planation area, pH ranged from 5.9 to 7.9, well within the range of accuracy, and therefore new data agrees with the feasibility study data. However, the USAID analyses also included organic matter, total N, available P, exchangeable K. a texture class for each sample, plus 7 samples

which included exchangeable Ca and Mg and cation exchange capacity, and the trace elements Fe, Mn, Zn and Cu in parts per million (Soil Services Division, Ministry of Agriculture).

These illustrations are made to emphasize a very important point. The data available from feasiblity studies alone is both unreliable and inadequate. Before a plantation is planted, a complete soil survey should be conducted, along with a topographic survey and a harvest systems survey.

Soil Surveys before Planting

Before a soils survey is undertaken, a detailed topographic map should be made on the ground by the co-op forester. This can be done with simple instruments and a couple of assistants. The topographic map should contain contour lines at close intervals, overlays of each module boundary, roads, houses, permanent farms, and other features within or between modules.

With such a map in hand, the soils survey can proceed to determine soil variations and take samples to be analyzed. Sampling methods on existing surveys are either 1 spot sample (to represent 1000 ha), undescribed samples, or random samples, in the case of some of the more elaborate surveys. None of these methods is recommended. Surveys should be conducted on "catenas." A catena is simply a transect running from the top of a ridge to the streambottom below. A sample would be taken near the top, part way down (assuming, in most cases here a short slope run) and near (but not at) the bottom. In the usual 1000 or 1100 ha plantation project a number of these would be run, representing north versus south slopes, gentle versus steep slopes, while variations in

parent material (basement rock) or other anomalies require repeated sampling.

It is recommended that a minimum of 6 samples per module would be needed in areas with the least variation in terrain. This would mean 60 to 66 for 1000 or 1100 ha.

To be included, in order of priority:

1. Depth--effective rooting depth. Very often tropical soils have very deep B horizons; this is effective for rooting and is particularly important in typhoon-prone areas.
2. Texture--by layers.
3. pH--by layers. While soil acidity is discussed in terms of pH (hydrogen ions), most tropical soil acidity is from exchangeable aluminum cations. Exchangeable aluminum precipitates at pH 5.5 to 6.0, hence above these figures, no aluminum acids will be detected. Standard pH and exchangeable aluminum acidity should both be taken.
4. Soil type (classification)--Order, suborder, great group, and series. Where money prohibits soil analyses for nutrients, this may prove especially important. For example, alfisols and ultisols in the tropics are typically deficient in phosphorus. Just knowing these orders may provide a clue that plantation managers should watch for phosphorus deficiencies or apply phosphorus as an experimental procedure.
5. Soil moisture-holding capacity should be calculated in areas of long drought; all of climatic type I, as well as a few sites where thin soils are coupled with low rainfall in parts of the year. Ipil ipil, for example, does poorly with long drought periods as compared to Acacia auriculiformis or the

Eucalypts suggested. Should A. mangium be a possible plantation species, it should also be avoided on soils of low moisture-holding capacity.

6. Phosphorus--total phosphorus is of little value in determining deficiencies, particularly in tropical soils, organic phosphorus is quickly "tied up," and organic phosphorus (i.e., from decaying organic material) is a large percentage of available phosphorus. Soils with low pH are to be suspected of phosphorus deficiencies, since at low pH iron and aluminum phosphates replace the more available calcium phosphate, thus, to some degree, soil liming will increase available phosphorus. While no process for determination of available phosphorus is applicable to all soils, the "modified Olsen" is generally most effective and has the additional benefit of extracting K, Ca, Mg, Zn, Mn, Fe, Cu--leaving only N and S to be extracted by other methods.

7. Nitrogen--this element is the most frequently applied fertilizer in the world and is essential to plant growth. It is recommended that the expense of N analysis be avoided on any soils meeting the criteria for the planting of legumes (see Table 2--Species Selections by Site Types). This is due to the fact that legume roots can form a symbiotic relationship with certain bacteria, which in turn can convert gaseous nitrogen to soluble nitrogenous compounds that plants can utilize. It should be understood, however, that it often takes about 2 years for a legume to effectively start N production.

8. Trace minerals--Sulfur is next in order of deficiencies in humid tropical soils, followed by calcium and magnesium. Olsen's revised method of P extraction also yields potassium, calcium, magnesium, zinc, manganese, iron, and copper. Before these elements or sulfur are tested for, contact with agricultural or forest soils personnel may reveal presence of such deficiencies in appropriate soils of the Philippines. Where deficiencies are expected, analysis should proceed.

Fertilizers

Fertilizers were almost uniformly applied to young ipil ipil seedlings, but there was a noticeable lack of uniformity in rates and types of fertilizers. Considering existing soils data, this variation is hard to understand. If more soils information is available and unknown by co-op personnel, then there may be better rationale. Some examples of the fertilizer recommendations will illustrate the situation:

1. superphosphate--small amount--2 tablespoons (a small cupped handful)
2. 14:14:14 N:P:K--small amount--1/4 handful
3. superphosphate (2 T), urea (2T)
4. 16:20:0 N:P:K--1/2 handful.

In all four of these cases from four different co-op plantations, no evidence was found nor did plantation managers know of any phosphorus deficiency. Four possible reasons are possible for the phosphorus recommendation:

1. Tropical soils are known to be low in P;
2. Local soils--some knowledge of the area is transferred to the site, and local soils are P deficient;
3. Recommendations are random--any fertilizer is bound to help;
4. Soils analyses have been made that co-op personnel are unaware of and do not show in any available data.

If points 1, 2 or 3 are involved, then P application may be a waste of money. If point 4 is the reason, then co-op personnel should be made aware of the reasons for P applicaton, and data should be in their hands.

A shot of nitrogen will help almost any seedling get a better start--even legumes (ipil ipil) which "fix" atmospheric nitrogen may benefit since it takes time for root nodules to appear and start to effect the process. Yet on two different plantations, application of an NPK fertilizer had been tried, found to have no effect, and abandoned. It is suggested that nitrogen should not be applied to plantations for these reasons. First, it will not be applied for sustained periods; second, not enough will be used; and third, high nitrogen levels inhibit nodule formation on legume roots.

If nitrogen is to be applied, ammonium sulfate should be considered, since a common deficiency in tropical soils (S) may be partially corrected. Also ammonium sulfate does not volatize its NH_4^+ ions as rapidly as most other N sources (such as urea), and when applied as a top dressing (the usual case), the N will be more effective. This is particularly important in basic (over pH 7) soil. Fertilizers should not be applied as top dressing until wet soil and rain can be assured.

Lime was also applied in small amounts at several co-ops. The futility of small amounts of lime to raise pH is discussed. It is

cheaper to switch to another tree than to try to lower the acidity of soils to accommmodate growing ipil ipil (see also species recommendations).

Intercropping for Fertility

Where soil nutrient deficiencies are known or suspected, proper intercropping the first year can partially offset certain deficiencies.

Nitrogen: Legumes intercropped will add to the total soil nitrogen regime through their roots and dead organic matter (leaves and tops) left after harvest. Pidgeon peas and mung beans were cited by many farmers as among the preferred food crops in plantations. These plants can be significant in not reducing nitrogen levels, particularly for nonlegume tree seedlings like Gmelina. But even for legume tress (Leucaena, Acacia), it takes time for the roots (1 or 2 years) to achieve high nodule formation and peak nitrogen production.

Phosphorus: Sweet potatoes should be encouraged as a crop or one of the crops in soils suspected or known to be phosphorus deficient. Having a low phosphorus demand, sweet potatoes won't utilize as much phosphorus as other crops, and thus more remains for plantation trees. A second benefit is the high protein production of sweet potatoes, a bonus for the farmer.

Potassium: Soils suspected or known to be low in potassium should not be encouraged to produce cassava as a crop. Cassava demands very high potassium levels, and thus leaves less for the plantation trees.

Hagonoy (Martial Law): A Compositae herb, tall rank weed that was deliberately seeded at Ilocos Norte and encouraged at Palawan sites

as a fertilizer crop and was recommended by BFD. Personnel at Ilcos Norte, Solsona, believed that ipil ipil did better with this plant as the major cover than when planted in cogon. While this is undoubtedly true, it is quite possible that the growth difference is more due to the intense competition and possible alleopathy of cogon and similar disturbance grasses.

At any rate, the plant's response to seeding in cogonal might be investigated. It is possible that if established, shade from hagonoy may suppress cogon. If, on the other hand, the growth response in hagonoy is due to lower competition, and cogon is suppressed from invading, then seeding may be worthwhile. As a third scenario, hagonoy may be a "natural" weed, part of secondary succession and cogon invasion was not a segment of that succession--in this case seeding hagonoy is of no particular value.

Soils Summary

1. Soils data is essential to proper choice of plantation trees as well as deciding fertilizer requirements.
2. Existing soils data for most co-op plantations is inadequate. Where soils data has been gathered beyond that of the feasibility study, great discrepancies exist, casting doubts on soils data, especially that of the feasibility studies, which in many cases were very perfunctory.
3. Recommended soil sampling procedure is to sample catenas (elevational transects). A minimum of 60 samples is recommended

for terrain that contains little topographic or parent material variation. Soil sampling should not be undertaken until topographic maps are made.

4. Soils field descriptions and chemical analyses should include (in order of priority): 1. depth, 2. texture, 3. pH (2 methods), 4. classification, 5. moisture-holding capacity, 6. phosphorus, 7. nitrogen (in certain cases), 8. trace elements (in certain cases).

5. Selection of crops planted the first year can improve soil nutrient regimes and should be encouraged.

III. SPECIES SELECTION

Introduction

Ipil ipil (Leucaena leucocephala) was adopted by NEA as the major species for over 42 sites covering over 40,000 ha. Yield predictions were relatively uniform for the entire 42 sites. These yields are only achievable on the best sites in the plantation areas. Early results of yield studies, as well as observations made in existing plantations, show that ipil ipil on many sites is simply not performing as predicted.

In the original feasibility studies, alternate species were generally recommended on sites "not suitable for growth of ipil ipil." However, since no site studies were made and no recommendations for ipil ipil site requirements outlined, many plantations that were visited had ipil ipil doing very poorly--Bolinao, Ilagan, Ilocos Norte, to cite a few. Personnel were often willing and eager to try other species, but lacked ability to judge accurately on which sites to plant other species and which other species would be most appropriate.

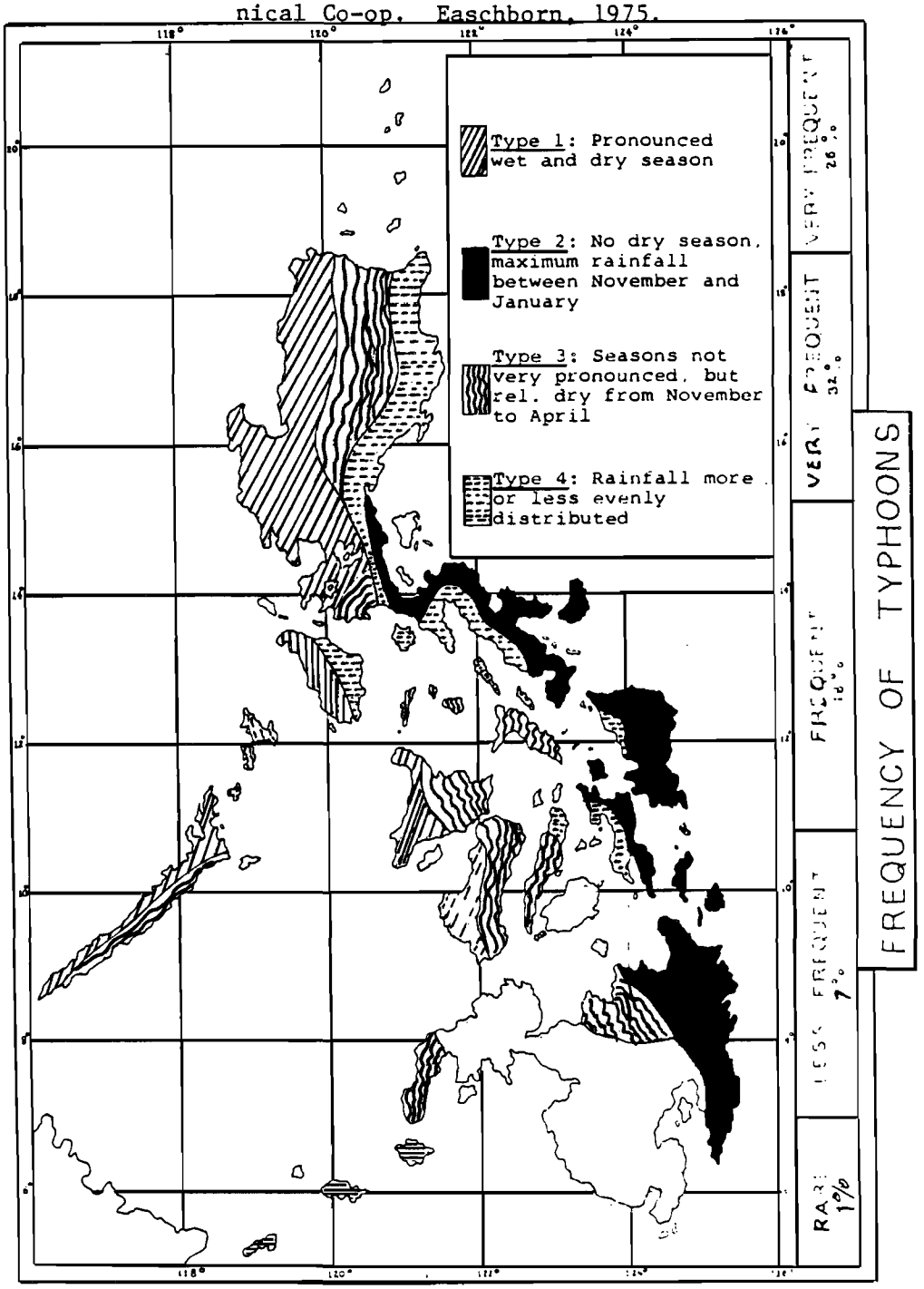
A summary of alternate species recommended in the feasibility studies is presented in Table 2, while the raw data is presented in Table 1. As can be seen, three species (Gmelina arborea, Gliricidia sepium and Acacia auriculiformis) accounted for 84% of the recommendations. In itself, this would be acceptable, but Tables 1 and 2 also show that there is no uniformity in the recommendation. Site (habitat) characteristics embrace the 4 major climatic regimes, all soil textures, a tremendous range of soil pH, as well as rainfall ranges from 1650 mm (65") to 3674 mm (145") (over 200% difference). With virtually no soils data, there

Table 2. Range in Site Conditions for Other Recommended Species
Data from NEA Feasibility Study data.

Species	n=30*	Range Total Ppt. mm	Climatic Types**	Texture Range	pH Range
Gmelina arborea	(26)	1650-3674 mean 80"	I,II,III,IV	clay to sandy clay	3.7-7.7
Gliricidia sepium	(12)	1650-2690 mean 41"	I,II,III,IV	clay to sandy	3.9-7.7
Acacia auriculiformis	(11)	2294-3674 mean 54"	I,II,III,IV	clay to sandy clay	3.8-7.5
Trema orientalis	(5)	1567-2713 mean 84"	I,II,III,IV	clay to clay loam	5.0-7.7
Bauhinia malabaricum*** (Piliostigma malabaricum)	(1)	1567 mean 62"	III		5.0-7.0
Casaurina equisetifolia	(1)	1834 mean 72"	III	clay loam to sandy loam	alkaline
Albizia procera	(2)	2713-2933 mean 111"	I	clay to clay loam	5.2-6.5
	(58)				

*Total sites with other species recommended = 29
**See climatic map (p. 22)
***This was cited as ali bang bang. Local books differ on the scientific name: Bauhinia purpurea is also possible.

Map 2. Climate Types and Typhoon Frequency. (Source: Manual of Reforestation and Erosion Control in the Philippines. H.J. Weidlt-Comp. German Agency for Technical Co-op. Easchborn, 1975.



CLIMATE MAP OF THE PHILIPPINES

seems little rationale for the choices presented. If on-the-site observations were used as indicators of species choice, this was not mentioned. For example, co-ops #3 and #5 have near identical rainfall, the same climate, same soils, both with basic pH, yet Gliricidia is recommended for #5 and not for #3, while Acacia auriculiformis is recommended for #3 but not for #5.

The soils discussion elucidates the need for soils data, and this need will not be repeated here. One point bears repetition, however. Without adequate soils data, coupled with climatic and topographic data, a correct species choice cannot be made.

Clearly, then, the selection of the proper plantation species is a most critical consideration. It is also a process which requires extensive knowledge, data, and time for a proper decision to be made.

Choosing Plantation Species--Criteria

Here is a brief outline of points to be considered in the selection of plantation trees for the dendro-thermal co-ops:

Habitat Conditions

1. total precipitation
2. length and severity of dry season
3. soil moisture-holding capacity
4. prevalence of typhoons
5. soils characteristics (depth and classification) to be mapped
    a. pH and aluminum acidity
    b. major nutrients--any deficiencies?
    c. texture

d. depth

e. trace elements--deficiencies?

f. cation exchange capacity

g. % aluminum and iron

6. topography--area to be mapped by slope % classes

7. temperature (seems not to be a factor in this case)

Fuel Value

1. rapid growth/high yield

2. high calorific value

3. high specific gravity

4. coppices readily

5. good form (single stem preferred)

6. quick drying

7. low ash

Amenities (desirable attributes)

1. evergreen--better shade, less fire hazard

2. nitrogen fixers--improve soil

3. human food--leaves, fruits, honey

4. animal food--leaves, fruit

5. compatibility with interplanted, first-year food crops

Other Characteristics

1. no major insect or disease problems

2. little genetic variation once a satisfactory cultivar has been selected

3. no toxic attributes to humans/animals

4. easily and cheaply propagated

5. fire resistance

6. easily direct seeded (avoids nursery and planting costs)

Choice of Species

There are an estimated 50,000 trees in the tropics. How does one go about choosing the right one (or several) for a particular dendro-thermal plantation?

Using the criteria above, choices are narrowed. Some species have undesirable characteristics, some do not meet major criteria--for example, many tropical trees of high calorific value are slow growing. Some fast-growing species are severely affected by insects. Many, many thousands of species exist for which there is so little data that they must be eliminated pro forma.

At this point in time, most of the successful tropical tree plantations consist of exotic species, that is, non-natives to the area. There are several reasons for the success of exotic species:

1. Since exotics are used world wide, there exists a data base of performance, habitat requirements, strengths and weaknesses for consideration. Generally, little data exists for species native to a particular area. For example, Albizia procera was being tried at Antique, but no knowledge of its promise seems to exist. A. procera might be a good or a bad plantation tree--but if it has been tried, performance data has not been located.
2. Exotics are often moved in from a great distance and hence beyond their natural insect and disease problems. But, this argument has another side, that is that the predators (the controls) for natural

pests are also left behind. However, referring back to the first point above, when a plantation fails or is severely damaged by insects or disease, the word gets about rather quickly.

3. Choice of species is wider; any one of the over 50,000 tropical trees may be a candidate. Whereas on a 1000 ha site, the number of native trees in the climate here considered (Philippines) probably doesn't exceed 500 primary and secondary species. In most areas where dendro-thermal plantations are located, all but a few native trees have long since been eliminated, and no one knows what was there originally.

Species Selected

While the choice is great, for many reasons the recommendations here are restricted to 8 species. For one reason, all have had some degree of success in the Philippines. Second, this is not a research project, therefore, it seems desirable to keep the number of species low, unless a rather large technical forestry staff with a substantial budget is added to NEA.

The following species were selected for dendro-thermal plantations; they were chosen for proven performance under similar climatic and soils situations:

1. *Acacia auriculiformis*
2. *Eucalyptus citriodora*
3. *Eucalyptus tereticornis*
4. *Eugenia jambolana*
5. *Gliricidia sepium*

6. Gmelina arboreum

7. Leucaena leucocephala

8. Trema orientalis.

A brief description of the important characteristics of each of these species follows, while Table 3 at the end of the species summaries presents a species selection guide for 8 site types. Map 2 presents climatic types referred to in Table 1.

Acacia auriculiformis--(auri)

Soils:	adaptable to a wide range of soils and sites, can grow successfully in low fertility and high water table
pH:	pH tolerance reported from 3.0-9.0
ppt:	total precipitation ideally under 1500-2000 mm up to 6 months dry
Yields:	yields 10-20 m^3/yr.
Shade:	good shade (to suppress cogon)
Browsing:	leaves unpalatable to stock
S.G.:	S.G. 0.6-0.75
Calories:	calorific value--4800-4900 Kcal/kg
Planting:	can be direct seeded
Coppice:	coppices poor to moderate (but easily regenerated from seed)
Drought:	should stand droughts of Climatic Type I (better than ipil ipil)
Typhoon:	moderately resistant to typhoon
Form:	form not too good--should not be a major problem
N_2:	high nitrogen fixer
Note:	Acacia auriculiformis was one of two species of 12 tried that could successfully grow in cogon areas in Papua New Guinea.

Recommendation: Acacia auriculiformis should be extensively used in dendro-thermal plantations as one of the top three species. Its usefulness is particularly great in areas of shallow soil and/or low soil pH. Note that the combination of shallow soils and low pH will not produce fuelwood at projected levels in four years with any suitable fuelwood species.

Eucalyptus citriodora and E. tereticornis

A number of eucalypts would seem appropriate for some of the dendro-thermal plantations. Due to insufficient local data, individual species are hard to recommend specifically. For all but the highest rainfall (Type IV climate) sites, E. deglupta should be avoided. E. camadulensis seems to do better at higher elevations, but sea-level plantations on Bataan are reported doing well.

The most promising two seem to be E. citriodora and E. tereticornis. Both have a wide range of soil and drought tolerance. Both produce heavily and have wood of high specific gravity (.7-1.0 or higher) and high calorific value (3800-4900 Kcal/kg). Both coppice well and are easily grown as seedlings for planting. E. tereticornis was recommended for cogon areas in Ilocos Norte by ADB consultants. It was one of two species of 12 tried to compete with cogon in Papua New Guinea. Eucalypts are not recommended for direct seeding.

Recommendation: To be used on cogon areas, particularly in plantations where long droughts are anticipated (Climatic Type I) or where there is low rainfall (under 2000 mm). Deeper soils are necessary, though there is no particular pH limitation (using the pH ranges in the preliminary data).

Eugenia jambolana--(duhat)

(Syzygium cumini)

Soils:	Adapted to a wide range of soils
pH:	not reported, but implied to tolerate acidic soils and growing naturally at Ilocos Sur (reported pH 6.0-8.0 from one source; 79 samples give 5.0-6.9). Local populations are abundant and soils conditions easily checked.
ppt:	1500 mm plus recommended. Ilocos Sur data, 1891 mm ppt., should give a reasonable medium.
Yields:	high
Shade:	high
Browsing:	unreported, likely of no value
S.G.	0.77
Calories:	calorific value 4800 Kcal/kg
Planting:	direct seeding (seed easily available but no genetic control)
Coppice:	reported as adequate locally
Drought:	ok--a Type I climate tree naturally
Typhoon:	appears ok as judged by Ilocos Sur, open grown trees
Form:	ok in plantation
N_2:	none
Other:	human food from fruits. Honey tree. Tannin from bark.

Recommendation: Eugenia jambolana is one of two native, on-site species recommended (Trema is the other). This locally popular fruit tree should be used in plantations where it is already present in or

near plantation sites as a wild tree. It should be used as a firebreak and buffer strip around plantation edges and along roads. Strips 10 to 20 m wide would help provide fire protection as well as a local food/revenue source. Such a strip would also force taking ipil ipil, gmelina, or other seeds from trees in the plantation rather than on the edge (see discussion on choice of species).

Duhat should also be used on Power Plant modules.

Gliricidia sepium (Kakawati)

(G. maculata)

Soil:	good, deep
pH:	neutral to basic
ppt:	1500-2300 mm
Yields:	40 m^3/ha/yr or less--initially lower--better on coppice (second and later rotations)
Shade:	drops leaves in severe drought--may thus encourage cogon and enhance fire severity, but this does cut water use
Browsing:	20% protein in leaves--ok for cattle--toxic to horses and other stock. Caroboa?
S.G.	S.G. .74
Calorific:	4900 Kcal/kg
Planting:	easily by cuttings; large trees can be gotten very quickly by using large cuttings from a clonal orchard. This assures genetic uniformity.
Drought:	moderately tolerant
Typhoon:	unknown; consult local foresters in N. Luzon
Form:	excellent from coppice
N_2:	high yields of nitrogen

Recommendation: Gliricidia sepium has considerable promise, one of its chief attributes is ease of establishment. Since it roots well from green cuttings placed in the ground, the following procedure should be tried. A clonal orchard of superior Gliricidia stock should be established on a dendro-thermal site. This is done by

(1) selecting superior local Gliricidia at the start of the rainy period, then planting them by cuttings. (2) Coppice these to produce long shoots. (3) Plant long shoots in the following fashion: (a) take cuttings 1 to 2 m long, (b) strip leaves off, (c) soak bases in dilute rooting hormones 24 hours (a mixture of indole-butyric and indole-acetic acids--commercially available will serve), (d) dig holes at least 20 cm wide and at least 40 cm deep--deeper is better, (e) replace topsoil in bottom of hole around cutting and tamp down, then add subsoil on top. At one site (Antique) 2" diameter cuttings of Gliricidia were set 6" into the ground wth 50% survival. Deeper planting plus pretreatment with hormones would likely increase this to near 100% survival.

This procedure will yield large trees, quickly, and will make it possible to maintain genetic control.

Gliricidia is such a promising species that contacts should be made with CATIE (Turrialba, Costa Rica) and CFI (Oxford, England), whose personnel are engaged in provenance work with this species. Undoubtedly the Gliricidia in the Philippines was of random seed source, probably brought at an early date by the Spanish due to its insecticidal properties. Better provenances exist in its natural range which is from southern Mexico to northern South America.

Gmelina arborea (melina--yemane)

Soils: survives on a wide variety. At Ilagan Gmelina is outgrowing Leucaena on reportedly slightly acid soils on ridgetops. Needs well drained soil, no waterlogging.

pH: tolerates acidic soils

ppt: 750-4500 mm

Yields: 18-32 m^3/ha/yr (stands at Ilagan should be measured)

Shade: very dense, appears good cogon represser

Browsing: palatable leaves, food value unreported

S.G.: .42-.64

Calorific: 4800 Kcal/kg, high ash content

Planting: can be direct seeded. Cuttings possible and thus genetic control effected.

Drought Resistance: reported ok for northern Philippines, Type I climate

Typhoon: check locally

Form: ok

N_2: none

Other: honey tree

Recommendation: Gmelina arborea should be one of the three most predominant trees involved in dendro-thermal plantations. It may be used on poorer sites than ipil ipil, that is sites with either shallower soils and/or more acidic soil pH.

Leucaena leucocephala (ipil ipil)

Soil:	deep, fertile, don't plant on high water table soils
pH;	poor or acid soils. Not recommended below pH 5.5.
ppt:	600-1700 mm reported as "ideal." (Yet best growth of ipil ipil seen in Philippines is in areas exceeding this amount.)
Yields:	10-40 m^3/ha/yr
Shade:	moderate repression of cogon
Browsing:	high protein (14-25%) in leaves. Varies in mimosine content--which is toxic to some extent when overused. Recommended for humans, cows, caroboa, chickens and goats.
S.G.	.45-.59
Calorific:	4200-4600 Kcal/kg
Planting:	direct seeding
Drought Resistance:	moderate, drought slows growth markedly
Typhboon:	ok
Form:	ok
N_2:	good fixer of N_2 and leaves high in protein
Human food:	green fruits (immature pods) are recommended for human food, they contain a remarkable 43% protein, higher than any of the common beans used for food as seeds.

Recommendation: Leucaena leucocephala should continue to be one of the three main species planted on dendro-thermal plantations. Site selection should be undertaken to assure that only sites with deep

soils with pH near neutral be planted with ipil ipil. It has been suggested that liming should help reduce the acidic reaction and hence aid Leucaena growth. While this is feasible, until genetic control is effected and strains of ipil ipil of proven low pH tolerance, it may not be practical from either the labor, the technology, or the cost of the lime. In one study in Papua New Guinea, it took 10 tons of limestone per hectare to achieve high yields of Leucaena on acid soils. This would be 10 x 1000 or 10,000 tons per plantation, and it would have to be renewed at least every 4 years. It is likely that planting acid tolerant Acacia or other species even at reduced yields would be more economical.

To be save, set the lower limit of pH for ipil ipil at pH 5.5--below this, choose another species. While ipil ipil will grow below this level, it is better to be on the safe side. At pH 5.5 to 6.0 aluminum is precipitated, and soils above this range are base saturated. Since aluminum ions (not hydrogen) are the main cause of tropical soil acidity, this is a critical pH range for safety's sake (see discussion on pH under Soils).

Trema orientalis (anabiong)

Soils: no particular restrictions, noted as good for poor soils, obvious on many areas on raw subsoil on road edges growing quite well

pH: most species, slightly acid to slightly alkaline

ppt: 2000-4000 mm

Yields: known to be a high producer in wild stands

Shade: a pioneer tree which produces moderate to dense shade

Browsing: no data

S..G.: no data

Calorific: 4500 Kcal/kg reported for Trema spp., unknown for Trema orientalis

Planting: tiny seed, probably best established from nursery grown seedlings. Seed treatment with Giberellic acid 500 ppm in water recommended. Stumps should be tried. (Stumps are seedlings, shorn of top branches and fine roots--easier to handle and plant than seedlings, no soil needs to be carried to the site--however, stumps must be kept moist.)

Drought Resistance: probably moderate

Typhoon: unknown--check local wild trees

Form: single stem, coppicing undocumented in plantations

N_2: none

Notes: Several sites had considerable Trema orientalis growing along roads and even in plantations. This is a local native species and should be tried where it is now found near plantations.

Recommendations: Trema orientalis should be used for dendro-thermal plantations on a trial basis only until more information is available on its performance. Difficulties in seed procurement and seedling production must first be overcome. Trials should only be undertaken where Trema is present at or very near prepared dendro-thermal plantations. (Seven research papers and three research contacts pertaining to Trema are listed in "Firewood Crops"--National Academy of Science, Washington, D.C. 1980).

Table 3. Selection of species by site types. Species with asterisks (*) are legumes and thus able to fix nitrogen.

I. Deep soils (B horizon over 1 meter deep), high pH (over 5.5), total rainfall over 2000 mm, drought period under 4 months:

*1. Leucaena leucocephala
2. Gmelina arborea
*3. Gliricidia sepium
4. Trema orientalis (locally)
5. Eugenia jambolana (local and restricted)

II. Moderately deep soils (B-0.5 to 1.0 m deep), pH variable, ranfall over 2000 mm, drought period under 6 months:

*1. Acacia auriculiformis
2. Eucalyptus citriodora
3. E. tereticornis
4. Gmelina arborea
*5. Leucaena leucocephala (if pH above 5.5)

III. Shallow soils (B under 0.5 m deep), pH variable, rainfall over 2000 m, drought period inconsequential:

*1. Acacia auriculiformis
2. Eucalyptus citriodora
3. E. tereticornis

IV. Rainfall under 2000 mm, other conditions variable, but soils shallow to moderately deep:

*1. Acacia auriculiformis
2. Eucalyptus citriodora
3. E. tereticornis

V. Rainfall under 2000 mm, soils deep (bottoms of slopes, concave draws and similar sites):

1. Gmelina arborea
*2. Gliricidia sepium
3. Trema orientalis (locally)
*4. Acacia auriculiformis
5. Eugenia jambolana (local and restricted)
*6. Leucaena leucocephala (best sites)

VI. Cogon areas, especially on moderately deep and shallow soils, all pH categories, all rainfall regimes:

*1. Acacia auriculiformis
2. Gmelina arborea (not on shallow soils)
3. Eucalyptus citriodora
4. E. tereticornis

VII. Fire-prone areas, all other conditions variable (fire losses are expected to be high, especially in cogon, any time in the first two years. Best fire insurance is not in species selection, but in adequate fire prevention and control organization.):

1. Eucalyptus citriodora
2. E. tereticornis
3. Eugenia jambolana (if conditions above listed for this species are met--use as fire break)

VIII. Especially rocky, stoney areas. Follow recommendations above, but use only species that can be direct seeded.

Seed Source (Provenance)

Most species selected for plantations range over a fairly large area, occupying a number of specifically identifiable different sites or habitats. Over the past few decades, it has become abundantly illustrated that each wide-ranging species exhibits a number of different forms or recognizable variation. In the botany of plant classification, only morphological variation is recognized, and when present in sufficient quantity, a variety of a species may be recognized.

However, in forestry and in dendro-thermal plantations, performance counts, and hence physiological and form variations are of high importance. Some examples may illustrate this. There are over 700 named races (mislabeled varieties, preferably called cultivars) of Leucaena leucocephala. Some are shrubby with numerous stems--some produce one clear trunk. Some are more resistant to drought than others. There is great variation in growth rates--but note that cultivar A may grow better than B on site X, while cultivar B is better than A on site Y. The quantity of mimosine (a toxic substance which causes hair loss and other ills) in the leaves varies considerably. The search continues in wild parts of Central America for new cultivars of ipil ipil. Which of the cultivars of ipil ipil should go into dendro-thermal plantations in the Philippines?

On the seven plantations visited, personnel listed the following as the cultivars of ipil ipil they had planted: Hawaiian, Hawaiian Giant, K-8, K-28 and Salvadoran. These are generally thought to be more or less co-equal in terms of growth on some sites, but different in regard to specific habitat factors, such as tolerance to soil anomalies, pest

resistance, and similar important growth or plantation development factors. Thus, the first generation if ipil ipil was selected by superior performance. But in the 10 modules on each of 40 sites, there are more than 4000 habitats--to assume that one or two cultivars of ipil ipil would perform equally well on over 4000 sites is contrary to current thinking concerning tree genetics. It is like saying, "Take any 40 areas in the Philippine mountain lowlands and plant rice--all will yield the same amount of rice."

One fact is certain, that is that assurance should be made that one of the "giant" cultivars of ipil ipil be planted.

In the second generation of seed procurement, all plantations visited got their seed from their own trees--by the farmers collecting seed from plantation trees. Some took seed from any tree, some took only from "superior" trees (taller, larger diameter). But only one of seven took seed from superior trees well into the plantation instead of along the edges. While trees along the edge bear heavier seed crops and grow larger, this reflects, in part, better growing conditions--in other words--part of the larger size is due to envrionment, not genes.

Leucaena is found to be highly self-fertile, this tends to keep genetic stock pure. Yet the existence of over 700 races indicates a degree of outcrossing. Further, in each new area where the trees are grown, new pollinators appear--they may hasten outcrossing--their absence may promote self-fertility. Ipil ipil was introduced to the Philippines very early in Spanish times. The Philippines are covered in all inhabited lowland areas by "wild" or common ipil ipil. The wild trees are of no particularly selected genetic makeup. The infusion of their

genes into selected races would more likely downgrade performance of the progeny than to cause better growth.

In every ipil ipil plantation visited, there was tremendous variation, generally on the order of 4x in diameter growth of trees. According to world literature, this is not to be expected if pure seed is used. Some of the variation, admittedly, could be from late germination of the smaller trees (hence slower start and ultimate suppression), or it could be to too close spacing; plantations with 1.5 x 1.5 meter spacing seemed to have more uniformity of diameters than those with 1 x 1 m. Nonetheless, initial seed sources should be pure seed stock, and subsequent seed should be taken only from superior (height and diameter) trees in the center of existing plantations. A qualified forester should monitor each step along the way to assure purity of seed source.

Evidence of different sources of ipil ipil is seen, in part, in apparent variations in mimosine content of the leaves. At Bolinao, farmers used ipil ipil leaf meal as feed for cows, ducks, pigs, chickens and caraboa, using 20% ipil ipil mixed with feed 3-4 times each week. At Puerto Princessa, by contrast, ipil ipil was tried as fodder, but then discontinued because "it made the hair fall out." Amounts used were small according to the farmers. If mimosine contents were low, hair loss would be nonexistent at low percentages of ipil ipil per unit food. Plantations should strive for low mimosine cultivars of ipil ipil, if it is to be used as a supplemental food source.

Illustrating basic tree genetics principals with ipil ipil poses some extraordinary problems with the other species recommended. Three courses of action are possible: (1) take locally tested seed sources and proceed, or (2) undertake a seed source testing program at each site, or

(3) undertake a thorough world literature search which would come only after soils/habitat information were available.

Let's examine these alternatives:

1. Local seed sources: Securing seed from superior strains or races should be possible for many of the alternative species. This will mean close cooperation with Philippine government and private forest agencies. For species like Trema orientalis and Eugenia jambolana, untested (evidently) in plantations in the Philippines, local superior tree seed sources will have to do. By local, on the site of the plantation is meant, (or at least very nearby and if nearby on the same general terrain and soil).

   This alternative is least expensive.

2. Testing program: A large-scale testing program to uncover superior races of any species is a long-term and expensive undertaking. Yet a compromise could be made by undertaking small-scale tests with known Philippine races at each dendro-thermal site. Test plantings of selected races, perhaps on the parent site, could be as small as 1/25 ha. It must be kept constantly in mind that these dendro-thermal plantations are not just a 4-year undertaking, they should go on for decades. Superior performance by an alternate species could easily make replacement of low-production ipil ipil a good investment.

3. World literature search: Several agencies are now collecting world literature on plantation performance of tropical trees. CSIRO (Australia), CATIE (Costa Rica), CFI (Great

Britain), the International Center for Research in Agroforestry (Nairobi), to name a few, are possible sources. Such a search should definitely be pursued--but only after soils/habitat data have been collected. A single forestry consultant, armed with the habitat/soils data and a budget to allow computer searches and a year's time would likely reap great rewards for future plantations.

Extensive world literature exists for: Acacia auriculiformis, Eucalyptus citriodora, E. tereticornis, Gmelina arborea and Leucaena leucocephala. Less literature is available for the other species, yet it does exist. A list of research contacts and literature is presented in "Firewood Crops" (National Academy of Sciences, Washington, D..C., Vol. 1, 1980; Vol. 2, 1983).

Species Selection Summary

1. Leucaena leucocephala (ipil ipil) is not the ideal species for all dendro-thermal plantations in the Philippines. Given a variety of habitats (sites) other species, acceptable in terms of wood requirements, will outproduce ipil ipil.
2. Plantation species must not only meet wood production characteristics, but also have to be adaptable to the local climate and environment as well as often meeting certain other criteria--such as being compatible with intercropping.
3. Species which should be considered in addition to ipil ipil, depending on site, include: Acacia auriculiformis, Eucalyptus citriodora, E. tereticornis, Eugenia jambolana, Gliricidia sepium, Gmelina arborea, and Trema orientalis. All of these are exotic (non-native to the Philippines) except Eugenia and Trema. Any anticipated plantation species should be subjected to a rigorous review of habitat requirements as well as production capabilities. A synopsis of these criteria is presented as well as suggestions for site (habitat) selection.
4. Seed source (provenance) is important in any plant species with a wide natural range. In almost any plantation tree species there is tremendous genetic variability which is reflected in adaption to the habitat and growth potential. Too little attention is being directed toward this source of variation.

IV. PLANTATION DEVELOPMENT AND MANAGEMENT

Under this rubric are miscellaneous observations meant particularly to aid other members of the forestry team in their specific assignments. They are the product of over 30 years experience in forestry, applied to dendro-thermal plantations under the assumptions stated in the Introduction.

Initial Surveys

Topographic map: A forester with two laborer assistants should make a detailed topographic map of each module and of the total plantation. The contour maps being used are unacceptable, the scale is too small. Such a map should include contour intervals of 5 meters (less in very steep terrain), roads, caraboa trails, houses, permanent agriculture, inholdings, rock outcrops--in short, every surface feature of present or future interest to the total plantation. Included will be a rough vegetation map, so that areas of cogon, brush and trees can be easily seen.

Such a map will be necessary for a reasonable soil survey and for design of a harvest and transportation system, as well as for eventual plantation management.

Preferably the co-op forester would be responsible for this map. Its construction is well within the capabilities of a trained forester or forestry technician.

Soil survey: Soil is the basic resource that, along with climate, will determine what trees to plant and what yields will ultimately be achieved. A detailed account of the soil survey requirements is

presented in the soils section. Attention should be directed at augmenting and modifying the vegetation map, if needed.

Harvesting/Transportation plan: Based on the topographic map plus soil survey, each plantation should have a harvesting plan before being planted. In many plantations visited, the personnel had no idea of how harvesting was to be carried out or how the wood would be transported. For example:

1. In one area they expected a cableway to extend over two major ridges to the power plant below.
2. In another they thought roads would be built (yet plantations were established thus necessitating a road through existing plantations).
3. In still another plantation they expected to haul wood on caraboa-drawn sleds--several kilometers to the power plant. They had no idea of how long this took, how many trips a day could be made or even if the light caraboa the farmers had could make the trip.
4. As to cable systems, from what was observed and through talking with the harvesting consultant (E. E. Aulerich) transportation of wood by cable may be doomed to failure; it simply will not work. Farmers will have to haul to cable, unload and reload. Cables will malfunction. Roads will be used. Caroboa will be used.

Plantation Siting

There were mixed emotions regarding the sites provided the co-ops for plantations by the B.F.D. Two GM's specifically praised them for giving either good sites or allowing room for expansions (though one had a poor site). The rest (5) of the co-ops seemed to feel that B.F.D. gave them poor and/or inaccessible sites. One person was so vehement he pounded on the table and declared the B.F.D. personnel were "corrupt" and would allow no good sites for that co-op without a payment under the table.

With no land ownership maps at hand, it was hard for the team to make a judgment on this matter. It did seem that many of the plantations were more remote than practical from the power plant (Palawan and Ilagan, for example). In others (Antique), modules are split with permanent farms between--providing problems with plantation damage by grazing caraboa, access and harvesting. The access here was poor, and the anticipated wood transportation cable must cover several kilometers and steep terrain. Some plantations were oriented to ridge tops (Bolinao), where very low yields have proven the choice of site a poor one indeed.

Since many plantations will not come up to projected yields, provisions must be made for expansion--more land is needed. In the future, this should be an absolute feature of plantation site locations--room for expansion.

To some degree, where possible and with cooperation of the B.F.D., co-op managers are taking matters into their own hands. At Palawan, they base module size on their projections for productivity, not on 100 ha. Another (Burgos) has 12 modules--"just in case"--so that they could meet their wood yield projections.

In the future, plantation sites should be as close as possible to power plants and access should be planned in advance. There are so many denuded cogon and scrub hectares in the Philippines that it seems that good sites could be spared for dendro-thermal plantatons rather than poor ones. Plantations could be split, as long as good access can be assured.

Personnel

Co-op personnel: While NEA regulations require one forester and one agriculturist per co-op, only 2 of 7 visited had a forester. The one plantation with a cogent forester (San Juan--Abra) was the best run unit we visited. There should be a graduate forester with every co-op plantation. This means B.S. forestry--not an agriculturist with a forester's title. (See tasks under Topographic map, Initial surveys and Cruising in Co-ops for professional tasks only a forester can be expected to perform.)

Personnel need up-to-date training. We found that some plantation personnel had been to several short courses, some to none. Some had visits by NEA technical people, some none. Farmers asked for courses on how to plant and what to plant. They need lots of help in nursery production (yet nurseries can be avoided by direct seeding).

NEA personnel: NEA needs a technical forestry staff of at least bachelors-level college graduates in their specialty: at minimum an experienced forest manager, an experienced silviculturist and a soils scientist should be in the central office on a permanent basis. When the full 40 sites are underway, this will be too few. Should numerous plantations start up at one time, this is too few. Tehcnical personnel

would give advice to plantation technicians on the site, with hands-on demonstrations. Farmers should also be invited, they are eager to learn.

Initially, a harvesting/transportation specialist is also required--either permanently by NEA or a near-full time consultant.

Planning

Co-op technicians need short courses in plantation planning before the planting occurs. This includes all of the survey information included above, as well as simple year-by-year plans. For example, on one plantation they had seedlings ready to plant out this year. They were not sure where, and of the seven people from the co-op in attendance, they were not sure who made the final decision.

Running a 1000 ha or more plantation is a technical operation and planning is essential.

Farmers' Associations

The clear and obvious need for farmers' co-ops is extension work--they need technical aid in many forms. Two categories rise to the top for consideration: (1) aid to make plantations better producing, more efficient, and (2) aid to benefit the farmers personally, thus, indirectly through more satisfied workers, helping the entire dendro-thermal project.

Some of the things that might be suggested are touched upon under the soils discussion, that is certain crops which could be planted to

help ameliorate soil nutrient deficiencies, or at least keep from intensifying them.

Other things that should be included in a farmers' extension program include:

1. Encourage feeding of ipil ipil to livestock. At one co-op where this was being done, he farmers said they learned of the stock food value from the radio.
2. Encourage farmers to eat green ipil ipil pods--they contain about 43% protein--higher than any bean seeds used for human food. In both this and the preceding category, the use of low mimosine ipil ipil should be our objective.
3. Ipil ipil pods and leaves should be used for composting and for green manure. Harvested tops unable to be otherwise utilized may be hauled to sites ready for planting (but after fire) and spread about for green manure. Once plantations are established, this should be done within the plantation.
4. Gmelina flowers (as well as Acacia and Leucaena) produce good honey. At no co-ops we visited was honey thought of as a venture.
5. Meetings and demonstrations, actual hands-on, in-the-field demonstrations of techniques relating to plantation and farm procedures.
6. Encourage selling of excess ipil ipil leaves left at harvest. In some cases a cash crop of ipil ipil leaves may be beneficial and preclude using leaves for green manure. Ipil ipil leaves are bringing P.80-1.20/kilo dried on the Cebu market. This use is not to be encouraged unless the farmers are in dire economic straits, as they now are because of lack

of payments. Local co-op use of food, fodder and green manure is the best use of leaves/pods.

On quite another subject relating to the farmers co-ops is the matter of uneven module productivity. It is quite clear that all of the modules will not produce the same amount of wood, irregardless of species. Yet the system is set up so that farmers are paid for wood delivered. What is to happen when Module 1 produces 4 times the revenue of Module 2--and Module 1 farmers are able to purchase luxuries with extra money, while Module 2 farmers are barely scraping by and perhaps cannot even meet their loan obligations? We can provide no clear solutioln, but can foresee the problem clearly, and it will be a big social headache for the electric co-ops.

Silviculture

Under this category came a number of items which can be set down in sub-categories:

Spacing: The 1 x 1 meter spacing advised seems not necessarily to optimize production. A thorough economic investigation should be undertaken to test the advantages of higher biomass per hectare likely achieved with close spacing versus lower handling and transportation costs of larger stems achieved by wider spacing.

Coppicing: In the only case observed of newly harvested trees (Bolinao), the trees were cut at as near ground level as possible, thus getting the maximum volume on the first cut. However, studies indicate that stump heights of about 3 decimeters will produce fewer and more vigorous sprouts. Since sprout numbers should likely be thinned to 2 or 3 per

stump, fewer sprouts would be an advantage, avoiding or minimizing after-thinning. Furthermore, harvesting is easier at 3 dm. levels, and is particularly better if chain saws are used, since this height lessens the chance of hitting dirt or rock with the chain.

Also at Bolinaeo, we saw trees being cut into short lengths with bolos, for this was the length preferred for use in the furnaces. Two things would argue against cutting short bolts in the field: (1) with a bolo, a lot of wood is wasted, chips from multiple cuts; (2) transportation (unless on human backs) is easier with larger units. A cut-off saw should be installed at the power plant wood yard--here bolts of appropriate lengths could be cut, from full trees hauled to the yard. (At Ilagan, each module had a chainsaw. Trees were taken to the wood yard in long lengths and a cut-off saw employed to reduce them to smaller lengths.)

Seed treatment, sowing and thinning: As applies to ipil ipil, some units put untreated seed in the ground, others used a cold water soak, other cold plus hot water. Some had such poor success with direct seedling that they are growing seedlings. A degree of standardization is appropriate, and a 24-hour cold water soak is reliable, producing near 100% germination. Direct seeding produces trees with better root systems and saves the cost of a nursery plus being cheaper to plant. The money involved in raising seedlings could be diverted to the task of thinning seed spots to 1-2 stems and replacement of blank spots. Many plantations had 3-5 stems per spot--this produces a more difficult harvesting chance--more stems = more handling. In general, species that can be direct seeded should be used in all plantations.

Seed source: This subject is more thoroughly treated in the section on species selection. We can summarize here that seed source (provenance) is highly important. Seeds should be of known source and should be kept "pure" in subsequent plantings. This is not being done at present.

Species trials: At Ilocos Norte--Solsona, trials are being undertaken using a number of species of trees. These trials were undertaken to choose a replacement for ipil ipil which was growing poorly. Yet at the nursery, no ipil ipil was being grown! Thus there is no control planned. One cannot compare seedlings grown in plastic bags with plants direct seeded. To make comparisons all species have to be treated the same way, planted in a random fashion on a large enough yet uniform area.

Fertilizers

As discussed under soils, fertilizers were almost uniformly applied to young ipil ipil seedlings, but there was a noticeable lack of uniformity in rates and types of fertilizers. With existing soils data this variation is hard to understand. If more soils information is known only by co-op personnel, then there may be better rationale. Some examples of the variation will illustrate the situation:

1. superphosphate--small amount, 2 Tablespoons
2. 14:14:14 N:P:K--small amount, 1/4 handful
3. superphosphate (2 Tablespoons), urea (2 Tablespoons)
4. 16:20:0 N:P:K--1/2 handful.

I suggest that nitrogen should not be applied to plantations. First, it will not be applied for sustained periods; second, not enough will be

used; and third, high nitrogen levels inhibit nodule formation on legume roots. If nitrogen is to be applied, ammonium sulfate should be considered, since a common deficiency in tropical soils may be partially corrected. Also, ammonium sulfate does not volatize its NH_4^+ ions as rapidly as most other N sources (such as urea), and when applied as a top dressing (the usual case), the N will be more effective. This is particularly important in basic (over pH 7) soils. Fertilizers should not be applied as top dressing until wet soil and rain can be assured.

Lime was also applied in small amounts at several co-ops. The futility of small amounts of lime to raise pH is discussed under soils. Here it is sufficient to repeat - it's cheaper to switch to another tree than to try and lower the acidity of soils to accommodate growing ipil ipil (See also Species Recommendations).

Diseases - Insects - Pests

By and large, ipil ipil and the few other plantation tree species seen were remarkably free of pest problems.

Termites were infesting some 5-10% of cut basal portions of stems seen stacked at Bolinao. Investigations of cutting height of stumps relative to continued infestation needs to be done. The second crop, with termites already in place, should have a higher loss rate.

"White grubs" were reported causing losses in two plantations. The co-op personnel were at a loss as to what to do or who to turn to for advice.

Stem borers were also reported causing losses on two sites with the same perplexity on what to do expressed by co-op people.

Rats or ground squirrels caused losses of seedlings, especially in cogonal, at one plantation. Control methods unknown.

Root rots were evident at one plantation in low-lying ground where there was very clayey soil and a high apparent water table. Ipil ipil trees 5 cm in diamater could be easily lifted from the ground. Here is a probable case of site mismatching. Ipil ipil shouldn't be planted in high ground water level soils - Acacia auriculiformis, on the other hand, should thrive in these conditions.

All of the above instances of plantation depredation serve as examples of the need for technical knowledge by plantation personnel, as well as the need for a technical extension staff at NEA who can be sought for advice and who are familiar with each plantation's problems and peculiarities.

Fire

There seems to be a lack of appreciation of the severity of fire. In Palawan, Bolinao, Ilocos Norte and Ilagan, fire was causing plantation losses. A recent fire of only a few weeks had killed or set back 2 or 3 ha of plantation at Bolinao. At Ilagan a module was visited that had burned 2 years ago - ipil ipil was 80-90% dead and those scattered living plants only 1 to 1.5 m tall; Cogon competition was keen.

Much cogonal is to be put into plantation. Cogon is a fire-type disturbance grass. Without fire a Kaingen area will return to brush and small trees in a few years. Cogon is an indicator of a potential fire problem.

Co-ops universally have no special fire tools, many have had no training in fire control, and few (if any) have knowledge of fire behavior. This is a major consideration. An investment in training, tools and extension work with the farmers to show them the potential loss to their pocketbooks should be initiated immediately on existing plantations. Future plantations should have a fire control plan, training and equipment required.

Fire breaks can be effective means of slowing fire. These are permanent plantings of dense, evergreen trees in strips, between and around modules and especially along roads. Fires in the Philippines are (virtually) all man-caused. Roads and trails are where man passes. So fire breaks along roads are especially useful. Eugenia jambolana could be used, as could species of class I timber which are supposed to be included at 500 trees per hectare. Deciduous trees with slowly decaying leaves, such as teak, are to be avoided (See also discussion under species description for Eugenia jambolana).

Fire breaks should only be used if adequate fire prevention, fire control, fire planning are part of the plantation management.

Yield

While yield figures are not complete from Hodam and Associates, examination of seven plantations and numerous modules shows that yield projections will not be met. This applies to some portions of visited modules on every plantation.

To help project yields and form a basis for extrapolation and planning, each co-op should run its own cruise (transects of sampling to measure yield). At present, co-ops depend on old (and tiny) plots of Denton's, or the slightly larger plots of Hodam's group. Neither are extensive samples.

Cruise lines should be run through modules on a catena, as described in soil surveys and for the very same reason. A forester could run such a cruise, and like the topographic map, a laborer or two could be used as helpers. It seems to me inefficient and incomplete to depend on small plots put in by others when co-ops should be capable of taking their own data. In cruising for yield determination, it is particularly important to cruise just before harvest, and then compare cruise data with yields in solid wood as paid to the farmers and delivered to the power plant.

As in other technical matters, having an experienced forester on hand at NEA for advice will be needed to help co-op foresters set up proper cruise procedures and help in data interpretation.

Most plantations are not expected to meet the demands for wood once power plants are operating continuously. Several means have been discussed to alleviate this problem under present guidelines. Plantation areas could be increased, species which have higher yields could be planted instead of ipil ipil. A third method is to buy wood from outside.

Outside wood sources can be of two types - in many areas, Palawan, Ilagan, for example, there's lots of wood from secondary forest available in the area. The Puerto Princessa power plant could start up now and run

on purchased local wood, which is abundant. In many areas, however, wood is scarce and in these areas outside tree farmers should be encouraged to grow wood to be purchased by the co-op. At PICOP-Bislig Bay they grow seedlings and sell them cheaply to farmers on a deferred pay basis. Farmers are so enthused they find growing wood more profitable than growing food crops. While the same situation won't exist in electric co-ops the parallel is there. With ipil ipil, gmelina, kakawati and duhat, for example, seedlings aren't necessary or even desirable. Seed costs could be borne by the co-op, in fact after plantations are up to year 4 there should be abundant surplus seed. This could be given to or charged to outside farmers at small cost. Some technical help could be provided by co-op agriculturists and foresters.

Buying from outside wood sources should be part of the management plan of every co-op. Even if plantations are producing adequately, contingencies such as fire or typhoon loss should be anticipated.

Erosion

Increased erosion is a feature of mountain areas with the forest removed throughout the world. Where heavy rains come suddenly, as in the Philippines, the problem is intensified. Steep slopes and erosive soils compound accelerated erosion losses.

While no measurements made on dendro-thermal plantations are known, certain basic realities can be extrapolated to dendro-thermal plantation from other parts of the tropics.

1. Tree cover will decrease erosion losses over open ground (Kaingen) and sparse shrub cover.

2. When dense trees are harvested and nothing left, as in the case of plantations, erosion will increase.
3. One way or the other, the only way to permanently decrease accelerated erosion is replacement by a permanent forest - which is not practical and not applicable to dendro-thermal plantations.
4. Highest erosion losses are to be expected in year 1 of planting followed by year 1 after harvesting. Since crops are to be grown simultaneously with trees, crop planning can reduce erosion slightly.
5. In high erosion areas, rice, cassava and corn should be discouraged as crops. Camote, peanuts and other crops with high ground cover would be preferred and would reduce erosion to as low a level as can be hoped for.
6. Buffer strips of uncut trees along stream courses can help tremendously in reducing sediment loads in streams.
7. Contour strip plantings of dense, low trees/shrubs will act to slow downslope overland flow sheet erosion and check small rill and gully erosion channels. Pruning will keep such strips low and dense - out of competition with plantation trees. If evergreen shrubs/trees, with quickly decaying leaves, are employed - the strip will serve also as a fire break. A species palatable to livestock (i.e. ipil ipil) would provide feed from the pruned tops.

V. SUMMARY

1. Before any new plantation is started, certain preliminary steps should be taken. These preliminaries were almost completely ignored in the plantations visited and those for which data was available (Table 1). Absence of these data, and the subsequent professional analyses, will result in losses of millions of pesos.
2. Initial surveys should include: topographic maps with major vegetation indicated, soils map based on catenas (transects) from top to bottom of slopes, vegetation map checked and modified.
3. A harvesting/transportation plan then needs to be developed based on the topographic and soils maps as well as the projected size of wood to be removed. At present, certain plantations have little hope of reasonable costs associated with conveying wood to the power plant. The cable system projected for certain units have little hope of success.
4. Plantation site location, for the most part, is not related to production or transportation needs. A better choice of plantation sites would be less expensive than working with poor sites (See Introduction - Assumptions).
5. Co-ops should employ a professional forester (B.S. Forestry) as directed by NEA. Certain tasks described herein cannot be effectively accomplished by others, unless <u>extensive</u> training is anticipated.

6. NEA needs a professional staff of foresters and a soil scientist. At least bachelors level plus experience, with pay competitive with industry, are essential criteria. A forest manager/planner, a silviculturist and a soils scientist are a minimum staff. A harvest/transportation specialist is certainly essential, but this individual could be retained as a consultant.
7. Planning is an essential aspect of plantation management. Considerable improvement can be made, assisted by the NEA technical staff.
8. Farmers associations need more technical help and guidance. This should be provided by both co-op technicians and the NEA technical staff.
9. Uneven productivity on farmers modules will pose a very real threat to smooth relations with farmers in the near future.
10. Optimum spacing of trees should be determined based on size at time of harvest.
11. Stump height at harvest (coppicing) needs clarification to maximize yield at the second rotation.
12. In most cases, tree length harvest and transport seems better than short bolts. This necessitates a simple cut-off saw at the power plant site.
13. With few exceptions, plantations should be established by direct seeding. This is cheaper and results in better root systems. An exception would be those species, like Gliricidia, which are developed from cuttings placed directly in the ground.

14. As far as can be determined, species trials now underway are faulted by not including ipil ipil. Without the concomitant judgment on the same sites of ipil ipil growth and yield, no valid extrapolations may be made.

15. Fertilizers, except in the case of severe deficiencies, should not be added. Better to change species or change sites or have longer rotations. Fertilizers are an unnecessary financial drain.

16. Depredation by pests of all kinds is minimal. Where present, co-op personnel seem at a loss as to remedial action. Here a NEA technical staff could be of tremendous help.

17. Fire is a very real threat to wood production on plantations. Cogonal is a fire perpetuated type of vegetation. Fire plans, fire tools, fire suppression techniques are all lacking in co-ops visited.

18. Fire breaks, strips of dense uncut trees with little growth underneath, can help once fires are started, but only in the presence of a properly trained and equipped fire suppression organization.

19. Co-op personnel should undertake their own inventory of yield. This will help effect planning for power plant needs.

20. Purchase of wood from outside sources needs to be effected in some plantations. Adequate planning and economic studies are needed.

21. Soil erosion, on some plantations, will continue to be a problem in year one and the first year after harvest. This cannot be avoided if trees are to be harvested. It appears

to be a problem of minor consequence in areas visited. Where it is problem, uncut buffer strips of trees along stream courses will be of considerable value in decreasing stream sediment loads, as will contour strip plantings.

VI. OPTIMISTIC FUTURE

A single fact must be stressed as we look to the future of the dendro-thermal project, and that is: wood can be an economical source of fuel for the production of electricity in the Philippines.

While the bulk of this report dwells on recommendations for changes in plantation development and management, taken in the aggregate, such changes are relatively small, considering the scope of the entire effort. Adoption of plantation practices with professional forestry guidance, coupled with close attention to the sociological needs of the tree farmers, should assure ample wood to fuel thermal generators.

The price of fossil fuel must increase. Regardless of optimistic predictions for the near-future, the supply of petroleum is finite. Wood, by contrast, can be produced in perpetuity. One day in the future, nations by the score will be using wood to produce electricity. There is no biological reason why the production of wood to fuel electrical generators is not feasible in the Philippines.

A positive, optimistic attitude should be the underlying theme for anyone considering the Philippines for dendro-thermal development projects.

FINANCIAL ANALYSIS OF DENDRO PLANTATIONS IN THE PHILIPPINES: OBSERVATIONS BASED ON SIX CASE STUDIES

Presented to

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Atlanta, Georgia

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A Consultant's Creed:

"For every evil under the sun
There is a remedy, or there is none.
If there be one, try and find it.
If there be none, never mind it."

From The Poetry Troupe, Isabel Wilmer, ed.

I. INTRODUCTION

A. Purpose and Scope

This report is submitted to the Georgia Institute of Technology (GIT) under its contract (A-3717) with the National Electrification Administration (NEA), Government of the Philippines (GOP). The Asian Development Bank (ADB) is the source of loan/grant funding for this evaluation, conducted with the support of NEA's Dendro Thermal Development Office (DTDO). Here it is assumed that ADB is the primary client for the data and observations to be presented.

The focus of the study is cash flow and financial viability at the level of individual dendro plantations. Each plantation consists of aggregates of 100-hectare modules, each module under the management of a Tree Farmers' Association (TFA). These institutional arrangements are fully described by NEA (e.g., see "Feasibility Study of the Sta. Maria Energy Tree Plantation") and Denton (1983, esp. Chapter III).

As of March 31, NEA had identified 41 existing and potential dendro plantation sites. Feasibility studies had been approved for 40 of these sites. Total area planted (at 36 sites) has been 17,450 hectares. By NEA's definition, plantation survival is 7,664 hectares. Essentially all of these plantations are of giant ipil-ipil (Leucaena leucocephala).

The analysis adopts a case study approach by assessing plantation cash flows at six widely differing dendro sites:

ANTECO (Hamtic, Antique)

CASURECO IV-A (Caramoan, Camarines Sur)

ISECO (Burgos, Ilocos Sur)

OMECO (Magsaysay, Occidental Mindoro)

PANELCO I (Bolinao, Pangasinan)

ZAMECO (Palauig, Zambales)

Dendro power plants managed by these particular Rural Electrification Cooperatives (RECs) are those relatively closest to completion (as measured by expenditure levels). Also in this group is INEC (Solsona, Ilocos Norte), although INEC is excluded here because of its reliance on open-market purchases to meet its wood requirements. Of course, this attests to a certain amount of failure in INEC's plantation development through the present time.

B. Problem Context

The context of this evaluation in mid-1984 is one in which the projected cash flows of the dendro plantations are adversely affected by the following technical and financial difficulties:

Low biological productivity.--The existing plantations apparently are growing at well below the 40-50 wet tons of biomass per hectare per year which NEA had assumed in its feasibility studies. All of the following can be cited as contributing factors: (a) inherently poor site quality over substantial portions of the Industrial Tree Plantation (ITP) leases which the RECs have obtained--or are obtaining--through the Ministry of Natural Resources; (b) possible excessive reliance on giant ipil-ipil as the single species for all edaphic and climatic conditions; and (c) inadequate allowances for the risks of slowed growth and plantation losses due to drought, fire, and other natural agents.

Macroeconomic crisis at the level of GOP.--Flows of loan monies from NEA to the RECs have virtually ceased. This has drastically curtailed new plantation development at all sites except where the RECs are advancing funds out of their own financial resources. Many dendro power plants will be indefinitely delayed, and some among these may be ultimately abandoned. This implies that some plantations will have lost their intended sales outlets, at least in the immediate time frame. Concurrently, the recent sharp surge in monetary inflation has created confusion and adjustment difficulties with respect to plantation cost guidelines and financial outlook. At the time of this writing the DTDO observes 1979-1980 currency figures for loan releases and all other financial data, even though price levels are now escalating by 40 percent per year

(estimate used by GOP in May-June news releases). Tree farmers' real incomes (i.e., adjusted for the purchasing power of the peso) have yet to be protected.

Anticipated high costs of plantation harvesting and biomass transportation.--This is a third major concern, even though the costs of biomass transportation are borne by the RECs and not by the TFAs. Few of the existing dendro plantations have been laid out with adequate advanced planning for later harvesting and biomass transport. Harvesting by chain saws--as originally anticipated by NEA--is a questionable choice of technology for tree farmers. With respect to biomass transport, steep ridges and difficult accessibility will preclude reaching certain modules at acceptable costs with either roads or cableways. Moreover, in some instances roads and cableways may encroach on areas already planted, carving losses in the plantation base. This report does not attempt to evaluate the costs of harvesting and transport in an empirical framework. The point here is to point out that average costs (if all areas are harvested) are likely to reach levels much higher than shown in Denton (pp. 190-193, 202).

The preceding are three constraints on plantation feasibility stated in terms of great generality. Critical sub-issues will be identified at appropriate points in the course of this report. The emphasis is cash flow at the plantation level, i.e., costs and revenues for the tree farmers. Financial attractiveness for the tree farmers is a necessary--even if not sufficient--condition for financial viability at the level of the

RECs if the concept of dendro plantations is to be retained in the dendro program.

C. Organization of the Report

Section II provides an empirical treatment of financial cash flows at the six dendro plantations. The first part of the section addresses methodology, focusing on the definition and data sources of the elements which comprise the cash flows. This is followed by "base case" computations to assess the financial performance of tree farmers' income streams. Three financial criteria are used: (a) present net worth (of tree farmers' income streams), (b) average annual equivalent income, and (c) internal rate of return. The third subsection presents a sensitivity analysis to test how financial performance responds to changed assumptions and conditions--tests of "what could be" (prospective changes) and tests of "what could have been" (retrospective changes). The fourth subsection then compares tree farmers' income streams with regional income targets. A fifth and and final subsection summarizes the principal implications of these six cases.

Section III recommends a number of measures--technical, fiscal, and organizational--to improve the financial viability of the dendro plantations. Some of the recommendations NEA could and should implement immediately, while others will require further study and external assistance. The recommendations are discussed individually, even though it is recognized that they will have to be considered as an integrated package.

II. FINANCIAL EVALUATION OF SIX DENDRO PLANTATIONS

A. Methodology

The empirical basis for this section is Table 1 (Sheets A-F), which shows "base case" financial cash flows in a simplified 8-line format. Each cash flow is for aggregates of modules which together comprise individual dendro plantations.

All figures in Table 1 are in current (i.e., nominal) thousands of pesos. Adjustments to compute real (i.e., deflated) cash flows are discussed later. Cash flows are shown for 25 years to correspond with the assumed economic life of the power plants, even though there is little evidence to suggest an appropriate economic life for ipil-ipil plantations.

The format for Table 1 borrows heavily from the cash flow models in NEA's feasibility studies. This enables a close comparison between NEA's *ex ante* projections vs. current expectations now that plantation development has been underway for four years.

However, unlike the NEA models, this analysis does not include cash flow components for BLISS housing (not present at any of the six sites studied). Furthermore, the format used here departs from certain other studies (e.g., World Bank 1983) in not showing income from timber trees (e.g., narra), most of which would occur beyond the 25-year time horizon. Even if included, the present net worth of timber revenue to be received twenty-five or more years from now would be relatively low at discount rates realistically reflecting the opportunity cost of capital.

Table 1A. Financial Cash Flow for Dendro Plantation at ANTECO

(values in thousands of current pesos)

No. of modules : 3

No. of farmers : 57

No. of hectares : 130

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13-25
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993-2005
CASH RECEIPTS													
1.Loan from REC	238	307	251	142 E									
2. Sales of farm products and ipil-ipil seeds, leaves													
3. Sale of ipil-ipil biomass to REC					146	154	161	169	178	187	195	206	217 +
CASH DISBURSEMENTS													
4. Plantation Development	238	307	251	142E									
LOAN PAYMENTS													
5. Principal and Interest					258	258	258	258	258	258	258	258	
CASH FLOW AFTER LOAN PAYMENTS													
6. Net balance					(112)	(104)	(97)	(89)	(80)	(71)	(63)	(52)	217 +
FARMERS DISPOSABLE INCOME													
7. Divisible cash	195	252	206	116	(112)	(104)	(97)	(89)	(80)	(71)	(63)	(52)	217 +
8. Divisible cash per farmer	3.4	4.4	3.6	2.0	(2.0)	(1.8)	(1.7)	(1.6)	(1.4)	(1.2)	(1.1)	(0.9)	3.8 +

Table 1 B. Financial Cash Flow for Dendro Plantation at CASURECO IV-A

(values in thousands of current pesos)

No. of modules : 10

No. of farmers : 121

No. of hectares : 330

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13-25
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993-2005
CASH RECEIPTS													
1.Loan from REC	114	246	257	152E									
2. Sales of farm products and ipil-ipil seeds, leaves	3	4	4	3E	3	3	3	3	3	3	3	3	3
3. Sale of ipil-ipil biomass to REC					797	843	879	925	972	1,019	1,066	1,125	1,183 t
CASH DISBURSEMENTS													
4. Plantation Development	114	246	257	152E									
LOAN PAYMENTS													
5. Principal and Interest					205	205	205	205	205	205	205	205	
CASH FLOW AFTER LOAN PAYMENTS													
6. Net balance	3	4	4	3E	595	641	677	723	770	817	864	923	1,186 t
FARMERS DISPOSABLE INCOME													
7. Divisible cash	96	206	215	129	595	641	677	723	770	817	864	923	1,186 t
8. Divisible cash per farmer	0.8	1.7	1.8	1.1	4.9	5.3	5.6	6.0	6.4	6.8	7.1	7.6	9.8 t

Table 1 C. Financial Cash Flow for Dendro Plantation at ISECO

(values in thousands of current pesos)

No. of modules : 10

No. of farmers : 97

No. of heclares : 560

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13-25
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993-2005
CASH RECEIPTS													
1.Loan from REC	283	387	309	255E									
2. Sales of farm products and ipil-ipil seeds, leaves				80	20	20	20	20	20	20	20	20	20
3. Sale of ipil-ipil biomass to REC					1,104	1,169	1,219	1,283	1,348	1,413	1,478	1,559	1,604 t
CASH DISBURSEMENTS													
4. Plantation Development	283	387	309	255E									
LOAN PAYMENTS													
5. Principal and Interest					335	335	335	335	335	335	335	335	
CASH FLOW AFTER LOAN PAYMENTS													
6. Net balance				80	789	854	904	968	1,033	1,098	1,163	1,244	1,624 t
FARMERS DISPOSABLE INCOME													
7. Divisible cash	232	317	253	289	789	854	904	968	1,033	1,098	1,163	1,244	1,624 t
8. Divisible cash per farmer	2.4	3.3	2.6	3.0	8.1	8.8	9.3	10.0	10.6	11.3	12.0	12.8	16.7 t

Table 1 2. Financial Cash Flow for Dendro Plantation at OMECO.

(values in thousands of current pesos)

No. of modules : 4
No. of farmers : 31
No. of hectares : 120

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13-25
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994-2006
CASH RECEIPTS													
1.Loan from REC	106	160	—	—									
2. Sales of farm products and ipil-ipil seeds, leaves													
3. Sale of ipil-ipil biomass to REC					190	198	209	219	230	240	253	267	280 t
CASH DISBURSEMENTS													
4. Plantation Development	106	160	—	—									
LOAN PAYMENTS													
5. Principal and Interest					79	79	79	79	79	79	79	79	
CASH FLOW AFTER LOAN PAYMENTS													
6. Net balance					111	119	130	140	151	161	174	188	280 t
FARMERS DISPOSABLE INCOME													
7. Divisible cash	87	131	—	—	111	119	130	140	151	161	174	188	280 t
8. Divisible cash per farmer	2.8	4.2	—	—	3.6	3.8	4.2	4.5	4.9	5.2	5.6	6.1	9.0 t

Table I E. Financial Cash Flow for Dendro Plantation at PANELCO I

(values in thousands of current pesos)

No. of modules : 10

No. of farmers : 101

No. of hectares : 1,100

Y E A R	1	2	3	4	5	6	7	8	9	10	11	12	13-25
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992-2004
CASH RECEIPTS													
1.Loan from REC	465	1,197	809	507									
2. Sales of farm products and ipil-ipil seeds, leaves	6	10	10	1	7	7	7	7	7	7	7	7	7
3. Sale of ipil-ipil biomass to REC					1966	2,057	2,178	2,270	2,390	2,511	2,631	2,753	2,904 †
CASH DISBURSEMENTS													
4. Plantation Development	465	1,197	809	507									
LOAN PAYMENTS													
5. Principal and Interest					804	804	804	804	804	804	804	804	
CASH FLOW AFTER LOAN PAYMENTS													
6. Net balance	6	10	10	1	1,167	1,260	1,381	1,473	1,593	1,714	1,834	1,956	2,911 †
FARMERS DISPOSABLE INCOME													
7. Divisible cash	387	992	673	417	1,167	1,260	1,381	1,473	1,593	1,714	1,834	1,956	2,911 †
8. Divisible cash per farmer	3.8	9.8	6.7	4.1	11.5	12.4	13.6	14.5	15.7	16.9	18.1	19.3	28.8 †

Table 1 F. Financial Cash Flow for Dendro Plantation at ZAMECO

(values in thousands of current pesos)

No. of modules : 10
No. of farmers : 99
No. of heclares : 226

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13-25
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992-2004
CASH RECEIPTS													
1.Loan from REC	267	768	347	339									
2. Sales of farm products and ipil - ipil seeds , leaves	3	3	3	3	3	3	3	3	3	3	3	3	3
3. Sale of ipil - ipil biomass to REC					367	384	407	424	446	469	492	514	542 t
CASH DISBURSEMENTS													
4. Plantation Development	267	768	347	339									
LOAN PAYMENTS													
5. Principal and Interest					466	466	466	466	466	466	466	466	
CASH FLOW AFTER LOAN PAYMENTS													
6. Net balance	3	3	3	3	(96)	(79)	(56)	(39)	(17)	6	29	51	545 t
FARMERS DISPOSABLE INCOME													
7. Divisible cash	222	633	288	281	(96)	(79)	(56)	(39)	(17)	6	29	51	545 t
8 Divisible cash per farmer	2.2	6.4	2.9	2.8	(1.0)	(0.8)	(0.6)	(0.4)	(0.2)	0.1	0.3	0.5	5.5 t

The data in Line #1 and Line #2 (through year 1984) are from the GIT questionnaires distributed to the dendro coordinators at the respective RECs. Line #1 shows actual loan releases to the TFAs as reflected in the accounting figures maintained by the RECs. No attempt is made to distinguish between loans in cash and loans in-kind, since the latter have been relatively insignificant in relation to the former. Here the figures are interpreted as cash amounts.

Plantation development and associated loan releases at PANELCO I were completed in 1982. ZAMECO completed four years of plantation development and loan releases in 1983, even though the area of surviving plantation is small. Among the six cases examined, the GIT questionnaires show only ANTECO and ISECO to be extending loans to TFAs in 1984. But CASURECO IV-A and ZAMECO also indicate plans for continued plantation development in 1984.

In this analysis the entries for 1984 in Line #1 are estimated (E) on the basis of REC planting targets and pre-1984 average loan releases (per hectare planted) for each of ANTECO, ISECO, and CASURECO IV-A (see Table 2). CASURECO IV-A has a 1984 planting target of 300 hectares; here it is assumed that only 50% of the target can be realized. Each of OMECO, PANELCO I, and ZAMECO has no entry for 1984 for the following reasons:

OMECO--No dendro funds remaining, and cooperative too strained financially to extend own funds.

PANELCO I--Plantation target achieved.

ZAMECO--Plans to continue plantation development may not be realistic in light of peace-and-order questions and available finance.

TABLE 2. Comparative Plantation Establishment Costs.

	Loan Releases, 1980-1983	
	Per Hectare Planted	Per Hectare Surviving
	(thousands of current pesos)	
ANTECO	2.16	7.24
CASURECO IV-A	1.01	2.33
ISECO	1.70	2.20
OMECO	1.73	2.21
PANELCO I	2.68	2.71
ZAMECO	2.23	7.62

Line #2 indicates that sales of by-products have not been particularly important to date (i.e., through mid-1984). The different products which have been sold are:

ANTECO: None indicated.

CASURECO IV-A: Sweet potatoes, corn, squash.

ISECO: Ipil-ipil seed (over five tons).

OMECO: Corn, upland rice, root crops.

PANELCO I: Corn, mongo.

ZAMECO: Upland rice, corn, vegetables.

No plantation has sold more than 10 thousand pesos of by-products in a single year, with the exception of ISECO in 1984. At ISECO four modules combined to sell 80 thousand pesos of ipil-ipil seed (about five metric tons) to NEA's TANGLAW Office for the Family Tree Farm Program. (Other dendro plantations not included among these case studies likewise have seed quotas with the TANGLAW Office.)

Line #2 probably understates the true value of plantation by-products obtained through 1984. In the first place, the questionnaire respondents (dendro coordinators and their agriculturalists) cannot be expected to possess accurate knowledge of these small transactions by dozens of individual farmers. Secondly, many dendro sites quite likely support more production of food crops for home consumption than for cash sales. This home consumption should be valued implicitly as cash savings for the farmer's family, but there is no estimate of this in the available data. Hence the figures in Line #2 present a lower benchmark. To keep the "base case" conservative, sales of

by-products for 1985 and beyond are assumed to remain at their recorded average for Years 1-4.

The sales values in Line #3 are computed on the basis of the following three elements: (a) plantation area (hectares); (b) mean annual increment (MAI) over this plantation area (wet tons of harvestable ipil-ipil biomass per hectare per year); and (c) sales price of the ipil-ipil biomass (pesos per wet ton). Data for (a) and (b) are shown in Table 3.

In Table 3 the plantation base at each dendro site is from NEA's data on surviving plantations as of March 31, 1984. To NEA's data have been added the following adjustments for expected plantation expansion in 1984:

ANTECO: +20

CASURECO IV-A: +65

ISECO: +116

These adjustments conservatively assume that the ratio of hectares surviving to hectares planted will be the same in 1984 as has been the average over previous years. As stated previously, the "base case" computations for OMECO, PANELCO I, and ZAMECO assume no new plantation additions for 1984.

During the first years of the first cutting cycle, biomass harvests will fall short of 25 percent of the area (4-year cycle) or 33 percent of the area (3-year cycle) if there are deficiencies of mature age groups. The percentages of surviving plantations to attain three years of age in given calendar years are as follows:

TABLE 3. Plantation Yield Estimates for "Base Case" Financial Analysis.

	Area of Surviving Plantation	Mean Annual Increment	
		First Harvest	Second & Later Harvests[1]
	(hectares)	(wet tons per hectare per year)	
ANTECO	130	13-20	13-20
CASURECO IV-A	330	32-39	32-39
ISECO	560	26-32	26-32
OMECO	120	20-24	20-24
PANELCO I	1,100	25-30	25-30
ZAMECO	226	NA	NA

[1] Assumes no difference from first harvest on "principle of insufficient reason." Growth rates on surviving stems will be increased, but this will be offset by stem mortality.

	1983	1984	1985	1986
ANTECO	0	21	6	73
CASURECO IV-A	0	15	33	52
ISECO	2	37	31	30
OMECO	0	15	85	
PANELCO I	27	46	27	
ZAMECO	36	35	29	

Comparing these distributions with the years of first cutting assumed in Table 1, each of the RECs is potentially capable of harvesting a full one-third (or one-fourth) of its existing plantation area during or before the first year of loan payment. Hence it appears that age-class constraints will not pose a problem for this analysis.

Concerning ipil-ipil growth and yield, the data in Table 3 reflect MacDicken's (GIT's) best interpretation of currently available knowledge. The computations use the midpoints of the indicated ranges. No yield estimates are available for the plantation at ZAMECO, and this analysis proceeds with computations assuming that ZAMECO's MAI is 25 tons/hectare/year (substituting the overall average of the other cases studied here).

With respect to the price of ipil-ipil biomass in sales from the TFAs to the RECs, the "base case" assumes that current NEA pricing policy will continue indefinitely. In 1980 NEA set guidelines specifying that the RECs pay 65.00 pesos per wet ton for plantation biomass harvested in 1984. NEA's policy allows for price increments of five percent per year. Thus the price

will be 68.25 pesos for biomass sold in 1985; 71.66 pesos for biomass sold in 1986; and so on. Sales revenues in Line #3 incorporate these annual price adjustments.

Line #4 shows expenditures for plantation development to be exactly equal to Line #1, loan releases from the RECs. While precise equality may not prevail, approximate equality is assured by the way the loan releases are dependent upon plantation accomplishments (Denton 1983, p. 189).

Line #5 is the amortization to repay the loan amounts shown in Line #1. Loan repayment takes place over the first 12 years, with an initial 4-year grace period. The amounts in Line #1 are carried to the end of Year 4 at 12 percent interest per year, compounded annually. A capital recovery factor (.2013) is then applied to this future amount to compute the equal annual payments for Years 5-12 of Line #5.

The net cash balance, Line #6, is computed as #1 + #2 + #3 - #4 - #5. Finally, Line #7 and Line #8 show payments of cash to tree farmers. For Years 1-4 in Line #7, NEA assumes that tree farmers retain 82 pesos (as compensation for labor) of every 100 pesos loaned by the RECs to the TFAs. This same ratio is conservatively applied in the "base case." However, the GIT questionnaires suggest that tree farmers may be retaining more than 82 percent of the loan monies, given that expenditures for seed, fertilizers, tools, etc., rarely exceed nominal amounts.

B. Results for the "Base Case"

This subsection will apply standard financial criteria to the income streams of the tree farmers, Line #8 of Table 1. In the "base case," only one real rate of discount will be employed, and only one rate of monetary inflation will be assumed. The analysis uses a 9 percent real rate of time preference to weight intertemporal consumption. This 9 percent rate is per NEDA guidelines (see Hyman 1983, p. 40). Because Line #8 of Table 1 is expressed in current pesos, an adjustment is required to convert this series to real incomes (i.e., adjusted for the purchasing power of the peso) before the 9 percent discount rate can be used. Here 1980 is chosen as the reference year for real incomes, mainly because NEA's dendro feasibility studies are based on price levels observed principally during 1979-1981.

The price deflator is the Consumer Price Index (CPI) for non-plantation workers outside of Metro Manila. This index stood at 137.0 in 1980 and 221.5 in 1983 (1978=100). Here it is assumed that the CPI will increase another 40 percent for 1984, giving an index value of 310.1 for 1984. Thus the average annual inflation rate for 1980-1984 is 22.7 percent. In the "base case" this rate is used to obtain real cash flow from nominal cash flow for all figures shown in Table 1.

Table 4 reports three measures of financial performance. Present net worth (PNW) and its corresponding annual average equivalent (AAE) are computed for divisible cash per farmer, Line #8 of Table 1. The results for PNW and AAE are reported for the entire 25-year time horizon, and also for the loan amortization

TABLE 4. Comparative Measures of Financial Performance, "Base Case" Cash Flows.

Years:	Present Net Worth[1] 1-12	Present Net Worth[1] 1-25	Ave. Annual Equivalent[1] 1-12	Ave. Annual Equivalent[1] 1-25	Internal Rate of Return[2] 1-25
	(thousands of 1980 pesos per tree farmer)				%
ANTECO	5.8	6.2	2.0	2.1	-8.8
CASURECO IV-A	7.4	8.4	2.6	2.8	27.8
ISECO	13.6	15.3	4.7	5.1	22.5
OMECO	8.0	9.0	2.8	3.0	12.4
PANELCO I	23.9	26.9	8.3	9.1	12.0
ZAMECO	6.9	7.5	2.4	2.5	-6.2

[1] On loan cash flow, Line #8 of Table 1.

[2] On investment cash flow, Lines #2, #3, and #4 of Table 1.

period (Years 1-12) separately. Because the first twelve years are of obvious critical significance for the success or failure of the dendro plantations, this subperiod merits careful attention apart from revenue flows which occur thereafter.

Internal rate of return (IRR) is not well defined for any period shorter than the complete 25-year horizon. The computation of IRR is based on Lines #2, #3, and #4 (i.e., excluding loan cash flow).

The results in Table 4 present an example of the frequent inconsistency between measures of investment efficiency vs. income generation. CASURECO IV-A and ISECO exhibit the highest IRRs, attributable in part to assumptions of relatively high biological productivity (see comparative MAIs in Table 3). Yet CASURECO IV-A and ISECO do not produce as much income per tree farmer as does PANELCO I, as evidenced by measures of PNW and AAE. The larger existing scale of investment at PANELCO I apparently explains comparatively higher PNW and AAE at that REC, even though CASURECO IV-A and ISECO generate higher returns per peso invested. Note, also, that IRR refers to the investment cash flow, not accounting for interest charges on the borrowed funding.

The results show that PNW and AAE for the entire investment period (i.e., Years 1-25) are only modestly larger than for Years 1-12. In no instance is the difference greater than 10 percent. That is, the cash flows occurring in the latter half of the investment period have low present value. For many practical

purposes, the late-occurring cash flows can be ignored or assumed to contribute only small positive contributions to present value.

C. Sensitivity Analysis

Many of the estimates in the computation of "base case" financial performance are subject to potentially wide margins of error. This section tests the sensitivity of farmers' real incomes to various changes in these estimates and assumptions. Only one criterion will be examined: average annual equivalent income in Years 1-12. This criterion is selected as that most likely to command primary attention for decision-making in the near term.

The scenarios tested here are divided into a "pessimistic" set and an "optimistic" set, classified by the direction in which they affect AAE. The impacts on AAE in Table 5 correspond to the following ordering:

(i) Pessimistic Set

1. One-year delay in start-up of power plant.--The "base case" shows that sales of ipil-ipil biomass to the RECs commence in timely fashion just when the first loan payment comes due. In reality, several among these first power plants are behind schedule. For a one-year delay in the sequence of biomass sales, AAE falls at all RECs except ANTECO and ZAMECO. This peculiarity at ANTECO and ZAMECO is explained by the postponement of negative cash flows during their loan amortization periods.

TABLE 5. Sensitivity Analysis of Average Annual Equivalent Income to Changed Assumptions.

Assumption		Average Annual Equivalent Income, Years 1-12 (thousands of 1980 pesos per tree farmer)
Original ("base case")	ANTECO	2.0
	CASURECO IV-A	2.6
	ISECO	4.7
	OMECO	2.8
	PANELCO I	8.3
	ZAMECO	2.4
(i) Pessimistic Set		
1. One-year delay before power plant operation	ANTECO	2.1
	CASURECO IV-A	2.1
	ISECO	3.9
	OMECO	2.4
	PANELCO I	7.2
	ZAMECO	2.4
2. Biological yields one-third below "base case"	ANTECO	1.7
	CASURECO IV-A	1.9
	ISECO	3.5
	OMECO	2.1
	PANELCO I	6.2
	ZAMECO	2.0
3. Only three-fourths of maximum MAI captured and delivered to power plant	ANTECO	1.8
	CASURECO IV-A	2.0
	ISECO	3.8
	OMECO	2.3
	PANELCO I	6.8
	ZAMECO	2.1
4. Loan reduced to 2,000 pesos per hectare	ANTECO	1.7
	CASURECO IV-A	2.4
	ISECO	4.4
	OMECO	2.5
	PANELCO I	7.9
	ZAMECO	2.0
5. Inflation rate increases by factor of 1.5x the "base case"	ANTECO	2.3
	CASURECO IV-A	1.8
	ISECO	3.4
	OMECO	2.4
	PANELCO I	6.8
	ZAMECO	2.5

(ii) Optimistic Set

6. Biological yields one-third above "base case"	ANTECO	2.3
	CASURECO IV-A	3.3
	ISECO	5.7
	OMECO	3.5
	PANELCO I	10.4
	ZAMECO	2.8
7. Plantation development will continue for three more years	ANTECO	3.1
	CASURECO IV-A	4.7
	ISECO	8.3
	OMECO	5.6
	PANELCO I	NA
	ZAMECO	3.5
8. By-product sales rise to 150 pesos per hectare per year	ANTECO	2.1
	CASURECO IV-A	2.7
	ISECO	4.9
	OMECO	3.0
	PANELCO I	8.8
	ZAMECO	2.5
9. Biomass price keeps up with inflation	ANTECO	2.6
	CASURECO IV-A	4.7
	ISECO	7.6
	OMECO	4.9
	PANELCO I	11.6
	ZAMECO	3.0

2. Biological yields are one-third below those in Table 3.--The GIT yield estimates may seem high in relation to those being generated by Hodam and Associates, Inc. If yields should prove to be 33 percent below those assumed in the "base case," then AAE declines (from "base case") by: -15 percent at ANTECO; -27 percent at CASURECO IV-A; -26 percent at ISECO; -25 percent at OMECO; -25 percent at PANECLO I; and -17 percent at ZAMECO.

3. Only three-fourths of maximum MAI is captured, harvested, and delivered to power plant.--The "base case" makes no allowances for losses of potential yield due to premature cutting (i.e., before peak MAI is achieved); fire, insects, and disease; and losses in handling and transport. If yields in Table 3 are adjusted downward by 25 percent to account for such losses, AAE declines (from "base case") by: -10 percent at ANTECO; -23 percent at CASURECO IV-A; -19 percent at ISECO; -18 percent at OMECO; -18 percent at PANELCO I; and -13 percent at ZAMECO.

4. Loan amount is reduced to 2,000 pesos per hectare.--NEA is currently studying the prospects of reducing loans for plantation establishment from 3,500 pesos per hectare to 2,000 pesos per hectare. This is a nominal reduction of 43 percent, but an effective reduction of less than that percentage since most plantations have been established at less than full allowance. Here we retrospectively reduce the loan amounts in Line #1 (and Line #4) of Table 1 by 30 percent. This lowers farmers' indebtedness, Line #5. If the rate and survival of plantation development would not have been affected by smaller disbursements during the loan release period, then Line #3

remains as shown in Table 1. The fall in AAE occurs because cash flow is shifted from the present towards the future. Reductions in AAE (from the "base case") are: -15 percent at ANTECO; -8 percent at CASURECO IV-A; -6 percent at ISECO; -11 percent at OMECO; -5 percent at PANELCO I; and -17 percent at ZAMECO.

5. Inflation rate increases by factor of 1.5x the "base case."--At the time of this writing the Philippines is contending with unusually troublesome monetary inflation. If inflation from 1985 onward should average 50 percent higher than for 1980-1984, then 34.1 percent is the appropriate inflation rate for the computations. This obviously reduces AAE (except at ANTECO and ZAMECO, where it lessens the present value of negative cash flows). Reductions in AAE (from "base case") are: -31 percent at CASURECO IV-A; -28 percent at ISECO; -14 percent at OMECO; and -18 percent at PANELCO I.

(ii) Optimistic Set

6. Biological yields are one-third above those in Table 3.--This is the inverse of sensitivity test No. 2. These higher yields reflect what possibly would have occurred with improved selection of sites, species, and silviculture. Improvements in AAE (above "base case") are as follows: +15 percent at ANTECO; +27 percent at CASURECO IV-A; +21 percent at ISECO; +25 percent at OMECO; +25 percent at PANELCO I; and +17 percent at ZAMECO.

7. Plantation development will continue.--For all RECs except PANELCO I, dendro plantations have not yet attained target

scale. If plantation development will continue in 1985 and subsequent years (Lines #1 and #4, Table 1), then Lines #3 and #5 will increase for 1989 and beyond. Here it is assumed that each REC (except PANELCO I) will proceed with three more years of plantation development (1985-1987) at an annual expenditure level equivalent to its past average. However, it will be hypothesized that accumulated experience will raise both survival percentages and MAI by one-third above past averages. Furthermore, increased harvests of biomass could already begin in 1987 (rather than 1989) under an "allowable cut effect." With all of these fairly optimistic assumptions combined, AAE increases substantially. Gains (above "base case") are: +55 percent at ANTECO; +81 percent at CASURECO IV-A; +77 percent at ISECO; +100 percent at OMECO; and +46 percent at ZAMECO.

8. By-product sales rise to 150 pesos per hectare per year (1984 currency).--This is the approximate attainment of ISECO in 1984. A realistic target on a sustained basis may be higher or lower than this amount, but 150 pesos provides a reasonable figure for the sensitivity test. All other plantations currently exhibit by-product sales well below this level. The improvement in AAE is modest but not to be disregarded. Gains (above "base case") are: +5 percent at ANTECO; +4 percent at CASURECO IV-A; +4 percent at ISECO; +7 percent at OMECO; +6 percent at PANELCO I; and +4 percent at ZAMECO.

9. Biomass price keeps up with inflation.--NEA's present policy to have biomass sales price increase by 5 percent per year is the "base case" for Line #3, Table 1. In light of recent

advances in the Philippine CPI well ahead of 5 percent per annum, NEA's DTDO is now reviewing alternative pricing options for the dendro plantations. If the price of biomass were to increase by exactly the same percentage as the rate of inflation in 1985 and beyond, then the impacts on farmers' incomes is as shown in this sensitivity test. Clearly, the increases are large. Gains (above "base case") are: +30 percent at ANTECO; +81 percent at CASURECO IV-A; +62 percent at ISECO; +75 percent at OMECO; +40 percent at PANELCO I; and +25 percent at ZAMECO. These results do not necessarily argue for indexing to the CPI. The question of indexing is addressed later.

D. Evaluation of Income Adequacy

Tables 4 and 5 must be judged by one or more standards in order to evaluate income adequacy and/or efficiency of invested capital at the dendro plantations. Table 6 presents one such standard in terms of income targets if dendro farmers are to attain parity with average family income in their respective geographical regions. Although this goal may not be stated formally by NEA, it is frequently mentioned informally as a desirable target to be achieved.

The income targets in Table 6 are expressed in 1980 pesos to be consistent with the rest of this analysis. NEDA's statistics on average family income are seriously outdated. Because income statistics for 1980 are not available, an indirect method is used to estimate a proxy for the 1980 income target. If real family income stayed the same between 1975 and 1980, then the 1975 data

TABLE 6. Plausible Income Targets for Tree Farmers in Terms of 1980 Pesos.

	(1) Ave. Family Income in Region, 1975[1] (thousand pesos)	(2) Increase in CPI, 1975-80[2] (%)	(1) x (2) Income Target in 1980 (thousand pesos)
ANTECO (Region 6)	5.5	177	9.7
CASURECO IV-A (R. 5)	4.3	177	7.6
ISECO (Region 1)	5.5	177	9.8
OMECO (Region 4)	5.4	177	9.6
PANELCO I (Region 1)	5.5	177	9.8
ZAMECO (Region 3)	5.8	177	10.2

[1] NEDA and NCSO, Philippine Yearbook 1983. Manila. Table 16.4.

[2] Countrywide average.

can be multiplied by the increase in the CPI to obtain family income in 1980 in terms of 1980 pesos. This is not to contend that real family income actually held constant, but only to find a rough measure of family income in 1980 currency. Note, also, that the CPI used here is a national average which does not allow for interregional differences.

Granting a generous margin of error for the crudeness of the method just described, the income targets for most dendro plantations exceed 9,000 pesos per year (in 1980 currency). The single exception is CASURECO IV-A in the Bicol Region, where the income target is lower.

Average annual equivalent income, Table 5, can now be compared with regional income targets, Table 6. The results are presented in Table 7 for the "base case" and the nine sensitivity tests (i.e., scenarios S.1 through S.9) at each REC.

At none of the RECs does the "base case" (representing current conditions and policy) achieve the regional income target, although the "base case" at PANELCO I approaches this level. The income target is exceeded at PANELCO I only under favorable scenarios S.6 (higher biological yields) and S.9 (biomass price keeps up with inflation).

Pronounced income shortfalls occur at ANTECO and ZAMECO under all scenarios, including the most optimistic ones. It will be recalled that yields at ZAMECO are not based on empirical observations, but rather are assumed to be "average" for the sake

TABLE 7. Tree Farmers' Incomes in Relation to Income Targets.

	(1) Average Annual Equivalent Income, Years 1-12	(2) Income Target, 1980	(1)/(2) Ratio
	(thousands of 1980 pesos)		
ANTECO			
"Base case"	2.0	9.7	.21
S. 1	2.1		.22
2	1.7		.18
3	1.8		.19
4	1.7		.18
5	2.3		.24
6	2.3		.24
7	3.1		.32
8	2.1		.22
9	2.6		.27
CASURECO IV-A			
"Base case"	2.6	7.6	.34
S. 1	2.1		.28
2	1.9		.25
3	2.0		.26
4	2.4		.32
5	1.8		.24
6	3.3		.43
7	4.7		.62
8	2.7		.36
9	4.7		.62
ISECO			
"Base case"	4.7	9.8	.48
S. 1	3.9		.40
2	3.5		.36
3	3.8		.39
4	4.4		.45
5	3.4		.35
6	5.7		.58
7	8.3		.85
8	4.9		.50
9	7.6		.78

OMECO			
"Base case"	2.8	9.6	.29
S. 1	2.4		.25
2	2.1		.22
3	2.3		.24
4	2.5		.26
5	2.4		.25
6	3.5		.36
7	5.6		.58
8	3.0		.31
9	4.9		.51
PANELCO I			
"Base case"	8.3	9.8	.85
S. 1	7.2		.73
2	6.2		.63
3	6.8		.69
4	7.9		.81
5	6.8		.69
6	10.4		1.06
7	NA		NA
8	8.8		.90
9	11.6		1.18
ZAMECO			
"Base case"	2.4	10.2	.24
S. 1	2.4		.24
2	2.0		.20
3	2.1		.21
4	2.0		.20
5	2.5		.25
6	2.8		.28
7	3.5		.34
8	2.5		.25
9	3.0		.29

of undertaking computations. Results in Table 7 suggest that, even if yields at ZAMECO should prove to be considerably higher than "average," financial performance of the dendro plantation is still likely to be unacceptable.

Income flow at ISECO comes close to meeting the regional target under optimistic scenarios S.7 (plantation development continues) and S.9 (biomass price keeps up with inflation). These scenarios provide 85 percent and 78 percent of average regional income, respectively.

CASURECO IV-A and OMECO show results intermediate to the modestly encouraging prospects at PANELCO I and ISECO, vs. the clearly discouraging outcomes at ANTECO and ZAMECO. However, even under the most favorable scenarios, CASURECO IV-A and OMECO will achieve only 62 percent and 58 percent of target income, respectively.

E. Implications

Cash flows accruing to tree farmers have been estimated for six dendro plantations. Data are sometimes crude, and the methodology to obtain cash flow is simplified. Nevertheless, the analysis furnishes a number of useful implications for plantation planning and policy:

(1) Because "base case" analysis reveals substandard incomes for tree farmers in all six case studies, past conditions and policies cannot be considered acceptable guidelines for dendro development in the future. That is, the results imply the need

to implement far-reaching change, not merely cosmetic and piecemeal corrections. Needed are fundamental revisions to enhance biological yields and alter pricing policy, at a minimum. Additionally, further plantation development should probably continue at some RECs (e.g., ISECO), while at other RECs this would only be "throwing good money after bad" (e.g., ANTECO and ZAMECO).

(2) The decidedly pessimistic cash flows in relation to NEA's original expectations may argue for: (a) a major and thorough policy review to weigh the advantages and disadvantages of open-market purchases of wood, (b) departure from meeting average regional income as a feasible or even desirable goal, and (c) agro-forestry technical assistance that would improve plantation survival and growth rates. A generous interpretation is that NEA could continue to support existing concepts, but would be obligated to adopt new practices. A less concessionary interpretation is that NEA should be encouraged to develop completely new concepts.

III. RECOMMENDATIONS TO IMPROVE FINANCIAL VIABILITY

Although the six case studies show generally unacceptable cash flows in the context of NEA's original framework, the analysis was purposely directed to "what is" rather than "what could be." Needed, then, is a carefully designed set of strategies to turn the accumulated experience into a viable program. This will require major organizational, technical, and fiscal adjustments, as identified and briefly described below.

A. Remove Uncertainty About NEA's Plans and Intended Support

To remove uncertainty about NEA's plans and intended support (financial and technical) at the individual dendro plantations, NEA needs to formulate and then implement an "action plan" in collaboration with the RECs and TFAs. An "action plan" is required for each dendro plantation, including those which now appear to have little opportunity of serving their original purpose. Decisions must be made promptly (i.e., in the next six months) to head off disillusionment among tree farmers.

The "action plans" should include a component(s) to generate immediate supplementary income. This refers to cash and income in-kind to help the TFAs past the financial crisis of NEA and GOP more generally. Sales of charcoal, firewood, seeds, and leaves can be considered immediately where the ipil-ipil has attained suitable size. As noted previously, the Family Tree Farm Program promises a large (but probably only temporary) market for seed. Other current discussion in NEA centers on investment in NEA-sponsored leaf pelletizers, one per region (A. Adriano, personal communication). This will require realistic assessments of production feasibility and pellet marketing, perhaps to an extent commanding greater resources than are allocated for this purpose at present.

Still ahead of NEA, the RECs, and the TFAs are difficult decisions about when and where to produce and sell charcoal and firewood (thus liquidating the first generation of tree capital stock). This refers principally to RECs which may not get a power plant in the next few years. All of this presupposes that

NEA and the RECs will aggressively pursue marketing studies and investigations of transportation economics.

Longer-term measures include efforts to establish bees, pigs and chickens, etc. in association with the ipil-ipil culture. But because these investments cannot be realized without at least one or two years of calendar time and modest capital input, they canot be considered an interim solution to the cash flow crisis.

B. Obtain More Land, Better Land

This is a medium-term proposition to annex more land and better land to the existing plantations, and to begin new plantations on lands of assured productivity. Enormous importance attaches to land policy--particularly site selection--because the unit costs of all subsequent plantation investments are determined primarily be the inherent qualities of the land.

In practice, proper site selection has proved difficult. At least four problems can be identified:

(1) Some of the sites are among the poorest of the denuded and otherwise degraded lands within the jurisdiction of the Ministry of Natural Resources. This refers to steep slopes, thin and infertile soils, and costly accessibility.

(2) As a consequence of inherently poor land productivity, NEA's original target of 1,100 hectares of plantation (for a 3 MW power plant) is certain to prove inadequate at a number of locations. Perhaps a full 50 percent of the total land area

heretofore selected for dendro plantations has been unsuitable for ipil-ipil planting (AID 1982, Appendix A).

(3) Within most plantations, modules have been laid out to be more or less equal in size. Biomass productivity, on the other hand, is known to be variable across modules, especially for ipil-ipil (Denton 1983, pp. 117-149). Unequal productivity across roughly equal-sized modules raises serious questions for both efficiency and equity.

(4) The Ministry of Natural Resources has been slow to grant final approval for the dendro-thermal ITPs. As of May 1984, only four or five ITP leases had been given final clearance. This adds further uncertainty and delay to plantation development, even though some RECs are proceeding without official approval from the Ministry.

NEA and the RECs have a number of potentially available strategic and technical options to mitigate the problem of inappropriate site selection. In 1980-81, the Ministry of Natural Resources (mainly through the Bureau of Forest Development) played the dominant role in assigning the dendro plantation sites, with largely passive agreement from NEA and the RECs. Since 1982, NEA and the RECs have asked that the Bureau of Forest Development identify not one site, but rather two or more site options for a dendro plantation. The RECs are then to request that NEA send a small technical team to help evaluate the sites in the field. Recently, at least a few proposed plantation sites have been rejected, even though none had been rejected in

the earliest years of the program (L. Bedano, personal communication).

Denton proposes a composite index for predicting ipil-ipil performance (Denton 1983, pp. 142-146). Alternative predictive models are being developed--or could be developed fairly rapidly if given adequate administrative support and funding. NEA should consider a policy to make all future site selection--including micro-site selection within an individual ITP--contingent upon the results of one or more of these predictive models. The benefit/cost ratio of applying such a model promises to be high in view of the pronounced yield variation observed both across and within plantations.

If only the best micro-sites of a plantation area are developed following Denton's guide or some similar approach, NEA and the RECs are advised to seek ITP leases such that three or more hectares of total land area are obtained for every one hectare to be planted. Even if species other than ipil-ipil are employed, it seems extremely prudent to lease more land than is prescribed by current policy.

Opportunity costs of the degraded lands are minimal. In fact, degraded lands can be considered the abundant factor of production. However, the variable component of biomass transportation costs will rise, and logistical/organizational problems could conceivably multiply. Also, there will be inevitable delays as the RECs and the Bureau of Forest Development seek mutually agreeable compromises on ways to enlarge the ITP leases.

C. Revise Pricing Policy for Biomass Sales

As harvesting of the dendro plantations comes onstream in the next few years, there will be a crucial testing of pricing policy between the RECs and the TFAs. As noted previously in this report, in 1980 NEA formulated guidelines (more correctly stated, assumptions) on the price of biomass to be sold from the dendro plantations to the power plants. This price is to be 65 pesos per wet ton (at roadside or cableway) for all biomass sold in 1984, increasing thereafter by 5 percent per year. However, it is premature to evaluate whether this policy will hold through time. Presumably, NEA and the RECs will remain flexible on pricing until a substantial amount of actual sales experience is accumulated.

As presently construed, the pricing policy may stand in need of modification in light of the following observations:

(1) While price is quoted per wet ton (mass), the current method of payment is by stacked cubic meter (volume), and the two are not linked with reliable conversion factors.

(2) The price does not take into account intermodule variation in harvesting difficulty. This refers principally to distance from the road or cableway. The RECs can anticipate the TFA's in the least accessible locations to claim that they should be paid more for their biomass (the equity argument). However, economic theory recommends precisely the opposite (the efficiency argument).

(3) The price does not take into account interregional variation in alternative demand for the plantation output. Given the difference in fuelwood availability between Ilocos and Palawan, for example, a unitary price fails to measure opportunity costs. The result is resource misallocation at local as well as national levels.

(4) The setting of a fixed price is not consistent with the usual approach of deriving demand for raw materials (i.e., plantation biomass) from demand for the final output (i.e., electricity). Different power plants managed by different RECs having different sales prices for electricity should, in principle, exhibit different derived demands for dendro biomass.

(5) The 5 percent annual price increase clearly lags far behind current rates of inflation. Section II demonstrated how financial performance brightens when biomass price keeps pace with inflation. While a 5 percent increase can be implemented mechanistically, it does not achieve a stated economic goal(s). Indexing to the CPI does not necessarily achieve a stated goal, either. In short, rules and procedures for price adjustments need more rationalization through a judicious blend of economic theory, administrative practicality, and concern for fairness to tree farmers.

(6) Some individual RECs show indications of pursuing their own pricing policies, apart from NEA guidelines. This draws attention to pricing practice in addition to the preceding points on pricing theory.

The importance of sound pricing decisions cannot be overemphasized (see Hyman 1983, p. 43). Because the efficiency and equity issues at stake are critical for the success of the dendro program, NEA in consultation with the RECs (and perhaps a small advisory team of economists) should give pricing policy a very thorough review. At this early juncture, the attention should be less on data gathering and more on pricing objectives, procedures, and methods for conflict resolution. Only after these larger conceptual and strategic questions are settled will it be appropriate to discuss specific empirical cases.

D. Encourage Private Enterprise Suppliers Outside of Dendro Plantations

NEA's DTDO already is making progress with this strategy. To a large extent, it has been forced upon RECs which now have active power plants but little plantation base (e.g., INEC, CASURECO IV-A). Undoubtedly other power plants to commence operation in the immediate future will find themselves in similar circumstances.

To make open-market purchases a purposeful policy rather than an accident of plantation failure, NEA and the RECs can pursue a variety of options. First and least-cost is simply to announce a purchase price for delivered wood (at power plant). Additionally, a REC trucking fleet (or REC trucking contractor) could be engaged to pick up wood at roadside for different prices in different transportation zones, possibly adopting some variation of the system employed at Paper Industries Corporation

of the Philippines (PICOP). Additionally, the RECS' current experiences with open-market purchases and transportation economics will have to be evaluated for lessons learned.

Beyond merely extracting wood stocks that happen to be available, NEA and the RECs can actively promote wood-growing on private lands in the vicinity of the power plants. This would be done through on-the-ground extension, radio messages, and marketing contracts (where appropriate). A possible linkage is with NEA's TANGLAW Office, particularly its Family Tree Farm Program. The Family Tree Farm Program should be evaluated for cost-effectiveness (i.e., numbers of trees grown per peso of program expenditure) as a guide to feasibility. Secondly, the wisdom of such expenditures will depend on: (a) the probability of the power plant being able to buy the wood in light of the grower's alternative sales and use options, and (b) the economics of handling and trucking small volumes per grower. These questions need to be addressed empirically in case studies for a sample of specific power plants.

Before NEA and the RECs consider open-market purchases on a wide scale, several issues will need to be examined:

(1) Existing power plants have not been sited with accessibility as a major criterion. On the contrary, many are in remote locations and reached over bad roads.

(2) An important social constraint is the potential deforestation impact of trees removed illegally from public lands.

(3) Open-market purchases cannot be pursued independently of decisions regarding dendro plantation development. Where both sources of biomass will be sought, careful attention must be given to the optimal combination of captive (i.e., plantation) wood vs. market wood. Both economic and psychological factors must be considered. The RECs cannot afford to jeopardize losing the support of the TFAs (or of being locked into purchasing agreements they cannot honor) by unduly favoring the open market. Conversely, private enterprise outside of the plantation area must be convinced that the power plant will indeed buy more wood than produced by the TFAs alone.

(4) A dependence on open-market wood fundamentally transforms the dendro concept. It downplays the socio-political objective of providing income to subsistence upland farmers who subsequently become the REC's tree farmers. But it gives emphasis to the financial objective of making the power plants operate at least cost for raw material. This conceivable tradeoff in goals--and relative shift in program philosophy--is a matter for NEA's upper-level administration to evaluate.

E. Seek Agro-Forestry Technical Assistance: How Much Can be Afforded?

By technical expertise in agro-forestry is meant inputs of mainly human capital ("applied knowledge") into improved site and species selection, site mapping, silvicultural choices, harvest planning, etc. This section addresses affordability of acquiring these inputs.

Through the end of 1983 NEA had released 53.91 million pesos to the RECs for plantation development (not adjusted for inflation). At the end of 1983 NEA considered 7.66 thousand hectares to be "surviving" out of 17.45 thousand hectares planted (44 percent success rate). If the 53.91 million pesos had been fully expended by the end of 1983, the effective development cost per surviving hectare is 7.04 thousand pesos. This compares with NEA's budgeted cost of 3.98 thousand pesos (175.93 million pesos in approved loans to develop a target of 44.20 thousand hectares of plantations). Granted that not all of the 53.91 million pesos released through the end of 1983 had been spent by that time, there nevertheless remains a serious question concerning the cost-effectiveness of plantation development.

The financial cost of plantation development is roughly 48 pesos per wet ton of biomass. This computation is based on the following elements:

(1) Recorded amounts loaned to the RECs for plantation development in each of 1980, 1981, 1982, and 1983, carried forward to the end of 1983 at 11 percent interest per annum;

(2) Capital recovery of this accumulated amount over the next 25 years, starting at the beginning of 1984;

(3) Combination of (1) and (2) to obtain annual equivalent cost of 7.37 million pesos per year for each of the next 25 years; and

(4) Assumed plantation growth of 20 wet tons per hectare per year for each of the next 25 years over the 7.66 thousand hectares of surviving plantations.

The estimate of 48 pesos per wet ton is not particularly sensitive to changed assumptions with respect to the period for capital recovery. However, it is sensitive to assumed plantation growth rates.

NEA's feasibility studies implicitly assume a financial cost for plantation development of 15 pesos per wet ton. (See "Sta. Maria Energy Tree Plantation": production of 37.5 wet tons per hectare per year over 1,100 hectares; amounts and timing of loan releases given in Table X; same capital recovery assumptions as previously). Hence cost overrun is currently 48/15, or more than a factor of 3x.

In light of various technical difficulties which have contributed to these high realized expenditures, it is worthwhile considering the costs and returns of technical assistance. Let us pose the following hypothetical question: How much funding could be justified for agro-forestry technical assistance in each of three consecutive years to achieve a 10 percent gain in plantation area surviving or a 10 percent gain in plantation growth rates? (Each type of gain has an identical effect on financial returns.) The figure of 10 percent is chosen arbitrarily to illustrate a modest target.

With respect to the dendro plantations now established, a gain of 10 percent in either growth or area surviving would have

decreased plantation development costs from 48 pesos per wet ton to under 44 pesos per wet ton. This assumes the given expenditure per planted hectare, but a 10 percent gain in biological success (as posited for illustration). The result would have been a cost savings of 4.37 pesos per wet ton realized over an annual production of 169 thousand wet tons for each of 25 years. Applying the same 11 percent discount rate as before, the present value of this cost savings would be 6.21 million pesos. This would justify spending up to 2.54 million pesos annually for an initial 3-year period of agro-forestry technical assistance.

A 5 percent biological gain would justify half of this amount (i.e., 1.27 million pesos), while a 30 percent gain would justify three times this amount (i.e., 7.62 million pesos). That is, the relationships are linear.

Clearly, the interest charge of 11 percent per annum represents subsidized capital form the perspective of alternative investments. If the opportunity cost of capital is 15 percent, then the preceding computations can be re-worked to justify 2.86 million pesos of agro-forestry technical assistance (during each year of an initial 3-year period) for each expected 10 percent gain in plantation survival or growth.

All of this still begs the key question about input and output: how efficient is agro-forestry technical assistance? Will a biological gain of at least 10 percent (during each of 25 years) be realized for an initial outlay of 2.54 to 2.86 million pesos for each of three years? Will more than a 20 percent gain

be obtained if this expenditure is doubled? This cannot be resolved here, but the relevant decision-makers should consider the following:

(1) the record of disastrous plantation results (less than 20 percent survival) at PANELCO III, BATELCO, PELCO II, BECO I, NEECO II, PALECO (A), and TAWELCO;

(2) the record of very poor plantation results (21 to 50 percent survival) at INEC, LUELCO, ISELCO II, ZAMECO, MARELCO, CASURECO IV (C), AKELCO, CAPELCO, ANTECO, ILECO I, ILECO II-A, NOCECO, and BOHECO II;

(3) the laying of responsibility for some proportion of plantation failure to factors outside of technical management (e.g., the prolonged drought of 1983; disturbances to peace-and-order) vs. that other proportion embracing decisions about sites, species, and silviculture well within the sphere of technical control; and

(4) a realistic appraisal of the extent of accumulated experience at the dendro plantations over these last four years; the degree of progress up the learning curve; and the capacity of local staffs to apply what they have learned without need for additional assistance.

F. Tie Decision-Making to the Costs and Returns of Alternative Silvicultural Practices

In connection with the previous discussion of technical assistance, a number of specific silvicultural questions need

prompt attention. This is not to propose a lengthy research agenda, nor to predetermine the issues to be addressed by a technical assistance mission. The point here is simply to identify a few of the very fundamental questions which have profound impact on financial returns, but for which there still are no reliable answers. All previous conventional wisdom and rules of thumb must be discarded to make way for objective investigation. Some of the serious voids in basic knowledge concern:

(1) the economics of alternative spacing in ipil-ipil, comparing unit costs (per wet ton of delivered biomass) from establishment through harvesting and transport;

(2) the economics of direct seeding vs. bare-root planting of ipil-ipil in cogon areas, focusing on valuation of lost time if an area needs re-establishment;

(3) the payoff to thinning of ipil-ipil for both seeded stands and coppiced stands;

(4) the feasibility of selecting and breeding ipil-ipil for acidic soils;

(5) a reassessment of biological and financial maturity (i.e., determination of the optimal cutting age) of ipil-ipil in light of currently observed growth rates in dendro plantations, recognizing that optimal cutting age on good sites is likely to be different from that on poor sites;

(6) decision-making criteria for selection of ipil-ipil vs. other species based on observed statistical means and variances (for growth and yield) in the framework of a risk-assessment model (e.g., using Bayesian statistics); and

(7) the costs and returns of applying soil amendments (especially fertilizer, but also lime) in dendro plantations.

Study of a few of these topics has been initiated by Denton and by Hodam and Associates, Inc. But their efforts are very small in relation to the magnitude of the total problem. NEA should attach high priority to settling these matters for the near-term rationalization of plantation management.

G. Reduce Loan Amount for Plantation Development?

NEA's DTDO is discussing a reduction in the amount of loan money it will make available per hectare of dendro plantation. Current policy specifies 3,500 pesos per hectare, although some RECs are known to devise their own local formulas for loan distribution among modules of varying difficulty. However, future amounts lent by NEA to the RECs could fall to 2,000 pesos per hectare (A. Adriano, personal communication).

This attests to NEA's acute shortage of funds for the dendro program. It may also attest to a policy shift not to lend for the full imputed costs of plantation establishment. Of course, given the recent upsurge in inflation, the amount of 3,500 pesos per hectare is already well below a full loan.

If the loan should fall to 2,000 pesos per hectare, the economic costs of plantation development do not change. The quantities, timing, and shadow prices of the inputs presumably are unaffected. Only the financial costs will change: farmers will be less indebted, but their period of greatest hardship will shift from Years 5-8 (as at present) to Years 1-4. Consequently, tree farmers will be more difficult to recruit as front-end attractiveness disappears. Hence the relatively mild decline in average annual income, Section II, probably understates the true significance of the proposed loan reduction.

It falls to NEA to define clearcut objectives and a procedure for monitoring results if it should dramatically decrease the loan amount. Before far-reaching decisions are taken, NEA should implement a few pilot tests of alternative loan amounts in strategically selected RECs.

At many dendro plantations, the largest expenditures per hectare have gone into the poorest micro-sites. Where more work has been required, more funds have been directed. But this runs contrary to efficiency precepts, since in agriculture and forestry it is the very best sites which consistently produce the highest returns to marginal expenditures. NEA's DTDO should consider issuing instructions on this point to the RECs after it makes its own empirical analysis of the problem. If there is an efficiency-equity dilemma here, the matter may have to be resolved in favor of efficiency until a dendro unit is mature and solvent.

H. Impose Tighter Discipline on Loan Releases

E. Tagudar, forester for PICOP, informally proposes that NEA's DTDO study the creation of a Monitoring and Evaluation (M&E) unit to oversee loan releases to TFAs. The purpose would be to impose strict control over payments to TFAs so that all loan releases are for "accomplishment" rather than for "subsistence" or "wages." The M&E body would operate autonomously, reporting directly to the Executive Director of DTDO. This independence will help ensure the objectivity of plantation evaluation and subsequent loan releases.

NEA's DTDO already assumes a monitoring role which includes oversight responsibility (L. Bedano, personal communication). The intent of M&E would be to formalize and strengthen this function, and to impress upon the RECs the importance of adhering to rigid policy. Continuation of loans from NEA to RECs can be made contingent upon compliance.

To be equitable to all concerned, tighter discipline over loan releases must be coupled with revised land policy, as discussed in Part B of this section. That is, the TFAs must be assigned modules on which they are assured a reasonable chance of plantation survival. Without revised land policy, the M&E proposition is not tenable.

I. Pool Risks of Plantation Losses

NEA, in collaboration with selected RECs, should investigate the concept of a self-insurance facility to pool risks of plantation losses due to natural hazards (fire, drought, typhoon,

insects, disease, etc.). The insurance could be mandatory or voluntary, and a REC may choose to match payments by the farmers. In all other respects, the facility would be modeled along the lines of conventional crop insurance schemes (e.g., those administered by the Philippine Crop Insurance Corporation).

Farmers would be assessed a certain number of pesos per cubic meter (or wet ton) sold to the power plant. This assessment would be deducted from the farmer's earnings and held by an insurance manager. The insurance fund would be kept in a low-interest but minimal-risk account.

Only stands attaining a specified minimum age (e.g., age 3) would be insurable. Furthermore, no farmer would be eligible to file a claim until he had deposited at least a minimum specified amount into the insurance facility.

This concept may not fit the institutional framework of the TFAs. Moreover, nothing is known about the extent to which the farmers exhibit risk-averse behavior. Thirdly, the establishment of such a facility invites "unaccountable disappearance of the funds." Still, the idea should be tested informally on a number of general managers, dendro coordinators, and--most importantly--TFAs. If preliminary feedback is at least partially supportive, then a more thorough study should be initiated.

J. Choose Appropriate Technology for Plantation Harvesting

NEA has anticipated that the dendro plantations will be harvested with chain saws, even though "techniques for these

processes are not yet fully developed" (Denton 1983, p. 190). Loan releases from the RECs to the TFAs include components for chain saw acquisition and fuel.

The estimated costs and production rates for chain saw harvesting are from observations at the Tobia Farm In Santo Domingo, Ilocos Sur (see "Observation on the Harvesting of Giant Ipil-Ipil at the Tobia Farm in Sto. Domingo, Ilocos Sur," report on file in NEA's DTDO). This operation (in 1982) harvested 5-year old ipil-ipil to meet a volume of 2,500 metric tons of wood for export. From these observations at the Tobia Farm was developed NEA's "Harvesting Scheme for Energy Tree Plantations."

However, the methods used at Tobia Farm may not be widely applicable on the dendro plantations for the following reasons:

(1) Stems at Tobia Farm had diameters of 5 centimeters and larger (average of 7.5 centimeters). But average stem size in the dendro plantations--under current spacing and seeding practices--promises to be much smaller. A high proportion of stems will be no thicker than a human index finger.

(2) At Tobia Farm a professional contractor was in charge of the work. Chain saw operators were rated from "fairly to highly skilled" (as reflected in their wages of 50 pesos per day). In contrast, an objective at the dendro plantations is to find methods suitable for farmers and their families to do the wood cutting, moving, and stacking themselves. This should assume no prior chain saw skills by the vast majority of tree

farmers. Nor should it be assumed that these skills are easily imparted by means of training sessions. Given the large numbers of farmers involved, training will prove costly and perhaps ineffective.

(3) The report on Tobia Farm does not indicate the length of the period for which observations were collected. Observations through the course of an extended time frame often discover major discontinuities due to broken chains, lack of spare parts, unavailability of gas and oil, and so on. But these paralyzing events may not be noted over shorter study periods covering just a few days.

(4) In the hands of inexperienced persons, chain saws are associated with a high incidence of serious accidents.

NEA and the RECs will do well to give the question of harvesting technology further consideration. Comments by REC agriculturalists at PANELCO I and OMECO imply that farmers have been frustrated with chain saws (specific reasons not enumerated). Hand saws--e.g., bow saws--provide one alternative (Laarman et. al. 1981, pp. 34-38). Questions of technical suitability and economic attractiveness could be tested by work study comparing different alternatives (including chain saws) under comparable conditions. On issues of labor-intensive harvesting and tool selection, NEA could exchange ideas with the Bureau of Forest Development (Tools and Equipment Section, Quezon City) and the University of the Philippines' College of Forestry (Center for Forestry Education and Development, Los Banos).

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GROWTH AND YIELD OF NEA FUELWOOD PLANTATIONS

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Appendix A proposed national standard approach to monitoring growth and yield

ABSTRACT

The National Electrification Administration (NEA) of the Philippines has undertaken a major plantation development project for the purpose of producing wood for steam generation. A field study of woody biomass yields of these plantations was undertaken and is described in this document.

During the early stages of Dendrothermal project planning, NEA predicted wood yields of 40 wet tons per hectare per year on each of its sites. A series of studies have shown that these yields have not been attained on any of the sites. While each of the studies of growth and yield to date have been incomplete, a compilation and analysis of these data has provided a rough estimate of existing wood yields for 11 of the NEA plantation sites. Estimated yields range from a low of 8 tons/ha/yr to a high of 30 tons/ha/yr, and are presented for each of the sites in Table 2.3.

The literature on wood yields of Leucaena leucocephala revealed that in general wood yield increase by 30-200 % or more over a rotation of 4 years. Since most of the reported wood yields (expressed as mean annual increment or MAI) are from young plantations of 1-3 years, it is anticipated that MAI will increase as the plantations mature. For the purposes of this study an increase of 30% was assumed, which is rather conservative given the increases in MAI reported in the literature. This results in predicted yields at the end of the four year rotations of between 10 and 39 tons/ha/yr.

SECTION 1

LITERATURE REVIEW

This review was conducted after an extensive computer literature search, and examination of a large number of other publications which were not found on the computer data bases. While much more work on fast-growing fuelwood plantations has been done in recent years, much of this work has not yet been reported in the literature. Much of the available literature on wood yields of fuelwood trees is not focused on intensively managed plantations of greatest interest in the Philippine dendrothermal project. These reported yields are generally significantly less than those which could be attained under more intensive management. Thus, only those reports which deal directly with growth and yield from plantations similar to the Philippine model are reported herein.

1.1 ATTAINABLE FUELWOOD PLANTATION YIELDS

A great deal of attention has been placed on fuelwood plantations in recent years. Much of this enthusiasm is due to the promise of high yields on short rotations of less than 5-10 years. While much higher yields are attainable in short-rotation, intensively-cultured (SRIC) plantations than in traditional forest plantations, the highest yields are only possible on the best sites.

However, these high yields are often published without adequate cautions to the reader about site quality, resulting in

a great deal of optimism about yield potentials. Unfortunately, much of this optimism has led to false expectations of attainable yields under field conditions on marginal lands. In this section yields of fuelwood species in SRIC plantations in the tropics will be reviewed.

It has been estimated that fiber production from either agronomic or forest tree crops is limited to a practical maximum of approximately 50 dry tonnes/ha/yr (Bevege, 1976). While this level of production remains unachieved in field plantings, it is not unreasonable to assume that such production levels may someday be attained on high quality sites.

At present, the highest reported yields for fuelwood plantings are less than 40 dry tonnes/ha/yr. Table 1.1 summarizes the stemwood yields reported in the literature.

With few exceptions, the yields reported in Table 1.1 are for stemwood only. Inclusion of branchwood commonly increases these yields by some 10-30% depending on species, spacing and age.

From the yields of Eucalyptus spp. and Leucaena leucocephala given in Table 1.1 it can be seen that yields in excess of 25 dry tonnes/ha/yr can be attained under experimental conditions. How these experimental yields compare to yields under field conditions is less certain. It can be said with certainty that actual plantation yields are significantly less than those attainable under experimental conditions. A major reason for this difference is the variability in site quality of most plantation sites. Agricultural lands are seldom allocated to

Table 1.1 Stemwood yields of fast-growing fuelwood species

Species	Location	Age (years)	Stocking (stems/ha)	MAI[1] (dry t/ha/yr)	Source
Eucalyptus fastigata	New Zealand	4	7,250	15	BioEnergy Dev. Corp.,1982
E. globulus	Australia	3	27,778	11	"
"	"	4	12,240	10	"
E. nitens	New Zealand	4	6,470	20	"
E. saligna	So. Africa	4	731	19	"
E. tereticornis	India	5	1,670	11	Singh and Sharma, 1978
Leucaena leucocephala	Taiwan	2	5,200	12	Lu and Hu, 1981
"	"	2	10,000	13	"
"	"	2	18,200	10	"
"	Hawaii	2	10,000	27	Van Den Belt and Brewbaker, 1980 *
"	"	4	10,000	27	Van Den Beldt, 1983 *
"	"	4	10,000	23	"
"	"	3	10,000	25	"
"	India	1.6	10,000	26	Relwani et al, 1983

1/ MAI = mean annual increment
*/ Stemwood and branchwood

fuelwood production, although in areas of high demand fuelwood may be considered a relatively low-risk, high value crop.

The variability found on most fuelwood plantation sites is readily evident from wood yields on the NEA plantation sites. Sample plot data from NEA plantations have shown plot yields which vary by well over 300% within a single plantation. This type of variation within marginal plantation sites results in overall yields which bear little relationship to experimental yields on much smaller pieces of land.

A key to reducing the gap between experimental yields and attainable plantation production is management, including site and species selection. How these aspects influence plantation success is to be dealt with by other members of the project team.

1.2 SUSTAINABLE PLANTATION YIELDS

Sustainability of wood yields under short rotation, intensively cultured plantations is an important consideration. Fuelwood projects are generally not designed to operate for a single rotation. More often plantations are planned for a number of successive rotations, each regenerated by coppice or through replanting. Each time wood is removed from a site nutrients are removed with it. In addition to these direct losses of nutrients, erosion and compaction often accompany harvesting and transport activities further accelerating nutrient losses. A

significant decrease in fertility can result in reduced yields from subsequent rotations.

Soil physical and chemical properties can be severely altered by erosion losses. Soil losses and degradation must be controlled if yields are to be maintained over time.

Nutrients which are lost in greatest quantities due to whole stem removal are nitrogen, calcium, magnesium, phosphorous and potassium. Some of these losses are replaced through the input of nutrients in rainfall and the release of nutrients by weathering parent material. Wise and Pitman (1981) reported that even with substantial yearly additions of several of the above mentioned nutrients, only magnesium losses could possibly be replaced through natural pathways in coastal Australia, assuming 10 year rotations of various eucalypt species. Potassium was reported to be partially replaced, but calcium, phosphorous and nitrogen inputs would not be sufficient to replace outputs, resulting in nutrient depletion over time.

Certainly nutrient removals under SRIC management are greater than those found under traditional forest management. They are also significantly less than those found for agricultural crops. While nutrient losses are clearly tied to species, site and soil characteristics, sustainability of yields on nutrient-depleted soils may require replacement of nutrients. Nutrient replacement costs using commercial fertilizers were estimated to be about 5-6% of the total cost of production of eucalypts in Australia (Wise, 1980).

The use of nitrogen-fixing trees such as Leucaena leucocephala reduces the amount of nitrogen extracted from the soil, and eliminates the need for nitrogen fertilization. Major nutrient problems on upland soils in the Philippines might be phosphorous, calcium, magnesium and potassium. Unfortunately little is presently known about nutrient losses under leucaena, although the potential for significant losses due to erosion and surface runoff is great. For example, leucaena leaves contain approximately .25 % phosphorous on a dry matter basis (Brewbaker and Hutton, 1979). Assuming an annual litterfall rate of 10 tonnes/ha/yr, approximately 25kg of P are recycled per ha/yr. If the litter is kept on the site this P will be recycled. If the litter is swept away by surface runoff, then there is a potential for the loss of 25kg of P per ha/yr.

These types of losses are not yet well studied, but are potentially limiting factors to the sustainability of wood production over time. For the present, it might be said that under appropriate management practices and periodic nutrient replacements, yields are likely to be sustainable indefinitely. Conversely, under mismanagement, nutrient levels are likely to decrease over time, resulting in a decrease in yields.

SECTION 2

REVIEW OF ACTUAL WOOD YIELDS

Knowledge of present and future natural resource supply is a key to resource management. Perhaps nowhere is it more important than in the plantation production of fuelwood for steam-powered electricity generation. Wood fuel supplies are as important to a wood-fired power plant manager as are oil supplies to fossil fueled power plants. Unfortunately, the biological processes involved in fuelwood production are often as unpredictable as the market fluctuations of fossil fuels.

Plantation inventory is one means of understanding some of the biological processes which are vitally important to plantation management. Periodic or regular inventories help the manager to assess growth rates, plan for and regulate future wood supplies - which is of vital importance to management, the farmer/producer and the electricity-consuming public.

2.1 DEFINITIONS OF GROWTH AND YIELD

Tree growth in the biological sense is the elongation and thickening of roots, stems and branches. This growth results in increases in wood volume and weight, which are of the greatest importance to those interested in biomass production. Growth is most often measured by height and diameter growth of individual trees, or by the average height and diameter growth of sample plots, stands or other populations. Growth may also be defined as the annual wood production per unit area, which is a more

useful measure than either height or diameter alone. For the purposes of this report, growth will be reported in wet tons per hectare per year (tonnes/ha/yr). While the yields reported in the previous section on yields used dry tons, nearly all of the yield estimates of productivity on the NEA sites have been in wet tones. Most of the growth calculations used by NEA and subsequent investigators have been mean annual increment calculations (MAI), which have taken yields at a given age and divided these yields by age in years.

Wood yield is the estimated or actual harvest of wood from an area of known size. For the purposes of fuelwood production, yield is best measured in terms of weight or volume. Weight is the preferred measure, since it allows direct calculation of useable heat from a given amount of wood. The only additional information generally needed for these calculations is moisture content. Volume estimates require conversion from cubic volume to weight before they become useful measures of fuelwood productivity.

Weight estimates vary tremendously with moisture content. For example, one cubic meter of wood (assuming a specific gravity of .50) would weigh 500 kg bone-dry, but would weigh 1,000 kg at 50% moisture content (wet basis). Thus, yield estimates must consistently use the same moisture content. This poses a problem when using wet-tonnes as a measure, since wood moisture content may vary significantly with site and season. However, since wet-tonnes have been consistently used in the past, they are used

through out this report.

2.2 REVIEW OF GROWTH AND YIELD STUDIES

A series of growth and yield estimates have been made of various NEA-funded dendro-thermal plantations. These studies were carried out by several different individuals and institutions, and are often in disagreement regarding actual yields measured to date. While these estimates often differ by a factor of 2 or more, the obvious general conclusion which all of these studies present is that yields are lower than the 25 bone-dry tonnes/ha/yr originally anticipated by NEA.

NEA has long recognized this fact, and has taken some steps to remedy the projected shortfalls in fuelwood supplies, primarily by increasing the amount of land allocated to the plantation sites. **The fact remains that after more than 4 years of fuelwood plantation experience, there are no truly reliable estimates available of plantation wood yields for any of the NEA sites.** The growth monitoring and yield inventory efforts made to date are reviewed in this section. Best estimates of yield resulting from a synthesis of these studies are presented in Section 2.3.

The greatest single danger in the utilization of these data is that only very limited estimates of the reliability of the sample data are presented. Nearly all of the yield estimates developed thus far include no indication of their reliability.

The reason for this lack of attention to the statistical

requirements of sample estimate reporting appears to be the limited number of samples taken in any single study. The low number of samples taken at each site results in large standard errors, and high "t values" which then result in very wide confidence limits around the mean. For example, 4 samples taken from the OMECO site showed mean total yields of approximately 33 tonnes/ha. Since this estimate was derived from only 4 sample plots, the confidence limits around the mean (t * standard error) were plus or minus 30 tonnes/ha. This results in a statistically significant, yet practically meaningless range of 3 to 63 tonnes/ha.

Much more accurate estimates could be made with relatively little additional effort should appropriate funding levels be made available. Recommendations for such efforts are presented in Sec. 4.1. **However, the present estimates should in no way be assumed to be accurate inventories of existing wood supply.**

2.2.1 NATIONAL ELECTRIFICATION ADMINISTRATION

Much of the work done to date in assessing plantation growth has been done by the NEA in cooperation with the electric Coops and the farmer associations. The data from these sources have been analyzed, summarized and published by Denton (1983).

NEA growth monitoring efforts were set up primarily by NEA consultant Frank Denton. Permanent growth plots were set up at at least 5 of the plantation sites beginning in 1981. These plots contain 15 sample trees, and were to be placed on each of

the 10 modules at each of the plantations. This would provide a sample of 150 trees from each plantation which were to be measured every 2 months. Data are presently being collected on these permanent plots by only 3 or 4 coops (NEA, personal communication).

Height and diameter growth data are also being collected from fixed area plots of 25-100 m^2 randomly scattered throughout the plantations. Approximately 6,500 trees from 150 such plots have been measured to date (Denton, 1983). These data provide a measure of population densities and stem size distributions.

While the smaller sized plots (25 m^2) were originally used to monitor growth, these plots were found to result in unacceptable levels of intra-plot variation, and were abandoned in favor of 49 m^2 plots (Denton, personal communication). A number of 100 m^2 plots were also established. Unfortunately, most of these plots are no longer being monitored due to the current financial crisis or due to lack of institutional interest.

These growth plots were to be randomly located in each of the modules of each plantation. Locations on the slope (i.e. top, middle, or bottom) were also recorded. While not all of the planned plots were established, these growth data provide the only quantitative basis for estimates of yield on a number of sites.

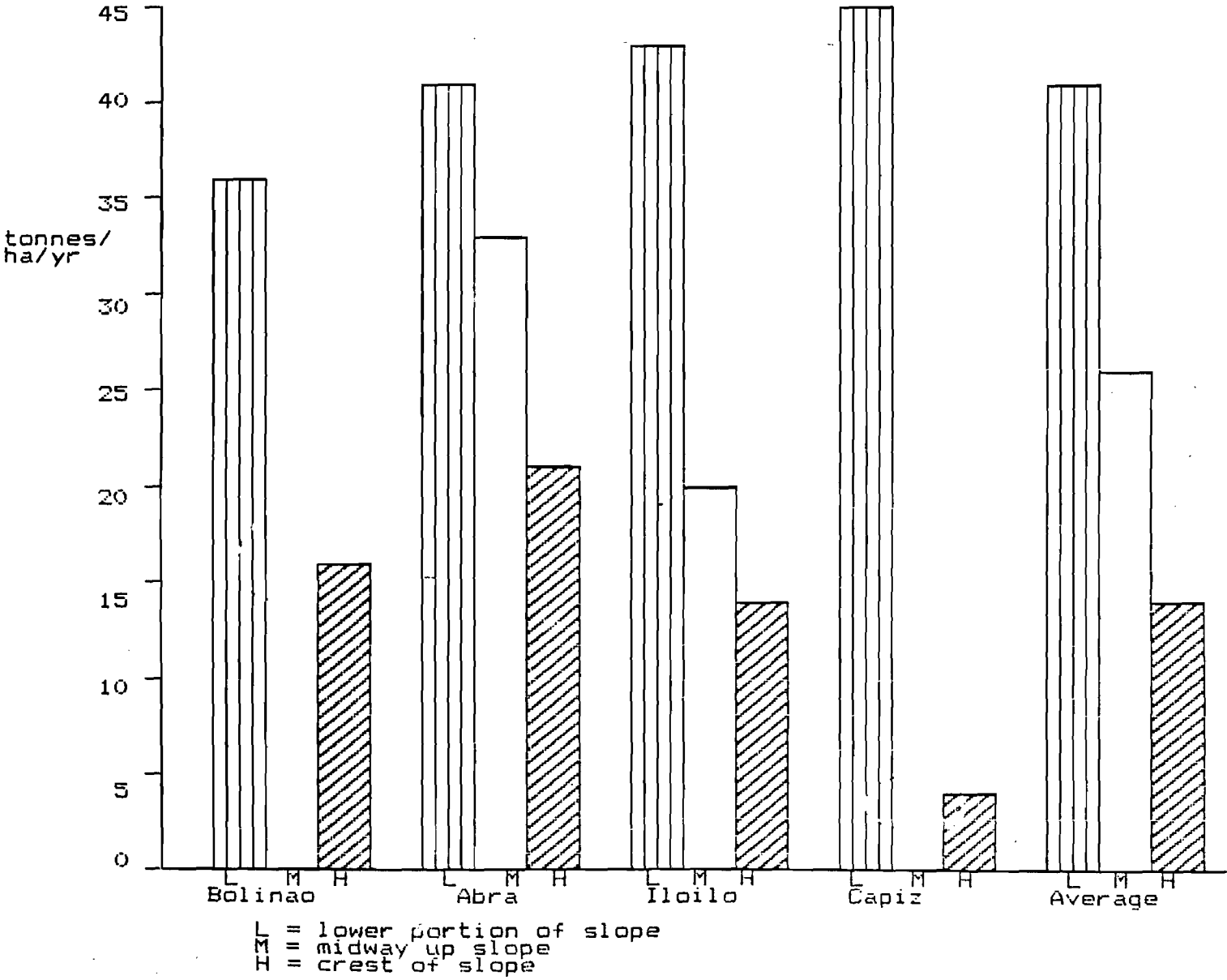
A major advantage of the NEA monitoring system is that it was simple, and relatively inexpensive. The participating coops and farmer associations provided much of the labor required for

the measurement and reporting of growth. Thus, the very limited resources allocated to the monitoring of plantation growth were maximized by the participation of coop personnel and farmers.

An important use of the growth data has been to show trends in yield in response to environmental conditions. This is a very important aspect of growth monitoring which has not been adequately addressed in subsequent studies. A prime example of the usefulness of these analyses is found in the relationship of slope and yield. Denton (1983) found that yields varied significantly with position on the slope - i.e. yields were generally lowest on the tops of slopes and greatest at the slope bottoms (Figure 2.1). This phenomenon is commonly recognized in forests elsewhere, is readily observed in the field, and was recorded in official NEA memos as early as 1982. **The NEA growth monitoring efforts have identified important trends in plantation growth which could be used to improve yields.**

Denton (1983) reports the first of several weight equations developed from stands of Leucaena leucocephala (ipil-ipil) in the Philippines. The Denton equation was developed using over 600 weighed sample trees, and provides conservative estimates of weight for trees over about 2.8 cm in diameter. Validation of this equation using both Denton's original data and data from the HAI inventory efforts show that the Denton equation consistently underestimates wood weight by 5% (self-validation using data from the ABRECO plantation) to 18% using data from HAI. Thus, calculations of wood yields on a **per-tree basis** using the Denton

FIGURE 2.1 Variation in yield as a function of position on slope



ADAPTED FROM: DENTON (1983)

equation are consistently less than actual wood yields.

This observation is in contrast to the fact that NEA estimates are generally found to be greater than those from other sources. This is explained by two factors. Early yield predictions by NEA were based on performance at the Bolinao site during its first two years of growth. Table 3.1 shows an increase in MAI of over 400% between years 1 & 2. Given this estimated increase in second year growth rates at this site, NEA felt it had reason for to believe projected yields would be attained for at least 5 sites (Denton, 1982 memo). Although the basis for the great difference in MAI is not known, it is clear that the assumption that increases of such magnitude would occur elsewhere is false.

The second reason for overestimates may well be the small sample size, and the location of the sample plots. Many of the existing growth records are from the 15 tree monitoring points, which when used to calculate existing weights consistently show greater amounts of wood than the HAI data. The sample sizes used in the NEA effort are quite small. For example, the 15 tree plots layed out in many of the plantation modules represent one million trees on the average (i.e. 100 ha/module x 10,000 trees/ha), or 0.0015 % of the population. Even if the 49 m^2 plots had been used in all of the modules, they would still only represent a sampling intensity of 0.0049 %, which is an extremely small sample in such variable plantations.

Several other observations may be made regarding the

accuracy of the NEA efforts to date. Denton (1983) recognizes two sources of non-experimental error in the data collection process: 1) measurement errors by the dendro farmers, and; 2) limited number of sample points for all locations. It is not known how great the measurement errors made by tree farmers have been, although Denton states that these errors have probably been minimal. The types of potential errors include mistakes in reading measurement tools, the taking of dbh measurements above or below 1.3 meters, etc. **In summary, the greatest sources of error in the NEA data are: 1) sample plot yields are not well related to overall plantation yields; 2) sample sizes are generally quite small, and; 3) a variety of measurement and recording methods have been used.**

The NEA data have been used to date in the form of averages from the growth plot yields. This is an important step in plantation inventory, yet when used as an un-weighted measure of yield can be quite inaccurate. This inaccuracy is a result of the false assumption that every plot represents an area of equal size, which is not the case. A more accurate procedure would be to stratify (i.e. delineate areas of a specified growth class) the plantations, sample each of the strata, calculate averages for each strata and weigh the overall plantation mean by using plot yields and the number of hectares in each strata. A comparison of the arithmetic average and a weighted average using data from Catanduanes showed a difference of over 4 tonnes/ha/yr in overall plantation yields.

This problem is not unique to the NEA/Denton data. None of the growth and yield studies so far have used weighted averages for more than a few of the plantations. Recommendations for simple improvements to these data are found in Sec. 3.1.

In summary, the advantages of the NEA/Denton approach are that it is relatively simple and inexpensive due to the use of a single-variable yield equation. On a per-tree basis, the equation provides conservative estimates of yield which were found to be 5-18% less than actual wood yields. Calculations using this equation to estimate average yield on a plantation basis without stratification were found to decrease the degree of conservatism inherent in the equation, and fairly closely approximates yields measured in the HAI inventory estimates.

As with the other estimates of growth and yield made to date, the NEA data provide crude, non-statistical measures of current wood increments. **While improvements could obviously be made in the sampling proceedure by stratification, larger sample plots, increased numbers of plots etc., the proceedure appears to be accurate enough to provide a first order assessment of growth and yield trends. However, as mentioned previously, the limitations to these data are identified by Denton (1983) and should be carefully considered in the use of these data.**

2.2.2 HODAM & ASSOCIATES, INC. (HAI)

Hodam & Associates is a California-based firm which has secured a contract with the National Dendro Development Corporation (NDDC) to study several aspects of the Dendro-thermal program, including plantation growth and yield. As a part of its efforts to assess plantation performance HAI has sub-contracted the Los Banos-based consulting firm MADECOR, the University of Idaho, and the Nitrogen Fixing Tree Association based in Hawaii.

HAI has been asked to collect tree growth data at 10 FSDC and 10 NEA energy plantations. As a result, 87 permanent random sample plots (PRSP) have been set up throughout the 20 sample plantations. Height and diameter data were collected once during early 1984 from these plots. The approaches used in this data collection have been different for all three of the sub-contractors and will be discussed separately.

A major problem with the HAI data is that the use of three independent sub-contractors to perform the growth and yield modeling work resulted in a great deal of duplication and inefficiency. Originally, sampling was envisioned to take place at an intensity of 1 plot per 60 hectares (Van Den Belt, 1984). Actual sampling was completed at an overall intensity of 1 plot for 82 hectares (Table 2.1), or approximately 0.01%. Thus, each of the three sub-contractors either states or implies that confidence in their results is very limited due to the limited number of samples taken, and due to the lack of a consistent stratification system.

Differences in definition and methodology have also limited the effectiveness of the HAI effort. Methods for stratification of plantations, definition of merchantable top diameters and data collection procedures are examples of problems which also limit the use of the HAI data. Review of plot data and the published summaries presented at a meeting on growth and yield in May, 1984 reveal several discrepancies in the sample plot data. These kinds of problems might be expected given the complexity of centralized data collection for three independent institutions, but in aggregate reduce the confidence which might be placed in the estimates.

Unfortunately, the data collection efforts of NEA and Denton were ignored by the HAI sub-contractors. The Univ. of Idaho consultant was not even aware that this source of data existed. Thus, a major source of both data and experience with the dendro program was overlooked from the onset.

Table 2.1 Sample plot distribution and intensity used by HAI in Dendrothermal plantations

Site	Number of hectares surviving	Number of sample plots	Number of hectares per plot
ABRECO, Abra	697	9	77
ANTECO, Antique	110	4	28
BOHECO I, Bohol	319	5	64
CAPELCO, Capiz	438	4	110
CASURECO III, Camarines Sur	319	3	106
FICELCO, Catanduanes	365	2	182
INEC, Ilocos Norte	511	8	64
ISEC, Ilocos Sur	444	3	148
ISELCO I, Isabella	377	5	75
PANELCO I, Pangasinan	1100	14	79
AVERAGE		5.7	82

2.2.2.1 MADECOR

MADECOR utilized the site index approach (see pg.28 for more detailed explaination of site index) to yield prediction as described by Revillia and Gregorio (undated). Previous work on leucaena yield modeling by MADECOR consultants provides the basis for the approach taken in the present efforts. Since the bulk of the MADECOR work is rightly considered as yield prediction, specific aspects of their model are discussed in Sec. 3.1.

MADECOR used a sampling procedure with concentric circles of varying sizes in anticipation of widely varying population densities. The MADECOR procedure was reported to be very time consuming in comparison to the procedures used by the other two HAI consultants. Time constraints limited data collections to 25 plots from only 5 of the FSDC and NEA sites. This limited number of samples prevented the satisfactory adjustment of the MADECOR yield prediction model to include stems under 5 cm in diameter. This adjustment may have resulted in an increase of some 20 m^3/ha over the current estimates (Revilla, personal communication). **Thus, while the MADECOR yield data are presented in the summary in Table 2.3, they are deemed to be systematically and unrealistically conservative, and are not recommended for use except in the complete absence of other data.**

2.2.2.2 University of Idaho

The Univ. of Idaho study was conducted by James Gaudie, and used a site index model approach similar to that used by MADECOR. The model suggested by Gaudie (1984) is of greater practical use than that proposed by MADECOR, primarily due to the inclusion of smaller diameter stems. The predictive value of this model is discussed in Section 3.1.

Sample plots of 100 m^2 were used by Gaudie, from which 20 random samples were taken for height measurements. DBH measurements were made on all of the trees in these sample plots. In addition, the height of the largest diameter tree in each plot was taken as a site index tree. Individual tree volumes were calculated using a formula previously derived by Kanazawa et. al (1982). A weight equation was derived from over 220 sample trees which were harvested from a number of sites and weighed.

This weight equation was compared with 6 other equations in this review using both independent and self-validation techniques as described in Burley and Wood (1976). **The Gaudie equation consistently predicted actual observed weights more accurately than the other equations (Table 2.2). Thus, its use is recommended when both height and diameter data are available.**

Gaudie (1984) presents the only comprehensive summary of the data collected under the HAI contract, which is also useful for calculations using data from other sources. Unfortunately, plantation averages were not calculated from a stratified sampling system, and the simple averages used in calculating

growth and yield parameters introduce potentially large errors into the results as discussed previously (Section 2.2.1).

A useful output of the UI sub-contract was the demonstration of volume-to-weight ratios for plantation grown ipil-ipil. Stem volume increments were reported to be consistently less than biomass increments. This suggests that non-stem wood (e.g. branches and tops) provide a significant proportion of the available biomass. While the factor assumed converting volume to weight is not evident from the Gaudie (1984) paper, it appears that branch and top wood provide 10-30% of the total wood weight from these plantations. This figure is consistent with other studies of stem weight-branch weight relationships.

In general, the Univ. of Idaho inventory results provide a format which is useful and fairly complete. However, simple averaging of sample plot data from a very low-intensity sampling design introduces significant errors which cannot easily be adjusted for.

2.2.2.3 Nitrogen Fixing Tree Association

The Nitrogen Fixing Tree Association (NFTA) prepared yield estimates for all 20 of the FSDC and NEA sites studied under the HAI contract. The NFTA approach utilized a similar sampling system as that of the Univ. of Idaho, and developed several individual tree weight equations. Thus, the problems with sampling intensity discussed previously also affect the NFTA results.

It might be noted that a major difference in initial methodology between the UI and NFTA sampling procedure was that while both approaches used 20 random sample trees from within the plot, the NFTA proceedure did not call for measurement of the remainder of the trees. Thus, no measure of actual plot populations were possible, nor was it possible to evaluate size class distribution per unit area. It is not known whether the production values given in the NFTA report are derived soley from the twenty sample trees or if the UI values were also used.

Both the UI and NFTA used three class ratings - good, average, and poor to classify sites. While Van Den Belt presents no data to support this approach, the UI summaries show little relationship between the site class and the site productivity in terms of biomass. This makes the gross plantation estimates in Van Den Belt (1984) questionable, a point that the author makes in his paper.

Several weight equations were presented in the NFTA results, and were compared with the Denton and Gaudie equations (Table 2.2). In general, the NFTA equation overestimates weight as compared with actual observed values, thus accounting for some of the variation between the calculated NFTA and Gaudie values. Using NEA plantation hectarages and the gross plantation production figures from Van Den Belt, the mean annual increment (MAI) is some 30-50% higher than those presented in Gaudie. Unfortunately, the actual MAI values used are not generally given, but for example the ISEC site is reported to have one plot

with a MAI of over 65 t/ha/yr. The highest plot MAI given in Gaudie for ISECO is 47 t/ha/yr or a difference of 38% from the same sample plot.

One reason for the differences might be the lack of time provided to adequately analyze the sample plot data. The last group of plot data was not received by the NFTA staff until one week prior to the presentation of results in the growth and yield meeting held in Quezon City in late May (Van Den Beldt, personal communication). This does not allow enough time for thorough analysis and interpretation of the data.

Table 2.2 Comparison of ipil-ipil weight equations

Validation sample #	Source** Denton	VDB1	VDB2	VDB3	Gaudie
	% of observed values				
1	-4.3*	17.6	32.5	9.6	5.1
2	-17.2*	5.4	20.5	6.5	na
3	-17.8	.9*	-28.4*	4.4*	6.5*
4	-23.0	-4.5*	4.0*	-8.0*	-.7*

*/ Self-validation data. Values shown without * are validated with independent data.

**/ Denton equation: $W = -4.0 + .54d^2$

VDB1 equation: $W = -29.54 + 6.04d^2$

VDB2 equation: $W = -1.046 + 0.453d^2h$ ***

VDB3 equation: $W = 0.060d^2h$

where: W = green weight in kg, d = diameter at breast height (dbh), h = height

***/ W = fresh weight in kg x 10

Unfortunately, the lack of MAI data in the NFTA presentation prevent a thorough comparison of their results with the University of Idaho data. However, the data which are published in Van Den Beldt (1984) do indicate that the NFTA estimates are significantly higher the those of the UI. This, coupled with the lack of adequate stratification, make the gross plantation yield estimates of questionable value.

2.3 ESTIMATED YIELDS OF SELECTED DENDRO PLANTATIONS

The only clear concensus shown from all of the yield studies to date is that yields have not met the 25 bone-dry ton (BDT)/ha/yr anticipated by NEA at any of the present sites. Beyond this very general conclusion, there is little agreement as to actual yields, nor is there a great deal of statistical information yet available regarding the reliability of previous estimates.

However, there is a "patchwork" of data from the sources mentioned previously which can be used to provide very rough estimates of mean annual increments. These estimates are labeled "MacDicken/GIT" and are summarized in Table 2.3, along with estimates from the other sources reviewed during this study. The general limitations to the use of this data are discussed in Sec. 2.4.

Table 2.3 Inventory estimates of existing yields in wet tons

LOCATION	WORLD BANK PRODUCTIVITY CLASS [3]	DENTON WT.1/ t/ha/yr	VDB WEIGHT 2/ t/ha/yr	GAUDI WT t/ha/yr	WORLD BANK t/ha/yr	MacDicken/GIT t/ha/yr
FICELCO, Catanduanes	A	19 **/	8	13	12.6	15-19
ISELCO II, Isabela	A	na	na	na	18.9	18-20
PANELCO I, Pangasinan	A	17	35	16	15.4	18-22
ABRECO, Abra	B	35 **/	24 ***/	17	15.4	17-22
OMECO, Occ. Mindoro	B	16	20	19 */	14.7	15-18
CASURECO IV, Camarines	B	31 **/	33	34 */	10.0	25-30
ISECO, Ilocos Sur	C	17	25	33	9.0	20-25
ANTECO, Antique	C	11	16	21	4.4	10-15
INEC, Ilocos Norte	C	3	9	13	4.4	8-13
BOHECO I, Bohol	na	na	9	11	na	8-11
CAPELCO, Capiz	na	3	15	21	na	15-20
AVERAGE		16.9	19.4	19.8	11.6	15.4-19.5

*/ Values calculated using Gaudie weight equation
**/ Values calculated from stratified NEA data
***/ Calculated from Van Den Belt (1984) tabulation
1/ Using Denton weight equation and values from Gaudie summaries
2/ Using Van Den Belt equation and values from Gaudie summaries
3/ Productivity classes were defined as: A = highest productivity
B = moderate productivity
C = lowest productivity
na = not available

2.4 LIMITATIONS TO THE USE OF EXISTING YIELD DATA

A number of limitations to the use of the present data are presented in Section 2.2. Many of these were recognized by previous investigators, and are summarized here only to support the conclusion stated earlier that the existent data are very preliminary in nature.

A. Lack of site stratification - None of the sites have been accurately stratified to provide accurate information on the amount of land in any given productivity class. **Without this kind of information it is virtually impossible to prepare accurate, weighted averages which can be applied to an entire plantation.**

Possible stratification options are discussed in Sec. 4.1 - Recommendations.

B. Use of simple arithmetic averages in plantation yield computations - The lack of stratification data forces the analyst to use simple averages from sample plot data. This can be important source of error.

For example, HAI sampled 2 plots at the FICELCO plantation on Catanduanes, and arithmetically averaged the yields of these plots to arrive at an average yield for the whole plantation of 12.6 tonnes/ha/yr (Gaudie, 1984). Examination of FICELCO growth records from each of the modules allows very crude stratification into poor, average and good

productivity classes based on height and diameter growth. When the average plantation yields are weighted using stratification and actual sample plot yields from Gaudie, the calculated average for the entire plantation is over 19 tonnes/ha/yr or an increase of over 50%.

While this example shows underestimation of annual plantation yields, yields at other sites may have been either underestimated or overestimated due to the use of un-weighted averages.

C. Limited number of sample plots - Due to time and resource constraints, the number of samples taken were far less than originally planned for the NEA and HAI studies. This is particularly true of the HAI design which called for one plot to be sampled for every 60 hectares of plantation, which was not accomplished in any of the NEA plantations.

The limited number of sample plots taken result in extremely large confidence limits, which generally render the results statistically meaningless.

SECTION 3

PREDICTING PLANTATION YIELDS

Prediction of wood yields at harvest is not the same as estimation of stand growth during the rotation. Growth rates change during the rotation due to physiological, environmental, and management factors. Thus, while an inventory of standing wood provides a measure of existing wood resources, it does not of itself provide a measure of future yields unless a time-series of measurements are made. This section reviews the yield prediction work done to date on the NEA plantations, and provides estimates of future yields for selected plantations.

3.1 PREDICTING WOOD YIELDS

Three basic approaches have been taken in predicting future yields of NEA plantations. The first of these is the site-index approach.

Site index is a common measure of site quality, and has been applied to a number of temperate timber species. Site index is based on tree growth patterns and refers to the height of dominant or codominant trees in even-aged stands at a specified age, usually 25, 50 or 100 years (Wenger, 1984). Since site index trees are rarely less than 10-25 years of age, climatic variables such as rainfall, solar insolation, etc. are integrated over time, making this approach practical for the slow growing species of the temperate zone.

Whether or not this approach is applicable to short-rotation (i.e. 3-5 years), intensively cultured fuelwood plantations in the tropics is an important question which remains to be answered.

The second approach in predicting wood yields is the use of environmental data which is correlated with the growth and yield of a specific tree species. Using this sort of approach, growth would be related to soil and climatic factors to develop a model which could then be used to predict wood yields on a site where the climatic and soils data were available. This approach is of greater interest than site index because it allows the planner/manager to assess potential productivity before planting activities begin, while the site index approach requires height performance data from trees planted on the site before predictions can be made.

Should each approach be developed for Leucaena leucocephala, they could well be integrated into a two-staged site assessment scheme which would provide the best possible predictive capability. **However, this predictive capacity does not yet exist.**

The third method of yield prediction has been to assess present growth rates, and to make assumptions from these rates about future yields. This method has been most widely used in predicting yields of the NEA plantations, but has not yet proven to be a reliable method of prediction (Section 3.3).

3.2 REVIEW OF YIELD PREDICTION STUDIES

As with the growth and yield studies reviewed in Section 2.2, yield prediction studies have been carried out by NEA and by Hodam & Associates. The sampling methods used in these studies are briefly reviewed in Section 2.2.

3.2.1 National Electrification Administration

The NEA efforts of Frank Denton focused on two basic approaches: 1) prediction of yields based on increases in present growth rates, and; 2) a "fertility index" based on measured chemical soil properties.

The first of these two efforts was utilized early on in the NEA experience to provide a general indication of how successful the plantations might be at harvest age. Unfortunately at the time of these early estimates (circa 1982), growth data were limited to a few sites, and increases in growth at the Bolinao plantation were used to predict future increases in growth at other sites. This has proven to be an inaccurate means of yield prediction (Section 3.3).

The development of a fertility index is a bold, innovative approach to site assessment. Soil fertility interactions are complex, and difficult to assess, yet Denton (1983) has identified 4 soil parameters which seem to be most important in limiting leucaena growth on a number of NEA sites. While the author admits that the fertility index is preliminary in nature, it is reported to fit the NEA yield data quite well. Certainly

this index could be improved upon with additional data, but it does point to an exciting aspect of the NEA project which could be used to provide a wealth of data for the cultivation of leucaena.

3.2.2 Hodam & Associates, Inc.

HAI yield prediction efforts have focused almost exclusively on the site-index approach. MADECOR and the Univ. of Idaho have both developed site-index equations, although entirely different data sets were used in the derivation of these two models.

An attempt was made to also correlate growth with soil chemical properties. This effort seems doomed to failure due to the improper handling of the soil samples. Soil samples were not properly dried, and were left for months prior to analysis. As of the writing of this report the required analyses had not yet been performed.

3.2.2.1 MADECOR

MADECOR began developing a site index model for ipil-ipil in 1976. The model used in the HAI contract was identical in many respects to the model published by Revilla in 1982. A significant addition to the HAI model was a table for trees spaced at 1 x 1 m spacing.

The major drawback to the use of the Madecor data for the NEA plantations is the size limits which were used for the model.

A merchantable top diameter of 5 cm was used, (i.e. only stems which were larger that 5cm were measured) which eliminated a large proportion of the stems and branches to used by the dendro plants. This obviously decreases the measured yields of the NEA plantations, many of which are largely composed of stems less than 5 cm in diameter at 3-4 years of age.

While it is not known how much difference is lost through the exclusion of these stems, it is thought to be a significant amount during the early years of the rotation, decreasing as rotation length exceeds 4-5 years (Revilla, personal communication). Indeed, the MADECOR model is much more useful for stands to be harvested on rotations of 5-10 years than for rotations of less than 5 years.

The limitations of the MADECOR model unfortunately prevent its practical use for the NEA plantations which are designed to be harvested at ages 3-5 years.

3.2.2.2 University of Idaho

At the time of this writing, the site index tables being developed at the Univ. of Idaho were not yet finished. Gaudie (1984) provides a preliminary table based on three relative productivity classes (i.e. poor, average, good), which was used to provide the estimates found in Table 3.2.

As stated in Section 3.1, the validity of the site index approach is questionable for short rotation plantations. Furthermore, the use of site index requires measurement of trees

of the same species on the site for which yield predictions are desired. It is not yet known what the minimum tree age will be to utilize the UI model, but the use of this method will require the planting and measuring of trees on the site before any predictions can be made.

3.3 PRESENT GROWTH VS. FUTURE YIELDS

One way of looking ahead at future yields is to look at mean annual increments (MAI) of growth over time, and make assumptions about what these MAI mean for the future. Two ideas about yields have been advocated so far: 1) mean annual increments remain relatively constant over time, and; 2) MAI increases significantly over time. This section presents data which reviews MAI of leucaena stands over time, and provides the background for the conclusions made in Section 3.4.

Van Den Beldt (1984) stated that yields from Hawaiian leucaena trials were shown to remain relatively constant after an initial establishment period of one year. This has not been borne out by data from the Philippine dendro plantations (Table 3.1). Indeed, data from Van Den Beldt (1983) show increases in MAI of up to 250% from year 1 to year 3 on one low productivity site in Hawaii (Table 3.1).

Data from Bolinao also provide a good example of the differences in MAI with age. Gaudie (1984) shows an average MAI of 17 tonnes/ha/yr for plots in plantings of about 4 years of age, and 13 tonnes/ha/yr for plots of 3 years of age. The

Table 3.1 Calculated differences in MAI over the rotation

Site	MAI (t/ha/yr) 1 yr	2yr	3yr	4yr	Percent increase
	wet t/ha/yr				-- % ---
CASURECO IV		21	59		181
OMECO		13	17		31
PANELCO I 1/			13	17	30
PANELCO I 2/			10	25	150
PANELCO I 3/	4	21			425
Maui, Hawaii 4/	4	8	12		200
Kauai, Hawaii 4/	19	27	32		68
Waimanalo, HI 4/	24	27	27	27	12
Molokai, HI 4/	31	36	25		-19

1/ Calculated from Gaudie sample plot data
2/ Calculated from June, 1984 NEA growth monitoring report
3/ Observed MAI in DRY TONS/HA/YR (Denton, 1982)
4/ Calculated from Van Den Beldt, 1983 yields of 1x1m spaced experimental plantings. Values for these data only are in dry tonnes/ha/yr.

results calculated from NEA data collected in June, 1984 show even greater differences. MAIs for the 1980 plantings were 25 tonnes/ha/yr, while those for the 1981 plantings were 10 tonnes/ha/yr.

While it is statistically impossible to attribute these differences to either experimental or biological causes, it does appear that there are significant differences in MAI during the short 4 year rotations envisioned for this project. **The assumption that MAI remains constant very likely results in estimates of yield which are on the average unduly conservative.**

3.4 PREDICTED YIELDS OF SELECTED NEA PLANTATIONS

After reviewing the data presented in Table 3.1, it was

assumed that MAI at each site changes, and that these changes are generally increases in MAI over time. While it is presently impossible to accurately predict what these increases might be, it has been assumed that they will be in excess of 30 % for most sites from ages 1 or 2, to ages 3 or 4. Most of the inventory estimates made to date have been of 1 to 3 year old plantations. Thus, it is assumed that MAI will be greater for most sites at the culmination of the rotation than have been measured during the early stages of growth.

The MacDicken/GIT predictive estimates presented in Table 3.2 are simply the inventory estimates presented in Table 2.3 increased by 30% to account for increases in MAI over time. While 30% is an arbitrary estimate, given the increases measured or calculated over time, it does appear to be a conservative one.

Table 3.2 Yield predictions for mean annual increments on four year rotations in wet tons

LOCATION	MADECOR VOL. m3/ha 2/	MADECOR WT 1/ tonnes/ha/yr	GAUDIE WT tonnes/ha/yr	MacDicken/GIT 3/ ESTIMATES tonnes/ha/yr
FICELCO, Catanduanes	9	2	4	19-25
ISELCO II, Isabela	na	na	21	18-20
PANELCO I, Pangasinan	25	5	11	25-30
ABRECO, Abra	25	5	11	22-29
OMECO, Occ. Mindoro	na	na	11 */	20-24
CASURECO IV, Camarines	38	8	11 */	32-39
ISECO, Ilocos Sur	55	11	21	26-32
ANTECO, Antique	55	11	21	13-20
INEC, Ilocos Norte	38	8	21	10-17
BOHECO I, Bohol	25	5	11	10-14
CAPELCO, Capiz	55	11	21	20-26
AVERAGE	36.1	7.3	14.9	19.5-25.1

*/ Classified as average sites using comparitive yield estimates only
1/ Conversion from m3 to weight made using 800 kg/m3 green weight
2/ These estimates are systematically lower than actual due to size class limitations (see text)
3/ Estimates made after reviewing all of the available growth data, based on assumption that MAI increases by approximately 30% from year 1 or 2 to year 3 or 4

SECTION 4

RECOMMENDATIONS

It is suggested that future NEA plantation development activities include the following:

1. Development of a plantation inventory system to assess quantities of standing wood, as well as evaluate growth rates. An example of this type of system is found in the Appendix.

2. A review of the most successful farmers in the current program for the purpose of learning from their experiences. Clearly there are a wide range of farmer-skills among the farmer associations which are not presently being utilized. Early NEA efforts sought to replicate farmer success through training. This effort should be strengthened and institutionalized.

3. Evaluation of practical, attainable improvements in plantation management practices which would result in increased yields. Simple fertilizer trials to evaluate the biological and economic benefits of several rates of fertilizer application and/or application methods are one example of this kind of field-oriented research.

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APPENDIX

A PROPOSED NATIONAL STANDARD APPROACH TO MONITORING GROWTH AND YIELD *

Recent work of the consulting firm Hodam and Associates, Inc. (HAI) has shown a need to develop a standardized program of growth and yield monitoring. Present inventory efforts, including those of HAI, are incapable of providing accurate inventory estimates with any statistical reliability. This Appendix reviews a system wherein work done at the Univ. of Idaho, under the HAI contract, is used to develop a simple, yet accurate, approach to plantation inventory.

This system utilizes a well-known system of forest inventory consisting of stratification of plantations, fixed plot cruises and local weight tables derived from a standard weight table which has already been developed (Appendix Table 1). It is suggested that the initial inventory work be done by NEA using centrally-funded crews of trained foresters and agriculturists. This work would be done by Filipino personnel over a one-year period and could encompass all of the active plantations for less cost than was involved in the HAI inventory effort (Appendix Table 2).

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*/ The author gratefully acknowledges the assistance of Mr. M.E. Drilling in the preparation of the detailed planning and cost figures found in this appendix.

Organizational structure

Three major organizational approaches are potentially useful in preparing for a detailed inventory of the NEA plantation efforts. One option would be to train crews from each of the participating electric coops to do the inventory. The second alternative would be to contract a Philippine-based firm to conduct the inventory. A third approach would be to assemble a team within NEA which would perform the initial inventory and train local coop foresters and agriculturists to continue the inventory efforts on their own.

The first option is rejected due to the large number of coops and personnel involved. While it is imperitive that dendro project field personnel be trained in the necessary techniques, it is believed that "on-the-job" training in this case would lead to gross errors, and would not be an effective means of training. The second option, to contract the inventory to an outside firm, is attractive in that it would help insure an accurate inventory, with a higher degree of NEA control than the first alternative. However, the contract approach is not suggested because it does not provide NEA with any institution-strengthening experience.

It is suggested that a team of Filipino foresters and agriculturists be assembled by NEA to perform the work outlined herein. The entire task should not require more than one year, and would require a staff of about 18 people, a number of which could be NEA staff temporarily assigned from the Dendro Thermal

Development Office, others would need to be contracted by NEA for the sole purpose of stratifying and inventorying the sites. In order to adequately carry out the inventory, it is important that these personnel have this task as their sole function during the life of the activity. The personnel required include:

1 - Project leader
4 - Field team leaders
8 - Forester/agriculturists
1 - Administrative assistant
1 - Bookeeper
1 - Driver/messenger
2 - Clerk/typists

It is suggested that one foreign inventory consultant be hired for one-month to work with the project leader, field team leaders and forester/agriculturists in developing specific inventory proceedures. While the inventory itself will be undertaken by four field crews of 3 men each, local staff of each of the target coops would be trained in the techniques as the inventory takes place. This should allow periodic monitoring by local staff with little or no additional inputs from NEA.

Weight table adjustments

A standard weight table has been calculated from the equation developed by Gaudie (1984), and is presented in Appendix Table 1. This table uses both diameter and height to predict individual tree weights. Since it uses both height and diameter, it can be used as a national model, as it accounts for variation in the relationships between height and diameter often found

under different environmental conditions. A major limitation to the use of this table in estimating yield is that it requires height measurements of individual trees. These measurements are both difficult to make accurately, and are much more costly than diameter measurements alone.

Thus, to simplify the inventory and monitoring proceedure, a method for adjusting the standard weight table is recommended. This adjustment allows the use of diameter measurements only to estimate tree weights. This proceedure is described by Husch, Miller, and Beers (1982):

1. Measurement of heights and dbh's of sample trees which are representative of the trees to which the local weight table will be applied.

2. Preparation of a curve showing height over dbh by the freehand method.

3. Reading of average heights to the nearest decimeter from the curve for each dbh class (may be in cm).

4. Interpolate the weight of the tree of average height for each dbh class and substitute the appropriate value into a new local weight table.

This proceedure need only be done once for each plantation, and could be done by the NEA inventory team. Once this adjustment is completed, only the local weight table need be used at each site, thus requiring only diameter measurements for the inventory.

Stratification

A national standard system of stratification is recommended which would be based on several average productivity classes.

Appendix Table 1 Standard weight table for Leucaena leucocephala

DBH (cm)	HEIGHT (m)															
	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0
	Weight in kg per tree															
1.0	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3	.3	.3	.3
2.0	.6	.8	.9	1.0	1.0	1.1	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5
3.0	1.7	2.1	2.4	2.6	2.8	3.0	3.1	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.9	4.0
4.0	3.5	4.3	4.9	5.3	5.7	6.0	6.3	6.6	6.8	7.0	7.2	7.4	7.6	7.8	8.0	8.1
5.0	6.1	7.5	8.5	9.2	9.9	10.4	10.9	11.4	11.8	12.1	12.5	12.8	13.1	13.4	13.7	14.0
6.0	9.5	11.7	13.2	14.4	15.4	16.3	17.0	17.7	18.4	19.0	19.5	20.0	20.5	21.0	21.4	21.8
7.0	13.9	17.1	19.3	21.0	22.5	23.7	24.8	25.9	26.8	27.7	28.5	29.2	29.9	30.6	31.2	31.8
8.0	19.2	23.6	26.7	29.1	31.1	32.9	34.4	35.9	37.1	38.3	39.4	40.5	41.5	42.4	43.3	44.1
9.0	25.6	31.5	35.6	38.8	41.5	43.9	45.9	47.8	49.5	51.1	52.6	54.0	55.3	56.6	57.8	58.9
10.0	33.1	40.8	46.1	50.2	53.7	56.8	59.4	61.9	64.1	66.2	68.1	69.9	71.6	73.2	74.7	76.2
11.0	41.8	51.5	58.2	63.4	67.8	71.6	75.0	78.1	80.9	83.5	85.9	88.2	90.4	92.4	94.3	96.2
12.0	51.8	63.7	72.0	78.5	83.9	88.6	92.8	96.6	100.1	103.3	106.3	109.1	111.8	114.3	116.7	119.0
13.0	63.0	77.5	87.5	95.4	102.1	107.8	112.9	117.5	121.7	125.7	129.3	132.7	136.0	139.0	141.9	144.7
14.0	75.5	92.9	104.9	114.4	122.3	129.2	135.3	140.9	145.9	150.6	155.0	159.1	163.0	166.6	170.1	173.4
15.0	89.3	110.0	124.2	135.4	144.8	153.0	160.2	166.8	172.8	178.3	183.5	188.3	192.9	197.3	201.4	205.3
16.0	104.6	128.8	145.5	158.6	169.6	179.1	187.6	195.3	202.3	208.8	214.8	220.5	225.9	231.0	235.8	240.4
17.0	121.3	149.4	168.7	183.9	196.7	207.7	217.6	226.5	234.6	242.1	249.2	255.8	262.0	267.9	273.5	278.8
18.0	139.5	171.8	194.0	211.5	226.2	238.9	250.2	260.4	269.8	278.5	286.5	294.1	301.3	308.1	314.5	320.7

ADAPTED FROM: GAUDIE (1984)

Stratification is the identification of strata which in this case would be portions of the plantations in which growth and yield are similar. National class limits defining these strata would be identified by the inventory team, and sites would be mapped according to these classes using measurements made during the survey. The national standard would allow direct comparison of sites, and minimize the ambiguity and confusion inherent in a series of locally derived definitions of productivity.

The cost estimates presented below assume a heavy emphasis would be placed on stratification. The mapping of areas by productivity class would not only help improve yield estimates, but would also be an invaluable tool in managing for improved productivity. Areas of poor growth could be readily identified by coop foresters and agriculturists, allowing them to place special emphasis in increasing the productivity of these areas by fertilization, replanting, improved weeding etc.

Plot selection

The sampling method suggested is stratified random sampling, which often provides more precise estimates for a fixed cost than simple random sampling (Wenger, 1984). Two major types of monitoring plots are recommended - permanent, and temporary fixed area plots. No calculations have been done to determine the optimum number of samples needed to provide given levels of productivity. Subsequent evaluations of statistical requirements and variability would provide the required estimates of minimum sample sizes.

Plot selection would be done randomly within strata according to well defined sampling techniques.

Data collection and analysis

Once the standard weight table has been adjusted to local conditions as described above, the only measurements required would be dbh and population density. Data analysis could be readily done on a microcomputer, which would be a required piece of equipment.

Cost

Clearly one of the most important criterion in selecting an inventory system is the cost involved. A detailed analysis of the system described above suggests that 30 of the NEA plantations could be surveyed for less than $150,000, which is approximately the cost of the HAI yield modeling excercise. Detailed cost figures are found in Appendix Table 2.

While these costs are based on an actual detailed analysis done in June 1984, changes in the survey design would certainly alter the cost of the activity. These costs are presented only to illuminate the magnitude of investment required to undertake a centrally-funded and operated monitoring system of plantation inventory.

Appendix Table 2 Estimated costs for the suggested inventory of 30 NEA plantations

Item	Estimated peso cost	Dollar cost*
Personnel		
Local - professional	560,000	
Local - administrative	355,000	
Foreign - professional (including travel expenses)		$20,000
Materials & supplies	868,000	
Travel (local only)		
Transportation	50,000	
Per diem	30,000	
Contingency (10%)	186,000	
TOTAL	P2,049,000	$20,000

DOLLAR COST:

Local currency equivalent @ P18:US$1	=	US$113,800
Foreign consultant cost	=	20,000
TOTAL		US$133,800

NOTE TO GEORGIA TECH TEAM MEMBERS: These cost figures were derived from a detailed analysis from 30 of the most active plantations, and may not reflect NEAs actual interests. Thus, these numbers become very "ballpark". However, they may be important to substantiate recommendations for a nationwide inventory, even though they might be off by a factor of 2!

FINAL DRAFT

Considerations of Forestry Management for the Dendro Thermal Project in the Philippines

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SUMMARY

This report contains a description of the management of tree plantations under the Dendro Thermal Project of the National Electrification Agency (NEA). The discussion entails both the activities of forest management and the technical silviculture systems followed. Recommendations are included both in the discussion when they are suggestions and in a section of detailed recommendations specific to Asian Development Bank (ADB) project funding with NEA.

Also included are discussions of agro-forestry, social forestry, institutional considerations, and an ecological evaluation of the project's activities.

Recommendations include:

* Forest Management Plan Development
* Funding
* Technical Assistance
* Institutional Strengthening
* Extension Systems
* Tools and Equipment
* Research
* Site Selection

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Appendix 5* Status of Plantation Development

Appendix 6* Persons Contacted

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Appendix 8** NEA and REC Technical Forestry Staff

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*Appendix 1,2,4,5, and 6 not included.

**Appendix 3,7, and 8 included in Volume I - Annexes.

I. INTRODUCTION

1.1 This paper will attempt to evaluate the Dendro Thermal Project from the aspects of forest management and planning; silviculture; including disease, pest control, and fire prevention; and social consideration of the farm foresters.

The ecological impact of forest management prescriptions will be discussed in order to balance the technical discussion of the project. In the final segment of the paper, recommendations for Asian Development Bank (ADB) provided assistance to the National Electrification Administration (NEA) will be detailed.

1.2 This paper is the result of a consultancy of approximately 50 days. During this period both NEA dendro plantations and private sector plantations were visited. Interviews were held with representatives of NEA, ADB, USAID, Rural Electric Cooperatives, Farmers' Associations (Tree Farmers), private consulting companies, PICOP, and the Manila Seedling Bank.

More than sixty (60) percent of the consultancy was spent in the field observing plantations and discussion problems and successes with field personnel. The other forty (40) percent of the time was spent in reviewing literature and reports pertinent to this report and in interviews in Manila.

1.3 Recommendations are advanced in relation to the already considerable success of the Dendro Thermal Project and to those

areas of deficiencies observed during the consultancy. Most of the recommendations have been discussed with NEA personnel and with other consultant team members.

1.4 Personnel of NEA express strong reservations about accepting technical assistance, either Filipino or expatriate, because of its cost and because there is no perceived need. The general feeling is of self-reliance and that problems can be solved by diligence and enthusiasm. This is definitely a positive attribute for the project but has resulted in less than efficient use of resources and also in some serious errors. For example, of 17,450 ha planted, only 7,664 ha have survived (See Appendix 5).*

Transfer of technology and adopting it to local conditions is easier than discovering and developing a "new" technology. Forestry developed through years of testing and experimentation. Planning technologies have developed in order to efficiently and effectively utilize scarce resources. Individuals and groups desiring to go into a forest project, or any other project, need not go into the tedious and expensive process of rediscovery of these methodologies. Acceptance and utilization of technical assistance is therefore a method of achieving maximum productivity of scarce resources in the minimum possible time. Of course, care must be taken to bring in just the proper type and quantity of assistance. (2,3)

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*Appendix not included.

II. FOREST MANAGEMENT

2.1 Forest management requires systematic consideration of all factors concerning selection, growing, and utilization of a forest whether in natural stands or in plantations. In order to effectively manage a forest certain basic information and criteria are essential. The Dendro Thermal Project is primarily plantation forestry utilizing exotic species with a well defined end use; therefore this discussion will be limited to concerns of this project only.

Plantation forestry is the most intensively managed silvicultural system. Establishment costs are generally very high and when unproven exotic species and unproven methodologies are used, the risk of failure is also high. Financial and economic appraisals are used to mitigate and evaluate the risks. But they are dependent on estimates of costs and yields actually achieved in practice. If these costs and yields differ markedly from those assumed in the initial appraisal, an apparently economic project can become a financial liability. (5,6)

2.2 The basic objective of forest management planning is to develop a forest or plantation management plan. This plan is based on several criteria.

* Objective of the Plantation
* Silviculture
* Harvesting

* Marketing
* Disaster Control
* Alternatives
* Monitor and Evaluation of Progress

2.2.1 In every plan constraints must be considered. These constraints can be classified into several areas:

* Technical Constraints: Factors including species suitability, methods of establishment, type of land (soil, topography, etc.) and weather (rain, typhoons, etc.), seed

* Economic Constraints: Economic and social factors requiring employment, return on investment, profit sharing, limitation on value of product or other factors that limit the options

* Institutional Constraints: Legal or statutory obligations or limitations imposed by political or social considerations

* Managerial and Organizational Constraints: Such factors as shortage of trained staff, difficult communications or organizational structures that hinder the smooth functioning of the project.

2.3 NEA has developed a working management plan. (10) In this document overall objectives and methods have been outlined. These are very general and not specifically oriented to any site. The

plan will be discussed step by step but some general statements are now required:

* Entire project oriented to one species - "Giant" Leucaena leucocephala (ipil ipil) with other species recommended for areas "not suitable" for ipil ipil. These "not suitable" areas are not defined other than "permanent" trees or fruit trees.
* Site selection criteria defined
* Site selection survey outlined
* Soil survey and analysis detailed
* Plantation planning requires detailing objectives and goals, schedule of technical activities, preparation of subdivision map, protection plan, manpower requirements, and list of tools and equipment.
* Support services requires listing of support personnel, keeping of plantation records, defining needed infrastructure and facilities, and outlining a financing plan.
* Gives technical instructions on planting techniques, nursery management, site preparation, replacement of failed seedlings, fertilization, weeding, fire prevention, pest and disease prevention, and harvesting.
* Gives a short description of 6 alternative species with suggested nursery activities and a brief description of requirements and attributes.
* Gives agro-forestry prescriptions for several crops and fruit trees.
* Includes a financial plan for the project.

2.4 On the surface, this appears to be an adequate document for planning and it may well be. But there does not appear to be sufficient technical ability or equipment within NEA or at the RECs to fulfill the requirements of the guidelines. There are few experienced foresters within the Agro-Forestry Department in the Dendro Thermal Office. Those holding these positions are trained generally in agriculture with some special short courses in forestry. The same is generally true at the field level. The only trained forester found during my field visits was at the San Juan, Abra plantation.

Note: Hodam and Associates is giving technical assistance to NEA under a contract sponsored by USAID but this is only in the area of growth and yield determination and species trials at four plantations. No direct assistance on plantation management is included.

All plantation site surveys in the feasibility studies reviewed generally give the same or very similar projections about the conditions and productivity at plantation sites. My visits to the field indicate serious discrepancies about soils, pH, potential growth, vegetation cover, and topography. These discrepancies are now causing re-thinking of the suitability of the silviculture now practiced on certain sites and unforeseen problems have caused the abandonment of several sites.

Adequate gathering of data about the ecological and social constraints before plantation establishment might have saved considerable time, effort, and money.

The cost and time required to do the appropriate studies are minimal when considered in light of potential losses or failure of a plantation to produce sufficient wood. These losses are not only financial but social. Farmers induced to participate in this program, take loans to cover costs, given promises of housing, and give up other opportunities will certainly not be as willing to follow another scheme in the future should this project fail.

Every effort to insure success of a project must be made prior to the decision to undertake the work. These efforts have not been complete in this project.

This can, and should, be rectified both for new sites and for existing sites. The section on recommendations will discuss how this can be accomplished. One conclusion is that a complete and detailed management plan is required at each plantation. This must include soil surveys, maps, prescriptions for treatments and species at each module, a harvesting plan, growth and yield predictions for the plantations and modules, and annual measurement of standing volume and work accomplished. Some effort to size modules to assure equal income to farmers groups should be attempted, i.e. modules should be sized in relation to their productivity.

Existing management plans at plantations are generally incomplete. They must be redone to reflect the conditions they address and to give adequate guidance to plantation activities.

2.5 Basic format for a Forest Management Plan varies but in general the following items should be included:

2.5.1 Description - Basic data on the management unit on which subsequent decisions are based.

2.5.2 Objectives of Management - National and local objectives and their priorities.

2.5.3 Evaluation of Alternatives - Identification of the alternative which best meets the objectives.

2.5.4 Prescriptions - Definition of the methods to be used, and why, and how work will be organized.

2.5.5 Input Forecast and Budget - Anticipation for a period of several years ahead, the amount of work to be done each year, the need for manpower and financial resources.

2.5.6 Output Forecast - Assessment of expected production at various times in the future.

2.5.7 Annual Plan - Set out, in detail, the work needed for the next year and where it will take place. Note: Could be done in the annual budget document.

2.5.8 Monitor and Control - Check actual progress against planned progress, in order to eliminate discrepancies and to adjust the next annual plan and future forecasts to the new situation.

2.5.9 Maps - Relate the written plan to the ground.

The need for reevaluation and modification of the management plan as results of activities become available are clear. This activity must be well defined and methods for changing the plan clearly detailed as part of the management plan.

2.6 As part of the developmental stages, the NEA management of a plantation, selection of a site for the plantation is required. This site selection is important because the management plan must be developed to fit a particular site with its particular constraints. In order to properly identify constraints about a particular site certain information is necessary:

* Climatic Type
* Vegetation Cover
* Soils
* Topography
* Ownership
* Occupants and Their Location
* Geographic Features such as rock outcrops and rivers
* Roads and other access
* Fire danger, typhoon danger, known insect or disease problems
* Ecological considerations, e.g. rare or endangered species

This information should be assembled prior to preparation of the management plan and, when possible, prior to accepting a site

for a dendro plantation. No site should be fully accepted until both phases as described below are completed.

Much of the information requires collection at the proposed site. This should be done in two phases:

The first is a preliminary phase done by ocular estimates and line surveys with only selected evaluations of such items as soils and social conditions. USAID conducted such surveys on the CENECO, ILECO and BOHECO I sites (8). This survey could serve as an example of preliminary site acceptance.

The second phase is very intensively done. This should include developing a base topography map of the plantation at 1:5000 scale. Overlays should be made to show vegetative cover, soils, geographic features and logging plan. The scale is larger than normally required for forestry work but the relatively small areas of the plantations makes local conditions more important in influencing the outputs of the project. Each module should be mapped at a scale of 1:2000. Illustrative map and overlays are included in Appendix 1.*

Soil surveys should be conducted as outlined in Mr. Fred Johnson's report.

Technical skills required to collect this information are easily transferred to personnel who now exist at most plantations.

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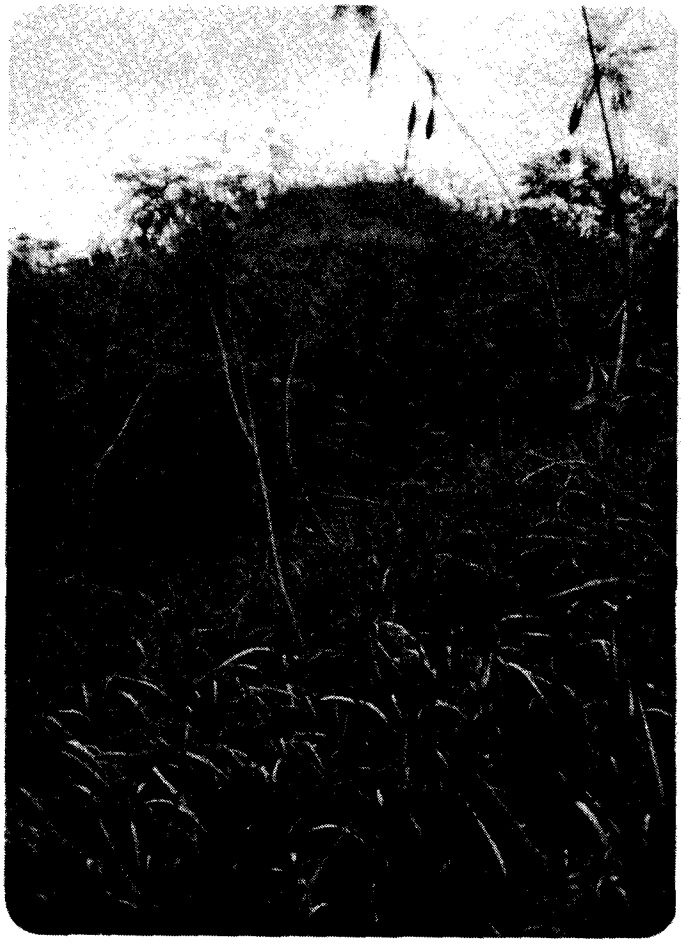
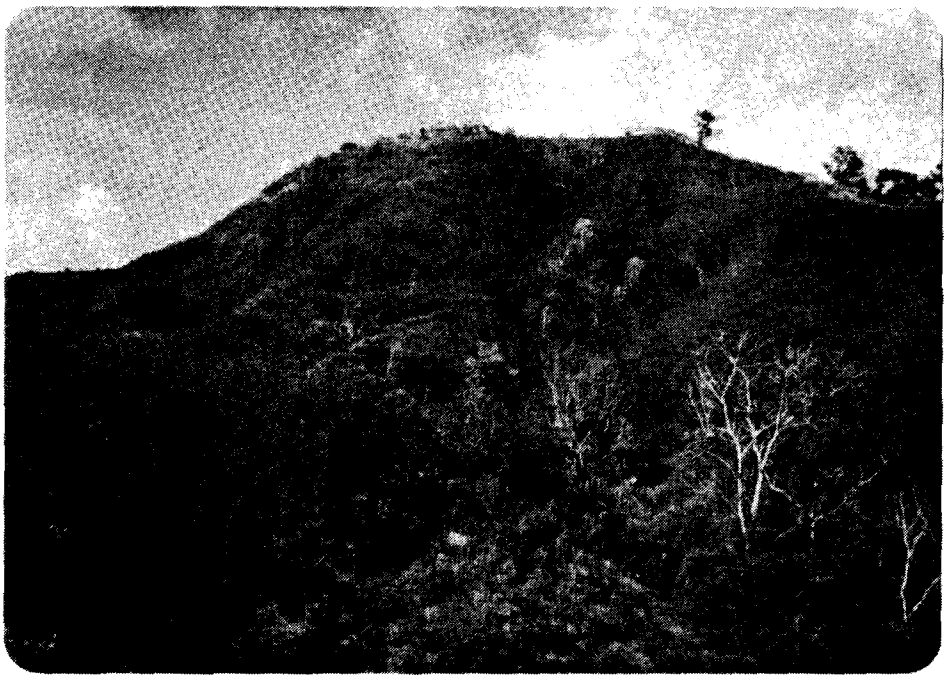
*Appendix not included.



Site variation - hilltop to hillside. All ipil-ipil trees in this photo are the same age. Hamtic Plantation, ANTECO.



Site variation - hillside. All ipil-ipil trees in this photo are the same age. San Juan Plantation, BURGOS.

They will require a few tools and some training, but these tools and skills will be used throughout the life of the project. Such things as soil analysis and logging planning require special labs and skills that should be contracted to outside firms. These activities are specialized and generally only done once; therefore no advantage would be gained by developing the skill at the plantation level.

Social surveys of the occupants on the plantation site are important. Some plantations have large numbers of people living on or using the plantation areas, e.g. BOHECO I, where 500 farm families live within the boundaries of the plantation. More about this will be discussed in social consideration of forestry in section 5.3.

III. TECHNICAL DISCUSSION

3.1 Silvicultural Concerns

Silviculture is the growing of trees in a manner that meets the objectives of a forest management plan. Silviculture includes the consideration of requirements for establishment, growth, composition and quality of the forest. For this discussion plantation silviculture will be emphasized.

The stated objectives of the NEA Dendro plantations are to establish tree plantations to be used for fuel in boilers to produce electricity. Additional benefits include developing

employment in rural areas and offsetting need for imported fossil fuels now producing this electricity.

In order to develop effective silvicultural prescriptions, consideration of the need for particular products and need to grow these in a labor-intensive but efficient manner is required. Whenever possible only Philippine-proven techniques will be suggested.

3.1.1 Species selected should be oriented toward fuelwood production, ease of establishment, and rapid growth. Whenever possible, species should be selected that give by-products such as honey production, fodder production, or valuable seed. Mr. Fred Johnson gives several species that hold promise for this project.

3.1.2 Planting methods are a key consideration of this project. The principal method now used for ipil ipil is direct seeding. In many areas, this has been very successful but has not given good results on some, especially where Imperata cylindrica (cogan grass) is dominating the site. Direct seeding has also failed where proper weeding was not maintained. In some instances, rodents have eaten the seeds and the young seedlings.

Bareroot seedlings, either raised in a nursery or taken from existing plantation's natural seedlings (wildings) have proven successful, except when planted late in the season or during unusual conditions such as the drought of '82-'83.

Table 1

Planting Methods[1]

Species	Direct Seeding	Cutting	Stumps	Bare Root	Containers
Leucaena leucocephala	1		4	2	3
Gmelina arborea	2	5	1	3	4
Gliricidia sepium	2	1		4	3
Eucalyptus spp.					1
Acacia auriculeaformis	1			3	2
Acacia mangium					1[2]
Tectona grandis	2		1	4	3
Swietenia macrophylla	3			1	2
Pterocarpus indica		3		2	1

[1]Column numbers reflect priority of selection of method
No number = no recommendation

[2]Because of scarcity and high price of the seed this is now recommended as the only method

These two methods should continue to be utilized for ipil ipil but other species may require different systems. Table 1 gives several species with alternative planting methods.

Nurseries have not been extensively used in this project. When other species are produced, nurseries may be required. Appendix 4 gives basic instruction for nursery culture applicable to those species suggested by Mr. Johnson.* This appendix is taken from "Manual of Reforestation and Erosion Control for the Philippines." (1)

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*Appendix not included.

3.1.3 Spacing selected has generally been 1 m x 1 m. This gives 10,000 trees per hectare and is assumed to produce the high biomass for short rotations. Generally only ipil ipil has been planted at 1 x 1 spacing by NEA. Where other species are planted, 2 m x 2 m spacing is generally selected. The Manila Seedling Bank has planted Acacia auriculeaformis at 1 m x 1 m spacing with good results. The Manila Seedling Bank has also planted ipil ipil at very close spacing, ½ m x ½ m, or less, for production of leaf-meal.

Some spacing experiments are on-going at Bolinao in cooperation with the Forestry Research Institute (FORI), but they have not produced published results. These types of experiments should be expanded to various sites and species.

Close spacing gives several advantages. Dense shading eliminates undergrowth, lowering competititon and fire risk. A major drawback is the large number of trees required per ha. Probably the only feasible methods of close planting are by direct seeding, by bareroot seeding, or by stumps.

Wide spacing is used when trees are very intolerant of shade or when they must be planted from containers. For longer rotations on poor sites wider spacing may be required.

Generally speaking, trees destined for firewood should continue to be planted at 1 m x 1 m spacing with the exception of

Fuel load under ipil-ipil plantation at Boliñao Plantation, PANELCO I. Demonstrates high fire danger.

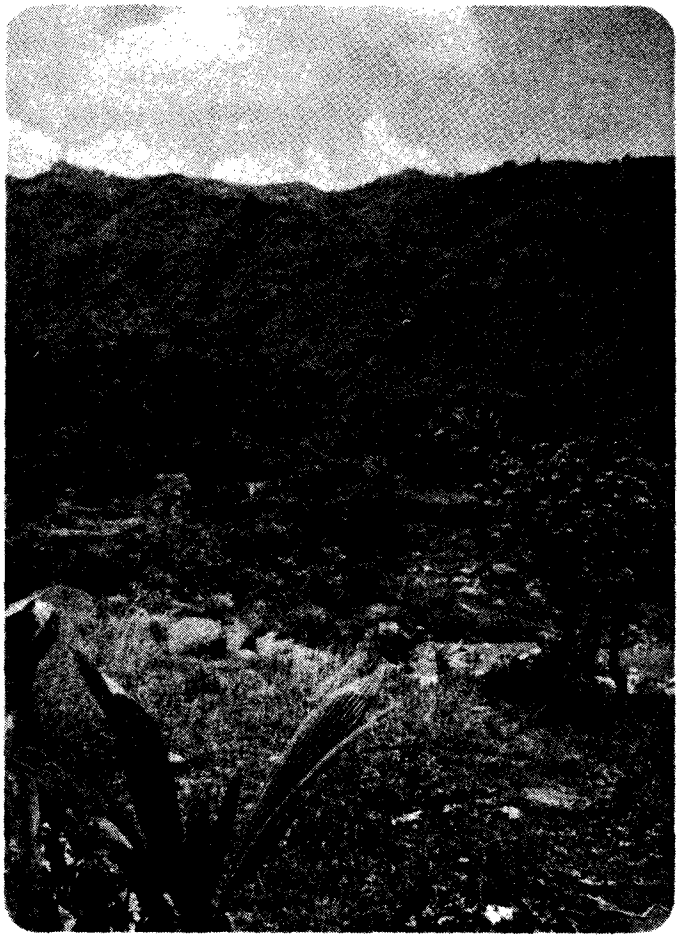
Numerous sprouts from stump after harvesting. Boliñao Plantation, PANELCO I.

Eucalyptus spp. and Acadia mangium which must be grown in containers. These should be grown on 2 m x 2 m spacing. Generally timber trees for long rotation should also be planted at 2 m x 2 m spacing unless a program of thinning is envisioned.

3.1.4 Fertilization and liming are sporadically used. Fertilizer is generally applied during or soon after planting. Amounts and types vary and are generally applied at rates smaller than recommended by soil analysis. Lime is only added rarely and when added in quantities so low as to have little effect. Studies indicate that approximately 2 to 3 tons of lime per hectare are required to raise the pH of tropical soil from 4.5 to 5.5. To be effective lime must be mixed with soil. (1,7).

The expense and labor required to fertilize and lime soil on steep slopes common to the dendro plantations make the feasibility of this treatment questionable. A better solution is to pick the proper species for the site. A good rule of thumb in forestry is to pick the tree for the site not to try to modify the site to fit the tree.

Where fertilization and lime are considered necessary, a soil analysis must be completed, fertilizer and lime types and amounts must be prescribed, and methods of application detailed. This is an expensive and tedious undertaking and if done wrong will result in lowered effects or even damage to the trees.



Site cleared by fire for planting ipil-ipil. Burgos Plantation, ISECO.

Charcoal kilns built by NEA at Boliñao Plantation, PANELCO I.

3.1.5 Site preparation entails slashing and burning during the dry season prior to planting. On some very low slopes plowing has been tried with good results especially on cogon sites.

3.1.6 Fire prevention is rather neglected in most plantations although it is probably the major reason for loss of established trees more than 6 months old. There is some training given to tree farmers but usually no fire fighting plan developed and no special fire tools provided. Fire breaks are sometimes used but they are not well constructed or maintained. In any case fire breaks do not stop arson and often fail when a fire is supported by wind, low humidity, and high temperature.

There is a need to have fire tools at the plantation and to give the tree farmers training on how to use these tools. This must be supported by a written plan on fire prevention and control. Fire prevention is most important and requires both direct methods such as fire breaks and fire watches and indirect methods such as talking with plantation neighbors to induce them to use fire with caution.

Proper fire prevention techniques require that high priority be given both at NEA and at the field. Full realization of the seriousness of this problem is only now developing. In the next few years, the problem will peak with plantations becoming more susceptible to fire as fuel levels build up. Serious fires can and should be expected, especially in climatic types 1 and 3.

Other climatic types are more resistant but there has been a damaging fire at Ilagan which is in type 4, therefore, even other climatic types are not completely safe. Fire should be of equal concern with typhoons as a potential for catastrophic loss. But unlike typhoons, we can prevent and combat fires.

3.1.7 Weeding is generally conducted during the first year, sometimes longer, after planting. This seems to be the single most important silvicultural treatment improving survival second only to planting during the rainy season. Weeding is done 2 or 3 times during and after the rainy season and is continued until the trees have grown to a height where their crowns are above the weeds. After complete crown cover, weeds loose vigor and are not considered competing with the trees.

When other species besides ipil ipil are planted, especially those with wider spacing, weeding may be required for a longer period. In some areas, generally wetter, more fertile sites, vines may be a problem and require weeding periodically during the entire rotation. Periodic weeding may help in fire prevention, especially around the edges of the plantation.

3.1.8 Seed collection for ipil ipil has been from within stands of known "Hawaiian Giant" provenances. This seed may have been tainted with "native" ipil ipil varieties. The wide variation observed in plantations may be the result of genetic decline of the seed source. Seed should only be collected from trees with

Vigorous stand of 3-4 year old ipil-ipil at Boliñao Plantation, PANELCO I.

Poor growth of ipil-ipil on cogan site. Trees 2-3 years old. Boliñao Plantation, PANELCO I.

superior form and growth, but a better system would be for each plantation to establish a seed production area. This would require rouging the stand. Roguing means to eliminate all trees with poor form, slow growth or other characteristics that are undesirable. The stand should be at least 3 years old and should be on a better site. Initial roguing and thinning should start at age 2, if possible.

Good seed for other species may be harder to get. Three appropriate species for dendro are Gmelina arborea, Acacia auriculiaformis, and A. mangium. These seeds are available in limited quantities from the Manila Seedling Bank. Acacia mangium is in the smallest quantity but a small amount for testing should be available. Eucalyptus spp. seed is available in the Philippines or can be imported from several sources.

3.1.9 Estimate for site quantity and growth is not an esay activity with exotic species that are newly planted. Preliminary estimates are being developed for established stands of ipil ipil by Hodam and Associates (HAI) under a contract to USAID. Mr. Ken MacDicken will discuss this fully in his report.

The forest manager needs to have some idea of how a stand will grow before the plantation is made. In the early stages of the Dendro Project, a blanket assumption of growth was made. This assumption has proven to be very optimistic. Most plantation sites have great variation in slopes, aspects, soils, pH, and

vegetation cover. Ridge tops and cogon areas are generally least productive everywhere. Areas that have been repeatedly farmed by slash and burn agricultural methods are often highly eroded and unproductive. All this has led to lower than expected growth of ipil ipil. Most plantations do not have maps of site variation of vegetative cover so areas of low and high productivity are only estimated. Even within such easy-to-define areas as cogan variability exists. In the ADB Ilocos Norte Reforestation Project background papers a four grass complex was identfiied on cogan sites. As each grass became dominant the site productivity changed. The poorest sites were dominated by "amorseco" with "cogan" being of better productivity than "amorseco". The other two grasses were on materially better sites. This may explain why ipil ipil grows better on some "cogan" sites than in others.

The importance of vegetative cover mapping cannot be over stressed for management decision making. When the vegetation cover is associated with soil information many decisions such as species, methods of planting, probably fire danger, rotation age and approximate production are sounder and more reliable.

3.1.10 In many plantations, stands are 3 to 4 years old. These stands can be measured for volume, expressed either as cubic volume or weight, using simple timber cruising methods. Data collected by HAI can be used to develop volume tables applicable to stands. Most foresters and agriculturists now at the plantations could be trained in a week to cruise a stand and

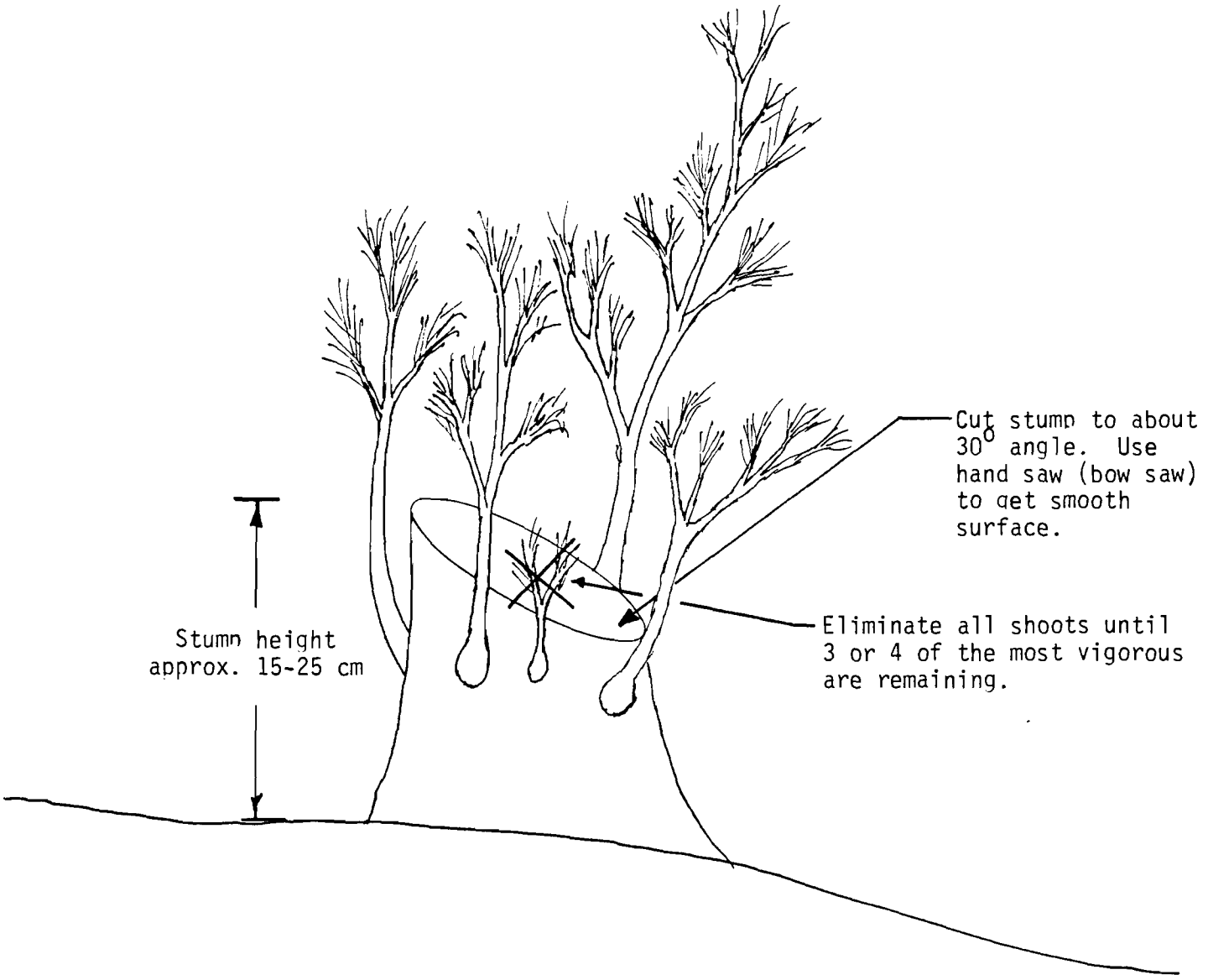
estimate its volume within 10%. Only simple tools are needed for this work, e.g. compass, diameter tape or calipers, 10 meter tape, Abney level or clinometer, and a field notebook. For more information see Chapmen and Meyer's "Forest Mensuration", Chapter 17. (3) Because of the great variation within stands, I recommend that a systematic cruise with fixed circular plots be used to estimate the standing volume. For additional discussion see Mr. MacDicken's report.

3.1.11 Harvesting and transport are concerns that should be attended during development of the original management plan. These concerns have only been addressed to the point where a cable loop system is generally thought as most appropriate. No logging plans were developed. Without logging plans, plantations are developed without consideration of how they will be harvested, as in the case of this project. Several studies are being made, one by Mr. Ed Aulerich of this team and another by Mr. Earl Cone of HAI.

Observance in the field points out the problems of harvesting where the program has not been fully thought out. At Bolinao, trees are cut to approximate 0.75 m lengths in the field. This results in not only many extra pieces to handle but also some loss of volume by cutting with a bolo. A better method would be to move tree length pieces or at least pieces as long as the transport system will allow and to put simple cut-off saws at the

Figure 1

CUTTING OF THE COPPICE STUMP



wood yard. This would save wood, labor and result in the transport system working to peak efficiency.

3.1.12 Post-harvest silviculture is an almost unknown factor. Only a few areas have started to harvest their plantations. In ipil ipil stands, rapid sprouting is common with 6 or more sprouts per stump. Stump heights are not standard and methods of cutting vary from chopping with a bolo to cutting with a saw. Stumps may be treated with a sealant but this has not been observed. Weeding is generally not required because of the rapid growth of the sprouts.

The root base is scheduled to last at least three rotations. Its care is important if productivity is to be maintained. Several considerations must be made. First the stump must be protected from wood rots or termites. These will probably not kill the tree but if the support for the sprouts rots away the sprouts become very susceptible to wind-throw.

In India and in many other countries where coppicing is practiced, the stumps are cut off in a smooth angle to allow moisture to drain off. Some places use a sealant/dressing to help prevent entry of fungus or termites. In India, this is locally prepared from a mixture of cow manure, cow urine and fine clay (40% cow manure, 60% fine clay, and enough cow urine to make the mixture wet to the consistency of heavy paint). This has reduced infections of the stump from 40% to less than 2%. In Central America a mixture of burnt-lime and fine clay has been used but no

data on comparison of treated stumps is available. In addition, several commercial tree wound dressings are available.

The problem of the number of sprouts emitting from the stump is in need of consideration. Some ipil ipil tree farmers feel that the work required to reduce the number of sprouts is not justified. Experiments in other parts of the world show that only a few sprouts become dominant. In India experiments with ipil ipil cut to 1.5 m stumps show that typically only 2-3 sprouts become dominant. But in observances at Bolinao with low stumps (10-30 cm) many sprouts are growing and living.

Experimentation should be undertaken to determine the proper stump height, method most appropriate for cutting, and whether or not thinning of the sprouts is required. But until this information is known practices generally found most productive around the world should be followed. Figure 1 shows recommended practices for cutting for coppice reproduction.

Sprouts should be thinned so that only 3-4 of the most vigorous remain. This should be done between 3 and 5 months after harvesting. The best method would be chopping with a bolo. Thinning will concentrate growth on fewer stems so that they will be larger at harvest. This will allow greater volume per stem and fewer pieces to be handled during harvest. Before one strays from these accepted and proven silvicultural methods, experimental

evidence should be collected of better production or more efficiency by other methods.

3.1.13 Pests and disease are not a major problem with ipil ipil at this time. Some damage was noted at Bolinao from termites. Estimated that 5% of the trees were attacked and 1% of the wood lost. This may be a problem, especially after the first harvest, if the termites infect the stumps.

Also at Bolinao, we observed evidence of a root rot in areas prone to flooding. The agriculturist stated that this was endemic in the plantation especially where "native" ipil ipil has been growing. Root rots are especially critical where trees are coppiced. Some study is required to determine the extent of this problem. Other plantations have not reported this matter.

White grubs, probably from the family Scarabaeidae or Curculionidae, have been reported from various areas as attacking the roots or the root collar of young ipil ipil trees. These insects can be controlled by insecticides. But insecticides should not be used unless a serious problem exists. Use of insecticide should be determined on a case by case basis with a forester and an entomologist consulted.

The other problem was with predation by rodents, especially on cogan sties. This happens to seed and young trees. Generally not much can be done about rodents. If there is a major problem

rodenticides, such as warfarin baits, could be used. These treatments are expensive and should only be used when a major problem exists that prevents acceptable survival.

3.1.13.1 Uncontrolled grazing was considered a problem at some sites. This was considered the major reason for failure of plantings at the ANTECO plantation at Hamtic, Antique. With very palatable trees such as ipil ipil, grazing must be controlled. Generally in the Philippines, grazing is controlled with animals being watched or tethered in place, but grazers do not respect the plantation area. The problem must be resolved by developing an understanding with grazers in the area of a plantation and by vigilance of the tree farmers.

A related problem is with fire used to improve grazing on hill sides. These fires may be a source of many of the destructive fires at existing NEA plantations.

3.1.14 Overall evaluation of the NEA silvicultural systems results in the following comments:

* Methods of establishment of ipil ipil are well developed and appropriate.
* Methods of establishment of other species are not well developed.
* NEA now realizes that ipil ipil will not grow everywhere and production of wood is extremely dependent on site.

* NEA has not developed adequate methods to evaluate site quality as part of the initial site selection process.
* NEA does not have experienced in-house expertise to develop appropriate silvicultural systems for other species of trees or for mixed species, multiple product stands. (See Section VI).
* Most field personnel do not have adequate training or tools to undertake standard forestry activities such as forest type mapping or cruising.
* Techniques for harvesting (cutting) of trees are not well developed or standard.
* Fire prevention given low priority. No tools provided. No fire plan required at plantations.
* Many proven forestry practices not followed or known in this project.
* Advice from senior, experienced foresters has not been utilized in this project. Often advice from this sector has been considered inappropriate for this project.

IV. AGRO-FORESTRY

A major objective of this project is to allow and induce tree farmers to intercrop plantations whenever possible with agricultural crops compatible with fuelwood tress. In the guidelines for development of the energy plantations a section is devoted to crops and methodology of intercropping. (10) This section is well written and fairly comprehensive. Crops are

classified by climate and soil texture. Prescriptions for intercropping and cultural requirements are detailed including harvest and disease and pest control.

Table 2

NEA Recommended Agro-Forestry Crops

Grains and vegetables	Fruit trees
Corn	Cashew
Peanut	Star apple
Mungbean	Sugar apple
Cassava	Avocado
Upland rice	Jack fruit
Cow pea	Mango
Pigeon pea	Bread fruit
Okra	Chico
Eggplant	Banana
Tomato	
Soybean	
Sitao	
Onion	
Ginger	
Sorghum	

Fruit tree culture is also included but it is not clear where fruit trees will be planted. To be productive they should have good soils and be close to roads in order to move the fruit to market. Perhaps these are meant to be planted around housing units or along roads. No fruit trees were seen on the plantations except around tree farmers' houses.

Intercropping is generally practiced during the first year after plantation establishment. Crops differ depending on local demand or desire. The cooperatives generally encourage intercropping, but no special allowances such as seed or fertilizer are given to the farmers.

In at least one plantation, e.g. Burgos, Ilocos Sur, farmers contracted their land to non-members to farm provided they kept weeds out of the plantation. Some farmers intercropped but others had access to better land outside the plantation and farmed there.

Intercropping was generally dependent upon the quality of the soil and access by tree farmers to better quality soils outside the plantation. During interviews with farmers, the general conclusion was that intercropping was beneficial, but that it was only a small supplement to the promised major income source of wood from the plantations. No farmer considered fruit trees as a possible income source.

While agro-forestry is considered a major part of this project, low priority is put on developing a system or program at each plantation. Some training is given at seminars but there is no requirement to report areas intercroped, crops planted, production of crops, or reasons why areas were not intercropped to NEA. No special allowances or tools to induce intercropping are given. Loans do not include costs for intercropping needs such as seed, tools, fertilizers, grafted fruit trees, etc. One can draw the conclusion that agro-forestry as now practiced in NEA plantations is encouraged but not supported. Each site is required to have an agriculturist as well as a forester on staff. This person is usually only monitored on his work in the plantation and not on the agro-forestry intercropping. As can be expected, some REC's take more interest in agro-forestry.

4.1 Agro-forestry includes not only intercropping of agricultural crops with trees but also agricultural use of tree products such as leaf fodder, leaf meal and green manure. Ipil ipil has been extensively studied for use as animal feed. It has been used as a major component of feed for dairy and meat cattle, for chickens, for pigs, for carabaos, and for many other animals. Leaf meal is already a major feed amendment in the Philippines. Green manure made from tree leaves and small branches can be added directly to fields or become a major ingredient in composting. Leaf meal is already a valuable product, e.g. compost is sold by the Manila Seedling Bank as a soils amendement.

A real advantage could be for the tree farmers to be able to use tree by-products in an animal raising program where a high bulk, low value product such as leaf meal could be converted to a low-bulk, high value product such as meat. There are several national programs such as KKK and Sariling Sikap that could help with this program.

Small areas of very high productivity could be converted to vegetable production or leaf meal production to support these programs. Intercropping should continue but with sufficient inputs of seed and fertilizer to gain the greatest output for the effort. Areas appropriate for intercropping should be identified in the management plans and be included on maps developed for the plantation. Such considerations as pH, fertility of soil, slope and erodibility should be taken into account when defining agro-forestry areas in the plantation.

Another incentive would be to develop a system of short term agricultural loans to buy seed, fertilizer, animal stock and equipment to grow and process agro-forestry produce. These loans could be devloped to cover the harvest period and be of rather low interest. This could be considered a sub-project.

Grafted fruit trees should be purchased and sold to the farmers with the cost included in the general plantation loan. Fruit trees should only be planted in very fertile soils where protection from fire is insured. This could be around the BLISS

housing units, around the power plant, or along roads within the plantations.

4.2 Agro-forestry on non-REC plantation land could provide an alternative source of wood for power plants. This system is being tried with some success at Miag-ao, Iloilo. The project should encourage farmers in the areas surrounding dendro sites to grow ipil ipil to sell to the plants. Such programs as free seed, cultural instruction, assurances of market through agreements and a posted price for wood delivered to the plant or picked up at the farm would give credence to the program. Prices for wood should be determined by size and species, with highest values given for high, caloric woods that are ready for burning. Alternative wood sources will probably be needed at all sites, at least in the short run. Preliminary growth rates from HAI studies indicate that most plantations will not produce enough wood to fuel the power plants at the proposed 6000 hours of annual operation. Unforeseen disasters such as a large fire, typhoon or drought, all of which have occurred since 1980, could drastically reduce wood volume at any plantation, therefore, alternate wood sources become not only desirable, but essential.

V. SOCIAL FORESTRY

Social forestry requires consideration of the ability of the tree farmer or farmers' association to plan and direct activities of growing trees on land they control. Basically, each Rural

Electric Cooperative (REC) organizes 10 or more tree farmer associations comprised of 10-15 members. These tree farmer associations are the primary working unit of the tree farm. Each association is assigned 100 hectares of land to plant with trees. The farmers are allowed to intercrop during the first year after trees are planted. Normally tree growth prevents intercropping after this period.

Farmers are generally allowed to select their association members. They then elect a president and treasurer. These officers are responsible for assuring accomplishment of work and distribution of loan releases to association members. The associations are given training provided by NEA or the REC on administration, technical forestry, and intercropping.

To find out how the associations function, interviews were held with 21 tree farmers at 6 plantations. Associations are given wide latitude in their internal functions. Work is divided among farmers and distribution of loans given in relation to work accomplished by each farmer. Farmers who do not or cannot work are allowed to substitute other workers but must pay them out of their own pockets or alternatively do not receive equal loan release money as those who worked every day.

The associations have developed internal regulations relating to removal of members, selecting new members and assistance because of death of a member or a member's dependent. Sometimes

these regulations are adopted plantation wide and sometimes are unique to only one association at a plantation. Generally, the REC will see that the associations have competent officers and will ask the association to replace those not functioning. The REC cannot force this but when asked the associations usually comply.

Generally, the associations are very autonomous with the REC giving technical assistance and verifying work completed for loan releases but not controlling fund distributions to association members. The only time the REC enters into internal association working is when requested by the members of their officers for specific reasons.

Farmers are very aware of their responsibility within the individual associations. They view their 100 ha module as belonging to the association and work together throughout the module; no member feels a certain part of the module is his and refuses to work another area. The farmers have developed their own working methods, have allocated work among themselves, and in some cases have taken the initiative to do work such as build skid roads or plant areas where loan releases were not available.

There are problems arising now because of the economic situation within NEA and the RECs. Most loan releases from NEA to the RECs have stopped. In some cases the REC is able to continue loan releases on a diminished scale. Throughout the project

farmers are fearful that the project will be cancelled. The farmers want to know if the loans will continue or if they should move on to other work. Most feel this project will improve their livelihood in the long run.

5.1 NEA is considering development of charcoal production at plantations where planting is well advanced but where a power plant is delayed. This could produce some income for the tree farmers but requires study. First, there is a need to transfer the technology of charcoal production to the tree farmer or to hire someone who knows how to produce charcoal in a kiln. Next, a market study to identify the market and the value of the charcoal is needed. Consideration must be given to the fact that many plantations are remotely located and have very poor access roads, in fact some are inaccessible during the rainy season. Where charcoal production is feasible, it appears to be a good project. Firewood may be another alternative. In Bohol, firewood was being sent to Cebu City where it sells for about P200 per solid cubic meter. Firewood production will also require a marketing study.

5.2 Evaluation of the social forestry aspects of this program indicates that the farmers are given great control over their activities. The only restrictions are based on technical forestry activities such as how to plant, when to weed, etc. This is certainly a major attribute of this project and one that will help in achieving project goals.

More training is required in the area of technical forestry, especially if nurseries are contemplated for other species. A major misunderstanding seems to be in the conditions of the loan. Farmers seem confused as to what is loan and what are wages. Additional explanation perhaps in local dialects may be helpful.

This program has worked best where the members were farmers. In one instances, Solsona, some members were non-farmers from Manila and other cities. These people have not done as good a job with technical forestry activities such as weeding as experienced farmers, although this may only be the result of a poor site, as Solsona certainly is. Other people may not be interested in this work. At Bataan (BATELCO) more than 1000 ha were planted but only 10 ha survived. Personnel at the Manila Seedling Bank plantation on Bataan, very near the NEA dendro plantation, said that they could not get workers for their plantation from people in the area and had to bring in workers from other areas. People of Bataan would not do forestry/plantation work. This could be a reason why the plantation has failed and is certainly a social forestry concern.

NEA must take action soon to secure the future cooperation and support of tree farmers' associations during these periods of no cash flow. Most farmers are still very interested but want to know what is happening. Some field extension may be required.

5.3 The fact that many people are living on proposed dendro plantation sites has not been fully considered. These people generally do not have title to the land and are considered to be squatters. Most REC managers consider that these people will move when told to go or will be taken into the coop as tree farmers.

This may be true, but in most forestry reforestation schemes, people who are displaced by the project or who loose land use rights because of the reforestation are a major cause of the plantations' failure. They start fires, do not respect plantation boundaries or force long legal proceedings to evict them from the land. The Manila Seedling Bank is now experiencing these problems at their Bataan plantation. The NEA cooperatives at ANTECO and BOHECO are experiencing similar problems.

These people must be identified during the first phase of site evaluation and realistic procedures developed to either integrate them into the dendro program or to relocate them.

VI. INSTITUTIONAL CONSIDERATIONS

The parts of NEA that are directly influencing the technical forestry activities of this project are the Dendro Thermal Development Office, the Agro Forestry Division, and the Institutional Development Division. Appendix 3 gives the organization of these offices and their responsibilities.* These offices are required to give the technical backstopping and training for field operations.

The RECs have different organizational systems but generally there is a Dendro Thermal Coordinator, responsible for coordinating and directing plantation activities, a Dendro Thermal Bookkeeper required to control and account for expenditure and loan releases, one or more Agriculturists who give field advice on forestry and intercropping and inspect and verify tree farm work, and, rarely, a Forester who has similar duties to the Agriculturist.

6.1 Training is done at seminars by either NEA personnel or by contracted personnel from Los Baños College or other sources. Seminars are given on various subjects from agro-forestry and fire fighting to administrative methods. Tree farmers have been sent to Bolinao to see the plantation and for field instruction.

This training, while good, is not supported with field manuals or study guides. Follow-up visits to plantations by

*Appendix included in Volume I - Annexes.

extensionists to insure the applicability of a method to a particular site is generally not done. A system of on-site training sessions provided by an extension service is required. A complete set of operational manuals for nursery management, plantation management, silviculture, and harvesting are essential for operation of a project covering over 40,000 hectares in widely scattered areas.

6.2 Communications are important to any organization. With the primary forestry expertise in the NEA Agro Forestry Department in Manila, communication is essential.

Extension systems are formed to disseminate information and also to collect information in the field and return it to the central office and to other field units. The extension program in NEA is not well developed and is functioning poorly because of several constraints.

The first constraint is that there is no perceived need for information circulation. This could be because the personnel of NEA are not trained in extension methods and philosophy. The second constraint is funding. NEA has no budget to support an extension service. Extension and dissemination of information are important services and they are very necessary in this project.

6.3 Personnel limitations are a major deterrent against complete success in this project. Only very few foresters are employed by

NEA or the RECs. This is not only surprising, but also shortsighted. The dendro project is one of the largest reforestation projects in the Philippines and one of the largest in the world at 40,000 hectares of plantation. This is similar to building a power plant without an engineer or building a skyscraper without an architect.

The agro-forestry staff is inexperienced and generally has very little training in forestry. No member of the staff has prior experience planning, managing or directing a major reforestation project.

The General Manager of each REC is the key person in this project. These managers are learning more about how to control and develop dendro thermal projects. Wherever success has been found with dendro plantations, the GM has taken a direct interest.

VII. ECOLOGICAL EVALUATION

Several questions are brought up by such a large scheme of monotypic plantatins. The chance of major ecological impact is real but is more positive than negative.

First, the plantations are from 1,000-2,000 hectares in size. These areas are generally selected because they are logged over and not in productive use. They are often typified by slash and burn agriculture (kaingin) resulting in accelerated erosion and

degradation to cogan. Reforestation of these sites will improve the area, conserve soil, and prevent rapid run-off during rains.

Siltation of water sources, stream beds, paddy fields, and fish ponds below reforested areas will be reduced. This project will help reduce the problems of siltation and erosion caused by deforestation and uncontrolled hillside farming.

The new tree stand will provide habitat for wildlife. In plantations one can see many birds that are only rarely seen on degraded or cogan sites.

Another major attribute is that most sites will purchase wood from farmers outside the coops. Therefore, the project will encourage farmers to plant trees as a cash crop. Fears of deforestation to provide fuel for these plants are generally without basis. First, most plants are located far from forested areas and secondly, economic constraints will not allow a very high price to be paid for wood. Generally, only small size pieces and waste wood will be used for fuel. These are not major products of the standing forest.

Several sites are located close to commercial forests, e.g. Jones, Ilagan, and Puerto Princesa. These sites should be closely monitored for ecological soundness of the forest management plan.

Overall, the many advantages of putting a permanent tree crop on hillsides that were under slash and burn far outweigh the disadvantages of monoculture plantations.

VIII. RECOMMENDATIONS

8.1 Forest Management

Developing within NEA and the RECs an ability to develop a strategy to achieve the stated objectives of this project is a major objective of Technical Assistance. This includes producing policies and introducing methodologies to develop and implement plantation management plans on a nation-wide level as well as on the REC level. NEA cannot do this efficiently without outside assistance. From a forestry standpoint, this assistance should be in several areas: financing; technical assistance, both long and short term; and institutional strengthening, mainly through training and staff support.

8.1.1 Financing of technical assistance and the tools and equipment necessary for its efficient use should be provided with grant funds if possible. These funds could come from multilateral participation by donors now assisting NEA. These include the Government of Britain, the Government of France, the Government of Japan, and USAID. USAID is now looking at ways to provide technical assistance to NEA that are both appropriate and acceptable.

NEA's reluctance to accept technical assistance is strong but must be overcome. The project has now reached a stage where problems with the growing of ipil ipil are obvious. Over the last four years only 44% of the total plantings have been successful and several plantations have failed completedly. (See Appendix 5).* Many of those problems could have been avoided or lessened if proper technical assistance were available early in this project. Now NEA is envisioning embarking on a new and much more complicated phase of plantations with several species, sometimes in mixed stands with multiple product outputs. This will require a much more complicated silviculture and nursery system. There will be a far greater need for basic data if sound decisions are to be expected. (11)

My evaluation is that without a strong, but temporary technical assistance component the chances of this reforestation project succeeding with NEA is small. In fact, acceptance of technical assistance should be made precedent to any laon for plantation management with NEA. With technical assistance accepted and fully utilized, this project should be successful and will serve as a model for the world of Philippine ingenuity and ability.

8.1.2 Technical Assistance Team (See Table 3 for schedule)

Note: Unless indicated, an agriculturist is not a substitute for a forester.

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*Appendix not included.

Table 3

Schedule of Consultancies

	Year 1	Year 2	Year 3
Team Leader	----------	36 months ----------	----------
Silviculturist	4 months ----------	2 ====	
Fire Manager	2 1 ------===		
Forest Mapper	1.5 1.5 ----====		
Extensionist		1.5 0.5 ----==	
Agroforester	5.5 ----------	0.5 ---===	
Mensurationist	1.5 1.5 ----====		

---------- Investigating

========== Conducting Training

8.1.2.1 Team Leader: Senior Forester/Silviculturist with expertise and experience in planning and implementing large scale forestry projects, including reforestation, in a developing country.

Qualifications: Minimum of Master's Degree in Forestry; Ten years experience at executive level in planning and implementing a large scale forestry project; famliar with labor intensive forest technology; familiar with establishing guidelines for experimentation and training.

Job Description: Will act as senior advisor to NEA and Rural Electric Cooperatives in the following areas:

* Development of a National Forest Management Plan for NEA
* Development of local forest management plans for each REC
* Identification of training needs for NEA and REC forestry personnel
* Implement other forest consultancies under this project

* Supervise and assist other forest consultants under this project
* Make reports as required by the terms of this loan
* As senior forester on the technical assistance team, make suggestions and assessments as necessary on NEA or REC forestry activities.

Note: This position will require considerable field visits. The person selected should be physically capable of riding in vehicles for hours over rough roads and climbing steep slopes to reach the plantation sites.

Support: This person will require an executive office fully equipped and easily accessible by NEA employees:
- A full time secretary
- Four wheel drive
- Fuel allotment
- Per diem and travel allotment
- Assistant Forester

Duration: 3 years (36 months)

8.1.2.2 Silviculturist: Experience with fast growing tropical

species essential, experience in the Philippines desirable; experience with tropical hardwood nurseries.

Qualifications: Minimum of Ph.D. specializing in Silviculture, but waived with considerable field experience; familiar with silviculture of coppice harvesting of fast growing, short rotation tropical trees. Familiar with labor intensive methods.

Job Description:

* Will develop guidelines for nursery management with emphasis on module located temporary nurseries
* Will develop guidelines for preliminary silviculture of fast growing tropical species for fuel wood production
* Will conduct training seminars for NEA and REC personnel on above guidelines
* Will identify needed research on silviculture and nursery management

Support: Transportation while in Philippines

Office and secretary

Per diem and travel

Printing budget for guidelines

Field crew of 2 technicians

Duration: 6 months - 2 visits, one 4 months and one 2 months

8.1.2.3 Fire Management Specialist: Experience in fire prevention in grass lands and brush lands; experience in developing country desirable.

Qualifications: B.S. in Forestry, minimum of 10 years experience in fighting, preventing fires in grassland and brushland areas; Experience using labor intensive methods to control fire.

Job Description:

* Assess the need for fire management in NEA plantations
* Develop training manuals for fire fighting at REC levels
* Develop guidelines for developing a REC Fire Management Plan
* Identify needed tools and equipment

and evaluate those available in the Philippine market

Support: Transportation while in Philippines
Office and secretary
Per diem and travel
Printing budget for manuals and guidelines
Field crew of 1 technician

Duration: 3 months

8.1.2.4 Forest Survey/ Mapping Specialist: Experience low technology mapping methods for vegetative cover, topography features, etc.

Note: Because normal forest mapping aids such as aerial photographs are unavailable and probably unfeasible because of the small size and scattered nature of NEA plantations, most work will have to be done with field crews comprised of NEA and REC staff. Appropriate methods to fit these constraints are required.

Qualifications: Minimum B.S. in Forestry; 10 years experience with field mapping techniques without the benefit of aerial photos or up-to-date topography

maps. Experience in a developing country desirable.

Job Description:

* Develop manual to map forest plantation sites to scales of 1:5000 and plantation modules to 1:2000. To include topography, general vegetative cover, geographical features such as roads, trails, rivers, etc.
* Train NEA staff in those procedures
* Identify tools and equipment needed to map plantations

Support:

Transportation
Office and secretary
Per diem and travel
Printing budget for manuals
Field crew of 2 technicians and 3 helpers

Duration: 3 months

8.1.2.5 Extension/Training Specialist

Qualifications: M.S. in Forestry or Agriculture with

emphasis in Extension. Should be familiar with extension systems successfully used in developing countries. Such systems as Travel and Visitation (T & V) are envisioned.

Job Description:

* Assist NEA in developing an appropriate extension system to transfer technology and information to and from REC personnel and tree farmers
* Assist NEA in developing an extension policy that views the existing system as the major communication line between NEA and the tree farmers' associations
* Give training to NEA personnel on extension methodology

Support: Transportation while in Philippines
Office and secretary
Per diem and travel

Duration: 2 months

8.1.2.6 Agroforestry Specialist: Experience with crops and animals commonly found in the Philippines

Qualifications: M.S. degree with specialization in intercropping with trees and use of tree by-products for agricultural use. Special emphases on use of Leucaena leucocephala (ipil ipil) and other tree species for animal feed, green manure and composting.

Job Description:

* Develop appropriate methods of intercropping grains, roots and vegetables in NEA plantations
* Investigate the possibility of production of crops from plantations after crown closure shades ground, e.g. honey, leaf meal, fruits, etc.
* Develop methods of local use of leaf fodder in animal-raising projects for tree farmer associations, raising of chickens, pigs, cows for milk and meat production, etc.
* Develop other minor forest products from NEA plantations
* Develop a manual for these technologies

Support: Transportation while in Philippines

Office and secretary

Per diem and travel

Printing budget for manuals

Duration: 6 months

8.1.2.7 Mensurationist: Expert in development of local volume tables for inventory of standing timber

Qualifications: M.S. in Forestry emphasizing mensuration. Experience in field cruises of standing timber of small sized e.g. 2-25 cm dbh

Job Description:

* Develop volume tables in cubic volume on weight utilizing growth and yield data collected by NEA. Develop a method to localize the tables by site index or other applicable methods
* Develop and test field practices using NEA and REC personnel
* Develop a standard system for cruises of standing timber to include field methods, statistics, and volume reports. Desire is to

predict within 10% of volume with high confidence.

* Develop a field manual for volume estimation
* Conduct training of corps of NEA personnel who will then train NEA and REC field personnel in this system.

Support: Transportation while in Philippines
Field crew of 4 technicians
Office and secretary
Per diem and travel
Printing budget for manuals

Duration: 3 months

8.1.2.8 Unassigned Consultancies: In a project such as this, unforeseen conditions may arise that require expert assistance. These unassigned consultancies are to answer these needs. This money could also be used to extend other consultancies if needed.

Duration: 6 months

8.2 Institutional Strengthening

8.2.1 Employment security and continuity is a concern in this project. Many personnel are moved from job to job. Important personnel such as Dendro Thermal Coordinators and Agricultural and Forestry Technicians are moved from one assignment to another. Turnover in these positions is high. One REC, OMECO, has had 5 Dendro Coordinators in less than a year. This lack of continuity will materially affect the management of a plantation and makes training difficult and inefficient. (See Appendix 8)*

It is difficult to eliminate this problem but more attention to recruitment and contracts that require minimum stay at particular sites could help. Developing a policy within NEA that discourages capricious moves would be helpful.

Development of detailed field guides and manuals to standardize technical activities in the field will mitigate problems arising from changes in personnel when necessary, but there is no substitute for experience at a particular site. I estimate that a technician will require 3 to 6 months at a site before he or she becomes fully productive.

8.2.2 Training is envisioned as both formal, in short courses and seminars, and in informal on-the-job training of field techniques.

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*Appendix included in Volume I - Annexes.

These training sessions should be conducted by NEA and REC personnel. Training should be fully supported by written study guides, field guides and manuals. The several consultants described in section 8.1.2 will help develop these support publications.

Special training classes, given for speical topics on a one time basis, are useful and this project should help provide funding as necessary.

No formal university education is envisioned for personnel in this program. The Philippines has a large cadre of professional but often inexperienced foresters to draw upon so that additional education for this project is unnecessary, short-courses and experience are necessary. This should be provided in the technical assistance for this project. Suggest that development of a short course schedule for technical training be developed with NEA personnel during project paper writing.

8.3 Social Forestry

8.3.1 Participation and motivation of tree farmers is a major requirement of this project. This can be assured only if the programs are geared to create self-interest (ownership attitudes) among the farmers are continued.

At this time, tree farmers' associations are fully responsible for their activities and their operating systems. They do feel that they are the owners and managers of the plantations. Every effort must be made to continue and expand this condition. I suggest a Tree Farmers' Newsletter where activities are reported, successes reported and problems reported about different associations within the NEA program. The information for this could be gathered by extensionists and compiled at NEA. The Newsletter could be distributed to REC for distribution to the farmers' associations. This publication would not be fancy - a mimeographed sheet or two would suffice.

One additional fact, there needs to be support of supplementary income schemes for the tree farmers. When income begins during harvest, it will be concentrated over a rather short period. Income sources during the rest of the year will be helpful. Such projects as intercropping, honey collecting, producing leaf meal, animal production should be encouraged and supported, both financially and technically.

8.3.2 Tree growing on private lands surrounding the power plant should be encouraged and supported. The NEA extension service in cooperation with local KKK and Sariling Sikap Projects and local administrators, could give technical advice and free seed for ipil ipil and other appropriate tree species. Some agreements to buy the wood could be worked out between the private farmed landowner and the REC to insure a market. This program would not only help

with a supplementary wood source but also will diminish deforestation in the area and give a local source of fuel wood.

8.4 Tools and Equipment

These are preliminary lists of tools and equipment needed to accomplish the technical work of the project. Individual consultants in the specialty may wish to augment these lists. Tools are designated by tree farms (REC) or NEA depending on where they are required. A star indicates this is optional. Two stars indicate repeated from another section.

8.4.1 Forest Management

1. Micro Computer - Disk drive with printer (NEA)

8.4.2 Silviculture and Mensuration - One set for NEA and one set in each NEA

1. Hand Compass - 1 ea
2. Staff Compass - 1 ea*
3. Metal Metric Tape, 50 m - 1 ea
4. Diameter Tape, 40 cm - 2 ea
5. Diameter Caliper, 30 cm - 2 ea
6. Height Measuring Hypsometer - 1 ea
7. Field Notebooks - 2 ea

8.4.3 Mapping

1. Hand Compass**

2. Staff Compass**
3. Metal Metric Tape, 50 m**
4. Clinometer of Abney level - 2 ea
5. Field Notebooks - 2 ea
6. Crosshatch Paper - 2 rolls
7. Drafting Table - 1 ea
8. Milar Paper - 1 roll

8.4.4 Fire Fighting (not required at NEA headquarters

Set for each Farmer's Association of 10 members

1. Long handled shovel - 4 ea
2. Fire Swaters - 6 ea
3. Canteens - 10 ea
4. Bolos - 10 ea
5. Water Spray Tanks - 2 ea

8.4.5 Library

A library of all field guides, study guides and manuals should be kept close to the plantation and should be open for use by agriculturists, foresters and tree farmers. Other appropriate publications as needed should be included.

8.5 Ecological considerations are important. Each plantation should be evaluated for ecological impact, both positive and negative during the feasibility study. Those plantations already underway should have an evaluation also. These evaluations should

be coordinated by NEA and should include inputs from local officials such as BFD and Provincial offices.

8.6 Research

Research needs for this project could be done through Philippine Universities. The obvious needs are for:

* Spacing trials for the different species planted in this project
* Fertilizer trials for tree species
* After harvest silviculture
* Production of forest by-products such as leaf meal, honey, and charcoal
* Markets for forest by-products
* Termite damage in dendro plantations

Other needs may develop as time goes on. Recommendation that NEA contracts these investigations and not attempt to develop in-house research capability.

8.7 Site Selection

Early in this consultancy, the need to identify sites for NEA/ADB project funding was emphasized. The lack of comprehensive data on the forty NEA sites makes selection of identification of a group of high-potential forestry sites impossible.

Three sites do have potential from a development viewpoint. These sites represent a cross section of the problems identified

during the consultancy which must be resolved if the project is to be successful.

8.7.1 Solsona (INEC) represents a site with a low potential for plantation success but the power plant is already in operation. This problem may be found in other project sites, e.g. ZAMECO, ANTECO.

The need is clear for developing alternative methods for acquiring wood fuel. Solsona should be selected as the site where this project develops and perfects the methodology to resolve this problem.

8.7.2 San Juan, Abra (ABRECO) represents a site where a high potential for the plantation to provide sufficient fuel with few technical difficulties are encountered. Most of the site is appropriate for ipil ipil with relatively gentle terrain, and few problems with competitive use of the land. This could be described as a typically high potential site and is therefore representative of any good dendro site.

8.7.3 Puerto Princesa, Palawan (PALECO) is a site where there is no potential for selling power to the National Power Corporation (NPC). The site is among the best for plantation forestry and is mostly covered by secondary forest. The problems associated with running a wood fired power plant with fluctuating load need to be addressed.

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THE BOLINAO, BURGOS, VIRAC,

AND SOLSONA DENDRO THERMAL PROJECTS

Presented to

Georgia Institute of Technology
Atlanta, Georgia, U.S.A.

by

Paper Industries Corporation of the Philippines
Makati, Philippines

August 1984

Errata

The Bolinao, Burgos, Virac, and Solsona Dendro Thermal Projects

Page 1, Section 2.0
Change "25,000" to "42,000"

Page 5, Section 5.4
Change "2 to 3" to "at least 3"

Page 5, Section 6.0
Change "₱40 per cubic meter" to "₱37.5 per Bolinao stere"

Page 6, Section 9.0
Change "9 kms" to "4.5 kms"

This consultants' report contains the observations of several employees of the Paper Industries Corporation of the Philippines (PICOP) who accompanied members of the Georgia Tech team to several of the tree plantations. These PICOP employees had the benefit of background experience in plantation growing of trees using tree farmer associations at their Bislig mill in southern Mindanao.

THE BOLINAO DENDRO THERMAL PROJECT

1.0 LOCATION

The Bolinao Dendro Thermal project is located in the Municipality of Bolinao, Pangasinan. It is under the Pangasinan Electric Cooperative I (PANELCO I) which has its main office at Bani, Pangasinan, about 24 kms. south of Bolinao. The plant site and tree farm is connected by a dirt road, slightly graveled which is about 17 kms. from the town proper of Bolinao.

2.0 THE POWER PLANT

The Dendro Thermal Power Plant. - is a 3 MW power plant of French design and built under the supervision of French Engineer. It is located inside the tree farm and it is estimated to cost about ₱47 million when fully completed. It is already operational. The wood consumption of the plant is estimated to be about 25,000 tons of wood per year. At an estimated 2.5 cubic meters of ipil-ipil per ton, the plant would need about 62,5000 cubic meters annually. Fuelwood, about 0.75 to 0.80 meter long irrespective of diameter, are fed to the mouth of the chipper/crusher assembly and are chipped and dried before being blown to the power furnace unit for burning.

3.0 THE TREE FARM

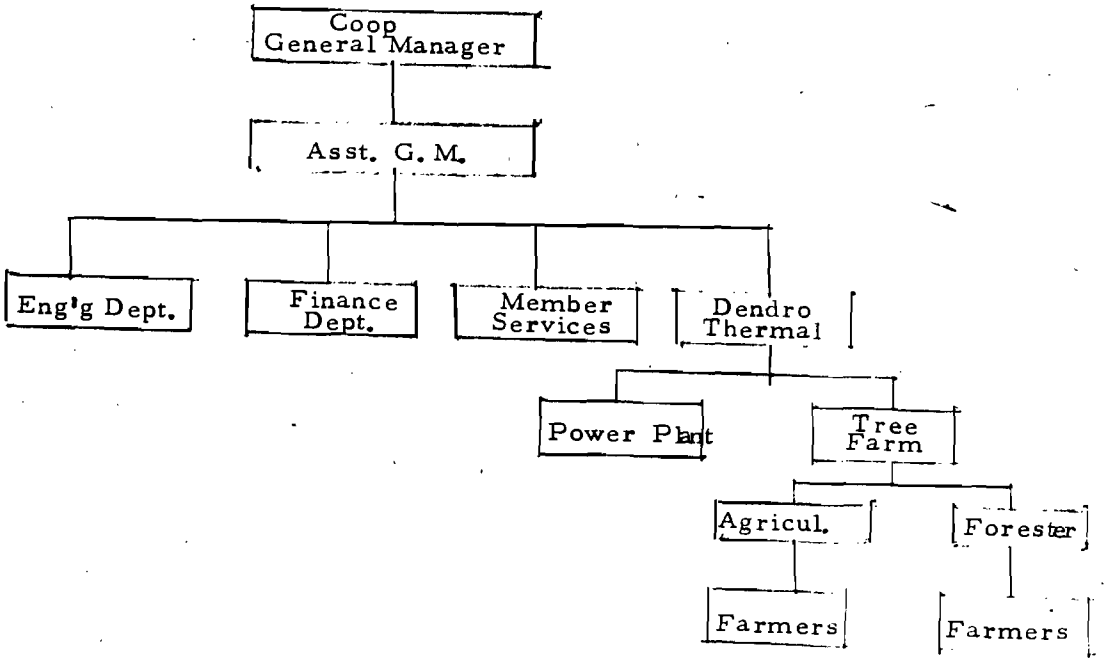
3.1 The Area

The tree farm has a total area of 1,000 hectares and is subdivided into 10 modules of 100 hectares each. Out of this area, 800 hectares is public forest and leased by the Cooperative from the Government for 25 years and renewable for the same period and the balance of 200 hectares,

was acquired by the Cooperative thru purchase from adjoining private landowners. The lease agreement was already granted by the Government but about 100 hectares of the area was further leased by the Government to somebody else. A nominal fee of ₱50 per year is charged for every 100 hectare module. The plant site is within a radius of 8 kms. of the tree farm. The tree farm is flat to moderately rolling with some or few steep areas. Outcropping limestone rocks are strewn all over the area but the scil is good, not severely eroded and is clay or sandy loam for those areas nearer the coastline. The area was originally, before the tree farm development, vegetated by cogons (Imperatra cylindrica) and stunted natural-grown trees. The start of planting was some three years ago (1981) and the Association have started harvesting some of their 3-year old ipil-ipil plantations.

4.0 THE ORGANIZATION

4.1 The Table of Organization is illustrated hereunder:



4.2 The Cooperative

The Cooperative (PANELCO) is semi-autonomous from the Central Office of the National Electrification Administration (NEA). However, there is a semblance of supervision and control of NEA over the Cooperative because of the money loaned by them for the installation/ construction of the dendro thermal power plant and the establishment of the tree farms. The Cooperative has also control and supervision over the association of farmers engaged in the tree farm establishment because of the money loan to them by the Coop.

4.3 The Association

The ten (10) modules with a total of 100 hectares each are assigned to 10 farmers. Each module is organized into an association which elects their President, Secretary and Treasurer annually. According to the General Manager of the Coop, the advantages of creating a group of farmers into single organization are problems on land and loan allocations, disseminating technology, etc. would be minimized. Some of the major responsibilities of the association are as follows:

1) Plans among themselves the tree farm development;
2) Decides collectively how the tree farm operations shall be developed and managed according to targets or programs;
3) Receives loan from the Cooperative and distributes the funds to the farmers;
4) Monitor performance; and,

5) Decides how income from the sales of fuelwood is shared and distributed among themselves.

5.0 THE TREE FARM DEVELOPMENT

5.1 The Loan

The loan carries a 11% interest from the NEA and the Cooperative charges 12% interest to the farmer-associations. The association submits area of the land to be site-prepared, planted and weeded to the Cooperative and the loan is released only after submission of the area activity accomplished. However, to tide over the farmer's lack of capital, at the start of the development, 50% of the amount of loan is granted by the Cooperative. Subsequent releases are already in full amount, depending upon the accomplishment submitted. Payment of the interests and principal starts on the 5th year and the full amount is paid over a period of 8 years.

5.2 Land Preparation

The area is cleared completely of vegetation, that is, if cogonlands, the grasses are pulled out from the ground and all standing trees are felled. This is done in December or January and the dried debris are burned in April before the rain starts to fall in May.

5.3 Planting

At the start of the rainy season, planting is conducted. With a sharpened stick, a shallow hole is made on the ground and several seeds, from 3 to 4 or more, are placed in the hole. A little soil, with the use of the foot, is pushed over the seeds and hole. Spacing was at 1 x 1 meter. In between the trees, agricultural crops such as corn or rice, are planted.

5.4 Weeding

Weeding is conducted from 2 to 3 times a year, that is, three months reckoned from planting and another weeding operations just before the rain stops. The last one is conducted when the rain starts again. Weeding is done by removing all weeds, vines, and other vegetations to keep the weeds suppressed and allow the seeds access to full sunlight.

5.5 Thinning

As evidenced by the very thick trees that grew after planting and coppices from stumps after harvesting, there is no thinning conducted to reduce the number of stems per hectare.

6.0 HARVESTING

The Association had already started harvesting their 3-year old ipil-ipil plantation and selling them to the Cooperative at ₱40 per cubic meter stack volume brought to roadsides or loading stations.

7.0 COMMUNICATION

1) Monthly meeting is conducted by the Cooperative with the officers and all members of the Associations.
2) Monthly reports of accomplishment of the Association are submitted by the Coop Agriculturist.

8.0 MONITORING

Progress of work accomplished or being done is conducted by their agriculturist. They have not hired the forester as indicated

in their TO. In fact, the General Manager and the Coop Coordinator do not believe that hiring a forester is to their advantage. Accordingly, they were disappointed with the foresters of the BFD whom they were in contact with.

Accordingly, progress of work accomplished is further monitored or checked by the NEA Central Office personnel.

9.0 THE WOOD TRANSPORT SYSTEM

The present systems of harvesting and transporting the fuelwood from the felling areas to the power plant site are described as follows:

9.1 The Swiss Lasso Light Cableway

The cableway system consists of two loops which are operated independently by shifting its engine drive gear to first and second gear, that is, if the first loop is operated, the first gear is used and the second loop, the second gear. The first loop has a total length of about 12 kms. and the second loop, 9 kms. These loops have intermediate supports made of steel, spaced approximately 20 meters apart and are anchored on the ground by two opposite guylines. It operates through an engine drive with an RPM of about 1.6 m. per second.

The cable system has only one single wire rope similar to skyline rope per loop in addition to the slingers [1/] that are hung on the wire to transport the bundled fuelwood

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1/ - Slingers are made of steel and used to bundle the fuelwood and hooked or hung on the wire rope and are transported from the loading stations in the cutting areas to the power plant site.

to the power plant site. The wire rope, 14 mm. (5/8 inch) in diameter, is used mainly as an endless skyline of the lasso cableway system. It passes the carriage assembly consisting of three sheaves, two sheaves above and one sheave below and hang on each support. The lasso wire rope can carry a total load of about one ton or 1,000 kilos. Between two intermediary steel supports, 5 bundles of fuelwood weighing 50 kilos each can be hooked/hung.

Along the cable route, several loading stations at strategic and convenient places are constructed. One main unloading-elevated-flatform station is installed at the plant site for each loop.

9.2 Wood Extraction Procedures

1) Felling and bucking

Bolo or ax is used in felling the ipil-ipil trees and bucked at 0.75 to 0.8 meter long.

2) Moving the fuelwood from cutting area to the loading station

If the distance from the cutting area to the loading station is close/near, manpower is used to transport/move the fuelwood from the felling area to the loading station. If far enough, say 200 meters or more, the fuelwood is transported by trucks by loading them over the truck and unloading them at the loading stations.

3) Loading on the cable

Fuelwood piled at the loading station are bundled with the use of slinger which weighs approximately 50 kilos. One to two men or more may be needed to lift the bundle of fuelwood and hook or hang on the cable.

Subsequent and continuous hooking to the wire rope will not interrupt the continuous movement of the skyline rope. Since the wire can carry a total of about one (1) ton or 1,000 kilos, 20 bundles can be hooked/hanged on the skyline rope at a given time between the two intermediary supports. Hence, simultaneous harvesting of two (2) modules can be done at the same time.

4) Transporting the fuelwood to the plant site

As soon as the fuelwood bundles are hooked, a radio signal is transmitted from the loading station to the engine operator to start the engine drive by rotating the cable around. While the cable moves toward the plant site simultaneous and continuous loading by hanging the fuelwood is done.

Another system of transporting the fuelwood is by truck. The fuelwood, being only 0.75 meter long are loaded manually and cross-filed end to end over the truck and unloaded at the plant site.

5) Unloading at the plant site

As soon as the bundles reach the elevated unloading-flatform station at the plant site, the chocker lines or slingers are sling off or unhooked manually from the skyline cable and the fuelwood automatically dropped to the inclined trough and loaded at a waiting truck. The pieces of fuelwood are again unloaded manually from the truck at the storage area near or away (about 40 meters) from the wood chipper or crusher area.

6) Mini Hagurtein yarders

There are two Hagurtein yarders bought by the Coop but not yet used. It is a brand new machine which have two drums, one for the mainline and the other, for the haulback line. They have erected an A-frame, about 6 meters high, as an artificial spar tree and installed about three meters from the top of the slope to yard the ipil-ipil planted along the steep slopes.

10.0 COMMENTS AND OBSERVATIONS

10.1 Tree Farm and Plant Sites

The power plant is inside the tree farm area. This is very ideal because hauling cost for fuelwood needed by the power plant will be greatly reduced, thereby lowering the cost of transporting the fuelwood for the Coop. Since fuelwood is a low-value forest products compared to the premium wood used to manufacture lumber, plywood, etc., the tree farm should be as close as possible to the power plant.

The chipper or crusher assembly is installed farther away from the fuelwood unloading flatform station. It should have been constructed just in front of the unloading flatform. This will reduce travel time of the fuelwood from the unloading station to the chipper assembly.

10.11 Organization

It was noticed that the Coop did not yet hire their forester as indicated in their Table of Organization. However, they have already hired their agriculturist.

The Association is functioning very well and electing their officers annually.

10.12 The Tree Farm Development

They have succeeded in planting formerly barren areas composed of cogonlands and stunted trees or unproductive land and converted them to lush and verdant productive tree farms of ipil-ipil by direct seeding. The Coop should be commended or be given credit and recognition for such success in spite of the lack of technical men to guide them in their first trial planting venture.

Loan procedures are in order although the Coop complained that sometimes the releases from the NEA central office is rather delayed. Hence, to keep the tree farm development project going following their program, the Coop has to lend their own money to the farmers.

Site preparation, planting (direct seeding) and weeding are in order as evidenced by the lack of weeds/grasses or vines in their two or three year old ipil-ipil plantations.

An inspection of the ipil-ipil plantations which are three-year old developed under direct seeding method and from 6 months to one (1) year old coppice plantations showed that in the former, about 50% of total number of stems per hectare is composed of the suppressed trees, 26% co-dominant trees and 24% dominant trees; while the latter (coppice plantation),

about 34% are dominant trees and 66% are suppressed. The objective of tree growing is to grow bigger sized trees and correspondingly with bigger volume of each tree to be harvested.

Monitoring of the progress of the tree farm development is done mostly alone by the Coop's agriculturist.

10.2 The Transport System

10.21 The Swiss lasso cable system

The lasso cableway system is now used to harvest the ipil-ipil plantations on areas with fairly rolling terrains. This requires construction of steel spars along the cable routes at equal or more or less the same ground elevation for all the intermediate supports, which are necessary to avoid slipping off of the slingers of hooked bundles of fuelwood on the wire rope as the cable travels from the loading stations to the unloading stations. Since it is already in place and expensive to replace it by other means at this time, it should be used with the following suggestions for further improvement until another system shall be substituted.

10.22 The mini-yarders

These two yarders can be used to yard fuelwood on steep areas and piled or stacked along accessible roads and the wood to be directly loaded on trucks and hauled directly to millsite or to feed the lasso cable system.

10.23 Felling and bucking

Bucking the felled trees into shorter lengths at stump increases cost of wood due to more bucking activities, handling and piling individual short pieces of fuelwood. Efficiency in bucking is greatly affected by ground conditions, especially on steep areas, and manueverability of the faller/bucker is affected.

10.24 Loading

Loading simultaneously several bundles of wood requires more labor activities as it requires one to two persons to load every 50-kilo bundle of fuelwood.

10.25 Hauling

The whole wire loop will move or rotate as it transports the hooked bundles of fuelwood from loading station to the unloading station at the plant site. It requires, therefore, more power for the engine drive to rotate the cable and also wear and tear of the cables.

11.0 RECOMMENDATIONS

11.1 The Tree Farm and the Development Schemes

a. From the economic standpoint the tree farm should produce taller and bigger-sized trees in order to reduce handling during the felling, gathering, transporting, loading and unloading operations and eventually reduce cost of fuelwood per cubic meter. This is of course conditioned on the manpower and mechanical resources available. To get larger dimension trees, a thinning regime has to be worked out. This will reduce the number of stems per hectare left to grow to the desired sizes. The agriculturist or the forester

can start the thinning which eventually can be taken over by the farmers themselves as the operation goes on. The operation is cheap and easy provided the trees to be thinned are still from 6 months to one year old. At this stage, it would be easy to determine/choose robust trees which will dominate the stand or become suppressed.

b. For better monitoring and evaluation of the progress of tree farm development and harvesting, the 100-hectare module should be divided into management blocks or units of 10 to 20 hectares each, placing semi-permanent poles/stakes at corners of the blocks. Progress of tree farm development and harvesting, checking of area planted, seedling survivals, mortalities and volume harvested can be accurately calculated.

c. The agriculturist and forester when hired should conduct short-term and easy-to-conduct researches of their own to give them first hand information on the following:

   i) Growth plots, at two plots of any convenient sample size per each module reckoned from date of planting and measured annually up to the fourth year should be established to monitor mortalities, rates of growth and volume projection for future planning.

   ii) Forest inventory at acceptable precision or accuracy of the tree farm by modules should be conducted to determine or forecast the volume that can be harvested. This is urgently needed so that other sources of fuelwood could be tapped, if and when the fuelwood resources from the Coop's tree farm is not enough to feed the power plant.

iii) This forest inventory should be validated by actual sample measurements of the fuelwood actually harvested from each module in order to have an accurate forecast of future harvest and volume that can be actually harvested per hectare.

iv) Species trials should be conducted by the Coop's forester and agriculturist for fast-growing species with high calorific values adaptable to the locality in order to determine the final species to be planted in the future. For this purpose small portions of the tree farm area can be set aside for the purpose.

d. As a guaranty or an assurance of a steady source of fuelwood for the power plant, adjacent private or government lands close to the plant should be developed for tree farm under the agroforestry scheme. There should be no fear for the excess fuelwood trees unutilized as the demand for fuelwood (charcoal or otherwise) will be great in the future due to increase cost of imported oil. The farmers should be assisted by the Coop, thru a special financing scheme, after a fuelwood supply contract and marketing agreement have been agreed or entered into and between the Coop and the farmers.

Incentives for these private landowners such as using the fuelwood for payment of electric bills, free technical assistance in the tree farm development, seeds/seedlings to be paid upon harvesting, etc., should be made as a condition of the agreement with the landowners or tree farmers.

e. The NEA should seek the cooperation of local and foreign governments to finance studies and assist the Coops on species trial plantings, spacing tests, growth studies, volume and other relevant studies needed to have a more successful tree farm development program and better forecast of the wood supply.

f. Monitoring of the progress of planting and harvesting should be conducted by an audit team reporting directly to the General Manager not by the agriculturist to prevent suspicion on the manipulation of report.

The NEA should create a monitoring and evaluation team reporting directly to the NEA Administrator, to determine and measure the progress of implementation both for the tree farm development, tree farm harvesting and transporting, and power plant construction and installation.

11.2 The Harvesting and Transport System

a. Cableway in combination with the yarders

The lasso cable system can be used in combination with the two (2) mini yarders of the Coop, that is, each yarder can make use of the existing intermediate supports of the cable system as its spar tree during yarding or erect another one near the loading stations. In level or fairly moderate terrains, animal power can also be used to feed the cable system. Whenever possible, the use of trucks to feed the lasso cable system, that is, loading the truck with fuelwood and unloading them again at the loading station should be discouraged because this

will entail double handling of the short pieces of fuelwood, thereby increasing fuelwood extraction expenses.

b) Felling and bucking

The bow-saw should be used in felling and bucking, in combination with the use of axes or bolos, that is, bigger and harder ipil-ipil trees should be cut by the bow saw to minimize waste and axes or bolos for the smaller suppressed trees which can be cut by a single stroke. Bucking lengths should be increased from 0.75 m. or 0.85 m to 4.0 meters in order to have one or two bundles of about 150 or 200 kilos, instead of 5 bundles at 50 kilos per bundle.

c) Loading

With the increase in load size from 50 kilos to 150 or 250 kilos, it will require only two men instead of the 5 or 10 men now used, thus reducing the man-hours required to load the wire rope. The 5/8 inch (14 mm.) wire rope can carry a total load of one (1) ton or 1,000 kilos, hence, the number of bundles can be reduced from 20 bundles to 4 or 6 bundles between spans or intermediate supports yet the total weight of the fuelwood is still the same in each case.

d) Hauling (transporting) the fuelwood

Reducing the number of bundle of fuelwood to be hooked to the skyline cable will correspondingly reduce abrassion on the wire ropes, thereby prolonging the use of the cables.

e) The two mini-yarders

These two yarders should be used extensively on

steep slopes, preferrably for uphill yarding. The A-frame (for spar tree) should be replaced by a small-diameter electric pole with a height of 10 or 15 meters in order to permit better lift of the fuelwood when yarded and to avoid hang-ups due to dead stumps of trees or protruding rocks during yarding. Three to four guy lines to anchor the spar tree and make it steady and firm during yarding should be used. The A-frame or the spar tree, for that matter, should be placed at least 5 meters away from the top of the downward slope to accommodate more fuelwood to be piled around the spar tree and prevent the others from sliding downhill.

f) Fuelwood at plant site

Should the recommendations for longer lengths of the fuelwood from 0.75 or 0.80 m. be approved, a set of conveyor system for moving the fuelwood from the unloading station flatform to the mouth of the chipper (crusher) assembly should be installed. This will eliminate unloading manually of fuelwood from trucks. However, the elevated flatform should be widened to accommodate for storing more pieces of fuelwood skylined or transported by the cable system to the plant site. The fuelwood storage flatform should be inclined towards the conveyor so that the pieces of fuelwood could be pushed easily or moved by set of moving conveyors toward the conveyor. Some 10 meters away from the mouth of the funnel-shaped wood container of the chipper or crusher, a swing circular saw or cutter saw should be installed

to cut the pieces of fuelwood to 0.75 m. so that the desired length of the fuelwood at 0.75 meter can be attained.

If the present length of the fuelwood (0.75 to 0.80 m.) cannot be lengthened to 4.0 meters, and no improvement of the fuelwood storage be done, the truck used in loading fuelwood at the unloading station should have a bucket container that can be tilted at one end upward to allow the fuelwood to slide down the storage area, thereby eliminating manual unloading. From the storage area, the fuelwood should be carried to the mouth of the chipper or wood crusher assembly by bucket-type front-end loader. This will greatly reduce manual handling and prevent health hazards of the workers manually loading the fuelwood to the funnel-shaped fuelwood container of the chipper assembly due to exposure to the elements and excessive dusts caused by the chipper or crusher.

Unfortunately, the crusher or chipper area is too far from the unloading flatform. It should have been installed directly at the opposite side of silo where it is located now and nearer and in front of the unloading flatform station. Longer movement of the pieces of fuelwood to the crusher or chipper area should have been minimized and a lot of time for moving the fuelwood could be saved.

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VIRAC DENDRO THERMAL PROJECT

1.0 LOCATION

The Virac dendro thermal project is located in Virac, Catanduanes.

2.0 THE POWER PLANT

The dendro thermal power plant is not yet installed.

3.0 TREE FARM[1/]

No detailed information was gathered about the tree farm development. Only scanty data was gathered as follows:

The area is steep and it has an approximate slope ranging from 40 to 70 degrees. The slope gradually rises and create a continuous ridge with approximate equal elevation. In between the mountains are deep valleys forming about 200 to 300 meters wide. About 1/3 of the area is on the other side of the river and 2/3 are served by passable roads passing thru resettlements, established by the local government. The tree farm is inside the public forest.

Out of the total area of 600 hectares, about 286 is already planted in 1981 to ipil-ipil, spaced also at 1 x 1 meter.

4.0 THE TRANSPORT SYSTEM

The wood transport system is not yet installed. The wood transport system recommended is as follows:

4.1 Planning

It is necessary that an aerial topographic map (from the Bureau of Coast and Geodetic Survey) be secured to study the economical route for transporting the fuelwood from the tree farm plantation to the power plant due to the rough topography of the area.

1/ - Very scanty information were gathered about the tree farm. The PICOP representative only looked into the wood transport system.

4.2 Felling and bucking

A combination of the following equipment should be used in the felling and bucking operations:

a. Bowsaw

b. Bolo

c. Ax

4.3 The harvesting system

1. Gravity yarding

The yarding equipment shall be brought by 6 x 6 truck on top of the ridge. A single skyline cable can be used with the use of an electric pole or tree as a spar tree erected on top of the ridge and skylined downhill to the unloading station near the power plant. A hydraulic carriage shall be mounted to the skyline with several octopus-like devices to accommodate more chocker lines for tying more pieces of fuelwood when transported downhill to the power plant.

2. Combination of transport system

With the presence of a river and roads, a combination of logging equipment consisting trucks, carabao and manpower harvesting can be used. As an example, trees along riverbanks can be carried manually to the river and the fuelwood can be floated on the river and retrieved near the power plant. Fuelwood farther the river bank and roads with favorable or rolling terrain ca. be skidded to roadsides by carabao. Another is the use of mini-yarders to yard the fuelwood and pile at landings near the road and thence, transported by trucks to the power plant site.

SOLSONA DENDRO THERMAL PROJECT

1.0 LOCATION

The Solsona dendro thermal project is located in the Municipality of Solsona, Province of Ilocos Norte. It is about 17 kms. from the national road of San Nicolas, Ilocos Norte and is along the Kalinga-Apayao national road.

2.0 THE POWER PLANT

The plant is a British design and also 3 MW. It burns short pieces of fuelwood, about 50 cms. long and not more than 22 cms. in diameter. Fuelwood are bought from private landowners at ₱40 per cubic meter stack volume because the ipil-ipil plantation of the cooperative is not yet ready for harvesting. Logs larger than 22 cms. diameter are splitted by the Coop's mechanical splitter. The plant is estimated to consume from 6 to 7 tons of fresh wood per hour. The plant operates 24 hours per day or 255 days or 5,500 hours per year. It was estimated by them that one ton of fuelwood has equivalent of about 2.4 cubic meters. At 14.4 cubic meter per hour (6 x 2.4) and operating at 24 hours per day, the plant is estimated to consume about 350 cubic meters per day or about 89,250 cubic meter per year. Based on this requirement of the plant and if their 4-year old ipil-ipil plantation will yield about 160 cubic meter per hectare, the Coop shall harvest about 558 hectares per year. The Coop should, therefore, develop a plantation of 2,232 hectares at four-year rotation where they can harvest at least 160 cubic meters per hectare.

3.0 THE TREE FARM

The Coop has a total area of 2,700 hectares and they estimate that about 1,500 hectares are only plantable due to rough terrains.

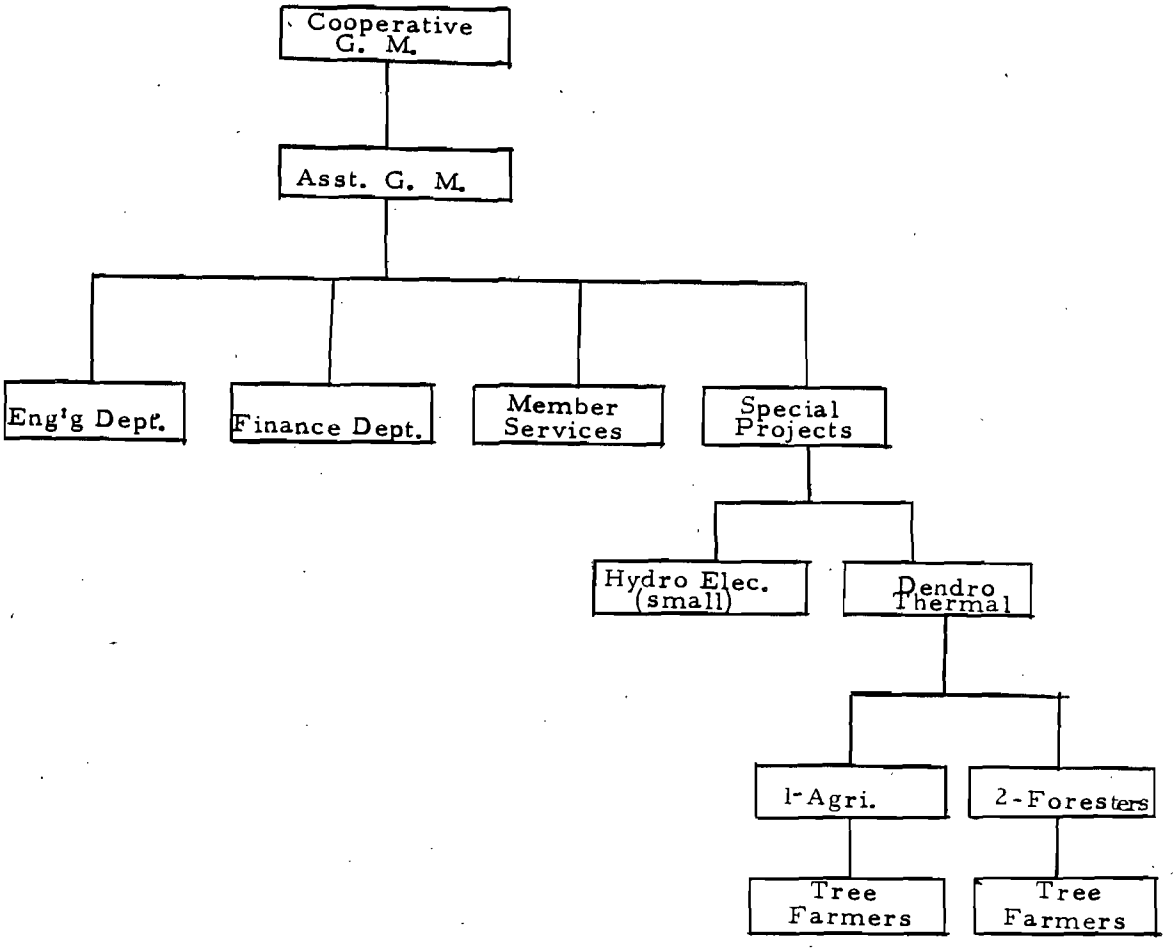
Two separate areas are developed, one of which is the Solsona tree farm, consisting of 6 modules and the Dingras tree farm 5 modules. The Coop is developing at their own expense a tree farm of about 100 hectares.

The Solsona tree farm is rough and the slope gradient is from 40 to 60 degrees. The soil is clay loam and is fertile at the lower portion of the slope but is severely eroded near and on top of the hills. The original vegetation, before development of the tree farm, was cogons and some stunted or short-boled natural-grown trees.

The Solsona farm is very close to the power plant but the Dingras tree farm is very much farther.

4.0 THE ORGANIZATION

4.1 Table of Organization



4.2 The cooperative

The Cooperative supervises and controls the development of the tree farms and distributes the loan. They have already hired one agriculturist and two foresters. One forester is in-charge of the Solsona tree farm and the other, the Dingras tree farm.

4.3 The association

Like other Cooperatives, they have already organized the associations for each module of 100 hectares, with the same responsibilities as the association in Bolinao.

4.4 Tree farm development

4.41 The loan

Loan procedures are also the same as the Bolinao, that is, interest is paid in the 5th year and the principal and interest are all paid in a period of 8 years.

4.42 Land preparation

Site preparation is done by total clearing and uprooting of cogons and other grasses. Partial cutting of the standing natural growths of stunted trees is done in some areas. Accordingly, it takes about 2 days to total clear or clean a hectare for 10 men each day or 20 man-day per hectare.

4.43 Planting

Planting is done by a combination of nursery-grown seedlings and direct seeding. Spacings tried are 1 x 1 meter, 1-1/2 x 1-1/2 meter and 2 x 2 meters. Accordingly, 2 x 2 meters spacing and planting of nursery-grown seedlings are the best they observed.

4.44 Weeding

Weeding is done by removing all grasses, vines and other weed species and is as follows:

Sequences	Duration
1st weeding	3 months after planting.
2nd weeding	2 months after the first planting or about the end of the rainy season.
3rd weeding	Start of the next rainy season.

No more weeding is expected thereafter.

5.0 TREE FARM DEVELOPMENT COSTS

Activities	Cost/Ha. (₱)
1. Total clearing/cleaning	₱100
2. Burning	100
3. Hole digging	100
4. Planting	300
5. Fertilizer	120
6. Pesticide spraying	120
7. Weeding	
i) First weeding	300
ii) Second weeding	200
iii) Third weeding	300
8. Supervision (patrolling) for the whole year	200
9. Materials/contingencies (not estimated)	

6.0 RE-ESTABLISHMENT OF TREE FARMS

After harvesting, the Coop will not finance the re-establishment of the tree farms. They believe that the associations have already earned money thru the sale of their planted trees and they can already re-establish their tree farms at their own expense.

.0 CAMPAIGN FOR TREE FARM DEVELOPMENT AND INCENTIVES

1. The Coop encourages their employees to plant trees at their own expense in private lands. The target for each employee is 5.0 hectares and therefore for 300 employees, they shall plant 1,500 hectares. If the employees do not have enough areas of their own, they can execute a contract with other private landowners for the purpose.
2. The KKK fund in the municipal level is being tapped for the development of tree farms by private landowners under the agroforestry scheme.
3. Bliss houses at the nearby thermal power plant is alloted to members of the associations.
4. Household owners are encouraged to sell their pulpwood to the Coop as payment for their electric bills so that they will be induced to plant trees in their own backyards.

8.0 SILVICULTURAL TREATMENT

Like the other Coops, they have not instituted thinning of the plantation to reduce the number of seedlings per hectare.

9.0 TRIAL PLANTINGS

The Hodam Associates, Inc. funded by the Agency for International Development (AID), U. S. A. is conducting several trial plantings of Acacia manguim, Gmelina arborea, Agoho, Acacia spectabilis Ackleng parang, and some other species in the Solsona tree farm.

10.0 THE WOOD TRANSPORT SYSTEM

The Coop has not yet installed the wood transport system of moving the fuelwood from the tree farm plantation to the power plant.

The Solsona tree farm is bounded by the Kalinga-Apayao national road on the east and a dirt road on the north. Since the planted area is rough, fuelwood has to be brought to the roadside landings by the gravity system. Access roads will be difficult and expensive to construct for the purpose of harvesting the plantation in the middle portion.

11.0 COMMENTS/OBSERVATIONS

11.1 Organization

As can be seen from the Table of Organization, they have already hired the technical men in the tree farm project. They have two foresters, one for the Solsona tree farm and the other, the Dingras tree farm including an agriculturist. Properly trained and motivated, they can very well undertake or implement the necessary technical and silvicultural practices for the successful development of the tree farms.

11.2 The tree farm development

Since the tree farm area is rough, it is necessary that the trees for fuelwood should be grown to bigger diameter sizes to reduce handling expenses and be suitable for the yarding machines to be used in harvesting the plantation.

12.0 RECOMMENDATION

12.1 Further orientation of the technical men

The foresters and the agriculturist involved in the tree farm development should be allowed to visit and observe the establishment of forest plantations in Luzon such as the Manila Seedling Bank or the Provident Tree Farm at Mindoro. These personnel can learn from the success or failures of these entities in plantation development.

12.2 It is also recommended that:

1) Thinning of the planted areas to remove the suppressed trees and retain the dominant and co-dominant trees should be conducted or they should already adopt the spacing of 2 x 2 meters as found by them to be the best method they have so far found.

2) The 100-hectare module should be subdivided into manageable blocks of 10 to 20 hectares for better control and supervision in both the plantation establishment and harvesting.

3) Growth plots should be established.

4) A forest inventory should be conducted for planted trees inside each module.

5) Actual sample measurements of trees harvested by module should be conducted.

6) Continue the species trials being done and as soon as the species suitable for the tree farm are found, the said species should be used for planting.

7) As a guaranty for a steady source of fuelwood, the Coop should further intensify the campaign for their employees to develop tree farms and other private landowners to plant their backyard to trees. All efforts should be exerted by them to have these projects be successful. The tree farm they are developing shall not be enough to feed the wood needs of their power plant. Excess wood can always be sold as fuelwood to tobacco growers in Ilocos Norte or as charcoal to Laoag and other towns in the province.

8) Monitoring and evaluation team or an audit team should be created which shall report directly to the General Manager - not to their foresters or agriculturists.

9). Encourage the farmers of the associations and those from adjacent communities to plant agricultural crops in between planted tree species to have better survival of the planted trees.

10.2 Harvesting and transport system

10.21 Harvesting

1) In felling, bucking, especially the bigger-sized trees, bowsaw should be used. This will save portion of the tree to waste. Wherever necessary and applicable, bolos and axes should be used in combination with the bowsaw. Length of the fuelwood should be on the multiples of 2.5 meters, 3 meters, 4 meters, to reduce handling cost not at 0.5 meters long per tree as needed by the power plant.

10.22 Wood transporting

1) The Kalinga-Apayao national road should be improved and used extensively in the hauling of fuelwood. The grade of the road is gradually going downward, hence very favorable for hauling.

2) Gravity system of moving the fuelwood to roadside landings should be used. The machine for such purpose can be mini yarders, equipped with a skyline,

mainline and a carriage, which should be positioned at the top portion of the hill. Another is the use of chutes[1/] placed at the end of a precipice where the f fuelwood are dropped directly to roadside landings.

EULOGIO T. TAGUDAR — AVELINO G. VERACION

1/- Chutes are made of plastics or wood, shaped like half of a barrel and joined together by knots/bolts and placed downward along slopes and at the end of precipice or steep areas towards the road.

THE BURGOS DENDRO THERMAL PROJECT

1.o LOCATION

This project is located in the Municipality of Burgos, Province of Ilocos Sur and is about 17 kms. from the national road, passing thru the town of Sta. Maria, Ilocos Sur. The project is under the supervision and control of the Ilocos Sur Electric Cooperative (ISEC) which is about 27 kms. from the town of Santiago, Ilocos Sur, the site of the main office of the electric cooperative.

2.0 THE POWER PLANT

It is 3 MW and of French design and similar to that of the Bolinao power plant. The plant site is about 3 to 5 kms. from the tree farm site. It is now in operation, using fuelwood purchased by the cooperative from private landowners at ₱40 per cubic meter stack volume of different species not necessarily ipil-ipil.

3.0 THE TREE FARM

This has a total area of 1,100 hectares of which 90% is plantable. It is classified as public forest and applied by the cooperative for lease agreement with the Bureau of Forest Development (BFD) since 1981 but same is not approved by the BFD. Most of the area is rough with an approximate gradient from 40 to 60 degrees. The soil is clay loam and not eroded as exhibited by the robust growth of ipil-ipil trees even when planting is done almost at the top of the hills. Before planting, the area was formerly covered by cogons and shrubs or stunted natural grown trees. The surface soil is still thick and good for planting.

The tree farm is from 3 to 5 kms. of the plant sites and accessible by a narrow dirt road of very adverse grades, making hauling of the fuelwood difficult and dangerous if not further improved.

4.0 ORGANIZATION

It has practically the same organization as that of the Bolinao project. The responsibilities of the association officers and members are almost same as the other electric cooperatives. They have hired their agriculturist but not the forester.

5.0 TREE FARM DEVELOPMENT

5.1 Loan

Loan procedures and releases are the same as those of the Bolinao project.

5.2 Land preparation

Site preparation is also by total clearing of the land and burning before the rain starts.

5.3 Planting

This is done by direct seeding by making holes with a sharpened stick or sharp bolo and placing from 3 or more seeds per hole. Spacing is 1 x 1 meter. Planting was started in 1981 and a total of 600 hectares are already planted by all the associations.

5.4 Weeding

Weeding is conducted twice during the first year by total cleaning of the planted area and once in the second year.

5.5 Development costs

i) Land preparation - ₱360/ha.

ii) Planting - 360/ha.

iii) Weeding

... 1st year (2 times) - 360/ha.

... 2nd year (once) - 300/ha.

To reduce cost, the association members bought and butchered pigs and make arrangement with neighboring communities to clear the land and pay them with meat based on the minimum agricultural wage and in accordance with the goal for the area to be accomplished.

5.5 Silvicultural treatment

No thinning is conducted one year or less after planting.

6.0 INCENTIVES

Incentives are given to the association for the protection and patrolling their areas at ₱3,000 per year.

7.0 TRANSPORT SYSTEM

No transport system is yet installed. Accordingly, the General Manager will also install the lasso cable system as done in Bolinao. He wants to install the cable system under his supervision to reduce cost.

8.0 COMMENTS, OBSERVATION AND RECOMMENDATIONS

8.1 Organization

The Coop has not yet hired their forester but they have already in their employ an agriculturist.

8.2 The tree farm

Because the area is rough, they should grow the fuelwood to bigger diameter sizes. Hence, they should also conduct thinning to reduce the number of stems per hectare.

As recommended for the Bolinao and Solsona Coops, they also undertake the following suggestions:

1. Subdivide the modules into smaller manageable blocks;
2. Establish growth plots inside each module.

3. Conduct forest inventory and actual measurements of tree harvested in each module;

4. Encourage inhabitants of communities near the power plant or from a distance of not more than 20 kms. from the power plant to plant trees good for fuelwood;

5. Establish a reliable audit team to determine progress of tree farm establish and harvesting; and

6. Leave a portion of the tree farm for trial plantings of other fast-growing species suitable for fuelwood.

8.3 Transport system

1. Because of the area is rough, a very careful planning of locating the route of transporting the wood should be made. An aerial photo of the area should be secured and the best and most economical route and system to be used should be studied carefully. High harvesting cost will substantially increase the cost of electricity which the consumer will pay. After the layout of the extraction route is made on the map, a ground survey should be made further to validate and/or correct the route as plotted in the map. Construction of roads for hauling the fuelwood seems to be out of the question because the present road constructed to the plantation is too adverse for economical and efficient hauling.

2. Harvesting and transporting

   a. Bolos, axes and lowsaw in combination is recommended.

   b. The same lasso system can be installed to transport the fuelwood but care should be done in locating where the intermediate supports should be installed such that

they must be of equal level or gradually downhill or uphill but not abruptly. Length of the fuelwood should be increased to 4.0 meters long. Loading should follow that of the Bolinao system as recommended.

c. Mini-yarders and the chute systems of yarding and/or transporting fuelwood from the felling areas to loading stations are recommended. Use of cow or carabao is out of the question because the area is too steep for the animals.

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FINANCIAL AND ECONOMIC EVALUATION OF THE PHILIPPINE DENDRO THERMAL PROGRAM

Volume II

Technical Report

Prepared for

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CHAPTER I

INTRODUCTION

The objectives of this analysis, expressed in general terms, are two-fold. -First, it is our objective to evaluate the Dendro Thermal project as it has progressed to date and, second, to address the replication potential of the Dendro Thermal concept using the historical record as a point of departure to be modified by the experience gained through the engineering and forestry analyses.

These objectives will be accomplished by concentrating on six individual project sites which are representative of the Dendro Thermal concept along two dimensions. The first dimension addresses the three different types of generation plants. The second dimension of variance to be captured is related to forestry. The six sites selected are located in a number of different regions thus providing sample points of widely disparate geographical distribution. An additional consideration in the site selection was the degree of completion attained, i.e., those sites most complete would provide the most reliable data. The six sites selected, and their locations, are provided on Table I-1. Throughout this report they will be referred to by their electric cooperative acronym.

Organization of The Report

The report is organized into five chapters; this introduction being the first. The second chapter discusses the research methodology used to achieve the objectives of the report, including a project description, methodological framework, the data sources and how they were used, as well as highlighting caveats to the results and conclusions presented as indicated by the inadequacies of the data secured.

The third chapter presents the financial analysis for the baseline and replication cases for the power plants, the tree farms, and these two project components consolidated as a project concept.

It includes the initial investment costs, projected income statements and cash flow statements, and the financial internal rates of return (FIRR). Also presented in the third chapter is a cost of production analysis.

The fourth chapter presents the economic analyses which incorporate adjustments for foreign currency and unskilled labor allocations for the tree farm and power plant components separately, as well as consolidated, with the economic internal rates of return (EIRR) for both the baseline and replication cases. This chapter also addresses the employment and foreign exchange impacts of the Dendro Thermal Program at the six sites.

Chapter V gives the results of the sensitivity analyses (conducted separately on the power plants and tree farms) and project risks.

Table I-1

Economic and Financial Analysis
Project Sites

Electric Cooperative Acronym	Town	Province
CASURECO IV-A	Caramoan	Camarines Sur
ZAMECO	Palauig	Zambales
OMECO	Magsaysay	Occidental Mindoro
ANTECO	Hamtic	Antique
PANELCO I	Bolinao	Pangasinan
ISECO	Burgos	Ilocos Sur

CHAPTER II

METHODOLOGY

Project Description

The Government of the Philippines (GOP) has placed top priority in developing biomass-based electricity generation which would substitute for imported-oil-based power plants through the implementation of its Dendro Thermal Program in various parts of the nation. The main objectives of the program, which began in 1979, are to cut down national expenses on oil imports and to generate employment opportunities through establishing tree farms to supply fuel wood to dendro power plants.

Denuded public upland, unused and owned by the government, was identified and assigned for tree planting under the program. Marginal upland farmers, who were either unemployed or underemployed, were organized for tree farming under the Tree Farmers Associations (TFAs). The TFAs are legal entities which receive loans and allocate funds for subsistence purposes, as well as receive income from the sale of wood. The TFAs lease land from the government on an annual basis, and are guaranteed a minimum price for the wood. Two parallel organizations are responsible for the administration of the program -- the National Electrification Administration (NEA) and the rural electric cooperatives (co-ops).

Tree farms for the wood-fired power plant program are developed on 100-hectare modules. Each module is operated by the Tree Farmers Association and consists of 10 farmers and their families. Each module is developed over a period of four years. Each year giant ipil-ipil (Leucaena leucocephala) is planted on 25 hectares. Trees are harvested in four-year cycles, and new trunks grow from coppices after each harvest. The wood is sold to dendro power plants at a guaranteed farm gate price, which, for the purposes of this analysis, is 65 pesos per metric wet ton, i.e., the current NEA recommended price.

Tree farms are financed through loans of up to 3,500 pesos per hectare or 3,500,000 pesos per farm module, extended over the 4-year tree farm development period. Loan releases are based on tree farm accomplishments and are administered by NEA and the co-ops.

As of December 31, 1983, the National Electrification Administration (NEA) had identified 44 existing and potential dendro tree farm sites. The total area planted at 36 sites has been 17,450 hectares. By NEA's definition, 7,664 hectares are surviving.

Although 36 tree farms are in operation, only 18 architectural and engineering contracts were awarded for the design of power plants; of these, 14 construction contracts were awarded, four of which were subsequently terminated or suspended. The 10 remaining projects for which actual cost data are available are presented on Table II-1. They are given in rank order of percentage completion.

Initially, seven projects were selected from those 10 on the basis of plant type and geographical diversity to achieve complete representation. However, tree farm data were not submitted by ISELCO II, so it was eliminated from the analysis. The remaining six project sites are given on Table II-2, along with the characteristics which led to their selection. The elimination of ISELCO II did not significantly reduce the ability of those sites to represent the Dendro Thermal concept. The six sites have two examples of each plant type under construction and are geographically varied. There is also variation in the number of hectares surviving (as of 1982), while all show high levels of participation as indicated by the number of tree farm associations and the number of members. These representative project sites form the basis for our evaluation of the Dendro Thermal concept.

The power plants to produce the electricity from the fuel wood are of several types and manufacturers. Presently, three types have been almost completely constructed, i.e., the French (Alsthom-Atlantique) 3.4 megawatt boiler-type; the British (Balfour-Beatty) 3.1 megawatt boiler type; and the French (Moteurs-Duvant) 0.96 megawatt

Table II-1

DENDRO Thermal Program Status As of December 31, 1983
For Projects Nearest Completion

	Electric Cooperative Projects									
	INEC Region I	PANELCO I Region I	ANTECO Region VI	ISELCO II Region II	OMECO Region IV	ZAMECO Region III	CASURECO-IV-A Region V	ISELCO I Region II	ISECO Region I	ILECO II-A Region VI
Construction % Completion	99.52	99.17	96.41	95.5	83.5	82.12	75.10	73.23	68.40	7.00
Power Plant Loan Releases										
Date of Loan Contract	9-02-81	9-02-81	10-07-81	10-18-81	10-07-81	1-06-82	1-13-82	11-04-81	12-15-81	5-16-82
% Released To Date	85.2	90.3	113.3	94.9	55.9	97.2	78.6	83.7	60.3	40.2
Power Plant Status										
Equipment Supplier	UK-BBEL	FR-AA	FR-MD	UK-BBEL	FR-MD	UK-BBEL	UK-BBEL	UK-BBEL	FR-AA	FR-AA
Date of Commissioning (1984)	1st QTR	1st QTR	1st QTR	1st QTR	2nd QTR	1st QTR	1st QTR	2nd QTR	1st QTR	2nd QTR
Tree Farm Loan Releases										
Date of Loan Contract	12-03-80	12-01-80	7-15-81	1-14-81	9-02-81	1-28-81	5-16-81	7-15-81	12-17-80	9-02-81
Approved Loan (1,000 Pesos)	4.74	4.50	1.75	4.39	2.10	4.39	4.39	4.04	4.39	4.39
% Released to Date	62.2	100.0	64.0	31.2	40.0	55.4	32.6	45.0	39.4	25.3
Tree Farm Status										
Area Planted (Has.)										
1980	406	310	10	20	-	20	55	28	8	-
1981	571	500	160	145	25	450	300	110	164	15
1982	303	300	111	146	128	155	104	182	259	300
1983	266	-	88	109	tem susp.	146	151	179	144	140
TOTAL	1,546	1,110	369	420	153	771	610	499	575	455
Area Surviving (Has.)										
1980	74	300	-	2	-	-	-	-	7	-
1981	91	500	23	27	18	79	39	69	164	7
1982	257	300	7	37	102	67	87	144	140	57
TOTAL	422	1,100	30	66	120	146	126	213	311	64
Farmer's Association Status										
Organizatons/Members	10/93	10/101	3/57	10/80	4/31	10/99	10/121	9/122	10/96	10/133
Status[1]	4	6	6	5,I	6	6	5	5,I	6	5

Table II-2

Characteristics of Power Projects
Selected for Analyses

Electric Cooperative Project	Region	Equipment Supplier	Area Surviving, 1982 (Has.)	Number of Farmers Associations/ Members
CASURECO IV-A	V	Balfour-Beatty	126	10/121
ZAMECO	III	Balfour-Beatty	146	10/99
OMECO	IV	Moteurs-Duvant	120	4/31
ANTECO	VI	Moteurs-Duvant	30	3/57
PANELCO I	I	Alsthom-Atlantique	1,100	10/101
ISECO	I	Alsthom-Atlantique	311	10/96

gasifier. Three other plant types are being considered. One is French, one is Japanese, and one is U.S. This second group has not been constructed and was therefore not included in our analysis.

These plants are the property of the rural electric cooperative (co-op) under assumption of debt associated with their purchase and construction. The foreign debt is denominated in foreign currency with the co-op assuming responsibility for exchange rate fluctuation.

The power produced from these plants is consumed locally and nationally through interconnection with the National Power Corporation (NPC) grid where such interconnection exists.

Objectives

The objectives of the analyses were to: (1) collect tree farm production and financial data for representative sites; (2) construct initial investment statements, income statements, cash flow statements, and conduct internal rate of return analyses for the representative sites; (3) collect power plant production and financial data for representative equipment types at specific sites; (4) construct initial investment statements, income statements, cash flow statements, and conduct internal rate of return analyses for the representative equipment types at specific sites; (5) conduct an economic analysis for the representative tree farm and power plant

sites; (6) extrapolate the representative project economic and financial analyses to include technical knowledge gained through the Program's experience to date to test the potential the Dendro Thermal concept has for replication at other similar sites; 7) estimate the costs of wood and power; and (8) analyze the employment and foreign exchange impact.

Methodology

This project analysis differs from most such studies because it is partly an evaluation of an existing program and partly a feasibility analysis for future projects. This dual objective was addressed by developing two sets of analytical outputs. The first set attempts to project the economic and financial situation for the selected project sites based solely on the progress made to date at each site. Actual data were used wherever available and forecasts, such as revenues, were based on these data to the maximum extent possible and all data were converted to 1984 pesos, using the consumer price index as supplied by National Economic Development Administration (NEDA). The second set of outputs relates to the potential the project site has for replication. The analyses of various participants in this research provided insight into how the experience gained to date could assist in improving the viability of the project concept.

Both sets of outputs were produced for the tree farms and the power plants separately, as well as consolidated for an evaluation of the concept taken in its entirety. The analysis is made more complex by the necessity to evaluate all of these separate components from both an economic and financial perspective. The distinction made between these two perspectives is that the economic viability is evaluated in terms of social costs of inputs and social value of outputs which can deviate from market costs (used in the financial analysis) for several reasons. The two major influences which cause this deviation are related to unskilled labor and foreign currency inputs. Unskilled labor is relatively abundant in the Philippines and

the wages are administered. This wage has been determined to be higher than the opportunity cost of labor, particularly in the rural areas where underemployment, as well as unemployment, is very high. For the tree farms, the divergence between market wage and social opportunity costs is particularly great. This is because the farmers are encouraged to continue their family farms supplemented by intercropping on the plantation sites so that their actual loss of farm production may be very small. The social opportunity cost is, therefore, largely composed of the disutility of labor and the improvements to family farm structures which could have been made in the absence of the tree farm plantation activities. The unskilled labor component of the power plant construction is more difficult to analyze in terms of social opportunity cost because no information was available on the source of this labor. Estimates of the shadow wage rate, i.e., the fraction of market wages which are real costs to society, range from .8 to .6. The lower estimate of .6 was chosen because of the identified low opportunity cost of the tree farm unskilled labor.

The second area where market costs diverge from social cost is foreign exchange. Developing economies usually experience shortages of foreign exchange which are controlled by various means. Foreign currency, therefore, demands a premium over the official exchange rate. The actual level of this premium can be indicated by observing market activities, such as the black market, though such observations cannot be accepted blindly. Analyses by the Philippine planning staff have generally used 1.20 as the shadow exchange rate to correct foreign currency distortions. This rate was adopted for this study.

As previously stated, the economic and financial evaluations were conducted on baseline and replication cases. The distinction between these two cases is very straightforward for the power plants in that the engineering analysis did not reveal major design or construction changes. Preliminary analyses indicated that a possibility for large efficiency improvements could be attained by upgrading the transmission facilities used to carry power from the power plant to

the co-op grid, but subsequent analysis did not confirm this for the project sites under study. There was a major operating cost item, however, which would be expected to change as the Dendro concept is replicated. Under the baseline case, a major shortfall in plantation fuel wood supply was forecasted. This shortfall could only be eliminated through substantial purchase of fuel wood on the open market. The replication case in the plantation reduced this shortfall considerably (and in some cases, a surplus was actually produced) which changed the average cost of fuel wood for the power plant. The power plant replication case incorporates this higher availability of plantation-supplier fuel wood.

The replication case for the plantation is considerably more complex in that a number of factors were modified. The planting cycle was normalized to achieve the original targets. It was assumed that development funds were available on a consistent and timely basis, and higher yields and survival rates were also assumed. These latter two factors were hypothesized on the basis of assumed appropriate site selection and species diversification. It was further assumed that no natural disasters, such as fires, occurred and that diligent silvicultural practices were followed. The yields were estimated on the assumption that these efforts would achieve a 100% survival rate and yield increases of 80%, 40%, and 20% were achieved for poor, fair, and excellent project sites, respectively. The tree farm replication case should, therefore, be considered as a "best case" scenario.

The costs of power and wood, presented in Chapter III, were estimated by annualizing the initial investment costs at various discount rates, adding these to the annual operating costs and dividing by the gross ouputs for the power plants and tree plantations, respectively. These cost estimates provide an additional dimension to the evaluation to increase the comparability of the Dendro Thermal concept to other projects. Cost estimates under both the baseline and replication cases were prepared.

The labor impacts were estimated by analyzing the expected staffing at the power plants, the labor component of the construction phase, and the tree plantation reported labor utilization levels for both development and operation phases. The impact is expressed in total person-years over the assumed 25 year life of the projects. The power plant construction phase employment was estimated by dividing the estimated skilled and unskilled labor component totals by mid-level and unskilled labor wage rates, respectively, as reported in the feasibility analyses. These wage rates were adjusted for inflation using the consumer price index to convert them to real 1984 pesos in the same manner as the other cost components of the projects. Labor intensity was measured as labor-year per million pesos of investment.

The foreign exchange impacts are particularly significant for evaluating the effectiveness of the Dendro Thermal concept, because one of its primary motivations is the conservation of foreign exchange. Essentially, the projects trade the initial foreign exchange outflows used to purchase equipment for a stream of foreign exchange savings over time due to the reduction in oil imports. Whether or not this trade is a beneficial one to the Philippines is measured by the foreign exchange earnings rate on the initial outflow. This rate is calculated by deriving the rate of return which equalizes the outflows to the inflows in present value terms. The higher this rate, therefore, the greater the benefit to the Philippines.

Data Sources

The primary data source for the plantation analysis was a survey conducted at the module level. Two survey instruments were developed. The first was designed to collect cost information on all the inputs, including labor, materials, supplies and equipment, consumed during the development phases of the modules and the outputs produced expressed as number of hectares planted. It included questions relating to expected costs for operation years and the quantity of wood to be harvested, yields, and surviving hectares, as well as price and availability of wood fuel in the markets at each project site.

This survey instrument is provided in Appendix A-1. A second questionnaire requested an evaluation of the productivity potential of the site on the module level. This questionnaire is provided as Appendix A-2. These two questionnaires were delivered to the general manager in each rural electric cooperative (co-op) which manages member Tree Farmers Associations (TFAs) and farm modules.

Field visits to dendro tree farms located in the different regions of the Philippines by project personnel were conducted in order to explain the questionnaires and to urge complete response to the questionnaires. The six chosen plantations, having a total of 48 tree farm modules, completed or partially completed the questionnaires. An attempt was made to secure data from a seventh site, ISELCO II, but no response was received. Although the questionnaire was designed to collect data at the module level (100 hectares each), OMECO responded with plantation level data. As a result, the total returned and completed questionnaires are 45 instead of 48.

Data contained in the returned questionnaires were tabulated and analyzed to derive investment costs, production costs, net income, and cash flow on individual farm modules. The plantation level data are derived from the aggregated value of modules.

Other data sources consulted included National Electrification Administration (NEA) reports and audits of plantation activity, but the comparability of the two sources was difficult due to different temporal and spatial aggregations.

The power plant data sources could be considered as two groups. The first group provided the data for the initial investment costs and the second provided the basis for operating costs. The initial investment cost data relating to equipment costs were secured from the NEA project summary reports as these were the most recent tabulations. An attempt was made to reconcile these data with the original equipment contracts, but without success. However, even these reports were somewhat out of date for construction costs due to additions made

during the construction phase. The construction cost data were, therefore, secured from the bid documents supplemented by the change authorization requests on file as of May 1984. In contrast to the equipment cost data, the construction costs will probably be modified further as construction continues on the power plant.

The operating cost data were projected on the basis of expected staffing requirements, maintenance costs, and fuel consumption as developed by the engineering analysis of the plants, taking into consideration the operating characteristics of each plant type at each site. Operating revenues were based on the estimated output of the plant disaggregated by local sales versus sales to the National Power Corporation (NPC). This split was derived from estimated load duration curves developed from the load factor, peak and demand data contained in the NEA "1982 Cooperative Annual Statistical Report." Co-op average transmission losses were also derived from this report and transmission losses from the plant to the co-op grid were based on the configuration installed and the distance to the grid.

Limitations of the Analysis

The largest single problem limiting the applicability of this analysis is related to timing. None of the power plants were completed. Thus, no final construction costs were available nor were there actual data on power plant or tree farm operations. Of these three cost elements, the lack of harvesting costs is probably the most significant.

Other problems also surfaced in the data that were available. The equipment cost data were supplied from two sources; the National Electrification Administration's (NEA) proposed project summary reports were one source and the equipment supplier contracts were the other. It was not possible to reconcile these two sources. The NEA reports were somewhat higher than the equipment cost contracts, and we were told that additional items had been added but, except for the cooling towers added to ZAMECO and CASURECO IV-A, they could not be

identified. Our use of the NEA reports, therefore, represents a more conservative approach. Another reason for using the NEA reports for the equipment costs was that the NEA reports were available for multiple points in time thus enabling a temporal disaggregation. The loan amortization schedules to cover these costs were, however, based on the equipment contracts as they were the only source which provided a disaggregation by type and amount of foreign currency.

The data collected by survey questionnaires for the tree farms suffer from many of the shortcomings common to all surveys. Some data were not supplied completely and secondary sources were utilized. An example of this is the number of hectares planted on the modules in ZAMECO, where NEA summary data were utilized because the questionnaires were not consistently completed for this parameter.

All data reported were converted to real, 1984 pesos, using the consumer price index series supplied by National Economic Development Administration (NEDA). Normally, this procedure is standard in project analysis and presents no great problem. In this case, however, there is a mixture of domestic inflation and exchange rate reevaluation, which interacts in a complex fashion thus raising the possibility that standard economic practices may over- or under-adjust.

Other data conflicted with secondary sources, such as the loan amounts received by the TFAs. It was not possible to reconcile these discrepancies without significant additional research. Where such discrepancies exist, the survey results were considered authoritative.

A conceptual problem also exists in the tree farm's unskilled labor costs, particularly during the harvesting years. An implicit assumption in our analysis is that variations among the plantations in per-hectare harvesting and development labor costs reflect cost of living and level of difficulty variations and not variations in standards of living. The level of return in excess of the reported labor costs would, therefore, reflect the profit to the farmer available to increase the standard of living. If it is the case that

the labor costs reported on the questionnaires reflect different standards of living at different plantations, then comparability between the plantations will be compromised.

CHAPTER III
FINANCIAL ANALYSIS

This chapter presents the financial analysis in four major subdivisions, with the first three having two major sections. The first subdivision is the presentation of the tree-farm plantation, the second presents the power plant, and the third consolidates the tree farm and power plant financial data for an evaluation of the entire Dendro Thermal concept. The two major sections in each of the three subdivisions present, first, the baseline case and, secondly, the replication case. As discussed in the "Methodology" chapter, the baseline case represents an evaluation of the success of the implementation of the Dendro Thermal concept as it has occurred to date. The replication case incorporates the insight gained from these projects to evaluate how well new projects could be expected to perform. The fourth major subdivision presents a cost analysis of the power and wood produced.

Tree Farm Plantations

Baseline Case

The tree farm plantations exhibited a great deal of variation in the level of activity during the four development years. Table III-1 presents the number of hectares planted at each of the six project sites. The data for 1984 are estimated on the basis of conversations among project team members and various officials. There are no funds from NEA to support the 1984 activity, so plantings are expected to occur only at those rural electric cooperatives (co-ops) which have expressed the intention of funding them internally. These planting data were derived from the survey data and, in most cases, diverge from NEA publications. It was not possible to reconcile this discrepancy completely though some can be explained by our excluding the co-op owned module.

Investment Costs. All costs associated with the tree farm development years (the first four years) are considered investment

Table III-1

Tree Plantation Hectares Planted in the Baseline Case

	1981	1982	1983	1984	Total
CASURECO IV-A	86	199	141		425
ZAMECO	394	130	123		647
OMECO	25	128			153
ANTECO	175	111	88	20	393
PANELCO I	270	535	170		1,010
ISECO	172	132	153	147	604

NOTE: Some modules were actually planted in 1980. These were analyzed as if they were planted in 1981 for presentational consistency.

Source: Tree plantation survey results.

costs. These costs include labor, fixed structures, tools, and materials. Their values were taken from the completed survey questionnaires at the module level and aggregated to the plantation level as presented on Table III-2. The labor costs for ANTECO and ISECO were not reported on the questionnaire as a separate item which necessitated an estimation of them as a residual net of all other reported costs. Labor costs clearly dominate all other cost categories in all the project sites.

The per-hectare development costs, also provided on Table III-2, display a wide variation both across years and across plantations. It would be expected that costs per-hectare would vary across plantations due to the differing conditions and cost structures. It is not clear why a given plantation would exhibit such variations over years unless the modules being planted differ greatly in the level of difficulty even within the plantation.

Projected Net Income. Tables III-3 through III-8 depict the projection of net income for the six project sites. The operating cost items include labor costs, which predominate, and farm maintenance costs, which include numerous items such as animal rental, materials, and supplies.

Because harvesting has not yet occurred to any great extent, the estimation of operating cost during the harvesting years is based on a

Table III-2

Tree Plantation Initial Investment Costs in Baseline Case
(in thousands of 1984 pesos)

	No. of Modules	Plantation Total Year 1981	1982	1983	1984	Investment Per Hectare Year 1981	1982	1983	1984	Average
CASURECO IV-A										
Total	10	404	322	195	23	4.69	4.63	1.38	*	2.22
Unskilled Labor		187	246	170	0					
ZAMECO										
Total	10	1,936	575	521	30	4.91	4.42	4.24	*	4.73
Unskilled Labor		1,566	428	431	0					
OMECO										
Total	4	225	103	16	4	9.0	.80	*	*	2.28
Unskilled Labor		159	61	0	0					
ANTECO										
Total	4	432	525	417	67	2.47	4.73	3.81	3.35	3.66
Unskilled Labor		367	427	333	66					
PANELCO I										
Total	10	845	1,844	1,233	557	3.13	3.31	6.02	*	4.08
Unskilled Labor		789	1,769	1,011	416					
ISECO										
Total	10	499	609	481	104	2.90	4.61	3.14	.71	2.80
Unskilled Labor		346	580	442	84					

*Not applicable due to zero plantings.

NOTE: Some modules were actually planted in 1980. These were analyzed as if they were planted in 1981 for presentational consistency.

Source: Tree plantation survey results.

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very meager information base. Analyses by other project team members (see Aulerich) indicated that harvesting costs are very site specific and can be exceedingly high. Unfortunately, the six project sites under present consideration were not provided with new harvesting plans. These costs were, therefore, estimated from the information gathered in the survey. Only two of the six plantations surveyed supplied estimates of harvesting costs, i.e., PANELCO I and OMECO.

Because PANELCO I has the greatest experience to date, their costs were used as a base from which the other site costs were estimated. Proceeding on the assumption that development costs per hectare planted capture the variation of wage rates, costs of living,

Table III-3

CASURECO IV-A Tree Plantation Projected Income Statement in Baseline Case
(in thousands of 1984 pesos)

Year	Total Revenues	Production Costs						Net Income
		Operating Costs						
		Maintenance	Unskilled Labor	Total Operating Costs	Interest	Depreciation	Total Production Costs	
1985	651	28	85	113	93	19	225	426
1986	651	28	85	113	85	19	217	434
1987	651	28	85	113	77	19	209	442
1988	651	28	85	113	67	19	199	452
1989	651	28	85	113	57	19	189	462
1990	651	28	85	113	45	19	177	474
1991	651	28	85	113	32	19	164	487
1992	651	28	85	113	17	19	149	502
1993-2009	651	28	85	113	0	19	132	519

Source: Table III-10 for total revenues; Tables III-9 plus calculations as described in text for interest, tree plantation survey results plus calculations described in text for depreciation. All other from tree plantation survey results.

Table III-4

ZAMECO Tree Plantation Projected Income Statement in Baseline Case
(in thousands of 1984 pesos)

Year	Total Revenues	Production Costs						Net Income
		Operating Costs						
		Maintenance	Unskilled Labor	Total Operating Costs	Interest	Depreciation	Total Production Costs	
1985	279	15	128	143	250	21	414	(135)
1986	279	15	128	143	230	21	394	(115)
1987	279	15	128	143	207	21	371	(92)
1988	279	15	128	143	181	21	345	(66)
1989	279	15	128	143	153	21	317	(38)
1990	279	15	128	143	121	21	285	(6)
1991	279	15	128	143	85	21	249	30
1992	279	15	128	143	45	21	209	70
1993-2009	279	15	128	143	0	21	164	115

Source: Table III-10 for total revenues; Tables III-9 plus calculations as described in text for interest, tree plantation survey results plus calculations described in text for depreciation. All other from tree plantation survey results.

Table III-5

OMECO Tree Plantation Projected Income Statement in Baseline Case
(in thousands of 1984 pesos)

		Production Costs						
		Operating Costs						
Year	Total Revenues	Maintenance	Unskilled Labor	Total Operating Costs	Interest	Depreciation	Total Production Costs	Net Income
1985	172	2	42	62	40	4	88	84
1986	172	2	42	62	37	4	85	87
1987	172	2	42	62	33	4	81	91
1988	172	2	42	62	29	4	77	95
1989	172	2	42	62	24	4	72	100
1990	172	2	42	62	19	4	67	105
1991	172	2	42	62	14	4	62	110
1992	172	2	42	62	7	4	55	117
1993-2009	172	2	42	62	0	4	48	124

Source: Table III-10 for total revenues; Tables III-9 plus calculations as described in text for interest, tree plantation survey results plus calculations described in text for depreciation. All other from tree plantation survey results.

Table III-6

ANTECO Tree Plantation Projected Income Statement in Baseline Case
(in thousands of 1984 pesos)

		Production Costs						
		Operating Costs						
Year	Total Revenues	Maintenance	Unskilled Labor	Total Operating Costs	Interest	Depreciation	Total Production Costs	Net Income
1985	156	5	85	90	130	*	220	(64)
1986	156	5	85	90	119	*	209	(53)
1987	156	5	85	90	108	*	198	(42)
1988	156	5	85	90	94	*	184	(28)
1989	156	5	85	90	79	*	169	(13)
1990	156	5	85	90	63	*	153	3
1991	156	5	85	90	44	*	134	22
1992	156	5	85	90	23	*	113	43
1993-2009	156	5	85	90	0	*	90	66

*Less than one thousand.

Source: Table III-10 for total revenues; Tables III-9 plus calculations as described in text for interest, tree plantation survey results plus calculations described in text for depreciation. All other from tree plantation survey results.

Table III-7

PANELCO I Tree Farm Plantation Projected Income Statement in Baseline Case
(in thousands of 1984 pesos)

		Production Costs						
		Operating Costs						
Year	Total Revenues	Maintenance	Unskilled Labor	Total Operating Costs	Interest	Depreciation	Total Production Costs	Net Income
1985	1,631	11	932	943	456	70	1,469	162
1986	1,631	11	932	943	419	70	1,432	199
1987	1,631	11	932	943	377	70	1,390	241
1988	1,631	11	932	943	331	70	1,344	287
1989	1,631	11	932	943	279	70	1,292	339
1990	1,631	11	932	943	220	70	1,233	398
1991	1,631	11	932	943	155	70	1,168	463
1992	1,631	11	932	943	82	70	1,095	536
1993-2009	1,631	11	932	943	0	70	1,013	618

Source: Table III-10 for total revenues; Tables III-9 plus calculations as described in text for interest, tree plantation survey results plus calculations described in text for depreciation. All other from tree plantation survey results.

Table III-8

ISECO Tree Plantation Projected Income Statement in Baseline Case
(in thousands of 1984 pesos)

		Production Costs						
		Operating Costs						
Year	Total Revenues	Maintenance	Unskilled Labor	Total Operating Costs	Interest	Depreciation	Total Production Costs	Net Income
1985	761	60	322	382	160	15	557	204
1986	761	60	322	382	147	15	544	217
1987	761	60	322	382	133	15	530	231
1988	761	60	322	382	116	15	513	248
1989	761	60	322	382	98	15	495	266
1990	761	60	322	382	77	15	474	287
1991	761	60	322	382	54	15	451	310
1992	761	60	322	382	29	15	426	335
1993-2009	761	60	322	382	0	15	397	722

Source: Table III-10 for total revenues; Tables III-9 plus calculations as described in text for interest, tree plantation survey results plus calculations described in text for depreciation. All other from tree plantation survey results.

and terrain which would apply to harvesting as well, the PANELCO I supplied harvesting costs per hectare were scaled upward or downward to reflect this variation. The resulting harvesting cost per hectare estimates were then applied to hectares surviving at the individual project sites to estimate the labor component of total harvesting costs. Because the planting activities (and therefore, harvesting) were uneven over the development years, these labor costs were averaged over the four year cycle to which were added the annual farm maintenance costs provided on the questionnaires.

It is significant to note that no information is available to determine the extent of replanting necessary to replace unproductive coppices. Any such replanting would raise the operating costs of the tree farm plantations. In keeping with the philosophy of the baseline case methodology, no replanting of nonsurviving hectares was included. Depreciation was estimated from the equipment and equipment lifetimes provided on the questionnaires using the straight-line depreciation method.

The interest charges were calculated by amortizing the loan proceeds received as provided on the survey forms plus an estimate of the interest accrued during the four-year development cycle grace period. The amortization was calculated based on a 12% interest rate and an eight-year repayment period. The initial loan balances, loan balances with accrued interest, and annual payment are provided on Table III-9. It should be noted that these loan balances are, in some cases, significantly lower than those reported in NEA summary reports.

The revenue projection was based on estimated harvests sold to the power plant at a price of ₱ 65 per metric ton, which is the most recent NEA recommended price. The harvests were based on the yield estimates provided by the survey. These estimated yields, which were comparable to estimates prepared by other project team members (see McDicken), were applied to the estimated surviving hectares at the module level as provided on the questionnaire. Table III-10 presents the elements used in the revenue calculation. Another source of revenue and/or income to the farmers which was included is the produce

Table III-9

Tree Plantation Loan Balances in Baseline Case
(1,000 Pesos)

	Loan Proceeds Received	Estimated Accrued Interest	Final Loan Balance	Annual Repayment
CASURECO IV-A	618	156	774	156
ZAMECO	1,660	422	2,082	419
OMECO	266	67	333	67
ANTECO	863	220	1,083	218
PANELCO I	3,027	770	3,797	764
ISECO	1,064	270	1,334	269

Source: Tree plantation survey results for loan proceeds received. All others based on tree plantation survey results plus calculations described in text.

Table III-10

Tree Plantation Estimated Revenues in Baseline Case
(in thousands of 1984 pesos)

	Average Annual Yield Per Surviving Hectare (metric ton)	Total Surviving Hectares	Average Annual Metric Tons Harvested	Fuel-Wood Revenue	Other Revenue	Total Revenue
CASURECO IV-A	33.17	249	8,259	537	114	651
ZAMECO	22.29	190	4,235	275	4	279
OMECO	22.00	120	2,640	172	0	172
ANTECO	18.35	131	2,404	156	0	156
PANELCO I	25.44	981	24,960	1,622	9	1,631
ISECO	20.86	555	11,577	753	8	761

Source: Tree plantation survey results for total surviving hectares and other revenue. All others based on tree plantation survey results plus calculations as described in text.

from intercropping activities and the sales of, for example, ipil-ipil seeds. This additional income is included where these data were supplied on the questionnaire.

Projected Cash Flow. Projected cash flow is closely related to net income. The difference is that noncash items such as depreciation are excluded and the total loan amortization (including both interest and principal) replaces interest. The cash flows which result from incorporating these adjustments are presented on Table III-11.

Table III-11

Tree Plantation Annual Financial Cash Flows
Including Debt Service in Baseline Case
(in thousands of 1984 pesos)

	Average Annual Cash Inflow			Average Annual Cash Outflows				Net Annual Cash Flow
	Loan Proceeds	Inflow Revenues	Total Inflow	Investment Costs	Operating Costs	Debt Service	Total Outflow	
CASURECO IV-A								
Development	233		233	236			236	(3)
Repayment		651	651		113	156	269	382
Post-Repayment		651	651		113		113	538
ZAMECO								
Development	645		645	766			766	(121)
Repayment		279	279		143	419	562	(283)
Post-Repayment		279	279		143		143	136
OMECO								
Development	104		104	87			87	17
Repayment		172	172		62	67	129	43
Post-Repayment		172	172		62		62	110
ANTECO								
Development	316		316	360			360	(44)
Repayment		156	156		90	218	308	(152)
Post-Payment		156	156		90			66
PANELCO I								
Development	955		955	1,010			1,010	(55)
Repayment		1,631	1,631		943	764	1,707	(76)
Post-Repayment		1,631	1,631		943		943	688
ISECO								
Development	387		387	423			423	(36)
Repayment		761	761		382	269	651	110
Post-Repayment		761	761		382		382	379

Development = 1981 thru 1984
Repayment = 1985 thru 1992
Post-Repayment = 1992-2009

Source: Tables III-3 through III-8 plus calculations as described in text.

The value of this presentation is that it allows the evaluation of these specific projects with the financial structure developed by National Electrification Administration (NEA). Even though all sites show positive cash flows following the end of the loan repayment period, ZAMECO, ANTECO, and PANELCO I show negative flows while the loans are being repaid. However, as discussed in the "Methodology" chapter, there is a problem in distinguishing between "wage" and "profit" components to the farmer's income reflected in the labor component of the harvesting costs.

Financial Internal Rate of Return. The financial internal rate of return (FIRR) calculations were made on the basis of assuming a 25 year project lifetime to be consistent with the power plant analysis. At the end of this period, however, the trees, which belong to the Tree Farmers Associations (TFAs) have a value. This value was estimated and becomes a residual value to the project. The financial structure developed by the NEA was excluded from the calculation to give a clear picture of the viability of the project concept. The cash flows and resulting FIRRs are presented on Table III-12.[1/]

Table III-12

Tree Plantation Financial Internal Rate of Return in Baseline Case
(in thousands of 1984 pesos)

	Net Cash Flows						
	1981	1982	1983	1984	1985-2004	Residual Value	FIRR (%)
CASURECO IV-A	(404)	(322)	(195)	(23)	538	1,048	31.0
ZAMECO	(1,936)	(575)	(521)	(30)	136	406	1.4
OMECO	(225)	(103)	(16)	(4)	110	119	19.6
ANTECO	(432)	(525)	(417)	(67)	66	191	1.6
PANELCO I	(845)	(1,844)	(1,233)	(577)	688	1,699	12.1
ISECO	(499)	(609)	(481)	(104)	379	1,263	16.4

Source: Table III-2 and Tables III-3 through III-8 modified as discussed in text.

[1/] Table III-11 and III-12 are reconciled by noting that Investment Costs on III-11 are averaged over the four-year development period. The total of net cash flows for the development period (1981, 1982, 1983, and 1984) on III-12 are equal to the total development period costs on III-11, i.e. four times the average annual cost.

CASURECO IV-A exhibits the highest financial internal rate of return (FIRR) due to relatively low development costs per hectare, which, following our method of estimating harvesting costs, also implies low operating costs. The survival rate for CASURECO is not particularly high, but the estimated yields on those hectares is high. This is in contrast with ZAMECO which has the highest development costs and low survival rates resulting in the lowest financial internal rate of return. ANTECO is also very low due to high development costs and low survival rates. The other plantations exhibit variations on these same themes. PANELCO I, for example, has extremely favorable survival rates coupled with high reported development costs to net a position near the median FIRR.

Replication Case

The replication potential analysis seeks to estimate the financial viability of the six plantations assuming that they are operating under certain ideal conditions. These conditions are:

1. Every module is assumed to plant 100 hectares, at a rate of 25 hectares per year, i.e., the target scale.
2. The planted tree survival rate is assumed to be 100%, which implies that the land assigned to the tree farms and the silvicultural practices followed are sufficient to achieve this.
3. Government loan releases for the development phase are available and on time so that tree planting activities in modules have not been hindered by the lack of funds.
4. There is no labor shortage and no major man-made or natural calamities.
5. Fuel wood is harvested at 25 hectares per module during the harvesting years.
6. Based on reported annual yields, replication yields are assumed to increase by 80% on poor sites (20 tons and below per hectare), 40% on fair sites (21-30 tons hectare), and 20% on good to excellent sites (31 tons and up hectare) due

to improved species and site selection and higher quality land.

7. Tree farms have an assured market outlet for their harvested fuel wood. The farm gate price is 65 pesos per metric wet ton in constant value over time.

Under these conditions, most plantations would have to modify their tree planting activities (in most cases, increase) in comparison to the historical record. As a result, their investment and production costs would be increased accordingly. On the other hand, their sales revenue would also be increased substantially because more hectares would be harvested with improved yields. The financial results for the six plantations under replication case assumptions are given in the following sections.

Initial Investment. As in the baseline case, investment costs for the replication case represent all expenses incurred in the tree farm four-year development period. It is assumed that each module would plant 25 hectares of trees annually. Baseline investment costs per hectare by plantation are used as the basis for deriving investment costs. Under the replication case assumptions, these development costs are constant in each year. The total investment costs, by plantation, are given in Table III-13. The unskilled labor component of these costs is also provided as it is used in the economic analysis of this case.

Projected Cash Flow and Financial Internal Rate of Return (FIRR). The replication case net income begins with 1985 as the first harvesting period, as in the baseline case. It is assumed that each module would harvest 25 hectares each year with improved yields as described. The farm gate sale price of fuel wood remains at 65 pesos per wet ton for all plantations. The non-fuel wood income is assumed to be equal to that in the baseline case. The total revenues and the elements of its derivation are given in Table III-14.

Table III-13

Tree Plantation Investment Costs in Replication Case
(in thousands of 1984 pesos)

	Baseline Average Investment Cost Per Hectare	Hectares Planted Per Year	Annual Investment Cost
CASURECO IV-A			
Total	2.22	250	555
Unskilled Labor			355
ZAMECO			
Total	4.73	250	1,182
Unskilled Labor			936
OMECO			
Total	2.28	100	228
Unskilled Labor			144
ANTECO			
Total	3.66	100	366
Unskilled Labor			260
PANELCO I			
Total	4.08	250	1,019
Unskilled Labor			907
ISECO			
Total	2.80	250	701
Unskilled Labor			601

Source: Tables III-1 and III-2 with calculations as discussed in text.

Table III-14

Tree Plantation Revenues in Replication Case
(in thousands of 1984 pesos)

	Annual Hectares Harvested	Metric Ton Average Annual Yield	Total Metric Tons Harvested	Fuel-Wood Revenue	Other Revenue	Total Revenue
CASURECO IV-A	250	39.80	39,800	2,857	114	2,971
ZAMECO	250	31.21	31,210	2,029	4	2,033
OMECO	100	30.80	12,320	801*	0	801
ANTECO	100	33.03	13,212	859*	0	859
PANELCO I	250	35.20	35,200	2,288	9	2,297
ISECO	250	29.20	29,204	1,898	8	1,906

*Fuel wood production exceeds power plant demand.
Excess production assumed sold at ₱ 65 per metric ton.
Source: Table III-10 and calculations as described in text.

Operating costs for this case were developed analogously to the development costs in that per hectare plantation averages were developed and applied to the surviving hectares in the replication case where it is assumed that a 100% survival rate will be obtained. Under the replication case assumptions, these operating costs are constant for each production year. The resulting operating costs are presented on Table III-15. The resulting cash flows and FIRRs are presented on Table III-16.

Table III-15

Tree Plantation Operating Costs in Replication Case
(in thousands of 1984 pesos)

	Baseline Average Harvesting Cost Per Hectare	Annual Hectares Harvested	Annual Operating Cost
CASURECO IV-A			
Total	1.82	250	454
Unskilled Labor			342
ZAMECO			
Total	3.0	250	753
Unskilled Labor			674
OMECO			
Total	2.07	100	207
Unskilled Labor			140
ANTECO			
Total	2.75	100	275
Unskilled Labor			260
PANELCO I			
Total	3.85	250	961
Unskilled Labor			950
ISECO			
Total	2.75	250	688
Unskilled Labor			580

Source: Tables III-13 through III-15 plus calculations as described in text.

Table III-16

Tree Plantation Financial Cash Flow Excluding Debt Service and Internal Rate of Return in the Replication Case (in thousands of 1984 pesos)

	1982	1982	1983	1984	1985-2009	Residual	FIRR
CASURECO IV-A							
Total	(555)	(555)	(555)	(555)	2,517	5,098	53.4
Unskilled Labor	355	355	355	355			
ZAMECO							
Total	(1,182)	(1,182)	(1,182)	(1,182)	1,280	3,777	20.1
Unskilled Labor	936	936	936	936			
OMECO							
Total	(228)	(228)	(228)	(228)	594	972	37.8
Unskilled Labor	144	144	144	144			
ANTECO							
Total	(366)	(366)	(366)	(366)	584	1,471	26.9
Unskilled Labor	303	303	303	303			
PANELCO I							
Total	(1,019)	(1,019)	(1,019)	(1,019)	1,336	3,430	23.2
Unskilled Labor	907	907	907	907			
ISECO							
Total	(701)	(701)	(701)	(701)	1,218	3,884	28.6
Unskilled Labor	601	601	601	601			

Source: Tables III-13 through III-15 plus calculations as described in text.

As can be seen by comparing these financial internal rate of returns (FIRRs) with those of the baseline case (see Table III-12), there is a dramatic improvement in financial viability. ZAMECO remains the lowest of the six sites, but has improved by a factor of almost 15. The key to these improvements seems to be, primarily, the increase in the survival rate which can only be actually achieved with improved land, site-specific species selection, and diligent silvicultural efforts.

Power Plant and Harvest System

Baseline Case

Initial Investment. The power plant and harvest system investment costs are summarized in eight main categories based on the cost breakdown used in NEA's "Summary of Funding Requirements" document. An

attempt was made to reconcile these data with the original equipment contracts but without success. This source was chosen because assurances were given that it was the most recent and all inclusive. It should be noted that the discrepancies found were not highly significant, and any uncertainties which arise as a result of them are clearly overwhelmed by the uncertainties associated with the lack of final construction costs due to incomplete construction and the absence of actual operations data. These eight cost categories are as follows:

I. Generation Plant CIF and Erection Supervision Costs
II. Architectural and Engineering Study Costs
III. Construction Costs
IV. Guest House Construction
V. Power Plant Site (land purchase)
VI. Ocean Freight
VII. Wood Transport System Equipment and Construction Costs
VIII. Miscellaneous Costs

We have further disaggregated costs for two of these categories as follows:

Construction Costs

a. Materials
b. Mobile/Demobilization
c. Unskilled Labor
d. Skilled Labor

Wood Transport System and Construction Costs

a. Cable System Purchase Cost
b. Erection Supervision
c. Access Road
d. Unskilled Labor
e. Skilled Labor

These sub-costs were identified to perform the economic analysis. Our cost estimates of the labor component and its division between skilled and unskilled labor provide the means to shadow price

unskilled labor. Likewise, the materials cost breakdown into local and foreign components allows us to shadow price foreign exchange for the economic analysis.

The majority of the effort required in developing the investment costs entailed breaking out the local vs. foreign and skilled vs. unskilled components from construction cost information supplied by NEA. The cost breakdowns were itemized by type of expenditure according to a fairly consistent list for each site but in no instance were labor costs or imported items separated for easy compilation. Through conversations with construction firms working at specific dendro sites, we were able to estimate what these firms considered to be typical fractions to use in order to break out these components from aggregate cost. These factors differed depending on the cost item in question: mechanical, electrical, civil works, or mobilization and demobilization. Given the lack of detailed information on the cost breakdowns for these critical components, we must stress the uncertainty in these estimates for each site.

The resulting investment cost details for each site are presented in Tables III-17 through III-22. Distribution of these costs over the four-year construction period is based on the disbursement schedules found in NEA's "Summary of Funding Requirements" for year ending 1982 and 1983. The 1981 costs were only available in aggregate form as "1981 funds released." The disaggregation of the aggregate releases was performed judgmentally. The 1984 costs are from the 1983 summary sheets and are calculated by subtracting the releases as of December 31, 1983, from total amount required for each cost item. Because, at the time these data were collected, most of the sites were still in the construction period, various cost variances were either being processed or anticipated so that these investment costs are still incomplete. It is our understanding that these cost variances, in most instances, will not appreciably change total cost as they are presented in the investment cost tables. Therefore, our estimates of total investment costs should be fairly accurate for each site.

Table III-17

CASURECO IV-A Power Plant Initial Investment in Baseline Case
(in thousands of 1984 pesos)

		1981			1982			1983			1984			Grand Total
		FC	LC	T	FC	LC	T	FC	LC	T	FC	LC	T	
I.	Generation Plant (CIF) & Erection Supervision				63,234		63,234	2,458	33	2,491	712	51	763	66,488
II.	Architectural & Engineering					1,124	1,124					570	570	1,694
III.	Construction				**240**	**1,819**	**2,059**	**901**	**6,838**	**7,739**	**716**	**5,431**	**6,146**	**15,944**
	a. Material				240	738	978	901	2,774	3,675	716	2,203	2,919	7,572
	b. Mobile/Demobile					0	0		0	0		0	0	0
	c. Unskilled labor					808	808		3,040	3,040		2,414	2,414	6,262
	d. Skilled labor					273	273		1,024	1,024		813	813	2,110
IV.	Guest House								61	61		106	106	167
V.	Power Plant Site					47	47							47
VI.	Ocean Freight													
VII.	Wood Transport System	**4,620**		**4,620**								**1,549**	**1,549**	**6,169**
	a. Cable System	4,620		4,620										4,620
	b. Erection Supervision													
	c. Access Road													
	d. Unskilled labor											77	77	77
	e. Skilled labor											1,472	1,472	1,472
VIII.	Miscellaneous Costs					119	119		15	15		4,822	4,822	4,956
		4,620		4,620	63,474	3,109	66,583	3,359	6,947	10,306	1,428	12,528	13,956	95,465

FC = Foreign Currency
LC = Local Currency
T = Total

Source: National Electrification Administration "Project Summary Reports," 1981-1984, plus additional calculation as described in text.

Table III-18

ZAMECO Power Plant Initial Investment in Baseline Case
(in thousands of 1984 pesos)

		1981			1982			1983			1984			Grand Total
		FC	LC	T	FC	LC	T	FC	LC	T	FC	LC	T	
I.	Generation Plant (CIF) & Erection Supervision				63,170		63,170	2,420	15	2,435	717	64	781	66,386
II.	Architectural & Engineering					1,247	1,247					915	915	2,162
III.	Construction				144	346	490	2,861	6,874	9,735	1,111	2,671	3,782	14,007
	a. Material				144	90	234	2,861	1,792	4,653	1,111	696	1,807	6,694
	b. Mobile/Demobile					7	7		148	148		58	58	213
	c. Unskilled labor					181	181		3,588	3,588		1,394	1,394	5,163
	d. Skilled labor					68	68		1,346	1,346		523	523	1,937
IV.	Guest House								209	209				209
V.	Power Plant Site													
VI.	Ocean Freight													
VII.	Wood Transport System	6,167		6,167		94	94		1,919	1,919		745	745	8,925
	a. Cable System	6,167		6,167										6,167
	b. Erection Supervision													
	c. Access Road													
	d. Unskilled labor					4	4		96	96		37	37	137
	e. Skilled labor					90	90		1,823	1,823		708	708	2,621
VIII.	Miscellaneous Costs					133	133		11	11		3,571	3,571	3,715
		6,167		6,167	63,314	1,820	65,134	5,281	9,028	14,309	1,828	7,966	9,794	95,404

FC = Foreign Currency
LC = Local Currency
T = Total

Source: National Electrification Administration "Project Summary Reports," 1981-1984, plus additional calculation as described in text.

Table III-19

OMECO Power Plant Initial Investment in Baseline Case
(in thousands of 1984 pesos)

	1981			1982			1983			1984			Grand Total
	FC	LC	T	FC	LC	T	FC	LC	T	FC	LC	T	
I. Generation Plant (CIF) & Erection Supervision				12,513		12,513	568		568		75	75	13,156
II. Architectural & Engineering											1,090	1,090	1,090
III. Construction							938	3,274	4,211	284	989	1,273	5,484
a. Material							938	970	1,907	284	293	577	2,484
b. Mobile/Demobile								191	191		58	58	249
c. Unskilled labor								794	794		240	240	1,034
d. Skilled labor								1,319	1,319		398	398	1,717
IV. Guest House													
V. Power Plant Site													
VI. Ocean Freight													
VII. Wood Transport System													
a. Cable System													
b. Erection Supervision													
c. Access Road													
d. Unskilled labor													
e. Skilled labor													
VIII. Miscellaneous Costs								57	57		1,808	1,808	1,865
				12,513		12,513	1,506	3,331	4,836	284	3,962	4,246	21,595

FC = Foreign Currency
LC = Local Currency
T = Total

Source: National Electrification Administration "Project Summary Reports," 1981-1984, plus additional calculation as described in text.

Table III-20

ANTECO Power Plant Initial Investment in Baseline Case
(in thousands of 1984 pesos)

	1981			1982			1983			1984			Grand Total
	FC	LC	T	FC	LC	T	FC	LC	T	FC	LC	T	
I. Generation Plant (CIF) & Erection Supervision				12,513		12,513	568		568		75	75	13,156
II. Architectural & Engineering					888	888		75	75		344	344	1,307
III. Construction				**1,466**	**7,843**	**9,309**	**706**	**3,778**	**4,484**	**273**	**1,459**	**1,732**	**15,525**
a. Material				1,466	2,855	4,321	706	1,375	2,081	273	531	804	7,206
b. Mobile/Demobile					0	0		0	0		0	0	0
c. Unskilled labor					3,307	3,307		1,593	1,593		615	615	5,515
d. Skilled labor					1,681	1,681		810	810		313	313	2,804
IV. Guest House													
V. Power Plant Site													
VI. Ocean Freight													
VII. Wood Transport System	**2,986**		**2,986**								**1,001**	**1,001**	**3,987**
a. Cable System	2,986		2,986										2,986
b. Erection Supervision													
c. Access Road											50	50	50
d. Unskilled labor											951	951	951
e. Skilled labor													
VIII. Miscellaneous Costs					188	188		350	350		1,495	1,495	2,033
	2,986		2,986	13,979	8,919	22,898	1,274	4,203	5,477	273	4,374	4,647	36,008

FC = Foreign Currency
LC = Local Currency
T = Total

Source: National Electrification Administration "Project Summary Reports," 1981-1984, plus additional calculation as described in text.

Table III-21

PANELCO I Power Plant Initial Investment in Baseline Case
(in thousands of 1984 pesos)

		1981			1982			1983			1984			Grand Total
		FC	LC	T	FC	LC	T	FC	LC	T	FC	LC	T	
I.	Generation Plant (CIF) & Erection Supervision				34,663	222	34,885	2,308	354	2,662	1,403	346	1,749	39,296
II.	Architectural & Engineering		483	483		436	436		408	408		588	588	1,915
III.	Construction	960	1,758	2,718	2,100	3,852	5,952	2,529	4,640	7,169	1,701	3,121	4,822	20,661
	a. Material	960	419	1,379	2,100	917	3,017	2,529	1,106	3,635	1,701	744	2,445	10,476
	b. Mobile/Demobile		43	43		95	95		114	114		77	77	329
	c. Unskilled labor		643	643		1,410	1,410		1,698	1,698		1,142	1,142	4,893
	d. Skilled labor		653	653		1,430	1,430		1,722	1,722		1,158	1,158	4,963
IV.	Guest House													
V.	Power Plant Site													
VI.	Ocean Freight													
VII.	Wood Transport System	4,975	318	5,293		1,598	1,598		1,414	1,414		968	968	9,273
	a. Cable System	4,975		4,975										4,975
	b. Erection Supervision											225	225	225
	c. Access Road					610	610		574	574		178	178	1,362
	d. Unskilled labor		16	16		36	36		33	33		28	28	113
	e. Skilled labor		302	302		663	663		798	798		537	537	2,300
VIII.	Miscellaneous Costs		320	320		289	289		595	595		1,930	1,930	3,134
		5,935	2,879	8,814	36,763	6,397	43,160	4,837	7,411	12,248	3,104	6,953	10,057	74,279

FC = Foreign Currency
LC = Local Currency
T = Total

Source: National Electrification Administration "Project Summary Reports," 1981-1984, plus additional calculation as described in text.

Table III-22

ISECO Power Plant Initial Investment in Baseline Case
(in thousands of 1984 pesos)

		1981			1982			1983			1984			Grand Total
		FC	LC	T	FC	LC	T	FC	LC	T	FC	LC	T	
I.	Generation Plant (CIF) & Erection Supervision				31,818		31,818				1,675	500	2,175	33,993
II.	Architectural & Engineering								297	297		1,117	1,117	1,414
III.	Construction							**2,388**	**8,961**	**11,349**	**1,526**	**5,727**	**7,253**	**18,602**
	a. Material							2,388	3,977	6,365	1,526	2,541	4,067	10,432
	b. Mobile/Demobile								137	137		88	88	225
	c. Unskilled labor								3,295	3,295		2,106	2,106	5,401
	d. Skilled labor								1,552	1,552		992	992	2,544
IV.	Guest House													
V.	Power Plant Site								206	206				206
VI.	Ocean Freight					18	18		1,991	1,991		1,071	1,071	3,080
VII.	Wood Transport System	**5,006**		**5,006**								**1,678**	**1,678**	**6,684**
	a. Cable System	5,006		5,006										5,006
	b. Erection Supervision													
	c. Access Road													
	d. Unskilled labor											84	84	84
	e. Skilled labor											1,594	1,594	1,594
VIII.	Miscellaneous Costs								240	240		1,731	1,731	1,971
		5,006		5,006	31,818	18	31,836	2,388	11,695	14,083	3,201	11,824	15,025	65,950

FC = Foreign Currency
LC = Local Currency
T = Total

Source: National Electrification Administration "Project Summary Reports," 1981-1984, plus additional calculation as described in text.

Projected Income. The power plant and harvest system projected income statements are presented in detail in Appendix B, Tables 1-6. The production cost items which are constant over time are presented on Table III-23. A summary of the net income projected for these sites is presented on Table III-24.

Revenues from the sale of electricity generated by the power plants were calculated by estimating the net power available to the grid and then determining what fraction of the load could be sold to co-op members based on the estimated load duration curve of the co-op. The remaining power would be sold to the National Power Corporation (NPC) except at OMECO which is not able to hook into NPC's grid. An assumption of 6,000 hours of operation for each power plant was used for these calculations though it should be noted that OMECO will not be at full capacity for all of these hours. Undoubtedly, some plants will not, in actual operation, achieve this level due to extraordinary and, therefore, unpredictable events. This assumption, therefore, represents a 'normal' operating year in which such events do not occur. The actual production levels should be used to verify this assumption following operational experience. Power demands in excess of dendro production are supplied by the NPC or from self-generation at OMECO.

The revenue calculations are shown in Table III-25 for each site. We used ₱ 1.10/kWh for the price the co-op receives for electricity sold to NPC. This price establishes parity between power purchased from NPC and sold to NPC. Parity was given as the most likely outcome of current negotiations as relayed to project staff from General Dumol, 9/12/84. The price the co-op receives for sales to its customers is given in Table III-26. These latter prices were provided by NEA dated July 26, 1984.

Table III-23

Power Plant Annual Operating Costs and Depreciation in Baseline Case
(in thousands of 1984 pesos)

	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Depreciation	Total
CASURECO IV-A	2,624	904	985	805	269	2,764	8,351
ZAMECO	4,078	904	985	805	269	2,711	9,752
OMECO	280	178	622	183	147	646	2,056
ANTECO	422	178	622	183	147	1,034	2,586
PANELCO I	3,283	544	805	474	273	2,134	7,513
ISECO	3,299	474	770	439	252	1,986	7,220

Source: Appendix B Tables B-1 through B-6.

Table III-24

Power Plant Projected Net Income Summary in Baseline Case
(in thousands of 1984 pesos)

	CASURECO IV-A	ZAMECO	OMECO	ANTECO	PANELCO I	ISECO
1985	5,345	8,647	3,285	3,994	9,255	10,610
1986	5,622	8,923	3,303	4,020	9,378	10,731
1987	5,919	9,219	3,224	3,949	9,329	10,680
1988	4,755	8,129	2,811	2,979	7,729	9,221
1989	5,113	8,486	2,839	3,018	7,839	9,415
1990	5,501	8,873	2,651	2,844	8,083	9,594
1991	5,923	9,292	2,718	2,926	8,284	9,791
1992	6,378	9,716	2,713	2,937	8,501	10,003
1993	6,811	10,236	2,796	3,038	8,737	10,233
1994	7,406	10,797	2,884	3,145	8,992	10,602
1995	7,986	11,344	2,980	3,263	9,269	10,753
1996	8,046	11,402	3,011	3,317	9,350	10,827
1997	8,113	11,465	3,045	3,377	9,436	10,906
1998	8,186	11,534	3,082	3,442	9,532	10,993
1999	8,265	11,609	3,120	3,510	9,636	11,088
2000	8,351	11,691	3,162	3,586	9,750	11,191
2001	8,447	11,782	3,208	3,668	9,873	11,304
2002	8,550	11,880	3,256	3,756	10,007	11,426
2003	8,664	11,987	3,290	3,834	10,155	11,560
2004	8,787	12,104	3,327	3,920	10,315	11,706
2005	8,923	12,233	3,368	4,013	10,490	11,915
2006	9,070	12,373	3,413	4,115	10,682	12,039
2007	9,233	12,527	3,462	4,228	10,890	12,228
2008	9,409	12,694	3,515	4,350	11,104	12,421
2009	9,603	12,878	3,574	4,485	11,302	12,633

Source: Appendix B Tables B-1 through B-6.

Table III-25

Electricity Sales and Total Revenue in Baseline Case

Site	Net Megawatt Hours Generated	Megawatt Hours Sold to Co-op	Megawatt Hours Sold to NPC	Total Revenues
CASURECO IV-A	13,330	4,333	8,997	18,173,000
ZAMECO	12,571	12,514	57	22,838,000
OMECO*	1,539	1,539	0	5,694,000
ANTECO	2,056	2,056	2,003	7,218,000
PANELCO I	14,439	4,886	9,553	19,108,000
ISECO	12,036	11,406	630	20,084,000

*This site has no sales to NPC because it is not connected to the NPC grid.

Source: Load duration curve analysis based on 1982 National Electrification Administration "Cooperative Annual Statistical Report," plus Table III-26 and calculations as described in text for total revenues.

Table III-26

Rural Electric Cooperatives' Prices to Customers
(pesos per kilowatt-hour)

Site	Residential Electricity Rates
CASURECO IV-A	1.910
ZAMECO	1.820
OMECO	3.700
ANTECO	2.439
PANELCO I	1.760
ISECO	1.700

Source: National Electrification Administration.

Based on this price structure it is obvious that the more power a co-op can sell to its members instead of the National Power Corporation (NPC), the more revenue it will accrue. As the economies in each co-op mature this will occur, but we have not attempted to factor this into the revenue calculations since we have no way of forecasting this economic development. We will illustrate possible

impacts from increased co-op usage in the sensitivity analysis section.

Fuel costs for generation were determined from the wood consumption requirements of each plant based on gross power generated. Since estimated wood production from each plantation falls short of requirements, the shortfall is assumed to be made up from local sources at each site. A price of 65 pesos per metric ton (MT) was used for plantation wood and estimates of local wood costs at each site were secured with the plantation questionnaires. Table III-27 presents the data used to derive the fuel cost estimates based on the prices discussed above.

Production materials expenditures were estimated to be an average 4% of total plant costs in each year. These costs cover replacement of components to the power plant over the life of the plant as well as extraordinary maintenance. For lack of any information on how to allocate the 4% labor (skilled and unskilled) and materials (foreign and local) we evenly split the costs to all four components.

Table III-27

Power Plant Fuel Cost Estimates in Baseline Case

	Requirements (metric tons)	Plantation (metric tons)	Purchases (metric tons)	Market Price (₱/metric ton)	Total Cost (1,000s)
CASURECO IV-A	43,041	8,259	34,782	60	2,624
ZAMECO	43,041	4,235	38,806	98	4,078
OMECO	3,845	2,640	1,205	90	280
ANTECO	9,218	2,404	6,814	39	422
PANELCO I	43,414	24,960	18,454	90	3,283
ISECO	43,414	11,577	31,837	80	3,299

Source: Engineering analysis for requirements, and tree plantation results for market price and Table III-10 for plantation, metric ton.

Labor cost estimates are based on information about staffing requirements for each plant and salary estimates by job class. As stated above these also include labor costs to cover anticipated replacement of power plant equipment over the life of the plant. Administration/overhead costs were estimated to be 15% of operating

expenses, i.e., the sum of fuel costs, production materials, and skilled and unskilled labor.

Depreciation of total investment costs is calculated at 4% per year or just the reciprocal of the life of the power plant which is assumed to be 25 years.

The amortization schedules developed for these sites are fairly complex, involving a number of currencies at a variety of interest rates, some of which change during the amortization period. The financial structure is manufacturer-specific; therefore, each type of plant will be discussed separately. A summary of the data used to develop the amortization schedules is provided on Table III-28.

o Balfour-Beatty (ZAMECO and CASURECO IV-A). There are three components to these amortizations. The first is the peso component which converts all costs except the power plant equipment, erection supervision by Balfour-Beatty personnel, and transportation costs from the United Kingdom to the Philippines. This component has a repayment schedule beginning six months after plant commissioning. It was assumed that both of these plants would be commissioned in mid-1984. The interest during this period does accrue and is added to the balance to be amortized over a 25-year period with the first three years carrying an interest rate of 3% and the remainder an interest rate of 9.5%. The second component of the amortization is the supplier credit which is denominated in dollars calculated as 77.160% of the equipment costs based on the exchange rates existing on the contract date. Like the peso component, there is a six-month grace period from the date of commissioning but without interest accrual. The amortization period is 10 years at a constant annual interest rate of 8.25%.

The third component is represented by funds supplied by the United Kingdom government calculated as 22.8394% of the equipment costs. The debt is denominated in British pounds, and has a 6.5 year grace period from the date of loan release with interest accrued and

Table III-28

Data Used to Develop Power Plant Loan Amortization Schedules[1]
(in thousands of 1984 pesos)

	Starting Balance	Payment Period	Interest Rate (%)	Annual Payment
CASURECO IV-A				
Government	8,017	1988-2012	.75	353
Commercial	45,553	1985-1994	8.25	6,865
NEA I	23,655	1985-1987	3.00	1,376
NEA II	21,924.19	1988-2009	9.50	2,410
ZAMECO				
Government	8,012	1988-2012	.75	353
Commercial	45,549	1985-1994	8.25	6,865
NEA I	22,692	1985-1987	3.00	1,303
NEA II	20,768.26	1988-2009	9.50	2,283
OMECO				
Government I	4,857	1987-1991	2.00	378
Government II	3,395	1992-2001	15.50	424
Commercial I	6,620	1985-1989	2.00	605
Commercial II	3,474	1990-1994	8.25	876
NEA I	7,260	1985-1987	3.00	423
NEA II	6,736.04	1988-2009	9.50	740
ANTECO				
Government I	4,857	1987-1991	2.00	378
Government II	3,395	1992-2001	15.50	424
Commercial I	6,620	1985-1989	2.00	605
Commercial II	3,474	1990-1994	8.25	876
NEA I	16,866	1985-1987	3.00	969
NEA II	15,436.15	1988-2009	3.00	1,697
PANELCO I				
Government	4,286	1987-2006	4.25	322
Commercial	17,673	1985-1994	8.25	2,664
NEA I	29,396	1985-1987	3.00	1,688
NEA II	26,903.90	1988-2009	9.50	2,957
ISECO				
Government	4,286	1987-2006	4.25	322
Commercial	17,673	1985-1994	8.25	2,664
NEA I	26,520	1985-1987	3.00	1,523
NEA II	24,271.71	1988-2009	9.50	2,668

[1]The foreign exchange rates used were reported in the June 13, 1984 Wall Street Journal as follows: 18 ₱ per $; 24.894 ₱ per British Pound; 2.1474 ₱ per French Franc.

Source: Equipment supplier contracts supplied by National Electrification Administration and calculations as described in text.

added to the balance amortized over 25 years at an interest rate of .75%.

o Alsthom-Atlantique (PANELCO I and ISECO). These plants also have three components in the financial structure. The peso component is structured identically to the Balfour-Beatty plants previously discussed. The remaining two components are both denominated in French francs but have different interest rates and repayment schedules. The government loan portion has a 20-year payback period not including a 5.5-year grace period from the first release of the loan. Interest is accrued during this grace period and is added to the principal balance. The interest rate applied over the repayment period is 4.25%. The commercial portion of the loan is amortized over 10 years carrying an interest rate of 8.25%. Repayment begins six months after commissioning of the plant with no interest accrued during the grace period.

o Moteurs-Duvant (ANTECO and OMECO). The peso component of this loan is also structured identically to that discussed in the Balfour-Beatty section. The government portion of the loan has a 15-year amortization period beginning 5.5 years from the date of first release on the loan. Interest accrues during this grace period at a rate of 2% and is added to the balance at the beginning of the repayment period. The interest rate charged during the repayment period is 2% for the first 5 years and 15.5% for the remaining 10 years. The commercial portion of the loan begins repayment six months from the commissioning date of the plant with no interest accrual during this grace period. The repayment period is 10 years with the first five years carrying an interest rate of 2% and the remaining five years carrying an interest rate of 8.25%.

Financial Cash Flow. The detailed financial cash flows are presented in Appendix B Tables B-7 thru B-12. We have included cost items which also appear in the income tables, instead of just using the net income figures, for completeness and clarity. Because we discussed the derivation of most items in the preceding investment

and income tables, we will not repeat those discussion here. The only item which needs some further explanation is the debt servicing and loan proceeds for a complete picture of each project's financial viability. The debt service figures, therefore, contain both principal and interest as opposed to only the interest payments in the income statements. We have converted the summary investment costs from nominal to real 1984 prices. A summary of these cash flows is presented on Table III-29.

We have not attempted to forecast future price changes for any cost or revenue item. Inflation in the Philippines in recent years has been running extremely high; the consumer price index (CPI) for outside metro Manila has risen at an average annual rate of 12% from 1980 to 1983 and has risen over 40% in the May 1983 to May 1984 period. With this kind of price volatility it is impractical to attempt an evaluation of the financial viability of the dendro plants by incorporating a forecast of price changes. By leaving prices at 1984 real values, we are implicitly assuming that no cost or revenue item will grow faster than the general rate of inflation, which also says that relative prices between any items in the tables, cost or revenue, remain unchanged from their 1984 values.

Financial Internal Rate of Return. The financial internal rate of return (FIRR) for the power plant and harvest systems for each site are shown in Table III-30. These FIRRs are calculated from the cash flow tables with financing and loan receipts removed. This provides a measure of the financial viability of each power plant/harvest system divorced from the financing structure involved.

The FIRRs resulting display a range of 10.2 for CASURECO IV-A to 17.5 for ISECO. All of the financial internal rate of returns (FIRRs) are above the World Bank required rate of return on power projects of 8%, but are below the commonly used 15% social discount rate (with the exception of ISECO) and the private sector cost of capital, which is probably in the range of 20% - 25%. The primary reason for the relatively lower financial internal rate of returns (FIRRs) of CASURECO IV-A and ZAMECO relative to PANELCO I and ISECO is the dollar component in the equipment cost which has undergone a large reevaluation relative to the other currencies.

Table III-29

Power Plant Projected Financial Cash Flow Summary
Including Debt Service in Baseline Case
(in thousands of 1984 pesos)

	CASURECO IV-A	ZAMECO	OMECO	ANTECO	PANELCO I	ISECO
1985	4,345	7,647	3,124	3,960	9,377	10,663
1986	4,345	7,647	3,124	3,960	9,377	10,663
1987	4,345	7,647	2,746	3,960	9,056	10,341
1988	2,955	6,296	2,429	2,854	7,786	9,196
1989	2,955	6,296	2,429	2,854	7,786	9,196
1990	2,955	6,296	2,290	2,715	7,786	9,196
1991	2,955	6,296	2,290	2,715	7,786	9,196
1992	2,955	6,296	2,244	2,670	7,786	9,196
1993	2,955	6,296	2,244	2,670	7,786	9,196
1994	2,955	6,296	2,244	2,670	7,786	9,196
1995	9,823	13,161	3,120	3,545	10,449	11,859
1996	9,823	13,161	3,120	3,545	10,449	11,859
1997	9,823	13,161	3,120	3,545	10,449	11,859
1998	9,823	13,161	3,120	3,545	10,449	11,859
1999	9,823	13,161	3,120	3,545	10,449	11,859
2000	9,823	13,161	3,120	3,545	10,449	11,859
2001	9,823	13,161	3,120	3,545	10,449	11,859
2002	9,823	13,161	3,544	3,969	10,449	11,859
2003	9,823	13,161	3,544	3,969	10,449	11,859
2004	9,823	13,161	3,544	3,969	10,449	11,859
2005	9,823	13,161	3,544	3,969	10,449	11,859
2006	9,823	13,161	3,544	3,969	10,449	11,859
2007	9,823	13,161	3,544	3,969	10,772	12,182
2008	9,823	13,161	3,544	3,969	10,772	12,182
2009	9,823	13,161	3,544	3,969	10,772	12,182

Source: Appendix B Tables B-7 through B-12.

Replication Case

The replication case for the power plants is considerably more straightforward than that for the tree farms. The only change incorporated is the greater availability of plantation-produced fuel wood which enables the reduction of open market purchases. The distribution of plantation vs. open market fuel wood purchases for this case are provided on Table III-31. The financial cash flows under the replication case and their attendant FIRRs are given on Table III-32.

Table III-30

Power Plant Internal Rate of Return in Baseline Case
(in thousands of 1984 pesos)

	1981	1982	1983	1984	1985-2009	FIRR (%)
CASURECO IV-A	(4,620)	(66,583)	(10,307)	(13,957)	12,586	10.2
ZAMECO	(6,167)	(65,134)	(14,309)	(9,794)	15,797	12.8
OMECO	0	(12,513)	(4,837)	(4,246)	4,284	15.7
ANTECO	(2,986)	(22,898)	(5,477)	(4,647)	5,666	12.2
PANELCO I	(8,814)	(43,160)	(12,248)	(10,058)	13,729	14.2
ISECO	(5,006)	(31,836)	(14,083)	(15,025)	14,850	17.5

Source: Appendix B Tables B-7 through B-12 with 1985-2009 modified as discussed in text, plus calculations as described in text for FIRR.

Table III-31

Power Plant Annual Fuel Wood Purchases and
Costs in Replication Case
(Annual)

Site	Requirements (metric tons)	Plantation Supplied (metric tons)	Open Market Purchases (metric tons)	Total Cost (1,000 P)
CASURECO IV-A	43,041	39,800	3,241	2,781
ZAMECO	43,041	31,210	11,831	3,188
OMECO	3,845	12,320	0	250
ANTECO	9,218	13,212	0	599
PANELCO I	43,414	35,200	8,214	3,027
ISECO	43,414	29,204	14,210	3,035

Source: Table III-14 for plantation supplied metric tons and Table III-27 for requirements and calculations as described in text.

As can be seen from a comparison of the financial internal rate of returns (FIRRs) in the baseline case (Table III-30) with those from the replication case, there is virtually no change. It should be noted, however, that the significant purchases of fuel wood required in the baseline case could, in some cases, dramatically increase the market price for fuel wood thus decreasing the FIRRs, as well as imposing burdens on other fuel wood consumers.

Table III-32

Power Plant Financial Cash Flow in Replication Case
(in thousands of 1984 pesos)

	1981	1982	1983	1984	Production Period 1985-2009	FIRR (%)
CASURECO IV-A	(4,620)	(66,583)	(10,306)	(13,957)	12,429	10.08
ZAMECO	(6,167)	(65,134)	(14,309)	(9,794)	16,687	13.44
OMECO	0	(12,513)	(4,837)	(4,246)	4,314	15.8
ANTECO	(2,986)	(22,898)	(5,477)	(4,647)	5,489	11.8
PANELCO I	(8,814)	(43,160)	(12,248)	(10,057)	13,985	14.40
ISECO	(5,006)	(31,836)	(14,083)	(15,025)	15,114	17.71

Source: Tables III-30 and III-31, plus calculations as described in text. For production period and FIRR.

Consolidated Financial Cash Flows and Internal Rate of Return

The cash flows from the power plants and the tree farm plantations were consolidated to provide a basis for analysis of the entire project. As before, these cash flows do not include the financing arrangements used by the National Electrification Administration (NEA) so that a clear picture of returns to investment can be depicted. The consolidated cash flows offer the advantage of removing complications associated with cash flows from one project element to the other. That is, the price of wood controls the transfer of funds from the power plant to the tree farm. A higher price would favor the tree farm economics at the expense of the power plant. A lower price would have the opposite effect. This is not to

say that the price of wood is not important, but it is best analyzed separately. The purpose here is to present the net cash flow from the Dendro Thermal concept as a total project.

Baseline Case

The financial internal rate of returns (FIRRs) of the six projects follow the power plant FIRRs very closely, indicating that the power plant financial flows dominate the tree farm plantations. As in the power plant analysis, CASURECO IV-A demonstrates the lowest consolidated FIRR at 10.6% and ISECO, the highest at 17.4%. These are presented on Table III-33.

Table III-33

Consolidated Financial Cash Flows and Internal Rate of Return in Baseline Case (in thousands of 1984 pesos)

	1981	1982	1983	1984	1985-2009	Residual Value	FIRR (%)
CASURECO IV-A	(5,024)	(66,095)	(10,502)	(13,980)	13,124	1,048	10.6
ZAMECO	(8,103)	(65,709)	(14,830)	(9,824)	15,933	406	12.5
OMECO	(225)	(12,616)	(4,853)	(4,250)	4,394	119	15.8
ANTECO	(3,418)	(23,423)	(5,894)	(4,713)	5,732	191	11.9
PANELCO I	(9,659)	(45,004)	(13,481)	(10,615)	14,417	1,699	14.0
ISECO	(5,505)	32,445)	(14,564)	(15,129)	15,229	1,263	17.4

Source: Tables III-12 and III-30, plus calculations as described in text.

Replication Case

Table III-34 presents the results of consolidating the cash flows from the tree farm and power plant replication cases. As expected, the (FIRRs) are somewhat higher than the replication case power plant FIRRs, but considerably lower than those for the tree farms taken separately. This results from the high proportion of costs and cash flows associated with the power plants.

Table III-34

Consolidated Cash Flow in Replication Case
(in thousands of 1984 pesos)

	1981	1982	1983	1984	Production Period (1985-2009)	Residual Value	FIRR (%)
CASURECO IV-A	(5,175)	(67,138)	(10,861)	(14,512)	14,946	5,098	11.93
ZAMECO	(7,349)	(66,316)	(15,491)	(10,976)	17,967	3,777	13.79
OMECO	(228)	(12,741)	(5,065)	(4,474)	4,908	972	17.1
ANTECO	(3,352)	(23,264)	(5,843)	(5,013)	6,073	1,471	12.6
PANELCO I	(9,833)	(44,179)	(13,267)	(11,076)	15,321	3,430	14.92
ISECO	5,707	32,537	14,784	15,726	16,332	3,884	18.26

Source: Tables III-16 and III-32, plus calculations as described in text.

Cost Analysis

Estimates of power and wood costs, as calculated traditionally, require additional assumptions. The initial investment costs must be converted to an equivalent annual stream at an assumed discount rate which should reflect the real cost of capital to investors in the Philippine economy. The volatility of these costs plus the necessity of using costs of capital at an equivalent level of risk cause the definition of the cost of capital to be somewhat arbitrary. The social discount rate most commonly used, according to National Economic Development Administration (NEDA), is 15%, but this rate is not directly applicable to analysis from a financial perspective as societal costs of capital typically diverge from real financial costs. Other studies of the Dendro Thermal concept, such as the AID project paper, use 20% as the real financial cost of capital. Our presentation will estimate the cost of power and the cost of wood for 15%, 20%, and 25%.

The methodology used to develop the cost of power was very straightforward. The initial investment costs were converted to an equivalent annual stream and added to the annual operating cost. This total average annual cost was then divided by the gross annual output assuming a 6,000 hour annual operation at the rated output except for OMECO which will be running at less than rated output.

Table III-35 presents the results for the baseline case. For all three assumed discount rates, ISECO demonstrates the lowest cost, ranging from ₱ 76 per kilowatt-hour to ₱ 1.07 per kilowatt-hour, and ANTECO the highest cost ranging from ₱ 1.21 to ₱ 1.81 per kilowatt-hour. The replication case presented on Table III-36 demonstrates some improvement over the baseline case with ISECO and ANTECO maintaining their positions as lowest and highest costs, respectively.

The costs of wood display a much larger variation as well as exhibiting a dramatic improvement in the replication case (Table III-38) over the baseline case (Table III-37). The lowest wood costs in both cases is found in CASURECO IV-A. ZAMECO has the highest and also exhibits the second largest improvement in the replication case having cost reductions in the neighborhood of 67%. ANTECO showed the greatest improvement in the replication case over the baseline case with a reduction at 73%.

There are several yardsticks that can be used to evaluate these estimated costs. The tree farm wood fuel costs can be compared to the recommended price of ₱65 per metric ton, as well as the prevailing market prices at each of the six sites. This comparison, using a discount rate of 20% for initial investment cost annualization, is presented on Table III-39. These data demonstrate that if the replication case conditions can be obtained, the average costs of wood can be below both the National Electrification Administration's (NEA) recommended price and, in the majority of cases, the market prices as well. Examining the baseline case costs, however, shows that if the replication case conditions are not met, the plantation produced fuel wood costs can be much greater than either the NEA price or the market price.

The yardsticks applicable to the power costs are the present costs of National Power Corporation (NPC) power for each of the three major production methods, i.e., oil-based, hydroelectric, and geothermal. According to NPC data, the Luzon oil-based costs per kilowatt-hour, as reported for 1983 and adjusted to 1984 pesos, was

Table III-35

Average Cost of Energy in Baseline Case
(in 1984 pesos)

	Total Investment (1,000s)	Annualized Investment at 15%	20%	25%	Annual Operating Cost (1,000s)	Total Annualized Cost at 15%	20%	25%	Gross Output MWhrs	₱ per kWh Average Annual Cost of Energy at 15%	20%	25%
CASURECO IV-A	95,466	14,768	19,295	23,957	5,587	20,355	24,882	29,544	18,600	1.09	1.34	1.59
ZAMECO	95,404	14,759	19,283	23,941	6,421	21,180	25,704	30,362	18,600	1.14	1.38	1.63
OMECO	21,596	3,341	4,365	5,419	1,410	4,751	5,774	6,829	2,409	1.97	2.40	2.83
ANTECO	36,008	5,570	7,278	9,036	1,387	6,957	8,665	10,423	5,760	1.21	1.50	1.81
PANELCO I	74,279	11,491	15,013	18,640	5,379	16,870	20,392	24,019	20,400	.83	1.00	1.18
ISECO	65,950	10,202	13,330	16,550	5,234	15,436	18,564	21,784	20,400	.76	.91	1.07

Source: Tables III-21 through III-26, plus calculations as described in text for total investment, Appendix Tables B-1 through B-6 for annual operating cost, gross megawatt hours from engineering analysis.

Table III-36

Average Cost of Energy in Replication Case
(in 1984 pesos)

	Total Investment (1,000s)	Annualized Investment at 15%	20%	25%	Annual Operating Cost (1,000s)	Total Annualized Cost at 15%	20%	25%	Gross Output MWhrs	₱ per kWh Average Annual Cost of Energy at 15%	20%	25%
CASURECO IV-A	95,466	14,768	19,295	23,957	5,430	20,198	24,725	29,387	18,600	1.09	1.33	1.58
ZAMECO	95,404	14,759	19,283	23,941	5,531	20,290	24,848	29,472	18,600	1.09	1.33	1.58
OMECO	21,596	3,341	4,365	5,419	1,729	5,070	6,094	7,148	2,409	2.10	2.53	2.97
ANTECO	36,008	5,570	7,278	9,036	1,564	7,134	8,842	10,600	5,760	1.24	1.54	1.84
PANELCO I	74,279	11,491	15,013	18,640	5,123	16,614	20,136	23,763	20,400	.81	.99	1.16
ISECO	65,950	10,202	13,330	16,550	4,970	15,172	18,300	21,520	20,400	.74	.90	1.05

Source: Tables III-21 through III-26, plus calculations as described in text for total investment, Appendix Tables B-1 through B-7 modified as described in text for annual operating cost, gross megawatt hours from engineering analysis.

Table III-37

Average Cost of Wood in Baseline Case
(in thousands of 1984 pesos)

	Total Investment	Annualized Investment at 15%	Annualized Investment at 20%	Annualized Investment at 25%	Annual Operating Cost	Total Annualized Cost at 15%	Total Annualized Cost at 20%	Total Annualized Cost at 25%	Metric Ton Gross Output	P/Metric Ton Average Annual Cost of Wood at 15%	P/Metric Ton Average Annual Cost of Wood at 20%	P/Metric Ton Average Annual Cost of Wood at 25%
CASURECO IV-A	945	146	191	237	113	259	304	350	8,259	31	37	42
ZAMECO	3,062	474	619	768	143	617	762	911	4,235	146	180	215
OMECO	348	54	70	87	62	116	132	149	2,640	44	50	56
ANTECO	1,441	223	291	362	90	314	382	453	2,404	130	159	188
PANELCO I	4,479	693	905	1,124	943	1,636	1,848	2,067	24,960	66	74	83
ISECO	1,692	262	342	425	382	644	724	807	11,577	56	63	70

Source: Table III-2 plus calculations as described in text for total investment, Tables III-3 through III-8 for annual operating cost, Table III-10 for gross ouput.

Table III-38

Average Cost of Wood in Replication Case
(in thousands of 1984 pesos)

	Total Investment	Annualized Investment at 15%	Annualized Investment at 20%	Annualized Investment at 25%	Annual Operating Cost	Total Annualized Cost at 15%	Total Annualized Cost at 20%	Total Annualized Cost at 25%	Metric Ton Gross Output	P/Metric Ton Average Annual Cost of Wood at 15%	P/Metric Ton Average Annual Cost of Wood at 20%	P/Metric Ton Average Annual Cost of Wood at 25%
CASURECO IV-A	2,220	343	449	557	454	797	903	1,011	39,800	20	23	25
ZAMECO	4,730	732	956	1,187	753	1,485	1,709	1,940	31,210	48	55	62
OMECO	912	141	184	229	207	348	391	436	12,320	28	32	35
ANTECO	1,464	226	296	367	275	501	571	642	13,212	38	43	49
PANELCO I	4,076	631	824	1,023	961	1,592	1,785	1,984	35,200	45	51	56
ISECO	2,804	434	567	704	688	1,122	1,255	1,392	29,204	38	43	48

Source: Tables III-13 plus calculations as described in text for total investment, Table III-15 for annual operating cost and Table III-14 for gross output.

₱1.51. This cost, with the exception of OMECO, is higher than all Dendro Thermal power estimates under the baseline and replication cases for costs annualized at 15% and 20%, and higher than the majority of sites at a 25% factor. OMECO's costs are much higher due to its low output. However, the hydroelectric costs of ₱.27 per kilowatt-hour and geothermal costs of ₱.52 per kilowatt-hour are lower than Dendro Thermal power costs. Based on cost of power estimates, therefore, the Dendro Thermal concept appears preferable to oil-based, but not to hydroelectric or geothermal.

Table III-39

Cost of Wood Comparison
(pesos per metric ton)

	Baseline	Replication	Market Price	Recommended Price
CASURECO IV-A	37	23	60	65
ZAMECO	180	55	98	65
OMECO	50	32	90	65
ANTECO	159	43	39	65
PANELCO I	74	51	90	65
ISECO	63	43	80	65

Source: Tables III-27, III-37, and III-38.

It is important to note that though the costs for power and wood are significant data, a large number of factors are not included in the calculation. This is particularly true of the power plants. The largest factor not included is the value of the output. Because of transmission losses, the value of the power produced is generally higher the closer the power plant is to the customer. The use of gross power output in the calculation of average power cost, therefore, understates the cost of power at the customers' premises.

The cost of power estimates can, however, be used to demonstrate the relative contribution represented by the power plants and tree plantation in the cost of production. Table III-40 provides a disaggregation of the total cost of production for the replication

case costs evaluted at a 20% discount rate factor. The three components isolated are the power plants, the tree plantation, and the cost of fuel wood purchased on the open market. The power plants represent 83.3% (ISECO) to 96.0% (OMECO) of the total costs while the tree plantations represent 4% (OMECO) to 11.2% (PANELCO I), which includes the farmers' margin. It is clear from these data that the power plant costs represent by far the largest component. This implies that small percentage savings in power plant costs can provide large percentage increases to funds for the planning and development of the tree plantation with no overall increase in costs.

Table III-40

Relative Costs of Power in Replication Case
Evaluated at a 20% Discount Rate Factor
(pesos per kilowatt-hour)

	Total	Power Plant	Tree Plantation	Market Purchased Fuel Wood
CASURECO IV-A				
Cost	1.33	1.18	.14	.01
% of Cost	100	88.70	10.50	.80
ZAMECO				
Cost	1.34	1.17	.11	.06
% of Cost	100	87.30	8.20	4.50
OMECO				
Cost	2.53	2.43	.10	0.00
% of Cost	100	96.00	4.00	0.00
ANTECO				
Cost	1.54	1.44	.10	0.00
% of Cost	100	93.50	6.50	0.00
PANELCO I				
Cost	.99	.84	.11	.04
% of Cost	100	84.80	11.20	4.00
ISECO				
Cost	.90	.75	.09	.06
% of Cost	100	83.3	10.00	6.70

CHAPTER IV
ECONOMIC ANALYSIS

The financial analysis provides a measure of commercial profitability which determines the viability of a project in the marketplace. However, factors such as market imperfections and externalities distort commercial profitability as a measure of a project worth to the nation.

The objective of the economic analysis is to examine the costs and benefits of the goods and services involved in the project to ensure they reflect their real value to the Philippines. The economic analysis will examine the costs and benefits to the Philippines as a whole of the Dendro Thermal Program projects at ANTECO, CASURECO IV-A, ISECO, OMECO, PANELCO I, and ZAMECO. The economic analysis compares the individual projects with the "status quo" scenario, which is defined as the nation without the project.

The procedure used in the economic analysis was to use the financial analysis for each project as a starting point and make the necessary adjustments to the costs and revenues used in the analysis so that the resources would reflect their real cost to the Philippines economy.

The first stage of the economic analysis examined and corrected market distortions; dealt with the elimination of transfer items; and evaluated traded inputs and outputs using broader prices and market prices for nontraded inputs and outputs. Also, all the project's costs and benefits were classified according to the following three components in anticipation of the second stage of the economic analysis which was the application of the shadow wage rate and shadow exchange rate:

- foreign currency items
- unskilled labor
- local currency items

The final result of the economic analysis is presented in the form of an internal rate of return, the net foreign exchange, and the amount of unskilled labor employed. A description of intangibles, that is, costs and benefits that cannot be readily quantified in terms of pesos, is not provided.

Shadow Prices

Shadow prices are used in place of market prices when the market price of any good or service is changed to make it more closely represent the opportunity cost to the Philippines. For this analysis, shadow prices were established for the value of wood and electricity, the foreign exchange rate, the unskilled wage rate, and the social discount rate.

Unskilled labor is relatively abundant in the Philippines and because the price for this labor is administered, the real cost to the society for this labor, as measured by the opportunity cost, is lower than the actual price paid. This is especially true for the tree farmers where indications are that reductions in farm output resulting from the tree plantation labor commitment are relatively minor. It is, therefore, appropriate that the unskilled labor costs attributable to the project be reduced to reflect the true societal costs.

Estimates of the amount by which the unskilled labor cost should be reduced range from 0.8 of actual labor costs to 0.6, as developed by the Philippines National Economic Development Administration (NEDA). The lower figure of 0.6, as used by the most recent United States Agency for International Development (USAID) analyses, was deemed most appropriate for this project because of the relatively low loss of farm output associated with the farmers.

The foreign exchange component of the project cost represents cost which is larger in societal terms than in financial terms, reflecting the relative scarcity of foreign exchange. This scarcity is indicated by both the restrictions the central bank places on

foreign currency movements out of the country as well as premiums provided for foreign exchange on the black market.

The official exchange rate in September 1984 is ₱18 to $1 and the black market exchange rate (Hong Kong) is approximately ₱22 to $1, which indicates a shadow exchange rate of about 1.2. This is consistent with the Philippines National Economic Development Administration recommendation of a foreign exchange premium of 20% and, therefore, a shadow exchange rate of 1.2 was the figure employed in this study. They also recommended a social discount rate of 15%.

Benefits

In the economic analysis, the tree plantations and power plants were examined separately rather than as a whole for the six projects. Benefits derived from the projects which could be quantified in terms of pesos are the wood produced, the electricity generated, and the increased value of the land.

The revenue which stemmed from the wood produced by the tree plantation in the financial analysis was based on the National Electrification Administration (NEA) guaranteed price at farm gate of 65 pesos per metric ton. For the economic analysis, the market prices of wood at the six project sites were used to determine the benefits since the market prices more closely represent what Filipino consumers are willing to pay for the wood and, thus, represents the opportunity cost for the wood used as power plant fuel. As can be seen from Table IV-1, at ANTECO, the market price of 39 pesos per metric ton was significantly below the guaranteed price, while at ZAMECO, at 98 pesos per metric ton, the opposite was true.

The benefits from the power plants do not arise primarily from the increased availability of electricity, but from the market for foreign exchange. Since the electricity generated by the wood fueled power plants substitutes for oil previously imported to generate electricity, the net effect is to release a sum of foreign exchange equivalent in value to the foreign exchange cost of the imported oil.

Table IV-1

Tree Plantation Benefits in Baseline and Replication Cases

	1984 Market Price[1] (pesos/ metric ton)	Baseline Case		Replication Case	
		Wood Produced[1] (metric ton)	Benefits (1984 pesos)	Wood Produced[2] (metric ton)	Benefits (1984 pesos)
CASURECO IV-A	60	8,259	495,540	39,800	2,388,000
ZAMECO	98	4,235	415,030	31,210	3,058,580
OMECO	90	2,640	237,600	12,320	1,108,800
ANTECO	39	2,404	93,756	13,212	515,268
PANELCO I	90	24,960	2,246,400	35,200	3,168,000
ISECO	80	11,577	926,160	29,204	2,336,320

1 Source: Table III-27.

2 Source: Table III-31.

This benefit was quantified using a price for oil of $38 per barrel (see Chapter V for sensitivity analysis with a price of $24/bbl), which results in a foreign exchange cost of $64.2 per megawatt-hour (MWh) of electricity produced. This figure was calculated in the following manner using values for electricity production of 10,000 Btu per kilowatt-hour and 5,922,000 Btu per barrel for the heat content of #2 fuel oil. Cost per MWh = ($38/bbl) (bbl/5,922,000 Btu) (10,000 Btu/kWh) (1,000 kWh/MWh). Table IV-2 shows the benefits for each of the six sites in terms of foreign exchange.

Table IV-2

Power Plant Benefits for Baseline and Replication Cases

	Gross Electricity Produced[1] (megawatt-hour)	Foreign Currency Value	
		Dollars[2]	Pesos (₱18 to $1)
CASURECO IV-A	18,600	1,194,120	21,494,160
ZAMECO	18,600	1,194,120	21,494,160
OMECO	2,409	154,658	2,783,844
ANTECO	5,760	369,792	6,656,256
PANELCO I	20,400	1,309,680	23,574,240
ISECO	20,400	1,309,680	23,574,240

1 Source: Table III-36.

2 Based on foreign exchange cost of $64.2 per megawatt hour. See text for discussion.

Another benefit resulting from the tree plantation is its residual value. The incremental residual value of the tree plantation results from the improvement in the land which, in the financial analysis, was estimated as the value of the trees remaining at the terminal year of the project.

However, the economic residual value was estimated as the present value of the perpetual stream of net income which the land could provide as a result of the project. The level of this perpetual annual income was estimated as the economic net cash flow to the tree plantations discounted, using the social discount rate of 15%.

If the land is returned to a productive condition through the humus accumulation, nitrification, and erosion control offered by the ipil-ipil, higher return products could be produced from the land, such as fruit crops, which would increase the value of the land even more. If this occurs, then the estimate of the economic residual value of the land should therefore be considered a conservative estimate.

Costs

Cost items on the financial statements for the tree plantations and power plants for the six projects were examined to identify any items which needed to be adjusted to more closely reflect their opportunity costs to the Philippines.

The financial statements were examined for transfer payments such as import duties and taxes, and price distortions in traded and nontraded items, but the only adjustment identified was in the cost of wood to the power plant.

All the wood for the power plants was valued at the local market price in the economic analysis, as opposed to the financial analysis where the National Electrification Administration (NEA) guaranteed price at farm gate of 65 pesos per metric ton was used for the wood produced by the tree plantations. Table IV-3 shows the adjusted local

currency component of the operating costs which include the adjusted price for wood.

Another cost associated with the power plant is the residual value of the principal of the loan which has been incorporated into the analysis. However, the power plants are assumed to have zero salvage value at the end of the 25 years.

Table IV-3

Power Plant Fuel Requirements at Market Prices for Baseline and Replication Cases

	Wood Requirements (metric ton)[1]	Wood Cost (thousands of 1984 pesos)	Operating Costs Local Currency Component (thousands of 1984 pesos)[2]
CASURECO IV-A	43,041	2,582	4,288
ZAMECO	43,041	4,218	5,924
OMECO	3,845	346	1,204
ANTECO	9,218	360	1,218
PANELCO I	43,414	3,907	5,257
ISECO	43,414	3,473	4,732

[1] Source: Table III-27.

[2] Local currency component of operating costs except for unskilled labor includes wood costs at market price, production materials, skilled labor, and administrative overhead. See Appendix Tables B-1 through B-6.

Net Benefits

In the previous discussions on benefits and costs, those items have been identified whose prices or costs require adjustment to reflect their value in use or their opportunity costs. Tables IV-4 through IV-6 present the net benefits for the tree plantations and power plants for both the baseline and replication cases.

Debt service is not included in the net benefit figures since in the economic analyses, it is treated as a transfer within the economy even though the projects will have foreign loan components and the debt service will be paid abroad. This is due to the convention of

Table IV-4

Costs and Benefits for Tree Plantations by Factor in Baseline Case
(in thousands of 1984 pesos)

	Cost and Benefits by Factor[1]			Costs and Benefits by Factor With Shadow Pricing		
	Local[2] Currency	Unskilled Labor	Net Benefits	Local Currency (1)	Unskilled Labor (SRW=.6)	Net Benefits
CASURECO IV-A						
1981	-218	-186	-404	-218	-112	-330
1982	-76	-246	-322	-76	-148	-224
1983	-26	-169	-195	-26	-101	-127
1984	-23	0	-23	-23	0	-23
1985-2009	+468	-85	+383	+468	-51	+417
Residual	+2,553			+2,780		
Internal Rate of Return of Net Benefits			24.7			29.5
Total Unskilled Labor		2,728				
ZAMECO						
1981	-370	-1,566	-1,936	-370	-940	-1,310
1982	-147	-428	-575	-147	-257	-404
1983	-90	-431	-521	-90	-259	-349
1984	-30	0	-30	-30	0	-30
1985-2009	+400	-128	+272	+400	-77	+323
Residual	+1,813			+2,153		
Internal Rate of Return of Net Benefits			6.7			11.5
Total Unskilled Labor		5,625			3,081	
OMECO						
1981	-66	-159	-225	-66	-95	-161
1982	-42	-61	-103	-42	-37	-79
1983	-16	0	-16	-16	0	-16
1984	-4	0	-4	-4	0	-4
1985-2009	+236	-42	+194	+236	-25	+211
Residual	+1,293			+1,407		
Internal Rate of Return of Net Benefits			28.7			36.3
Total Unskilled Labor		1,270				

Table IV-4 (cont.)

	Cost and Benefits by Factor[1]			Costs and Benefits by Factor With Shadow Pricing		
	Local[2] Currency	Unskilled Labor	Net Benefits	Local Currency (1)	Unskilled Labor (SRW=.6)	Net Benefits
ANTECO						
1981	-66	-366	-432	-66	-220	-286
1982	-98	-427	-525	-98	-256	-354
1983	-84	-333	-417	-84	-200	-284
1984	*	-66	-67	-1	-40	-41
1985-2009	+89	-85	+4	+89	-51	+38
Residual	+27			+253		
Internal Rate of Return of Net Benefits			0.0			1.3
Total Unskilled Labor		3,318				
PANELCO I						
1981	-57	-788	-845	-57	-473	-530
1982	-76	-1,768	-1,844	-76	-1,061	-1,137
1983	-222	-1,011	-1,233	-222	-607	-829
1984	-141	-416	-557	-141	-250	-391
1985-2009	+2,235	-932	+1,303	+2,235	-559	+1,676
Residual	+8,687			+11,173		
Internal Rate of Return of Net Benefits			20.9			34.5
Total Unskilled Labor		27,285				
ISECO						
1981	-153	-346	-499	-153	-208	-361
1982	-29	-580	-609	-29	-348	-377
1983	-39	-442	-481	-39	-265	-304
1984	-19	-85	-104	-19	-51	-70
1985-2009	+866	-322	+544	+866	-193	+673
Residual	+3,627			+4,487		
Internal Rate of Return of Net Benefits			21.8			33.5
Total Unskilled Labor		9,502				

*less than one thousand pesos.

[1] Source: Appendix Table C-1.

[2] Sum of maintenance and benefits in Appendix Table C-1 for the 1985-2009 period.

Table IV-5

Costs and Benefits for Tree Plantation by Factor in Replication Case
(in thousands of 1984 pesos)

	Cost and Benefits by Factor[1]			Costs and Benefits by Factor With Shadow Pricing		
	Local Currency	Unskilled Labor	Net Benefits	Local Currency (1)	Unskilled Labor (SRW=.6)	Net Benefits
CASURECO IV-A						
1981-84	-200	-355	-555	-200	-213	-413
1985-2009	+2,276	-342	+1,934	+2,276	-205	+2,071
Residual	+12,893			+12,893		
Internal Rate of Return of Net Benefits			45.5			56.6
Total Unskilled Labor		9,970				
ZAMECO						
1981-84	-246	-936	-1,182	-246	-562	-808
1985-2009	+2,980	-674	+2,306	+2,980	-404	+2,576
Residual	+15,373			+15,373		
Internal Rate of Return of Net Benefits			31.1			43.1
Total Unskilled Labor		20,594				
OMECO						
1981-84	84	-144	-228	-84	-86	-170
1985-2009	+1,042	-140	+902	+1,042	-84	+958
Residual	+6,013			+6,013		
Internal Rate of Return of Net Benefits			49.2			60.5
Total Unskilled Labor		4,076				

Table IV-5 (cont.)

	Cost and Benefits by Factor[1]			Costs and Benefits by Factor With Shadow Pricing		
	Local Currency	Unskilled Labor	Net Benefits	Local Currency	Unskilled Labor (SRW=.6)	Net Benefits
ANTECO						
1981-84	-63	-303	-366	-63	-182	-245
1985-2009	+500	-260	+240	+500	-156	+344
Residual	+1,600			+1,600		
Internal Rate of Return of Net Benefits			13.3			24.5
Total Unskilled Labor		7,712				
PANELCO I						
1981-84	-112	-907	-1,019	-112	-544	-656
1985-2009	+3,157	-950	+2,207	+3,157	-570	+2,587
Residual	+14,713			+14,713		
Internal Rate of Return of Net Benefits			33.4			49.1
Total Unskilled Labor		27,378				
ISECO						
1981-84	-100	-601	-701	-100	-361	-461
1985-2009	+2,228	-580	+1,648	+2,228	-348	+1,880
Residual	+10,987			+10,987		
Internal Rate of Return of Net Benefits			35.3			50.1
Total Unskilled Labor		16,904				

[1] Source: Appendix Table C-2 plus calculations as described in text.

Table IV-6

Costs and Benefits For Power Plants by Factor In Baseline and Replication Cases
(in thousands of 1984 pesos)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
CASURECO IV-A								
1981	-4,620			-4,620	-5,544			-5,544
1982	-63,474	-2,301	-808	-66,583	-76,169	-2,301	-485	-78,955
1983	-3,359	-3,907	-3,040	-10,306	-4,031	-3,907	-1,824	-9,762
1984	-1,428	-10,038	-2,491	-13,957	-1,714	-10,038	-1,495	-13,247
1985-2009	+21,042	-4,288	-805	+15,949	+25,250	-4,288	-483	+20,479
Internal Rate of Return of Net Benefits				13.0%				14.5%
Total Net Foreign Currency	453,169							
Total Unskilled Labor			26,464					
ZAMECO								
1981	-6,167			-6,167	-7,400			-7,400
1982	-63,314	-1,635	-185	-65,134	-75,977	-1,635	-111	-77,723
1983	-5,281	-5,344	-3,684	-14,309	-6,337	-5,344	-2,210	-13,891
1984	-1,828	-6,535	-1,431	-9,794	-2,194	-6,535	-859	-9,588
1985-2009	+21,042	-5,924	-805	+14,313	+25,250	-5,924	-483	+18,843
Internal Rate of Return of Net Benefits				11.6%				13.3%
Total Net Foreign Currency	449,460							
Total Unskilled Labor			26,856					

Table IV-6 (cont.)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
OMECO								
1981								
1982	-12,513			-12,513	-15,016			-15,016
1983	-1,506	-2,537	-794	-4,837	-1,807	-2,537	-476	-4,820
1984	-284	-3,722	-240	-4,246	-341	-3,722	-144	-4,207
1985-2009	+2,695	-1,204	-183	+1,308	+3,234	-1,204	-110	+1,920
Internal Rate of Return of Net Benefits				3.1%				5.4%
Total Net Foreign Currency	53,072							
Total Unskilled Labor			5,609					
ANTECO								
1981	-2,986			-2,986	-3,583			-3,583
1982	-13,979	-5,612	-3,307	-22,898	-16,775	-5,612	-1,984	-24,371
1983	-1,274	-2,610	-1,593	-5,477	-1,529	-2,610	-956	-5,095
1984	-273	-3,709	-665	-4,647	-328	-3,709	-399	-4,436
1985-2009	+6,567	-1,218	-183	+5,166	+7,880	-1,218	-110	+6,552
Internal Rate of Return of Net Benefits				11.1%				13.4%
Total Net Foreign Currency	145,663							
Total Unskilled Labor			10,140					

Table IV-6 (cont.)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
PANELCO I								
1981	-5,935	-2,220	-659	-8,814	-7,122	-2,220	-395	-9,737
1982	-36,763	-4,951	-1,446	-43,160	-44,116	-4,951	-868	-49,935
1983	-4,837	-5,681	-1,731	-12,248	-5,804	-5,681	-1,039	-12,524
1984	-3,104	-5,783	-1,170	-10,057	-3,725	-5,783	-702	-10,210
1985-2009	+23,302	-4,009	-474	+18,819	+27,962	-4,009	-284	+23,669
Internal Rate of Return of Net Benefits				18.6%				20.4%
Total Net Foreign Currency	531,911							
Total Unskilled Labor			16,856					
ISECO								
1981	-5,006			-5,006	-6,007			-6,007
1982	-31,818	-18		-31,836	-38,182	-18		-38,200
1983	-2,388	-8,400	-3,295	-14,083	-2,866	-8,400	-1,977	-13,243
1984	-3,201	-11,652	-172	-15,025	-3,841	-11,652	-103	-15,596
1985-2009	+23,337	-4,732	-439	+18,166	+28,004	-4,732	-263	+23,009
Internal Rate of Return of Net Benefits				20.7%				22.8%
Total Net Foreign Currency	541,012							
Total Unskilled Labor			14,442					

[1] Source: Appendix Table C-3.

assuming that all financing for a project will come from domestic sources and all returns from the project will go to domestic residents. This convention separates the decision of how good a project is from the decision of how to finance it.

An examination of the economic rate of return illustrates that the benefits and costs attributed to the power plants are of such a magnitude that they dominate the combined rates of return for the tree plantation and power plant.

The economic rate of return for the tree plantations varied between 1.3% for ANTECO to 36.3% for OMECO in the baseline case. Significant improvement in the economic rate of return for the tree plantations was possible in the replication cases which ranged from 24.5% to 60.5%.

The power plant baseline and replication cases benefits and costs were the same. The economic rate of return for the power plants ranged from 5.4% for OMECO to 22.8% for ISECO. OMECO's low economic rate of return relative to the other sites is a consequence of its inability to sell excess power to a grid system. OMECO must rely on the demand level of its co-op members, which is less than half of what the power plant could sell if it operated at full potential. This has had a very negative impact on OMECO's economic results because of the way power plant benefits are determined in this analysis.

Although the power plant benefits and costs excluded foreign financing, an analysis was made to calculate the power plant economic rates of return including foreign financing since it was known. As can be seen from Appendix Table C-4, the economic rates of return increased significantly for all sites except OMECO and ranged from 6.1% to 63.6%.

Using a 15% cut-off rate for the economic rate of return, the combined tree plantation power plant projects can be evaluated with respect to their value to the nation (see Table IV-7). In the baseline case, PANELCO I (21.0%), and ISECO (23.1%) would be implemented and CASURECO IV-A (14.7%), ZAMECO (13.2%), OMECO (6.4%),

Table IV-7

Net Benefits for Tree Plantations and
Power Plants in Baseline and Replication Cases
(in thousands of 1984 pesos)

	Net Benefits In Baseline Case			Net Benefits in Replication Case		
	Plantation	Plant	Total	Plantation	Plant	Total
CASURECO IV-A						
1981	-330	-5,544	-5,874	-413	-5,544	-5,957
1982	-224	-78,955	-79,179	-413	-78,955	-79,368
1983	-127	-9,762	-9,889	-413	-9,762	-10,175
1984	-23	-13,247	-13,270	-413	-13,247	-13,660
1985-2009	+417	+20,479	+20,896	+2,071	+20,479	+22,550
Residual	+2,780		+2,780	+12,893		+12,893
Internal Rate of Return on Net Benefits			14.7%			15.6%
ZAMECO						
1981	-1,310	-7,400	-8,710	-808	-7,400	-8,208
1982	-404	-77,723	-78,127	-808	-77,723	-78,531
1983	-349	-13,891	-14,240	-808	-13,891	-14,699
1984	-30	-9,588	-9,618	-808	-9,588	-10,396
1985-2009	+323	+18,843	+19,166	+2,576	+18,843	+21,419
Residual	+2,153		+2,153	+15,373		+15,373
Internal Rate of Return on Net Benefits			13.2%			14.6%
OMECO						
1981	-161		-161	-170		-170
1982	-79	-15,016	-15,095	-170	-15,016	-15,186
1983	-16	-4,820	-4,836	-170	-4,820	-4,990
1984	-4	-4,207	-4,211	-170	-4,207	-4,377
1985-2009	+211	+1,920	+2,131	+958	+1,920	+2,878
Residual	+1,407		+1,407	+6,013		+6,013
Internal Rate of Return on Net Benefits			6.4%			9.3%

Table IV-7 (cont.)

	Net Benefits In Baseline Case			Net Benefits in Replication Case		
	Plantation	Plant	Total	Plantation	Plant	Total
ANTECO						
1981	-286	-3,583	-3,869	-245	-3,583	-3,828
1982	-354	-24,371	-24,725	-245	-24,371	-24,616
1983	-284	-5,095	-5,379	-245	-5,095	-5,340
1984	-41	-4,436	-4,477	-245	-4,436	-4,681
1985-2009	+38	+6,552	6,590	+344	+6,552	+6,896
Residual	+253		+253	+1,600		+1,600
Internal Rate of Return on Net Benefits			13.2%			13.7%
PANELCO I						
1981	-530	-9,737	-10,267	-656	-9,737	-10,393
1982	-1,137	-49,935	-51,072	-656	-49,935	-50,591
1983	-829	-12,524	-13,353	-656	-12,524	-13,180
1984	-391	-10,210	-10,601	-656	-10,210	-10,866
1985-2009	+1,676	+23,669	+25,345	+2,587	+23,699	+26,286
Residual	+11,173		+11,173	+14,713		+14,713
Internal Rate of Return on Net Benefits			21.0%			21.8%
ISECO						
1981	-361	-6,007	-6,368	-461	-6,007	-6,468
1982	-377	-38,200	-38,577	-461	-38,200	-38,661
1983	-304	-13,243	-12,939	-461	-13,243	-13,704
1984	-70	-15,596	-15,666	-461	-15,596	-16,057
1985-2009	+673	+23,009	23,682	+2,228	+23,009	+25,237
Residual	+4,487		+4,487	+10,987		+10,987
Internal Rate of Return on Net Benefits			23.1%			24.0%

Source: Appendix Tables C-1 through C-3 plus calculations as described in text.

and ANTECO (13.2%) rejected. In the replication case, only ZAMECO (14.6%), OMECO (9.3%), and ANTECO (13.7%) would be rejected.

To this point of the economic analysis, the foreign exchange and employment implications of the project have been valued using the appropriate shadow prices and viewed in the analyses as the amount of aggregate consumption that would be obtainable. Although the economic internal rate of return provides the most comprehensive evaluation measure, it is useful to provide information on the employment and foreign exchange impacts.

An important objective of the Dendro Thermal project is to generate employment, especially in the rural areas. Table IV-8 provides estimates of the employment generated by labor category over the life of the projects for both the baseline and replication cases.

The unskilled labor in person-years for each project site was estimated in the following manner for the tree plantations and power plants. The questionnaire data collected on the tree plantations provided estimates of unskilled labor used in pesos. For the power plants expert opinion was used to provide estimates of unskilled labor in pesos. Although there will be some regional differences in the unskilled labor rate for the purposes of this analysis, a figure of ₱13,000 per year was used which includes wages and benefits.

The total unskilled labor in person-years for the each project reflects the difference in the plantation size and power plant type (see Table IV-8). In the baseline case, employment for unskilled labor over the life of the project ranged between 529 person-years for the four module tree plantations using the Moteur-Duvant power plant at OMECO to 3,396 person-years for the ten module tree plantations using the Alsthom-Atlantique power plant at PANELCO I. The unskilled labor estimates in the replication case reflect more intensive use of such labor on the tree plantations.

The skilled labor estimates were derived solely from the power plant construction and operation phases. Construction skilled labor in pesos was derived from the power plant investment tables and is a

Table IV-8

Employment Implications of the Tree Plantation and Power Plant Projects[1]

	Unskilled Labor (person-year)		Skilled Labor (person-years) Baseline and Replication Case			Total Labor (person-years)		Million of 1984 pesos of Investment	
	Baseline Case	Replication Case	Construction	Operation	Total	Baseline Case	Replication Case	Baseline Case	Replication Case
CASURECO IV-A	2,246	2,803	258	600	858	3,104	3,661	32	38
ZAMECO	2,499	3,650	328	600	928	3,427	4,578	36	48
OMECO	529	745	247	600	847	1,376	1,592	64	74
ANTECO	1,035	1,373	137	600	737	1,772	2,110	49	59
PANELCO I	3,396	3,403	448	600	1,048	4,444	4,451	60	60
ISECO	1,842	2,441	271	600	871	2,713	3,312	41	50

[1]Source: See text for calculation method.

sum of the architectural and engineering cost item, construction skilled labor cost item, and the wood transportation system skilled labor cost item. The ₱20,484 per year, which includes wages and benefits used to convert the peso value of skilled labor to person-years, was based on the wage classification of a "junior professional." For the operational phase of the power plants, the skilled labor reported in the staffing projections made in the original feasibility studies -- supplemented by later analyses -- was used.

A measure of the degree of labor intensiveness is shown in Table IV-8 for each of the projects. The person-years per million pesos of investment in 1984 pesos ranged from 32 to 64 in the baseline case and from 38 to 79 in the replication case.

Another important objective of the Dendro Thermal program is the foreign exchange generated by the substitution of wood produced electricity for electricity produced using imported oil. Table IV-6 shows the total net foreign exchange accumulated over the life of the project for each site.

Assuming that foreign exchange has a time value, that is, having foreign exchange sooner rather than later is beneficial, then there is a problem in interpreting these cumulative net foreign exchange figures. However, the internal rate of return can be calculated for the foreign exchange flows and is equivalent to evaluating the desirability of an investment of foreign currency which produces foreign currency returns. This measure is referred to as the "foreign exchange earning capacity rate" and is the discount rate that equalizes the foreign exchange cost and net foreign exchange benefits over the life of the project.

These internal rates of return on foreign currency before the shadow exchange rate is applied are CASURECO IV-A (19.9%), ZAMECO (19.2%), OMECO (14.2%), ANTECO (22.9%), PANELCO I (28.3%), and ISECO (31.9%). Given a social discount rate of 15% for the Philippines, the net foreign currency flows have a positive impact in all cases except OMECO.

CHAPTER V

SENSITIVITY ANALYSIS

The role of sensitivity analysis is to determine which assumptions made in the development of project costs or revenues are critical to the success of the project. Normally, these tests are conducted by varying the quantity and/or the price of those inputs and outputs which have the greatest uncertainty. For the power plant, these uncertainties are greatest for the equipment costs and the revenues received from electricity sales. For the tree farms, the greatest uncertainties lie in the average yield per hectare planted and the harvesting costs. The sensitivity analysis will be conducted using these parameters on the financial cash flows for the replication case separately for the plantation and power plants.

In addition to the sensitivity analysis on financial results, we have included a reevaluation of economic benefits with a lower oil price that reflects the recent decline in world oil price. The results of this analysis changes results in various tables presented in Chapter IV. These tables are duplicated in this analysis with the changes resulting from the alternative oil price. Our new oil price analysis will follow the financial analyses sensitivities for the power plant since the new oil price only affects net benefits for the power plants.

Power Plant Sensitivity Analysis

Financial Sensitivities

The two power plants which demonstrate the highest and lowest financial rates of return (FIRRs) (see Table III-32) are ISECO and CASURECO IV-A, respectively. These plants were therefore selected for analysis of sensitivity to initial investment costs. Uncertainties about the equipment costs arise from several different sources. The largest single factor affecting future equipment costs would be the exchange rate because a great deal of the equipment is imported. Other factors would include uncertainties about equipment supplier prices and construction costs. To test the project sensitivity to all

these factors taken in combination, the initial investment costs were increased and decreased by 20% and FIRRs re-estimated. The results of this exercise are given on Table V-1. The differences between the FIRRs for these two projects under the three initial investment cost scenarios are in the range of 2%-4% for a 20% change in cost. These results indicate that the viability of these projects is not particularly sensitive to the uncertainties over initial investment cost.

Table V-1

Power Plant Initial Investment Cost Sensitivity Analysis
Annual Cash Flows
(in thousands of 1984 pesos)

	1981	1982	1983	1984	Production Period 1985-2009	FIRR (%)
ISECO						
High-Investment Cost	(6,007)	(38,203)	(16,900)	(18,030)	15,114	15.1
Mid-Investment Cost	(5,006)	(31,836)	(14,083)	(15,025)	15,114	17.7
Low-Investment Cost	(4,005)	(25,469)	(11,266)	(12,020)	15,114	21.3
CASURECO IV-A						
High-Investment Cost	(5,544)	(79,900)	(12,367)	(16,748)	12,429	8.2
Mid-Investment Cost	(4,620)	(166,583)	(10,306)	(13,957)	12,429	10.1
Low-Investment Cost	(3,696)	(53,266)	(8,245)	(1,116)	12,429	12.6

Source: Table III-32 modified as described in text.

The second area of uncertainty in the power plant financial viability is the revenue generated. The revenue picture is complicated for the power plants because uncertainties exist in three areas. These are: 1) the price received from co-op customers; 2) the price received from the National Power Corporation (NPC) for excess power; and 3) the split between power sold to the co-op vs. that sold to NPC. This latter parameter is a function of the level and growth of demand in the co-op. It has been assumed in this work that the price established for sales to co-op customers is the appropriate price; to alter this price would, therefore, serve to change only the allocation of benefits between customers and the co-op. Also, the co-op cannot distinguish between power generated and power purchased in

its price structure. Therefore, the price for dendro power cannot be considered a distinct entity. The price received for sales to NPC is, however, distinct and is of uncertain value and, therefore, price. It is unlikely that the price will be zero, but the price may be lower than ₱1.10/kilowatt-hour used in the analysis. This price is considered an upper bound. The lower bound would be a price of zero. This is effectively already the case for those sites not connected to the grid. The two projects chosen to test for sensitivity to these issues are ISECO and PANELCO I as an example of sites with high local demand and low local demand, respectively.

Another revenue scenario involves the future demand for power within the co-op. The scenarios implicit in the baseline and replication cases are conservative in that they do not project growth in the local demand for power. Table V-2 addresses this issue by projecting a 5% annual growth in local demand (baseline and peak) and calculating the impact this growth has on the revenue. The third scenario depicts a situation where the entire output from the power plant is sold within the co-op. This scenario is unrealistic for these project sites but it does provide some insight into how a similar project would fare in an area with higher local demands for power at the time the plant is commissioned.

These three alternative revenue scenarios are presented on Table V-2. The replication case previously discussed is provided as the "high NPC price" case. The "low NPC price" case assumes a buy-back price of ₱.35 per kilowatt-hour. This price was chosen because it was the price provided as one of the likely results of negotiations with the National Power Corporation (NPC). ISECO does not demonstrate sensitivity to these alternative revenue assumptions as might be expected from their initial high local demand. PANELCO I, however, exhibits great sensitivity, implying that the viability of the Dendro Thermal concept is very much dependent on the level and value of sales to the NPC grid, or, alternatively, the level of local demand.

Table V-2

Power Plant Revenue Sensitivity Analysis
Annual Cash Flows
(in thousands of 1984 pesos)

	1981	1982	1983	1984	Production Period 1985-2009	FIRR (%)
ISECO	(5,006)	(31,836)	(14,083)	(15,025)		
Zero NPC Price					14,421	17.0
Low NPC Price					14,642	17.2
High NPC Price					15,114	17.7
Demand Growth					16,610*	17.9
All Power Sold Locally					15,227	17.8
PANELCO I	(8,814)	(43,160)	(12,248)	(10,057)		
Zero NPC Price					2,927	4.6
Low NPC Price					6,564	6.2
High NPC Price					13,985	14.4
Demand Growth					15,267*	15.3
All Power Sold Locally					20,034	19.5

*Average cash flow; FIRR calculated basis of annual cash flow.
Source: Table III-32 modified as described in text.

Economic Analysis Sensitivity

In the economic analysis chapter (IV), benefits from the power plants were defined as the amount of foreign exchange the power plants release from import substitution of foreign oil. Using oil substitution and, hence, foreign exchange release as the benefits accrued by the wood fired power plant projects, ties benefits to the price of world oil over the time horizon used in the analysis. Although forecasting the world price of oil is well beyond the scope of this analysis, we can illustrate the sensitivity of our baseline/replication case results for the economic analysis using an alternate oil price in all years (no increase in the real price of oil). This section will present the results of a change in the price of oil from $38/bbl used in the economic analysis in Chapter IV to $24/bbl.

In Table IV-2 we presented the power plant benefits calculated as described above, for each of the six sites. In Table V-3 below,

benefits are shown using the alternate oil price of $24/bbl. Since our alternative oil price is 63% of the previous price, the figures in Table V-3 reflect a substantial drop in benefits.

Table V-3

Power Plant Benefits Using $24/bbl for Oil

	Gross Electricity Produced[1] (megawatt-hour)	Foreign Currency Value	
		Dollars[2]	Pesos (₱18 to $1)
CASURECO IV-A	18,600	754,181	13,575,259
ZAMECO	18,600	754,181	13,575,259
OMECO	2,409	97,679	1,758,217
ANTECO	5,760	233,553	4,203,951
PANELCO I	20,400	827,166	14,888,994
ISECO	20,400	827,166	14,888,994

[1] Source: Table III-36 and IV-2.

[2] Based on foreign exchange cost of $64.2 per megawatt hour. See Chapter IV for discussion.

In Table V-4, we have duplicated the power plant costs from Table IV-6 and added the new benefit calculations. These figures are based on revised Appendix C tables. Tables C-3 and C-4 have been revised to reflect the change in oil price and appear as Tables C-5 and C-6, respectively.

Given the large reduction in benefits from the lower oil price, it is not surprising to see a significant worsening of results. Table V-5 illustrates this by comparing each site's EIRR calculated with each oil price. In Figure V-1 these results are shown in a bar chart for each power plant. In Figure V-2 the resulting EIRRs for the consolidated analysis are shown.

Because the power plants are such a large fraction of overall costs relative to the plantations, the consolidated results also indicate significant drops in EIRR for each site. The numerical results for the consolidated analysis are shown in Table V-6.

Table V-4

Costs and Benefits For Power Plants by Factor Using $24/Barrel for Oil
(in thousands of 1984 pesos)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
CASURECO IV-A								
1981	-4,620			-4,620	-5,544			-5,544
1982	-63,474	-2,301	-808	-66,583	-76,169	-2,301	-485	-78,955
1983	-3,359	-3,907	-3,040	-10,306	-4,031	-3,907	-1,824	-9,762
1984	-1,428	-10,038	-2,491	-13,957	-1,714	-10,038	-1,495	-13,247
1985-2009	+13,123	-4,288	-805	+8,030	+15,748	-4,288	-483	+10,977
Internal Rate of Return of Net Benefits				5.8%				7.5%
Total Net Foreign Currency	255,194							
Total Unskilled Labor			26,464					
ZAMECO								
1981	-6,167			-6,167	-7,400			-7,400
1982	-63,314	-1,635	-185	-65,134	-75,977	-1,635	-111	-77,723
1983	-5,281	-5,344	-3,684	-14,309	-6,337	-5,344	-2,210	-13,891
1984	-1,828	-6,535	-1,431	-9,794	-2,194	-6,535	-859	-9,588
1985-2009	+13,123	-5,924	-805	+6,394	+15,748	-5,924	-483	+9,341
Internal Rate of Return of Net Benefits				3.8%				5.9%
Total Net Foreign Currency	251,485							
Total Unskilled Labor			26,856					

Table V-4 (cont.)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
OMECO								
1981								
1982	-12,513			-12,513	-15,016			-15,016
1983	-1,506	-2,537	-794	-4,837	-1,807	-2,537	-476	-4,820
1984	-284	-3,722	-240	-4,246	-341	-3,722	-144	-4,207
1985-2009	+1,669	-1,204	-183	+282	+2,003	-1,204	-110	+689
Internal Rate of Return of Net Benefits				0.0%				0.0%
Total Net Foreign Currency	27,422							
Total Unskilled Labor			5,609					
ANTECO								
1981	-2,986			-2,986	-3,583			-3,583
1982	-13,979	-5,612	-3,307	-22,898	-16,775	-5,612	-1,984	-24,371
1983	-1,274	-2,610	-1,593	-5,477	-1,529	-2,610	-956	-5,095
1984	-273	-3,709	-665	-4,647	-328	-3,709	-399	-4,436
1985-2009	+4,115	-1,218	-183	+2,714	4,938	-1,218	-110	+3,610
Internal Rate of Return of Net Benefits				4.8%				7.0%
Total Net Foreign Currency	84,363							
Total Unskilled Labor			10,140					

Table V-4 (cont.)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
PANELCO I								
1981	-5,935	-2,220	-659	-8,814	-7,122	-2,220	-395	-9,737
1982	-36,763	-4,951	-1,446	-43,160	-44,116	-4,951	-868	-49,935
1983	-4,837	-5,681	-1,731	-12,248	-5,804	-5,681	-1,039	-12,524
1984	-3,104	-5,783	-1,170	-10,057	-3,725	-5,783	-702	-10,210
1985-2009	+14,617	-4,009	-474	+10,134	+17,540	-4,009	-284	+13,247
Internal Rate of Return of Net Benefits				10.5%				12.4%
Total Net Foreign Currency	314,786							
Total Unskilled Labor			16,856					
ISECO								
1981	-5,006			-5,006	-6,007			-6,007
1982	-31,818	-18		-31,836	-38,182	-18		-38,200
1983	-2,388	-8,400	-3,295	-14,083	-2,866	-8,400	-1,977	-13,243
1984	-3,201	-11,652	-172	-15,025	-3,841	-11,652	-103	-15,596
1985-2009	+14,652	-4,732	-439	+9,481	+17,582	-4,732	-263	+12,587
Internal Rate of Return of Net Benefits				11.5%				13.6%
Total Net Foreign Currency	323,887							
Total Unskilled Labor			14,442					

[1] Source: Appendix Table C-3.

Table V-5

Comparison of EIRRs for the Power Plants
Using Two Oil Prices

Site		EIRR at $38/bbl	EIRR at $24/bbl
1.	CASURECO IV-A	14.5%	7.5%
2.	ZAMECO	13.3%	5.9%
3.	OMECO	5.4%	0.0%
4.	ANTECO	13.4%	7.0%
5.	PANELCO I	20.4%	12.4%
6.	ISECO	22.8%	13.6%

Source: Table IV-6 and V-4.

Tree Farm Plantation Sensitivity Analysis

Using the replication case financial internal rate of return (FIRR) values in Table III-16, we can choose a best and worst site for the sensitivity analysis. The site with the largest FIRR (best case) is CASURECO IV-A and the site with the smallest FIRR (worst case) is ZAMECO. These two sites will be used to test the change in FIRR resulting from the following changes:

CASE 1: 20% higher yield
CASE 2: 20% lower yield
CASE 3: 100% increase in operating cost

Case 3 comes about from the uncertainty in harvest costs at all dendro sites. The evidence suggests that the original harvest systems may be ill-suited to the terrain and overall conditions of a tree farm site and in all likelihood harvesting will be far more costly than anticipated. Cases 1 and 2 test the sensitivity to another uncertain and important aspect of the tree farm plantations; crop yield. The results for each case are displayed in Table V-7, along with the replication case results ('mid yield' in the table) for comparison.

Table V-6

Net Benefits for Tree Plantations and
Power Plants in Baseline and Replication Cases
(in thousands of 1984 pesos)

	Net Benefits In Baseline Case			Net Benefits in Replication Case		
	Plantation	Plant	Total	Plantation	Plant	Total
CASURECO IV-A						
1981	-330	-5,544	-5,874	-413	-5,544	-5,957
1982	-224	-78,955	-79,179	-413	-78,955	-79,368
1983	-127	-9,762	-9,889	-413	-9,762	-10,175
1984	-23	-13,247	-13,270	-413	-13,247	-13,660
1985-2009	+417	+10,977	+11,394	+2,071	+10,977	+13,048
Residual	+2,780		+2,780	+12,893		+12,893
Internal Rate of Return on Net Benefits			7.9%			9.2%
ZAMECO						
1981	-1,310	-7,400	-8,710	-808	-7,400	-8,208
1982	-404	-77,723	-78,127	-808	-77,723	-78,531
1983	-349	-13,891	-14,240	-808	-13,891	-14,699
1984	-30	-9,588	-9,618	-808	-9,588	-10,396
1985-2009	+323	+9,341	+9,664	+2,576	+9,341	+11,917
Residual	+2,153		+2,153	+15,373		+15,373
Internal Rate of Return on Net Benefits			6.1%			8.1%
OMECO						
1981	-161		-161	-170		-170
1982	-79	-15,016	-15,095	-170	-15,016	-15,186
1983	-16	-4,820	-4,836	-170	-4,820	-4,990
1984	-4	-4,207	-4,211	-170	-4,207	-4,377
1985-2009	+211	+689	+900	+958	+689	+1,647
Residual	+1,407		+1,407	+6,013		+6,013
Internal Rate of Return on Net Benefits			0.0%			4.5%

Table V-6 (cont.)

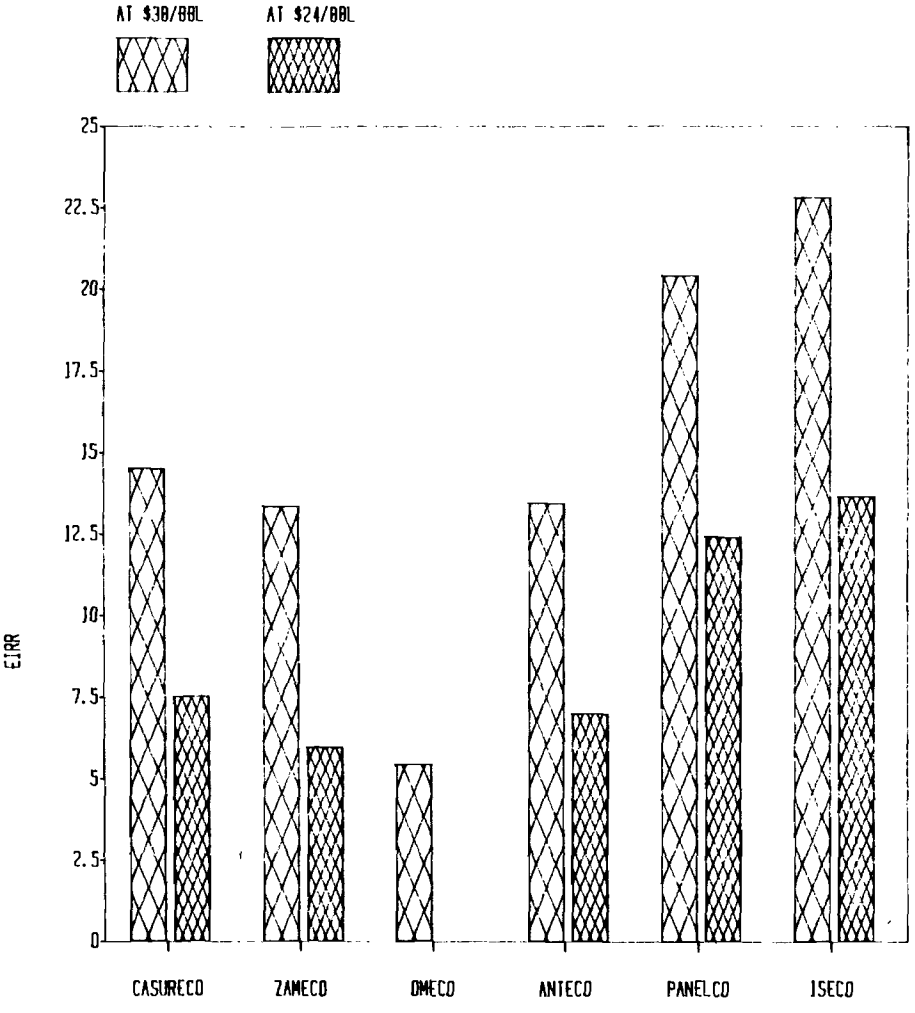
	Net Benefits In Baseline Case			Net Benefits in Replication Case		
	Plantation	Plant	Total	Plantation	Plant	Total
ANTECO						
1981	-286	-3,583	-3,869	-245	-3,583	-3,828
1982	-354	-24,371	-24,725	-245	-24,371	-24,616
1983	-284	-5,095	-5,379	-245	-5,095	-5,340
1984	-41	-4,436	-4,477	-245	-4,436	-4,681
1985-2009	+38	+3,610	3,648	+344	+3,610	+3,954
Residual	+253		+253	+1,600		+1,600
Internal Rate of Return on Net Benefits			13.2%			7.7%
PANELCO I						
1981	-530	-9,737	-10,267	-656	-9,737	-10,393
1982	-1,137	-49,935	-51,072	-656	-49,935	-50,591
1983	-829	-12,524	-13,353	-656	-12,524	-13,180
1984	-391	-10,210	-10,601	-656	-10,210	-10,866
1985-2009	+1,676	+13,247	+14,923	+2,587	+13,247	+15,834
Residual	+11,173		+11,173	+14,713		+14,713
Internal Rate of Return on Net Benefits			13.5%			14.3%
ISECO						
1981	-361	-6,007	-6,368	-461	-6,007	-6,468
1982	-377	-38,200	-38,577	-461	-38,200	-38,661
1983	-304	-13,243	-12,939	-461	-13,243	-13,704
1984	-70	-15,596	-15,666	-461	-15,596	-16,057
1985-2009	+673	+12,587	+13,260	+2,228	+12,587	+14,815
Residual	+4,487		+4,487	+10,987		+10,987
Internal Rate of Return on Net Benefits			14.2%			15.5%

Source: Appendix Tables C-1 through C-3 plus calculations as described in text.

FIGURE V-1

POWER PLANT ECONOMIC INTERNAL RATE OF RETURN

COMPARISON OF EIRRS FOR TWO OIL PRICES

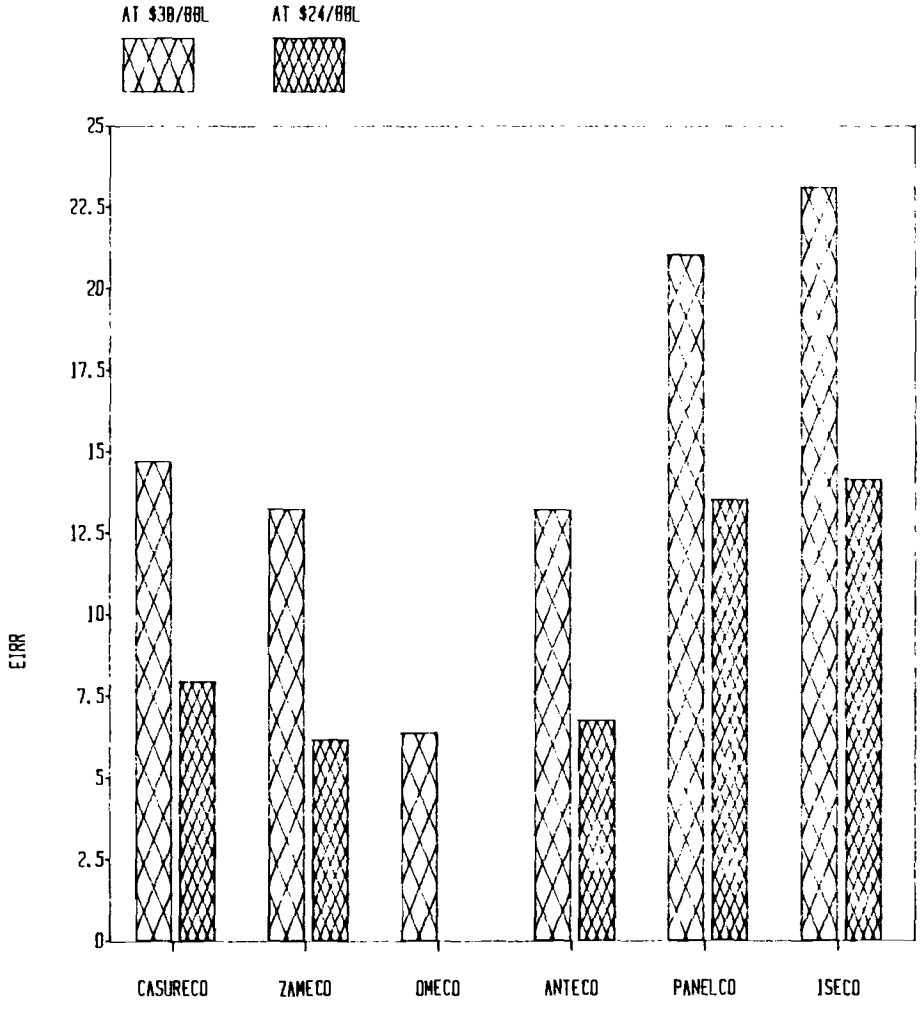


OMECOs EIRR at $24/bbl oil price is virtually zero.

FIGURE V-2

CONSOLIDATED EIRR - BASELINE CASE

COMPARISON OF EIRRs FOR TWO OIL PRICES



OMECOs EIRR at $24/bbl oil price is virtually zero.

Table V-7

Tree Plantation Sensitivity Analysis Annual Cash Flows
(in thousands of 1984 pesos)

	1981	1982	1983	1984	Production Period 1985-2009	Residual	FIRR (%)
CASURECO IV-A	(555)	(555)	(555)	(555)			
High Yield					3,088	6,118	60.1
Mid Yield					2,517	5,098	53.4
Low Yield					1,946	4,078	45.7
High Operating Cost					2,063	4,644	47.4
ZAMECO	(1,182)	(1,182)	(1,182)	(1,182)			
High Yield					1,686	4,472	24.8
Mid Yield					1,280	3,727	20.1
Low Yield					874	2,982	14.6
High Operating Cost					527	2,974	9.2

Source: Table III-16 modified as described in text.

The severe drop in financial internal rate of return (FIRR) for ZAMECO for case 3 results from a larger operating cost component relative to revenues. This indicates that the plantations located in high cost areas could be seriously affected by higher than anticipated operating costs, even under the ideal circumstances inherent in the replication case. A lesser sensitivity is exhibited for yield differences in the ranges tested. It should be noted, however, that additional insight into project sensitivity to land productivity is given by comparing the baseline and replication cases as presented on Tables III-12 and III-16, respectively. This comparison dramatically demonstrates the importance of proper forestry planning and silvicultural practices in site selection, species selection, and tree farm maintenance in determining the viability of the plantation component of the Dendro Thermal concept.

Project Risks

The purposes of project risk analysis are to isolate those factors which could prevent the project from reaching its potential and to discuss how those factors might be ameliorated. The sensitivity analysis assists in identifying these factors though there may be other factors as well which must be considered. This section is somewhat limited in scope since it only deals with factors which have arisen as a result of the economic and financial analyses.

The project risks associated with the power plants are greatest in the area of the National Power Corporation (NPC) buy-back price and the level of local demand. A substantial differential exists between the value of power consumed locally and the off-peak power sold to the NPC grid. This differential arises due to the transmission losses associated with moving the power from one co-op grid to another as well as the relatively lower cost of off-peak power production which would be saved by NPC by purchasing this power from the dendro plants. The buy-back price should be established to reflect the actual cost savings accruing to NPC through the availability of dendro power, perhaps on a site specific basis. A price which does not reflect those cost savings will introduce distortions into the electric power production resource allocation mechanism and result in inefficiencies. The derivation of this price is an extremely complex task and well beyond the scope of the present analysis, but it is unlikely that the parity between buy and sell rates accurately reflects cost savings. The co-ops are buying power at peak and selling it off-peak. The latter almost certainly having a lower value. The net result of all these factors is that project risks increase as the level of local demand decreases.

Another potential risk, which has arisen as a result of our investigation, relates to the expected short-fall in fuel-wood supply from the tree farm plantations. Any short-fall must be made up through purchases on the fuel-wood markets. It was implicitly assumed that these purchases would not affect these markets as information on fuel wood supply and demand is practically nonexistent. There were

indications, however, through conversations with local personnel that the demand for domestic and industrial fuel wood is increasing due to high fossil fuel prices. This is particularly true around metropolitan areas. This implies that dendro plants near metropolitan areas which have significant short-falls in plantation fuel wood supply could experience large price increases in market-purchased fuel wood as well as restricted availability. This potential problem could be ameliorated by ensuring adequate plantation supplied fuel prior to construction of the power plant.

The greatest sensitivities in the farm viabilities are revealed both in the sensitivity analysis and in the differences between baseline and replication cases. The improvement areas addressed in developing the replication case were site and species selection to increase survival and yields, and development conducted on a regular and consistent timetable. The increase in returns resulting from these improvements were quite significant indicating that proper planning, consistent financing, and in-depth site specific forestry analysis are all necessary to reduce project risks.

Another area where significant project risks were revealed relates to harvesting costs. Should those costs be significantly higher than reported in our survey of tree farm modules (which is likely given that actual harvesting has been extremely limited), the rate of return to the tree farms is greatly reduced. This risk can only be resolved by site specific harvesting planning activities conducted prior to tree farm development with this factor incorporated into the site selection process.

The nature of the tree farm project also opens up another unquantifiable area of risks associated with natural disasters. The greatest risk seems to be fire, but risks also are present from storm or insect damage. These risks, particularly fire, can be reduced but only at the expense of productivity. For example, land devoted to fire breaks is not available for tree plantings and must be cleared on a regular basis. There is also a question regarding the productivity

of the trees following several coppice cycles. The extent and timing of replantings are not known at present and can only be resolved with further research and experience at each site.

In summary, the Dendro Thermal concept appears to be a viable alternative to conventional power production methods, but only if potential risks are reduced. The concept is not appropriate for all places at all times; the land must be suitable for the fuel-wood species selected and the level of local power demand, as well as the value of power produced in excess of local demands, must be carefully evaluated. All of these factors underscore the need for coordination of the power production aspects of these projects with the National Power Corporation and the economic development aspects with the appropriate planning agencies. It should also be emphasized that all of the conclusions contained in this report are based upon project costs which are not yet final and upon operational data that are estimated. It is, therefore, strongly recommended that these project sites be reevaluated following a one- to two-year operational period to verify the data used in this analysis.

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Rural Electric Cooperatives and construction contractors for sites of CASURECO IV-A, ZAMECO, OMECO, ANTECO, PANELCO I, and ISECO.

Organizations and Individuals Consulted

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APPENDIX A

Plantation Questionnaires

A-1: Dendro Thermal Program Farm Module Questionnaire

A-2: Farm Module Rating Sheet

DENDRO THERMAL PROGRAM FARM MODULE QUESTIONNAIRE

GENERAL INSTRUCTIONS:

The objective of this questionnaire is to collect data on actual yields, incomes, and costs for each 100 plus hectare module in the following projects: PANELCO I, ISECO, ISELCO II, ZAMECO, OMECO, CASURECO IV-A, and ANTECO.

Please provide actual data where available. If actual data is not available for specific income or cost items, indicate your best estimate followed by an (E). For example, an estimate of peso value of sales of ipil-ipil leaves in year 3 may be entered as follows: $75-100 (E).

Please provide the following information on the individual(s) who filled out the questionnaire.

Name _____

Title _____

Agency _____

Address _____

Telephone _____

Please return questionnaire by May 14, 1984 to:

Dr. Robert Williams
DENDRO Thermal Development Office
National Electrification Administration
D&E Building
Quezon Avenue
Quezon City

I. Farm-Module Identity and Operating Conditions

Electric Cooperative _____ Region ____

Town _____ Province _____

Name of Farmers Association _____

Module Number ____ Module Size (hectares) _____ Number of Farmers ____

Planting Status:

Farm Development Cycle (check one): 4 years ____ 3 years ____

For year planting was done provide the following:

	1980	1981	1982	1983	1984
Hectares planted in:					
Hectares surviving to date:					

Expected first harvesting year is 19_____

II. Farm-Module Development Costs

Actual expenditures incurred by the farm module in planting and caring for the trees up to first harvest.

Where appropriate, show:

- **o the estimated life for equipment, buildings, etc. (i.e., a chainsaw could have an estimated life of four years);**
- **o the maintenance costs (i.e., maintenance on a chainsaw could be shown as $200 per year for four years); and**
- **o if the item was imported.**

Data is available based on actual expenditures and funds returned to farmers on a work-accomplished basis. If actual expenditure data is not available, please allocate those funds to the items shown as accurately as possible.

All cost data should be in pesos unless otherwise requested.

1. What was the total cost for this farm module development?

1st Year	2nd Year	3rd Year	4th Year	Total

THIS TOTAL FARM MODULE DEVELOPMENT COST HAS BEEN DIVIDED INTO THE FOLLOWING CATEGORIES FOR WHICH SPECIFIC EXPENDITURE DATA OR ESTIMATES ARE REQUESTED IN QUESTIONS 2-7: MATERIALS, EQUIPMENT, BUILDINGS, AND LABOR.

2. Itemize materials costs such as seeds, fertilizers, pesticides, seedlings, etc., and if imported, specify foreign currency costs and unit of currency.

Item	Check if Imported	1st Year	2nd Year	3rd Year	4th Year
Seeds					
Fertilizers					
Pesticides					
Seedlings					

3. Tools and equipment used in planting, **not harvesting**, and for administrative tasks show initial costs, life, and annual maintenance costs. If imported, specify the foreign currency costs and unit of currency.

Item	Initial Cost (excluding import duties)	Import Duties	Life	Year Placed In Service	Annual Maintenance Costs

4. Buildings and infrastructure costs, for example, roads.

Item	Life	Year Placed In Service	Initial Cost	Annual Maintenance Costs

5. Labor allowance for tasks associated with farming such as nursery establishment, clearing and planting, care and weeding, supervision and patrolling, and other. Separate by skilled or unskilled categories.

Category	1st Year	2nd Year	3rd Year	4th Year
Unskilled Labor				
Skilled Labor				

6. Labor allowance for administrative tasks associated with this farm module.

Category	1st Year	2nd Year	3rd Year	4th Year
Unskilled Labor				
Skilled Labor				

7. For the skilled and unskilled labor categories in questions 5 and 6, show the average hourly wage and average annual salary at this farm module.

Category	1st Year	2nd Year	3rd Year	4th Year
Unskilled Labor				
Average Hourly Rate				
Average Annual Salary				
Skilled Labor				
Average Hourly Rate				
Average Annual Salary				

III. Farm-Module Harvesting and Maintenance Costs

Actual expenditures incurred by the farm module on an annual basis for a normal operating year after first harvesting. These recurring costs have been divided into two categories: harvesting and farm maintenance (i.e., replanting, etc.).

Harvesting includes felling, trimming, cutting to length, dragging to loading point, and stacking of the wood. It does not include transportation costs from the loading point to the power plant.

1. Tools and equipment required for harvesting. Do not include those equipment items listed in Section II, question 3. Show initial costs, life, annual maintenance costs, and if imported, import duties,the foreign currency costs and unit of currency.

Item	Initial Cost (excluding import duties)	Import Duties	Life	Year Placed In Service	Annual Maintenance Costs

2. Farm maintenance costs, excluding labor costs, includes annual operating expenses for a normal operating year after first harvesting and should be listed below (i.e., items such as materials and supplies needed for replanting and animal rental).

Item	Annual Cost

3. Annual labor allowance for tasks associated with harvesting and farm maintenance such as replanting and fire patrols. If possible, separate these two labor uses by skill category.

Category	Harvesting	Farm Maintenance	Total
Unskilled Labor			
Skilled Labor			

IV. Farm-Module Incomes

1. Loan income from Rural Electric Cooperative

Kind	1st Year	2nd Year	3rd Year	4th Year
Cash (pesos)				
In-kind (pesos)				

Statements about loan conditions such as interest rate, duration, and farm module size.

2. Estimated annual sales of wood for a Normal Operating Year, After First Harvesting.

Expected _____ hectares to be harvested a year.

Estimated annual yield _____ metric tons per hectare.

Expected sale price _____ pesos per metric ton of wood.

Total annual sales _____ pesos.

3. Sales of ipil-ipil seeds, leaves, and other farm products.

Income opportunities for farmers have been possible at some modules from these sources. Are farmers at this module earning such income? (check one) No _____. Yes _____. If yes, please indicate the items and peso value of sales.

Item	Start-up Period				Normal Operating Year
	1st Year	2nd Year	3rd Year	4th Year	

V. Based on your opinion, can the performance of this farm module be improved? If it can be improved, to what extent can it be improved and in what areas? If all areas can be improved to the extent of your expectation, then what annual yield per hectare can be expected? What additional costs would be incurred to achieve this yield?

VI. Additional information about this farm module.

1. Moisture content of wood at time of sale to power plant _____

_____

2. Specific gravity of wood _____

3. Whether sale price of wood includes the transportation costs from the farm location to a power plant site. If yes, please indicate the distance and unit transportation cost. _____

_____

_____

4. A statement about the timeliness and reliability of cash loan to this farm module. _____

_____

_____

5. Is the annual income earned by farmers on this module (check one): higher ( ), same ( ), lower ( ) as that provided by other job opportunities in the community?

   If you checked lower, please complete this statement about other job opportunities which have better income. The average annual income for a farmer on this module is _____ pesos, and the average annual income for a readily available job in this community is about _____ pesos.

6. A statement about the availability of technical assistance on silviculture to this farm module.

_____

_____

_____

_____

_____

7. Please give current roadside market prices of firewood by species in this farm community.

Wood Species	Unit*	Price (Pesos)	Availability (check one) Abundant	Normal	Scarce

* Prefer in weight.

Comments: _____

Farm Module Rating Consideration and Rating of All Tree Farms under the DENDRO Program

If all tree farm modules selected under this study are rated as poor, fair, good, and excellent, please give your rating on each farm module based on the considering factors given in the following table. (Your rating is important to us in the evaluation on the forecast of financial-economic feasibility of the DENDRO Thermal Program.)

Rating of Farm Modules Based on the Growth-Yield Conditions

	Condition	Poor	Fair	Good	Excellent
1.	Soil conditions	Acidic soils	Slightly acidic	Near neutral	Neutral soils
2.	Average height in meters after 5 years	7	10	13	16
3.	Yield after 4 years (cu.m./ha.)	70 and below	71-120	121-220	221 and up
4.	Growth per year (tons/ha./year)	20 and below	21-30	31-40	41 and up

Please provide the following information on the individual(s) who filled out the questionnaire.

Name _____

Title _____

Agency _____

Address _____

Telephone _____

Please return questionnaire by May 15, 1984 to :

LEA F. BEDANO
Division Manager - Agro-Forestry Division
DENDRO Thermal Development Office
National Electrification Administration
4th Floor, D & E Building
Quezon Avenue,
Quezon City

RATING SHEET

Coop	Module	Soil Condition		Average Height		Yield after 4 years		Growth per year	
		Data	Rating	Data (m)	Rating	Data (cu.m./ha)	Rating	Data (tons/ha/ year)	Rating
	I								
	II								
	III								
	IV								
	V								
	VI								
	VII								
	VIII								
	IX								
	X								
	XI								

APPENDIX B

Power Plant Detailed Financial Data

Power Plant Projected Income Statements in Baseline Case

B-1 CASURECO IV-A

B-2 ZAMECO

B-3 OMECO

B-4 ANTECO

B-5 PANELCO I

B-6 ISECO

Power Plant Financial Cash Flow Including Debt Service

B-7 CASURECO IV-A

B-8 ZAMECO

B-9 OMECO

B-10 ANTECO

B-11 PANELCO I

B-12 ISECO

Appendix Table B-1

CASURECO IV-A POWER PLANT PROJECTED INCOME STATEMENT IN BASELINE CASE
(in thousands of 1984 pesos)

		Production Costs											
		Operating Costs						Interest					
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Gov't	Commercial	NEA	Depreciation	Total Production Costs	Net Income
1985 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**		**3,758**	**719**	**2,764**	**12,828**	**5,345**
LC		2,624	452	985	805	269	5,135			719	2,764		
FC			452				452		3,758				
1986 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**		**3,501**	**699**	**2,764**	**12,551**	**5,622**
LC		2,624	452	985	805	269	5,135			699	2,764		
FC			452				452		3,501				
1987 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**		**3,224**	**679**	**2,764**	**12,254**	**5,919**
LC		2,624	452	985	805	269	5,135			679	2,764		
FC			452				452		3,224				
1988 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**60**	**2,924**	**2,083**	**2,764**	**13,418**	**4,755**
LC		2,624	452	985	805	269	5,135			2,083	2,764		
FC			452				452	60	2,924				
1989 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**58**	**2,599**	**2,052**	**2,764**	**13,060**	**5,113**
LC		2,624	452	985	805	269	5,135			2,052	2,764		
FC			452				452	58	2,599				
1990 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**56**	**2,247**	**2,018**	**2,764**	**12,672**	**5,501**
LC		2,624	452	985	805	269	5,135			2,018	2,764		
FC			452				452	56	2,247				
1991 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**53**	**1,866**	**1,980**	**2,764**	**12,250**	**5,923**
LC		2,624	452	985	805	269	5,135			1,980	2,764		
FC			452				452	53	1,866				
1992 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**51**	**1,453**	**1,940**	**2,764**	**11,795**	**6,378**
LC		2,624	452	985	805	269	5,135			1,940	2,764		
FC			452				452	51	1,453				
1993 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**49**	**1,007**	**1,895**	**2,764**	**11,302**	**6,811**
LC		2,624	452	985	805	269	5,135			1,895	2,764		
FC			452				452	49	1,007				
1994 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**47**	**523**	**1,846**	**2,764**	**10,767**	**7,406**
LC		2,624	452	985	805	269	5,135			1,846	2,764		
FC			452				452	47	523				
1995 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**44**		**1,792**	**2,764**	**10,187**	**7,986**
LC		2,624	452	985	805	269	5,135			1,792	2,764		
FC			452				452	44					
1996 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**42**		**1,734**	**2,764**	**10,127**	**8,046**
LC		2,624	452	985	805	269	5,135	42			2,764		
FC			452				452						

Appendix Table B-1 (cont.)

		Production Costs											
		Operating Costs											
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Interest Gov't	Interest Commercial	Interest NEA	Depreciation	Total Production Costs	Net Income
1997 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**40**		**1,669**	**2,764**	**10,060**	**8,113**
LC		2,624	452	985	805	269	5,135			1,669	2,764		
FC			452				452	40					
1998 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**37**		**1,599**	**2,764**	**9,987**	**8,186**
LC		2,624	452	985	805	269	5,135			1,599	2,764		
FC			452				452	37					
1999 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**35**		**1,522**	**2,764**	**9,908**	**8,265**
LC		2,624	452	985	805	269	5,135			1,522	2,764		
FC			452				452	35					
2000 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**33**		**1,438**	**2,764**	**9,822**	**8,351**
LC		2,624	452	985	805	269	5,135			1,438	2,764		
FC			452				452	33					
2001 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**30**		**1,345**	**2,764**	**9,726**	**8,447**
LC		2,624	452	985	805	269	5,135			1,345	2,764		
FC			452				452	30					
2002 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**28**		**1,244**	**2,764**	**9,623**	**8,550**
LC		2,624	452	985	805	269	5,135			1,244	2,764		
FC			452				452	28					
2003 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**25**		**1,133**	**2,764**	**9,509**	**8,664**
LC		2,624	452	985	805	269	5,135			1,133	2,764		
FC			452				452	25					
2004 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**23**		**1,012**	**2,764**	**9,386**	**8,787**
LC		2,624	452	985	805	269	5,135			1,012	2,764		
FC			452				452	23					
2005 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**20**		**879**	**2,764**	**9,250**	**8,923**
LC		2,624	452	985	805	269	5,135			879	2,764		
FC			452				452	20					
2006 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**18**		**734**	**2,764**	**9,103**	**9,070**
LC		2,624	452	985	805	269	5,135			734	2,764		
FC			452				452	18					
2007 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**15**		**574**	**2,764**	**8,940**	**9,233**
LC		2,624	452	985	805	269	5,135			574	2,764		
FC			452				452	15					
2008 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**13**		**400**	**2,764**	**8,764**	**9,409**
LC		2,624	452	985	805	269	5,135			400	2,764		
FC			452				452	13					
2009 Total	**18,173**	**2,624**	**904**	**985**	**805**	**269**	**5,587**	**10**		**209**	**2,764**	**8,570**	**9,603**
LC		2,624	452	985	805	269	5,135			209	2,764		
FC			452				452	10					

Appendix Table B-2

ZAMECO POWER PLANT PROJECTED INCOME STATEMENT IN BASELINE CASE
(In thousands of 1984 pesos)

		Production Costs											
		Operating Costs											
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Interest Gov't	Interest Commercial	Interest NEA	Depreciation	Total Production Costs	Net Income
1985 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**		**3,758**	**681**	**2,711**	**14,191**	**8,647**
LC		4,078	452	985	805	269	6,589			681	2,711		
FC			452				452		3,758				
1986 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**		**3,501**	**662**	**2,711**	**13,915**	**8,923**
LC		4,078	452	985	805	269	6,589			662	2,711		
FC			452				451		3,501				
1987 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**		**3,224**	**643**	**2,711**	**13,639**	**9,219**
LC		4,078	452	985	805	269	6,589			643	2,711		
FC			452				451		3,224				
1988 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**60**	**2,924**	**1,973**	**2,711**	**14,709**	**8,129**
LC		4,078	452	985	805	269	6,589			1,973	2,711		
FC			452				451	60	2,924				
1989 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**58**	**2,598**	**1,944**	**2,711**	**14,352**	**8,486**
LC		4,078	452	985	805	269	6,589			1,944	2,711		
FC			452				452	58	2,598				
1990 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**56**	**2,246**	**1,911**	**2,711**	**13,965**	**8,873**
LC		4,078	452	985	805	269	6,589			1,911	2,711		
FC			452				451	56	2,246				
1991 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**53**	**1,865**	**1,876**	**2,711**	**13,546**	**9,292**
LC		4,078	452	985	805	269	6,589			1,876	2,711		
FC			452				451	53	1,865				
1992 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**51**	**1,482**	**1,837**	**2,711**	**13,122**	**9,716**
LC		4,078	452	985	805	269	6,589			1,837	2,711		
FC			452				451	51	1,482				
1993 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**49**	**1,006**	**1,795**	**2,711**	**12,602**	**10,236**
LC		4,078	452	985	805	269	6,589			1,795	2,711		
FC			452				452	49	1,006				
1994 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**47**	**523**	**1,719**	**2,711**	**12,041**	**10,797**
LC		4,078	452	985	805	269	6,589			1,719	2,711		
FC			452				451	47	523				
1995 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**44**		**1,698**	**2,711**	**11,494**	**11,344**
LC		4,078	452	985	805	269	6,589			1,698	2,711		
FC			452				451	44					
1996 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**42**		**1,642**	**2,711**	**11,436**	**11,402**
LC		4,078	452	985	805	269	6,589			1,642	2,711		
FC			452				451	42					

Appendix Table B-2 (cont.)

		Production Costs											
		Operating Costs											
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Interest Gov't	Interest Commercial	Interest NEA	Depreciation	Total Production Costs	Net Income
1997 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**40**		**1,581**	**2,711**	**11,373**	**11,465**
LC		4,078	452	985	805	269	6,589			1,581	2,711		
FC			452				452	40					
1998 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**37**		**1,515**	**2,711**	**11,304**	**11,534**
LC		4,078	452	985	805	269	6,589			1,515	2,711		
FC			452				451	37					
1999 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**35**		**1,442**	**2,711**	**11,229**	**11,609**
LC		4,078	452	985	805	269	6,589			1,442	2,711		
FC			452				451	35					
2000 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**33**		**1,362**	**2,711**	**11,147**	**11,691**
LC		4,078	452	985	805	269	6,589			1,362	2,711		
FC			452				451	33					
2001 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**30**		**1,274**	**2,711**	**11,056**	**11,782**
LC		4,078	452	985	805	269	6,589			1,274	2,711		
FC			452				452	30					
2002 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**28**		**1,178**	**2,711**	**10,958**	**11,880**
LC		4,078	452	985	805	269	6,589			1,178	2,711		
FC			452				451	28					
2003 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**25**		**1,074**	**2,711**	**10,851**	**11,987**
LC		4,078	452	985	805	269	6,589			1,074	2,711		
FC			452				451	25					
2004 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**23**		**959**	**2,711**	**10,734**	**12,104**
LC		4,078	452	985	805	269	6,589			959	2,711		
FC			452				451	23					
2005 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**20**		**833**	**2,711**	**10,605**	**12,233**
LC		4,078	452	985	805	269	6,589			833	2,711		
FC			452				452	20					
2006 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**18**		**695**	**2,711**	**10,465**	**12,373**
LC		4,078	452	985	805	269	6,589			695	2,711		
FC			452				451	18					
2007 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**15**		**544**	**2,711**	**10,311**	**12,527**
LC		4,078	452	985	805	269	6,589			544	2,711		
FC			452				451	15					
2008 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**13**		**379**	**2,711**	**10,144**	**12,694**
LC		4,078	452	985	805	269	6,589			379	2,711		
FC			452				451	13					
2009 Total	**22,838**	**4,078**	**904**	**985**	**805**	**269**	**7,041**	**10**		**198**	**2,711**	**9,960**	**12,873**
LC		4,078	452	985	805	269	6,589			198	2,711		
FC			452				451	10					

Appendix Table B-3

OMECO POWER PLANT PROJECTED INCOME STATEMENT IN BASELINE CASE
(In thousands of 1984 pesos)

		Production Costs											
		Operating Costs											
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Interest Gov't	Interest Commercial	Interest NEA	Depreciation	Total Production Costs	Net Income
1985 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**		**132**	**221**	**646**	**3,377**	**3,285**
LC		280	89	622	183	147	1,321			221	646		
FC			89				89		132				
1986 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**		**120**	**215**	**646**	**3,359**	**3,303**
LC		280	89	622	183	147	1,321			215	646		
FC			89				89		120				
1987 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**97**	**108**	**209**	**646**	**3,438**	**3,224**
LC		280	89	622	183	147	1,321			209	646		
FC			89				89	97	108				
1988 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**92**	**95**	**640**	**646**	**3,851**	**2,811**
LC		280	89	622	183	147	1,321			640	646		
FC			89				89	92	95				
1989 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**86**	**83**	**630**	**646**	**3,874**	**2,839**
LC		280	89	622	183	147	1,321			630	646		
FC			89				89	86	83				
1990 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**80**	**287**	**620**	**646**	**4,011**	**2,651**
LC		280	89	622	183	147	1,321			620	646		
FC			89				89	80	287				
1991 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**74**	**238**	**608**	**646**	**3,944**	**2,718**
LC		280	89	622	183	147	1,321			608	646		
FC			89				89	74	238				
1992 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**144**	**185**	**596**	**646**	**3,949**	**2,713**
LC		280	89	622	183	147	1,321			596	646		
FC			89				89	144	185				
1993 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**132**	**128**	**582**	**646**	**3,866**	**2,796**
LC		280	89	622	183	147	1,321			582	646		
FC			89				89	132	128				
1994 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**120**	**67**	**567**	**646**	**3,778**	**2,884**
LC		280	89	622	183	147	1,321			567	646		
FC			89				89	120	67				
1995 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**107**		**551**	**646**	**3,682**	**2,980**
LC		280	89	622	183	147	1,321			551	646		
FC			89				89	107					
1996 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**94**		**533**	**646**	**3,651**	**3,011**
LC		280	89	622	183	147	1,321			533	646		
FC			89				89	94					

Appendix Table B-3 (cont.)

		Production Costs											
		Operating Costs						Interest					
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Gov't	Commercial	NEA	Depreciation	Total Production Costs	Net Income
1997 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**80**		**513**	**646**	**2,617**	**3,045**
LC		280	89	622	183	147	1,321			513	646		
FC			89				89	80					
1998 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**65**		**491**	**646**	**3,580**	**3,082**
LC		280	89	622	183	147	1,321			491	646		
FC			89				89	65					
1999 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**50**		**468**	**646**	**3,542**	**3,120**
LC		280	89	622	183	147	1,321			468	646		
FC			89				89	50					
2000 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**34**		**442**	**646**	**3,500**	**3,162**
LC		280	89	622	183	147	1,321			442	646		
FC			89				89	34					
2001 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**	**17**		**413**	**646**	**3,454**	**3,208**
LC		280	89	622	183	147	1,321			413	646		
FC			89				89	17					
2002 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**			**382**	**646**	**3,406**	**3,256**
LC		280	89	622	183	147	1,321			382	646		
FC			89				89						
2003 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**			**348**	**646**	**3,372**	**3,290**
LC		280	89	622	183	147	1,321			348	646		
FC			89				89						
2004 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**			**311**	**646**	**3,335**	**3,327**
LC		280	89	622	183	147	1,321			311	646		
FC			89				89						
2005 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**			**270**	**646**	**3,294**	**3,368**
LC		280	89	622	183	147	1,321			270	646		
FC			89				89						
2006 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**			**225**	**646**	**3,249**	**3,413**
LC		280	89	622	183	147	1,321			225	646		
FC			89				89						
2007 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**			**176**	**646**	**3,200**	**3,462**
LC		280	89	622	183	147	1,321			176	646		
FC			89				89						
2008 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**			**123**	**646**	**3,147**	**3,515**
LC		280	89	622	183	147	1,321			123	646		
FC			89				89						
2009 Total	**5,694**	**280**	**178**	**622**	**183**	**147**	**1,410**			**64**	**646**	**3,088**	**3,574**
LC		280	89	622	183	147	1,321			64	646		
FC			89				89						

Appendix Table B-4

ANTECO POWER PLANT PROJECTED INCOME STATEMENT IN BASELINE CASE
(in thousands of 1984 pesos)

		Production Costs											
		Operating Costs						Interest					
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Gov't	Commercial	NEA	Depreciation	Total Production Costs	Net Income
1985 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,552**		**132**	**506**	**1,034**	**3,224**	**3,994**
LC		422	89	622	183	147	1,463			506	1,034		
FC			89				89		132				
1986 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,552**		**120**	**492**	**1,034**	**3,198**	**4,020**
LC		422	89	622	183	147	1,463			492	1,034		
FC			89				89		120				
1987 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,552**	**97**	**108**	**478**	**1,034**	**3,269**	**3,949**
LC		422	89	622	183	147	1,463			478	1,034		
FC			89				89	97	108				
1988 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,522**	**92**	**95**	**1,466**	**1,034**	**4,239**	**2,979**
LC		422	89	622	183	147	1,463			1,466	1,034		
FC			89				89	92	95				
1989 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,522**	**86**	**83**	**1,445**	**1,034**	**4,200**	**3,018**
LC		422	89	622	183	147	1,463			1,445	1,034		
FC			89				89	86	83				
1990 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,522**	**80**	**287**	**1,421**	**1,034**	**4,374**	**2,844**
LC		422	89	622	183	147	1,463			1,421	1,034		
FC			89				89	80	287				
1991 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,522**	**74**	**238**	**1,394**	**1,034**	**4,292**	**2,926**
LC		422	89	622	183	147	1,463			1,394	1,034		
FC			89				89	74	238				
1992 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,522**	**144**	**185**	**1,366**	**1,034**	**4,281**	**2,937**
LC		422	89	622	183	147	1,463			1,366	1,034		
FC			89				89	144	185				
1993 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,522**	**132**	**128**	**1,334**	**1,034**	**4,180**	**3,038**
LC		422	89	622	183	147	1,463			1,334	1,034		
FC			89				89	132	128				
1994 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,522**	**120**	**67**	**1,300**	**1,034**	**4,073**	**3,145**
LC		422	89	622	183	147	1,463			1,300	1,034		
FC			89				89	120	67				
1995 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,522**	**107**		**1,262**	**1,034**	**3,955**	**3,263**
LC		422	89	622	183	147	1,463			1,262	1,034		
FC			89				89	107					
1996 Total	**7,218**	**422**	**178**	**622**	**183**	**147**	**1,522**	**94**		**1,221**	**1,034**	**3,901**	**3,317**
LC		422	89	622	183	147	1,463			1,221	1,034		
FC			89				89	94					

Appendix Table B-4 (cont.)

	Total Revenues	Production Costs											
		Operating Costs						Interest				Total Production Costs	Net Income
		Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Gov't	Commercial	NEA	Depreciation		
1997 Total	7,218	422	178	622	183	147	1,552	80		1,175	1,034	3,841	3,377
LC		422	89	622	183	147	1,463			1,175	1,034		
FC			89				89	80					
1998 Total	7,218	422	178	622	183	147	1,522	65		1,126	1,034	3,777	3,442
LC		422	89	622	183	147	1,463			1,126	1,034		
FC			89				89	65					
1999 Total	7,218	422	178	622	183	147	1,522	50		1,072	1,034	3,708	3,510
LC		422	89	622	183	147	1,463			1,072	1,034		
FC			89				89	50					
2000 Total	7,218	422	178	622	183	147	1,522	34		1,012	1,034	3,632	3,586
LC		422	89	622	183	147	1,463			1,012	1,034		
FC			89				89	34					
2001 Total	7,218	422	178	622	183	147	1,522	17		947	1,034	3,550	3,668
LC		422	89	622	183	147	1,463			947	1,034		
FC			89				89	17					
2002 Total	7,218	422	178	622	183	147	1,522			876	1,034	3,462	3,756
LC		422	89	622	183	147	1,463			876	1,034		
FC			89				89						
2003 Total	7,218	422	178	622	183	147	1,522			798	1,034	3,384	3,834
LC		422	89	622	183	147	1,463			798	1,034		
FC			89				89						
2004 Total	7,218	422	178	622	183	147	1,522			712	1,034	3,298	3,920
LC		422	89	622	183	147	1,463			712	1,034		
FC			89				89						
2005 Total	7,218	422	178	622	183	147	1,522			619	1,034	3,205	4,013
LC		422	89	622	183	147	1,463			619	1,034		
FC			89				89						
2006 Total	7,218	422	178	622	183	147	1,522			517	1,034	3,103	4,115
LC		422	89	622	183	147	1,463			517	1,034		
FC			89				89						
2007 Total	7,218	422	178	622	183	147	1,522			404	1,034	2,990	4,228
LC		422	89	622	183	147	1,463			404	1,034		
FC			89				89						
2008 Total	7,218	422	178	622	183	147	1,522			282	1,034	2,868	4,350
LC		422	89	622	183	147	1,463			282	1,034		
FC			89				89						
2009 Total	7,218	422	178	622	183	147	1,522			147	1,034	2,737	4,485
LC		422	89	622	183	147	1,463			147	1,034		
FC			89				89						

Appendix Table B-5

PANELCO I POWER PLANT PROJECTED INCOME STATEMENT IN BASELINE CASE
(In thousands of 1984 pesos)

		Production Costs											
		Operating Costs											
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Interest Gov't	Interest Commercial	Interest NEA	Depreciation	Total Production Costs	Net Income
1985 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**		**1,458**	**882**	**2,134**	**9,853**	**9,255**
LC		3,283	272	805	474	273	5,107			882	2,134		
FC			272				272		1,458				
1986 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**		**1,359**	**858**	**2,134**	**9,750**	**9,378**
LC		3,283	272	805	474	273	5,107			858	2,134		
FC			272				272		1,359				
1987 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**182**	**1,251**	**833**	**2,134**	**9,777**	**9,329**
LC		3,283	272	805	474	273	5,107			833	2,134		
FC			272				272	182	1,251				
1988 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**176**	**1,134**	**2,556**	**2,134**	**11,379**	**7,729**
LC		3,283	272	805	474	273	5,107			2,556	2,134		
FC			272				272	176	1,134				
1989 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**170**	**1,008**	**2,578**	**2,134**	**11,269**	**7,839**
LC		3,283	272	805	474	273	5,107			2,578	2,134		
FC			272				272	170	1,008				
1990 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**164**	**872**	**2,476**	**2,134**	**11,025**	**8,083**
LC		3,283	272	805	474	273	5,107			2,476	2,134		
FC			272				272	164	872				
1991 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**157**	**724**	**2,430**	**2,134**	**10,824**	**8,284**
LC		3,283	272	805	474	273	5,107			2,430	2,134		
FC			272				272	157	724				
1992 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**150**	**564**	**2,380**	**2,134**	**10,607**	**8,501**
LC		3,283	272	805	474	273	5,107			2,380	2,134		
FC			272				272	150	564				
1993 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**142**	**391**	**2,325**	**2,134**	**10,371**	**8,737**
LC		3,283	272	805	474	273	5,107			2,325	2,134		
FC			272				272	142	391				
1994 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**135**	**203**	**2,265**	**2,134**	**10,116**	**8,992**
LC		3,283	272	805	474	273	5,107			2,265	2,134		
FC			272				272	135	203				
1995 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**127**		**2,199**	**2,134**	**9,839**	**9,269**
LC		3,283	272	805	474	273	5,107			2,199	2,134		
FC			272				272	127					
1996 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**118**		**2,127**	**2,134**	**9,758**	**9,350**
LC		3,283	272	805	474	273	5,107			2,127	2,134		
FC			272				272	118					

Appendix Table B-5 (cont.)

		Production Costs											
		Operating Costs						Interest					
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Gov't	Commercial	NEA	Depreciation	Total Production Costs	Net Income
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**110**		**2,049**	**2,134**	**9,672**	**9,436**
LC		3,283	272	805	474	273	5,107			2,049	2,134		
FC			272				272	110					
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**101**		**1,962**	**2,134**	**9,576**	**9,532**
LC		3,283	272	805	474	273	5,107			1,962	2,134		
FC			272				272	101					
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**91**		**1,868**	**2,134**	**9,472**	**9,636**
LC		3,283	272	805	474	273	5,107			1,868	2,134		
FC			272				272	91					
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**81**		**1,764**	**2,134**	**9,358**	**9,750**
LC		3,283	272	805	474	273	5,107			1,764	2,134		
FC			272				272	81					
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**71**		**1,651**	**2,134**	**9,235**	**9,873**
LC		3,283	272	805	474	273	5,107			1,651	2,134		
FC			272				272	71					
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**61**		**1,527**	**2,134**	**9,101**	**10,007**
LC		3,283	272	805	474	273	5,107			1,527	2,134		
FC			272				272	61					
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**49**		**1,391**	**2,134**	**8,953**	**10,155**
LC		3,283	272	805	474	273	5,107			1,391	2,134		
FC			272				272	49					
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**38**		**1,242**	**2,134**	**8,793**	**10,315**
LC		3,283	272	805	474	273	5,107			1,242	2,134		
FC			272				272	38					
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**26**		**1,079**	**2,134**	**8,618**	**10,490**
LC		3,283	272	805	474	273	5,107			1,079	2,134		
FC			272				272	26					
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**	**13**		**900**	**2,134**	**8,426**	**10,682**
LC		3,283	272	805	474	273	5,107			900	2,134		
FC			272				272	13					
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**			**750**	**2,134**	**8,218**	**10,890**
LC		3,283	272	805	474	273	5,107			750	2,134		
FC			272				272						
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**			**491**	**2,134**	**8,004**	**11,104**
LC		3,283	272	805	474	273	5,107			491	2,134		
FC			272				272						
1997 Total	**19,108**	**3,283**	**544**	**805**	**474**	**273**	**5,379**			**257**	**2,134**	**7,806**	**11,302**
LC		3,283	272	805	474	273	5,107			257	2,134		
FC			272				272						

Appendix Table B-6

ISECO POWER PLANT PROJECTED INCOME STATEMENT IN BASELINE CASE
(in thousands of 1984 pesos)

		Production Costs											
		Operating Costs						Interest					
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Gov't	Commercial	NEA	Depreciation	Total Production Costs	Net Income
1985 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**		**1,458**	**796**	**1986**	**9,474**	**10,610**
LC		3,299	237	770	439	252	4,997			796	1986		
FC			237				237		1,458				
1986 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**		**1,359**	**774**	**1986**	**9,353**	**10,731**
LC		3,299	237	770	439	252	4,997			774	1986		
FC			237				237		1,359				
1987 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**182**	**1,251**	**751**	**1986**	**9,404**	**10,680**
LC		3,299	237	770	439	252	4,997			751	1986		
FC			237				237	182	1,251				
1988 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**176**	**1,134**	**2,306**	**1986**	**10,853**	**9,221**
LC		3,299	237	770	439	252	4,997			2,306	1986		
FC			237				237	176	1,134				
1989 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**170**	**1,008**	**2,271**	**1986**	**10,689**	**9,415**
LC		3,299	237	770	439	252	4,997			2,271	1986		
FC			237				237	170	1,008				
1990 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**164**	**872**	**2,234**	**1986**	**10,480**	**9,594**
LC		3,299	237	770	439	252	4,997			2,234	1986		
FC			237				237	164	872				
1991 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**157**	**724**	**2,192**	**1986**	**10,283**	**9,791**
LC		3,299	237	770	439	252	4,997			2,192	1986		
FC			237				237	157	724				
1992 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**150**	**564**	**2,147**	**1986**	**10,071**	**10,003**
LC		3,299	237	770	439	252	4,997			2,147	1986		
FC			237				237	150	564				
1993 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**142**	**391**	**2,098**	**1986**	**9,841**	**10,233**
LC		3,299	237	770	439	252	4,997			2,098	1986		
FC			237				237	142	391				
1994 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**135**	**203**	**2,044**	**1986**	**9,472**	**10,602**
LC		3,299	237	770	439	252	4,997			2,044	1986		
FC			237				237	135	203				
1995 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**127**		**1,984**	**1986**	**9,321**	**10,753**
LC		3,299	237	770	439	252	4,997			1,984	1986		
FC			237				237	127					
1996 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**118**		**1,919**	**1986**	**9,247**	**10,827**
LC		3,299	237	770	439	252	4,997			1,919	1986		
FC			237				237	118					

Appendix Table B-6 (cont.)

	Production Costs												
		Operating Costs						Interest					
	Total Revenues	Fuel	Production Materials	Skilled Labor	Unskilled Labor	Admin. Overhead	Total Operating Cost	Gov't	Commercial	NEA	Depreciation	Total Production Costs	Net Income
1997 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**110**		**1,848**	**1986**	**9,168**	**10,906**
LC		3,299	237	770	439	252	4,997			1,848	1986		
FC			237				237	110					
1998 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**101**		**1,770**	**1986**	**9,081**	**10,993**
LC		3,299	237	770	439	252	4,997			1,770	1986		
FC			237				237	101					
1999 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**91**		**1,685**	**1986**	**8,996**	**11,088**
LC		3,299	237	770	439	252	4,997			1,685	1986		
FC			237				237	91					
2000 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**81**		**1,592**	**1986**	**8,883**	**11,191**
LC		3,299	237	770	439	252	4,997			1,592	1986		
FC			237				237	81					
2001 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**71**		**1,489**	**1986**	**8,770**	**11,304**
LC		3,299	237	770	439	252	4,997			1,489	1986		
FC			237				237	71					
2002 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**61**		**1,377**	**1986**	**8,648**	**11,426**
LC		3,299	237	770	439	252	4,997			1,377	1986		
FC			237				237	61					
2003 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**49**		**1,255**	**1986**	**8,514**	**11,560**
LC		3,299	237	770	439	252	4,997			1,255	1986		
FC			237				237	49					
2004 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**38**		**1,120**	**1986**	**8,368**	**11,706**
LC		3,299	237	770	439	252	4,997			1,120	1986		
FC			237				237	38					
2005 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**26**		**923**	**1986**	**8,159**	**11,915**
LC		3,299	237	770	439	252	4,997			923	1986		
FC			237				237	26					
2006 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**	**13**		**812**	**1986**	**8,035**	**12,039**
LC		3,299	237	770	439	252	4,997			812	1986		
FC			237				237	13					
2007 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**			**636**	**1986**	**7,846**	**12,228**
LC		3,299	237	770	439	252	4,997			636	1986		
FC			237				237						
2008 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**			**443**	**1986**	**7,653**	**12,421**
LC		3,299	237	770	439	252	4,997			443	1986		
FC			237				237						
2009 Total	**20,084**	**3,299**	**474**	**770**	**439**	**252**	**5,234**			**231**	**1986**	**7,441**	**12,633**
LC		3,299	237	770	439	252	4,997			231	1986		
FC			237				237						

Appendix Table B-7

CASURECO IV-A POWER PLANT FINANCIAL CASH FLOW INCLUDING DEBT SERVICE
(in thousands 1984 pesos)

	Inflow			Outflow										(A-B)
		Loan	(A)	Investment			Prod. Materials		Labor		Admin.	Debt	(B)	Cash
	Revenues	Proceeds	Total	Foreign	Local	Fuel	Foreign	Local	Skilled	Unskilled	Overhead	Service	Total	Balance
1980		4,620	4,620	4,620									4,620	0
1981		66,583	66,583	63,474	3,109								66,583	0
1982		10,306	10,306	3,359	6,947								10,306	0
1983		13,957	13,957	1,428	12,529								13,957	0
1984						2,624	452	452	985	805	269	8,241	14,871	4,345
1985	18,173		18,173			2,624	452	452	985	805	269	8,241	14,871	4,345
1986	18,173		18,173			2,624	452	452	985	805	269	8,241	14,871	4,345
1987	18,173		18,173			2,624	452	452	985	805	269	9,628	16,258	2,955
1988	18,173		18,173			2,624	452	452	985	805	269	9,628	16,258	2,955
1989	18,173		18,173			2,624	452	452	985	805	269	9,628	16,258	2,955
1990	18,173		18,173			2,624	452	452	985	805	269	9,628	16,258	2,955
1991	18,173		18,173			2,624	452	452	985	805	269	9,628	16,258	2,955
1992	18,173		18,173			2,624	452	452	985	805	269	9,628	16,258	2,955
1993	18,173		18,173			2,624	452	452	985	805	269	9,628	16,258	2,955
1994	18,173		18,173			2,624	452	452	985	805	269	2,763	9,393	9,823
1995	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
1996	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
1997	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
1998	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
1999	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
2000	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
2001	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
2002	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
2003	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
2004	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
2005	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
2006	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
2007	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
2008	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823
2009	18,173		18,173			2,624	452	452	985	805	269	2,636	9,393	9,823

Appendix Table B-8

ZAMECO POWER PLANT FINANCIAL CASH FLOW INCLUDING DEBT SERVICE
(In thousands 1984 pesos)

	Inflow			Outflow										(A-B)
		Loan	(A)	Investment			Prod. Materials		Labor		Admin.	Debt	(B)	Cash
	Revenues	Proceeds	Total	Foreign	Local	Fuel	Foreign	Local	Skilled	Unskilled	Overhead	Service	Total	Balance
1980														
1981		6,167	6,167	6,167									6,167	0
1982		65,134	65,134	63,314	1,229								65,134	0
1983		14,309	14,309	5,281	9,028								14,309	0
1984		9,794	9,794	1,828	7,966								9,794	0
1985	22,838		22,838			4,078	452	452	985	805	269	8,168	14,899	7,647
1986	22,838		22,838			4,078	452	452	985	805	269	8,168	14,899	7,647
1987	22,838		22,838			4,078	452	452	985	805	269	8,168	14,899	7,647
1988	22,838		22,838			4,078	452	452	985	805	269	9,501	16,232	6,296
1989	22,838		22,838			4,078	452	452	985	805	269	9,501	16,232	6,296
1990	22,838		22,838			4,078	452	452	985	805	269	9,501	16,232	6,296
1991	22,838		22,838			4,078	452	452	985	805	269	9,501	16,232	6,296
1992	22,838		22,838			4,078	452	452	985	805	269	9,501	16,232	6,296
1993	22,838		22,838			4,078	452	452	985	805	269	9,501	16,232	6,296
1994	22,838		22,838			4,078	452	452	985	805	269	9,501	16,232	6,296
1995	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
1996	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
1997	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
1998	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
1999	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
2000	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
2001	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
2002	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
2003	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
2004	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
2005	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
2006	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
2007	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
2008	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161
2009	22,838		22,838			4,078	452	452	985	805	269	2,636	9,367	13,161

Appendix Table B-9

OMECO POWER PLANT FINANCIAL CASH FLOW INCLUDING DEBT SERVICE
(in thousands 1984 pesos)

	Inflow			Outflow										(A-B)
				Investment			Prod. Materials		Labor		Admin.	Debt	(B)	Cash
	Revenues	Loan Proceeds	(A) Total	Foreign	Local	Fuel	Foreign	Local	Skilled	Unskilled	Overhead	Service	Total	Balance
1980													0	0
1981													0	0
1982		12,513	12,513	12,513									12,513	0
1983		4,837	4,837	1,506	3,331								4,837	0
1984		4,246	4,246	284	3,962								4,246	0
1985	5,694		5,694			280	89	89	622	183	147	1,160	2,570	3,124
1986	5,694		5,694			280	89	89	622	183	147	1,160	2,570	3,124
1987	5,694		5,694			280	89	89	622	183	147	1,538	2,948	2,746
1988	5,694		5,694			280	89	89	622	183	147	1,855	3,265	2,429
1989	5,694		5,694			280	89	89	622	183	147	1,855	3,265	2,429
1990	5,694		5,694			280	89	89	622	183	147	1,994	3,404	2,290
1991	5,694		5,694			280	89	89	622	183	147	1,994	3,404	2,290
1992	5,694		5,694			280	89	89	622	183	147	2,040	3,450	2,244
1993	5,694		5,694			280	89	89	622	183	147	2,040	3,450	2,244
1994	5,694		5,694			280	89	89	622	183	147	2,040	3,450	2,244
1995	5,694		5,694			280	89	89	622	183	147	1,164	1,574	3,120
1996	5,694		5,694			280	89	89	622	183	147	1,164	1,574	3,120
1997	5,694		5,694			280	89	89	622	183	147	1,164	1,574	3,120
1998	5,694		5,694			280	89	89	622	183	147	1,164	1,574	3,120
1999	5,694		5,694			280	89	89	622	183	147	1,164	1,574	3,120
2000	5,694		5,694			280	89	89	622	183	147	1,164	1,574	3,120
2001	5,694		5,694			280	89	89	622	183	147	1,164	1,574	3,120
2002	5,694		5,694			280	89	89	622	183	147	740	2,150	3,544
2003	5,694		5,694			280	89	89	622	183	147	740	2,150	3,544
2004	5,694		5,694			280	89	89	622	183	147	740	2,150	3,544
2005	5,694		5,694			280	89	89	622	183	147	740	2,150	3,544
2006	5,694		5,694			280	89	89	622	183	147	740	2,150	3,544
2007	5,694		5,694			280	89	89	622	183	147	740	2,150	3,544
2008	5,694		5,694			280	89	89	622	183	147	740	2,150	3,544
2009	5,694		5,694			280	89	89	622	183	147	740	2,150	3,544

Appendix Table B-10

ANTECO POWER PLANT FINANCIAL CASH FLOW IN DEBT SERVICE
(in thousands 1984 pesos)

	Inflow			Outflow										(A-B)
		Loan	(A)	Investment			Prod. Materials		Labor		Admin.	Debt	(B)	Cash
	Revenues	Proceeds	Total	Foreign	Local	Fuel	Foreign	Local	Skilled	Unskilled	Overhead	Service	Total	Balance
1980														
1981		2,986	2,986	2,986									2,986	0
1982		22,898	22,898	13,979	8,919								22,898	0
1983		5,477	5,477	1,274	4,203								5,477	0
1984		4,647	4,647	273	4,245								4,647	0
1985	7,218		7,218			422	89	89	622	183	147	1,706	5,809	1,757
1986	7,218		7,218			422	89	89	622	183	147	1,706	5,809	1,757
1987	7,218		7,218			422	89	89	622	183	147	2,084	6,187	1,379
1988	7,218		7,218			422	89	89	622	183	147	2,812	6,915	651
1989	7,218		7,218			422	89	89	622	183	147	2,812	6,915	651
1990	7,218		7,218			422	89	89	622	183	147	2,951	7,054	512
1991	7,218		7,218			422	89	89	622	183	147	2,951	7,054	512
1992	7,218		7,218			422	89	89	622	183	147	2,996	7,099	467
1993	7,218		7,218			422	89	89	622	183	147	2,996	7,099	467
1994	7,218		7,218			422	89	89	622	183	147	2,996	7,099	467
1995	7,218		7,218			422	89	89	622	183	147	2,21	6,224	1,342
1996	7,218		7,218			422	89	89	622	183	147	2,21	6,224	1,342
1997	7,218		7,218			422	89	89	622	183	147	2,21	6,224	1,342
1998	7,218		7,218			422	89	89	622	183	147	2,21	6,224	1,342
1999	7,218		7,218			422	89	89	622	183	147	2,21	6,224	1,342
2000	7,218		7,218			422	89	89	622	183	147	2,21	6,224	1,342
2001	7,218		7,218			422	89	89	622	183	147	2,21	6,224	1,342
2002	7,218		7,218			422	89	89	622	183	147	1,697	5,800	1,766
2003	7,218		7,218			422	89	89	622	183	147	1,697	5,800	1,766
2004	7,218		7,218			422	89	89	622	183	147	1,697	5,800	1,766
2005	7,218		7,218			422	89	89	622	183	147	1,697	5,800	1,766
2006	7,218		7,218			422	89	89	622	183	147	1,697	5,800	1,766
2007	7,218		7,218			422	89	89	622	183	147	1,697	5,800	1,766
2008	7,218		7,218			422	89	89	622	183	147	1,697	5,800	1,766
2009	7,218		7,218			422	89	89	622	183	147	1,697	5,800	1,766

Appendix Table B-11

PANELCO I POWER PLANT FINANCIAL CASH FLOW INCLUDING DEBT SERVICE
(In thousands 1984 pesos)

	Inflow			Outflow										(A-B)
		Loan	(A)	Investment			Prod. Materials		Labor		Admin.	Debt	(B)*	Cash
	Revenues	Proceeds	Total	Foreign	Local	Fuel	Foreign	Local	Skilled	Unskilled	Overhead	Service	Total	Balance
1980														
1981		8,814	8,814	5,935	2,879								8,814	0
1982		43,160	24,803	36,763	6,397								43,160	0
1983		12,248	12,248	4,837	7,411								12,248	0
1984		10,057	10,057	3,104	6,953								10,057	0
1985	19,108		19,108			3,283	272	272	805	474	273	4,352	9,731	9,377
1986	19,108		19,108			3,283	272	272	805	474	273	4,352	9,731	9,377
1987	19,108		19,108			3,283	272	272	805	474	273	4,673	10,052	9,056
1988	19,108		19,108			3,283	272	272	805	474	273	5,943	11,322	7,786
1989	19,108		19,108			3,283	272	272	805	474	273	5,943	11,322	7,786
1990	19,108		19,108			3,283	272	272	805	474	273	5,943	11,322	7,786
1991	19,108		19,108			3,283	272	272	805	474	273	5,943	11,322	7,786
1992	19,108		19,108			3,283	272	272	805	474	273	5,943	11,322	7,786
1993	19,108		19,108			3,283	272	272	805	474	273	5,943	11,322	7,786
1994	19,108		19,108			3,283	272	272	805	474	273	5,943	11,322	7,786
1995	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
1996	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
1997	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
1998	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
1999	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
2000	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
2001	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
2002	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
2003	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
2004	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
2005	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
2006	19,108		19,108			3,283	272	272	805	474	273	3,280	8,659	10,449
2007	19,108		19,108			3,283	272	272	805	474	273	2,957	8,336	10,772
2008	19,108		19,108			3,283	272	272	805	474	273	2,957	8,336	10,772
2009	19,108		19,108			3,283	272	272	805	474	273	2,957	8,336	10,772

Appendix Table B-12

ISECO POWER PLANT FINANCIAL CASH FLOW INCLUDING DEBT SERVICE
(in thousands 1984 pesos)

	Inflow			Outflow										(A-B)
		Loan	(A)	Investment			Prod. Materials		Labor		Admin.	Debt	(B)	Cash
	Revenues	Proceeds	Total	Foreign	Local	Fuel	Foreign	Local	Skilled	Unskilled	Overhead	Service	Total	Balance
1980														
1981		5,006	5,006	5,006									5,006	0
1982		31,836	31,836	31,818	18								31,836	0
1983		14,083	14,083	2,388	11,695								14,083	0
1984		15,025	15,025	3,201	11,829								15,025	0
1985	20,084		20,084			3,299	237	237	770	439	22	4,187	9,740	10,663
1986	20,084		20,084			3,299	237	237	770	439	22	4,187	9,740	10,663
1987	20,084		20,084			3,299	237	237	770	439	22	4,509	10,062	10,341
1988	20,084		20,084			3,299	237	237	770	439	22	5,654	11,207	9,196
1989	20,084		20,084			3,299	237	237	770	439	22	5,654	11,207	9,196
1990	20,084		20,084			3,299	237	237	770	439	22	5,654	11,207	9,196
1991	20,084		20,084			3,299	237	237	770	439	22	5,654	11,207	9,196
1992	20,084		20,084			3,299	237	237	770	439	22	5,654	11,207	9,196
1993	20,084		20,084			3,299	237	237	770	439	22	5,654	11,207	9,196
1994	20,084		20,084			3,299	237	237	770	439	22	5,654	11,207	9,196
1995	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
1996	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
1997	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
1998	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
1999	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
2000	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
2001	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
2002	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
2003	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
2004	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
2005	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
2006	20,084		20,084			3,299	237	237	770	439	22	2,991	8,544	11,859
2007	20,084		20,084			3,299	237	237	770	439	22	2,668	8,221	12,182
2008	20,084		20,084			3,299	237	237	770	439	22	2,668	8,221	12,182
2009	20,084		20,084			3,299	237	237	770	439	22	2,668	8,221	12,182

APPENDIX C

Economic Analysis

C-1: Costs and Benefits for Tree Plantations in Baseline Case

C-2: Costs and Benefits for Tree Plantations in Replication Case

C-3: Costs and Benefits for Power Plants in Baseline and Replication Case

C-4: Costs and Benefits for Power Plants in Baseline and Replication Cases After Foreign Financing

Appendix Table C-1

Costs and Benefits for Tree Plantations in Baseline Case
(in thousands of 1984 pesos)

	Investment Costs[1]			Operating Costs[2]				
	Local Currency	Unskilled Labor	Total	Unskilled Labor	Maint.	Total	Benefits[3]	Net Benefits
CASURECO IV-A								
1981	-218	-187	-405					-405
1982	-76	-246	-322					-322
1983	-26	-170	-196					-196
1984	-23	0	-23					-23
1985-2009				-85	-28	-113	+496	+383
Residual								+1,727
ZAMECO								
1981	-370	-1,566	-1,936					-1,936
1982	-147	-428	-575					-575
1983	-90	-431	-521					-521
1984	-30	0	-30					-30
1985-2009				-128	-15	-143	+415	+272
Residual								+1,567
OMECO								
1981	-66	-159	-225					-225
1982	-42	-61	-103					-103
1983	-16	0	-16					-16
1984	-4	0	-4					-4
1985-2009				-42	-2	-44	+238	+194
Residual								+773
ANTECO								
1981	-66	-367	-433					-433
1982	-98	-427	-525					-525
1983	-84	-333	-417					-417
1984	*	-66	-67					-67
1985-2009				-85	-5	-90	+94	+4
Residual								-2,004
PANELCO								
1981	-57	-789	-846					-846
1982	-76	-1,769	-1,845					-1,849
1983	-222	-1,011	-1,233					-1,233
1984	-141	-416	-557					-557
1985-2009				-932	-11	-943	+2,246	+1,303
Residual								+8,760
ISECO								
1981	-153	-346	-499					-499
1982	-29	-580	-609					-609
1983	-39	-442	-481					-481
1984	-19	-84	-103					-103
1985-2009				-322	-60	-382	+926	+544
Residual								+2,660

1 See Table III-2.

2 See Tables III-3 through III-8.

3 See Table IV-1.

*less than one thousand pesos

Appendix Table C-2

Costs and Benefits for Tree Plantations in Replication Case
(in thousands of 1984 pesos)

	Investment Costs[1]			Operating Costs[2]				
	Local Currency	Unskilled Labor	Total	Unskilled Labor	Maint.	Total	Benefits[3]	Net Benefits
CASURECO IV-A								
1981-84	-200	-355	-555					-555
1985-2009				-342	-112	-454	+2,388	+1,934
Residual								+12,893
ZAMECO								
1981-1984	-246	-936	-1,182					-1,182
1985-2009				-674	-79	-753	+3,059	+2,306
Residual								+15,373
OMECO								
1981-84	-84	-144	-228					-228
1985-2009				-140	-67	-207	+1,109	+902
Residual								+6,013
ANTECO								
1981-84	-63	-303	-366					-366
1985-2009				-260	-15	-275	+515	+240
Residual								+1,600
PANELCO I								
1981-84	-112	-907	-1,019					-1,019
1985-2009				-950	-11	-961	+3,168	+2,207
Residual								+14,713
ISECO								
1981-84	-100	-601	-701					-701
1985-2009				-580	-108	-688	+2,336	+1,648
Residual								+10,987

1 See Table III-13

2 See Table III-15

3 See Table IV-1

Appendix Table C-3

Costs and Benefits For Power Plants in Baseline and Replication Cases
(in thousands of 1984 pesos)

	Investment Costs[1]				Operating Costs[2]					Net Benefits (Before Foreign Financing)	Foreign Financing[4]		Net Benefits (After Foreign Financing)
	Foreign Currency	Local Currency	Unskilled Labor	Total	Foreign Currency	Local Currency	Unskilled Labor	Total	Benefits[3]		Loan Amount	Annual Payment	
CASURECO IV-A													
1981	-4,620			-4,620						-4,620	+4,620		
1982	-63,474	-2,301	-808	-66,583						-66,583	+63,474		-3,109
1983	-3,359	-3,907	-3,040	-10,306						-10,306	+3,359		-6,947
1984	-1,428	-10,038	-2,491	-13,957						-13,957	+1,428		-12,529
1985-1987					-452	-4,288	-805	-5,545	+21,494	+15,949		-7,915	+8,034
1988-1994					-452	-4,288	-805	-5,545	+21,494	+15,949		-9,058	+6,891
1995-2009					-452	-4,288	-805	-5,545	+21,494	+15,949		-2,193	+13,756
Residual													-1,043[5]
ZAMECO													
1981	-6,167			-6,167						-6,167	+6,167		
1982	-63,314	-1,635	-185	-65,134						-65,134	+63,314		-1,820
1983	-5,281	-5,344	-3,684	-14,309						-14,309	+5,281		-9,028
1984	-1,828	-6,535	-1,431	-9,794						-9,794	+1,828		-7,966
1985-1987					-452	-5,924	-805	-7,181	+21,494	+14,313		-7,911	+6,402
1988-1994					-452	-5,924	-805	-7,181	+21,494	+14,313		-9,051	+5,262
1995-2009					-452	-5,924	-805	-7,181	+21,494	+14,313		-2,186	+12,127
Residual													-1,043[5]
OMECO													
1981													
1982	-12,513			-12,513						-12,513	+12,513		
1983	-1,506	-2,537	-794	-4,837						-4,837	+1,506		-3,331
1984	-284	-3,722	-240	-4,246						-4,246	+284		-3,962
1985-1986					-89	-1,204	-183	-1,476	+2,784	+1,308		-885	+423
1987					-89	-1,204	-183	-1,476	+2,784	+1,308		-1,263	+45
1988-1989					-89	-1,204	-183	-1,476	+2,784	+1,308		-1,473	-165
1990-1991					-89	-1,204	-183	-1,476	+2,784	+1,308		-1,744	-436
1992-1994					-89	-1,204	-183	-1,476	+2,784	+1,308		-1,790	-482
1995-2001					-89	-1,204	-183	-1,476	+2,784	+1,308		-914	+394
2002-2009					-89	-1,204	-183	-1,476	+2,784	+1,308		-490	+818

Appendix Table C-3 (cont.)

	Investment Costs[1]				Operating Costs[2]					Net Benefits (Before Foreign Financing)	Foreign Financing[4]		Net Benefits (After Foreign Financing)
	Foreign Currency	Local Currency	Unskilled Labor	Total	Foreign Currency	Local Currency	Unskilled Labor	Total	Benefits[3]		Loan Amount	Annual Payment	
ANTECO													
1981	-2,986			-2,986						-2,986	+2,986		
1982	-13,979	-5,612	-3,307	-22,898						-22,898	+13,979		-8,919
1983	-1,274	-2,610	-1,593	-5,477						-5,477	+1,274		-4,203
1984	-273	-3,709	-665	-4,647						-4,647	+273		-4,374
1985-1986					-89	-1,218	-183	-1,490	+6,656	+5,166		-1,103	+4,063
1987					-89	-1,218	-183	-1,490	+6,656	+5,166		-1,481	+3,685
1988-1989					-89	-1,218	-183	-1,490	+6,656	+5,166		-1,855	+3,311
1990-1991					-89	-1,218	-183	-1,490	+6,656	+5,166		-2,126	+3,040
1992-1994					-89	-1,218	-183	-1,490	+6,656	+5,166		-2,172	+2,994
1995-2001					-89	-1,218	-183	-1,490	+6,656	+5,166		-1,296	+3,870
2002-2009					-89	-1,218	-183	-1,490	+6,656	+5,166		-872	+4,294
PANELCO I													
1981	-5,935	-2,220	-659	-8,814						-8,814	+5,935		-2,879
1982	-36,763	-4,951	-1,446	-43,160						-43,160	+36,763		-6,397
1983	-4,837	-5,680	-1,731	-12,248						-12,248	+4,837		-7,411
1984	-3,104	-5,783	-1,170	-10,057						-10,057	+3,104		-6,953
1985-1986					-272	-5,257	-474	-6,003	+23,574	+17,571		-3,816	+13,755
1987					-272	-5,257	-474	-6,003	+23,574	+17,571		-4,138	+13,433
1988-1994					-272	-5,257	-474	-6,003	+23,574	+17,571		-5,003	+12,568
1995-2006					-272	-5,257	-474	-6,003	+23,574	+17,571		-2,339	+15,232
2007-2009					-272	-5,257	-474	-6,003	+23,574	+17,571		-2,017	+15,554
ISECO													
1981	-5,006			-5,006						-5,006	+5,006		
1982	-31,818	-18		-31,836						-31,836	+31,818		-18
1983	-2,388	-8,400	-3,295	-14,083						-14,083	+2,388		-11,695
1984	-3,201	-11,652	-172	-15,025						-15,025	+3,201		-11,824
1985-1986					-237	-4,732	-439	-5,408	+23,574	+18,166		-3,643	+14,523
1987					-237	-4,732	-439	-5,408	+23,574	+18,166		-3,965	+14,201
1988-1994					-237	-4,732	-439	-5,408	+23,574	+18,166		-4,702	+13,464
1995-2006					-237	-4,732	-439	-5,408	+23,574	+18,166		-2,038	+16,128
2007-2009					-237	-4,732	-439	-5,408	+23,574	+18,166		-1,716	+16,450

1 See Table III-17 through Table III-22.

2 See Appendix Table B-1 through Table B-6.

3 See Table IV-2.

4 See Table III-28.

5 Remaining principal on loans that extend to the year 2011.

Appendix Table C-4

Costs and Benefits For Power Plants by Factor In Baseline and Replication Cases
After Foreign Financing
(in thousands of 1984 pesos)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
CASURECO IV-A								
1981								
1982		-2,301	-808	-3,109		-2,301	-485	-2,786
1983		-3,907	-3,040	-6,947		-3,907	-1,824	-5,731
1984		-10,038	-2,491	-12,529		-10,038	-1,495	-11,533
1985-1987	+13,127	-4,288	-805	+8,034	+15,752	-4,288	-483	+10,981
1988-1994	+11,984	-4,288	-805	+6,891	+14,381	-4,288	-483	+9,610
1995-2009	+17,806	-4,288	-805	+12,713	+21,367	-4,288	-483	+16,596
Internal Rate of Return of Net Benefits				29.6%				42.3%
Total Net Foreign Currency	406,004							
Total Unskilled Labor			26,464					
ZAMECO								
1981								
1982		-1,635	-185	-1,820		-1,635	-111	-1,746
1983		-5,344	-3,684	-9,028		-5,344	-2,210	-7,554
1984		-6,535	-1,431	-7,966		-6,535	-859	-7,394
1985-1987	+13,131	-5,924	-805	+6,402	+15,757	-5,924	-483	+9,350
1988-1994	+11,991	-5,924	-805	+5,262	+14,389	-5,924	-483	+7,982
1995-2009	+17,813	-5,924	-805	+11,084	+21,376	-5,924	-483	+14,969
Internal Rate of Return of Net Beneftis				28.1%				42.0%
Total Net Foreign Currency	406,170							
Total Unskilled Labor			25,425					

Table C-4 (cont.)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
OMECO								
1981								
1982								
1983		-2,537	-794	-3,331		-2,537	-476	-3,013
1984		-3,722	-240	-3,962		-3,722	-144	-3,866
1985-1986	+1,820	-1,204	-183	+423	+2,172	-1,204	-110	+858
1987	+1,432	-1,204	-183	+45	+1,718	-1,204	-110	+404
1988-1989	+1,222	-1,204	-183	-165	+1,466	-1,204	-110	+152
1990-1991	+951	-1,204	-183	-436	+1,141	-1,204	-110	-173
1992-1994	+905	-1,204	-183	-482	+1,086	-1,204	-110	-228
1995-2001	+1,781	-1,204	-183	+394	+2,137	-1,204	-110	+823
2002-2009	+2,205	-1,204	-183	+818	+2,646	-1,204	-110	+1,332
Internal Rate of Return of Net Benefits				0.2%				6.1%
Total Net Foreign Currency	42,220							
Total Unskilled Labor			5,609					
ANTECO								
1981								
1982		-5,612	-3,307	-8,919		-5,612	-1,984	-7,596
1983		-2,610	-1,593	-4,203		-2,610	-956	-3,566
1984		-3,709	-665	-4,374		-3,709	-399	-4,108
1985-1986	+5,464	-1,218	-183	+4,063	+6,557	-1,218	-110	+5,229
1987	+5,086	-1,218	-183	+3,685	+6,103	-1,218	-110	+4,775
1988-1989	+4,712	-1,218	-183	+3,311	+5,654	-1,218	-110	+4,326
1990-1991	+4,441	-1,218	-183	+3,040	+5,329	-1,218	-110	+4,001
1992-1994	+4,395	-1,218	-183	+2,994	+5,274	-1,218	-110	+3,946
1995-2001	+5,271	-1,218	-183	+3,870	+6,325	-1,218	-110	+4,997
2002-2009	+5,695	-1,218	-183	+4,294	+6,834	-1,218	-110	+5,506
Internal Rate of Return of Net Benefits				16.5%				23.3%
Total Net Foreign Currency	129,962							
Total Unskilled Labor			10,140					

Table C-4 (cont.)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
PANELCO								
1981		-2,220	-659	-2,879		-2,220	-395	-2,615
1982		-4,951	-1,446	-6,397		-4,951	-868	-5,819
1983		-5,680	-1,731	-7,411		-5,680	-1,039	-6,719
1984		-5,783	-1,170	-6,593		-5,783	-702	-6,485
1985-1986	+19,486	-5,257	-474	+13,755	+23,383	-5,257	-284	+17,842
1987	+19,164	-5,257	-474	+13,433	+22,997	-5,257	-284	+17,456
1988-1994	+18,299	-5,257	-474	+12,568	+21,959	-5,257	-284	+16,418
1995-2006	+20,963	-5,257	-474	+15,232	+25,156	-5,257	-284	+19,615
2007-2009	+21,285	-5,257	-474	+15,554	+25,542	-5,257	-284	+20,001
Internal Rate of Return of Net Benefits				36.7%				46.8%
Total Net Foreign Currency	501,640							
Total Unskilled Labor			16,856					
ISECO								
1981								
1982		-18		-18		-18		-18
1983		-8,400	-3,295	-11,695		-8,400	-1,977	-10,377
1984		-11,652	-172	-11,824		-11,652	-103	-11,755
1985-1986	+19,694	-4,732	-439	+14,523	+23,633	-4,732	-262	+18,639
1987	+19,372	-4,732	-439	+14,201	+23,246	-4,732	-262	+18,252
1988-1994	+18,635	-4,732	-439	+13,464	+22,362	-4,732	-262	+17,368
1995-2006	+21,299	-4,732	-439	+16,128	+25,559	-4,732	-262	+20,565
2007-2009	21,621	-4,732	-439	+16,450	+25,945	-4,732	-262	+20,951
Internal Rate of Return of Net Benefits				48.6%				63.6%
Total Net Foreign Curency	509,656							
Total Unskilled Labor								

[1]See Appendix Table C-3

Appendix Table C-5

Costs and Benefits For Power Plants Using $24/barrel for Oil
(in thousands of 1984 pesos)

	Investment Costs[1]				Operating Costs[2]					Net Benefits (Before Foreign Financing)	Foreign Financing[4]		Net Benefits (After Foreign Financing)
	Foreign Currency	Local Currency	Unskilled Labor	Total	Foreign Currency	Local Currency	Unskilled Labor	Total	Benefits[3]		Loan Amount	Annual Payment	
CASURECO IV-A													
1981	-4,620			-4,620						-4,620	+4,620		
1982	-63,474	-2,301	-808	-66,583						-66,583	+63,474		-3,109
1983	-3,359	-3,907	-3,040	-10,306						-10,306	+3,359		-6,947
1984	-1,428	-10,038	-2,491	-13,957						-13,957	+1,428		-12,529
1985-1987					-452	-4,288	-805	-5,545	+13,575	+8,030		-7,915	+115
1988-1994					-452	-4,288	-805	-5,545	+13,575	+8,030		-9,058	-1,028
1995-2009					-452	-4,288	-805	-5,545	+13,575	+8,030		-2,193	+5,837
Residual													-1,043[5]
ZAMECO													
1981	-6,167			-6,167						-6,167	+6,167		
1982	-63,314	-1,635	-185	-65,134						-65,134	+63,314		-1,820
1983	-5,281	-5,344	-3,684	-14,309						-14,309	+5,281		-9,028
1984	-1,828	-6,535	-1,431	-9,794						-9,794	+1,828		-7,966
1985-1987					-452	-5,924	-805	-7,181	+13,575	+6,394		-7,911	-1,517
1988-1994					-452	-5,924	-805	-7,181	+13,575	+6,394		-9,051	-2,657
1995-2009					-452	-5,924	-805	-7,181	+13,575	+6,394		-2,186	+4,208
Residual													-1,043[5]
OMECO													
1981													
1982	-12,513			-12,513						-12,513	+12,513		
1983	-1,506	-2,537	-794	-4,837						-4,837	+1,506		-3,331
1984	-284	-3,722	-240	-4,246						-4,246	+284		-3,962
1985-1986					-89	-1,204	-183	-1,476	+1,758	+282		-885	-603
1987					-89	-1,204	-183	-1,476	+1,758	+282		-1,263	-981
1988-1989					-89	-1,204	-183	-1,476	+1,758	+282		-1,473	-1,191
1990-1991					-89	-1,204	-183	-1,476	+1,758	+282		-1,744	-1,462
1992-1994					-89	-1,204	-183	-1,476	+1,758	+282		-1,790	-1,508
1995-2001					-89	-1,204	-183	-1,476	+1,758	+282		-914	-632
2002-2009					-89	-1,204	-183	-1,476	+1,758	+282		-490	-208

Appendix Table C-5 (cont.)

	Investment Costs[1]				Operating Costs[2]					Net Benefits (Before Foreign Financing)	Foreign Financing[4]		Net Benefits (After Foreign Financing)
	Foreign Currency	Local Currency	Unskilled Labor	Total	Foreign Currency	Local Currency	Unskilled Labor	Total	Benefits[3]		Loan Amount	Annual Payment	
ANTECO													
1981	-2,986			-2,986						-2,986	+2,986		
1982	-13,979	-5,612	-3,307	-22,898						-22,898	+13,979		-8,919
1983	-1,274	-2,610	-1,593	-5,477						-5,477	+1,274		-4,203
1984	-273	-3,709	-665	-4,647						-4,647	+273		-4,374
1985-1986					-89	-1,218	-183	-1,490	+4,204	+2,714		-1,103	+1,611
1987					-89	-1,218	-183	-1,490	+4,204	+2,714		-1,481	+1,233
1988-1989					-89	-1,218	-183	-1,490	+4,204	+2,714		-1,855	+859
1990-1991					-89	-1,218	-183	-1,490	+4,204	+2,714		-2,126	+588
1992-1994					-89	-1,218	-183	-1,490	+4,204	+2,714		-2,172	+542
1995-2001					-89	-1,218	-183	-1,490	+4,204	+2,714		-1,296	+1,418
2002-2009					-89	-1,218	-183	-1,490	+4,204	+2,714		-872	+1,842
PANELCO I													
1981	-5,935	-2,220	-659	-8,814						-8,814	+5,935		-2,879
1982	-36,763	-4,951	-1,446	-43,160						-43,160	+36,763		-6,397
1983	-4,837	-5,680	-1,731	-12,248						-12,248	+4,837		-7,411
1984	-3,104	-5,783	-1,170	-10,057						-10,057	+3,104		-6,953
1985-1986					-272	-5,257	-474	-6,003	+14,889	+8,886		-3,816	+5,020
1987					-272	-5,257	-474	-6,003	+14,889	+8,886		-4,138	+4,748
1988-1994					-272	-5,257	-474	-6,003	+14,889	+8,886		-5,003	+3,883
1995-2006					-272	-5,257	-474	-6,003	+14,889	+8,886		-2,339	+6,547
2007-2009					-272	-5,257	-474	-6,003	+14,889	+8,886		-2,017	+6,869
ISECO													
1981	-5,006			-5,006						-5,006	+5,006		
1982	-31,818	-18		-31,836						-31,836	+31,818		-18
1983	-2,388	-8,400	-3,295	-14,083						-14,083	+2,388		-11,695
1984	-3,201	-11,652	-172	-15,025						-15,025	+3,201		-11,824
1985-1986					-237	-4,732	-439	-5,408	+14,889	+9,481		-3,643	+5,383
1987					-237	-4,732	-439	-5,408	+14,889	+9,481		-3,965	+5,516
1988-1994					-237	-4,732	-439	-5,408	+14,889	+9,481		-4,702	+4,779
1995-2006					-237	-4,732	-439	-5,408	+14,889	+9,481		-2,038	+7,443
2007-2009					-237	-4,732	-439	-5,408	+14,889	+9,481		-1,716	+7,765

1 See Table III-17 through Table III-22.

2 See Appendix Table B-1 through Table B-6.

3 See Table IV-2.

4 See Table III-28.

5 Remaining principal on loans that extend to the year 2011.

Appendix Table C-6

Costs and Benefits For Power Plants by Factor Using $24/Barrel for Oil
After Foreign Financing
(in thousands of 1984 pesos)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
CASURECO IV-A								
1981								
1982		-2,301	-808	-3,109		-2,301	-485	-2,786
1983		-3,907	-3,040	-6,947		-3,907	-1,824	-5,731
1984		-10,038	-2,491	-12,529		-10,038	-1,495	-11,533
1985-1987	+5,208	-4,288	-805	+115	+6,250	-4,288	-483	+1,479
1988-1994	+4,065	-4,288	-805	-1,028	+4,828	-4,288	-483	+107
1995-2009	+10,930	-4,288	-805	+5,837	+13,116	-4,288	-483	+8,345
Internal Rate of Return of Net Benefits				7.2%				12.2%
Total Net Foreign Currency	208,029							
Total Unskilled Labor			26,464					
ZAMECO								
1981								
1982		-1,635	-185	-1,820		-1,635	-111	-1,746
1983		-5,344	-3,684	-9,028		-5,344	-2,210	-7,554
1984		-6,535	-1,431	-7,966		-6,535	-859	-7,394
1985-1987	+5,212	-5,924	-805	-1,517	+6,254	-5,924	-483	-153
1988-1994	+4,072	-5,924	-805	-2,657	+4,886	-5,924	-483	-1,521
1995-2009	+10,931	-5,924	-805	+4,208	+13,124	-5,924	-483	+6,717
Internal Rate of Return of Net Beneftis				2.8%				8.7%
Total Net Foreign Currency	208,195							
Total Unskilled Labor			25,425					

Table C-6 (cont.)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
OMECO								
1981								
1982								
1983		-2,537	-794	-3,331		-2,537	-476	-3,013
1984		-3,722	-240	-3,962		-3,722	-144	-3,866
1985-1986	+784	-1,204	-183	-603	+941	-1,204	-110	-373
1987	+406	-1,204	-183	-981	+487	-1,204	-110	-827
1988-1989	+196	-1,204	-183	-1,191	+235	-1,204	-110	-1,079
1990-1991	-75	-1,204	-183	-1,462	-90	-1,204	-110	-1,404
1992-1994	-121	-1,204	-183	-1,508	-145	-1,204	-110	-1,459
1995-2001	+755	-1,204	-183	-632	+906	-1,204	-110	-408
2002-2009	+1,179	-1,204	-183	-208	+1,415	-1,204	-110	+101
Internal Rate of Return of Net Benefits				0.0%				0.0%
Total Net Foreign Currency	16,570							
Total Unskilled Labor			5,609					
ANTECO								
1981								
1982		-5,612	-3,307	-8,919		-5,612	-1,984	-7,596
1983		-2,610	-1,593	-4,203		-2,610	-956	-3,566
1984		-3,709	-665	-4,374		-3,709	-399	-4,108
1985-1986	+3,012	-1,218	-183	+1,611	+3,614	-1,218	-110	+2,286
1987	+2,634	-1,218	-183	+1,233	+3,161	-1,218	-110	+1,833
1988-1989	+2,260	-1,218	-183	+859	+2,712	-1,218	-110	+1,384
1990-1991	+1,989	-1,218	-183	+588	+2,387	-1,218	-110	+1,059
1992-1994	+1,943	-1,218	-183	+542	+2,332	-1,218	-110	+1,004
1995-2001	+2,819	-1,218	-183	+1,418	+3,383	-1,218	-110	+2,055
2002-2009	+3,243	-1,218	-183	+1,842	+3,892	-1,218	-110	+2,564
Internal Rate of Return of Net Benefits				4.5%				9.3%
Total Net Foreign Currency	68,662							
Total Unskilled Labor			10,140					

Table C-6 (cont.)

	Costs and Benefits by Factor[1]				Costs and Benefits by Factor With Shadow Pricing			
	Foreign Currency	Local Currency	Unskilled Labor	Net Benefits	Foreign Currency (SER=1.2)	Local Currency (1)	Unskilled Labor (SWR=.6)	Net Benefits
PANELCO								
1981		-2,220	-659	-2,879		-2,220	-395	-2,615
1982		-4,951	-1,446	-6,397		-4,951	-868	-5,819
1983		-5,680	-1,731	-7,411		-5,680	-1,039	-6,719
1984		-5,783	-1,170	-6,593		-5,783	-702	-6,485
1985-1986	+10,801	-5,257	-474	+5,070	+12,961	-5,257	-284	+7,420
1987	+10,479	-5,257	-474	+4,748	+12,575	-5,257	-284	+7,034
1988-1994	+9,614	-5,257	-474	+3,883	+11,537	-5,257	-284	+5,996
1995-2006	+12,278	-5,257	-474	+6,547	+14,234	-5,257	-284	+9,193
2007-2009	+12,600	-5,257	-474	+6,869	+15,120	-5,257	-284	+9,579
Internal Rate of Return of Net Benefits				16.6%				24.2%
Total Net Foreign Currency	284,515							
Total Unskilled Labor			16,856					
ISECO								
1981								
1982		-18		-18		-18		-18
1983		-8,400	-3,295	-11,695		-8,400	-1,977	-10,377
1984		-11,652	-172	-11,824		-11,652	-103	-11,755
1985-1986	+11,009	-4,732	-439	+5,838	+13,211	-4,732	-262	+8,217
1987	+10,687	-4,732	-439	+5,516	+12,824	-4,732	-262	+7,830
1988-1994	+9,950	-4,732	-439	+4,779	+11,940	-4,732	-262	+6,946
1995-2006	+12,614	-4,732	-439	+7,443	+15,137	-4,732	-262	+10,143
2007-2009	+12,936	-4,732	-439	+7,765	+15,523	-4,732	-262	+10,529
Internal Rate of Return of Net Benefits				21.3%				30.8%
Total Net Foreign Curency	292,531							
Total Unskilled Labor								

[1]See Appendix Table C-3

TECHNICAL ANALYSIS

OF THE

DENDRO THERMAL POWER PLANTS

Submitted to

National Electrification Administration
Government of the Philippines

by

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September 1984

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Errata

Technical Analysis of the Dendro Thermal Power Plants

Page 1, Line 34

Change "chipped" to "cut into blocks"

Page 13, Line 19

Change "0.8" to "0.3"

Page 31

Figure 9 modified from draft

Page 33, Line 3

Change "drag chain" to "screw"

Page 84, Line 34

Change "replaces" to "may replace"

Page 96, Line 28

Change "MW" to "MW-hr"

Page 104, Line 20

Add the following paragraph:

"However, it is recognized that local A & E's have not had total responsibilities for design of the plants to date. Thus it is further recommended that any new major program include assistance in the areas of technical assessment of plants as well as scheduling, contracting and funding allocations. This assistance should be under the direct control of the funding agency."

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I. EXECUTIVE SUMMARY

The use of wood as fuel for a steam electric power plant is not a new technology, nor is it technically difficult. It is commonly used throughout the world, including the Philippines. However, it is usually utilized in conjunction with forest products industries, a particular processing industry that generates a combustible waste product. What is unique about the Philippine Dendro Thermal Development Program is that its primary purpose is to generate electricity on a relatively large scale and that it is the largest program known to exist.

Currently 29 generating plants are in various stages of operation, construction or planning under the program, for a total capacity of 92.3 MW. These plants are provided through a variety of financial schemes but generally on a concessionary basis.

Five 3.1 MW steam plants are of British design. Those five are either in operation or in the final stages of construction. They are basically the same design. Fuel wood in log form is fed into the furnace/boiler by a conveyor. The boiler is a standard marine type horizontal drum watertube model, and the turbine is a seven-stage, single extraction condensing unit. The units are rated to have a net power output of 2.97 MW and an efficiency rating of 16 percent.

Seven 3.4 MW and two 1.2 MW steam plants are of French design. They have all been manufactured, two are in the final stages of construction, and seven are in various storage locations. Design details of the 1.2 MW French designed steam plants were not available. The 3.4 MW French design utilizes a fuel wood crusher, wood dryer, covered storage building with automatic loading and retrieval, and pneumatic conveyor. The furnace/boiler input is a two-drum watertube boiler with superheater, economizer, and air heater. The turbine is a three-stage, single extraction condensing unit. The units are rated to have a net power output of 2.91 MW and an efficiency rating of 15.6 percent.

Two 0.96 MW gasifier plants are of French design. Both are in final stages of construction. Both consist of a 600 KVA gasifier-engine-generator system. The gasifier converts wood fuel to a gas which is used as fuel in a reciprocating diesel engine. The fuel wood is chipped, dried and fed into the

gasifier by a semi-automatic loader. The units are rated to have a net power output of 0.66 MW and an efficiency rating of 20 percent.

Nine 3.4 MW steam plants of Japanese design are planned. The basic design of the units and the implementation plan have recently been completed. A construction schedule has not yet been established. The preliminary design calls for chipped, dried and stored fuel wood, automatically fed to the furnace/boiler. The specifications of the boilers and turbines have not yet been determined.

Three 5.0 MW steam plants of U.S. design are planned. The design, construction and implementation schedules for these units have not yet been determined.

Since, with few exceptions, the dendro thermal power plants will be interconnected to the NPC power grid, each project must be engineered to ensure compatibility. If the power plant's net output is greater than can be utilized by the REC, then power will be sold to NPC. Likewise, if the power plant's net output is less than the REC requirements, power will be purchased from NPC. This interconnection requires detailed engineering.

Dendro thermal power plants do not present any unusual environmental problems. However, by Philippine law, each project must be studied, environmental aspects considered, and an Environmental Compliance Certificate obtained from the National Pollution Control Commission.

The overall conclusion reached by the GTRI team is that the dendro thermal program of the Philippines is technically feasible and that the implementing agencies, with technical assistance, could implement the program. This chapter contains a number of recommendations related to the continuation and expansion of the program. It is the GTRI team recommendation that the Philippine Dendro Thermal Development Program standardize to the extent possible on a standard plant design. This standard design should have the following characteristics: 3.0-5.0 MW in size, utilization of chipped wood fuel, non-utilization of dryers, enclosed control room and cooling towers, and maximum use of packaged, off-the-shelf equipment.

II. INTRODUCTION

The utilization of wood as the fuel for a steam electric power plant is a common practice in the United States and throughout the world; however, most of these wood-fired power plants are located at forest products industries where the wood fuel is produced as a waste product. The firing of this waste wood fuel is as much a method of waste disposal as it is a means of producing energy. In recent years, a number of non-forest products industries have converted to wood fuels as a source of energy for production of electricity and process heat, but only a small number of plants have been designed to burn wood fuel exclusively for the production of electricity. There are no known plants where the fuel is produced from a plantation.

The dendro thermal power production program of the National Electrification Adminsitration (NEA) of the Government of the Philippines is the largest program in existence where the objective is the production of electrical power exclusively from wood. The overall program plan is to construct 72 power plants capable of producing approximately 200 MW of power. The fuel for these plants will be produced from plantations having an area in excess of 200,000 acres (approximately 81,000 hectares). Thus the project will also incorporate the largest fuel plantation area in the world at this time.

A list of the 72 plants as identified in the Agency for International Development (AID) project paper (1) is presented in Table 1. Currently 29 plants are in various stages of construction or planning. The table identifies the plant name, the location by town and province, the plant capacity, the equipment supplier (if selected) and the plant category. As described in the notes to the table, a Category 1 plant is one of the nine plants selected for initial completion by NEA. A Category 2 plant is a plant for which equipment has been purchased but which will not be completed until all Category 1 plants are operational. A Category 3 plant has no equipment purchased but does have some funds invested in the plantation. A Category 4 plant has no funds invested in equipment or the plantation but was identified in the AID project paper.

The analysis of the power plants will emphasize Category 1 and 2 plants,

Table 1
List of 72 Plants

Plant No.	Site Name	Province	Town	Equipment Supplier	Capacity (MW)	Category	Inspection
1	PANELCO I	Pangasinan	Bolinao	Alsthom-Atlantique	3.40	1	X
2	INEC	Ilocos Norte	Solsona	Balfour Beatty	3.10	1	X
3	ANTECO	Antique	Hamtic	Moteurs Duvant	0.96	1	X
4	ISECO	Ilocos Sur	Burgos	Alsthom-Atlantique	3.40	1	X
5	ISELCO II	Isabela	Ilagan	Balfour Beatty	3.10	1	X
6	ZAMECO	Zambales	Palauig	Balfour Beatty	3.10	1	X
7	CASURECO IV-A	Camarines Sur	Caramoan	Balfour Beatty	3.10	1	X
8	ISELCO I	Isabela	Jones	Balfour Beatty	3.10	1	
9	OMECO	Occidental-Mindoro	Magsaysay	Moteurs Duvant	0.96	1	X
10	ABRECO	Abra	San Juan	Alsthom-Atlantique	3.40	2	
11	NUVELCO	Nueva Vizcaya	Dupax del Norte	Balfour Beatty	3.10	2	
12	PALECO (A)	Palawan	Aborlan	Alsthom-Atlantique	1.20	2	
13	MARELCO	Marinduque	Buenavista	Alsthom-Atlantique	3.40	2	
14	AKELCO	Aklan	Nabas	Alsthom-Atlantique	3.40	2	
15	FICELCO	Catanduanes	Virac	Alsthom-Atlantique	1.20	2	
16	PALECO (A)	Palawan	Puerto Princesa	Alsthom-Atlantique	3.40	2	
17	ILECO II-A	Iloilo	Lambunao (A)	Alsthom-Atlantique	3.40	2	X
18	CAPELCO	Capiz	Tapaz	WEST JEC	3.40	3	
19	BOHECO I	Bohol	Inabanga	Stone and Webster	5.00	3	
20	ILECO I	Iloilo	Miag-ao	WEST JEC	3.40	3	
21	LUELCO	La Union	Arningay	WEST JEC	3.40	3	
22	CASURECO III	Camarines Sur	Balatan	WEST JEC	3.40	3	
23	CAGELCO II	Cagayan	Lallo/Lasam	WEST JEC	3.40	3	
24	CASURECO II	Camarines Sur	Pili	WEST JEC	3.40	3	
25	CASURECO IV-B	Camarines Sur	Garchitorena	WEST JEC	3.40	3	
26	CENECO	Negros Occidental	Murlia	Stone and Webster	5.00	3	
27	QUEZELCO	Quezon	Macalolon	WEST JEC	3.40	3	
28	MASELCO	Masbate	Mabo	WEST JEC	3.40	3	
29	ILECO II-B	Iloilo	Lambunao (B)	Stone and Webster	5.00	3	

X - Indicates Inspection Made

Table 1 (Cont.)
List of 72 Plants

Plant No.	Site Name	Province	Town	Equipment Supplier	Capacity (MW)	Category	Inspection
30	CENPELCO	Pangasinan	Aguilar		3.00	3	
31	BATELCO	Bataan	Morong		3.00	3	
32	PANELCO III	Pangasinan	San Manuel		3.00	3	
33	CAPELCO	Capiz	Tapaz		3.00	3	
34	PELCO II	Pampanga	Porac		3.00	3	
35	NEECO II	Nueva Ecija	Pantabangan		3.00	3	
36	TAWELCO	Tawi-Tawi	Balimbling		1.00	3	
37	NOCECO	Negros Occidental	Binalbagan		3.00	3	
38	BECO I	Bulacon	Domindos Trinidad		3.00	3	
39	BOHECO II	Bohol	Danao		3.00	3	
40	CANORECO	Camarines Norte	Labo		3.00	3	
41	CASURECO I	Camarines Sur	Lupi		3.00	4	
42	CEBECO I	Cebu	Dalaquete		3.00	4	
43	TARELCO (M)	Tarlac	Mavantoc		3.00	4	
44	ALECO	Albay	Pio Duran		3.00	4	
45	VRESCO	Negros Occidental	Victorias		3.00	4	
46	CEBECO II	Cebu			3.00	4	
47	BATELEC I	Batangas	Calaca		3.00	4	
48	BATELEC II	Batangas	Rosario		3.00	4	
49	CAGLECO	Cagayab	Enrile		3.00	4	
50	SULECO	Sulu	Panamao		1.00	4	
51	QUINELCO	Quirino			1.00	4	
52	NORECO I	Negros Occidental			3.00	4	
53	CEBECO III	Cebu			3.00	4	
54	CEBECO II	Cebu			3.00	4	
55	CANECO	Negros Occidental			3.00	4	
56	BATELCO II	Batangas			3.00	4	
57	NEECO III	Nueva Ecija			3.00	4	
58	BOHECO I	Bohol			3.00	4	

X - Indicates Inspection Made

Table 1 (Cont.)
List of 72 Plants

Plant No.	Site Name	Province	Town	Equipment Supplier	Capacity (MW)	Category	Inspection
59	AURELCO	Aurora			3.00	4	
60	NORECO II	Negros Occidental			3.00	4	
61	SAMAR I	Northern Samar			3.00	4	
62	MOPELCO	Mountain Providence			1.00	4	
63	KAELCO	Kalinga-Apayao			1.00	4	
64	ILECO I	Iloilo Leon			3.00	4	
65	VRESO	Negros Occidental			3.00	4	
66		Polilio Island			1.00	4	
67		Cuyo Island			1.00	4	
68	PALECO (B)	Palawan	Brooks Point		1.00	4	
69	NEECO I	Nueva Ecija	Gen Tinio		3.00	4	
70	TARELCO (S)	Tarlac	Sacobia		5.00	4	
71	LUBELCO	Lubang	Lubang		1.00	4	
72	PELCO I	Pampanga	Arayat		3.00	4	

X - Indicates Inspection Made

as equipment has been purchased for these plants, and most of these plants are nearing operational status. However, it will also address the Category 3 plants being supplied by the Japanese and Americans to the extent that data is available. It should be noted that a proposal for construction of seven power plants has been submitted by Swedyards, a large Swedish industrial group. However, this proposal will not be addressed in this report.

A. RELATIONSHIP OF THE NATIONAL ELECTRIFICATION ADMINISTRATION (NEA) AND THE NATIONAL POWER CORPORATION (NPC)

Most of the power produced in the Philippines is generated by the NPC, which currently operates plants having a total capacity of approximately 4400 MW. NPC also owns and operates all of the major transmission lines in the Philippines. NPC is under the control of the Minister of Energy, and thus the production of power in the Philippines is directed at the presidential cabinet level.

The NEA provides for the distribution of power to individual customers through Rural Electric Cooperatives (RECs) located in individual provinces. The RECs own and operate the equipment and are responsible for the day-to-day interactions with customers. Most of the power distributed by the RECs is purchased from NPC, but some RECs produce their own power with mini-hydro and geothermal plants. NEA acts as an umbrella agency for the RECs, providing financing, administrative and engineering services. NEA is under the control of the Ministry of Human Settlements and is also directed from the cabinet level.

The primary interface between NEA and NPC will be negotiation of the interconnection agreement for the connection of RECs with operating dendro thermal plants to the NPC grid. This interface is required for several reasons. Many RECs have connected loads during peak hours which exceed the capacity of the dendro plant, and thus power must be purchased from NPC to meet the REC power demand. Some of these RECs have excess power to sell to NPC during off peak hours, and thus an acceptable buy-back must be established. An agreement to buy back power is also needed for RECs whose load does not exceed the plant capacity even during peak hours.

One of the overall objectives of the dendro program is the replacement of imported fuels with renewable fuels produced in the Philippines. Most of the fuel currently used by NPC is imported, and thus interconnection is necessary to achieve this overall goal of reducing imported energy.

B. GENERAL RESPONSIBILITIES OF CONTRACTORS

The construction of the dendro thermal plants involves three different contractors: the equipment supplier, the architect engineer (A & E), and the construction contractor. All three of these contractors interface directly with NEA on technical and administrative matters.

The equipment supplier is responsible for the design, selection and shipment of the major plant process equipment, supervision of construction and start-up, and training of operators (2, 3). There are some modifications to this basic scope of supply that were included in the contracts for the Japanese and American plants, which will be discussed in later sections. The equipment for the Category 1 and 2 plants was supplied from France and England, with funding provided through loans with the equipment suppliers' respective governments.

The A & E is responsible for design of support equipment, foundations, buildings and other site works, and for supervision of construction (4). All A & E's are Philippine companies. A & E's responsible for specific sites will be identified later. Funding for the A & E is provided by NEA. In general, a specific A & E handles all work for a specific REC, including dendro plants, power distribution systems and mini-hydro plants.

The construction contractor is responsible for installation of equipment designed by the A & E and the equipment supplier. These contractors are also Philippine companies and are funded through NEA. The specific contractor for each plant will be identified later.

III. CURRENT POWER PLANT DESIGN

A. BRITISH BALFOUR BEATTY DESIGN (3.1 MW)

1. Description and Status of Plants

The British power plants are designed by Balfour Beatty Engineering Limited of Kent, England, and financed by a loan from the British government. Each of the plants is designed to have a nominal gross output of 3.1 MW. A typical Balfour Beatty plant is shown in Figure 1.

Table 2 provides a summary of the status of the British plants. The initial purchase order with Balfour Beatty was for equipment for six plants and was signed on October 15, 1980 (4). Since the initial purchase, the work on NUVELCO has been terminated, with only minor site works being completed.

Figure 2 shows the approximate location of the six British sites, and Table 2 lists the province and nearest town to the six sites. As seen in the figure, most of the sites are located in northern Luzon, and only one site is located on the southern end of the main island.

The table also identifies the architect and engineering (A & E) and construction contractors for the plants. These different A & E's are involved in plant support design, and each plant has a different construction contractor. An A & E is usually selected by NEA to handle all design work for a particular province or region.

The five British plants currently under construction are planned for startup in 1984. The table indicates the status of the plant construction as reported by NEA.

2. General Technical Details

All of the British plants employ the same basic design with the exception of the condenser cooling water system (5). The INEC, ISELCO I and ISELCO II plants utilize river water cooling, while the ZAMECO, CASURECO IV and NUVELCO plants have cooling towers. There are also some minor differences in the support systems and equipment designed by the different A & E's involved.

Figure 1

Typical British Balfour Beatty Plant

Table 2
Summary of British Power Plants (as of May 1984)

Plant Name	Location (Town, Province)	A & E	Construction Contractor	Construction Status	Planned Operational Date
INEC	Solsona, Ilocos Norte	DCCD	Pacific Asia Builders	BI	1984
ISELCO I	Jones, Isabela	AWIA	Ecco Asia	75%	1984
ISELCO II	Ilagan, Isabela	AWIA	Engineering Equipment	BI	1984
ZAMECO	Palauig, Zambales	MIESCOR	Rimco	95%	1984
CASURECO IV	Caramoan, Camarines Sur	AWIA	BWIC	80%	1984
NUVELCO	Dupax, Nueva Vizcaya	AWIA	WGS Construction Specialists	Terminated	--

BI - Break In
% - Percent Completion

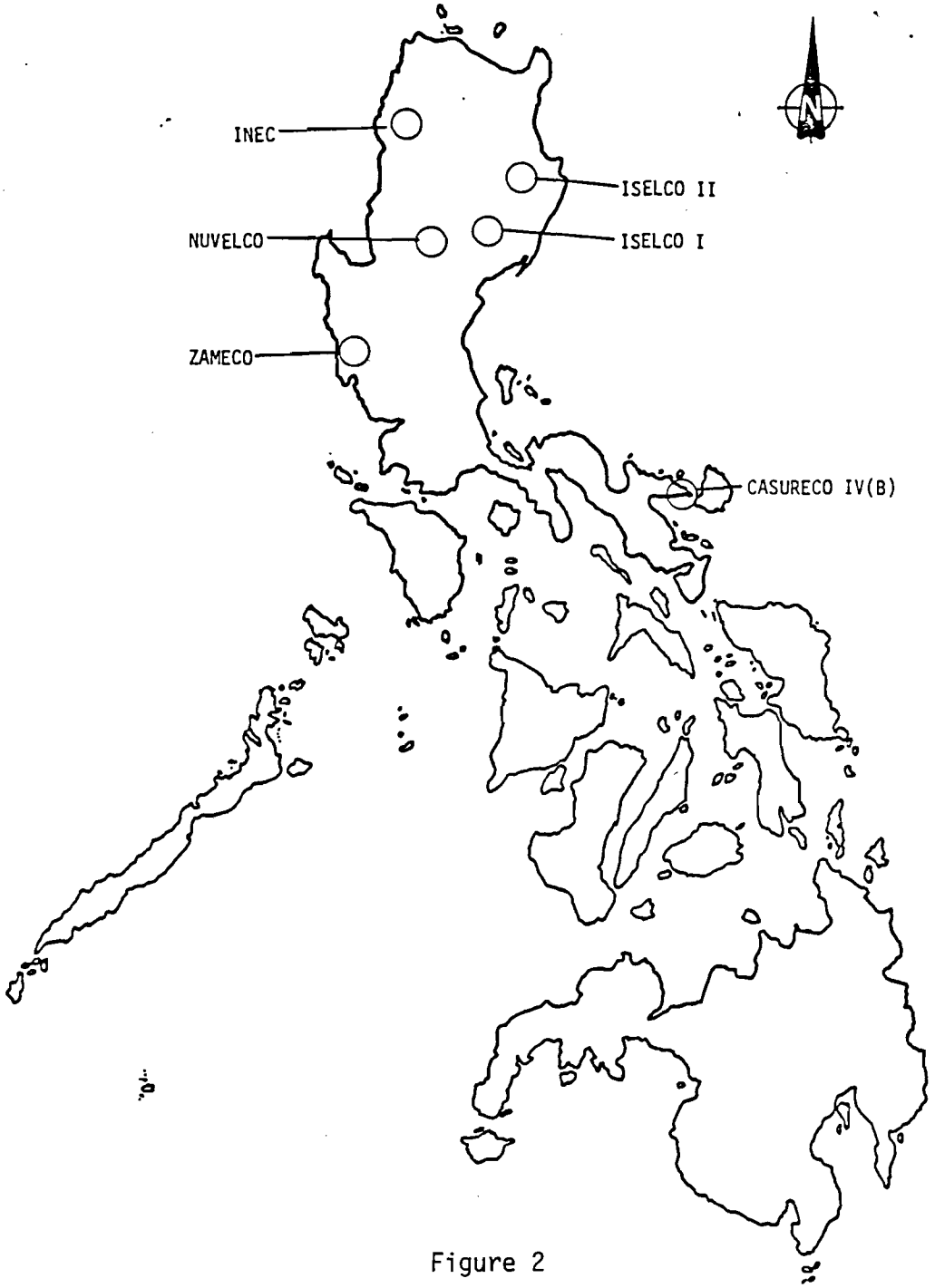


Figure 2

Locations of Balfour Beatty Plants

Figure 3 shows a generalized process diagram of the British design. The figure indicates the major equipment required to convert raw fuel delivered by the Lasso cable system into electricity.

Raw wood fuel in the form of logs is received at the plant from the Lasso cable transport system (in most instances). The design and performance of this system is discussed in another section of this report. The design of the unloading station for the cable system varies from plant to plant, but in most cases the fuel is transported by handcart to the fuel sizing stations.

A chainsaw sizing system has been added to the plant due to the non-uniform size of the fuel currently being received at the plants. Standard ipil-ipil logs could be fired in the boiler as received from the cable system; however, due to problems growing ipil-ipil trees on some plantations, wood from other sources is being used. This wood requires sizing to reduce length or diameter before swing blade sizing.

The bulk storage area at these plants consists of uncovered stacks of logs, with transportation to and from storage provided by handcart. The size and configuration of the bulk storage area varies from plant to plant.

Swing blade sizing is required to reduce the length of the logs to less than 0.8 meters before feeding to the boiler. There are usually four or more swing blade saws at each plant, which are manually operated by wood yard personnel.

The surge storage at the plant consists of stacks of completely sized wood (length and diameter) located on the two sides of the boiler feed conveyor. Logs are manually loaded into the boiler feed conveyor from the surge storage. This storage area is being covered at some sites to facilitate operations during the rainy season.

The boiler feed conveyor is a metal "vee" trough flight conveyor which transports the wood from the surge storage area to the boiler fuel feed slot. The conveyor is driven by an AC motor, and thus fuel feed must be controlled by rate of conveyor loading or by starting and stopping of the conveyor.

The boiler for the British plants is a Fraser horizontal drum model manufactured by Towler and Son Ltd. of Essex, England. The boiler is designed to burn logs which are fed through a slot on the front side of the boiler. The hot gases make three passes through the boiler and a single pass through

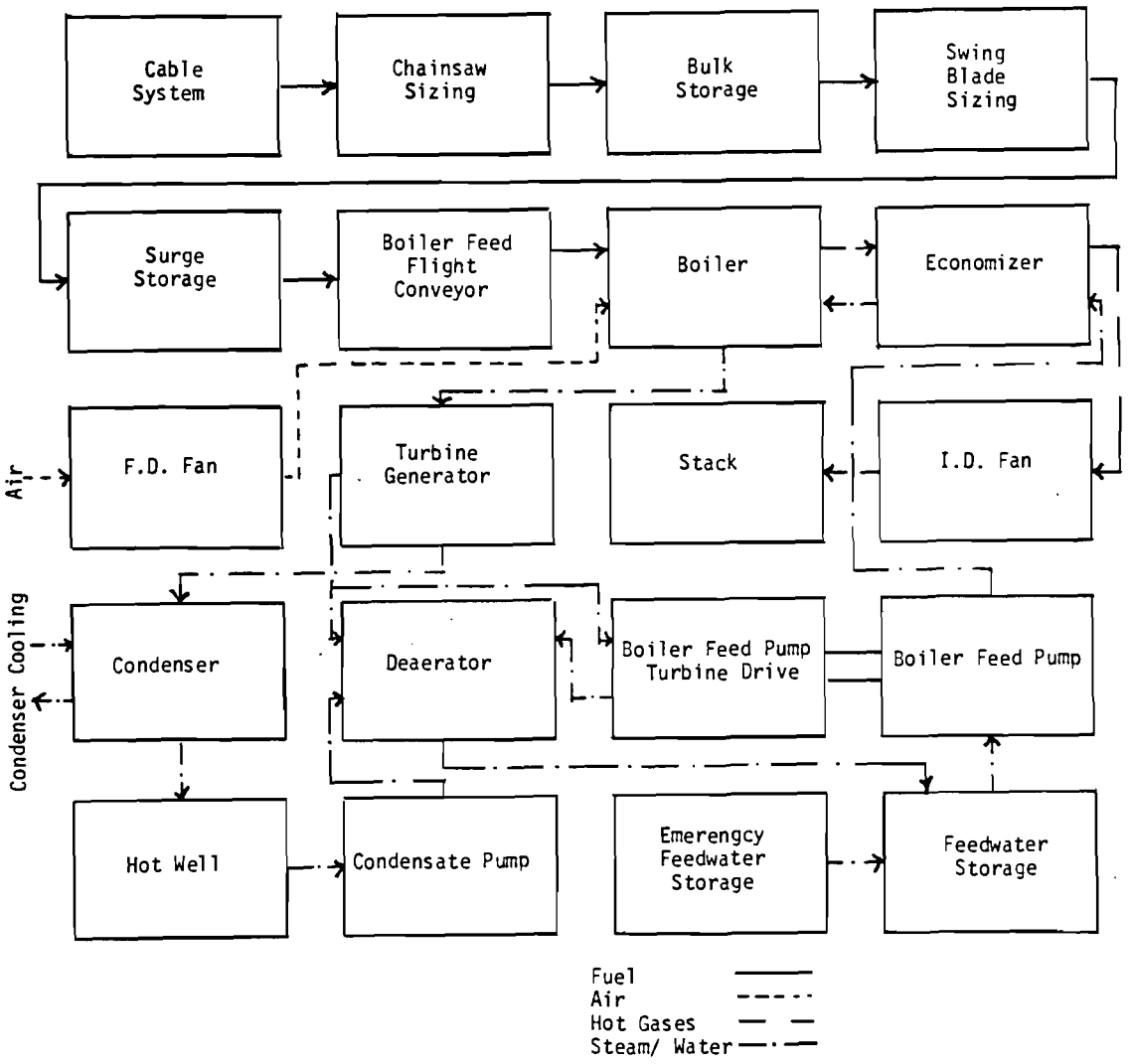


Figure 3

Balfour Beatty Process Diagram

an economizer, and are exhausted to atmosphere through a 40-foot steel chimney. Feedwater from the deaerator storage tank enters the boiler through the economizer, is heated in tubes and vaporized in the steam drum, and superheated in the horizontal superheater.

The boiler utilizes a single drum, and headers are used for tube connections in place of the lower drum. Headers are also used for connection of waterwall tubes. All tubes are installed by expanding the end of the tube inside the drums and headers instead of the usual practice of welding.

The boiler has no cyclones for particulate emission control, as the manufacturer claims that the three passes are sufficient to remove particulates. Ash is manually removed from the furnace section of the boiler through access hatches on the front side of the boiler.

The turbine is a seven-stage, single extraction condensing unit manufactured by Peter Brotherhood Limited of Peterborough, England. The unit was originally designed for marine applications. Steam from the boiler superheater is expanded in the turbine to generate shaft power and is then exhausted to the condenser. The turbine is connected to the generator through a gearbox.

The condenser removes the heat of vaporization from the turbine exhaust steam and rejects this heat through a cooling tower to atmosphere or to a river, depending on the plant site. Condensed steam is collected in a hotwell located directly beneath the condenser. A vacuum pump is used to maintain condenser vacuum by removing any non-condensible gases present in the steam.

Condensate is pumped from the condenser by the centrifugal condensate pump. The condensate is pumped to a deaerator where it is heated to its boiling point to improve cycle efficiency by preheating and for removal of non-condensible gases. The condensate enters the deaerator through a vent condenser, and deaerating steam is supplied from the turbine extraction and the boiler feed pump turbine exhaust.

The feedwater storage tank is located directly beneath the deaerator. In addition to the primary feedwater storage tank, an emergency tank is provided to supply feedwater during drought conditions. Water make-up to the system is made through the emergency storage tank. The boiler feedwater pump takes suction from the storage tank and supply water to the boiler economizer.

In addition to the primary systems discussed in the preceding paragraphs, each plant has the following auxiliary systems:

- Make-up water treatment--This system consists of sand filters for grit removal and anion-cation multiple bed demineralizers.

- Air compressor--This system supplies both service air and instrument air for plant operation.

- Diesel generator--The generator provides power required for a "black start" of the plant.

3. Plant Layout

Figure 4 shows a general layout of the British power plants. The layout of each of the plants is essentially the same, with the exception of minor differences depending on the particular A & E responsible for the plant design.

The boiler and turbine are enclosed in the same metal sided building with an internal partition separating the two major equipment items. The British plants do not have a central control room but have the boiler and turbine controls located near their respective pieces of equipment. The switchpanel controls are located in the turbine section of the building.

The fuel loading area of the plant is located on the left front side of the boiler. The British plant does not have an automatic fuel surge hopper, and thus an adequate supply of fuel must be maintained in the loading area. Although not included in the initial design, the fuel loading area at most plants is being covered with an open-sided building.

The deaerator and feedwater storage tanks at the British plants are located at the rear of the power plant. Water treatment equipment is located behind the deaerator. Location of cooling towers, river water cooling intakes, and cable system unloading is dependent upon the particular site.

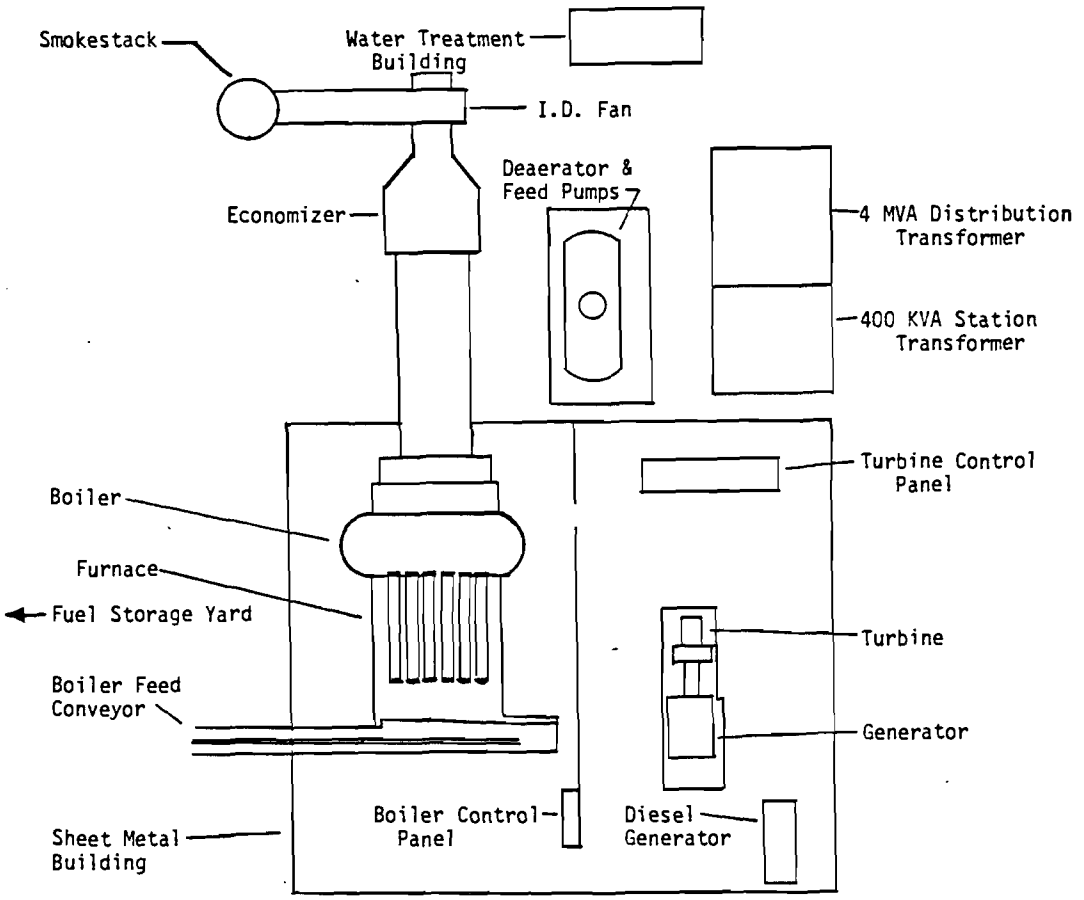


Figure 4

Balfour Beatty Plant Layout

4. Heat Balance

Figure 5 presents a simplified heat balance for the British plants, and Figure 6 shows the turbine curve for the plant. The balance shows the mass and energy flows to the major equipment in the British system. The boiler thermal efficiency is assumed to be 80 percent, and the boiler feed pump turbine is assumed to have a thermal efficiency of 80 percent. Table 3 shows the auxiliary electrical loads at the British plant. The net output of the plant is thus 297 MW, and the net plant heat rate is 5368 kcal/kWh (21,300 Btu/kWh). The net thermal efficiency of the plant is 16 percent.

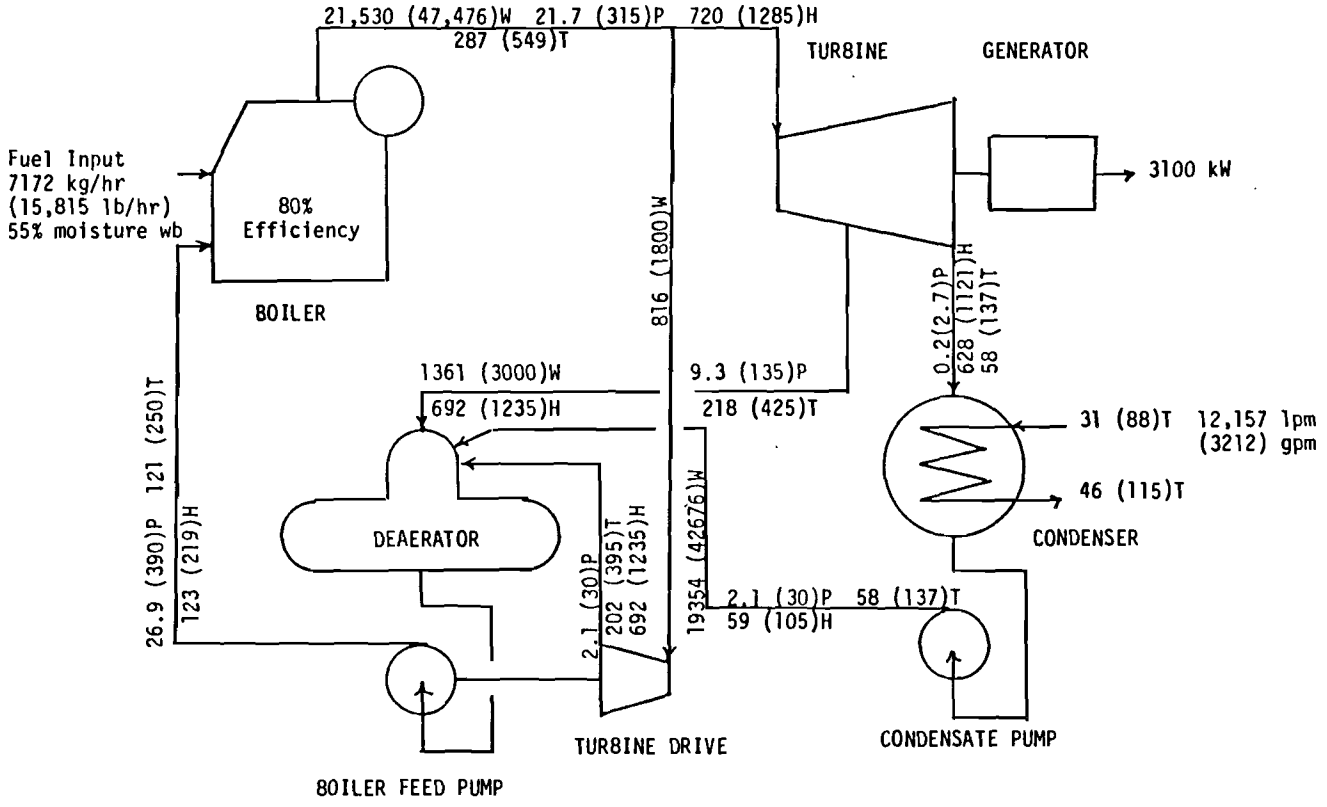
5. Manufacture and Construction

As discussed in previous sections, Balfour Beatty Engineering Limited is responsible for supplying the power plant equipment, the A & E's are responsible for design of site modifications and supporting equipment, and the construction contractors are responsible for installation of the British equipment and other equipment designed by the A & E.

Table 4 presents a revised and modified schedule for the construction of two of the five British plants with a brief explanation of the major causes for construction delays. As seen in the table, there are numerous factors which have caused delays in the completion of the plants, but the most significant factor appears to be the lack of local currency funding by NEA. This lack of funding has resulted in delays in equipment deliveries, payment of subcontractors, and other problems which have impacted the start-up of all plants. Additionally, some problems were noted with determination of responsibility for overall site operations.

6. Operation, Maintenance and Training

As of the publication of this report, only limited plant operation data was available, mostly from start-up and commissioning of the plants. The personnel required for plant operation on each shift are shown in Table 5. These numbers were estimated through discussions with field engineering personnel



P - Pressure, bar (lb/in^2)
T - Temperature, C° (F°)
W - Mass Flow, kg/hr (lb/hr)
H- Enthalpy, kcal/kg (Btu/lb)

Figure 5

Balfour Beatty Heat Balance

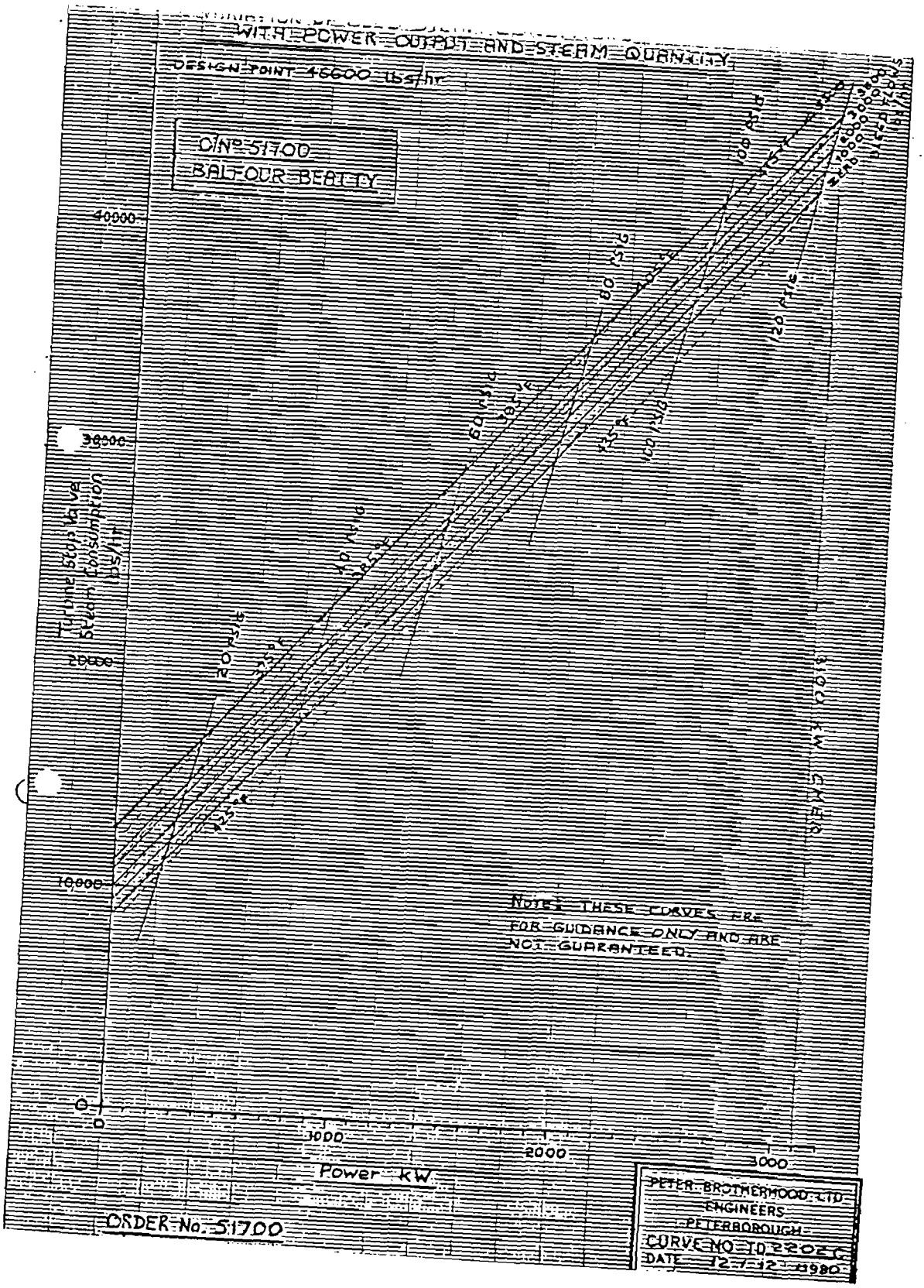


Figure 6

Balfour Beatty Plant Turbine Performance Curve

Table 3

Balfour Beatty Plant Auxiliary Loads

Load	Number Operational	Horsepower	Total kW
Air Compressor	1	15	11.2
Induced Draft Fan	1	74	55.2
Forced Draft Fan	1	10	7.5
Secondary Air Fan	1	7	5.2
Auxiliary Oil Pump	1	10	7.5
Vacuum Pump	1	5	3.7
Extractor Pumps	1	10	7.5
Lift Pumps	1	10	7.5
Fuel Conveyors	--	7	5.2
Cooling Water Pumps	1	20	14.9
Miscellaneous			6.3
Total			131.7

Table 4
Balfour Beatty Plant Design and Construction Schedule
Palauig Dendro Thermal Project

	Planned Start Date	Actual Start Date	Planned Completion Date	Actual Completion Date	Primary Reason for Delay
A & E Detailed Design	1 April 1981	1 April 1981	5 Dec. 1981	30 Nov. 1981	
Bidding of Construction Contract	6 Dec. 1981	1 Dec. 1982	15 Mar. 1982	11 Mar. 1982	
Site Civil Works	31 May 1982	1 June 1982	18 Oct. 1982	Ongoing	1. Surveying problems in the project area
Building Construction	6 June 1982	7 June 1982	1 Nov. 1982	Ongoing--painting and touch-up work	2. Slow delivery of construction materials, inadequate equipment, logistics problem of Contractor
Substation and Switchyard	31 May 1982	30 Apr. 1983	15 Sep. 1982	Ongoing	- Arrival of transformer in knockdown form - Supervision by BBEL Engineers required for its assembly
Delivery of Plant Equip.					
a) Major	6 June 1982	1 July 1982	4 Sep. 1982	30 June 1983	- Late arrival of equipment from major supplier
b) Balance of Plant	6 Aug. 1982	20 Sep. 1982	4 Nov. 1982	98.42% complete as of 4/30/84	- Inability of Contractor to source the specified equipment
Electrical/Mechanical Installation	18 Oct. 1982	30 Jan. 1983	21 Jan. 1983	Ongoing	1. Differing site conditions 2. Occasional work slowdown/work stoppage by Contractor due to nonpayment of services 3. On and off presence of British Field Engineers 4. Additional extra work required by A & E
Test and Commissioning	30 Nov. 1982	1 May 1983	11 Feb. 1983	Ongoing	
Distribution Line Extension	--	--	--	--	

Table 4 (Cont.)
Balfour Beatty Plant Design and Construction Schedule
Solsona Dendro Thermal Project

	Planned Start Date	Actual Start Date	Planned Completion Date	Actual Completion Date	Primary Reason for Delay
A & E Detailed Design	1 June 1981	8 June 1981	31 Dec. 1981	9 Jan. 1982	
Bidding of Construction Contract	18 Sep. 1981	17 Dec. 1981	7 Dec. 1981	16 Jan. 1982	
Site Civil Works	18 Jan. 1982	March 1982	August 1982	25 Nov. 1983	- Site acquisition problem
Building Construction	2 Feb. 1982	April 1982	1 June 1982	3 Mar. 1983	
Substation and Switchyard	2 Feb. 1982	--	15 June 1982	--	- Force Account
Delivery of Plant Equipment	Arrive Manila 20 Nov. 1982	--	Arrive site 30 Jan. 1982	April 1982 March 1982	
Electrical/Mechanical Installation	April 1982	July 1982	August 1982	25 Nov. 1983	
Test and Commissioning	1 Sep.1982	1 Sep. 1983	15 Oct. 1982	11 Sep. 1983	
Distribution Line Extension	3 Aug. 1981	--	30 Sep. 1981	--	- Force Account

Table 5

Personnel Required for Balfour Beatty Plants

Position Title	Job Category	Job Level	Number Required
Plant Supervisor	Dept. Manager	17	1
Mechanic	Jr. Prof.	10	1
Shift Supervisor/Engineer	Div. Chief	15	4
Turbine Operator	Jr. Prof.	10	4
Boiler Operator	Jr. Prof.	10	4
Switch Panel Operator	Jr. Prof.	10	4
Lab Man	Skilled	9	1
Driver	Skilled	7	1
Utility Man	Nonskilled	2	1
Dendro Supervisor	Div. Chief	15	1
Buyer Scaler	Jr. Prof.	9	1
Tramway Operator	Skilled	7	2
Cutter	Nonskilled	3	3
Handler	Nonskilled	3	24
Total Personnel Required			52

and differ significantly from estimates in the feasibility analysis. The large number of handlers used for plant operation is required to manually feed the boiler and to reduce the size of the non-ipil-ipil wood fuel required for the log burning boiler.

As discussed in the section on plant layout, the British plants do not have a central control room, and thus operators for the boiler turbine and switchgear panels are located in different plant areas.

Each plant has a full-time maintenance engineer assigned to the plant who is responsible for general equipment servicing. In addition, all operators are trained in troubleshooting equipment problems to identify items needing repair or replacement.

Training is provided through sponsorship of a training engineer by the Overseas Development Authority of the British government. A copy of the general training course outline is included in Appendix 1. The general training course requires approximately 6 weeks, of which 2 weeks are conducted at an operating plant and 4 weeks are conducted at the plant where the operators are assigned. A full-time engineer was provided by Balfour Beatty to accomplish this training.

The project team discussed the training program with the Balfour Beatty engineer at one of the plant sites. In general, the curriculum for the program appears well founded and comprehensive. One of the most useful aspects was the creation of hypothetical in-plant problems to be solved by the students. Examination of the tests given to the students (included in the Appendix) revealed that they dealt with practical problems, although more emphasis could probably be put on safety and dealing with boiler upsets and the protection of the pressure vessels.

7. Spare Parts

Spare parts are included in the scope of supply from Balfour Beatty; however, during the initial start-up of the plants, parts from the NUVELCO plant were being used as temporary replacements at the other plants. A system for central location, inventory control and distribution of spare parts has not yet been established.

B. FRENCH ALSTHOM-ATLANTIQUE DESIGN (3.4 MW)

1. Description and Status of Plants

The French steam power plants are designed by Alsthom-Atlantique of Paris, France, and financed by a loan to NEA from the French government. Seven of the plants are designed to have a nominal gross output of 3.4 MW, and two of the plants are designed to have a capacity of 1.2 MW. A typical French plant is shown in Figure 7.

Table 6 provides a summary of the status of the French steam plants. The initial purchase order with Alsthom-Atlantique was for equipment for seven 3.4 MW plants and two 1.2 MW plants and was signed on December 19, 1979 (6). Currently the only plants that are planned for initial completion are PANELCO I and ISECO.

Figure 8 shows the approximate location of the nine Alsthom-Atlantique plants, and Table 6 lists the province and nearest town to the nine sites. As seen in the figure, the sites are located in various areas through the northern Philippines. PANELCO I and ISECO, the only French plants still under construction, are in the same region of northern Luzon.

The table also identifies the architect and engineering (A & E) and construction contractors for the plants. The same A & E's are involved in the Balfour Beatty plants, with the exception of Trans Asia Pacific (TAP). The FICELCO plant is the only plant for which TAP is responsible for design. Except for ECCO Asia, which has responsibility for two plants, a different construction contractor is used on each plant.

The PANELCO I plant is listed as operational, but as of June 1984 Alsthom-Atlantique was making major modifications to the fuel system. The ISECO plant is scheduled for commissioning during 1984, but significant work is still to be accomplished, and the fuel system modifications have yet to be initiated. All construction work at the other plants has been suspended, terminated or not yet started.

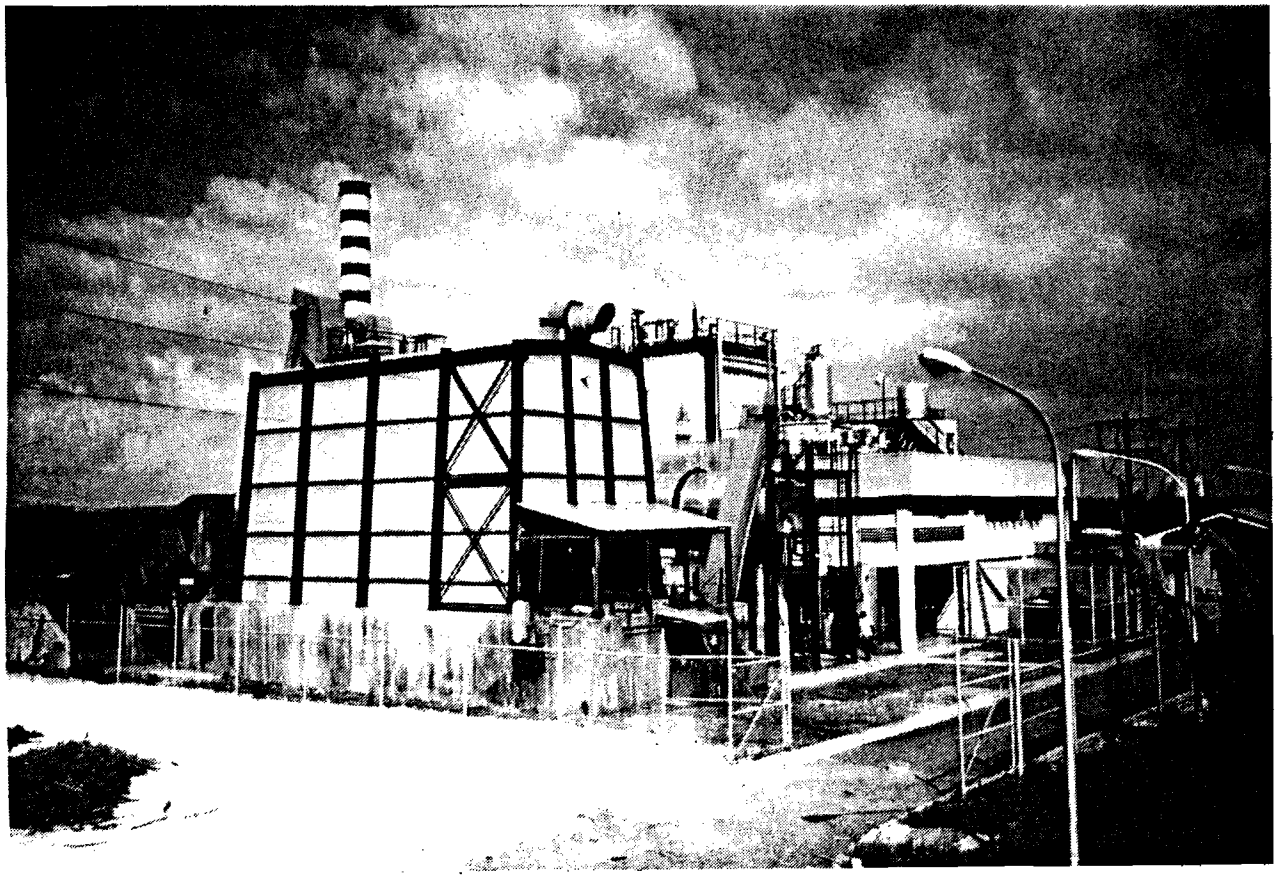


Figure 7

Typical French Alsthom-Atlantique Plant

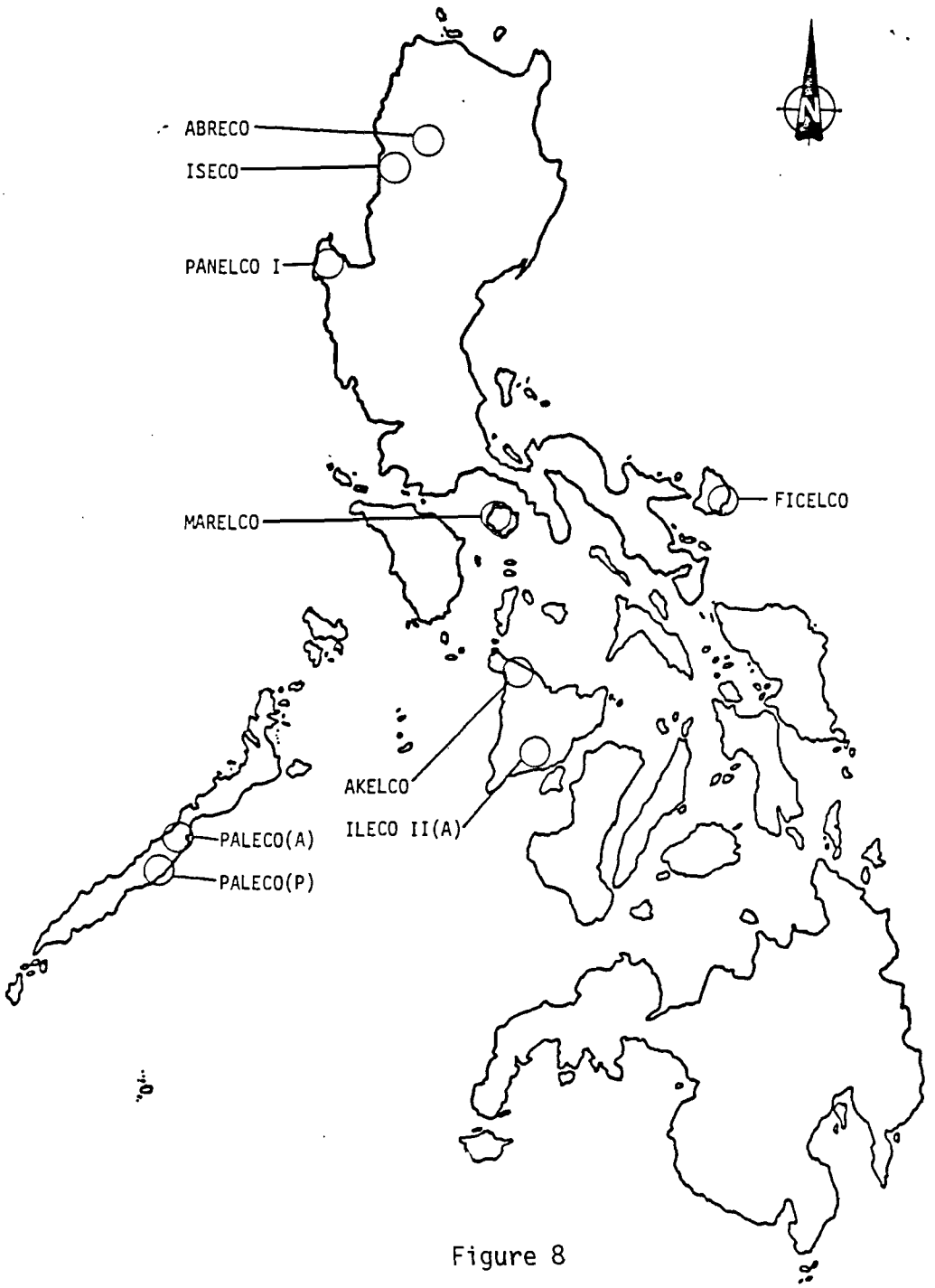


Figure 8

Locations of Alsthom-Atlantique Plants

Table 6
Summary of French Alsthom-Atlantique Power Plants

Plant Name	Capacity (MW)	Location (Town, Province)	A & E	Construction Contractor	Construction Status	Planned Operational Date
PANELCO I	3.4	Bolinao, Pangasinan	MIESCOR	Ecco Asia	C	1984
ISECO	3.4	Bungos, Ilocos Sur	DCCD	C.R. Baluzot	80%	1984
ABRECO	3.4	San Juan, Abra	AWIA	S.D. Flores	S	--
AKELCO	3.4	Nabas, Aklan	AWIA	Ecco Asia	T	--
ILECO II-A	3.4	Lambunao, Iloilo	DCCD	Engineering Equipment	T	--
MARELCO	3.4	Torrijos, Marinduque	MIESCOR	PCCC	S	--
PALECO (P.P.)	3.4	Puerto Princesa, Palawan	DCCD	--	S	--
FICELCO	1.2	Virac, Catanduanes	TAP	--	S	--
PALECO (A)	1.2	Aborlan, Palawan	--	--	--	--

C - Complete
% - Percent Completion
S - Suspended
T - Terminated

2. General Technical Details

The remainder of the discussion of the Aslthom-Atlantique plants will address only the 3.4 MW plants, as neither of the 1.2 MW plants has been constructed, and design details were not available. All of the Alsthom-Atlantique 3.4 MW plants are identical in design, and all utilize cooling towers for condenser cooling (7, 8). As with the British plants, there are minor differences in the support systems and equipment that were designed by the different A & E's involved.

Figure 9 shows a generalized process diagram of the Alsthom-Atlantique design. The figure indicates the major equipment required for conversion of raw fuel from the Lasso cable system into electricity. It is evident from the process diagram that the Alsthom-Atlantique plant is much more complicated than the British plant.

Raw wood fuel is received in the form of logs at the plant from the Lasso cable transport system (in most instances). The design and performance of this system is discussed in another section of this report. The design of the unloading station for the cable system varies from plant to plant, but in most cases the fuel is transported by handcart to the fuel sizing stations.

The bulk storage area at these plants consists of uncovered stacks of logs with transportation to and from storage provided by handcarts. The size and configuration of the bulk storage area varies from plant to plant.

Raw fuel enters the system through a hopper which feeds the crusher feed conveyor. This conveyor is a rubber belt with flights to allow a steeper conveyor angle.

The crushing system consists of two stages. The initial design of the Alsthom-Atlantique system incorporated one stage of crushing before drying and a second stage after drying, but this system has been modified to accomplish both stages before the surge storage and dryer. The first stage crusher consists of a single drum, and the second stage utilizes two parallel drums.

The crushed fuel from the outlet of the crusher is transported by a conveyor to surge storage. The conveyor is of a similar design to the crusher feed conveyor.

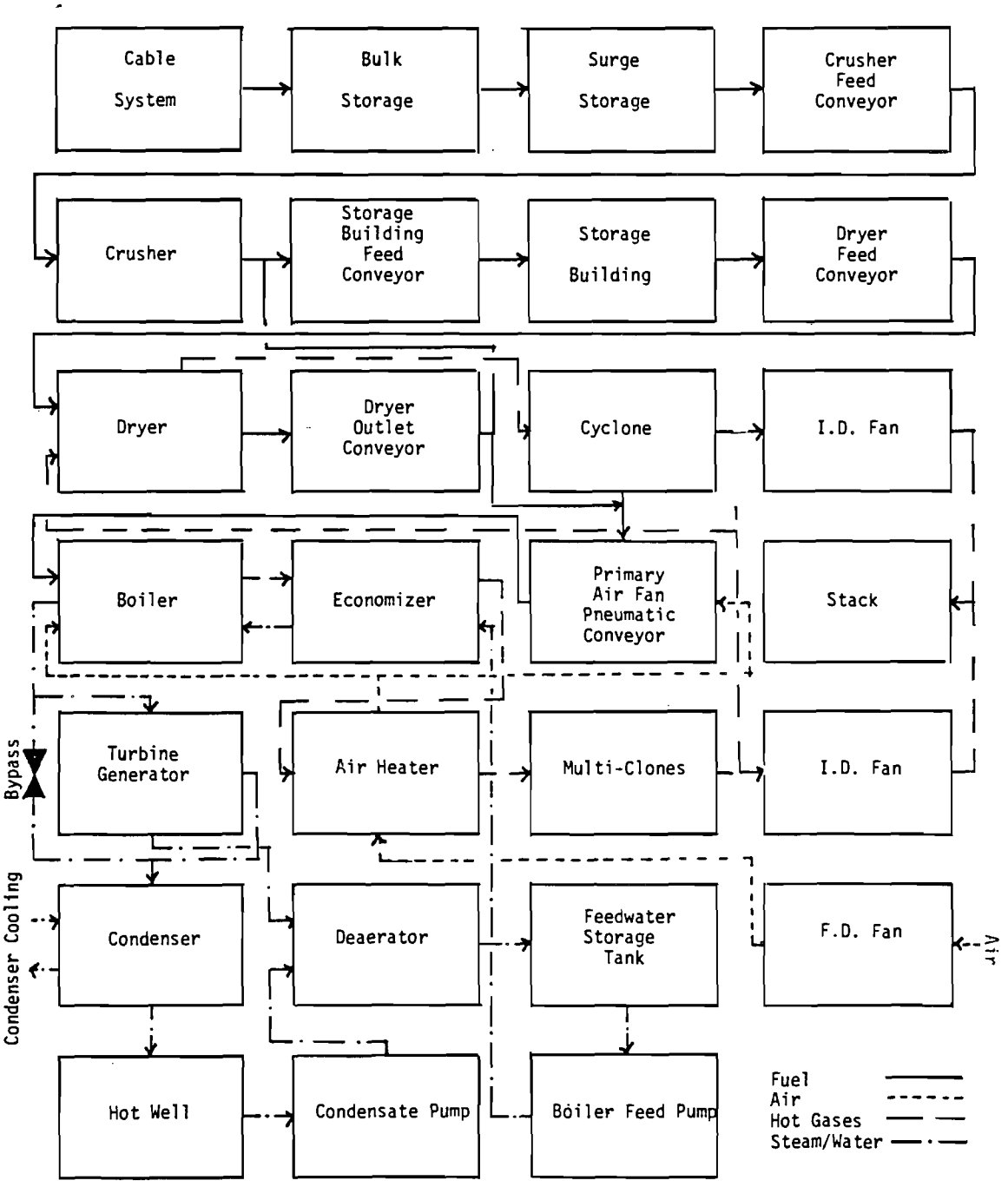


Figure 9

Alsthom-Atlantique Process Diagram

The surge storage building is a covered metal building with sufficient capacity for 36 hours of fuel storage at peak plant output. Screw conveyors located at the top of the building are used for automatic distribution of fuel being loaded into the building, and a push-pull system is used for automatic fuel extraction. A screw conveyor at the outlet of the surge storage building moves the fuel to the dryer feed conveyor.

The dryer feed conveyor is of a similar design to the crusher and surge storage feed conveyors, and the conveyor transports the fuel from the surge storage building to the dryer inlet.

The dryer is a single pass rotary dryer with internal screw type flights. Wet fuel and exhaust gases enter the boiler at the same end and flow concurrently to the exhaust. Dry fuel drops out of the dryer onto a screw conveyor. Dryer exhaust gases exit from the top of the dryer and flow to a cyclone where fines are removed. The fines drop onto the screw conveyor with the dry fuel, and the exhaust gases flow to the stack. The dryer temperature is controlled by a damper which allows hot gases to bypass the dryer if the temperature gets too hot.

The dryer outlet screw conveyor transports fuel to the pneumatic boiler feed system or to the surge storage feed conveyor. The routing to the surge storage feed conveyor allows recirculation of the dry fuel back to the surge storage building.

The air for pneumatic transport of fuel to the boiler is supplied from the boiler air heater. A primary air fan provides the velocity required to transport the fuel to the boiler through two fuel feed nozzles located on opposite sides of the boiler. The balance of the air from the air heater is supplied to the boiler through four secondary air nozzles.

The boiler for the Alsthom-Atlantique plants is manufactured by ADF in France. The unit is a two-drum watertube boiler with superheater, economizer, and air heater. Hot gases pass through the main boiler, then to the economizer and finally, to the air heater. A forced draft fan supplies air to the air heater. Hot exhaust gases pass through one of three parallel cyclone separators before flowing to the dryer. An alternate path is provided to bypass the dryer system with separate induced draft fans provided for each path. The boiler is tangentially fired with two fuel and four secondary air nozzles. The boiler tubes are not welded but are expanded into the drums.

Feedwater enters the boiler through the economizer, is heated in tubes, vaporized in the steam drum, and superheated in the pendant type superheater. Ash is automatically removed from the boiler by a drag chain conveyor.

The turbine is a three-stage, single extraction condensing unit manufactured by Rateau of France. Steam from the boiler is expanded in the turbine to generate shaft power and is exhausted to the condenser. The turbine is connected to the generator through a gearbox.

A control valve is provided for bypassing the turbine and allowing steam to pass directly to the condenser. A desuperheater is provided in this line to prevent damage to condenser tubes. The condenser removes the heat of vaporization from the turbine exhaust steam and rejects the heat through a cooling tower to atmosphere. Condensed steam is collected in a hotwell located directly beneath the condenser. A steam jet air ejector is used to establish and maintain condenser vacuum by removing any non-condensible gases present in the steam.

Condensate is pumped from the condenser by two centrifugal condensate pumps. The condensate is pumped to a deaerator where it is heated to its boiling point to improve cycle efficiency by preheating and to remove non-condensible gases. The condensate enters the deaerator through a bent condenser, and deaerating steam is supplied from a turbine extraction.

The feedwater storage tank is located directly beneath the deaerator. The boiler feedwater pumps take suction from this storage tank and supply the feedwater to the boiler economizer.

In addition to the primary systems discussed in the preceding sections, each plant has the following auxiliary systems:

- Make-up water treatment--This system consists of sand filter for grit removal and anion-cation multiple bed demineralizers.

- Air compressor--This system supplies both service air and instrument air for plant operation.

- Diesel generator--The generator provides power required for a "black start" of the plant.

3. Plant Layout

Figure 10 shows a general layout of the Alsthom-Atlantique power plants. The layout of each of the plants is essentially the same, with the exception of minor differences depending on the particular A & E responsible for the plant design.

The boiler at the Alsthom-Atlantique plant is completely uncovered, while the turbine is located under a sheet metal roof building with partial siding.

There is a building on the Alsthom-Atlantique site which houses the central control room where all plant operations can be controlled and monitored. The deaerator and feedwater storage tank are located on top of this building, and the boiler feed pumps, compressor and diesel are located in a bay in this building. The building also contains the emergency storage batteries and sleeping quarters for operators.

The fuel loading area is located at the top left side of the figure behind the surge storage building. Once fuel is manually loaded into the system, all fuel transportation should be automatic from that point.

The location of the Lasso unloading system, bulk storage area, and cooling tower depends on the particular site.

4. Heat Balance

Figure 11 presents a simplified heat balance for the 3.4 MW Alsthom-Atlantique plants. The balance shows the mass and energy flows to the major equipment in the system. The turbine performance curve used to generate this heat balance is shown in Figure 12. As a curve was not available from the manufacturer, an approximate curve was developed so that the heat balance could be generated. The thermal efficiency of the boiler is assumed to be 80 percent.

The major auxiliary electrical loads for the plant are shown in Table 7. This table reflects the large parasitic load on the plant resulting from the complex fuel feed system.

Based on the heat balance and auxiliary load tables, it is concluded that the Alsthom-Atlantique 3.4 MW plant will have a net power output of 2.91 MW

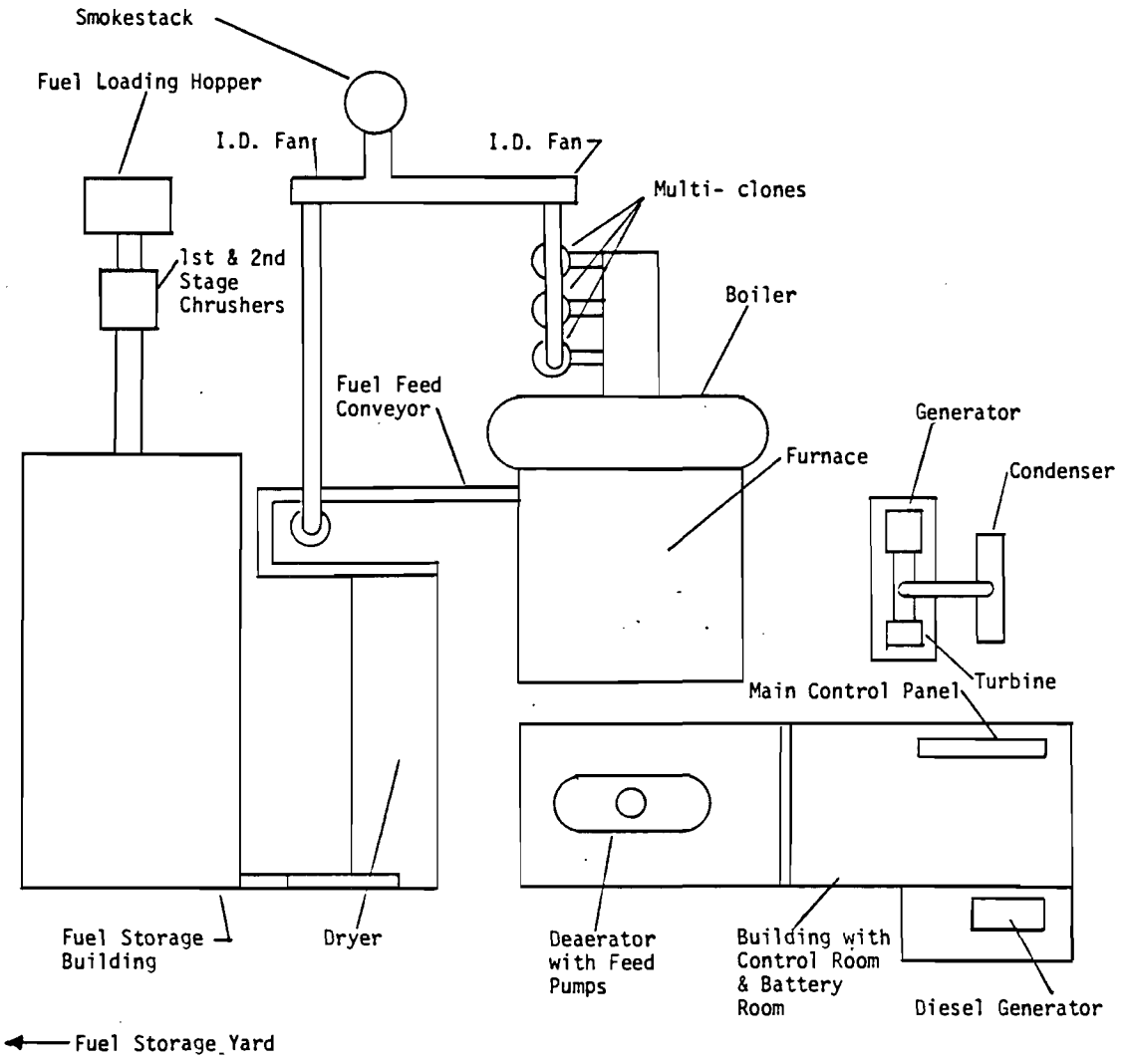
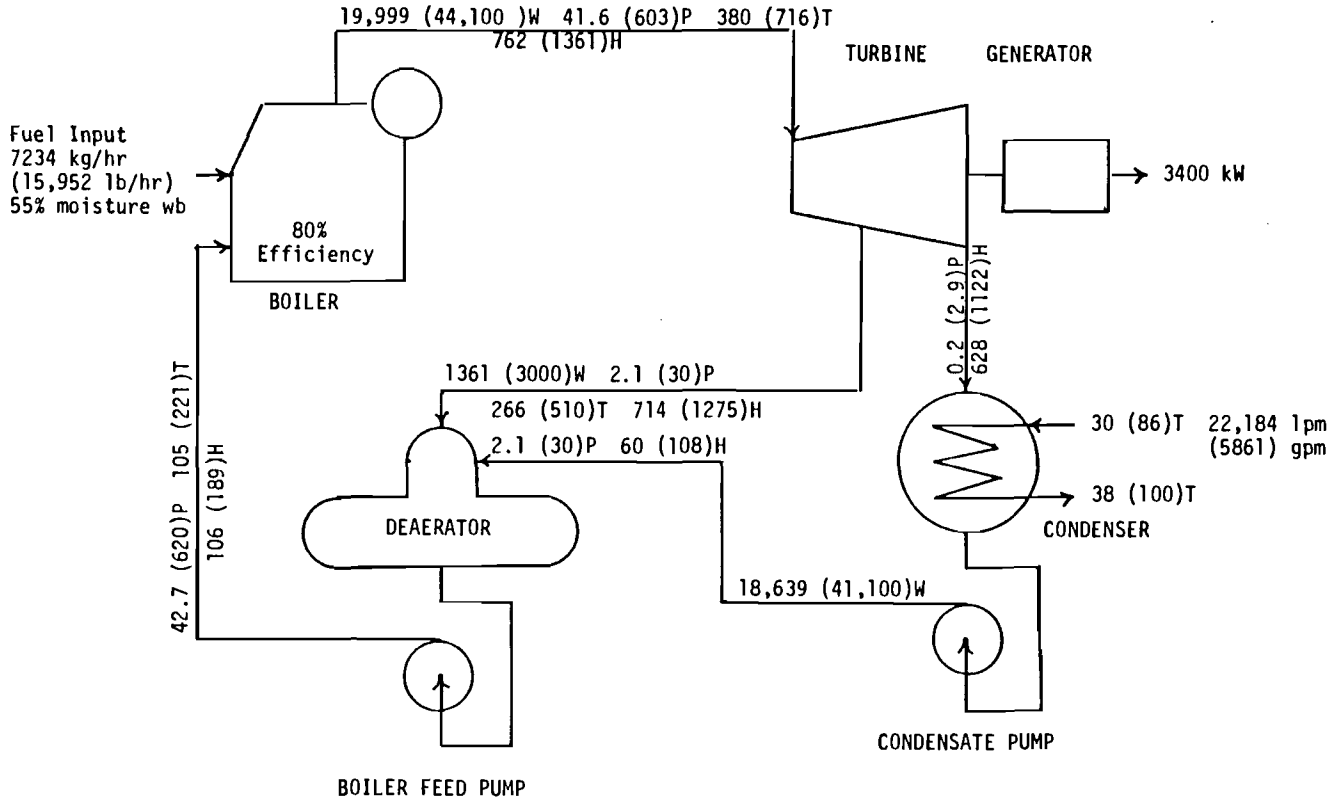


Figure 10

Alsthom-Atlantique Plant Layout



P - Pressure, bar (lb/in^2)

T - Temperature, C^o (F^o)

W - Mass Flow, kg/hr (lb/hr)

H - Enthalpy, kcal/kg (Btu/lb)

Figure 11

Alsthom-Atlantique Heat Balance

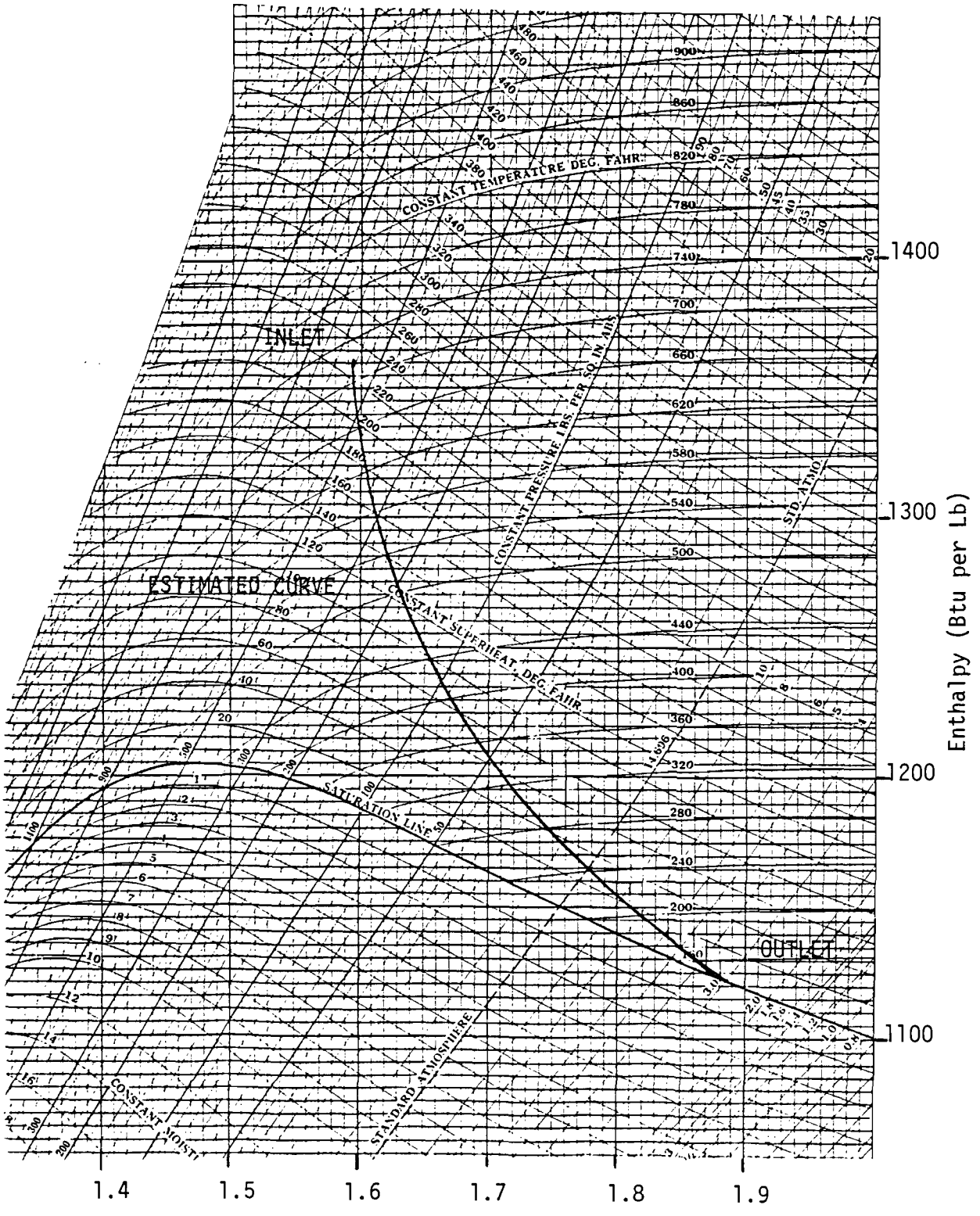


Figure 12

Alsthom-Atlantique Plant Turbine Performance Curve

Table 7

Alsthom-Atlantique Plant Auxiliary Loads

Load	Number Operational	Horsepower	Total kW
Dryer	1	26.8	20.0
Primary Crusher	1	100.6	75.0
Secondary Crusher	2	4.0	6.0
Cooling Water Pump	2	20.1	30.0
Air Compressor	1	22.8	17.0
Crusher Feed Conveyor	1	14.8	11.0
Surge Storage Feed Conveyor	1	4.0	3.0
Surge Storage Extraction	1	4.0	3.0
Primary Air Fan	1	13.4	10.0
Forced Draft Fan	1	60.3	45.0
Induced Draft Fan	2	134.1	100.0
Feed Pump	1	60.4	45.0
Condensate Pumps	1	13.4	10.0
Miscellaneous (5%)			19.0
Total			394.0

and a net plant heat rate of 5526 kcal/kWh (21,927 Btu/kWh). The net plant thermal efficiency is 15.6 percent.

5. Manufacture and Construction

The contractual responsibilities for the design, construction and start-up of the Alsthom-Atlantique plants are similar to those of the British plants. Alsthom-Atlantique is responsible for plant design and supply of equipment, the A & E's are responsible for the balance of plant design, and the construction contractors are responsible for site erection.

Table 8 presents a revised and modified schedule for the construction of the two Alsthom-Atlantique plants still under construction with a brief explanation of the major causes for construction delays. As is the case with the British plants, the reasons for delays are varied, but adequate funding appears to be the primary problem. For example, the ISECO plant is awaiting delivery of boiler tubes which are being held in bonded storage until payment of shipping fees is made.

6. Operation, Maintenance and Training

As of the publication of this report, only limited plant operation data was available, most of this data from start-up and commissioning of the plant. The estimated personnel required for plant operation on each shift are shown in Table 9. This estimate is based on interviews with plant personnel and observations by the engineering team.

Each plant has a full-time maintenance engineer assigned to the plant who is responsible for general equipment servicing. In addition, all operators are trained in troubleshooting equipment problems to identify items needing repair or replacement.

Training is provided as a part of the equipment supply contract with Alsthom-Atlantique. A copy of the general training course outline is included in Appendix 2. The general training course requires approximately 6 weeks, of which 2 weeks are conducted at an operating plant and 4 weeks are conducted at the plant to which the operators are assigned. The training is conducted by the Alsthom-Atlantique start-up engineer.

Table 8
Alsthom-Atlantique Design and Construction Schedule
Burgos Dendro Thermal Project

	Planned Start Date	Actual Start Date	Planned Completion Date	Actual Completion Date	Primary Reason for Delay
A & E Detailed Design	1 Jan. 1982	3 May 1982	30 July 1982	7 Oct. 1982	
Bidding of Construction Contract	10 Aug. 1982	26 July 1982	30 Sep. 1982	14 Oct. 1982	
Site Civil Works	17 Jan. 1983	10 Jan. 1983	25 Dec. 1983	15 June 1984	- Lacking logistics and delayed payments as alleged by Contractor
Building Construction	13 Mar. 1983	4 Feb. 1983	4 July 1983	15 June 1983	- do -
Substation and Switchyard	5 June 1983	1 Aug. 1983	3 July 1983	--	
Delivery of Plant Equipment	1 April 1983	3 April 1983	10 Oct. 1983	--	- Some crates were not withdrawn immediately at the customs
Electrical/Mechanical Installation	14 May 1983	6 June 1983	15 Dec. 1983	--	- do-
Test and Commissioning	7 Sep. 1983	--	25 Dec. 1983	--	- Electro/Mechanical works not yet completed
Distribution Line Extension					- Installed by Coop during the civil works construction (200 meters)

Note: Project's work accomplishment as of April 25, 1984, is 75.12%.

Table 8 (Cont.)
Alsthom-Atlantique Design and Construction Schedule
Bolinao Dendro Thermal Project

	Planned Start Date	Actual Start Date	Planned Completion Date	Actual Completion Date	Primary Reason for Delay
A & E Detailed Design	1 Dec. 1980	1 Dec. 1980	31 Oct. 1981	30 Nov. 1981	- Late arrival of manufacturer's drawings
Bidding of Construction Contract	15 Oct. 1981	23 Nov. 1981	15 Feb. 1982	5 Feb. 1982	
Site Civil Works	14 Feb. 1982	1 Mar. 1982	15 June 1982	84.92% complete as of 10/31/83	- Lack of manpower, aggregates, unpassable access road caused by heavy rainfall, suspension of work by Contractor due to nonpayment of services
Building Construction	22 Mar. 1982	1 Apr. 1982	30 June 1982	15 Mar. 1983	- Same
Substation and Switchyard	15 Apr. 1983	1 Oct. 1982	30 Aug. 1982	30 Apr. 1983	- Adjusted to follow delay in electromechanical installation
Delivery of Plant Equip. a) Major	31 Mar. 1982	15 June 1982	30 Apr. 1982	31 Dec. 1982	- Bad road condition due to heavy loads and collapse of Balingasay Bridge leading to project site
b) Balance of Plant	25 May 1982	15 July 1982	15 Aug. 1982	30 Nov. 1982	

Table 8 (Cont.)
Alsthom Atlantique Design and Construction Schedule
Bolinao Dendro Thermal Project (Cont.)

	Planned Start Date	Actual Start Date	Planned Completion Date	Actual Completion Date	Primary Reason for Delay
Electrical/Mechanical Installation	1 May 1982	1 Aug. 1982	30 Aug. 1982	31 May 1983	1. Mechanical failures and malfunctions of French-supplied equipment, necessitating repairs and/or modifications 2. Late receipt of control cable schedule from supplier, thus causing delay in material procurement 3. Differing site conditions particularly on ropeway installation 4. Occasional work stoppage/ because of nonpayment of services 5. Additional work required by A & E
Test and Commissioning	21 Aug. 1982	1 Apr. 1983	21 Sep. 1982	11 Feb. 1984	
Distribution Line Extension	--	--	--	--	

Table 9

Personnel Required for Alsthom-Atlantique Plants

Position Title	Job Category	Job Level	Number Required
Plant Supervisor	Dept. Manager	17	1
Mechanic	Jr. Prof.	10	1
Shift Supervisor/Engineer	Div. Chief	15	4
Turbine Operator	Jr. Prof.	10	4
Boiler Operator	Jr. Prof.	10	4
Switch Panel Operator	Jr. Prof.	10	4
Lab Man	Skilled	9	1
Driver	Skilled	7	1
Utility Man	Nonskilled	2	1
Dendro Supervisor	Div. Chief	15	1
Buyer Scaler	Jr. Prof.	9	1
Tramway Operator	Skilled	7	2
Cutter	Nonskilled	3	3
Handler	Nonskilled	3	12
Total Personnel Required			52

7. Spare Parts

Spare parts are included in the scope of supply from Alsthom-Atlantique; however, during the initial start-up of the PANELCO I and ISECO plants, some replacement parts were obtained from the plants not under construction. A system for central location, inventory control and distribution of spare parts has not yet been established.

C. FRENCH DUVANT GASIFIER DESIGN (0.96 MW)

1. Description and Status of Plants

Two gasifier-based power stations, each of capacity 0.96 MW, have been supplied by Moteurs Duvant of Valenciennes, France. Each station is comprised of two separate gasifier-engine-generator systems. A typical plant is shown in Figure 13. Each individual gasifier-engine-generator is made up of the following components:

- One fixed-bed Duvant GA20 gasifier plant (including separate combustion chamber, fuel drying and loading, and gas conditioning systems).

- One 6 VJGS 600 kVA engine gen set capable of dual fuel operation (diesel fuel and low Btu gas), of Duvant manufacture.

- One Jeumont-Schneider brushless AC generator with ERTCR excitation, 600 kVA, 0.8 pf, 720 rpm, 60 Hz.

- Engine auxiliaries, including compressed air start and fuel oil injection system.

One of the stations is owned by the Occidental Mindoro Electric Cooperative (OMECO) and is located in the municipality of Magsaysay. The other station is owned by the Antique Electric Cooperative (ANTECO) and is

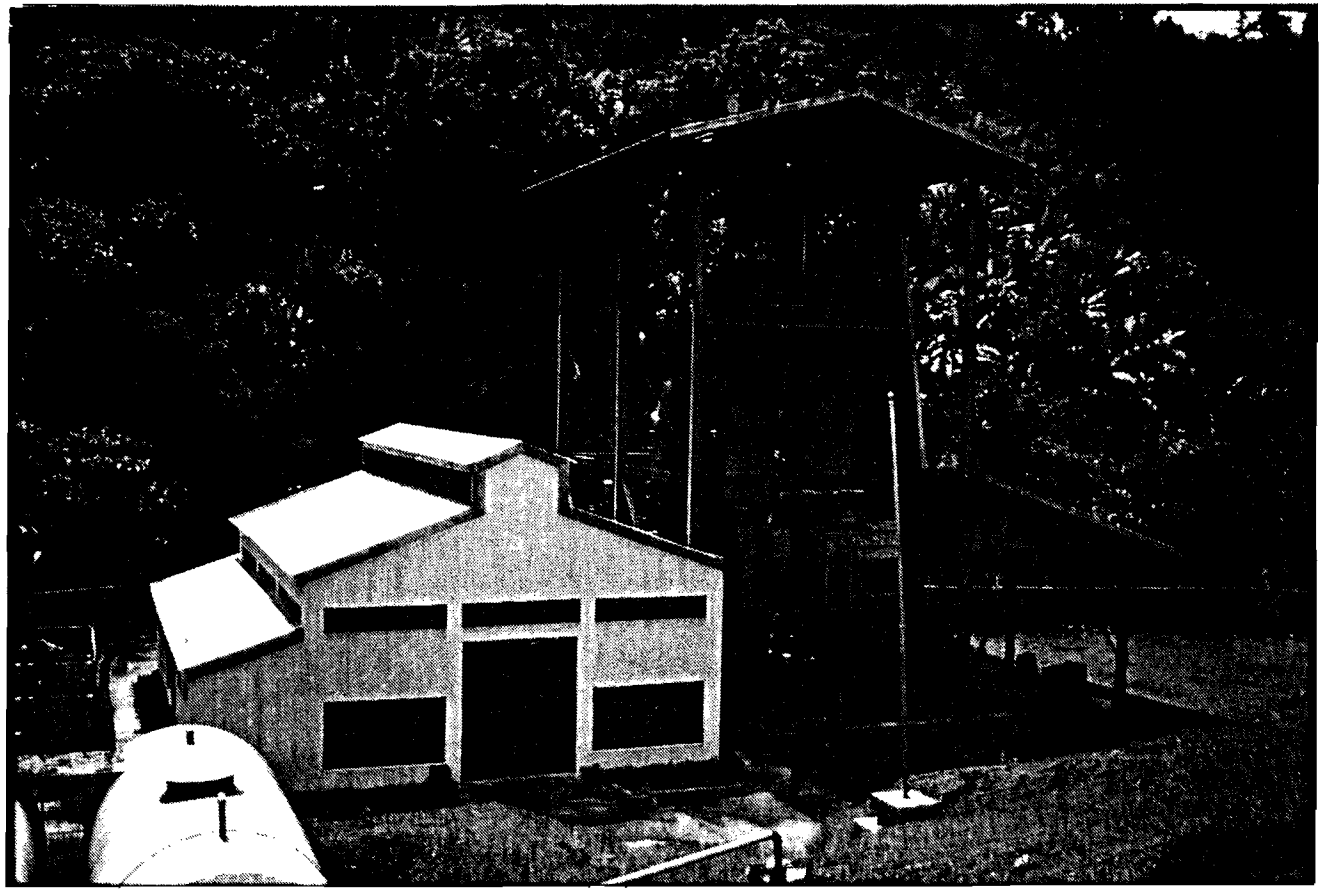


Figure 13

Typical French Moteurs Duvant Plant

located in the municipality of Hamtic. The OMECO site is 88.35 percent complete with a target completion time of 699 days. The ANTECO site is 96.41 percent complete with a target completion time of 604 days (9). At both sites, the major reasons for delay are lack of funds due to the current financial crisis within the Philippines and NEA, and delay with the shipping of refractory cement used to install the firebrick in the gasifier and combusion chamber. A summary of the plants is presented in Table 10, and the locations of the plants are shown in Figure 14.

2. General Technical Details

Each power station consists of a pair of 600 KVA gasifier-engine-generator systems. The gasifier converts wood fuel to a low-Btu fuel gas (about 135 kcal/SCM, or 150 Btu/scf), which is used as fuel in a reciprocating diesel engine. A small quantity (usually 10 to 20 percent of total energy input) of diesel fuel is required by the engine for ignition purposes. A process diagram for the plant is shown in Figure 15 (9, 10, 11, 12).

The main features of the gasifier--a Duvant model GA20--are its fixed bed and separate combustion chamber. Fuel wood, received at the station from the plantation, is broken into 7.62 cm x 12.70 cm (3" x 5") (maximum) size pieces, dried using engine exhaust gas, and conveyed to the top of the gasifier reactor by a semi-automatic loading skip. The reactor fuel port is sealed by a horizontal sliding plate. Static pressure inside the top of the reactor is claimed to be zero, so gas does not escape during fuel loading, i.e., with the sliding plate in the open position.

As fuel descends inside the reactor it undergoes drying, pyrolysis and, finally, gasification. Ash, which collects on the grate, is plowed to a central discharge port, where it falls into a detachable container.

A sketch of the gasifier is shown in Figure 16. Movement of pyrolysis gas upwards through the bed to the top of the gasifier is provided for by an air ejector. This air ejector--essentially a venturi mounted to one side of the gasifier near the top--is supplied with compressed air from a 25 kW Roots type blower. After it exits the upper reactor, the pyrolysis gas, which is rich in heavy hydrocarbons, mixes with the air at the venturi, and the mixture is delivered to a separate combustion chamber adiacent to the main gasifier

Table 10
Summary of French Moteurs Duvant Plants (as of May 1984)

Plant Name	Location (Town, Province)	A & E	Construction Contractor	Construction Status	Planned Operational Date
ANTECO	Hamtic, Antique	AWIA	F. F. Cruz	96%	1984
OMECO	Magsaysay, Occidental Mindoro	DCCD	PCI - IOCCI	85%	1984

% - Percent Completion

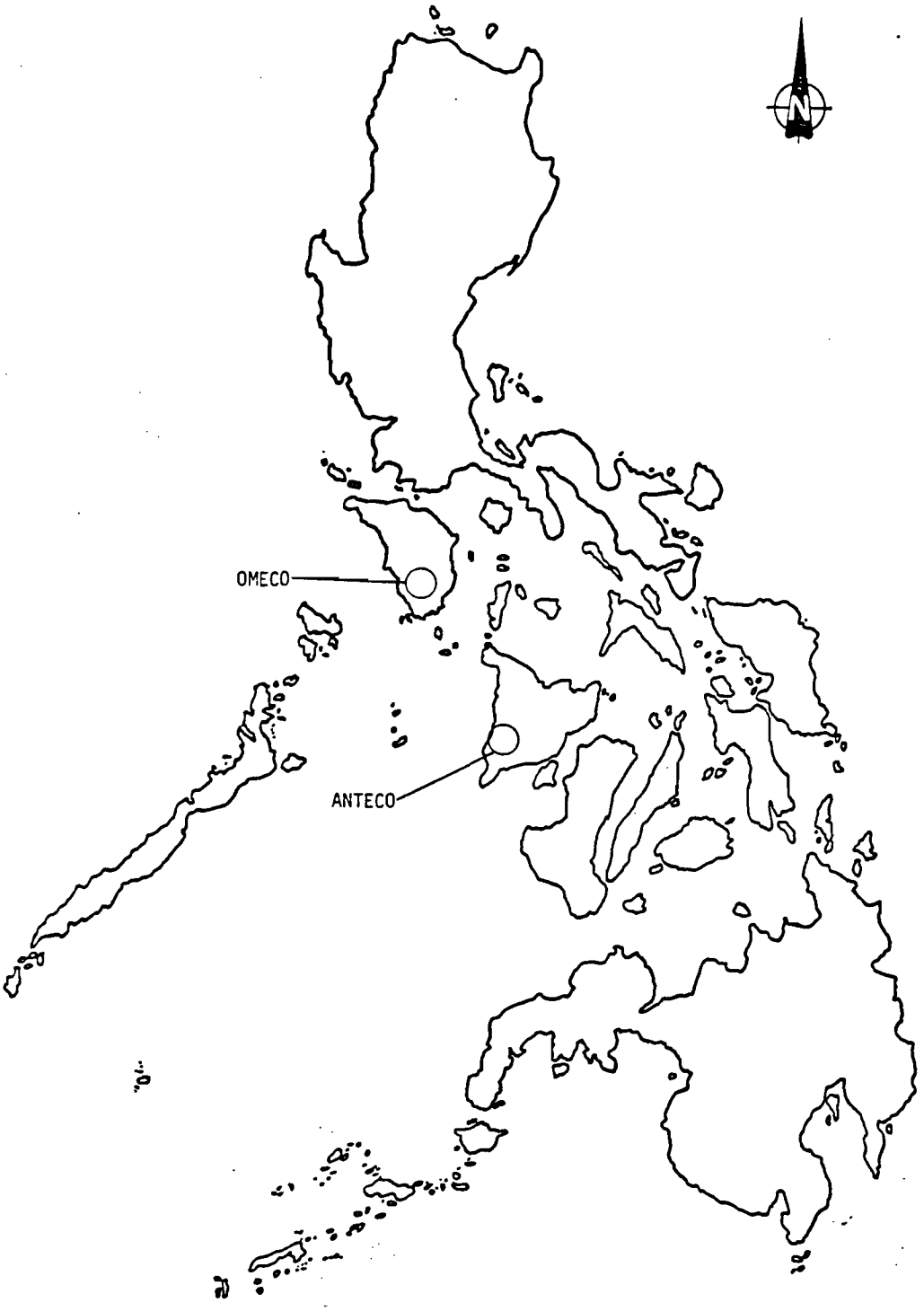


Figure 14

Locations of Moteurs Duvant Plants

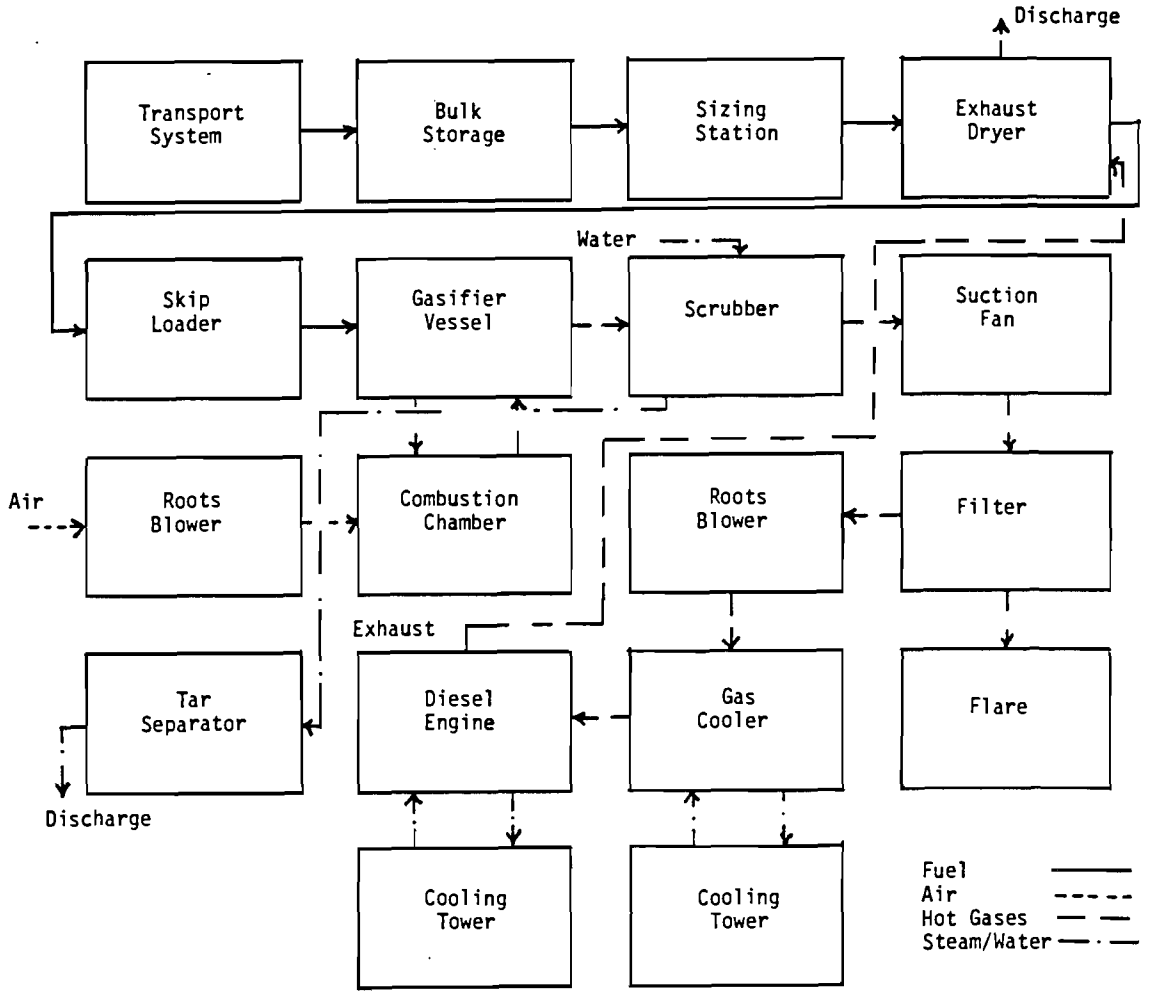


Figure 15

Moteurs Duvant Plant Process Diagram

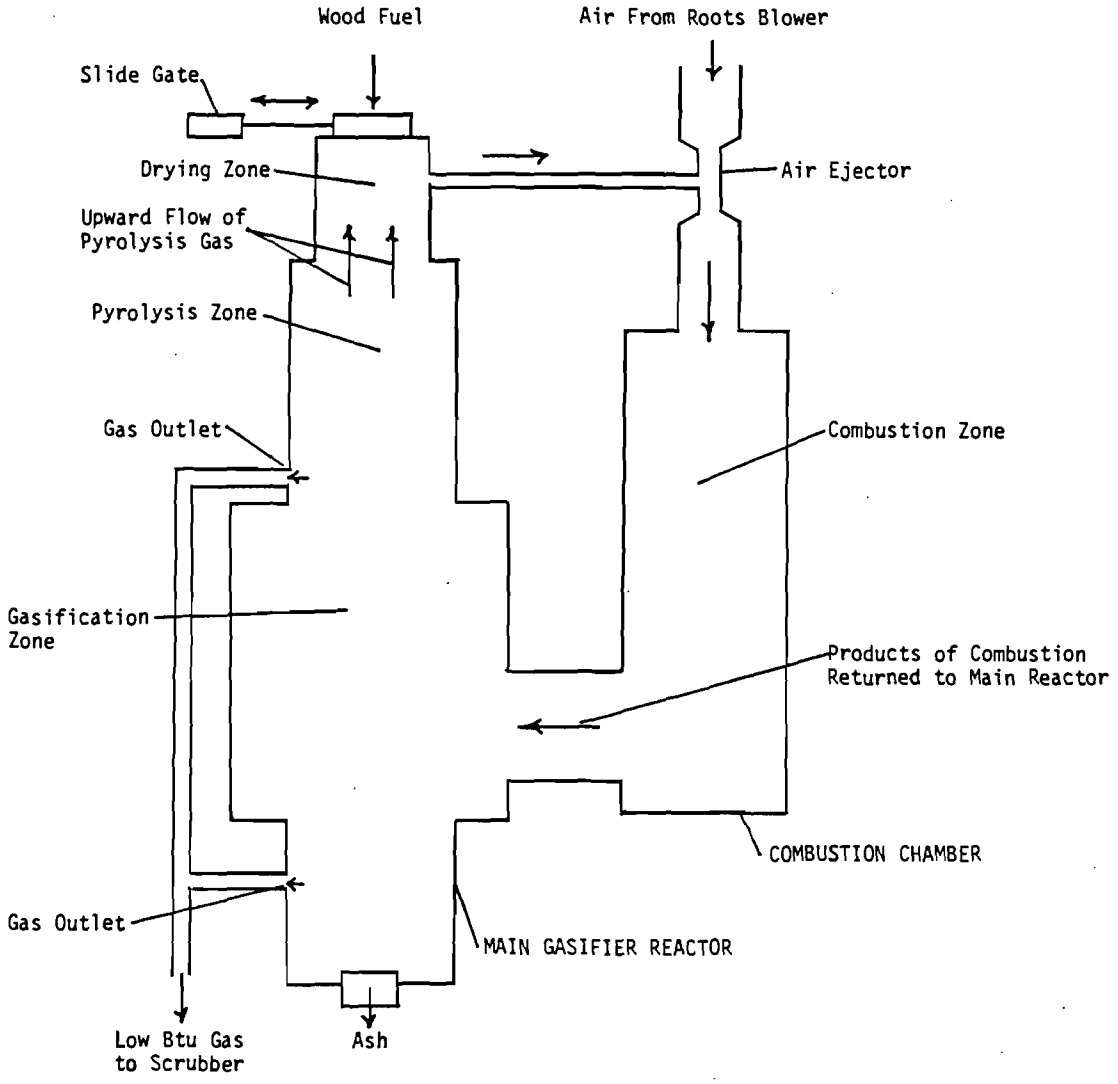


Figure 16

Sketch of Duvant Gasifier

reactor. This combustion chamber is lined with refractory firebrick, and inside it the pyrolysis gas is partially cracked by combustion with air. Products of combustion and cracking leave the bottom of the chamber to reenter the fuel within the main gasifier reactor. At this location in the gasifier the bed consists of carbon; the hot products react with the carbon to form the desired low-Btu gas. Gas exits the reactor at two levels (four exit ports per level) above and below the point of reintroduction of hot products from the combustion chamber.

Gas, exiting the main reactor at the two levels, is combined and delivered to a wet scrubber consisting of a vertical, baffled spray tower. Scrubber water is circulated through cooling towers and filters. Suction is applied to the scrubber by a 7.5 kW centrifugal fan. Leaving the fan, gas is passed through safety cartridge filters and delivered to the inlet side of a 50 kw Roots type compressor to increase gas pressure prior to delivery to the engine. Heat of compression is removed in a second spray tower. The system is piped so that gas can recirculate around the gas compressor. The engine draws gas as required by station electrical load; surplus gas is flared.

The gasifier plant is started up by means of an auxiliary oil burner mounted at the top of the separate combustion chamber. Gas can be flared during start-up.

The Duvant-supplied dual-fuel engine is a standard diesel with modifications to accommodate operation in dual-fuel mode. In particular, gas and air are compressed separately and introduced into the cylinder head through separate valves. Gas flow is controlled by a butterfly valve in the gas header driven by the engine governor. Diesel injection flow rate is set at the minimum required for ignition of the gas.

The engine is started with compressed air and cooled with water which is circulated through two cooling towers at the back of the engine house. Engine exhaust is used for drying the gasifier fuel. Air supply to the engine is supercharged. Air pressure is increased automatically with load. Gas pressure is corrected to remain above air pressure, regardless of load, to ensure adequate fuel mixing in the cylinders.

Controls for the gasifier auxiliary motors (total of 11) are mounted on the main electrical control panel.

Safety devices consist of an alarm system (horn and lights) and electrically controlled valves which dump gas to flare and bypass the gas pressure booster. The alarm systems and safety valves are connected to system supervisory monitors capable of responding to temperature and pressure water level, and gas flow excursions within the system.

3. General Construction Details

The gasifier main reactor is fabricated in seven flanged sections rolled from carbon steel. The reactor, combustion chamber and connecting duct are lined with refractory firebrick.

Piping for pyrolysis gas between reactor and combustion chamber (including air ejector) and the gas outlet piping (manifolded from eight locations) is in stainless steel.

The eight gas outlet ports consist of hooded square tubes protruding through the refractory into the fuel bed. Tubes and hoods are fabricated from stainless steel.

4. Plant Layout

Wood fuel for the two gasifiers is to consist of ipil-ipil from energy plantations adjacent to the power station. Tree stems, cut into bolt lengths, are to be transported to the station by a Lasso cableway. The wood will be received in bundles at an unloading station.

Major components of the station include engine/generators, gasifiers and fuel preparation, which are arranged in line. Two systems, capable of independent operation, are installed at both the ANTECO and OMECO sites.

Wood fuel is broken into 3 inch x 5 inch pieces as per Duvant specifications. This fuel is passed through a tunnel dryer employing engine exhaust heat; covered fuel storage is provided.

The general layout is shown in Figure 17. The three major components of the power station are the engine house, gasifier plant and fuel processing, and storage.

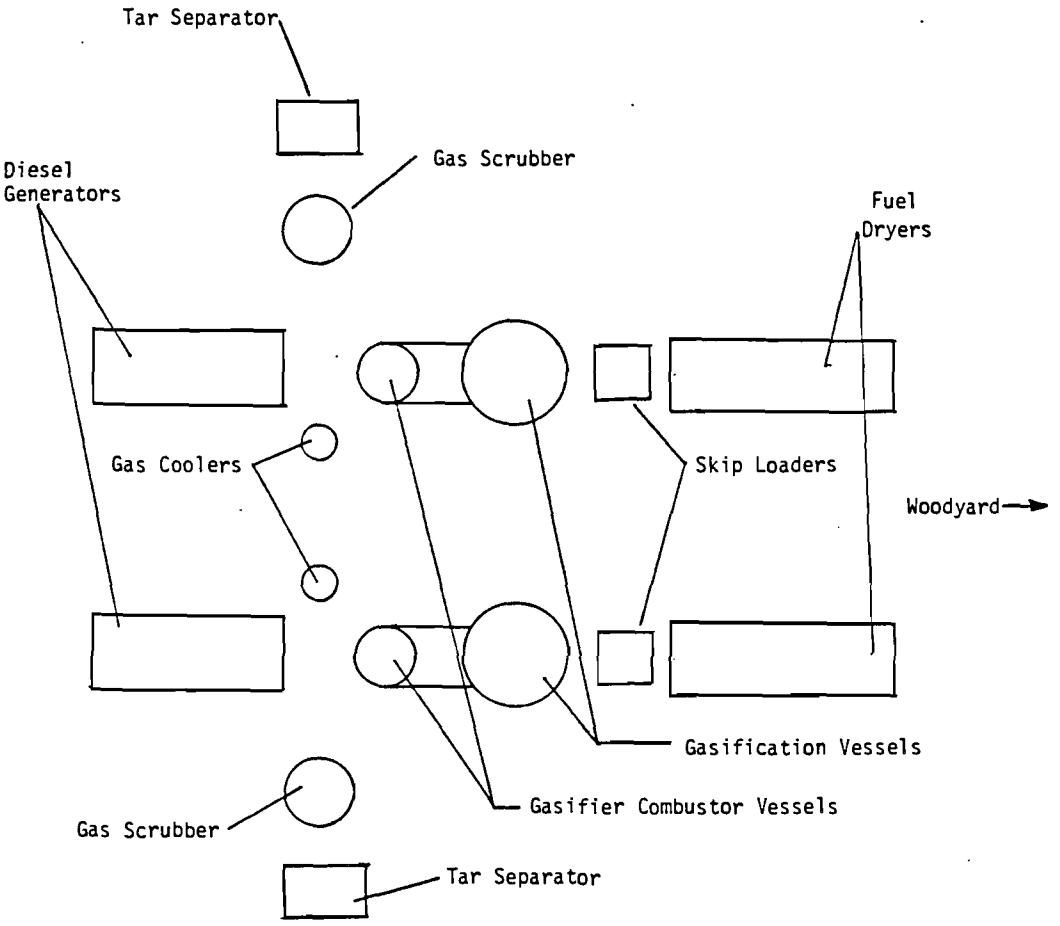


Figure 17

Moteurs Duvant Plant Layout

The two engine-generator sets, electrical control panel, compressors for engine start-up and compressed air control systems, and fuel oil delivery system (for dual-fuel operation) are located inside the engine house. The two gasifiers, combustion chambers and gas conditioning plant are located adjacent to the engine house. Fuel drying and storage facilities are under a covered enclosure next to the gasifiers.

Cleaned and pressurized gas is piped through the wall of the engine house from each gasifier system to its respective engine. Exhaust gases from the engines pass to the drying tunnels in the fuel storage area. Dried fuel is delivered directly to the gasifier skip loaders.

Four cooling towers, two for the engine coolant and two for the gas cleaning plant scrubbing liquor, are located to one side of the station.

5. Heat Balance

Gross electrical output for one station (two gasifier systems) is 0.96 MWe at the bus. Total station load--blowers, pumps, etc.--is equivalent to 0.30 MWe. Net station output is 0.66 MWe or 0.58 million kcal/hr (2.25 million Btu/hr).

Fuel consumption by both gasifiers is stated by Duvant to be 1 tonne/hr. For each reactor the specific fuel consumption rate will be 50 lb/(hr x ft^2). Fuel consumption by both gasifiers is equivalent to 14 million Btu/hr (assuming an HHV for ipil-ipil, as fired, of 6.500 Btu/lb).

Diesel fuel consumption by both engines, when running at full load in dual-fuel mode, will be 27 litres/MW hour or about 1 million Btu/hr. Allowing for the efficiency of conversion of wood to low-Btu gas, the diesel consumption will be 10 to 15 percent of total fuel energy input to the engines. Overall station thermal efficiency will be about 20 percent.

6. Manufacture and Construction

The four gasifier-engine-generators were designed and manufactured by Moteurs Duvant. Duvant has supplied NEA with complete fabrication drawings for the gasifiers and layout plans for the two stations.

The gasifier plants were broken down to major roll-ups (for the reactors) and individual components of the gas processing train, for shipping. The Duvant diesel-fuel diesel sets were shipped as complete units.

Manufactured subcomponents such as positive displacement blowers, pumps, engine governor, etc., were purchased by Duvant.

Assembly of the gasifier plant, structural steelwork, walkways, concrete work, building construction, and engine foundation work were undertaken by the contractors (Power Consultants at the OMECO site, F. F. Cruz and Company at the ANTECO site) under the guidance of a Duvant resident site engineer. Consultants to NEA at the two sites are Adrian Wilson International Associates, Incorporated and DCCD Engineering Corporation. Duvant is represented in the Philippines by the PIECO Corporation. Duvant requires their engineer to be present during start-up and commissioning of the two plants.

7. Operation, Maintenance and Training

Since neither of the two stations has been commissioned or started up, currently there exists no experience with plant operation or with maintenance requirements. The estimated manpower required for plant operation is shown in Table 11.

Training for proposed operating personnel has yet to be undertaken. Maintenance schedules for gasifier systems and engines are provided, but as yet there is no actual experience with implementation.

8. Spare Parts

Spare parts were not available at the NEA warehouse nor visible at the OMECO site. There were some spares on hand at ANTECO.

Replacements for fabricated parts of the gasifier plant could be manufactured locally. The usual inventory of spares for engine parts could be maintained on site; large components would need to be replaced from France.

Table 11

Personnel Required for Moteurs Duvant Plants

Position Title	Job Category	Job Level	Number Required
Plant Supervisor	Dept. Manager	17	1
Mechanic	Jr. Prof.	10	1
Shift Supervisor/Engineer	Div. Chief	15	4
Turbine Operator	Jr. Prof.	10	4
Boiler Operator	Jr. Prof.	10	4
Switch Panel Operator	Jr. Prof.	10	4
Lab Man	Skilled	9	1
Driver	Skilled	7	1
Utility Man	Nonskilled	2	1
Dendro Supervisor	Div. Chief	15	1
Buyer Scaler	Jr. Prof.	9	1
Tramway Operator	Skilled	7	2
Cutter	Nonskilled	3	3
Handler	Nonskilled	3	8
Total Personnel Required			36

D. JAPANESE DESIGN (3.4 MW)

1. Description and Status of Plants

In addition to the French and British power plants, a commitment has been made to NEA by the Overseas Economic Cooperation Fund (OECF) to build a number of dendro thermal plants of Japanese design. The first phase of this process involved producing a basic design and an implementation plan for the Japanese projects. Funds for these activities were provided to NEA through a low-interest loan of approximately ₱14 million from OECF. The duration of these activities was for a nominal 14 months, consisting of activity both in the Philippines and in Japan.

The work on this phase of the project was carried out by a team comprised of West Japan Engineering Consultants, Inc. (WEST JEC) of Fukuoka, Japan, and Meralco Industrial Engineering Services Corporation (MIESCOR) of Manila. At the time of this writing, the basic design and the implementation plan had just been completed (13, 14). Thus, there has been no actual construction done on the power plants. The next phase of activity under this project will involve detailed design and then construction of some of the plants. It appears now that there will be at least a one-year delay on any further funding from the Japanese government to start construction of the plants.

Initially, the WEST JEC team examined some 14 potential power plant sites that were being considered by NEA. From these candidates WEST JEC chose 9 sites, as shown in Table 12. The location of these sites is shown on the map in Figure 18. As noted in the table, the original plan called for completion of four of these plants in 1987 and an additional five in 1988, but this process has now been delayed at least one year.

2. General Technical Details

The scope of the Basic Design Report completed recently covered the power generation facilities, including building works, civil works, and the interconnecting distribution lines from the power plant to the existing 13.2 kV distribution lines.

Table 12

Summary of Japanese Power Plants

Plant Name	Location Town/Province	A & E	Planned Operational Date
CAGELCO II	Lallo/Lasam, Cagayan	MIESCOR	1988
CASURECO II	Pili, Camarines Sur	MIESCOR	1987
CASURECO III	Balatan, Camarines Sur	MIESCOR	1987
CASURECO IV	Garchitorena, Camarines Sur	MIESCOR	1988
CAPELCO	Tapaz, Capiz	MIESCOR	1987
ILECO I	Miag-ao, Iloilo	MIESCOR	1987
LUELCO	Aringay, La Union	MIESCOR	1988
QUEZELCO I	Macalelon, Quezon	MIESCOR	1988
MASELCO	Mobo, Masbate	MIESCOR	1988

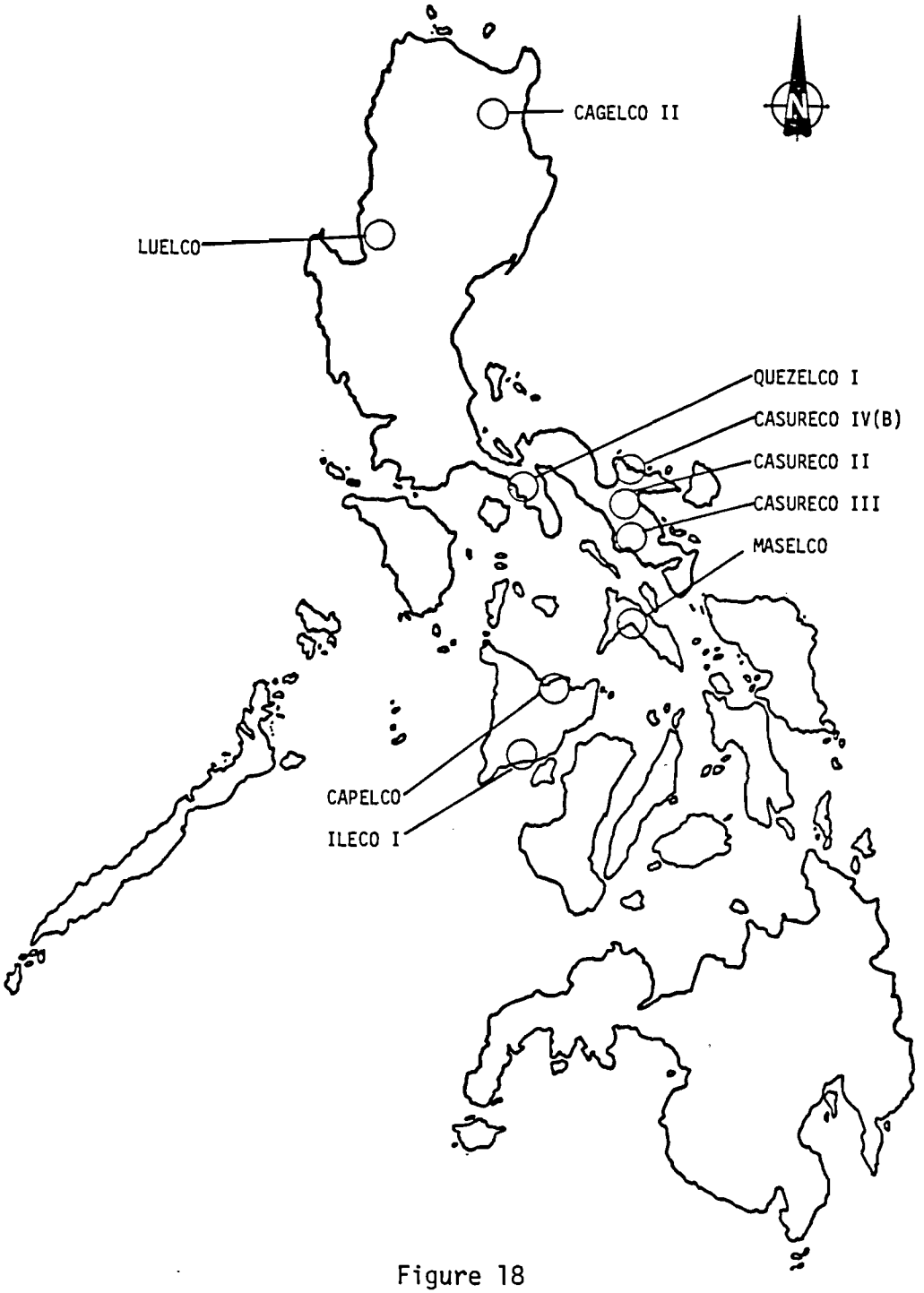


Figure 18

Locations of Japanese Plants

All of the Japanese plants employ the same basic design, including the use of a cooling tower for condenser cooling. There will be minor differences in plant layout due to the site-specific details of each site. Figure 19 shows the overall layout of a typical Japanese plant.

The design calls for a large log storage yard neatly laid out in rows with room for access by carts, forklifts, or simple manpower. Delivery to the unloading area may be by truck, cableway or other means depending on the specific characteristics of the site.

The logs will be transferred to the log handling platform where they will be conveyed to one of two log chippers. Normal storage in the wood yard is planned for one month (approximately 7000 tonnes). The planned stacking height of the wood piles is two meters.

Transfer of wood to the chipping conveyors will be accomplished using the forklift or manual labor. Two chippers of the rotary disc type will be installed with a capacity of 20 tonnes/hr each. These chips will have a nominal chip size of 30 mm (1.18") per side.

After chipping, the wood chips will be stored in an enclosed chip storage house having a capacity of about 1600 tonnes, which, according to the designers, will be enough for one week's operation of the power plant. The chip pile in the fuel house will be managed by a tractor with front end loader, and the chips will be loaded onto a supply conveyor for conveying to a two-hour surge hopper adjacent to the boiler.

The designers have chosen 30 kg/cm^2 (425 psi) as the boiler operating pressure. Size of the plant output will be 3.4 MW (gross). Steam conditions will be 30 kg/cm^2 and 350°C at boiler outlet and 29.5 kg/cm^2 and 345°C at turbine inlet. Steam flow of the boiler will be approximately 20 tonnes/hr (45,000 lb/hr), and the boiler type has not been finalized. The designers are considering pile burners, thin bed burners (with spreader stokers) and suspension burners. During the detailed design phase the boiler design will be finalized.

No fuel dryer is planned for the Japanese plants, although an air preheater will be utilized to help dry the fuel in the furnace.

A sootblower will be utilized to help keep the heat transfer surfaces of the boiler clean.

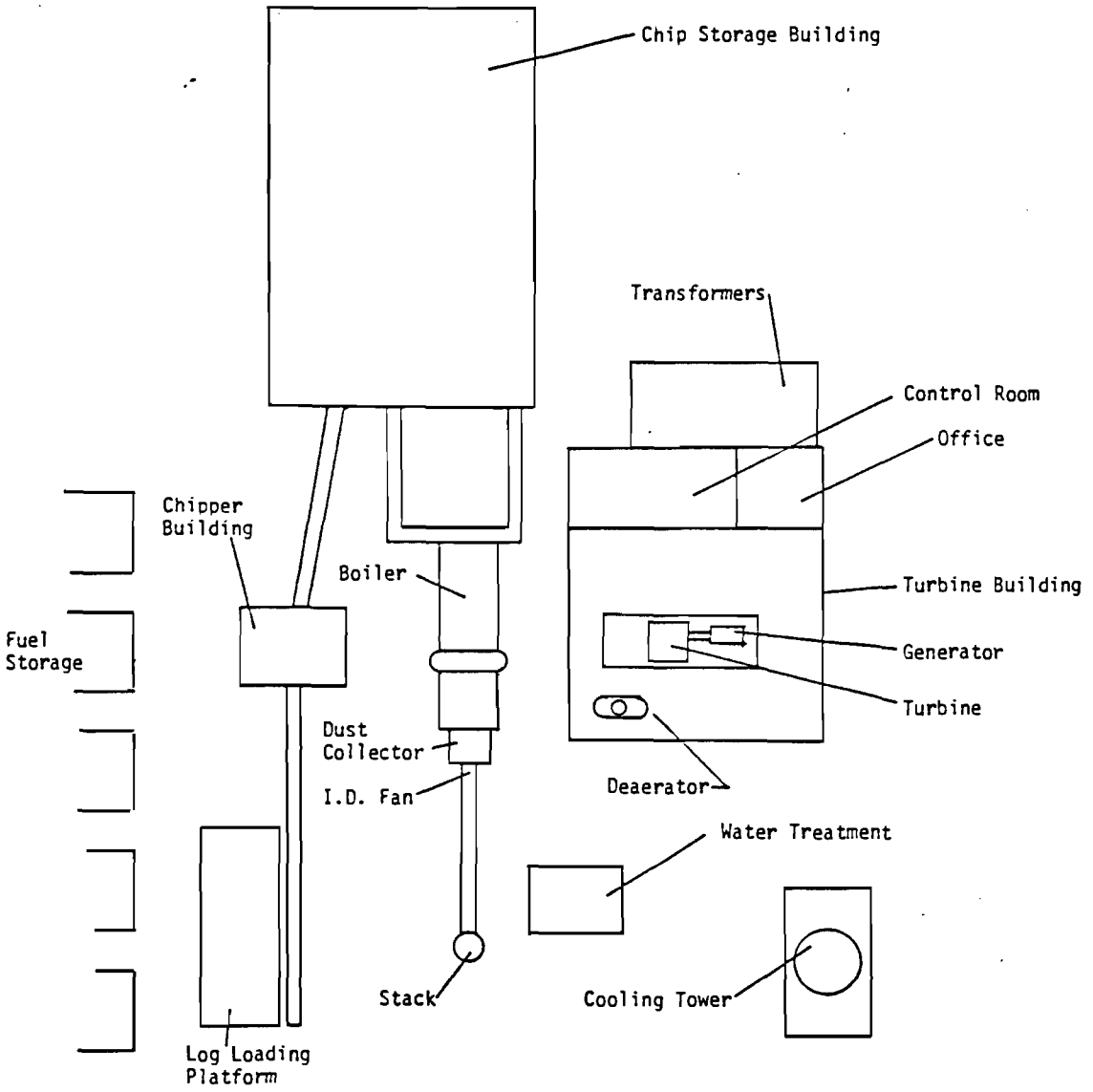


Figure 19

WEST JEC Plant Layout

The boiler will be operated balanced draft with forced draft and induced draft fans. Discharge of the boiler will probably be into a mechanical dust collector of the cyclone variety to control particulate emissions to some extent. The stack will be a steel stack approximately 30 meters in height.

Boiler ash removal will be accomplished through an automatic conveying system which will depend on the final boiler design.

The steam turbine design has not been finalized, but plans call for a synchronous generator driven by a high-speed turbine with gear reducers, similar to the French and British designs.

Turbine cooling will be provided with a surface condenser and a cooling tower.

Other accessories for the power plant are as expected, including deaerator, condensate pumps, air ejector, boiler feedwater pumps, etc. Details of fluid flows are shown in Figure 20. Details of electric services within the plant are shown in Figure 21.

The designers have paid considerable attention to many details such as the level of water treatment which will be needed at each site, the parasitic horsepower that will result from various plant accessories, the size of the black start diesel generator that will be needed, etc.

3. Heat Balance

Since the final designs for the boiler and turbine have not been determined, no heat balance can be performed. The designers claim that the overall station efficiency will be 18.5 percent, which seems somewhat optimistic.

4. Manufacture and Construction

No comments can be made on these subjects, since equipment suppliers for the various power plant components have not yet been identified.

5. Operation, Maintenance and Training

No definite plans have yet been formulated for the training of operators.

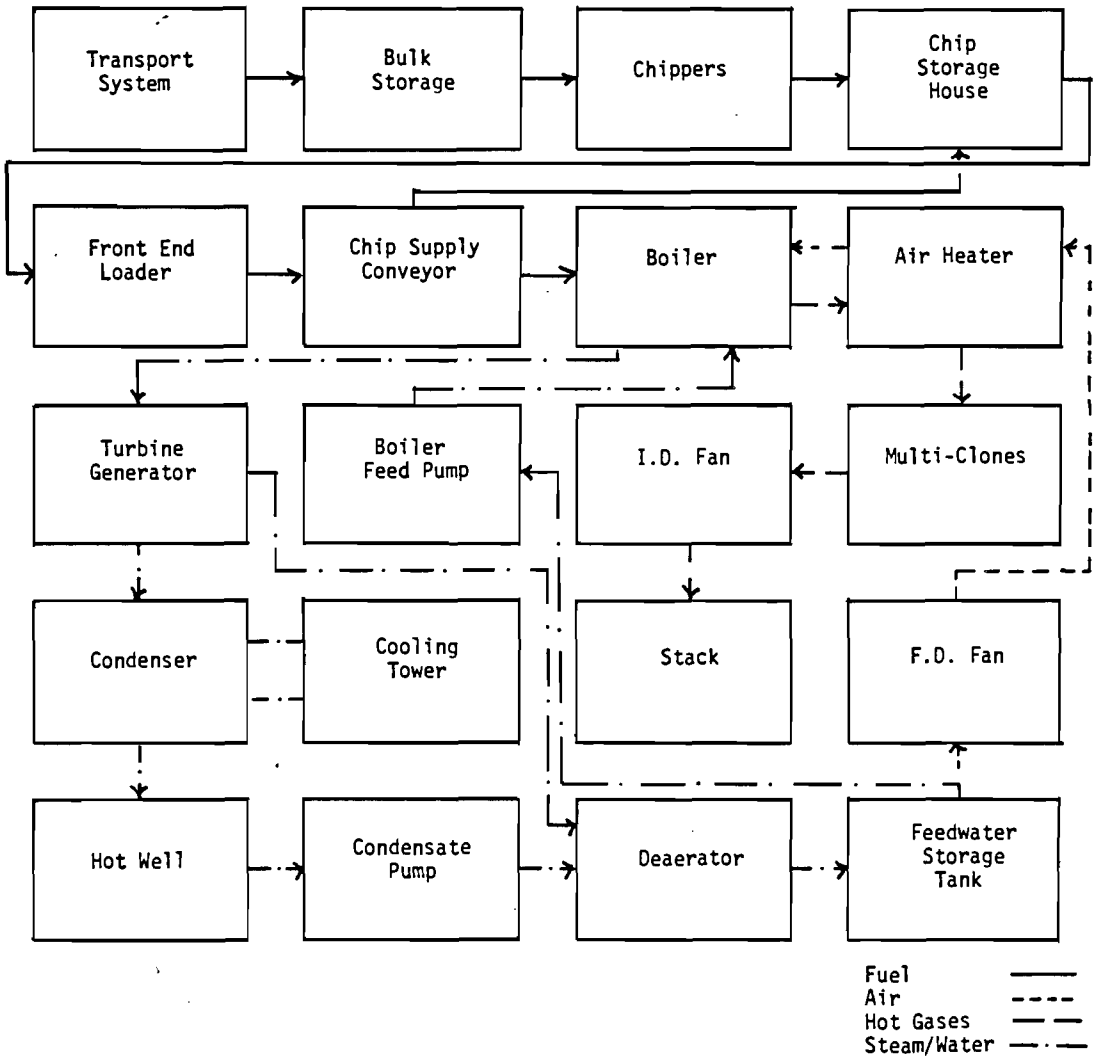


Figure 20

Japanese Plant Process Diagram

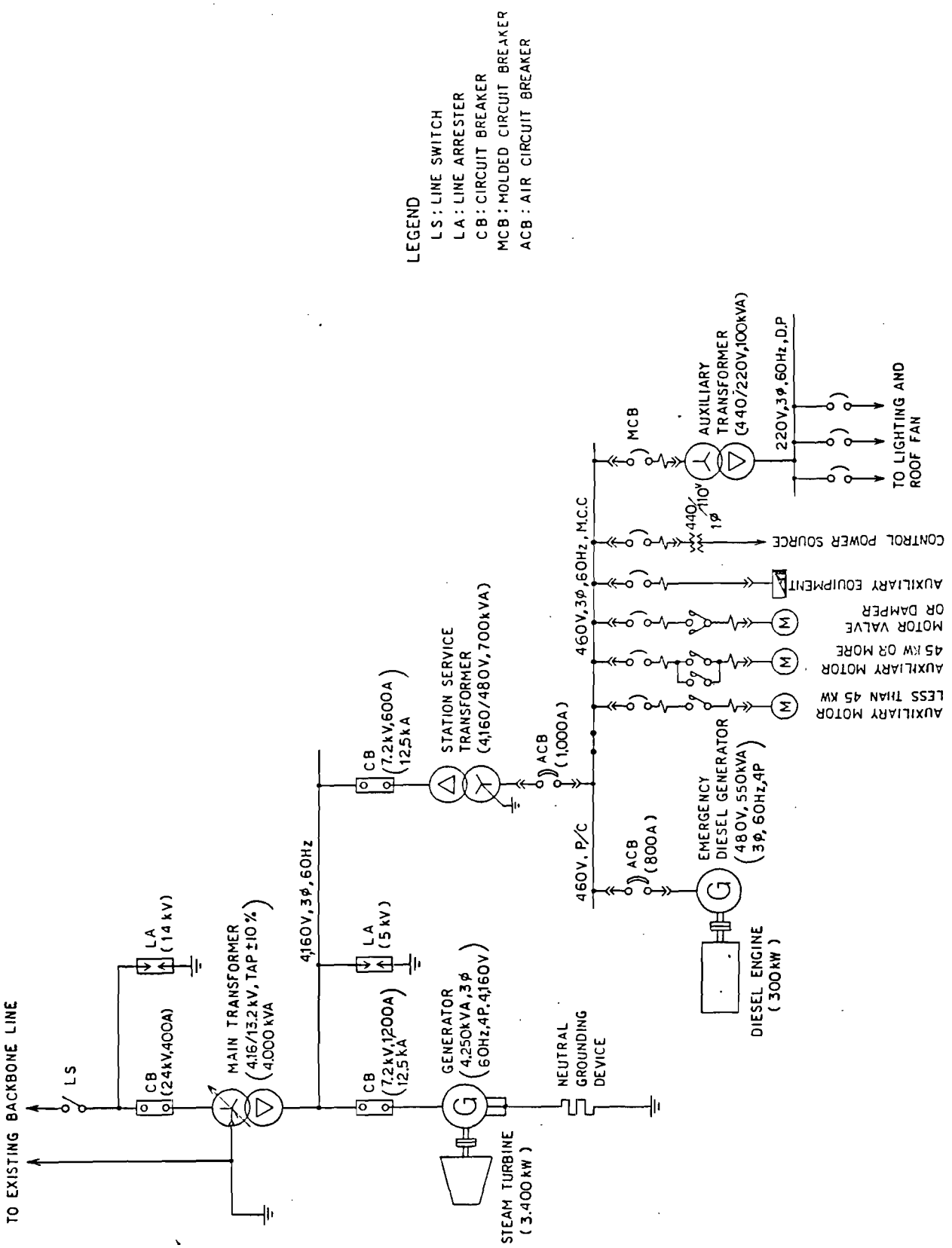


Figure 21

Electrical Services in Japanese Plant Design

6. Spare Parts

A schedule of spare parts inventory for the power plants has been outlined. This task will be made easier by the overall standardization of the Japanese plants.

E. AMERICAN DESIGN (5.0 MW STEAM PLANTS)

USAID and NEA have a long record of cooperation on rural electrification projects. Thus, when NEA began to formulate its plan for the dendro thermal program, USAID began to investigate ways in which it could get included in the program. Early investigations resulted in an USAID project paper (1). The particular portion of the project paper dealing with dendro thermal is "Annex I: Wood-Fired Power Plants Sub-Project."

This project paper describes in detail the basis for the construction of three 5.0 MW power plants in the Visayas region of the Philippines. The locations were agreed upon mutually by USAID and NEA. Table 13 lists the particulars on the three projects to be built by USAID, and Figure 22 shows the locations of the projects on a map of the Philippines.

The USAID approach to its power plant projects differs somewhat from the approaches by the British and French as previously described. For these projects a consultant in the U.S. will be hired as designer of the three plants. This architect/engineering firm will also be responsible for project management and will actually run the job sites. No Filipino A & E firms will be involved directly as has been the case with the British and French plants. The A & E firm of Stone and Webster, headquartered in Boston, Massachusetts has been selected to perform the A & E functions.

Stone and Webster will be responsible for preparing all plans, specifications and bidding documents and will supervise the activities of the other contractors for the USAID project. These contractors will include the U.S. equipment supplier or suppliers and the civil works construction firm (a Philippine construction contractor).

Due to the changes in economic conditions in the Philippines since 1982, USAID has seen fit to issue an amendment to its original project paper dealing with the wood-fired power plants (15). This amendment was completed in June

Table 13

Summary of American Plants

Plant Name	Location Town/Province	Capacity (MW)
ILECO II-B	Lambrunao/Iloilo	5.0
CENECO	Murlia/Negros Occidental	5.0
BOHECO	Inabanga Bohol	5.0

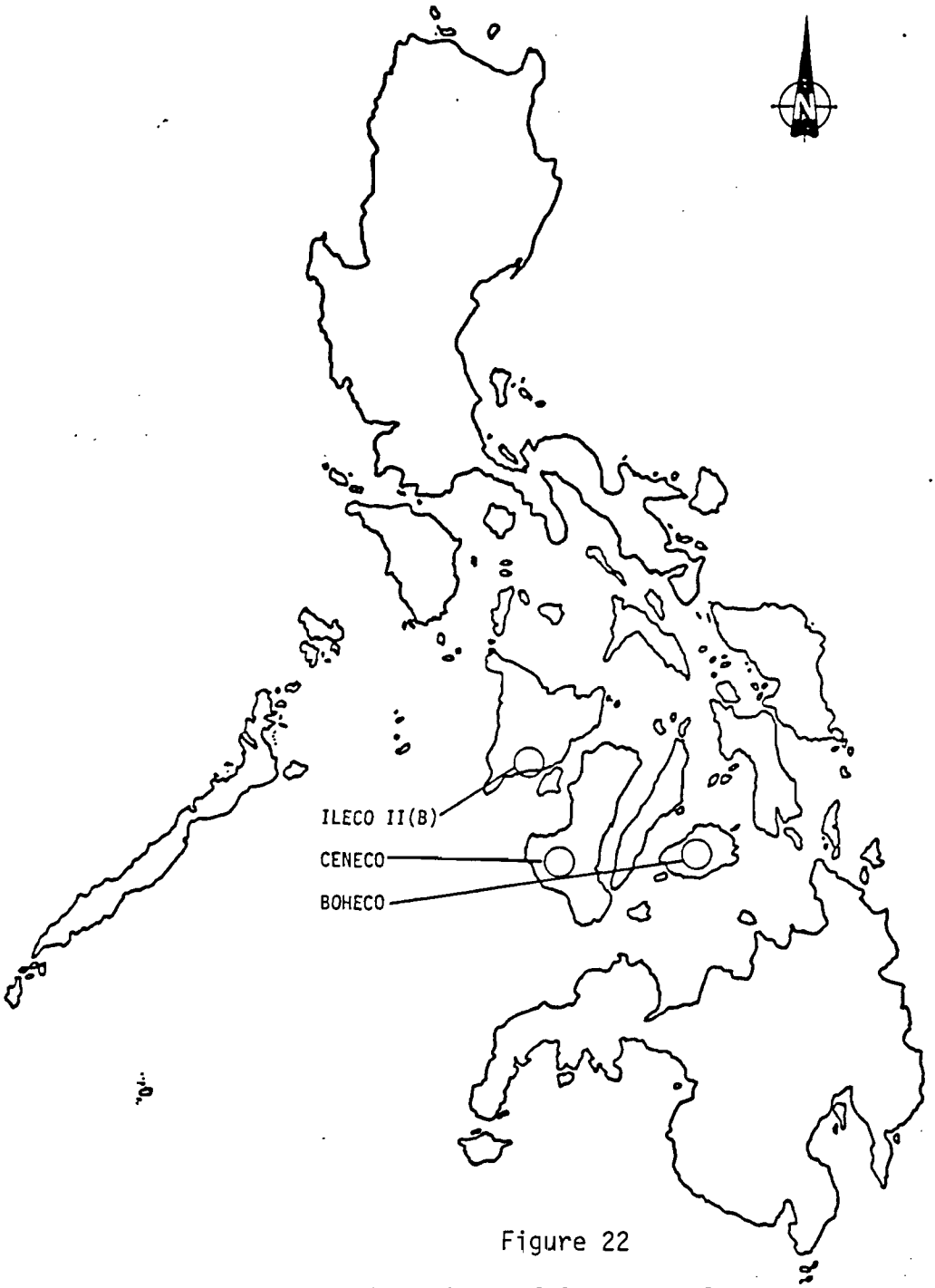


Figure 22

Locations of American Plants

1984 and contains some changes in direction and important new information. Essentially, the original USAID project was to provide the Philippines with a $10 million Economic Support Funds (ESF) appropriation to procure the equipment for the power plants from a U.S. supplier. In addition, the government of the Philippines was to provide $12.6 million (equivalent) of its own funds to pay for civil works, local equipment, local A & E services, tree farms and transport, and contingencies and escalation.

As we have seen in earlier sections of this report, these local counterpart funds have been increasingly hard for NEA to come by due to the present economic crisis being experienced by the government of the Philippines. Thus it was decided by USAID that the June 1984 amendment should document the need for additional funds to cover the local counterpart components and update the economics of the projects. The original (1982) project cost total was projected to be $22.6 million for the construction of three 5.0 MW power plants and the establishment of the associated tree farms. The present (1984) costs for these activities have been estimated at approximately $24 million. Thus each 5.0 MW power plant project will cost the host REC approximately $8 million.

Unfortunately, as of this writing, USAID/Washington has not approved the substantial increase in USAID funds required (from $10 million to $24 million) to build these power plants. The revised project paper has slipped the start-up of the U.S. plants to late 1988 already, and it appears that even further delays may actually occur.

An interesting aspect of thse plants is the different situation facing the dendro thermal plants in the Visayas from those in Luzon. Table 14 shows the situation for each host REC. In 1981 CENECO had a total load by itself that was far in excess of the dendro thermal plant's capability, while ILECO II and BOHECO I did not have enough load to absorb the electricity supply from the dendro plant. The projected load rise in 1985 makes the situation appear more promising from the independent REC's point of view. However, what is important to note is that each one of these islands has its own grid with total loads far in excess of the capabilities of the dendro plants. As shown on the chart, even with the dendro plants built (originally projected for 1985), each island still obtains a substantial portion of its load from diesel power systems. Competitively, the economics of a dendro plant look extremely good when compared to a diesel plant.

Table 14

USAID Project Demands

Project	1981 Coop Peak Load	1985 Coop Peak Load	Island Load % Diesel
CENECO	21.0 MW	38 MW	37%
ILECO II (Lambunao B)	4.0 MW	8 MW	79%
BOHECO I (Inabanga)	2.2 MW	5 MW	53%

Since the contract between USAID and Stone and Webster has not yet been finalized, there has been little work done on the design of the USAID plants. Originally it was thought that these plants would use logs as fuel, but that position may be up for reconsideration.

As far as the study team could learn, there have been no definite indications at this time that the USAID program will not move ahead. If the project were to be cancelled, however, the sites chosen for the USAID plants have some attractive aspects to them, and they should definitely be considered by any agency or company contemplating future plant construction.

IV. ANALYSIS

A. GENERAL TECHNIQUES USED FOR ANALYSIS

In order to accomplish an analysis of the plants, a number of site visits, interviews and investigations were made by the various members of the engineering team. Specific aspects of this analysis include the following:

- o The dendro thermal plant sites indicated in Table 1 were visited by the engineering team.
- o The feasibility studies for all plants listed above and the plant at ISELCO I were reviewed.
- o The Outline Engineering Reports for several plants were reviewed.
- o All operating documentation available on the Balfour Beatty, Alsthom-Atlantique and Moteurs Duvant plants were reviewed.
- o Contracts with equipment suppliers, A & E's, and construction contractors were reviewed.
- o Interviews were conducted with AWIA, DCCD and MIESCOR to discuss experiences in plant design and construction and solicit recommendations for future plants.

Data gathered from these various sources was then examined by the engineering team to produce a comprehensive analysis of the plants.

B. BRITISH DESIGN--OVERVIEW

The primary advantage of the British design is simplicity, in that the system burns logs and thus minimizes the number of mechanical systems required for plant operation. The Fraser boiler is a proven system which has been

used many times in developing countries for burning waste fuels. The turbine is also a proven equipment item which has been used in marine applications. The compact British design is well suited for the dendro thermal application.

1. Plant Performance and Efficiency

The plant performance and efficiency were analyzed using the data provided by the manufacturers, A & E's, site inspections and other sources. The British plants will produce 2.97 MW of net power output while consuming 7,172 kilograms per hour (15,815 lb/hr) of fuel for a net plant efficiency of 16 percent.

2. Status

The status of the British plant construction as shown in Table 2 appears to be reasonable based on field inspections. There has been little construction at the NUVELCO plant, and some equipment has been removed from this plant for use on other Balfour Beatty plants. Thus it may be assumed that construction at the plant must be completely restarted.

C. SPECIFIC ADVANTAGES AND DISADVANTAGES OF THE BRITISH DESIGN

The analysis of the British plants indicated both advantages and disadvantages associated with the design. These advantages and disadvantages are associated with design responsibilities of the A & E's, as well as the equipment furnished by Balfour Beatty.

The advantages of the British plants are as follows:

- o Simple design.
- o Training program.

The disadvantages of the plant are as follows:

- o Fuel feed system.
- o Ash removal system.

- o River water cooling at some plants.
- o Maintenance and spares.

1. Advantages

a. Simple Design

The simple design of the British plant not only facilitates installation, but also should result in higher availability for the plant. The difficulty of transportation to the dendro sites can greatly complicate the construction of the plant. The design of the British plant allows for easy transportation of equipment. In addition, the plant is easily assembled once the equipment is delivered to the site. This simplicity is one of the reasons the start-up of the British plants is proceeding faster than that of the Alsthom-Atlantique plants.

The simple design will also result in fewer maintenance and operating problems, and thus the availability of these plants will be greater. The fuel loading system currently requires only one electric motor, although a second motor may be required for the automatic distribution system retrofit. Boiler tubes are not welded and can thus be easily replaced. The design should also permit plant personnel to accomplish many repairs.

b. Training

The training program for the operators of the British plants is excellent and should also result in high plant availability. The outline of training is well organized and covers all major aspects of plant operation. The training engineer, Mr. Rupert Elstow, is exceptionally well qualified. His concept of tailoring his training to the background of the personnel and purposely creating problems for personnel to troubleshoot are excellent training techniques.

2. Disadvantages

a. Fuel Feed System

The fuel feed system of the British plants has several major problems. The primary problem in the original design was the boiler fuel distribution system where logs entering the boiler through the fuel feed slot tend to stack up on one side of the boiler. In order to operate the boiler, three wood handlers are required to manually distribute the fuel across the grates.

The boiler manufacturer claims that if ipil-ipil logs of the length and diameter as specified in the boiler purchase were used, the fuel would distribute itself properly. As the tree farms at the British plants have not produced adequate ipil-ipil trees, and other fuel species have been purchased from private sources, the claim of the manufacturer does have some validity. However, as the estimates by the foresters indicate that less than 50 percent of the plant fuel can be provided by the tree plantations, the boiler feed system must be modified.

As of the publication date of this report, the boiler manufacturer had completed a design of an automatic fuel distribution system. This system has been installed on at least one of the power plants being commissioned.

The firing of fuel other than ipil-ipil has caused problems in boiler subsystems. The fuel feed conveyor and the fuel feed slot on the boiler require that logs must be of a specified size or smaller. Ipil-ipil logs meet this size requirement, but most wood purchased from outside the tree plantation will require additional sizing. As a result, the chainsaw and swingsaw sizing system has been incorporated at the Balfour Beatty plants, and as a consequence additional personnel are required for plant operation.

Another problem with the fuel feed system is the lack of any automatic surge capacity on the boiler, and thus plant personnel are continuously required, to feed the boiler. This situation could result in problems maintaining boiler output during bad weather or if other operational problems occur.

b. Plant Control

There are several problems associated with the control system. The primary problem is the absence of a central air-conditioned control room with a communications system to other areas of the plant and the National Power Corporation (NPC) central controllers. The air-conditioned control center would assure that a single individual, working in an environment not affected by adverse weather conditions, could prevent operational errors during upset conditions. Adequate communications, particularly with NPC controllers, could help prevent problems such as that at the ISELCO II station, where a non-synchronized unit was apparently connected to the grid.

The simplicity of the control system is advantageous from the standpoint of ease of operation and maintenance. However, the automation of the control of critical parameters and the routing of critical alarms and controls to a central control room is desirable.

c. River Water Cooling at Some Plants

The INEC, ISELCO I and ISELCO II plants are designed with river water cooling systems and have already encountered problems with silt being sucked into the condenser cooling water system during the rainy season. Silt cleanout systems have been retrofitted, but these systems have yet to be checked out during operation. Nevertheless, river water supplies for condenser cooling have caused problems with the plant operation.

d. Ash Removal System

The ash removal system has been a problem at some plants, where operators have experienced difficulties in removing ash. Balfour Beatty has indicated that ash can be easily removed by reducing boiler load, isolating one half of the boiler by shutting off the forced draft fan and removing the ash from that side of the boiler. The procedure is repeated for the other side of the boiler. While this concept is workable, reducing boiler load just to remove ash is not recommended. A mechanical ash removal system is preferable.

e. Maintenance and Spares

The contract for purchase of the power plants specified spare parts for the plants. However, a number of problems exist with obtaining replacement parts. A current problem is obtaining these spare parts from bonded storage due to the lack of funds to pay shipping and storage charges. This funding problem is expected to be resolved shortly.

However, once this problem is resolved, there is still a difficulty of supplying spare parts in the event of failure of a critical component on a plant, particularly during the rainy season. Many spare parts are stored in the NEA warehouse in Manila, and thus transport to field sites could be a problem in adverse weather conditions.

D. ALSTHOM-ATLANTIQUE DESIGN--OVERVIEW

The primary advantage of the Alsthom-Atlantique design is efficiency. The design, which utilizes dry wood fired in suspension, maximizes the efficiency of energy conversion of biomass. The centralized control concept of the Alsthom-Atlantique plant is excellent for assuring proper plant control and avoidance of problems.

1. Plant Performance and Efficiency

The plant performance and efficiency were analyzed using the data obtained from Alsthom-Atlantique, A & E's, site inspections and other sources. The Alsthom-Atlantique plants will produce 2.91 MW of net power output while consuming 7,234 kilograms per hour (15,952 lb/hr) of fuel, for a net plant efficiency of 15.6 percent.

2. Status

The status of the Alsthom-Atlantique plant construction as shown in Table 6 appears to be reasonable for the PANELCO I plant, but the ISECO plant appears to be further behind schedule. As none of the boiler tubes, main processes piping, refractory or boiler lagging have been installed, the 80

percent estimate appears optimistic. In addition, all of the modifications being installed at PANELCO I must be retrofitted on the ISECO plant. It is unlikely that the plant will be on line before 1985.

E. SPECIFIC ADVANTAGES AND DISADVANTAGES OF THE ASLTHOM-ATLANTIQUE DESIGN

The analysis of the Alsthom-Atlantique plants indicated both advantages and disadvantages associated with the design. These advantages and disadvantages are associated with designs under the responsibility of the A & E's, as well as equipment furnished by Alsthom-Atlantique.

The advantages of the design are as follows:

- o High efficiency.
- o Central control.

The disadvantages of the design are as follows:

- o Fuel feed system.
- o Complex control system.
- o Lack of communications to NPC.
- o Maintenance and spares.

1. Advantages

a. Central Control Scheme

The central control room used on the Alsthom-Atlantique design is an excellent concept and should provide smooth control for the plant. It is important that the chief operator of a plant be able to function in an environment where he has access to data on the status of all system operations and to the mechanism for control of all processes. The Alsthom-Atlantique design provides all of these features.

All alarms, meter readings and other key data are displayed in the control room. The mimic panel on the main control panel is well laid out and provides an on-off status indication of all processes. The motor control

center for all plant equipment is also located in the control room, and thus the chief operator can start and stop all equipment. Local controls for all motors are provided near the motors, such that these can be shut down in emergency situations. The central control room is air-conditioned and isolated from the plant noise environment, thus permitting the operator to function without the adverse heat, humidity and noise conditions which exist at the plant. This is particularly advantageous when the operator must make critical decisions during upset conditions.

b. Maximum Efficiency Design

The use of suspension burning and waste exhaust heat for fuel drying maximizes the overall plant efficiency. The Balfour Beatty design recovers some of the exhaust heat in the economizer; however, a significant quantity of the energy in the exhaust gases is wasted to the atmosphere. The Alsthom-Atlantique design recovers some of the exhaust gas energy in the air heater but also incorporates the dryer to reduce the exhaust temperature to the lowest point possible. In addition, fuel pre-drying and grinding, such that the fuel is burned in suspension, increases the boiler efficiency. Thus the overall process is optimized.

2. Disadvantages

a. Fuel Feed System

Alsthom-Atlantique is in the process of making significant modifications to the original design of the fuel feed system. These modifications include relocation of the second stage crushers, redesign of the fuel nozzles to the boiler, and installation of two additional cyclones to prevent carryover of "sparklers" to the dryer. However, there are still several major design problems remaining in the system.

The fuel feed system is very complex and has no bypasses for major pieces of equipment; and thus the failure of a single equipment item will shut the plant down. Unfortunately, due to the pneumatic boiler fuel feed system and the suspension burning boiler, equipment items such as the grinders and dryers

cannot be bypassed. The fuel feed system complexity is a plus from the standpoint of improving system efficiency but is a minus from the standpoint of incorporating the potential for numerous single-point failures. The problem is further complicated by the problem of spare parts, which is discussed in a later section.

The current system is not adequately designed for dryer fire problems. Even the best dryer system design has the potential for fire, and precautions are required to minimize fire damage. Small fires often occur in a dryer, but if the fuel is going directly to the boiler, there is usually no problem as the burning wood is simply transported to the boiler. However, if the recirculation system back to the surge storage building is operational during one of these small dryer fires, there is a possibility of a large fire occurring in this building. Should the small fire in a dryer increase, the only current solution is to shut down the fuel feed system and use water hoses to extinguish the dryer.

It is recommended that the recirculation system to the storage bin be disconnected and a "fire dump" be located between the primary air fans and the surge storage feed conveyor. Figure 23 illustrates the recommended location of the fire dump. The screw conveyor bottom should be cut at this point and a concrete sump located under the conveyor end. The sump should be open on one side for removal of ash and equipped with a water deluge system to extinguish the fire. The deluge system and the routing of wood to the fire dump should be controlled from the main control room based on temperature alarms in the dryer.

A potential explosion problem exists due to the extensive dusting created by the fuel feed system. The crushers are the primary cause of the dusting problem, although conveyors contribute to the problem. The dusting is such that a dangerous explosion could easily occur. Dust prevention systems such as covers for conveyors and bins and better seals for crushers are needed immediately to prevent a serious future explosion.

b. Control System Complexity

The centralized monitoring system of the Alsthom-Atlantique design is a plus, but the complexity of some instrumentation may cause problems. Numerous

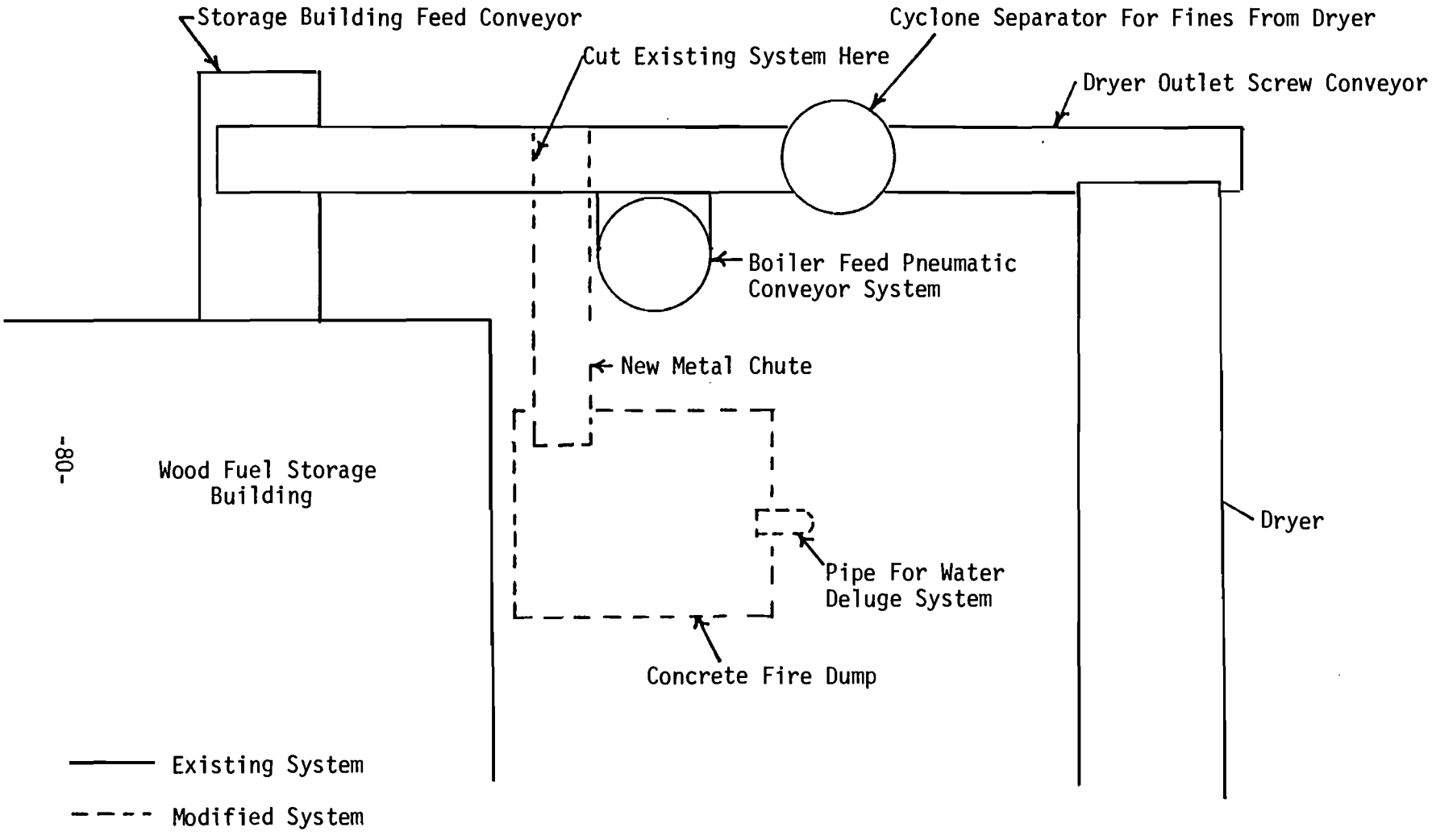


Figure 23

Alsthom-Atlantique Plant Fire Dump Facilities

strip chart recorders are utilized for continuous recording of key plant parameters. The problem of repair and replacement of this equipment at the remote plant sites may cause problems. Simple guages with data recorded manually by the operator might have been more appropriate.

c. Lack of Communications to NPC

The only major item lacking from the control room on the Alsthom-Atlantique plants is a communication link to the local NPC load control center. This communications equipment is required to prevent problems such as those that occurred at the ISELCO II plant.

d. Maintenance and Spares

The problems associated with maintenance and spares are the same as exist for the British plants. The complexity of the Alsthom-Atlantique plant makes the problem more acute, as failed parts are more likely to put a plant completely out of commission.

F. DUVANT DESIGN--OVERVIEW

Neither of the two gasifier-based stations are finished at the time of writing this report. Furthermore, information on operating experience with other, similar Duvant gasifier installations (of which there may be five or six at most elsewhere in the world) is not readily available. With no actual operating experience, the following analysis is based on the project team's experience with other gasifier plants of similar design and capacity.

G. SPECIFIC ADVANTAGES AND DISADVANTAGES OF THE DUVANT DESIGN

1. Advantages

The gasifier-based power station has the advantage of higher overall thermal efficiency (up to 25 percent) and lower capital and operating costs than a steam cycle plant, primarily in sizes less than 1.0 MWe. Specific advantages of the Duvant system are:

- Use of a separate combustion chamber to produce a clean gas, thus reducing the load on, and liquid pollutant discharge from, the gas conditioning train.

- Extensive gas processing, ensuring a clean gas product.

- Thorough monitoring and control of gas temperatures, pressures and flow rates.

- Use of an engine of proven performance on low-Btu gas, running in dual-fuel mode.

- Separation of flows in the gasifier and engine circuits, enabling the engine to draw gas as required from the gasifier circuit. This avoids problems of thermal inertia in the gasifier system during load changes.

- The use of dual-fuel engine provides built-in backup in the event of an interruption to wood fuel supply. The engine is simply run on 100 percent diesel fuel, avoiding any interruption to power supply.

- A high level of workmanship was observed by both manufacturer and contractor, particularly at the ANTECO site.

2. Disadvantages

Although the use of a gasifier (or gas producer) to generate a gaseous fuel for use in an engine is a concept 150 years old, experience with the new generation of highly automated plants is very limited. The old gas producers were labor intensive, and operators were highly sensitive to the idiosyncracies of their own plants. Response of the new generation of gasifiers to modern process control concepts is an unknown factor. A notable feature of gasification is extreme irregularities in gas flow, quality, temperature and pressure. Specific disadvantages of the Duvant system are seen to be:

- o Complicated monitoring and control systems requiring the operator to be familiar with modern process control instrumentation.

- o Elaborate start-up and shut-down procedures during which mistakes can easily be made.

- o High parasitic load on the station (about 30 percent) arising from gasifier system auxiliaries.

H. JAPANESE DESIGN--OVERVIEW

At this point there is really no analysis that can be done on the Japanese plants based on operational experience since the plants have not yet been constructed. It is doubtful that the designers have specific experience with a plant of this exact design, as this design is apparently unique to the Philippines.

I. SPECIFIC ADVANTAGES AND DISADVANTAGES OF THE JAPANESE DESIGN

1. Advantages

- o Use of chips.
- o Use of cooling towers.
- o Central control room.

2. Disadvantages

- o Possible need for more capacity in surge bin.

J. SPECIFIC ADVANTAGES AND DISADVANTAGES OF THE AMERICAN DESIGN

No analysis could be made of the Stone and Webster design.

K. STANDARDIZATION OF PLANT DESIGNS

Standardization of plants is important for a number of reasons. The primary reason is that spare parts are easier to store and distribute if only a limited number of items is required. Replication of a proven standard component or complete system will increase reliability. Procurement of new plants or replacement parts is simplified.

The current program has achieved a degree of standardization in that there are several plants built which incorporate the same design. Most of these designs use standard off-the-shelf components such as pumps, compressors and turbines. The Balfour Beatty design maximizes standardization--the boiler is essentially a "packaged" model shipped in pieces and assembled in the field.

It is not advisable to standardize future plants to the extent that only one supplier is used for all plants. Such a practice tends to discourage competition that is beneficial in optimizing design and obtaining competitive prices. However, consideration should be given to some component standardization.

L. SIZE SELECTION

The selection of a size for a wood fired power plant involves a number of factors. Analysis of these factors can be very complicated when a large central station plant is being considered. However, in the case of the dendro plants this analysis involves three main considerations.

The first consideration is the selection of plant size relative to the demand of the local cooperative grid. The capacity of most plants is larger than the current peak REC demand. Likewise, the load factor for most of the RECs is very low. This will result in most of the power produced by the plant being sold to the NPC grid.

This situation is not considered to be a problem for several reasons. The REC load will grow in size such that at some future date all power produced by the plant will be sold within the REC. In addition, the power sold to NPC from the dendro replaces power generated from imported oil. Thus the national balance of trade is improved. However, the sale to NPC will benefit the REC only if an equitable price is paid for the power.

The second consideration is that an adequate fuel supply is available for the plant. Typically, fuel must be available within 80 km (50 miles) of the plant or the cost of transportation becomes a problem. A plant located at the center of a 1200 hectare (2965.2 acre) plantation will have a maximum transport distance of about 1.8 kilometers (1.1 miles) within the plantation. Assuming the plantation supplies only about 50 percent of the wood required, the balance of the fuel must be secured within approximately 78 km (49 miles) of the plantation perimeter. Based on very preliminary investigation by the engineering team, securing an adequate fuel supply should not be a problem.

The final consideration in plant size selection is the economy of scale which can be achieved with larger plants. The average plant cost is $1,700 per kWh. A 50 MW plant was recently constructed in the United States for a cost of $1600 per kW using new equipment, while a 12 MW plant was built for $800 per kW using used equipment.

The use of used equipment for the dendro plant is not recommended, and thus only the 50 MW unit provides a basis for comparison. Construction of a 50 MW plant will be more expensive in the Philippines due to the cost of shipping and the difficulty of construction of large plants in very remote areas. It can therefore be concluded that significant economies of scale could not be realized on the dendro project.

In summary, the selection of plant size based on REC load, fuel transportation distance and economies-of-scale is acceptable. The only consideration that might be appropriate is to select the exact size such that existing packaged equipment can be utilized to the maximum extent possible.

M. DENDRO PROJECT TECHNICAL PERSONNEL

During the course of the engineering review, meetings and discussions were held with engineers from NEA, numerous RECs, equipment suppliers, A & E's and construction contractors. In general, these individuals were knowledgeable, capable and very enthusiastic about the project. Thus a strong engineering nucleus exists on the project.

The areas where additional support would be beneficial are the addition of a senior staff engineer for technical support to the NEA engineering staff and outside technical assistance if a new major program is undertaken.

The addition of a senior staff engineer with extensive experience in wood fired power plants would significantly help the current staff. The current staff is knowledgeable and capable, but also quite young and without extensive experience. This individual should not be placed in the line staff but should be used as a resource available to all engineers. This assistance would be of particular value in the resolution of specific problems such as the ISELCO II grid connection.

The technical assistance would provide support if a new program is undertaken. This assistance would be used for evaluation of the technical details of a project as well as the preparation of specifications, contracts, schedules and funding. Those providing this assistance would preferably report to the agency providing funding for the project.

V. FINDINGS AND CONCLUSIONS

Based on the analysis of the Balfour Beatty, Alsthom-Atlantique and Duvant plants, the engineering team has generated the following findings and conclusions. It should be noted that these findings and conclusions are based exclusively on the 29 plants included in the analyses, and thus the recommendations stated in Section IX are applicable to the balance of plants in the initial 72 plant system as proposed by the AID project paper.

A. BRITISH DESIGN

There are a number of design modifications to the current Balfour Beatty design that could be incorporated to improve operational efficiency. It is assumed that the fuel feed system has been modified to incorporate an automatic boiler fuel distribution system. However, at this time, no additional modification to the British design is recommended, and it is concluded that the plant will operate as designed.

B. ALSTHOM-ATLANTIQUE DESIGN

There are two problems which require immediate modifications to the Alsthom-Atlantique plants:

- o Installation of a fire dump for the dryer.
- o Reduction of the dust from the fuel feed system.

The engineering design of the Alsthom-Atlantique plants is basically sound, and the plants should perform as designed. However, due to plant complexity, additional maintenance time will be required, and thus the availability of the plant will probably be lower than that of the British plants. An availability of 330 days per year is recommended for economic evaluations.

C. DUVANT DESIGN

At the time of writing, the stations were incomplete.

Very limited worldwide experience exists with this technology.

The two gasifier-based stations should be viewed as experimental.

Performance of the engine when running in dual-fuel mode is not expected to present any problems, although a key issue, with significant impact on economics, is how much diesel fuel will be required to supplement the low-Btu gas.

Numerous technical issues affect performance of the gasifier. These will not be resolved until at least one of the stations is started up.

The gasifier system is a complex process which includes sophisticated process control equipment. The ability of local personnel to assume responsibility for station operation remains in doubt.

There has been but little interchange of technical information between the manufacturer, Duvant, and NEA staff. A formal training program for potential station operators has yet to be instituted.

D. JAPANESE DESIGN

No findings or conclusions could be made on the Japanese design.

E. AMERICAN DESIGN

No findings or conclusions could be made on the Stone and Webster design.

F. SUMMARY

It is the assessment of the engineering team that the 17 Category 1 and 2 plants will function as designed with the incorporation of the specific modifications recommended. The overall effort by NEA, equipment suppliers, A & E's and construction contractors was well managed, and no serious errors were made by any party. Problems which have occurred to date are related primarily to financial difficulties, and some lack of experience with biomass systems. Bank funding should eliminate the financial difficulties, and the experience gained during the past five years should preclude future technical problems.

VI. ENVIRONMENTAL ANALYSIS

A. INTRODUCTION

The dendro thermal project utilizes two basic power generation processes:

- o Steam turbine/generator systems.
- o Wood gas/diesel engine generators.

Each of the two processes, typified by low and medium pressure solid (wood) fueled boiler-turbine-generator and gasifier-engine-generator power systems, have fundamental differences in environmental impact. No differentiation is made (except where noted) between the Balfour Beatty low pressure steam systems, Alsthom-Atlantique medium pressure systems, or other proposed steam systems, as the environmental aspects of these systems are quite similar. Both processes produce somewhat similar waste streams composed of solid, gaseous and liquid components. In addition, the gasifier system produces pyrolytic tars. Table 15 provides the approximate quantities of wastes expected from the two processes at the various rated power generation rates. The environmental impacts of these wastes are a function of the quantities, compositions, and disposal options available for each of these waste streams.

1. Solid Wastes

The solid wastes produced by the two power plant processes are charcoal and ash. From a standpoint of maximum yield of electric power per unit input of fuel, the power systems are expected to produce a negligible quantity of charcoal. Production of charcoal is expected to be limited to transient conditions such as start-up and generator trip. From an environmental standpoint, therefore, the proportion of charcoal to ash from either process is not relevant. The final ash production is expected to be 2,449 kg per MWh (5,400 lb/MWh) for steam systems and 1,723 kg per MWh (3,800 lb/MWh) for wood gas systems. This equates to approximately 1 percent by weight of the fuel wood input.

Table 15

Summary of Waste Outputs

Specific Waste Output for the Two Power Generation Processes

Waste Output	Steam Turbogenerator System	Wood Gas/ Diesel Engine Generator System
Wood Ash	5,400 lbs/MWh	3,800 lbs/MWh**
Stack Particulates	11 lbs/MWh	nil
Thermal Waste*	15.3 MMBtu/MWh	0.39 MMBtu/MWh
Liquid Wastes	nil	185.4 lbs/MWh**

Average Waste Ouput for the Two Power Generating Processes

Waste Output	Steam Turbogenerator System	Wood Gas/ Diesel Engine Generator System
Wood Ash	15,900 lbs/hr	3,380 lbs/hr
Stack Particulates	32 lbs/hr	nil
Thermal Waste*	45.0 MMBtu/hr	0.35 MMBtu/hr
Liquid Wastes	nil	165.0 lbs/hr

*Heat to river cooling water.
**Estimated values since Duvant technical data not available.

Ash wastes from wood combustion are considered less detrimental than solid residues from coal and other fuels. A typical ash analysis for wood fuel is shown in Table 16 (16). Only trace amounts of heavy metals, phosphorus, and nitrogen are present; thus the hazards to the environment are limited. Ash from wood burning is, however, considered solid waste and as such is subject to the provisions of a solid waste management program which is appropriate for the environment and government regulation. The ash is a chemical base made up primarily of potassium, silica, sodium hydroxide and calcium carbonate. In the United States, the typical method of disposal is landfill because of its good characteristics of low leachate rate and low toxicity to plants. Protective measures can prevent surface runoff (containing ash) from contaminating streams due to high alkalinity and turbidity which can harm aquatic life.

The ash disposal systems at all plants currently under construction utilize a dry storage at the plant site for temporary storage of ash removed from the combustion system. Ash removal may be either a manual or a mechanized operation depending on the design of the equipment supplier. The actual transporting of the ash to the plant storage area is usually a manual operation.

A preliminary investigation of the plant sites has indicated that the problem of runoff has not been addressed. The grading at most sites is designed to allow water to drain into the local stream. It is suggested that sites be regraded as required to retain water in the ash storage area. It is recognized that, due to the large quantity of rain at the plant during the summer, containment of all water is not possible. It is recommended that drainage be routed such that it mixes with the acidic runoff from the wood storage pile such that both streams are neutralized.

Wood ash is frequently used as an alkalinity builder in pulp and paper forestry operations in the United States similar to current practices of slash-and-burn techniques in agriculture common in the Philippines. Thus, it is desirable to utilize the ash products of the power plants to return nutrients and to adjust soil acidity of the fuel wood plantations. Success in this program means that the following three potential problems should be addressed:

Table 16

Typical Wood Ash Analysis
(Percent by Weight)

			White-Fir Bark*	Spruce Bark*	Redwood Bark*
Silica	as	SiO_2	1.7	32.0	14.3
Iron	as	Fe_2O_3	3.2	6.4	3.5
Titanium	as	TiO_2	0.0	0.8	0.3
Aluminum	as	Al_2O_3	3.2	11.0	4.0
Manganese	as	Mn_3O_4	3.9	1.5	0.1
Calcium	as	CaO	60.8	25.3	6.0
Magnesium	as	MgO	3.0	4.1	6.6
Alkalies	as	Na_2O	10.4	10.4	25.0
Sulfate	as	SO_3	3.0	2.1	7.4
Chloride	as	Cl	0.4	trace	18.4
Carbonate	as	CO_2	11.5	7.0	14.0
Undetermined			--	--	--

*Salt-water stored.

- o Handling and transportation of ash products to fuel wood plantations.

- o Proper administration of ash according to soil requirements.

- o Controlling runoff to rivers and streams bearing fish as a food source.

Transportation of ash throughout the plantation will be difficult due to the poor road system, although the Lasso cable system might be used to distribute the ash. Correct application to supply the proper dosage of nutrients to the soil and prevent runoff should be determined with the REC dendro coordinator.

It is anticipated that some combination of landfill and soil treatment will be employed at all sites depending primarily on soil conditions of the fuel wood plantations. The small quantity of ash produced at the power plant sites coupled with the remote locations should cause ash disposal to have minimal effect on the environment.

2. Liquid Wastes

One source of liquid waste that is common to both power plant processes is rainfall runoff from wood storage piles. This leachate is primarily composed of turpentines. The environmental hazard of this leachate is reduced, however, due to several factors. First, the wood used for fuel in the power plants is primarily composed of low resinous woods which have a much lower turpentine content than other softwoods. Second, the wood will be stored as logs, which reduces the ability of rainfall to leach turpentines from the wood. Thirdly, many turpentines are volatile and thus are released to the atmosphere. Thus, the major hazard would be the contamination of ground waters with turpentines, which are not toxic but do impart objectionable taste and odor.

The proposed design of the Japanese plants will incorporate outside chip storage, which will increase the amount of turpentines leached from the wood.

The design of the open chip storage area should assure that drainage does not run directly to a stream. As discussed earlier, mixing of drainage from the ash and wood storage areas could be used to neutralize the waste stream.

The wastewater from the gasifier power plant process, however, does present serious environmental problems. As reported by J. V. Maxham, the wastewater from a similar fixed bed updraft gasifier located at Texas Tech University (Lubbock, Texas) includes a very high COD (in the range of 50,000 to 70,000), high TOC (in the range of 11,000 to 18,000), and a very high color (17). In addition, the wastewater is acidic (due, mostly, to acetic and proprionic acids) and fairly toxic, probably due to the phenols and creosols. The treatment alternatives available fall into three basic categories: physical/chemical, biological and pretreatment prior to discharge to a municipal biological system.

An inspection of the gasifier sites by the engineering team has indicated that there is a potential for contamination of the nearby streams. The water from the gas scrubbers is discharged directly into these streams at a flow rate of 75 liters per hour (20 gallons per hour). While this flow rate is small compared to the river flow rates of 719,778 liters per hour (190,166 gallons per hour) at OMECO and 359,889 liters per hour (95,083 gallons per hour) at ANTICO, a problem does exist.

The liquid discharge from the gasifiers requires a thorough investigation, including sampling to determine the specific pollutants being dumped into the nearby water. Additional pollution control equipment may be required to reduce BOD and COD levels.

Five physical/chemical treatment processes are available. All have major difficulties when applied to the treatment of wood gasification wastewaters. Activated carbon adsorption, when used in conjunction with a high rate fixed film activated sludge process, does, according to J. V. Maxham (18, 19) provide sufficient levels of treatment in both COD removal and color removal when applied at a rate of about one pound of activated carbon per gallon of water. The cost of such treatment, however, is prohibitive. It also creates a solid waste problem of similar proportions to the original wastewater problem. Ozoneation is another feasible process, but the consensus is that its cost would exceed that of even activated carbon. Solvent extraction was investigated by Kao (20) and, though some success in reducing toxicity was achieved

utilizing methylethylketone, sufficient treatment levels to allow discharge to surface waters or even direct discharge to a biological system were not achieved. Also, the cost of solvent extraction would be very high. Research is continuing to isolate a solvent providing both reasonable costs and sufficient treatment levels, but nothing promising is yet available.

A fourth physical/chemical possibility is to borrow evaporative technology now in common usage in the pulp and paper industry for treating the spent black liquors of sulfite pulping operations. The process basically uses a cascade system to distill the aqueous and volatile phases of the black liquor until a solids content of about 70 percent by weight is achieved. The solids are then incinerated to produce ash. It is not known if this technology can be applied to the treatment of wood gasification wastewater. The components of the wastewater can be said, a priori, to be very different from the pulp black liquor. Its water content is much higher (which implies a higher energy requirement), and it is likely to contain a higher proportion of volatile compounds which could present other problems. It is almost certain that substantial R & D work would have to be undertaken prior to the application of evaporative technology to the wood gasification wastewater.

All biological wastewater treatment systems employ some form or combination of aerobic or anaerobic digestion. A wide spectrum of biological processes were investigated by J. V. Maxham (17). From an energy standpoint, the most advantageous process would be anaerobic digestion to yield methane. A further advantage of anaerobic digestion was found to be the higher loading rates achievable. The disadvantages of anaerobic digestion include a greater sensitivity to shock loading, a more prolonged and difficult start-up period, and a lack of dependability in COD reduction.

A more consistent and easily managed system was a high-rate fixed film activated sludge process with nutrient addition. COD reduction in the 70-80 percent range was achieved utilizing this process which is not, by itself, sufficient to allow discharge to surface water.

Direct discharge of this waste stream will have detrimental effects on aquatic life and possibly human life in the event the stream is subsequently utilized for irrigation and/or fishing. The exact level of impact is dependent on the assimilative capacity of the stream to accept a high BOD, turbidity, and acidity stream.

3. Gaseous Wastes

All of the gaseous wastes will result from the direct combustion of wood in the steam power plants and of wood gas and diesel in the gasifier-engine power plants. The qualitative combustion products of the wood fuel, similar for both processes, are water vapor, carbon dioxide and traces of nitrogen oxide. Carbon monoxide will also be present in very low levels depending on the trim of the boilers and tune of the wood gas/diesel engines. Sulfur compounds are negligible since wood is naturally low in these compounds. However, if high sulfur diesel is used in the gasifier-engine-generator sets, some traces will be present even with small quantities of the fuel.

Table 17 presents a summary of the emission factors and the size of boiler required to produce 100 tons per year of the pollutant. Emissions of 100 tons per year or less are acceptable levels for gaseous emissions. As seen in the table, sulfur and nitrogen oxides should not present a problem. The variation in carbon monoxide and hydrocarbon emissions accounts for the problems of incomplete combustion. The current systems proposed for the dendro program should present no problems in meeting the required standards.

Overall, the emissions from these power plants will be less than the current emissions produced to generate the power that is to be displaced in the dendro thermal program.

4. Particulates

Emission factors for particulates emitted from wood fired boilers without cleanup systems are presented in Table 17 (21). All boiler systems without particulate cleanup like the Balfour Beatty designs are expected to emit approximately 5 kg per MW of power produced. Systems with cyclone collectors (Alsthom-Atlantique) will produce about half that quantity. The characteristics of the particulates are the same as those for the solid wastes in that environmental hazards are quite small for the power plants with their low levels of emissions and rural locations.

Table 17

Typical Wood Fired Power Plant Emissions

	Emission Factor ($lb/10^6$ Btu)	Size Boiler Required to Produce 100 Tons/Year of Pollutant
Sulfur Oxides	0.017	98,039
Carbon Monoxide	0.23 - 6.98	72,464 - 2,388
Hydrocarbons	0.23 - 8.14	72,464 - 2,048
Nitrogen Oxides	0.25	66,667
Particulates	3.49	4,775

5. Environmental Regulatory Compliance

In accordance with Presidential Decree No. 1586, all projects and project proposals whether public or privately undertaken must be reviewed so that socio-economic undertakings are reconciled with the goals of maintaining environmental quality (22). Under Section 4 of the Decree, all projects or areas in which projects are undertaken that are deemed critical to the environment must obtain an Environmental Compliance Certificate (ECC) to construct and operate such a project. Projects and areas in which projects are to be undertaken are determined critical by the President of the Philippines by his own initiative or upon the recommendation of the National Environmental Protection Council (NEPC).

At the time of printing, nine sectors are outlined as environmentally critical per Proclamation No. 2146 (22), which are:

- o Non-ferrous metals industry.
- o Iron and steel industry.
- o Mining.
- o Pulp and paper industry.
- o Dams and reservoirs.
- o Petroleum and petrochemical industries.
- o The chemical industry.
- o Agriculture.
- o Urban growth.

Since dendro thermal power plants are not on this list, only those power plants located in environmentally critical areas must obtain an ECC.

To obtain an ECC, a package of information called Environmental Impact Documentation (EID) must be submitted to NEPC. This package contains two components:

1. Project Description (PD).
2. Environmental Impact Statement (EIS).

The project description component of the EID describes the project and project site characteristics (prior to developmental activities) and identifies whether or not further study is necessary prior to project implementation. In detail, the PD must include the following:

- o Descriptions of existing environmental conditions (prior to project implementation).
- o Project size and scale.
- o Process diagram, work program, plan of operation, and PERT chart.
- o Project outputs of effluents, emissions, and/or solid wastes.
- o Waste disposal plan/waste management plan.

The EIS is far more detailed in that it must address the primary, secondary, and tertiary impacts of the proposed project. This document should weight the environmental/health effects with the socio-economic effects on the region.

It is implied that the EID should be submitted to the NEPC prior to project implementation; however, the expressed language of such is not found. Details with examples of the preparation of this documentation are presented in the Environmental Impact Assessment Handbook available from the NEPC (22).

Under the rules and regulations of the NEPC, Article II, Section 2, it is possible to obtain a waiver in obtaining an ECC for reasons of national interest. Those plants that may be located in environmentally critical areas may pursue this route if additional pollution control adversely affects plant economics. Obtaining this waiver would thus be done on the basis of the socio-economic impact the plant would have on the local populus.

At present, the 11 plants under construction are not known to be located in environmentally critical areas, and an ECC should not be necessary. However, the National Pollution Control Commission (NPCC), which certifies pollution abatement equipment, and the NEPC should be consulted on each plant system and plant site for any special environmental problems that might arise.

Two problems have been found by the study team which may require special considerations for NEPC. First, the Balfour Beatty steam power plants discharge cooling water at 46°C, which exceeds NEPC standards set at 40°C (23). This small difference may have little impact except at locations of small streams. Second, the gasifier-engine power plants dicharge gas cooling waters of 80°C temperature and high chemical content. Although this effluent stream is quite small (2 ton/hr), it may have a noticeable effect on water quality downstream if the water source is used for fishing, irrigation and/or drinking (Class AA through D stream).

Table 18 presents a summary of the river water flows for the INEC, ISELCO I and ISELCO II plant sites and the required cooling water flow for the power plant. During the dry season, the discharge of cooling water from the power plant will cause a rise in the river water temperature. However, the dry season occurs at the same time as the maximum water temperature, and thus thermal pollution should not be a problem.

Table 18

Analysis of British Design Plants
River Water Cooling Systems

Plant	Equipment Water Required (gpm)	Maximum River Flow (gpm)	Minimum River Flow (gpm)
INEC	3212	31,698	10,460
ISELCO I	3212	316,985	158,492
ISELCO II	3212	63,397	9,510

VII. LOCAL MANUFACTURE OF FUTURE POWER PLANTS

All of the power plants discussed in the previous sections were purchased from foreign manufacturers on loans provided by the governments of these manufacturers. These loans must be repaid in the currency of the foreign manufacturer, resulting in a negative balance of trade situation. It would be desirable on future projects to manufacture as much of the equipment and replacement parts as possible in the Philippines to improve this balance of trade situation.

To assess the possibility and desirability of local manufacture of future power plants, the engineering team made a number of investigations. Interviews were conducted with the AWIA, DCCD and MIESCOR architect and engineering firms to discuss their capabilities and the resources available in the country. The local representatives of Balfour Beatty and Alsthom-Atlantique were interviewed to determine their assessment of the local manufacturing question. Data was also obtained from NEA personnel, field engineers and REC personnel.

Based on information obtained during these interviews, the manufacturing firm of Atlantic, Gulf and Pacific (AG&P) was identified as having the capacity for manufacture of a large amount of power plant equipment, and thus AG&P was interviewed by the engineering team. The company is certified by the American Society of Mechanical Engineers for manufacture of pressure vessels. They represent Riley Stoker, Cleaver Brooks and Combustion Engineering of the United States and NEI and Towler of Great Britain. The company manufactures some of the equipment for these suppliers. In addition, the company manufactures their own design of packed firetube, oil-fired boilers. AG&P has worked extensively with the Philippine sugar industry.

Table 19 presents a matrix which identifies the equipment which can be manufactured in the Philippines and that which must be purchased from foreign sources. As seen in the table, equipment such as concrete, structural steel and buildings are locally available and are being locally supplied on the current plants. Almost all other components with the exception of low pressure piping are being purchased from foreign manufacturers.

Table 19

Sources of Power Plant Equipment

Equipment	Local Manufacture	Foreign Manufacture
Concrete	X	
Structural Steel and Buildings	X	
Low Pressure Boilers	X	
High Pressure Boilers		X
Pumps		X
Fans		X
Large Motors		X
Small Motors	X	
Low Pressure Piping	X	
High Pressure Piping		X
Turbines Generator		X
Controls	X	
Condensers	X	
Electrical	X	

The major item of dendro thermal equipment which could be locally manufactured is a low pressure boiler such as that used on the British plant. A high pressure boiler such as that used in the French design would probably be purchased from a foreign manufacturer. AG&P currently manufactures low pressure boilers.

The turbine generator and drive turbines are currently not available in the Philippines and must be purchased from foreign manufacturers. It is possible that a license from a foreign manufacturer could be obtained by a Philippine company, but the availability of the precision manufacturing facilities required to manufacture the turbine is questionable. In addition, the limited market for turbine generators in the country would probably not justify the establishment of a turbine manufacturing capability. Likewise, pressure piping, pumps, fans and large motors must be purchased from foreign sources.

Additionally, MIESCOR, AWIA and DCCD are well qualified for plant design, as evidenced by their performance on this and other projects. Their experiences on this project have familiarized the design engineers with the particular requirements of wood fueled systems. It is thus recommended that future dendro project design be contracted directly with the local A & E's.

It is concluded that approximately 50 percent of the power plant could be manufactured in the Philippines, and further concluded that the complete plant design could be accomplished by local architect and engineering firms.

VIII. WOOD FUEL PROCESSING

The discussion of the power plants currently under construction or planned has addressed various biomass fuel forms including logs, chips, crushed and gasified. The advantages and disadvantages of each form were examined. In addition to the fuel forms previously discussed, the use of charcoal and densified fuel must also be considered.

A. CHARCOAL PRODUCTION

Charcoal is commonly produced in the Philippines for use as a residential cooking fuel. Charcoal is not used for electricity production at any known location in the world. The primary problem with charcoal is that wood is only 20 percent charcoal and 80 percent volatile fuel. The production process consumes the 80 percent volatile fuel, and thus a substantial portion of the fuel is lost. A preliminary analysis of the economics of a charcoal-fired power plant indicates that the plant is not feasible.

B. DENSIFICATION

Of the various wood densification technologies which are commercially available, pelletization is the most developed. More experience is available with pelletizing than with cubing or extrusion processes.

The effect of pelletizing is to increase the heating value of the boiler fuel. Assume this is increased from 5,500 to 8,000 Btu/lb. Accordingly, for a given station output of 3.0 MWe, fuel consumption (lb/hr) will be reduced when pellets are used. Furthermore, since pelletized fuel is dry (10 percent moisture as opposed to 50 percent moisture for unprocessed wood fuel), the boiler will operate at a higher efficiency. Energy is not wasted in evaporating wood moisture to steam.

1. Location of Densification Facility at Dendro Station

Unprocessed wood fuel consumption by a 3.0 MWe power station is expected to be about 15,000 lb/hr. With pellets, an equivalent energy input to the

boiler will be accomplished with a fuel consumption rate of 10,300 lb/hr (18.5 million Btu/hr). Assume the actual pelletized fuel consumption rate is 9,000 lb/hr, to allow for an increase in boiler efficiency. This is equivalent to about 100 tons per 24 hour day.

The capital cost of a wood pelletizing plant of capacity 100 tons/day, installed adjoining a dendro station, would be about $US 3.00 million. Such a pelletizing facility would include rotary dryer, hammer mill, screens and intermediate conveyors and silos. The price is for a turnkey facility.

Assuming that the pelletizing facility is financed by bilateral aid at 3 percent for ten years (approximate equipment life), annual payments to debt service will be $US 350,000 or ₱250 per ton of pelletized product (station operates 5,500 hrs/yr). Operating labor, maintenance and spares will increase this cost to over ₱300/ton. Pelletizing the wood fuel at the dendro station will quadruple the cost of fuel delivered to the boiler.

With regard to economics, the main advantage of using pelletized fuel is reduced fuel consumption rate requiring a smaller and cheaper boiler firebox. The fuel is also more convenient to handle than chips or logs.

The amount of wood to be harvested and transported remains the same, so there is no reduction in plantation costs. Station stack gas could be used as fuel for the dryer, although this presents technical difficulties already encountered at stations where it has been tried. Electrical power consumption by the pelletizing facility will be about 100 kWh per ton or about 2.5 million kWh/yr. This is 15 percent of gross output from a 3.0 MWe plant.

The advantages and disadvantages of installing a pelletizing plant at a dendro station are as follows:

Advantages:

- Possibility of installing a smaller boiler.

Disadvantages:

- Quadrupling of fuel cost at boiler front.
- Consumes 15% of gross station output.

- o Technical problems, particularly wear of pellet mill dies and rollers.

- o Taking a material that is already in acceptably large pieces (logs), grinding it to sawdust, and then densifying it is not a logical procedure.

2. Centrally Located Fuel-Processing Facility and Densified Fuel Plantation

a. Densified Fuel Plantations, Basic Concept

Such a plantation would be established at a central location and would service the fuel requirements of several (from three to six) dendro power stations. The fuel processing facility, a fully integrated pellet plant, would be located in close proximity to the tree plantation. All wood from the plantation would be densified at the pelletizing facility and transported to the dendro stations.

b. Size and Location

The plantations would cover an area of 5,000 to 10,000 hectares, and each would service the fuel requirements of up to six dendro stations. The plantations would be located on marginal agricultural land such as abandoned sugar land, or land in foothill regions. Ideally, a plantation would be contiguous or occupying parcels of land in close proximity.

c. Organization

Production management at the plantations would be undertaken by NEA staff. A professional forester will be responsible for management of each plantation. Plantations operations will be, as far as possible, labor intensive to maximize employment, but the plantation will be organized along private sector guidelines. The NEA dendro office staff complement will be strengthened to enable them to assume responsibility for the central fuel processing facilities and the plantations feeding them.

d. Advantages

1) Species selection: Uniformity of topography and soil type will make species selection procedures straightforward. Selection of species for trials will be based on a rigorous analysis of climate, ease of propagation, topography and soil. Species trials plots will later be converted to seed orchards. Correct species selection will be accomplished at minimum cost and with maximum accuracy.

2) Silvicultural techniques: Uniformity of the plantation site will render selection of appropriate silvicultural procedures and, later, management of these activities easier to accomplish. Spacings, thinning procedures, rotation times and coppicing techniques will be selected to maximize yields. Once established, these procedures would be standardized throughout the plantation.

3) Plantation management: Further, a highly orchestrated program of planting, cultivation and cutting is now possible. The plantation will be sectionalized according to tree age. It will be laid out to minimize the distance from any harvesting location to the main transport arteries and to avoid any transport of wood through new growth. Planned, scientific management techniques will ensure a supply of wood to the processing plant, and hence, several dendro stations, without fear of interruption.

4) Transportation within the plantation: Favorable topography and careful planning in the design of the transport arteries will reduce the wood transport problem to a minimum. Conventional systems (roads) will generally be employed.

5) Potential for plantation by-product: Leaf-meal, obtained from the tree canopy, can be sold as animal feed following densification. Transport and densification capability (with modifications) will already be established on site. A valuable by-product available at minimum extra cost will greatly enhance profitability.

6) Location of dendro power stations: It will no longer be necessary to select a station site from the point of view of plantation suitability. Siting can now be optimized relative to the coop electrical demand center and to facilitate export of surplus power to NPC during off-peak hours. At some

existing stations, this cannot be achieved without expensive system improvement. Sale of power to NPC will generate additional revenue for the coop and enable a station to run continuously at design output, avoiding efficiency losses associated with turndown.

7) Retention of benefits of the dendro concept: The coops will retain their capability to generate their own power using a fuel indigenous to the Philippines. Advantages to consumers of relieved dependency from NPC or imported diesel fuel are retained. At the same time, the coop is now relieved of its responsibility for the tree plantation with its attendant headaches. Fuel acquisition is now a simple purchasing procedure as with conventional fuels. Forestry, plantation management and organization of the tree farmer associations are tasks for which the coops are rarely equipped.

8) Improved use of NEA technical and management resources: Limiting the number of plantations to a few larger ones will facilitate streamlining of supervisory and advisory activities. The agro forestry group wil be able to concentrate their efforts on fewer sites. Acquisition of land will be simplified since fewer sites are involved.

9) Advantages of densified (pelletized) fuel: The effect of pelletizing is to increase the energy density of the fuel. The energy density of pellets is almost 300,000 Btu/ft^3. Stacked ipil-ipil wood of less than 20 percent moisture content and in pieces two inches maximum diameter has a bulk density of 20 lb/ft^3. If the heating value at 20 percent moisture is 6,400 Btu/lb, then the energy density is 130,000 Btu/ft^3. Pellet energy density is 2½ times that of raw wood. Instead of transporting raw wood to the dendro station (about 150 million Btu per ten tonne truck), pellets would be transported at 350 million Btu per truck load.

10) Alternative feedstock and markets: Where spare capacity exists at the processing facility, this can be taken up by densifying agricultural wastes which may be locally available such as bagasse or rice hulls. The pelletized fuel can be sold to other markets in addition to the dendro stations such as private sector boilers. Flexibility is inherent in the processing plant such that shortfalls in either feedstock availability or demand for the product can be accommodated.

e. Economics

The following cost figures are estimates based on discussions with private sector forestry groups in the Philippines and manufacturers of densification plants and on data from "Wood for Energy and Rural Development, the Philippine Experience" by Frank H. Denton.

Assumptions: Wood yield of 40 green tons per ha per year. Area to be planted 5,000 ha. (Such a plantation could serve four to five dendro stations.)

Total plantation establishment ₱30.0 million. This amount is loaned to the plantation operating company at 11 percent payable over 15 years.

Installed cost of wood densification plant 400 ton per day capacity, US$ 3.75 million, financed at 3 percent over ten years. Plant operates 300 days each year.

1.6 tons of green wood are required to produce 1 ton of pellets.

Estimated Product Cost (Financial)

Item	Cost per Year	Cost per Ton Product
Land rent (5,000 ha)	₱ 5.0 million	₱ 40
Plantation establishment and operation	₱ 4.3 million	₱ 36
Harvesting	--	₱ 60
Transport	₱ 2.0 million	₱ 17
Densified fuel plant (capital)	US$ 400,000	₱ 66
Densified fuel plant (operating cost)	--	₱ 25
TOTAL		₱ 244

f. Disadvantages

There are two major disadvantages to the concept. The first is the loss of social forestry aspects of the energy tree plantations where these are located at each dendro station. The dendro plantations, as they are now, generate gainful employment for the rural poor, particularly in the upland

regions. Painstaking effort has been put into organization of the tree farmer associations. This is a valuable social program with the potential to alleviate many problems associated with rural poverty.

There remains the question, however, as to whether or not it is wise to entrust the supply of fuel for a 3.0 MW power station to a group of farmers organized along the lines of a cooperative. A more appropriate use of the wood might be for charcoal production which is a less demanding end user (in terms of problems caused by interruption to fuel supply). Highly successful charcoal producing programs, using low-technology kilns, are already underway under the supervision of NEA and the Farm Systems Development Corporation. Charcoal kilning is flexible--kilns are easily rebuilt at new locations, and it requires no highly specialized technical skills. Current programs have already demonstrated the existence of a market for charcoal.

The second major disadvantage is fuel cost. Densified fuel, delivered to a dendro station, will cost over three times the cost of unprocessed raw wood obtained from an adjacent plantation.

However, the densified fuel is dry, easy to handle (similar to coal), and has a heating value 1.5 times that of raw wood, leading to reduced capital costs of fuel handling equipment and boiler firebox.

A detailed economic analysis of the concept should be undertaken. A potential plantation location should be selected for this purpose.

C. CONCLUSIONS

The use of charcoal for power generation is not recommended. The loss of fuel to produce charcoal for the boiler would make the economics of the dendro plant prohibitive.

Densification is also not recommended for the dendro project. Densification at the plant would permit a smaller boiler size, but the capital and operating costs of the equipment make the concept economically infeasible. Densification at a central plantation would optimize tree growth through species selection and ideal soil conditions. However, the operating cost of the system and the problems of transportation would make the concept infeasible.

IX. SPECIFIC PROGRAM RECOMMENDATIONS

The detailed analysis of the Balfour Beatty, Alsthom-Atlantique and Duvant plants has identified a number of recommendations which should be incorporated in the program. Some of these are applicable only to new plants, with equipment suppliers yet to be identified. Others should be incorporated in the Japanese and American designs before the final designs are completed. These recommendations are as follows:

1. The overall dendro plant design concept is technically viable, and the program should be continued.

   The analysis of the plants under construction and planned has indicated that there are no major design problems which make the concept technically infeasible.

2. A senior staff engineer is needed at NEA.

   This senior engineer should have extensive experience in both power generation and wood energy systems. This engineer would provide support to the capable but inexperienced NEA staff.

3. Comprehensive training programs are needed for operators.

   The training program currently being conducted by the British is the only comprehensive program currently in place. A similar program with qualified instructors is needed for all present and future plants. The outline for the British program (copy provided in Appendix 1) is suggested as a guideline for all future training programs.

4. Adequate spares and a system for distribution are needed.

   The contracts for the British and French plants included provisions for spares, but these spares are not always available due to a number of reasons. An adequate supply of spares must be available for all systems. Additionally, a distribution system for the spares, particularly during the rainy season, must be provided. Storage of spares at a centrally located plant is suggested.

5. A detailed electrical transmission distribution analysis must be conducted.

A technically viable design of the integrated REC/NPC power network requires a detailed analysis of power transmission and distribution. Such an analysis has not been conducted but is needed as soon as possible to optimize the system.

6. Communication links to the local NPC controller should be provided at all plants.

A VHF radio link to the local NPC controller should be installed at all plants. As discussed above, the link should be located in the control room.

7. Additional technical assistance should be provided with any new major program.

The assistance would provide support in the areas of technical assessment of plants as well as scheduling, contracting and funding allocations. This assistance should be under the direct control of the funding agency.

8. Philippine contractors should be used as much as possible for design and construction of all new plants.

Inspection of plant sites, discussions with A & E's, and review of in-country manufacturing industries have indicated that Philippine contractors are capable of 100 percent of the plant design, 50 percent of the equipment manufacture and 100 percent of the construction. Assistance from outside specialists in the areas of turbines, controls, and fuel handling may be required initially.

Maximum economic utilization of in-country manufacturing should be made, but specialized equipment such as turbines, where only a limited number will be required on the dendro or other projects, should be imported. Capabilities for manufacture of equipment such as pumps, fans, and pressure piping should be established. This establishment may require the licensing of some foreign technology.

9. Wood chippers should be used for fuel sizing at all plants.

The difficulties at the Balfour Beatty plants have shown that some sort of fuel sizing is required, especially where fuel other than ipil-ipil is fired. The difficulties at the Alsthom-Atlantique plant have shown that grinding the fuel to a size suitable for suspension burning is not advisable. A system which simply reduces the fuel to chip size would permit combustion of the fuel on a grate type boiler. It is further recommended that two chippers, each with full boiler fuel feed capacity, be provided and the system configured such that either unit can be utilized if the other breaks.

10. A detailed analysis of the liquid effluent from the two gasifiers currently in place is required.

Liquid effluents from gasifier scrubbers have known carcinogens which have the potential for severe pollution problems. A thorough analysis including sampling is needed to determine the types of pollutants and requirements for control equipment.

11. Central air conditioned control rooms should be used for each plant.

The controls for the plant boiler, turbine and switch panel should be located in a control room. The room should be air conditioned and isolated from plant noise to allow the shift supervisor to operate in an environment free from distraction. Communication links to NPC should be located in this control room.

12. Cooling towers should be used on all plants.

The intense summer rains make silt a major problem if river water is used for condenser cooling. It is recommended that only cooling towers be used on all future plants.

13. Dryers should not be utilized on future plant designs.

Due to the difficulties of operating dryers, particularly in remote locations, it is recommended that dryers not be used on future plants. This restriction will require boilers with grate rather than suspension burning.

14. Gasifiers should not be used on systems in the near future.

The use of gasifiers on future plants is not recommended until the technology is further developed. Numerous difficulties have been experienced in the United States with gasification systems, and thus similar difficulties are anticipated in the Philippines. The severity of the problem will be increased due to the remote location of the sites. The further installation of gasifiers is not suggested until this equipment has established a better record of reliable service.

15. Standardization should be maximized on all future projects.

Design standardization such as the use of chippers, cooling towers and central control rooms, and the elimination of dryers should be implemented. Components should be standardized to the extent that the same components are used to the maximum extent possible.

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Appendix 1

Balfour Beatty Training Plan

BRITISH DENDRO THERMAL POWER PLANTS

OPERATOR TRAINING

Introduction

The training programme for operators at British Dendros started officially on February 5 and is due to continue to January 1985. To date two power plants have had operators trained. In these notes the background and purpose of the training programme are set out.

Background

At the stage when BBEL/NEA were formulating the contract for the six British Dendro the NEA did not want training to be included in BBEL's contract. Therefore, provision of skilled engineers and operators to assist BBEL during commissioning and then take over the plant became an NEA/Coop responsibility. During the latter stages of construction BBEL commenced planning for commissioning. Advice was given to the NEA on the type, numbers and likely source of skilled power plant staff.

When BBEL's engineers came closer to commissioning the coops had been unable to engage experienced staff thus BBEL recommended that NEA set up a training programme, possibly engaging the services of a local consultant. BBEL have prepared a very comprehensive operating and maintenance manual so it was considered that an engineer with experience of thermal power plants could train others, it would not be essential to use a BBEL engineer. At the same time BBEL submitted a commercial offer to NEA for training by BBEL. It appeared to BBEL that little progress was being made with either a BBEL or local A & E training arrangement thus a further option was considered.

BBEL prepared a case and made submission to the British Government, Overseas Development Administration for a grant to fund training. On behalf of NEA, BBEL were successful in securing an ODA grant for UK costs of a training engineer. NEA had to fund day to day Peso expenses. This is the basis of the training programme that is in progress.

Training

By the time the training programme started BBEL had already commissioned two plants and thus got to know the type of engineers that needed training. Based upon the type of engineers that coops could engage and the programme of construction foreseen by NEA BBEL formulated a training programme that would progress through the constructed sites. It was originally anticipated that once the

first site was operational and training nearly complete then the staff from the second site would visit the first site to be given training on a working plant prior to starting their own plant.

This cascade with overlap programme has not proven practical and currently the training engineer spends approximately eight weeks at each site training the operators.

The training is carried out mainly on the plant and by physical demonstration of how to operate the equipment, some classroom training is given. Training follow the training programme attached.

Progress to Date

The operators of the Solsona Dendro and Ilagan Dendro have been trained and are now able to operate the power plant without assistance. There could be incidents of an abnormal nature arising which require a greater depth of knowledge that it is possible to achieve in a training programme then the power plant operators will have to call for the assistance of the A & E or BBEL. By mid June training should be in progress at the third site, Caramoan and within 1984 it is hoped that the staff at four sites will have been trained.

Attachments:-

1. Training Programme Dendro Contract.

2. Letter sent to all coops advising arrangements for power plant staff training.

3. Report on training at Solson in which it is noted that INEC have worked hard to achieve maximum benefit from the training and trainees have worked hard.

4. Training agreement between BBEL and ODA.

TRAINING PROGRAMME - DENDRO CONTRACT

1.0 Object

To train the Coop engineers and operators to run and maintain the Dendro plants in a safe and efficient manner.

2.0 Level of Training

The level of training is to be carried out in 3 distinct stages viz

Stage (1) To train the 3 shifts at a station to be capable of operating without full time supervision of the training officer so that the plant can run 24 hours per day 7 days per week. This will enable the plant to be generating electricity and earning money for the coop as soon as possible. The training officer will be still stationed at the site during this period working a normal 40/50 hours per week but not necessarily on call at site all the time.

Stage (11) To improve, stage (1) training with particular attention to the shift charge engineers and station manager to a level such that the plant can be safely run while the training officer is absent at another site. It is not expected that a full understanding of the theory of the plant operation will have been grasped in stage (1) and stage (11) training.

Stage (111) The third stage, after some weeks of being left to run on their own will consist of more advanced training in efficiency of operation including theoretical work. The establishment of a routine maintenance system. Review of overall operation.

3.0 Type of Training for the 3 Stages

Stage (1) This will consist of basic training, mostly by example and direction, of the engineers and operators in the areas of: -

- Start up of plant
- Water treatment plant operation
- Feed water system operation
- Boiler stoking and firing
- Running of turbine
- Synchronizing to NPC

- Emergency shut down procedures

- Keeping records of operation

Training at this level should be kept to the minimum basic practical knowledge to get the plant running and earning money for the Coops.

Stage (11) This should concentrate on training of the station manager and engineers to ensure that they reach a level of competence to issue instructions to operators, etc. to run the station safely. At this stage it should be largely practical instruction with a minimum of theoretical knowledge. Particular reference should be made to use of the Operating and Maintenance Manuals for general instruction and problem solving. The aim being to enable them to be left to run the station while the training officer is absent at another station.

Stage (111) This should take place on a return visit of the training officer after some weeks of running. It should consist of: -

- Review of efficiency of operation to date

- Training necessary to improve thermal efficiency of station

- Training on maintenance and the implementation of a maintenance schedule

- Theoretical training needed to enable engineers and manager to have a better grasp of overall operating parameters.

Balfour Beatty

Your ref

Our ref 40052/019/PJT/moa

Date 19th March 1984

Balfour Beatty Engineering Limited
Suite 402 JEG Building
150 Legaspi Street
Legaspi Village
Makati Metro Manila

Telephone 89 11 89 14
Telex 66086 BBEL 64138 BB PHIL

Mr. Simon Alberto
General Manager
Isabela II Electric Cooperative
Ilagan, Isabela

Dear Sir:

Re: Dendro Power Plant Operator Training

We are writing to advise you of the arrangements that have been made for training of Dendro Power plant engineers.

An aid grant has been obtained from the British Government which enables us to provide the training engineer. The grant pays the engineer's UK salary, international air fares and cost of training materials.

The NEA is responsible for providing a Landrover, a driver and daily expenses. A Landrover is being provided by allocating one of the three Landrovers currently used by supervising engineers to the training engineer. An existing Balfour Beatty driver has been assigned to the training engineer. Food and other expenses are processed by BBEL and NEA.

The Coops are responsible for providing a house at site, fully equipped and a cook/house keeper. This being the house that was used by BB engineers during construction.

The training engineer is Mr. R. Elstow who has many years experience with power plant and similar equipment operation. Mr. Elstow is British but has previously worked in the Philippines. All trainees should find Mr. Elstow an approachable person and should not hesitate to ask any questions.

The programme of training is as shown on attached notes. The actual date upon which training will start at a particular power plant will depend upon when the plant is commissioned and will be coordinated with the coop. The first training will take place in advance of stage one when a selected few persons will visit an already operational power plant for about two weeks. For example Solsona is operational so Caramoan staff will visit. Later when Caramoan is operational and the training engineer is there the Palauig engineers will visit.

The training can only be fully effective if the power plant has a proper supply of wood, chemicals and is properly equipped with tools, etc. etc. Coops should ensure that all items on the check list of preparation for operation, as issued by Balfour Beatty are completed.

Should you have any questions regarding the training please do not hesitate to ask Mr. Elstow or write to us in Manila.

Very truly yours,

PETER J. TOTTMAN
Manager - Dendro Thermal Project

cc: Col. F. T. San Miguel
BBEL Sidcup

Training Report : Dendro Thermal Units (Solsona)

Period Covered : February 6th - March 6th

A joint training programme for both disciplines of mechanical and electrical engineering has been constructed and implemented during this month. The training programme has been disigned to cover the practical aspects of the operation and maintenance of Dendro Thermal Units.

The programme is prepared such that three stages of training will be covered viz.

Stage I Cover the training of both mechanical and electrical disciplines to the point of plant operation without full time supervision.

The areas covered in this phase are:-

a) A general understanding of what equipment has been provided and its place in the overall station design concept.

b) The operation of each piece of equipment and the likely effect of failure both to itself and the plant.

c) With particular reference to the mechanical engineers, the theory, and more particularly the practice of combustion. The principles of safe operation of boiler plant and the study of grate management.

d) For the electrical trainees, the circuitry and switching of 4.16kV power, the practice and logic of circuit investigation, the practical aspects of electrical fault finding.

e) The application of boiler feedwater treatment and the practical aspect of de-mineralized water plant operation (mechanicals).

f) The physical determination of gas passage and feed water system in the boiler (mechanicals).

g) The operation of the turbine as a heat engine with the additional consideration of wet, saturated and super-heated steam, their formation and uses (mechanical).

h) Consideration of the oil, cooling water and vacuum systems on the turbine (mechanical and electrical).

i) The combined work force to consider the needs and practical problems of communication with each other and the intercourse between sections ie. Boiler House, Turbine House, Switchgear, external Switchgear and the various levels of management.

j) The combined work force to consider their efforts to be part of a National Resource with responsibilities of efficiency and their contribution to the National Effort.

k) The needs and provisions for breakdown, preventive and scheduled maintenance of plant. Also to engender logical through the implementation of such a maintenance programme, and its association with Management, customer, Accounting Dept. Stores and lead time for purchase of spares and consumables.

l) The other man's job - where the electrical engineers operate the boiler and turbine under the supervision of the mechanical engineers and the mechanical engineers operate the switchgear and gain some understanding of the electrical system under the supervision of their electrical colleagues.

Stage I has been generally completed although it has only been possible to run the plant on infrequent occasions. This has been wholly due to the absence of chemicals for feed water treatment and the paucity of tools and test instrumentation for the maintenance and general running of the plant. Since there is no sharp delineation between stages part of Stage II has also been covered during the month.

Stage II This section seeks to involve the Station Manager and Shift Charge Engineers in the paths of suitable management in the light of operating experience gained. It is also designed to improve the understanding of the trainees and to induce confidence and precision into the Station operation. With the additional aim of high lighting the needs of self discipline and dedication to their particular jobs.

a) The operation of the station carrying its own internal load, punctuated by unexpected trips, faults and shut downs and the implementation of remedial and emergency procedures.

b) The design and implementation of set shifts procedures e.g. as a new shift takes over, the outgoing and incoming engineer should inspect their section of the plant together and note any problems which has occured or can be predicted for the future.

c) Observation by the Station Manager & Shift Charge Engineers of the operation of the shift work, the fuel supply and the availability of labour.

d) Design and implementation of reporting procedures both up and down the management chain the design and implementation of programmes to improve the efficiency of the station, with particular regard to the keeping of logs and the extraction of data from the sheets. This data will figure in future management policy.

e) The design and implementation of manning levels and systems for outlying switching and sub-stations together with communication facilities for emergency conditions.

f) The trainees to become familiar with the O&M Manuals their contents and advise back of shortcomings they find.

Some stage II work has already been completed because the non availability at the station for operation has caused a blurring of the interface between stages. In order to obtain continuity some work has been taken out of context and applied at a date earlier than intended.

Stage III Will take place as a review content for the programme, return visits will be made to ensure that there are no gaps in the coverage of the previous stages. During this stage more emphasis will be placed on the practical aspects of maintenance.

General appreciation of the programme so far and the means by which the effects have been measured.

Mechanical

It must be said of INEC Management that every effort has been made to facilitate the training programme. No effort has been spared to ensure that men and materials within their authority and supply have been available.

Moreover the dedication and application of the trainees to their appointed tasks, assignments and studies has been excellent.

Where sins of omission and comission have been commited they have been wholly due to small problems in communication. However, repetition of theory and "by example" in practice have cured the outstanding problems. Repetition has been appreciated by those

who did not understand and has been endured with goodwill by those who did which makes the training enigneers task much easier.

In order to assess the level of understanding of the course a 4 hour examination paper was set, the results from this are that of 7 engineers who completed the course 6 passed, 3 with distinction and 3 with varying levels of competance, the last engineer who failed is actually the storekeeper who sat the examination but did not attend the lectures and programmes, nor did he take part in the set assignments or emergency procedures. Examination papaer is Appendix I.

Electrical

There the story is very different. Of 5 available trainees only one made a concerted effort to attend lectures and assignments and in the final examination the results he produced were excellent and correct in every particular. The other 4 engineers were reluctant to attend at the site and their showing in the examination was abysmal. An investigation into their reasons for lateness and non-attendance reveals that a considerable salary difference between their attendance at headquarters, for work there, and their attendance at site for instruction reduced their enthusiasm for site attendance. This has now been resolved by the good offices of the Station Manager and 5 days of intensive training have ensued, a further examination has been prepared and the results will be appended to this report. The original examination has been added as Appendix II the additional paper is accorded as Appendix III.

Recommendations as to the fitness of various personnel for duty as Shift Charge Engineers or operators is offered as Appendix IV.

Solsona Dendro Thermal Unit is now ready for operation without prejudice to any outstanding remedial or completion work which may still be outstanding for BBEL.

The personnel are ready to undertake their duties and their understanding of those duties is such that there is no hindrance to the plant operation. Indeed it is desirable that continuous operation be undertaken to improve their confidence in their own abilities.

However it is essential that availability of chemical and engineering consumables is assured and continous, also that transport is at site to move the fuel wood in an adequate quantity to sustain the plant operation.

Mechanical Questions

1. The wood handler who empties the ash skip draws your attention to unburnt carbon in the ash. Give the causes for this.

2. What are the main losses on a boiler, state in a few words how to keep them as low as possible.

3. Describe in your own words:

   a. What is saturated steam and how does it differ from wet steam?

   b. What is superheated steam and how is it produced?

   c. Why do we superheat steam?

4. Describe briefly, the various stage which occur in a power station during the conversion of the chemical energy in wood into electrical energy.

5. The boiler you are steaming has a CO_2 indicator but you have not been given CO_2 figure to work to and the analysis of the fuel you are burning is not known. How would you set about getting the highest CO_2 for good combustion.

6. Describe the procedure for the start up of the turbine up to and including synchronizing with INEC supply, include the people with whom you would communicate your actions.

7. Describe how you would induce the suction on a cooling water pump after it has been shut down, stripped and reassembled after overhaul.

8. Draw a sketch of the layout of the Turbine indicator panel, name the instruments and state the approximate readings you would expect to have when running on load.

9. In planning the shut down of the power station for general maintenance, which authorities would you agree your plan with, what procedure would you adopt to ensure that the overhaul was completed on time. Explain how you would establish the most suitable time of year for an overhaul to take place.

10. State in a <u>few words</u> what is meant by the following terms:

    a. Corrosion
    b. CArry over or priming
    c. Hardwater
    d. De-aerated water
    e. Conductivity meter
    f. Blowdown

11. Show by calculation how the setting on the thermal overloads on an electric motor are established, the overloads are there to protect the motor from damage.

- O -

From the 11 questions which have been set, select 8. Your answers together with my comments will be forwarded to INEC Management before return to the trainees.

Time Limit : 4 Hours-split 2 Hours 10:00-12:00 & 14:00-16:00

Appendix II

Electrical Questions

1. Explain the function of the excitation control and the governor control when:

   a. in parellel with INEC
   b. in parallel with NPC

2. Explain in detail the synchronizing procedure aligning the generator with NPC from the time the turbine operator advises you he is ready to accept station load.

3. A motor breakdown has been reported to you, actually the motor has an open circuit winding, describe what procedure you would adopt to locate the fault.

4. Describe what you think are the most important functions of the 110 volt DC battery supply and charger.

5. It is necessary to synchronize the blackstart genertor with the turbo-alternator - describe how this should be done.

6. Describe the action you would take in the event of the following faults occuring on the main transformers:

   a. Buckholz alaram
   b. Winding temperature alarm
   c. Oil temperature alarm

7. What would be the effect of our power station generating in parallel with NPC but having a higher power factor.

8. Describe the procedure for setting the "NORMAL" and "FIRST LOW LEVEL ALARAM" and the opening and closing functions of the boiler feed water valve modulating system, using the electrical/ electronic control boards.

- O -

Please attempt all 8 questions. Your answers together with my comments will be forwarded to INEC management before return to trainees.

Time limit: 4 Hours - split 2 hours 10:00-12:00 & 14:00-16:00

cc J Masterson
M Smith - Accts
D Jarrold - Cost Cont
P. Tottman - Mnl
R Elstow

OVERSEAS DEVELOPMENT ADMINISTRATION

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ATTENTION MR P A DUCKWORTH
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Kent
DA15 7AU

Your reference 40052/845/VRT/JB

Our reference CON 517/138/01

Date 20 February 1984

Gentlemen

I am directed by the Secretary of State for Foreign and Commonwealth Affairs to refer to recent discussions and correspondence between Balfour Beatty Engineering Limited ("the Consultants") and the Overseas Development Administration ("ODA") and to confirm that, in response to a request from the Government of the Philippines under British technical cooperation arrangements, the British Government wishes to engage the Consultants on the terms set out in this letter and its Appendix to provide the services of a Training Engineer to train local engineers and operators of Dendro Thermal (Woodburning) Power Stations, the Philippines.

2. Terms of Reference

The Consultants' terms of reference for this engagement are as set out in the Appendix to this letter.

3. Period of Engagement and Staffing

In order to fulfil this engagement which shall be for a period of twelve (12) months residential service in the Philippines with effect from about 2 February 1984, the Consultants shall arrange for Mr W R B Elstow to travel to the Philippines on or about 2 February 1984 for the purposes of this engagement. Mr P A Duckworth will be responsible for the overall supervision and coordination of this engagement.

4. Provision of Substitutes

If, owing to death, illness or other circumstances beyond the control of the Consultants, Mr Elstow should be unable to carry out his duties under this engagement the Consultants shall, if requested by the ODA, provide a substitute acceptable to the ODA. Provided Mr Elstow was certified as being medically fit within one month prior to travelling to the Philippines in respect of this engagement the British Government shall reimburse the Consultants for such additional cost, including air fares and other incidental expenses, as may be agreed between the Consultants and the ODA as having been reasonably incurred in providing such a substitute. If, for any other reason, Mr Elstow does not carry out his duties under this engagement the Consultants shall be responsible for providing without delay a substitute acceptable to the ODA without further cost to the British Government.

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5. British Carrier

The Consultants shall, when it is reasonable and practicable to do so, travel by a British Carrier.

6. Reports

In addition to the reports required by the terms of reference the Consultants, in respect of this engagement, shall submit reports as follows:

Date due	Nature of Report	No of copies required by a. ODA	b. Government of Philippines
Each quarter, 1st due 14 May 1984	Progress report	10	10
February 1985	Final Report, outlining inputs made, results achieved and any recommendations the Consultants may wish to make	10	10

The Consultants' final report shall be submitted in accordance with the note of the presentation of reports enclosed with this letter.

7. Fees and Expenses

In consideration of the satisfactory performance by the Consultants of this engagement and subject to paragraphs 8 and 9 the British Government shall make the following payments to the Consultants:

i. fees for the time, including travelling time, necessarily spent by Mr Elstow for the purpose of this engagement at the periodic rate of [redacted] per quarter (which rate shall apply pro-rata for part periods);

ii. reimbursement of reasonable out-of-pocket expenses necessarily incurred by the Consultants in carrying out this engagement, including the items set out below:-

a. economy class return airfares and associated travel expenses up to an overall total cost of [redacted]; and

b. training materials etc up to an overall cost of [redacted] provided ODA has first agreed in writing to the purchase of any training materials recommended by the Consultants,

but excluding expenses for the items mentioned in paragraph 17 below.

8. Fees: Definition

The fees payable to the Consultants are deemed to cover the cost of salary, overseas inducements and leave allowances, bonuses, profit, insurances, superannuat and all other costs, overheads and expenses of whatsoever nature that the Consultan may incur except those specifically otherwise provided for in the terms of this engagement.

9. Financial Limit

The financial limit of the British Government's liability to the Consultants under this engagement shall not exceed a total sum of £38,000 (thirty-eight thousand pounds) unless the amount of any such excess has first been agreed by the ODA in writing before the Consultants have taken any action which might result in the financial limit for this engagement being exceeded.

10. Payments

The sums due to the Consultants under the terms of this engagement shall, subject to the ODA being satisfied that this engagement is being or has been carried out to its satisfaction, be paid in sterling in London quarterly in arrear on the receipt and approval by the ODA of the Consultants' statement of account which should be submitted in accordance with the enclosed note on submission of statements of account.

11. Value Added Tax

Although the Consultants are being engaged by the British Government and payments under this engagement will be made from aid funds, the services of the Consultants will be supplied to the Government of Philippines. In accordance with the provisions of Item 6 of Group 9 in Schedule 5 to the Value Added Tax Act 1983, VAT will not be payable on the Consultants' fees and expenses. Services supplied to the Consultants by sub-contractors cannot, however, be zero-rated under the aforementioned provisions of the Value Added Tax Act 1983. Accordingly it will be for the Consultants to recover any VAT paid in respect of such services from HM Customs and Excise in accordance with the normal rules, and any such VAT payment shall not be eligible for reimbursement to the Consultants under the terms of this engagement.

12. Currency

If it is necessary for the Consultants to purchase foreign exchange for the purpose of this engagement, for the purpose of evaluating one currency in terms of the other the conversion shall be made at the purchasing rate legally applicable at the time and place of, and to the currency utilised in, the underlying expenditure or transaction.

13. Indemnity

The Consultants shall indemnify and keep indemnified the British Government in respect of any claims arising out of, or related to, this engagement howsoever they may arise.

14. Assignment to Others

The Consultants shall not, without the consent in writing of the ODA, assign or transfer or cause to be assigned or transferred, whether actually or as the result of takeover, merger or other change in identity or character of the Consultants, this engagement or any part, share or interest therein. Upon any such assignment or transfer this engagement may forthwith be terminated by the ODA.

15. Termination

i. If in the opinion of the ODA it appears desirable that this engagement should be terminated, the ODA may at any time give the Consultants written notice of

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three months, or such other period as may be agreed between the Consultants and the ODA, of their intention to terminate this engagement and this engagement shall be deemed to terminate on the expiry of such notice. Reports due in accordance with the terms of this engagement during the period of the notice shall be furnished but, unless so agreed between the parties, no final report or draft thereof. Payments due to the Consultants under this engagement shall be made for services rendered up to the date of termination less any unrecovered or balance of advances made. No other payments shall be due to the Consultants.

ii. If the Consultants should at any time during this engagement go into liquidation or enter into any arrangement with their creditors the ODA may forthwith terminate this engagement. In that case payments due to the Consultants under this engagement shall be made for services rendered up to the date of termination, less any unrecovered or balance of advances made. No other payments shall be due to the Consultants.

16. Force Majeure: Cessation of Obligations

If the rights of the Consultants or of the British Government under this engagement are wholly or substantially diminished or the performance of this engagement rendered wholly or substantially impossible by reason of force majeure, then the party so affected shall promptly notify the other party in writing and as from the date of that notification the obligations of both parties shall cease forthwith except that the British Government shall pay the Consultants:

i. all fees, expenses and other sums due and outstanding under the terms of this engagement up to and including the date the obligations so ceased ("the relevant date");

ii. in respect of each person who, in accordance with the terms of this engagement, was employed by the Consultants in order to fulfil this engagement on the relevant date, or who was due to be so employed during the following two months, a fee at the rates provided for by this engagement for such period, not exceeding two months from the relevant date, as such person was due to work under this engagement;

iii. reimbursement of reasonable expenses necessarily incurred by the Consultants after the relevant date in winding up this engagement.

17. Local Services and Facilities

The Consultants shall provide the following:-

a. Accommodation in the Philippines (engineer and driver/assistant)

b. Land Rover (LWB) and VHF radio

c. Salary of Driver/Assistant

d. Land Rover Maintenance and Fuel

e. Incidental expenses

The British Government shall not be responsible for the provision of, or cost of, and shall accept no liability in connection with, such services and facilities.

18. Settlement of Disputes: Arbitration

Should the Consultants and the ODA be unable to reach agreement on the meaning or interpretation of any of the terms of this engagement, any matters in dispute shall

be referred to an arbitrator to be agreed between the parties or failing such agreement to be nominated by the President of the Law Society of England and Wales on the application of either party, and the decision of the arbitrator shall be final and binding on both parties.

19. I should be grateful if you would confirm in writing that you accept this engagement on the terms set out in this letter and its Appendix.

I am, Gentlemen,
Your obedient Servant

J W Last
Consultancies Section

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APPENDIX

Woodburning Power Stations - Philippines

Terms of Reference

Object

- To train the operating staff of the six stations situated at Solsona, Iligon, Palavig, Jones, Caramoon and Dupax in Luzon to enable them to operate and maintain the stations efficiently and safely.

Type and Extent of Training

- All training will be at the power plant sites (although it is possible that at times operating staff from a yet to be commissioned station, will be transferred for training purposes to the running station where the training engineer is located), as decided by and for such periods as the National Electrification Administration (NEA) shall determine.

- Training shall be largely practical but shall also cover the minimum theoretical knowledge necessary.

- Training shall cover two separate aspects viz:-

    Station Operation
    Station Maintenance

- Training shall emphasise the use of and reference to, the comprehensive operating and maintenance manuals provided

- It shall include the setting up of routine records, shift logs, maintenance logs etc, initiation and recording of maintenance work

- It shall instill an awareness of possible dangers and attention to safety and safe working practices

Items of Plant to be covered

Boiler Plant including economiser, fans, sootblowers and auxiliaries. Particular attention shall be paid to training the engineers and operators in maintaining correct firing conditions. Regular use of sootblowers to keep the gas passes clean and correct operation of fans to maintain efficient combustion and control of smoke.

Instruction in the correct operation of the water treatment plant to provide boiler feed water. Chemical dosing and regular water testing shall be stressed.

Instruction in the correct operation of the deaerator and feed water system including blowdown regimes. Emergency shut down procedures shall be included.

Turbine Plant

Instruction in the running up of the turbine and its normal and emergency shut down. The routine logging and the necessity to observe the readings to detect any change in operation. Routine changing of oil filters and oil coalescer filters shall be included.

Instruction in the correct operation of vacuum pumps, condensate pumps and main

Electrical

(Note - The Training Engineer will be assisted by the Consultants' Electrical Engineers, whenever available.)

480V Auxiliary System

Training shall include the start up and running of the black start diesel generator set together with its emergency use for the safe shut down of the station. Instruction in the starting of motor drives and the setting of auto changeover systems for standby drives shall be given.

4.16kV Main Generation System

Instruction in the correct operation of the generator excitation controls including adjusting voltage and power factors as necessary. Synchronization with the grid system shall be demonstrated. The operation of the main switchboard and the main auxiliary transformers shall be included.

General

Emphasis shall be placed on the regular routine recording of information together with its interpretation. This shall include setting up systems for such things as:-

- Regular logging of plant operating conditions
- Analysis of operating log sheets to detect deviations from normal
- Initiation of periodic maintenance to plant items and the recording of work carried out
- Recording and ordering of consumable stores and spare parts

Support in the field

The Consultants' office in Manila shall provide support in the field for the training engineer. This shall cover such aspects as -

- Communication back to UK and elsewhere
- Vehicle maintenance arrangements
- Arrangements to draw money in the field (to be covered by an expense sheet)
- Act as link to NEA Manila Headquarters

Reporting

The engineer must complete daily record sheets to show where he is located and what training has been carried out. He is also required to produce approx monthly reports covering such items as -

- Training carried out
- Recommendations as to competence of engineers trained
- Recommendations to the Co-operative owners of the plant as to any extra staff, improvement in shift arrangements, maintenance etc

Such reports should be written at the end of a spell at any one station and handed to the General Manager of the Co-operative, and the NEA. The reports should be incorporated in the quarterly reports required by ODA under the terms of paragraph 6 of the contract. Where a spell at a station is to cover a two month period an interim report must be provided to the General Manager of the Co-perative and the NEA after one month.

Appendix 2

Alsthom-Atlantique Training Plan

ON-THE-JOB TRAINING ON DENDRO POWER PLANT OPERATIONS AND MAINTENANCE (FRENCH-DESIGNED)

I. RATIONALE

The establishment of power plants utilizing wood as fuel continues to be the concrete objective for which the dendro thermal development program was initiated by the National Electrification Administration. To date, dendro power plants of 3-MW capacity each have been successfully built and established in Bolinao, Pangasinan; Solsona, Ilocos Norte; and Ilagan, Isabela. Their efficient operation, however, entails the availability of local manpower equipped with the necessary expertise to competently manage the power plant systems.

Along this line, a series of on-the-job training courses had been conducted, last year on the operation of the 550 KW Korean-designed dendro power plant in Occidental Mindoro Electric Cooperative, Inc. The course enabled the participants to acquire basic knowledge in and familiarity with dendro power plant operations and maintenance.

For this year, an extension of this course is being proposed to supplement previously acquired learnings and to afford co-op engineers and power plant operators with a more rigid and specialized training on the actual operations of the French-designed dendro power plant. The proposed training will be for one month* (24 working days) to provide the participants with a comprehensive and adequate exposure to the actual operations and maintenance of the system.

* adjusted to one and a half months or 46 working days.

II. GENERAL OBJECTIVE

The objective of the course is to develop the competence of trainees in the different technical approaches, systems, and procedures of effectively operating and maintaining a French-designed dendro thermal power generating plant.

SPECIFIC OBJECTIVES

At the end of the training course, the participants will be able to:

1) acquire the capability and skill necessary in the actual operations and maintenance of the power plant;

2) familiarize themselves with the different equipment parts and components, how they function and their correlation with each other;

3) develop constant awareness and observance of proper safety procedures and practices in the course of plant operations and maintenance work; and

4) understand fully the scope of their duties and responsibilities as power plant operators and/or engineers in-charge of plant operations and maintenance.

III. COURSE CONTENT

FRENCH DENDRO POWER PLANT

Subject Matter	No. of Hours
A. Lectures	
1. General Presentation and Principles of a Dendro Power Plant	1 hour

	Subject Matter	No. of Hours
2.	Wood Processing and Gas Flow Generalities and Presentation	1 hour
3.	Steam Generator and Water Flow and Electric Power Distribution Generalities and Presentation	1 hour
4.	Instrument at Flow and Cooling Water Generalities and Presentation	1 hour
5.	Boiler and Accessories	2 hours
6.	Turbo Generator and Oil System	2 hours
7.	Condenser, Water Treatment, Feed Water Degasing	2 hours
8.	Crushing Station, Storage Tank and Rotary Dryer	2 hours
9.	Cooling Water, Black Start Diesel and Air Compressor	2 hours
10.	Electric Protection and Distribution	2 hours
11.	Automation	2 hours
12.	Regulation	2 hours
13.	Operation of the Plant	2 hours
14.	Starting Procedure	2 hours
15.	Maintenance	2 hours
B.	Actual Observation and On-the-Job Training	110 hours
C.	Wrap-up and Evaluation	4 hours
	T O T A L	140 hours

IV. METHODOLOGY

The training course shall be held for one month and centered on the French power plant in Bolinao, Pangasinan.

The course will start with theoretical instructions to be conducted classroom style. Each subject matter

lectured and discussed will be followed immediately by on-the-job but off-line directions and ocular inspection. The effect should be a much better and faster way of learning and familiarizing the participants with the subject matter. On-the-job on-line actual operation instructions shall be given whenever circumstances permit. Reactions during the discussions and open forum should provide a gauge of each trainee's learning progress.

Lecture topics will deal on the nomenclature, description, functions and operating characteristics of the equipment, assemblies, and auxilliaries and how they fit into the different systems that make up the operations of the plant as a whole. Information manuals shall be furnished. Instructions shall be given to all trainees as a group regardless of each individual's technical expertise or specialization. It is through a thorough understanding of all the systems in plant operations, aside from merely knowing their specific job assignment, that these plant technicians can do their work more efficiently and effectively. This will also enable them to easily coordinate their actions with the other sections of the plant when already performing their particular jobs.

The rest of the course will be devoted to actual on-the-job training. An evaluation and wrap-up activity will be conducted to assess the effectivity of the training course.

Handouts and other information materials will be distributed during the training period.

V. PARTICIPANTS

The participants of each cooperative shall be composed of a power plant engineer and prospective operators of the boiler, the turbine and the panelboard. Participating co-ops will be:

1) PANELCO I
~~2) MARELCO~~
3) ISECO
~~4) PALECO~~
5) AKELCO
6) ABRECO
~~7) PIGELCO~~
8) ILECO II

Five NEA-DTDO Engineers will also participate in the activity. There will be around ~~25~~ 21 participants for the French power plant session.

IV. SPEAKERS

A resource person from A DE VERA TRADING with the proper technical knowledge and work experience will serve as trainor for the duration of the training program. Personnel from the host co-op will be requested from time to time to assist.

VII. STAFF

Members of the training staff who will administer the course will be rotated weekly.

VIII. OPERATING DETAILS

1. Date and Venue: ~~January 30, 1984~~ February 6 to ~~February 24~~ March 17, 1984
Bolinao, Pangasinan

2. Time Schedule:

MONDAYS THRU SATURDAYS

AM Session	-	8:00 - 12:00
PM Session	-	1:00 - 5:00
AM Snacks	-	10:00 - 10:15
PM Snacks	-	3:00 - 3:15
Breakfast	-	7:00 - 8:00
Lunch	-	12:00 - 1:00
Dinner	-	6:30 - 7:30

3. A general assessment of the course and written recommendations from participants on how plant operations could be better improved will be undertaken towards the end of the training program.

IX. CERTIFICATES

Certificates of completion will be awarded to participants who attend at least 85% of the training hours and complete course requirements.