# INNOVATION NETWORK IN GREEN ENERGY:

# EVIDENCE FROM BRAZIL

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by

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**INNOVATION NETWORK IN GREEN ENERGY:
EVIDENCE FROM BRAZIL**

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I would like to thank my advisor, Dr. Nair-Reichert, for her feedback, patience and faith.

In addition, I would like to recognize here all the hard work my parents have done since they first left their home country to make sure endeavors like these were possible for their children. Thank you.

## ACRONYMS

| | |
|---|---|
| **ANEEL** | Brazilian Electricity Regulatory Agency |
| **BNDES** | National Bank of Development |
| **CNPq** | National Center for Research |
| **DCs** | Developed Countries |
| **ELETROBRAS** | Brazilian power utility |
| **FDI** | Foreign Direct Investment |
| **GW** | Gigawatt |
| **LDCs** | Less-Developed Countries |
| **MW** | Megawatt |
| **NIS** | National Innovation System |
| **NLS** | National Learning System |
| **PROINFRA** | Program of Incentives for Alternative Energy Sources |
| **R&D** | Research and Development |

## Abstract

Green energy innovation and investment around the world is picking up as nations diversify their energy sources to reduce dependency while remaining environmentally conscious.  My work characterizes the Brazilian green energy market in terms of players, frequency of investment in research and thereby advances made for wind, solar and wave energy.  Surveying the data publicly available shows that although efforts have been made to spur investment in renewables with programs such as the Program of Incentives for Alternative Energy Sources (PROINFA), not enough has been done to reduce the heavy reliance on hydropower and biomass through innovation.  Universities and companies are not collaborating together enough to perfect alternative sources of energy for the country, despite the growth in energy demand.  The Brazilian government needs to work with the private sector and universities to catalyze further diversification in energy sources, thereby necessitating deeper research. It needs to reduce costs in constructing wind farms, solar panels and devices that capture wave energy, reduce macroeconomic instability, provide easier access to information on financial incentives and establish more financial programs to stimulate greater partnerships between research institutes like universities and the private sector.  Otherwise, significant challenges remain ahead as domestic energy demand increases in a strongly nationalistic nation reluctant to depend on foreign energy sources.

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# Innovation Network in Green Energy: Evidence from Brazil

## Introduction

Following the battering faced by most countries due to the economic recession, governments and firms are looking for promising sectors to focus their energies and finances on to attain sustainable growth in GDP. Due to environmental concerns and potential for profit, they are finding it worthwhile to invest in green energy technology. The Brazilian government has introduced efforts to promote cooperation, induce innovation and learning and improve the synergies between the private sector, universities and the public sector. However, many studies evaluating these efforts have concluded that at a national level there are still many issues to be worked out. These problem areas include: the lack of firm knowledge of and capabilities to use the incentives available, the irrelevance of university research, a low amount of funds allocated by firms to research and development, a lack of an entrepreneurial mentality and a bias of innovative activity in urban centers. Such issues are also applicable to other industrializing nations as they remain behind the leaders in innovation and import new technologies from abroad. However, evidence suggests that the Brazilian green energy sector has characteristics which diverge significantly from the aforementioned national norms.

The goal of this project is to characterize how the green energy domain's innovative framework operates in Brazil. My method takes cooperation and further technological growth within a company and a nation into account. Specifically, I will focus on energy sources from wind, solar and waves. I target these three particular energy types because, as previously stated, innovation in this sector differs from the behavior of others, due to the fact that it may have more knowledge of investment mechanisms provided by government. In addition, green energy offers a perfect case study for innovation because it is still a relatively new technology. Brazil is particularly strong in biomass and large hydropower energy; therefore, its investment in green energy sources is high. However, the country has faced energy crises and blackouts leading to political turmoil, loss of productivity and general discontent among the population due to problems with large hydropower energy, which provides most of the electricity for the country. Therefore, there are benefits to uncovering the strengths, weaknesses and potential of wind, solar and wave technology in order to decrease the strong reliance on large hydropower. This research proves that, based on data publicly available, investments in wind, solar and wave energy remains low or slow. Despite implementation of the incentive program for biomass, small hydropower and wind energy, PROINFA, in 2002, there are still many challenges ahead in this sector. The challenges include: reduction of bureaucracy in obtaining a permit for construction, assurance from government that the energy prices are competitive, further improvement in economies of scale, availability of financial aid for start-ups and amelioration in the amount and quality of research universities do.

## Literature

### i. Technical Change

In the quest for growth faced by nations all over the world, technological change has been defined as the key ingredient necessary for sustainable growth patterns. Behind the concept of technological change lies its fundamental prerequisite: accumulation of knowledge. Investments in research and development (R&D), education and in advanced technologies are seen as the main tools through which such agglomerations can be created. A nation can then induce technological change with the product of said investments: innovation.

However, not all nations developed equally and there is a large gap in knowledge accumulation capabilities and innovation between those at the vanguard of the technological frontier (i.e. developed countries) and those lagging behind (i.e. developing countries and underdeveloped countries). In order to remain at the forefront, developed countries (DCs) must continuously produce innovation - defined here as the introduction of something new, be it a product, knowledge or process. Less developed countries (LDCs), in turn, absorb innovations from abroad to engender technical change.

Therefore, the aforementioned model of technological change works primarily in industrialized nations. As a consequence, although LDCs should also strive for accumulation of knowledge, innovation for them is conceived differently and should therefore be defined differently.

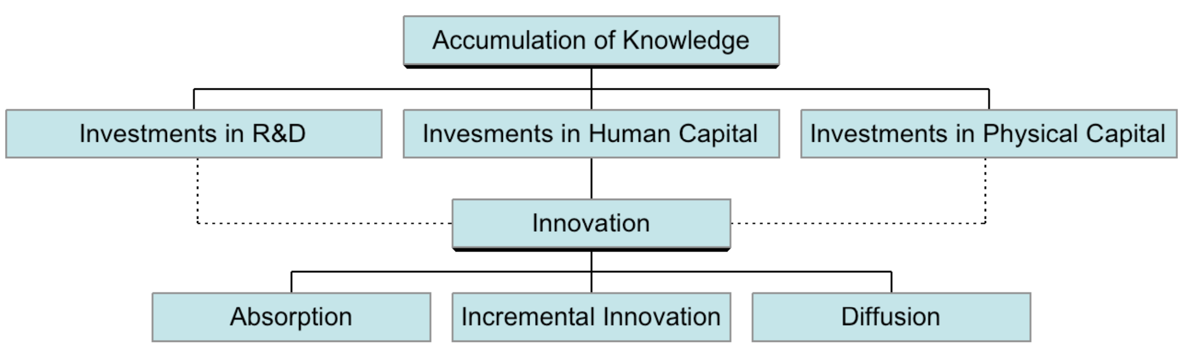
Brazil fits the definition of an LDC because of its economic characteristics and because it is not yet a member of the Organization for Economic Cooperation and Development (OECD), which is composed of developed, "rich" nations.

### ii. National Innovation Systems and National Learning Systems

In order to more fully understand and exploit the potential for innovation within a nation, the concept of national innovations systems (NISs) has been created. Indeed, "[t]he concept of national innovation systems rests on the premise that understanding the linkages among the actors involved in innovation is key to improving a technology performance" (OECD, 1997).

However, according to Viotti, the notion of an NIS should be altered for LDCs and instead be called National Learning Systems (NLSs). Technical change for LDCs should be interpreted as a process of learning and not of innovation, where learning here is defined as a process of absorption, incremental innovations and diffusion. Ideally, LDCs take knowledge (machines, processes) from DCs (absorption), adapt the knowledge to local conditions (incremental innovations), introduce it into their factories and thereby induce competitors to also adopt the technologies in order to remain competitive (diffusion). Foreign technologies can enter LDCs through foreign direct investment (FDI), imports of capital goods, foreign licensing and technical consultancy. This altered interpretation should be considered when accounting for innovation in countries such as Brazil and other LDCs.

**Fig. 1 Visual representation of NISs (upper portion including innovation) and NLSs (includes the entire diagram)**



In categorizing a country in such a general form of either NIS or NLS, we run the risk of not accounting for certain sectors within the national system which may actually be some of the global leaders in innovation for their respective area. I agree with including the concept of learning in the technological progress made in countries. However, learning and innovating are not mutually exclusive things. In order to avoid an over-generalization I suggest analyzing national innovation/learning systems according to a cluster analysis. This allows me to focus on certain groups of firms and sectors "according to their technological and networking characteristics" (OECD, 1997). I use this reasoning in analyzing one particular area of the economy: green energy.

Key to my work is understanding how the different actors all work together (or fail to) to produce knowledge and/or innovation.

### iii. Innovation and Learning Institutions

Institutions play crucial roles in spurring the learning process. They also have to ensure that the agglomeration of knowledge and learning "follow *local* specific conditions to adapt, engage and mobilize local actors and agents" (Conceição & Heitor, 2002). Conceição and Heitor`s study takes a two-pronged approach to analyzing elements of learning necessary for economic development by considering the importance of both innovation and competence building. The authors highlight the importance of local human capital and emphasize that competence depends on both individual and collective skills. In addition, Conceição and Heitor discuss the influence that education has on learning capabilities and argue that the "efficient governance of innovation cannot be reduced to devising incentives regarding research and development (R&D) but that it must also rest on incentives appropriate to increase the social infrastructure" (2002). Furthermore, competence depends on more general characteristics such as creativity, initiative and risk-taking.

Although they recognize that learning is driven by components other than just innovation and competence building, they do not take these into account. Neglecting factors such as macroeconomic conditions and economic and political past will fail to provide us with a clear understanding of the current innovative and competence-building network in the Brazilian case. Brazil has high interest rates, risk-adverse firms and as of yet, no strong entrepreneurial mindset due to the economic crises and political turbulence faced in the past. Recognizing and removing the bottlenecks these traits inflict on innovation and competence building is necessary to promote learning and thereby economic development. Additionally, during Fernando Henrique Cardoso's term as president in 2001, the country faced frequent energy shortages, which led to a push to expand energy sources. This historical fact is important in illuminating why there is a greater push for innovation and emphasis in alternative forms of energy although they have mainly concentrated on hydroelectric energy and to some degree solar water heating.
The three most important local actors in building the framework of a learning and knowledge network to induce innovation and learning are government, universities and the private sector. However, I suggest analyzing the green energy cluster with a fourth player in mind: foreign firms. The reason for this is because the country in question is developing and overall the sector is more than likely correctly characterized as a learning system

cluster. Foreign firms must be taken into account as they own most of the companies active in green energy in Brazil.

Within this framework of four players, universities perform basic research (upstream scientific research) and companies exploit the basic research by transforming it into commercial use (downstream science). Foreign firms, through FDI, joint ventures or installation of business units in a foreign country, transfer new technologies or money from abroad. The government plays an overarching role as the facilitating institution for interactions between the four. The public sector should deal with providing information, mitigating uncertainty, managing conflicts and cooperation, providing incentives and channeling resources to innovation activities (Charles Edquist, 1997). It introduces science and technology (S&T) policies in order to do so. As per Ekboir, effective S&T policies should: "(1) foster interactions among agents (whether public or private), (2) increase the effectiveness of public research, extension and funding institutions, (3) give sufficient freedom to researchers to set their research programs, and (4) monitor the quality of research (rather than of research outputs)" (2003).

Although analyzing all four criterions would be ideal, the task is too extensive for this paper. Here I will analyze interactions between the four major players with a particular focus on the sources of knowledge, collaborations, competence building, funding mechanisms and any technological growth achieved, which are the first two of the four criterion mentioned by Ekboir.

**iv. Innovation within Brazil**

During Luiz Inacio Lula da Silva's first term in office as Brazilian president (2003-2006), the important *Projeto de Lei de Inovação* (Innovation Law) was introduced to integrate efforts between universities, research institutions and technology-based companies. In 2005, the year the law was signed by the president, Brazilian firms introducing new products in the domestic market were characterized by the following four factors: (i) the external acquisition of technology through purchase of R&D, licenses, patents, registered trademarks, consulting and technology transfer agreements; (ii) a weak internal capacity for R&D; (iii) the small degree to which machines contribute in product innovation; and (iv) the strong role that export activity plays as a trigger for innovative activities (Goncalves, Lemos, & de Negri, 2008). Financing from government bodies is helpful for firms to become independent of foreign knowledge and to generate their own either through in house R&D or through research projects with universities or research institutions. Evidence from Brazil demonstrates that well-directed, albeit small, state financing improved the innovative and learning capabilities of genomic and bioinformatic projects (Harvey & McMeekin, 2005). These fields of knowledge are commonly attributed to DCs, however, thanks to government aid, the projects were successful.

A survey conducted by the Industry Federation of the State of São Paulo (FIESP) has shown that the quantity of incentives or their effectiveness do not explain the lack of learning-capacity building. Despite the fact that both federal and state governments provide a myriad of financial and consulting opportunities to firms, the survey revealed that over 90% of firms questioned have little knowledge of the support options available and more than 64% do not have enough capacity to be able to use the incentives offered

(Federação das Indústrias do Estado de São Paulo - FIESP. Departamento de Competitividade e Tecnologia, 2006).

### v. Energy in Brazil

Hydropower and ethanol fuel have been around as alternative energy options in Brazil for about four centuries and now supply much of the energy market. According to the EIA (2009) oil (including ethanol) and hydroelectric power provided 85% of the total energy consumed in 2006.

**Figure 2. Energy Consumption in Brazil by Type, as of 2006**

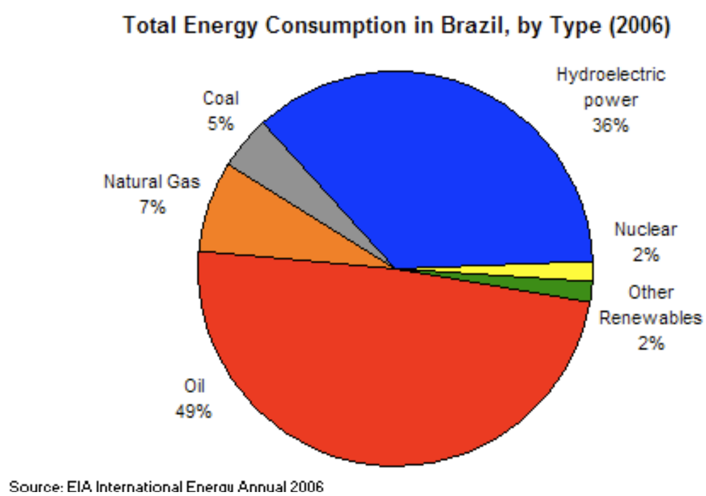
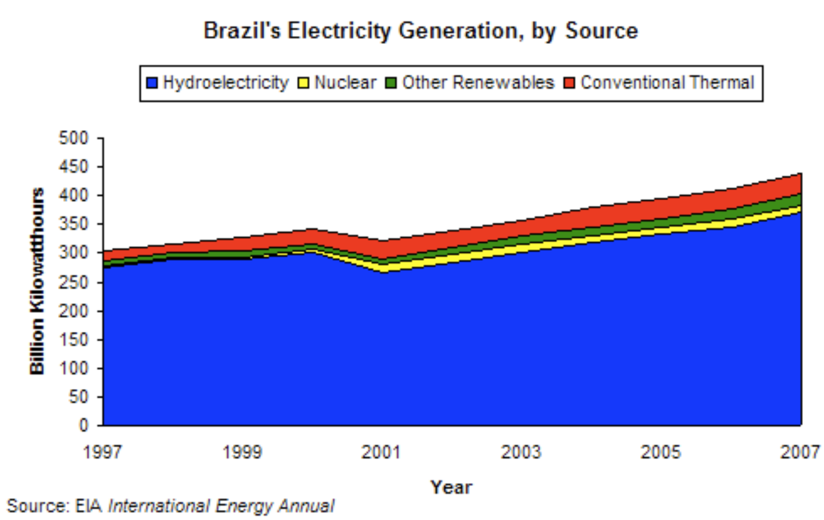



**Figure 3: Electrical Energy Generation by source (1997 – 2007)**

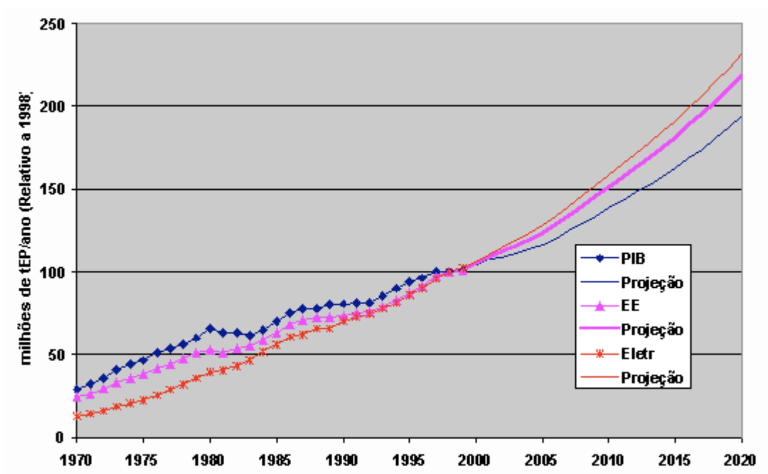


The amount of energy derived from hydroelectric sources increases drastically when considering electric energy consumption. Hydroelectric power provides 85% of the total electrical energy generation (Energy Information Administration 2009). As far as total electrical generation capacity is concerned, 73% of the 105.4 GW available in 2007 came from renewable sources such as large and small hydropower, wind and biomass (Global Wind Energy Council, 2009). In fact, the largest operational hydroelectric plant in the world, the Itaipú dam located on the Paraná River, is co-owned by both Paraguay and Brazil and was first opened in 1984. Ethanol also plays a prominent role in Brazil. This is due to the oil crisis in the 1970s. The military regime heading the country began the National Ethanol Program (PROALCOOL) in 1974. The program provided financial incentives to mills and facility building and subsidized the domestic car industry to create a special vehicle to run on 100% hydrated alcohol. The government facilitated the transition to greater use of ethanol fuel by requiring blending of anhydrous ethanol with gasoline, funding a distribution network and artificially maintaining the price of ethanol lower than that of gasoline, among other things. As of 2008, Brazil was second to the US in world ethanol fuel production (Licht, 2008) and the largest exporter of fuel ethanol, mandates that all gasoline in the country contain between 20% to 25% ethanol (E20 to E25) and in 2007 obtained about 40% of its vehicle fuel from ethanol (Hemlock).

Perhaps due to the enormous influence that ethanol and hydropower hold in the energy sector, not much diversification into other sources of energy is currently present in Brazil. Nuclear energy accounts for 2%, natural gas 7%, coal 5% and other renewables 2% of total energy consumed and nuclear, conventional thermal and other renewables provided

15% of electrical energy in 2007 (Energy Information Administration, 2009). Expanding the energy sources to include more renewables would be desirable, for environmental reasons and because of issues concerning hydropower energy, which are discussed below. Forecasts for future electricity demand show that thanks to favorable economic growth dissipating down to the lower classes, electricity demand is set to expand in the upcoming years.

**Fig.4. Actual and forecasted GDP, energy consumption and electrical energy consumption relative to 1998**




Source: Economia e Energia, 2000

The goal of this paper is to determine the characteristics of the innovation network within the sector of clean forms of alternative energy in Brazil and compare them across the three green energy types investigated here. Reports show that in 2006 Brazil was not among the top five countries in the word to invest in adding to new renewable capacity (REN21). In 2009, however, it ranked 5th place and was 4th in solar hot water/heat added (REN21). Clearly there have been some improvements in green energy investment. Normally, technological activity is concentrated around urban centers because other areas are lacking urban, productive and science and technology infrastructures and capacity for technical knowledge spillovers (Goncalves & Almeida, 2009). However, wind parks have been set up in Ceará, in the northeast of a Brazil, a particularly poor area, due to the favorable natural conditions. This departure from the country's norm is worth looking into. Especially worth examining is whether and how universities around the area have adapted.

### vi. Issues Remaining in Current Green Energy Sources

Brazil has an installed hydropower capacity of 83,752 MW, the second largest amount in the world, second only to China (World Energy Council, 2009). With its vast amount of water resources the country has fully exploited the opportunities provided by nature as most of its energy comes from hydropower. This is a laudable fact, because hydropower has much smaller environmental impact in comparison to coal, nuclear or natural gas power. Furthermore, it helps regulate water supplies so that in times of drought not as much is lost and during heavy rainfall water overflow is diminished.

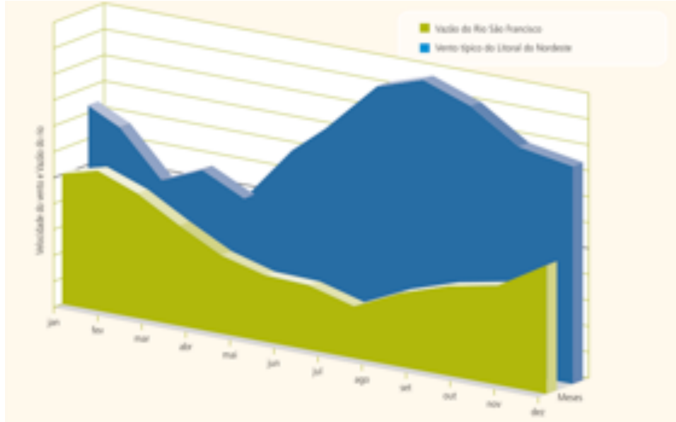
However, complications exist as was evidenced during the energy crunch in 2000 causing political upheaval and a 2009 blackout which affected the most productive areas of the nation . With such a heavy dependence on this form of energy, Brazil is incredibly vulnerable to fluctuations in nature and faces shortages when there is a small amount of rain. During droughts or periods of little rainfall, energy crises ensue as that which occurred in 2001, when hydroelectric power provided more than 90% of the nation's electricity (Wadia, 2001).

In addition, wetlands and forests around the area flood when a dam is built, causing displacements, diminishing biodiversity and water quality. Further along the river, the diminished water source transforms former magnificent waterfalls, such as the Iguacu Falls, into nothing other than dry cliffs as occurred in 2006 (Valente, 2008) or floods former cascades, such as the Sete Quedas in 1982 after the construction of the Itaipú Dam (Switkes, 2008 ). Moreover, hydropower plants downriver suffer since they do not generate as much power when more are built further upstream. Therefore, economies of scale cannot be achieved when building more and more dams.

Besides improving its transmission system and the efficiency of interconnected electrical grids, the nation would do well if it further diversified its sources of energy. This fact was recognized and was an impetus for the creation of the Program of Incentives for Alternative Electricity Sources (PROINFA) implemented in 2002. The government and Eletrobrás set a goal of installing 3,300 MW of renewable energy (specifically wind, biomass cogeneration and micro-hydropower) by 2007. Eletrobrás would purchase the energy at prices much higher than those from hydropower energy. The program had difficulty initially, especially when concerning wind energy. The only company which produces wind turbines in Brazil is Wobben and the company places high prices on its products since it knows that importing turbines is an expensive alternative for firms. Thanks to financing from the BNDES, however, along with work from the government and industries, the goal for 2007 was met.

Wind is an especially appropriate complement to hydroelectric energy's cyclical fluctuations. During periods with fewer amounts of rainfall, there is a higher amount of wind energy, measured in wind velocity.

**Fig. 5: Water flow (green) and wind velocity (blue) over a period of 12 months for the Sao Francisco River and Northeastern coast.**




Source: Eólica Tecnologia - Centro Brasileiro de Energia Eolica – CBEE/UFP, 2000

Brazil's strong emphasis on using ethanol for automotive fuel is another strength in green energy the country possesses. Ethanol has placed it ahead of others in decreasing both its oil dependence and its negative impact on the environment. However, resources for ethanol fuel are limited and have fueled food crises in the past. Other countries have acknowledged these problems and are invested in finding alternative sources of car fuel, such as electricity. Brazil should consider doing the same and, in so doing, can further minimize the amount of oil it must import.

## Description of Tasks

In order to investigate the interactions taking place between private, public, and university spheres, my research will draw only on publicly available data. This is an informal mode of research but must be carried out this way since the data has never been collected before and contacts with Brazilian officials who could provide the data do not exist. Because not all information is available online there will be a certain amount of error introduced although I have done much work to ensure this does not happen.

To investigate university activity and its research activity I had to look at all public information available online. Since carrying this out for every single university in the country would be difficult, I only considered the most prominent universities within each state. In order to decide which universities to evaluate, I took university ratings from a third party. The Coordenação de Aperfeicoamento de Pessoal de Nivel Superior (CAPES) is run by the Brazilian ministry of education and shares goals similar to those of the Fund for the Improvement of Post-Secondary Education from the US. Every three years, the CAPES evaluates post-secondary programs within the nation and posts the results online. For the year 2007, 2,256 programs were analyzed for the years 2004-2006. I took these results and focused my search to programs for environmental engineering, civil and environmental engineering, environmental technology, water resource and environmental engineering, water resource and environmental technology, oceanic engineering and electrical engineering. I then looked at each individual program's evaluation to see how they scored in the "intellectual production" and "social inclusion" categories. The results range from (in order of worst to best) "weak," "wanting," "regular," "good" and "very good."

CAPES further divided the two categories into three items. Intellectual production had as first item: "Qualified publications by permanent professors," second: "Distribution of qualified publications in relation to the program's professors" and third: "Other products considered relevant (production, techniques, patents, products, etc)”. I considered only the first and third items, since I feel they are most relevant for my research. The other category, social inclusion, was divided thusly, "Regional and (or) national insertion and impact," "Integration and cooperation with other programs to develop its research post-secondary program" and "Transparency for their actions." The first two items were the only ones I examined.

Universities that got at least a "good" rating in two items for either the intellectual production category or social inclusion category, were incorporated into my study. To illustrate, university A may have received a "regular" evaluation (or "weak" or "wanting") for both items of the intellectual production category, but if the two items under the social inclusion category I considered were evaluated "good" (or "very good"), I still included the university in my research.

I then looked at each university's website and found out what their lines of research, laboratories were and research projects undertaken since 2004. Afterwards, for every professor who was found to have a connection to renewable energies through the research line, laboratory or research project, I consulted their CV to find publications since 2004 relevant to either solar, wind or wave energy with care taken to ensure that no documents were counted twice. Information presented on those CVs also disclosed projects performed by the professors and usually who they received financial aid from or partnered with.

Some universities may have improved their scores or introduced the programs I researched since CAPES performed its evaluation. However, this data is as of yet not publicly available. As such, I could not include those universities in my research.

National organizations will shed some light on programs within the public sector concerning funding or research projects geared specifically toward clean types of energy. They can also detail what projects were funded in the past. The public institutions I researched can be divided into 3 different categories according to what clients they are mandated to assist. Some are geared toward helping students and professors with financing issues, for example, CAPES and the National Center for Research (CNPq), others help companies, such as ANEEL, and the National Development Bank for Brazil (Banco Nacional do Desenvolvimento - BNDES), and finally the Funding for Studies and Projects (Financiadora de Estudos e Projetos – FINEP) organization is for universities, research institutions and companies. Any and all results presented online were searched for proposals related to wind, solar PV or wave energy.

Along with public institutions working on a national level, I researched the results from the Foundations for Research and Development Assistance for each state. For both national and regional public institutions, I looked online for any special programs for renewable energy funding or financial aid. Some websites had information on financial aid granted in the past, I gathered this data, when available, for the 2004 – 2010 period.

As for firms, I obtained information on which companies already were constructed or had constructed wind farms from the ANEEL website. The data taken from public institutions was the only way to identify what research the companies were undertaking, since their websites frequently did not publish this. Any R&D done under the companies auspices that was not publicly available could not be taken into account.

## Results

Of the post-graduate programs CAPES evaluated for 2004-2006, I examined 54 university results. Of these, 33 universities were considered satisfactory to investigate further according to the criterion I mentioned above. A mere 15 universities were adequate enough to be included in my research. 17 universities were dropped for differing reasons. Some did not have functioning websites, did not have information on projects, professors and/or papers available online or had information which did not relate to my research. To illustrate, environmental engineering often dealt with hydropower, water resources and garbage. Frequently, laboratories working with alternative energies only handled ethanol and those filed as dealing with renewable energies only researched hydropower.

As previously mentioned, I recorded the projects universities have started or completed since 2004. I did so for projects handling wind, solar photovoltaics (PV), solar PV/wind, wave and wind/wave energies. I show my results here according to the state the university was located in and according to the region in which the universities are located.

**Table 1. Research Projects According to Energy Type and State**

| Projects by Region | Northern | Northeast | Central-West | Southeast | South |
|---|---|---|---|---|---|
| Wind | 7 | 11 | 0 | 9 | 12 |
| Solar PV | 20 | 11 | 0 | 8 | 12 |
| Solar PV/Wind | 4 | 2 | 0 | 1 | 1 |
| Wave | 0 | 0 | 0 | 0 | 0 |
| Wave/Wind | 0 | 0 | 0 | 1 | 0 |
| Total | 31 | 24 | 0 | 19 | 25 |

**Table 2. Research Projects According to Region**

| | MG | CE | PA | PE | RS | RJ | BA | SP | SC |
|---|---|---|---|---|---|---|---|---|---|
| Wind | 6 | 5 | 7 | 6 | 12 | 3 | 0 | 0 | 0 |
| Solar PV | 0 | 7 | 20 | 3 | 7 | 1 | 1 | 7 | 5 |
| Solar PV/Wind | 0 | 0 | 4 | 1 | 1 | 1 | 1 | 0 | 0 |
| Wave | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wave/Wind | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

I considered separating the projects up by region of particular importance, since certain regions of the country have natural capabilities for exhibiting strength in a particular renewable energy (see Annex - Table 1 for list of regions, states and their corresponding abbreviations). The Northern and Northeast Regions, to illustrate, get the most sunshine in the country, which gives them a natural advantage and incentive to invest in solar PV technologies. The Northern region is, in fact, the region that most undertook research projects from 2004 – 2010 in solar energy by a quantity nearly double the amount of the Southern Region, which has the second largest number. Furthermore, there was only one university in the Northern Region, Federal University of Pará, located in Pará, which executed all the projects. There are 7 states within the Northern Region, yet I did not find evidence that they also contributed to research projects.

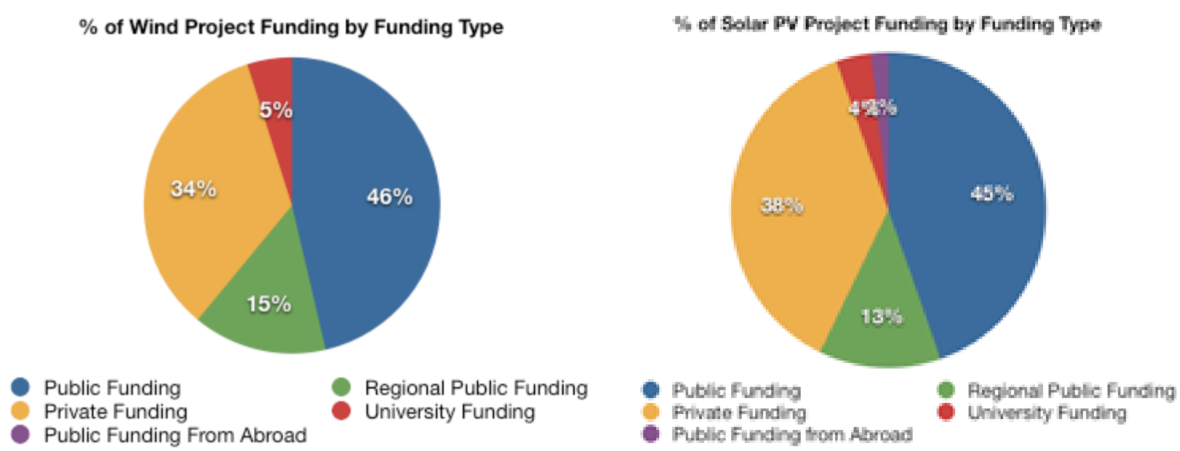
Brazil's most fertile region for wind energy is the Northeastern one, with an estimated potential of 75 GW, followed by the Southeast, 29.7 GW and the Southern region, 22.8 GW (Ministério de Minas e Energia). This fact matches with the amount of projects observed in each region, although not perfectly. The South, Northeast and Southeast regions contributed the most to advancement of research in wind energy through research projects, the South reporting 12, Northeast 11 and Southeast 9. Although the Northeast has the largest potential, it is the second contender, though only by one project.

I also considered the research projects' funding types in order to see who played the strongest role in financing university endeavors. I categorized research financial aid by 5 different types: public funding, regional public funding, private funding, university funding and funding from abroad. I divided these up by energy types to get a clearer picture. I reasoned that there may be bigger firms active in certain renewable energy technologies, such as wind, as opposed to budding green energy types, for example, wave, which would therefore have more capital available to invest in research and development.

**Table 3. Funding by Energy Type and Funding Type on Average**

| | Wind | Solar PV | Solar PV/ Wind | Wave/Wind |
|---|---|---|---|---|
| **Public Funding** | 19 | 25 | 9 | 1 |
| **Regional Public Funding** | 6 | 7 | 1 | 0 |
| **Private Funding** | 14 | 21 | 0 | 0 |
| **University Funding** | 2 | 2 | 1 | 0 |
| **Public Funding from Abroad** | 0 | 1 | 0 | 0 |

**Fig. 6 – 7 Percentage of Research Project Funding by Funding Type**




For all three sorts renewable energy I researched, the public sector on a national level played the largest role on average. For wind and Solar PV private funding was the second most important source (34% and 38%, respectively), whereas the more experimental hybrid of solar PV and wind projects received financial help from public institutions. This pattern goes along with what I had in mind, although firms were not the greatest contributors for funding as I had anticipated.

In addition, I divided the national public funding to observe which institutions assisted the most, on average. The most aid, 56% came from the CNPq, which is unsurprising since it was created to assist researchers. The same process was done for private institutions, where no single firm was a significant provider of aid, with Petrobras and the State Company of Electrical Energy from Rio Grande do Sul making up the largest individual shares, on average, of 14% and 11% respectively.

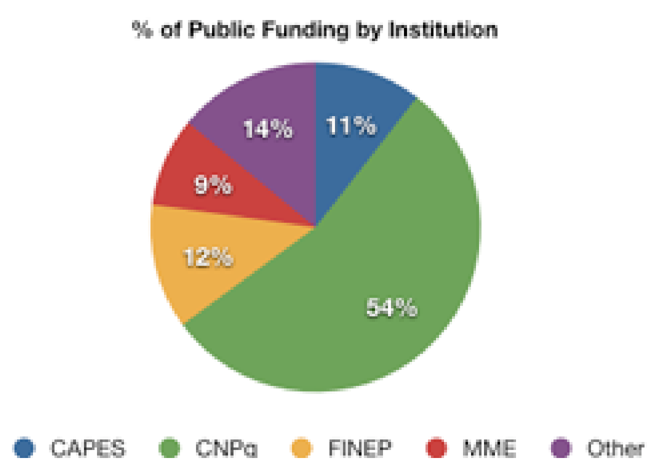
**Table 4. Public Funding by Amount of Occurrences, on Average**

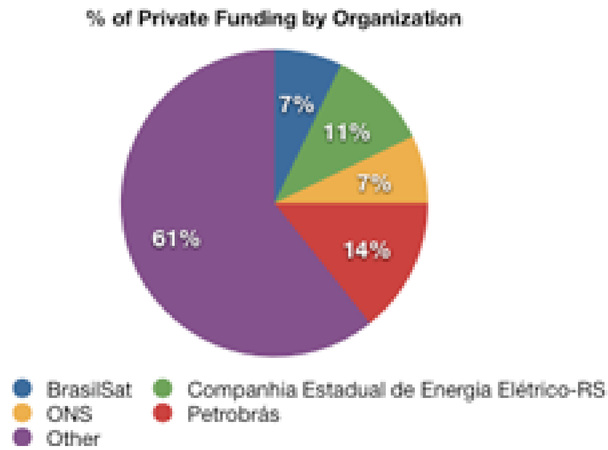
| | CAPES | CNPq | FINEP | MME | Other |
|---|---|---|---|---|---|
| **Occasions** | 6 | 31 | 7 | 5 | 8 |

**Table 5. Private Funding by Amount of Occurrences, on Average**

| | BrasilSat | Companhia Estadual de Energia Elétrico-RS | ONS | Petrobrás | Other |
|---|---|---|---|---|---|
| **Occasions** | 2 | 3 | 2 | 4 | 17 |

**Figure 8-9. Percentage of Public Funding by Institution, Percentage of Private Funding by Organization**






Of papers published, the greatest amount occurred for wind energy, followed by solar PV publications. Most articles related to wind energy were published by universities in the state of Minas Gerais, in the Southeast of Brazil. This is surprising, since no indications have been given to support strong investments in wind energy in the landlocked state. Perhaps because it is relatively developed and a great amount of firms are present there, universities in the area considered it a good idea to research a capital-intensive energy source like wind to satiate firm requests. The strong leader in solar PV publications was the Federal University of Santa Catarina, located in the State of Santa Catarina, in the southern region. The largest amount of papers were published in the Northeast, most of them dealing with wind and solar PV. In the Southeast the main energy type dealt with was wind. Whereas in the South, must publications handled Solar PV.

**Table 6. Papers According to Energy Type and State**

| Papers | BA | CE | MG | PA | PE | RJ | RS | SC | Total |
|---|---|---|---|---|---|---|---|---|---|
| Wind | 5 | 14 | 32 | 10 | 15 | 10 | 11 | 0 | 97 |
| Solar PV | 0 | 17 | 2 | 13 | 12 | 1 | 1 | 44 | 90 |
| Solar PV/Wind | 1 | 0 | 0 | 11 | 0 | 0 | 1 | 0 | 13 |
| Wave | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 11 |
| Wave/Wind | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 6 | 31 | 34 | 34 | 27 | 22 | 13 | 44 | 211 |

**Table 7. Papers According to Energy Type and Region**

| Papers by Region | Northern | Northeast | Central-West | Southeast | South |
|---|---|---|---|---|---|
| Wind | 10 | 34 | 1 | 42 | 11 |
| Solar PV | 13 | 29 | 0 | 5 | 45 |
| Solar PV/wind | 11 | 1 | 0 | 0 | 1 |
| Wave | 0 | 0 | 0 | 11 | 0 |
| Wave/Wind | 0 | 0 | 0 | 0 | 0 |
| Total | 34 | 64 | 1 | 58 | 57 |

Funding for universities and enterprises is available from institutions called the Foundations for Research and Development present in nearly every single state. These regional entities release public calls for projects and research papers, considers requests for scholarships and financial aid for trips to conventions. Each has some programs set up on a national level by CNPq along with some programs reflecting their own interests. Funding comes from CNPq and from the states' own coffers. The programs only consider entries from their own states. Meaning, that a university or firm from a state with low financial resources can not apply for aid from these regional foundations in another state.

Of the 26 states in Brazil, 23 have such foundations and 21 had results for past public calls publicly available. Within these 21, only 7 foundations published results which contained projects relevant to the three energy categories I am researching. None were found to have specific programs for investing in renewable energy knowledge. This is left to the national public institutions. Because it is such little data, it is not of much use to reveal deeper truths, besides the fact the the FAPERJ is a very active foundation due to the large amount of results published online. Indeed, it was the regional institution which provided most assistance for solar PV and solar PV/wind projects.

**Table 8-9. Regional Public Entities and Funding of Projects According to Energy Type and Institution Requesting Aid**

| Regional Public Entity | State | Wind | Solar PV | Solar PV/ Wind | Wave | Wave/Wind |
|---|---|---|---|---|---|---|
| **FAPERJ** | RJ | 0 | 3 | 3 | 0 | 0 |
| **FACEPE** | PE | 1 | 3 | 0 | 0 | 0 |
| **FAPEDF** | DF | 1 | - | - | - | - |
| **FUNCAP** | CE | 1 | - | - | - | - |
| **FAPEMA** | MA | 1 | - | - | - | - |
| **FAPEMS** | MS | 1 | 1 | - | - | - |
| **FAPESP** | SP | 1 | 0 | 0 | 0 | 0 |

| Energy Type/Institution seeking aid | Firm | University |
|---|---|---|
| **Wind** | 3 | 2 |
| **Solar PV** | 2 | 5 |
| **Solar PV/Wind** | 0 | 3 |

On a national scale, the CNPq, CAPES and National Institutes of Science and Technology (INCT), funded by CNPq, are the most vital public actors for universities, since they provide most of the funding. The CNPq is under the Ministry of Science and Technology, as are the National Institutes of Science and Technology since they are overseen by the CNPq. There are a total 114 national institutes in the nation, 3 of which handle energy. The institute in Pará, National Institute of Science and Technology of Amazonian Renewable Energies and Energy Efficiency, was the one pertinent to my research. This institute provides financial aid for research in universities and companies all over the country. It obtains its funds from CAPES, the BNDES, and the Foundations of Research and Development from the states of the Amazon, Pará, São Paulo, Minas Gerais, Rio de Janeiro and Santa Catarina. It also has partnerships with firms Celpa - Rede S.A. and Guascor Ltda, both of which are energy companies, the latter of which deals only with renewables.

The Financial Supporter for Studies and Projects (Financiadora de Estudos e Projetos - FINEP) was also created by the Ministry of Science and Technology. It is not restricted to universities and also assists research institutions and micro, small and medium-sized enterprises. Under FINEP, 18 programs have been established, which provide funds for selected themes. One of these "sectoral funds," was created exclusively for energy, especially for energy efficiency, alternative energy sources with lower costs, improved quality and an increase in competitiveness and is called CT-Energia. In 2006, a public call was issued for proposals in development and innovation in wind and solar renewable energy. Those firms which applied needed to be Brazilian and have set up a partnership with either a university or research institution within the nation (for more details on the research institutions and firms, please see Annex - Table 2).

**Table 10. Results from 2006 Energy Sectoral Fund Public Call for Proposals in Renewable Energy**

| CT-Energia - 2006 Results | Type of Energy in Project | Firm's Base | Research Institute type | RI Location |
|---|---|---|---|---|
| **Natucel Energia Solar Ltda.** | Solar PV | CE | Technology Park | CE |
| **Acumuladores Moura S.A.** | N/A | PE | University | PB |
| **Eletrovento S.A.** | Wind | SP | Research Institute | AP |
| **SDS Soluções em Desenvolvimento de Sistemas Ltda.** | N/A | PR | University | SC |
| **WEG Automação/Solaris Tecnologia Fotovoltaica Ind. Com. e Serviços Ltda.** | Solar PV | SC | University | SP |
| **Metalúrgica Fratelli Ltda.** | N/A | RS | University | RS |
| **Humberto Ferraro Franca - ME** | Wind | SP | Research Institute | SP |
| **ENERSUD Indústria e Soluções Energéticas Ltda.** | Wind | RJ | University | SP |
| **ANALO Sistemas de Energia Ltda.** | N/A | SP | University | SP |
| **Microsol Tecnologia Ltda.** | Solar PV | CE | University | CE |
| **Elepot - Estudos e Pesquisas Ltda.** | Wind | RJ | University | RJ |
| **Irmãos Sanchis & CIA Ltda.** | Solar PV | RS | University | RS |

In most proposals, the firm agreed to work with universities in their vicinity, the only exception being the partnership between Eletrovento, who is based in São Paulo and The Science and Technology Institute of the State of Amapá, located in Amapá. However, this is understandable since the some of the highest potential for using wind energy is in the North.

Under the Ministry of Education, CAPES was founded to assist universities. Of the 27 programs it details on its website, none handle renewables. The BNDES, another significant funder, is categorized under the Ministry of Development, Industry and External Commerce. It grants long-term financing for projects. As previously mentioned, it provides the finances for the PROINFA program.

Yet another ministry of relevance is the Ministry of Mines and Energy, which heads the Brazilian Electricity Regulatory Agency (ANEEL). This agency is in charge of collecting a percentage of revenue from firms authorized in distribution, generation and transmission of electrical energy and distributing the money to other national agencies, like the Ministry of Mines and Energy (MME), National Fund for Development in Science and Technology (FNDCT).

**Table 11. Distribution of Revenue Percentage Charged According to Type of Electrical Firm and Recipient**

| Segmento | Lei 12.212/2010 (alterou incisos I e III do art. 1º d | | | |
|---|---|---|---|---|
| | Vigência: 21/01/2010 a 31/12/2015 | | | |
| | P&D | PEE | FNDCT | MME |
| D | 0,20 | 0,50 | 0,20 | 0,10 |
| G | 0,40 | | 0,40 | 0,20 |
| T | 0,40 | | 0,40 | 0,20 |

Results published from past research funded by ANEEL sheds some light on research conducted by the private sector. This data, combined with that released by the regional foundations for R&D aid, give the following results, divided into firms cooperating with universities and firms researching by themselves. Note that the results from the CT-Energia 2006 call for proposals was not included here.

**Table 12. Reseach and Development Cooperation Agreements between Companies and Universities**

| Participation/Cooperation with | Energy type | with | Funding From |
|---|---|---|---|
| **Bitzer Compressors Ltda and Refricol Indústria e Comercio Marechal Ltda** | Solar PV | USP | FAPESP |
| **Companhia de Geração Térmica de Energia Elétrica** | Wind | PUCRGS | ANEEL |
| **Gesellschaft für Technische Zusammenarbeit** | Solar PV | UFSC | Kreditanstalt für Wiederaufbau |
| **Global Master Internacional** | Solar PV | UCP | FAPERJ |
| **HIBRITEC Equipamentos e Sistemas Ltda** | Solar PV | | FAPERJ |
| **Ibiritermo S.A.** | Wind | UFRGS | Fundação de Apoio da UFRGS |
| **MPX** | Wind | UFC | FUNCAP - CE |
| **Nano Select** | Solar PV | UFRJ | FAPERJ |
| **Petrobras and Solaris Tecnologia Fotovoltaica Indústria e Serviços Ltda** | Solar PV | USP | ANEEL and Ibiritermo S.A. |
| **Rede Energia** | Solar PV/Wind | UFPA | MME |
| **Technische Universität Dresden** | Wind | UFMG | DAAD/CAPES |
| **UFPE, Universitat Politècnica de Catalunya and Universidad de Alcalá** | Solar PV/Wind | UFRJ | CAPES |

**Table 13. Research and Development in the Private Sector along with Funding Source**

| Only firms R&D | Energy type | Funding from |
|---|---|---|
| **Amazontech** | Wind | FAPEMA |
| **Ampla Energia e Seviços S/A** | Wind | ANEEL |
| **Ampla Energia e Seviços S/A** | Solar PV | ANEEL |

| Only firms R&D | Energy type | Funding from |
|---|---|---|
| Celesc Distribuição S.A. | Solar PV | ANEEL |
| Celesc Distribuição S.A. | Solar PV | ANEEL |
| Claff Engenharia Projetos e Instalações | Solar PV | FACEPE |
| Eletropaulo Metropolitana Eletricidade de São Paulo S/A | Solar PV | ANEEL |
| Eletrosul Centrais Elétricas S/A | Wind | ANEEL |
| Eletrosul Centrais Elétricas S/A | Solar PV | ANEEL |
| Eólica Tecnologia Ltda. | Wind | FACEPE |
| Guasor do Brasil Ltda. | Solar PV | ANEEL |
| Hidrocinética Engenharia Ltda | Wind | FAPEDF |
| Petrobras | Wind | ANEEL |
| Termopemambuco S/A | Solar PV | ANEEL |
| Transmissora de Energia S/A | Solar PV | ANEEL |
| Usina Terméletrica Norte Fluminense S/A | Wind | ANEEL |

Taking the CT-Energia results into account, it was the program which provided the most funding for partnerships between universities and the private sector.

**Table 14. Participation/Cooperation between Universities and Firms, According to the Institution which Appropriated Funding**

| Participation/ Cooperation with | ANEEL | ANEEL and Ibiritermo | CT-Energia | DAAD/ CAPES | FAPERJ | FAPESP | FUNCAP | Fundação de Apoio da UFRGS | Kreditanstalt für Wiederaufbau | MME |
|---|---|---|---|---|---|---|---|---|---|---|
| Occasions it has funded | 1 | 1 | 12 | 1 | 3 | 1 | 1 | 1 | 1 | 1 |

Of the companies which had wind farms up and running or under construction by 2006 (ANEEL, 2006), 24% were owned by Energias Renovaveis do Brasil Ltda, 19% by SIIF Énergies do Brasil Ltda and 9% by Gamesa Serviços Brasil Ltda (for the full list, please see Annex - Table 3).  None of the top five constructors were found to have worked with universities or research institutions.  It very interesting to have had this result, since it strongly suggests that there needs to be much more cooperation between the reality seen on the field with firms and the theoretical basis which the work is founded upon in universities.

In order to improve the innovation network, perhaps Brazilian officials, entrepreneurs and scientists can take some lessons from the United States.

After finally deciding to take a new direction, the White House has made it a priority to pass energy and climate legislation to reduce dependence on imported oil, mitigate carbon emissions and create jobs in the process. In President Obama's Recovery and Reinvestment Act, $80 billion has been reserved for the generation of renewable energy sources, a smarter electric grid and sustainable jobs (*Energy and the Environment*, 2010). It is expected that this major investment will fuel a further $90 billion in clean energy projects from private investment (*Progress Report: The Transformation to a Clean Energy Economy*, 2010). It is more than likely that due to financial turbulence, the private sector needs a strong display of commitment from the government before investing. Of the $80 billion, $18.5 billion is specifically designated for energy efficiency and renewable energy, $2.3 billion of which will be invested in advanced energy manufacturing facilities to create wind turbines, solar panes and other renewable energy components (*Progress Report: The Transformation to a Clean Energy Economy*, 2010).

In addition, $12.6 billion for science and technology to be developed in national labs and universities has also been set aside. In 2009, the Advanced Research Projects Agency - Energy (ARPA-E) was given $400 million in Recovery Act funds to invest in "targeted projects to accelerate the pace of innovation to make advanced energy technologies like energy storage and biofuels dramatically more effective and affordable" (*Progress Report: The Transformation to a Clean Energy Economy*, 2010). The idea of ARPA-E within the Department of Energy was first suggested in the 2006 National Academies Report, which reexamined how the US spurs innovation. It was first authorized in the 2007 America COMPETES Act but remained without funding until 2009. ARPA-E is essentially a tool used to bridge the gap between development/industrial innovation and basic energy research along with that between scientists, engineers, students and entrepreneurs.

In a nation such as the US, where the ethos strongly supports entrepreneurs who take risks in hopes of creating a successful, profitable business from nothing, it is not surprising that the urgency of an agency like ARPA-E would be noted. To create a globally competitive, and thereby successful and more lucrative business, firms must remain on the cutting edge of new technologies. Indeed, this is the same case for countries: "The nation that successfully grows its economy with more efficient energy use, a clean domestic energy supply, and a smart energy infrastructure will lead the global economy of the 21st century" (ARPA-E, 2009). How does this entrepreneurial mentality work in Brazil, where there is a weak presence in venture capital and corruption interrupts faith in the government and therefore justice? How many risks are firms willing to take in new technologies and innovations when there is not support from government? How likely are firms to get this when they do not have a connection with some government official? Will creating agencies like ARPA-E with program directors who have "one foot in science, the other in technology and business" do much to alleviate issues present in the business mentality caused by past macroeconomic instability?

My research shows that universities are doing their part in R&D, although they frequently must call on aid from government. There was no evidence of an institution established to connect the demands of business with theoretical advances in research institutions. It seems that only in times of crises, like the recession in the US, oil crises and political crises in Brazil, do states find the motivation to institute greater stimulus for change. The largest Latin American nation much admired for its already highly successful ethanol program should strive to "lead the global economy of the 21st century" along with setting the pace in clean energy innovation, research and development.

## Conclusion

Much has been said of the redistribution of global powers and growing influence of the BRICs after the recent global financial crisis. Admittedly, they do have a stronger role to play in global politics and economics, yet there still need to be improvements in the standard of living, innovation and industrial strength present in the BRIC countries. A rise in innovation creates stronger firms which can compete internationally with the best from abroad. Shifting exports from commodities like oranges and food products like beef and improving domestic firm competitiveness is sure to increase revenues, secure better-paying jobs and improve overall wealth in Brazil.

To see how far the largest Latin American economy has come along in improving its innovative capabilities, a sector with considerable investments in research and development in several countries around the world was selected, that of clean renewable energies. It is of particular importance to Brazil, since with its growing economy and rising incomes, electricity demand is expected to continue expanding in the future.

After amassing information from online sources a clearer picture of the green energy innovation in solar, wave and wind has resulted. With these insights it becomes clear that cooperation between universities and firms still needs to be improved. Major wind farm constructors do not even seek out universities for their research and universities are used to receiving financial aid from public institutions without the need to secure a partnership with the private sector. The Energy Sectoral Fund, under the auspices of FINEP, had the only program which directly tried to stimulate interaction between the two.

The Brazilian innovation and leaning network for renewable energy types wind, solar is still missing several links.

Universities should further focus on researching green energy types other than hydropower and biomass and should work with companies to test out the demand and functionality of ideas produced. Companies, in turn, should look to building stronger networks with universities around the area or areas with a natural advantage and fund projects relevant to their needs. They should also push for greater financial aid from the government to establish stronger domestic firms, such as domestic turbine producers to reduce costs. The public sector should, in turn, provide greater financial aid and agencies to bridge the gap in knowledge and need between universities and companies, along with offering lower interest rates for loans and maintaining macroeconomic stability. The nation's goal should be to help identify actions Brazil can take to become one of the global leaders in sustainable, eco-friendly development that satisfies the growing energy demands of the population domestically and possibly even abroad.

## Annex

### Table 1. Regions, States and their Abbreviations

| Region | States | Abbreviation |
|---|---|---|
| **Northern Region** | Acre | AC |
| | Amapá | AP |
| | Amazonas | AM |
| | Pará | PA |
| | Rondônia | RO |
| | Roraima | RR |
| | Tocantins | TO |
| | | |
| **Northeast Region** | Alagoas | AL |
| | Bahia | BA |
| | Ceará | CE |
| | Maranhão | MA |
| | Paraíba | PB |
| | Pernambuco | PE |
| | Piauí | PI |
| | Rio Grande do Norte | RN |
| | Sergipe | SE |
| | | |
| **Central-West Region** | Goiás | GO |
| | Mato Grosso | MT |
| | Mato Grosso do Sul | MS |
| | Distrito Federal | DF |
| | | |
| **Southeast Region** | Espírito Santo | ES |
| | Minas Gerais | MG |
| | Rio de Janeiro | RJ |
| | São Paulo | SP |
| | | |
| **South Region** | Paraná | PR |
| | Rio Grande do Sul | RS |
| | Santa Catarina | SC |

**Table 2. Detail on Results from 2006 Energy Sectoral Fund Public Call for Proposals in Renewable Energy**

| CT-Energia - 2006 Results | Firm industry | Research Institute - RI |
|---|---|---|
| **Natucel Energia Solar Ltda.** | Solar Energy | PADETEC (Technological Park of UFCE) |
| **Acumuladores Moura S.A.** | Batteries | UFCG (Campina Grande) |
| **Eletrovento S.A.** | Wind Energy | Instituto de Pesquisas C&T do Estado do Amapá |
| **SDS Soluções em Desenvolvimento de Sistemas Ltda.** | Plasma Materials | UFSC |
| **WEG Automação/ Solaris Tecnologia Fotovoltaica Ind. Com. e Serviços Ltda.** | Wind Energy | USP |
| **Metalúrgica Fratelli Ltda.** | Metallurgy | Colegio Evangelico Panambi Escola de 1 e 2 Graus |
| **Humberto Ferraro Franca - ME** | N/A | Instituto Tecnológico de Aeronáutica - ITA |
| **ENERSUD Indústria e Soluções Energéticas Ltda.** | Electrical Energy | USP |
| **ANALO Sistemas de Energia Ltda.** | Electrical Energy | USP/POLI |
| **Microsol Tecnologia Ltda.** | Solar Energy | UFCE |
| **Elepot - Estudos e Pesquisas Ltda.** | Electrical Energy | COPPE |
| **Irmãos Sanchis & CIA Ltda.** | Electrical Ovens | PUC-RS |

**Table 3. Firms with Wind Farms under Construction or Already Owned**

| | MW of wind power to be constructed or already constructed | Partnerships/Parent Company | Parent Company /Partner From |
|---|---|---|---|
| **Cataventos Novas Energias Brasil Ltda.** | 236 | Brazilian firm | - |
| **Central Nacional de Energia Eólica Ltda** | 4.8 | Brazilian firm | - |
| **Compinvest Mercosul** | 50.4 | Brazilian firm | - |
| **Cooperativa de Comunicação e Desenvolvimento do Vale do Sirigi Ltda.** | 9.9 | Brazilian firm | - |
| **Eco Energy Beberibe Ltda** | 25.2 | Brazilian firm | - |
| **Elebrás Projetos Ltda** | 279 | Brazilian firm | - |
| **Elecnor do Brasil Ltda** | 200 | Elecnor | Spain |
| **Eletrowind S.A.** | 262.85 | Brazilian firm | - |
| **Empreendimentos em Energia Ltda** | 10 | Brazilian firm | - |
| **Empresa Energética Santa Marta Ltda** | 39.6 | | - |
| **Enerbrasil** | 49.3 | Iberdola Energias Renovables | Spain |
| **Energia Regenerativa Brasil Ltda** | 115 | | - |
| **Energias Alternativas do Ceará** | 36 | | - |

| | MW of wind power to be constructed or already constructed | Partnerships/Parent Company | Parent Company /Partner From |
|---|---|---|---|
| **Energias Renovaveis do Brasil** | 1438.2 | Brazilian firm | - |
| **Energimp** | 99.6 | IMPSA WIND part of IMPSA | Argentina |
| **Eólica Formosa** | 104.4 | Brazilian firm | - |
| **Eólica Fortim Ltda** | 93.6 | Brazilian firm | - |
| **Eólica Icaraizinho Ltda** | 54 | Brazilian firm | - |
| **Eólica Pecém Ltda** | 46 | Brazilian firm | - |
| **Eólica Redonda Ltda** | 300.6 | Brazilian firm | - |
| **Fuhrlander Energia Brasil Ltda** | 46 | Fuhrländer | Germany |
| **Gamesa Serviços Brasil Ltda** | 563.52 | Brazilian firm | - |
| **Guascor Empreendimentos Energéticos Ltda** | 105 | Brazilian firm | - |
| **New Energy Options Inc** | 151.8 | American firm | US |
| **Parque Eólico de Santa Catarina Ltda** | 12 | Brazilian firm | - |
| **Petrobras S.A.** | 3 | Brazilian firm | - |
| **Renova Energia S.A.** | 246 | Brazilian firm | - |
| **Rosa dos Ventos Ltda** | 37.5 | Brazilian firm | - |
| **SeaWest do Brasil Ltda** | 130.3 | Brazilian firm | - |
| **Servtec Energia Ltda** | 50 | Partnership with Bradley Energy Intl INC | - |

| | MW of wind power to be constructed or already constructed | Partnerships/Parent Company | Parent Company /Partner From |
|---|---|---|---|
| **SIIF Énergies do Brasil Ltda** | 1135.8 | Brazilian firm | - |
| **Ventos Energia e Tecnonlogia Ltda** | 128 | Brazilian firm | - |
| **Wobben wind Power Indústria e Comércio Ltda** | 0.6 | ENERCON | US |

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