Energy Management at Georgia Tech

A Guide and Cost-Benefit Analysis of the ISO 50001 Standard

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Abstract

The goal of this paper is to provide a roadmap and cost justification for Georgia Tech to create an Energy Management System (EnMS) and become certified for the ISO 50001 (2011) Energy Management Standard. The Standard provides guidance for organizations to integrate energy efficiency into their management practices, which would enable the Institute to establish the systems and processes necessary to continuously improve energy performance, thus increasing efficiency and reducing costs in a transparent and sustainable fashion.

The paper is broken down into four main chapters: Chapter 1 includes an introduction that provides a background analysis and explains the ISO 50001 standard. Chapter 2 is primarily focused on case studies and has a brief list of organizations that have adopted the standard with their experiences and results. Many organizations that have implemented the standard have seen energy performance improvements of 15-20%. Chapter 3 provides a road map that has step by step suggestions and recommendations for the Georgia Tech community to move forward with the process of implementing the standard.

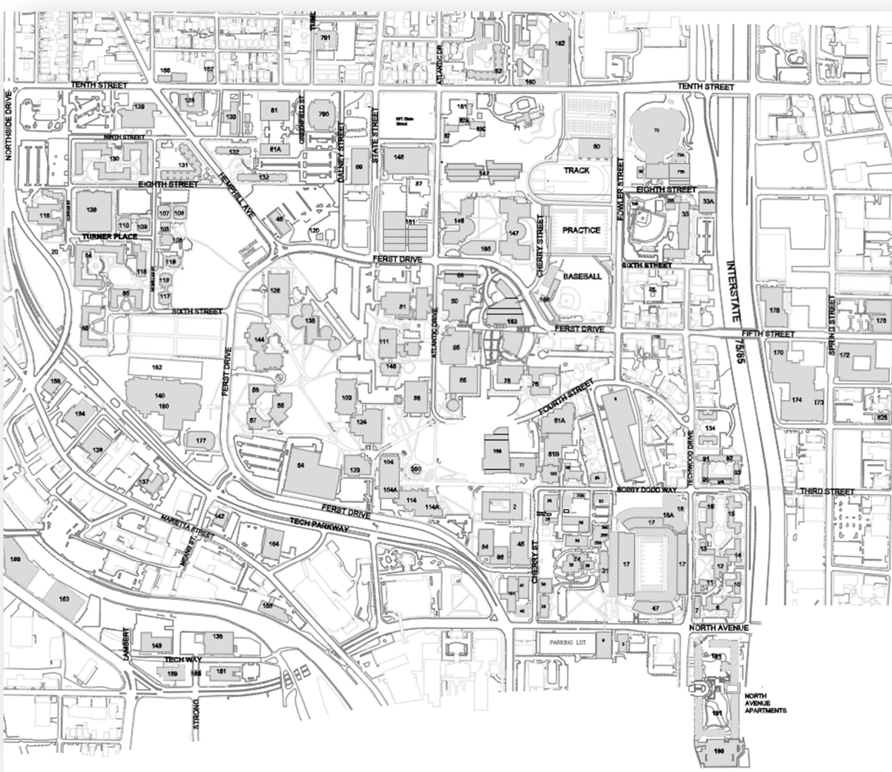
Chapter 4 includes a cost-benefit analysis for ISO implementation. The costs and benefits to the Institute from increased personnel time devoted to ISO administrative duties, capital expenditures for energy efficiency projects, and annual energy cost savings are estimated from 2013 to 2020. The net present values of costs and benefits are calculated for three different social discount rates, and benefit-cost ratios are presented to aid in the decision making process. The benefit-cost ratio for ISO 50001 implementation is over 2.7 for all discount rates, which means the present value of the benefits outweighs that of the costs.

Chapter 1 - Introduction

Background Analysis: Georgia Tech & Energy Conservation

Georgia Tech is a growing research institute located in Atlanta, Georgia that has a daily campus population of about 30,000 faculty, staff, and students, making it larger than many towns in the United States. The Atlanta campus covers 400 acres in the Midtown neighborhood and consists of 163 buildings dedicated to student housing, classrooms, research, and recreation (Visitors 2012). The gross square footage of the campus buildings has been increasing dramatically in recent years due to new construction—going from 9.5 million gross square feet (GSF) in 2007 to over 11.5 million GSF in 2011—thus requiring more energy for lighting, HVAC, and other equipment each year (Krajewski 2012). A map of all buildings on campus is presented in Figure 1.1.

Figure 1.1 – Map of Georgia Tech Atlanta Campus Buildings as of 2012



The Institute has made strong efforts towards sustainability and energy efficiency in recent years, earning it recognition and awards from the Sierra Club, Princeton Review, the League of American Bicyclists, and other national organizations. Georgia Tech Facilities Management has an Energy Conservation Team that has taken on major projects such as replacing steam lines, installing variable frequency drives on pumps and fans, performing energy audits, and retrofitting lighting with state of the art LEDs (Leasure). According to Jennifer Krajewski, who is the Energy Conservation and Management Coordinator for GT's Energy Conservation Team, "the number one mission of the team is to provide utilities to campus buildings, and the second mission is to save energy and water" (Krajewski). When asked how the Energy Conservation Team determines which projects to pursue, Krajewski said that in accordance to their first mission, their first priorities lie in maintaining and fixing systems so all campus buildings have reliable utilities. She went on to say that when it comes to energy conservation projects, the ones with the greatest energy savings and lowest payback periods get done first. These "low-hanging fruit" projects are being pursued aggressively by the Conservation team, and the benefits are already being realized.

The Institute also created a Climate Action Plan (CAP) in 2009 as a result of signing the American College & University President's Climate Commitment (ACUPCC) in 2007 (Georgia Tech 2009). This plan outlines a strategy for reducing greenhouse gas (GHG) emissions, with goals of a 15% reduction of energy consumption per square foot by 2020 from 2007 levels, a 50% reduction by 2040, and the achievement of climate neutrality by 2050. The Institute plans to reach these goals by modernizing utility systems, conducting more building energy audits, eliminating wasted energy, adopting new and efficient technologies, and purchasing utilities strategically (Krajewski 2012).

Although Georgia Tech has made a great deal of progress towards energy efficiency, the incremental steps towards efficiency mentioned previously would not be enough to achieve the ambitious goals outlined in the Climate Action Plan (CAP). It was determined from a linear projection that at the current rate of energy conservation, Georgia Tech will use 91,451 BTU/GSF by the year 2050, when the CAP targets climate neutrality. The linear equation, seen in Equation 1, used energy intensity data to form a projection of future energy use:

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1) \qquad \text{(Equation 1.1)}$$

where x_1, x_2, y_1, y_2, and represent years and energy intensities, respectively. With the conservative assumption that gross square footage will remain the same in 2050 as it was in FY 2011 (11.5 million GSF), then the Institute will still be consuming over 1 million MMBtu annually, or about 310,000 MWh. To offset that much energy with photovoltaic cells, for example, would require more than 800 solar arrays like the one on top of the Campus Recreational Center, which has a capacity of 250 kW (Krajewski 2012).

While the incremental efficiency projects taken on by the Institute are beneficial and will make a lasting impact, Georgia Tech should adopt an energy management strategy, which would provide a management-system approach that requires decisions to be made based on organization-wide energy goals and priorities, rather than continuing on with a project-based approach that lacks far-reaching goals. Georgia Tech has the expertise and the resources to implement such an energy management strategy—in fact, the ISO 50001 (2011) Energy Management standard was co-developed by Georgia Tech energy specialists working at the campus economic development branch, the Enterprise Innovation Institute (EI2). Implementing this standard would allow GT Facilities Management, the Office of Environmental Stewardship, the Department of Housing, and other departments within the Institute to work towards commonly established energy goals and objectives.

Since the ISO 50001 standard was first introduced in June 2011, numerous manufacturing plants have been certified along with a municipality in Austria, University College Cork in Ireland, and the Massachusetts Institute of Technology (MIT). These early adopters of the standard have already seen energy performance improvements that will be discussed in the Case Studies section. By providing a comprehensive literature review along with a roadmap for implementing the standard, this research paper will allow the Institute to create a strategy that integrates the goals outlined in the

CAP into a management system that reduces energy consumption on the entire Atlanta campus.

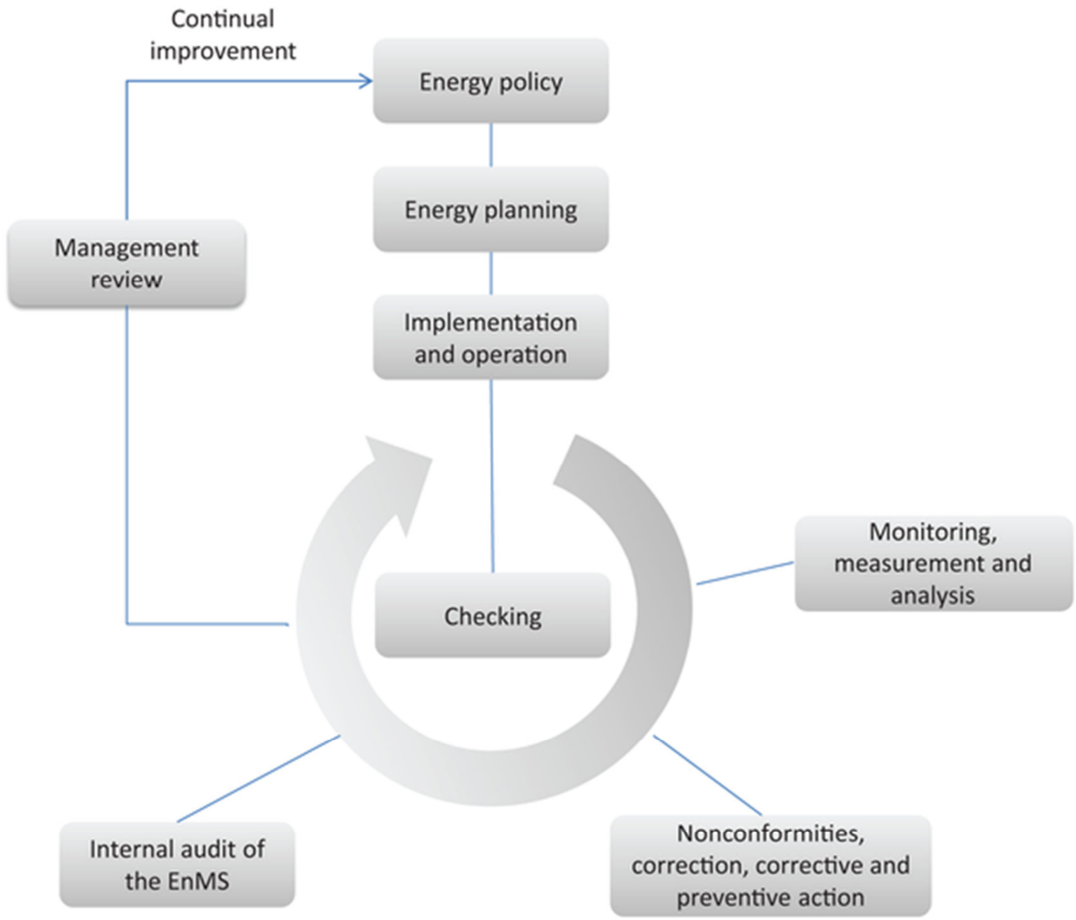
What is ISO 50001?

The ISO 50001 (2011) Energy Management standard was created by the International Organization for Standardization (ISO), which is a group consisting of a membership of 160 national standards bodies from countries all over the world. Because there are thousands of ISO standards, the work of preparing the standards is carried out through ISO technical committees. The process of creating a new ISO standard is lengthy and beyond the scope of this research paper, but ISO 50001 was prepared by Project Committee ISO/PC 242, which consisted of energy specialists at Georgia Tech's EI2 as well as other professionals from across the world (ISO 2011). The Introduction section of the standard's requirements with guidance for use sums up the main purpose of the standard:

> This International Standard specifies energy management system (EnMS) requirements, upon which an organization can develop and implement an energy policy, and establish objectives, targets, and action plans which take into account legal requirements and information related to significant energy use. An EnMS enables an organization to achieve its policy commitments, take action as needed to improve its energy performance and demonstrate the conformity of the system to the requirements of this International Standard. (ISO 2011)

The introduction goes on to indicate that the standard is based on the Plan – Do – Check – Act continual improvement framework. This cycle "assures continuous improvement through defining and testing possible energy-savings measures to determine their impacts" (Parrish & Ledewitz, 2012). Figure 1.2, which is also included in the ISO 50001 Introduction section, illustrates the organizational framework of this energy management system model.

Figure 1.2 – ISO 50001 Plan - Do - Check - Act Management System



Source: https://www.iso.org/obp/ui/#iso:std:iso:50001:ed-1:v1:en

The standard integrates the Plan-Do-Check-Act framework into specific elements of the Energy Management System. ISO (2011) requires the following elements as part of the EnMS: (1) management responsibility, (2) an energy policy, (3) an energy planning process ("plan"), (4) an implementation plan ("do"), (5) an evaluation ("check"), and (6) a management review ("act") (Ledewitz). The specific elements are outlined in this section of the paper, and recommendations for implementation at Georgia Tech are included in the Roadmap sections.

Management Responsibility

This section of the standard includes requirements for top management to commit to the EnMS and provide the resources necessary to maintain and improve energy performance for the organization. It says the organization must:

- Determine how it will meet the requirements of the standard
- Communicate the importance of energy management throughout the organization
- Consider energy performance in long-term planning

It also allows upper management to appoint a management representative who ensures the EnMS is established, implemented, and maintained in accordance with the standard. The management representative also promotes awareness of the energy policy and objectives throughout all levels of the organization.

Energy Policy

The energy policy is a broad statement that conveys the organization's commitment to improving energy performance. Some requirements for the policy are that it must:

- Ensure the availability of information and necessary resources to achieve energy goals
- Provide the framework for setting and reviewing said goals
- Support energy-efficient procurement and design
- Be regularly reviewed and updated as necessary

Note that the energy policy does not have to make commitments to specific energy performance targets—it must only state that the organization is committed to continual improvement in energy performance.

Energy Planning

This section is the "plan" part of the plan-do-check-act cycle. It requires the management representative and energy team to develop and document a plan to achieve the commitments outlined in the energy policy. It requires the energy team to:

- Analyze and evaluate past and present energy use and consumption
- Identify equipment, systems, and processes that significantly affect energy use
- Establish an energy baseline by considering a data period suitable to the organization’s energy use and consumption
- Identify energy performance indicators (EnPIs) that are appropriate for monitoring and measuring energy performance
- Establish energy objectives and targets, time frames for achievement, and action plans for achieving these objectives and targets

Implementation

This section is the “do” part of the plan-do-check-act cycle. Communication and documentation are some aspects of this part of the standard—the organization is required to communicate internally about the EnMS and energy performance objectives and targets. It is also required to make workers aware of the importance of conformity with the energy policy, as well as their roles and responsibilities in achieving the requirements of the EnMS. In addition to this, operations and maintenance activities are modified so that they are consistent with the energy policy and action plans, if they are not already.

Checking

The checking phase allows the organization to evaluate the implementation of the EnMS by ensuring that the energy performance indicators are measured and the objectives and targets are achieved. An internal audit is also included in the checking section, in which the organization audits to make sure that they are conforming to the standard and that the EnMS is actually serving its purpose of improving energy performance

Management Review

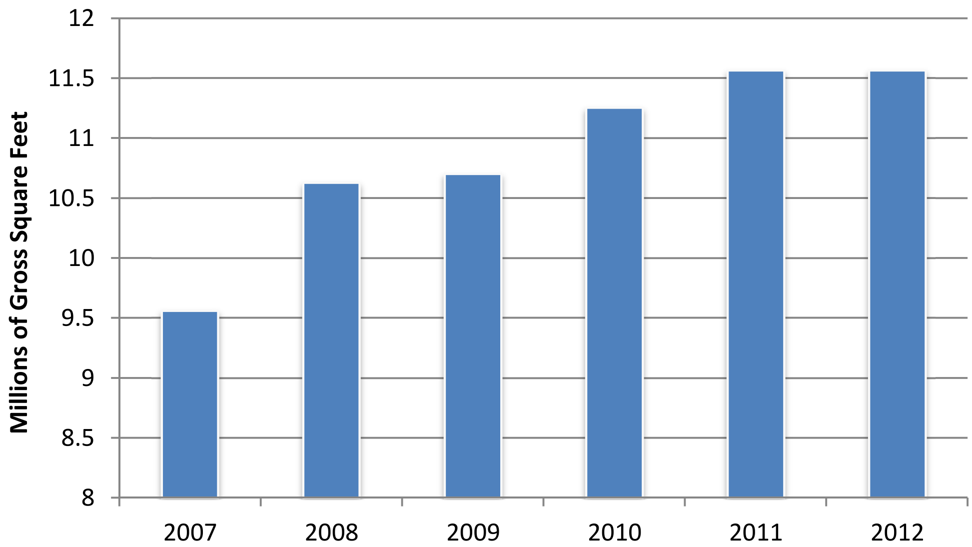
The management review section provides the opportunity for upper management to review the EnMS and make changes to the energy policy, objectives, targets, and the allocation of resources to the EnMS. According to Parrish and Ledewitz, the review “often takes the form of a briefing meeting where Top Management is presented with the EnMS documents for review and the energy team…presents the energy savings resulting from EnMS implementation” (2012, pg. 3-275).

One important thing to note about the ISO 50001 standard is that it does not establish absolute requirements for the energy performance of organizations. It is only used for the certification, registration, and self-declaration of the energy management system, which will be created entirely at the discretion of the Institute. Because of this, the energy committee, which would be in charge of energy planning and policy on campus, will have the freedom to create energy targets and objectives that are tailored specifically to the complex energy needs of Georgia Tech. The Plan - Do - Check - Act system will allow the Institute to create an energy management system that is attainable and agreed on by the diverse stakeholders in energy efficiency on campus.

Why ISO 50001?

In the past few years, increasing energy prices at Georgia Tech have motivated the various stakeholders on campus to reduce their energy consumption. While consumption per square foot has been decreasing steadily, the Institute continues to build new classroom and research space each year, leading to an overall increase in energy consumption each year. Figure 1.3 displays the increase in square footage each year between 2007 and 2012.

Figure 1.3 – Georgia Tech Building Gross Square Footage, 2007-2012

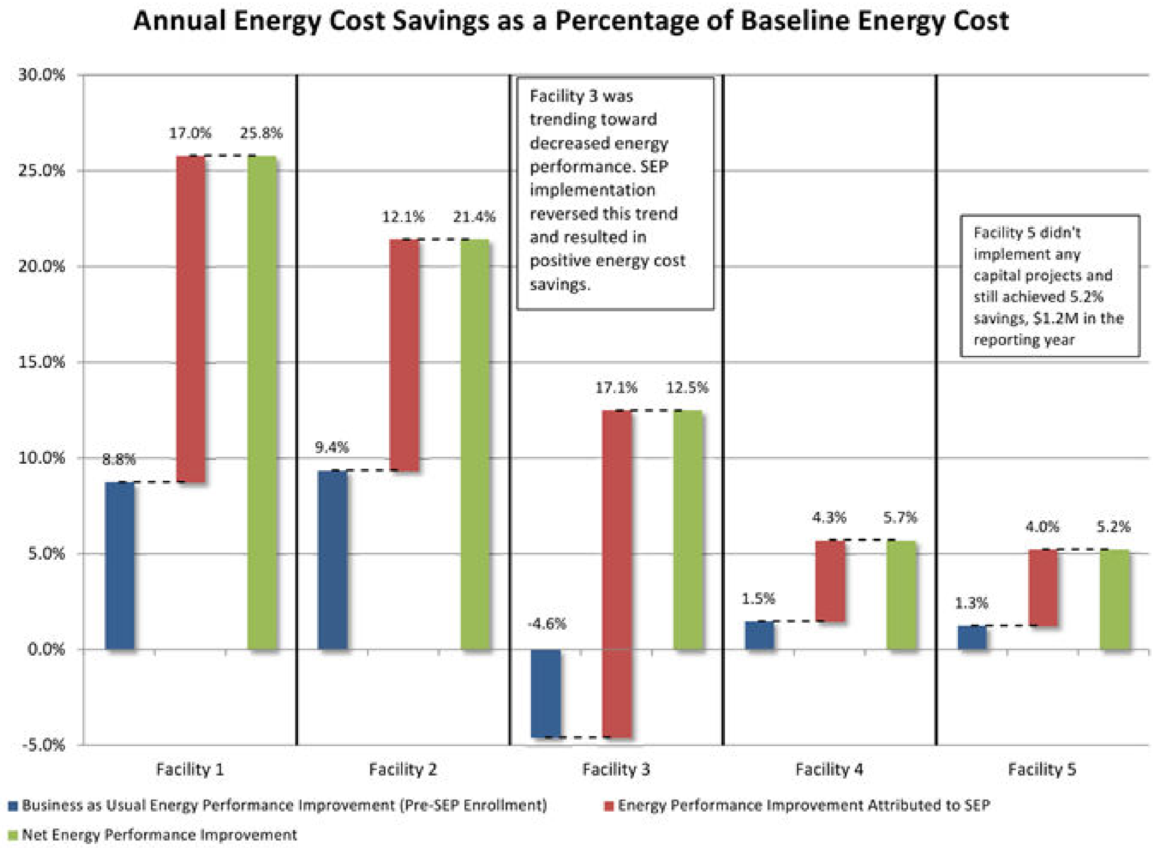


In order for Tech to achieve its energy conservation goals, it has to foster awareness for energy reduction and cost savings throughout the Institute. According to a study about ISO 50001 (2011) released by Lawrence Berkeley National Laboratory (LBNL), "price alone will not build *awareness* within the corporate management culture of the potential for energy reduction and cost savings…that can be realized from the systematic pursuit of…energy efficiency" (McKane, Desai et al. 2009, pg. 2).

The LBNL study also states that an energy management standard "is needed to influence how energy is managed…, thus realizing immediate energy use reduction through changes in operational practices, as well as creating a favorable environment for adoption of more capital-intensive energy-efficiency measures and technologies (McKane, Desai et al. 2009). Other ISO standards, such as 140001 and 9001, had enormous industry impacts in their respective areas of environmental and quality management, and many people are projecting ISO 50001 to have a similar scale of impact. In fact, McKane, Desai, et al. conclude that ISO 50001 "has the potential to impact 60% of the world's energy use, including not only industry, but also the commercial and institutional sectors" (pg. 12). For individual organizations, the authors say that based on demonstrated savings that have already been achieved by organizations following the ISO 50001 standard, energy intensity improvements of “greater than 2.5% per year are achievable and can be sustained for the next decade” (McKane, Desai et al. 2009). The study also states that ISO 50001 “is expected to achieve major, long-term increases in energy efficiency (20% or more)” in facilities spanning many different sectors (McKane, Desai et al. 2009). A 20% or more increase in energy efficiency at Georgia Tech would allow the Institute to achieve the Governor’s energy challenge (15% reduction per GSF by 2020), and put the Institute on track to achieve the ambitious goals outlined in the Climate Action Plan.

Another LBNL study of facilities that had implemented the ISO 50001 standard found significant improvements in energy performance. This study took into account energy performance improvements that would have resulted from business as usual. It also examined the improvements that were attributed to the Superior Energy Performance (SEP) program, which is a ratings system based on the ISO 50001 standard. The study found net energy cost savings between 5.2% and 21.4%, with one facility achieving savings without implementing any capital projects focused on energy efficiency. The results are shown in Figure 1.4.

Figure 1.4 – LBNL Study of ISO-certified Facilities



Source: McKane & Meffert, LBNL

It can be seen from Figure 1.4 that significant energy cost savings can be seen from implementing ISO 50001. Even in the scenarios of decreasing energy performance and no implementation of capital projects,

Georgia Tech has the resources and ability to pursue the ISO 50001 standard, which would provide the systematic approach necessary to build awareness throughout the Atlanta campus for energy efficiency and cost reductions. The energy management standard would benefit the Conservation team because it would give them a mandate for achieving their goals. Also, the establishment of an energy policy, which is part of ISO 50001, could also improve academics at the Institute and raise energy awareness not only among faculty and staff, but also among the student body as a whole. An energy policy with commitments to improving energy efficiency each year along with an emphasis on community participation would bring a culture of energy knowledge to Georgia Tech—a strong energy policy could even push the research focus of the Institute in new directions, furthering Tech's reputation as a cutting-edge, progressive research Institute.

Chapter 2 - Case Studies

Since the release of ISO 50001 in 2011, many organizations have adopted the standard and are already seeing improvements in their energy performance. These organizations span the globe and come from a wide range of sectors: manufacturing plants, commercial buildings, power plants, universities, and even municipalities. By examining organizations that have already implemented the standard, Georgia Tech can gain valuable expertise and insight that may save campus stakeholders a large amount of time and money.

Bentley Motors

One of the first adopters of ISO 50001 was the automobile manufacturer Bentley Motors, which is based in the United Kingdom. All of Bentley's operations—design, engineering, production, sales, and marketing—take place at a single location that employs about 4,000 people (Straughan 2012). Bentley's car production increased ten-fold between 2002 and 2007, but energy costs per vehicle dropped continuously throughout that period. According to Michael Straughan, Board Member of Bentley Motors, "The introduction of an ISO 50001-based system has…influenced our approach to energy management…energy review meetings are held monthly, with representation from senior management levels, so information is readily available across the company. This also ensures that a level of energy management is established from top to bottom" (2012).

Bentley Motors achieved impressive results from the implementation of the ISO 50001 Energy Management standard. Between 2000 and 2010, "the energy used on site for each car produced was reduced by two thirds, and by 14% for the overall site"

(Straughan 2012). The manufacturer has also gone beyond energy management—they implemented a recycling strategy and a green travel policy for their employees. As a result of these strategies, they have achieved a recycling rate of 77%, and 19% of their employees cycle to work each day (Straughan 2012).

University College Cork

University College Cork (UCC) in Ireland was the first university in the world to achieve ISO 50001 certification. The school has almost 16,000 students—13,000 undergraduate and 3,000 graduate—making it slightly smaller than Georgia Tech (1st University 2012). It is also one of the oldest universities in Ireland, so its building stock ranges in age from hundreds of years old to a decade old. Like Tech, UCC had to meet a future energy target, and they used ISO 50001 as a framework for achieving the National Energy Efficiency Plan (NEEP) target of a 33% energy reduction by 2020.

To reduce the time and effort spent on creating an EnMS, UCC used automated energy performance tracking software aimed specifically at ISO 50001 implementation from a company called Enerit. The software allowed the university to "run a systematic energy management program throughout the university," while providing transparency for the energy management team (1st University 2012). The software is cloud-based and available on the internet, so the team could check their objectives and targets, track progress towards their goals, and make their data available to any campus stakeholders who wanted to see it

UCC achieved ISO 50001 certification in only four months, and the quick implementation has resulted in additional support from upper management, staff, and students. In the first six months of implementation, UCC saw an overall reduction in electricity consumption of 5.14% and a natural gas reduction of 8% with weather factors taken into account. The university made projects for their annual energy, cost, and CO2 savings for 2012, and they are:

- Energy savings: 2,465,348 kWh/year
- Cost savings: €212,955/year, or over $277,000/year at the current exchange rate (December 2012)

- CO_2 emissions savings: 807,606 kg, or about 890 short tons

The cost savings that UCC has seen from implementing ISO 50001 could also be achieved at Georgia Tech. This is a massive benefit that upper management at the Institute should be aware of when considering adoption of an energy management system.

Municipality of Bad Eisenkappel

The ISO 50001 standard is not limited to manufacturing plants and universities—the municipality of Bad Eisenkappel in Austria implemented the standard in 2011. The mayor of the 2,400 inhabitant community said an EnMS was important because "continuous energy savings make budgets available for other important issues, and local energy resources create added value in the region" (Lambert 2012). Other motivations for pursuing the standard were climate change, growing energy consumption in municipal buildings and plants, increasing energy prices, and over-dependence on fossil fuels. The town's energy manager became convinced of the value of ISO 50001 from a presentation by an energy expert, and soon after the mayor, local council, and other political parties supported the initiative.

The municipality projects electrical energy consumption to decrease by nearly 25% during the first year of ISO 50001 certification (Lambert 2012). These savings will be achieved with an update of the town's waste water plant, conversion of street lights to LED bulbs with motion sensors, and improvements to municipal ventilation systems and the warm water supply. The town also plans to install thermal solar collectors on some of the municipality's buildings. While Bad Eisenkappel has a much smaller population than the Georgia Tech community, the town proved that the ISO 50001 standard can be implemented in an area with a wide range of buildings, from residential to commercial to industrial.

Coca-Cola Enterprises – United Kingdom

Georgia Tech's fellow Atlanta-based organization, Coca-Cola Enterprises, has already achieved ISO 50001 certification in its Wakefield, England manufacturing plant.

According to Ian Johnson, Operations Director at the company, “Coca-Cola Enterprises…believes the certification will help us drive forward with new efficiencies and cut our carbon footprint and costs even further” (Johnson et. al. 2012). The plant has implemented various energy efficiency measures to meet ISO 50001 requirements, such as air recovery from compressed air systems, LED lighting, introducing natural lighting to the assembly lines, and installing a real time monitoring system to measure energy and water usage.

Since 2007, the Wakefield plant has cut water consumption by 10% and energy use by 16.5%. This indicates that the organization was committed to efficiency before the introduction of ISO 50001, but Johnson says the standard has been beneficial to the company. He says that ISO 50001 “helps us to achieve continual improvement of energy performance…in addition, there is a financial benefit for the business given the current high prices of energy” (Johnson et. al. 2012). Georgia Tech has also been committed to efficiency for many years, and the example of Coca-Cola enterprises shows that the ISO 50001 standard can provide a point of focus and improvement for these energy-savvy organizations.

Massachusetts Institute of Technology

The Massachusetts Institute of Technology (MIT) was an early adopter of ISO 50001 and can provide many lessons for implementation at Georgia Tech. Their Cambridge, Massachusetts campus is slightly smaller than Tech’s—12 million square feet of building space compared to about 14 million in Atlanta. MIT has approximately 158 buildings that range in age from 2 years old to 130 years old, compared to Georgia Tech’s 163 buildings of a similar age range (Parrish & Ledewitz 2012, pg. 3-272). Their buildings also serve similar purposes to Tech’s—plenty of laboratory space, scientific research, classrooms, and residential halls for undergraduate and graduate students.

Kristen Parrish of Lawrence Berkeley National Laboratory (LBNL) and Julia Ledewitz of MIT released a report of lessons learned from developing an ISO 50001-conformant management system in the 2012 ACEEE Summer Study on Energy Efficiency in Buildings. They broke down the Standard by sections and described how

MIT developed specific elements of their EnMS to conform to these sections. A summary of each section is provided below.

Scope and Boundary

The first step in creating an EnMS is selecting the scope and boundary, which are the activities encompassed in the EnMS and the physical limits of the system, respectively. MIT decided to start small with their scope and boundary, then eventually scale up to the entire campus. They initially wanted to certify a single building, so they selected the activities within one building and “the physical building, excepting energy for transportation of people and goods to and from the building” as their scope and boundary (Parrish & Ledewitz 2012, pg. 3-275). The energy team at MIT selected the materials science lab building, which is 183,000 square feet and houses engineering labs and office spaces.

Management Responsibility

Recall from the introduction that the Management Responsibility section involves selecting Top Management and a Management Representative. Because the initial scope of the EnMS was constrained to one building, MIT selected their Top Management as the Directors of the MIT Department of Facilities. The Management Representative, who was to work with the energy team and report directly to Top Management, was the Facilities Director of Commissioning and MEP Turnover. Much like Georgia Tech, MIT already had a knowledgeable energy team in place, so they used the same group for their EnMS energy team (Parrish & Ledewitz 2012, pg. 3-275).

Energy Policy

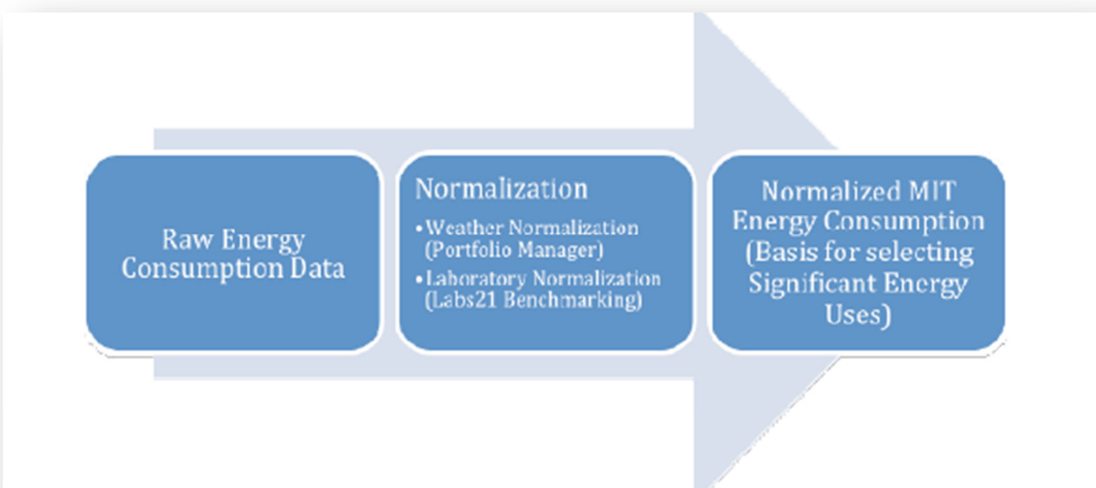
MIT drafted an original energy policy for ISO 50001 that reflected the commitments they were making to the building involved in the EnMS. They also included a provision in the policy for annual review and revision to be sure the policy stays up to date. More importantly, they opted to write their policy a way that it could be scaled up to apply to the entire campus instead of only one building. It will be necessary for the Georgia Tech energy team members to plan ahead while writing their energy policy so it can also be scaled up in an efficient manner.

Energy Review

For the energy review, MIT "chose to hire a third-party consultant…due to resource constraints internally" (Parrish & Ledewitz 2012, pg. 3-277). This consultant set up trend logs so the energy team could better understand how energy is used in the buildings. This helped the team identify significant energy uses in the building, such as laboratory ventilation. MIT's energy team used the DOE/EPA Labs21 tools to identify laboratory energy uses in the EnMS building compared to other lab buildings on their campus and throughout the country.

Parrish & Ledewitz also state that MIT will be weather normalizing their energy consumption "to ensure that large energy consumption for certain uses is not a result of varying weather conditions" (2012, pg. 3-275). They are using the ENERGY STAR Portfolio Manager program for weather normalization because it "is easy to use and requires monthly utility bill inputs that MIT had immediate access to." Figure 2.1 shows the process of weather normalization at MIT.

Figure 2.1 – Energy Normalization Process at MIT



Source: Parrish & Ledewitz 2012, pg. 3-278

At the time of the writing of Parrish & Ledewitz's paper, preliminary energy efficiency measures were being considered for the building, such as a fume hood sash management program and other improvements to the ventilation system. The energy team is targeting "a 12-15% reduction in whole-building energy consumption compared to a 2010 energy consumption baseline" (Parrish & Ledewitz 2012, pg. 3-278).

Lessons Learned and Future Implementation

The energy team at MIT planned ahead when they created the organizational elements of their EnMS—these elements can be scaled up to apply to the entire campus without much additional effort. However, the team still has some questions about getting the whole campus ISO 50001 certified. Instead of looking at specific systems like boilers and lab ventilation as significant energy uses, they plan to "treat those buildings that consume most energy" as the most significant energy users (Parrish & Ledewitz 2012, pg. 3-279). The energy management team is also considering using automated energy performance tracking software, much like the team at UCC in Ireland.

The MIT group has not yet determined how they will evaluate the effectiveness of their EnMS, although they have discussed evaluating energy savings in those buildings identified as significant energy uses. The campus stakeholders are expecting ISO 50001 implementation to lead to measurable energy savings in the future that will display the effectiveness of the EnMS. Because MIT and Georgia Tech are similar Institutions, the Energy Conservation Team at Tech learn best practices from MIT's implementation process. This will make the development of Tech's EnMS more streamlined and efficient.

Conclusion

A matrix that summarizes all of the reviewed literature was created for easy reference. Table 2.1 displays the article/paper title and the energy, cost, and CO2 savings data that was provided.

Table 2.1 – Summary of Savings from Reviewed Literature

Literature	Annual Energy Savings	Total Energy Savings	Cost Savings	CO2 Emissions
Bentley First with ISO 50001 (Straughan)	-	In ten years, overall energy reduction of **14%**	-	
UCC Case Study (Enerit)	Initial 6 months electricity savings of **5%**	Projected annual savings of **2.4 million** kWh	Projected annual cost savings of **~$276,000**	Projected annual savings of **802,000** kg CO2
Thinking Globally (McKane)	-	**20%** increase in energy efficiency expected	-	-
Continual Improvement of Energy Performance (McKane)	-	Average energy savings of **11%** over 3 years	Typical EnMS payback of **4-6** months	-
Early ISO 50001 Adopters Report Major Gains (Lambert)	-	Energy consumption in Bad Eisenkappel expected to decrease by nearly **25%**	Expected annual savings of EUR 16,000 (over **$20,000**)	-
ISO 50001 On Fire (Johnson)	-	Coca-Cola Enterprises cut energy use by **16.5%** since 2007	-	-
Early Lessons From ISO 50001 at MIT (Parrish)	-	Targeting a **12-15%** reduction in whole-building energy consumption compared to 2010 baseline	-	-

In Table 2.1, the savings data is shown in **bold**. It is evident from the savings matrix that ISO 50001 has been adopted by a wide range of organizations, from manufacturing plants to universities to municipalities. The organizations that are most similar to Georgia Tech—UCC in Ireland and MIT in Cambridge, MA—are projecting overall energy savings of 5-15%, and UCC is projecting an annual cost savings of about $276,000 from their comprehensive energy management strategies resulting from ISO 50001 implementation. Georgia Tech could see numbers similar to this from developing and implementing an energy management system in accordance with the ISO 50001 standard.

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Chapter 3 – Roadmap for ISO 50001 Implementation

Georgia Tech has the personnel and resources to make the ISO 50001 Energy Management Standard a success. This section breaks down each step of the standard and provides recommendations for all groups involved in the implementation process. Another resource that should be used in conjunction with this roadmap is the US

Department of Energy (DOE) eGuide for ISO 50001. The eGuide is an online toolkit designed to help organizations implement the ISO standard through an organized step by step process. It includes forms, checklists, templates, examples, and guidance that will assist Georgia Tech throughout the implementation process, from establishing the structural framework to sustaining and improving the energy management system. The DOE eGuide can be accessed through the following link: https://save-energy-now.org/EM/SPM/Pages/Home.aspx.

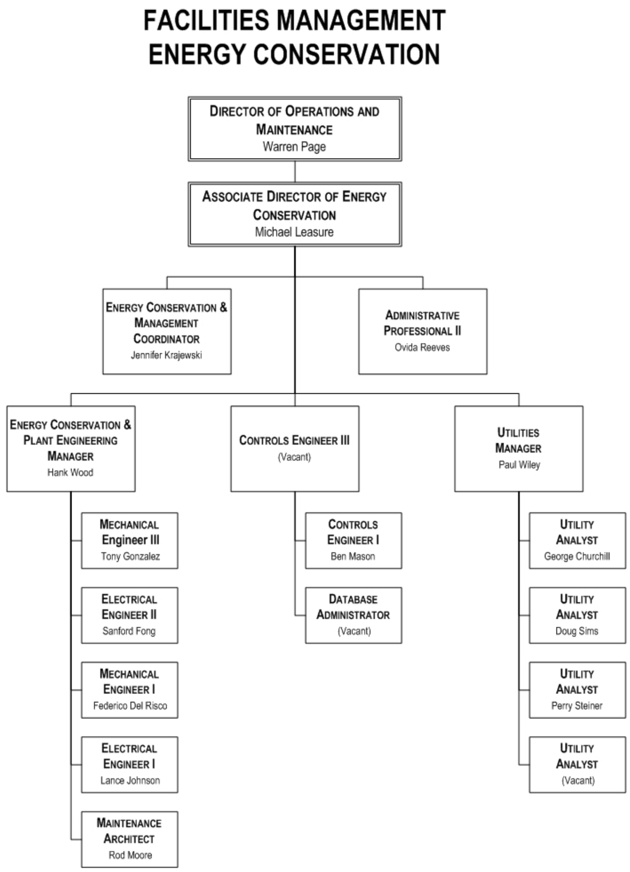
The newly established GT Facilities Management Energy Conservation team can assume the responsibility of implementing the ISO energy management system. The purpose of the standard is improving energy performance, which is complementary to the goals of Georgia Tech's Energy Conservation team. According to the team's website (2013), the responsibilities of the team include:

- developing a sustainable energy and water conservation program
- providing the Institute with reliable and cost effective utilities
- striving for the most efficient use of energy and water
- eliminating all wasteful and non-mission critical use of utilities
- reducing Tech's energy consumption to meet the Institute's energy and greenhouse gas commitments

In addition to this, the team has access to utility information for all buildings on campus, including electricity and gas consumption and rate structures from the energy utilities like Georgia Power. The team also has the ability to perform energy audits, which will allow them to determine significant energy uses on both the individual building scale and campus scale.

The organizational structure of the Energy Conservation team is shown in Figure 3.1.

Figure 3.1 – Organizational Structure of Facilities Energy Conservation Team



Source: http://www.energyconservation.gatech.edu/?q=content/energy-team

It can be seen from Figure 3.1 that the Energy Conservation team has a wide variety of personnel with the necessary skills to implement the ISO standard. The team has multiple utility analysts, a controls engineer, electrical and mechanical engineers, a compliance engineer, and others with the technical ability to develop an energy review, baseline consumption, and determine energy performance indicators. The team also has the management and policy expertise to organize the varied skill sets to achieve meaningful energy performance improvements.

Management Responsibility

Members of Georgia Tech's Energy Conservation team can assume the roles of top management and management representative. It is important that these representatives come from the team because they both must understand the implications of energy performance in long-term planning. When energy objectives and targets are established, members of the Conservation team will understand if they allow Georgia Tech to meet the goals outlined in the Climate Action Plan and the Governor's Energy Challenge. By referencing the organizational chart shown in Figure 3.1, it can be assumed that the Associate Director of Energy Conservation will assume the role of top management, while the Energy Conservation and Management Coordinator will be the appointed management representative.

Establish the Scope and Boundaries – eGuide Step 1.2.1

One of the responsibilities of top management is to identify the scope and boundaries to be addressed by the energy management system. This will allow Georgia Tech to focus efforts and resources by defining the extent of the EnMS on campus. The scope of the EnMS can be a specific building, group of buildings, or the entire campus, and it will cover the "activities, facilities, and decisions associated with the energy sources within in scope" (DOE eGuide, 2013). The boundaries are the physical limits that can include one or more processes or buildings, and the eGuide states that the scope may include several boundaries.

Like MIT, Georgia Tech should establish the initial scope and boundaries of the EnMS as one building with isolated energy processes that allow for a simple analysis of significant energy uses. For example, the Institute of Paper Science and Technology (IPST) is an ideal candidate because it has a dedicated chilled water system, as opposed to being on the central campus system. Once the EnMS is implemented on a single building, the energy conservation team can scale it up to include a group of buildings, then eventually the entire campus. The scope and boundaries worksheet in the Appendix is a useful resource for top management to achieve this step in the ISO 50001 implementation process. Because the scope and boundaries will change as the EnMS is scaled up, the planning framework should be designed to increase in scale accordingly without the need for a rewrite. For example, the energy policy, baseline, targets, and objectives should be created with multiple scales in mind for ease of expansion in the future.

Energy Policy

Define the Energy Policy – eGuide Step 1.2.4

The energy policy will create a framework for Georgia Tech to set energy conservation targets that are consistent with the already-existing goals outlined in the Climate Action Plan. This is necessary for Tech's energy conservation efforts because it will give the Energy Conservation team some individual formalized goals to strive for each year. Additionally, the adoption of a campus-wide energy policy will project the message to Georgia Tech students, faculty, staff, and surrounding community that the Institute is serious about energy conservation.

According to the ISO eGuide, the energy policy must state management's commitments to:

- achieving continual improvement in energy performance
- ensuring availability of information and resources to meet energy objectives
- compliance with applicable legal and other energy requirements
- support purchasing energy efficient products and services
- support design for energy performance improvement (eGuide 2013)

While all of the points above must be addressed, the energy policy can range in length from only a few sentences to several paragraphs. Also, the policy is meant to be a living document—it should be regularly reviewed and updated as necessary, and it should be communicated to all levels of the Georgia Tech community. Some ways to communicate the policy are through the Daily Digest emails and through Tech's Green Buzz website (www.gatech.edu/greenbuzz/). Two energy policy worksheets and an example energy policy have been included in the Appendix of this report.

It was concluded from discussions with Jennifer Krajewski (Facilities Management Energy Conservation and Management Coordinator) that the process of creating an official energy policy should be open to all members of the campus community. There are numerous groups on campus that could provide useful input for an energy policy, and the Energy Conservation team can coordinate a series of public meetings and discussions about the future of energy consumption at Georgia Tech. Some on-campus groups and organizations that may be interested in working with GT Facilities Management on a campus energy policy are:

- Energy and Sustainability Services, Enterprise Innovation Institute (Bill Meffert)
- Brook Byers Institute for Sustainable Systems (Dr. John Crittenden)
- School of Public Policy (Dr. Marilyn Brown)
- School of City & Regional Planning (Dr. William Drummond & Dr. Steve French)
- Students Organizing for Sustainability
- Department of Housing (Fran Gillis)
- Office of Environmental Stewardship (Marcia Kinstler)
- Earth Day Committee (Cindy Jackson)

Involving a wide variety of stakeholders in the planning process will not only result in an energy policy that best fits the entire campus, but it will also start a dialogue between Facilities Management and other campus stakeholders. This dialogue of energy-related information will give various organizations the opportunity to share ideas and best practices for energy efficiency. It could even lead to inter-organizational collaboration that will further Georgia Tech's reputation as a leader in sustainability and energy efficiency.

The series of meetings will also allow Facilities Management to communicate the importance of energy transparency to the various stakeholders. Many groups are unaware of the level of energy data that the Energy Conservation Team collects from the sub-metered buildings on campus. Some of the research groups, like the Brook Byers Institute for Sustainable Systems, may be able to perform some analyses on Georgia Tech's energy data that could greatly benefit efficiency efforts on campus. Students can also use energy data for initiatives that lead to energy conservation. For example, the annual GT Flip the Switch competition pits residence halls against each other for a month-long contest to see who can reduce their energy consumption the most. Widespread availability of energy consumption data could allow initiatives like Flip the Switch to increase in scale to the point that individual Colleges within Georgia Tech could compete to reduce energy, and the money saved from efficiency efforts can be used to invest in future energy projects.

Understand EnMS Documentation – eGuide Step 1.4

Documentation is an important aspect of ISO 50001 implementation, and the standard says that each organization should "establish, implement and maintain information…to describe the core elements of the EnMS and their interaction" (ISO 50001, pg. 9). Additionally, the standard requires the organization to establish and maintain records, as necessary, to demonstrate conformity to the requirements of its energy management system. Documents and records are separate types of documentation—the former provides information that guides actions in the present while the latter provides information about the past. For example, documents state current policies and commitments and describe how activities will be done, whereas records state results achieved and provide evidence of activities performed in the past (eGuide Step 1.4).

While documentation provides benefits to many organizations that pursue ISO 50001 certification, it will be especially beneficial for Georgia Tech. When the Georgia Institute of Technology announces its goal of creating an Energy Management system and pursuing ISO certification, some of the stakeholders on campus will request details about the specifics. Much like the process of creating an energy policy, an open documentation process throughout ISO implementation will allow the entire campus community to get involved in pursuing energy efficiency. The Energy Conservation team could create a section on their website that allows the general public to access certain documents and records, as well as provide input to the process. Additionally, it would provide an excellent resource for other organizations that would like to pursue ISO 50001 certification in the future. Documentation will also help Facilities scale up the energy management system. When the system grows from one building to the entire campus, the individual building managers, college deans, students, and maintenance workers will have all of the information they need to help the energy conservation team implement the system smoothly and successfully.

Energy Review

Profile Your Energy Situation – eGuide Step 2

This step of the eGuide explains the processes of acquiring and tracking energy data, determining significant energy uses, identifying energy opportunities, establishing a baseline, and determining energy performance indicators (EnPIs). These measures are necessary for the Energy Planning portion of the ISO 50001 standard, and they form the basis of the energy management system. Georgia Tech's Energy Conservation Team currently has a head start on this step of the process—they already acquire and track campus-wide energy data, and they have the tools in place to quickly complete the energy review. Also, the existing smart sub-meters throughout campus can play a crucial role in the energy review because they make energy data remotely available in real time, so Facilities Management employees do not have to manually check the meters in each building on campus. These smart meters, combined with technical experience and proficiency, will allow the Energy Conservation Team to acquire all of the necessary energy data for the planning process.

While obtaining all the data is a useful step in energy planning, it is important to use this data to determine the significant energy uses, which will pave the way for establishing energy objectives, targets, and action plans. Once the significant energy uses are determined, the Conservation team can decide how to achieve the most improvement in energy performance with the fewest available resources. The DOE eGuide breaks this process down into individual steps, such as preparing a list of energy systems, developing an energy balance, determining criteria for significance, recording significant energy uses, and analyzing these uses. During the initial phase of ISO 50001 implementation, the significant energy uses (SEUs) could be individual systems within a building, such as air compressors or fume hoods. Once the EnMS is scaled up to the campus level, SEUs can change from systems to individual buildings that have a substantially larger energy use intensity (EUI) than others. The eGuide provides some useful resources for documenting and tracking SEUs, including a control chart that can be used to list SEUs and document other information needed to ensure significant energy uses are properly managed.

Establish Baseline and Determine Energy Performance Indicators – eGuide Step 2.6

The energy baseline acts as a reference point that is used as the basis of comparison for determining energy performance. It is established using the data obtained from the initial energy review, which consists of past energy consumption, evaluation of present energy consumption, significant energy uses, and identification of opportunities for improved energy performance. The energy baseline will allow the conservation team to compare the status of its energy performance after ISO implementation with the performance before any energy management system.

Because the energy conservation team has already completed a full energy audit of the Sustainable Education Building (SEB), it has the experience necessary to create a baseline that portrays an accurate picture of energy consumption before ISO 50001 implementation. This energy audit experience will also allow the energy team to easily develop energy performance indicators (EnPIs), which provide metrics for quantifying energy performance over time. In fact, Georgia Tech Facilities already has an EnPI that it uses to compare building efficiency across campus—the Energy Use Index (EUI). The EUI is defined as the total energy (in BTUs) consumed per gross square foot per year in a building. Facilities Management also has an EUI value for the entire campus, which will be useful when ISO implementation is scaled up to include more than one building.

Although the energy conservation team has an existing EnPI, the ISO 50001 standard requires a baseline EnPI to be calculated using some form of tool for regression analysis. The eGuide provides an excellent resource for calculating this baseline EnPI—it contains a tool created by the Georgia Tech Research Corporation that performs this regression analysis on past energy data. The tool is a simple Excel spreadsheet that takes existing electricity and natural gas consumption data inputs from the user and outputs regression models for each variable, along with corresponding graphs. This tool can be found in the Implementation Resources section of Step 2.6, and it is called ‘Step 2.6.5 EnPI Tool v.3.02’.

Once the baseline EnPI is created using a regression analysis, energy performance improvements are measured by comparing the baseline EnPI to the original EnPI calculated from current energy data (the EUI in this case). If the EUI is below the baseline EnPI, this indicates an improvement in energy performance over time. If it is above the baseline EnPI, there has been a deterioration in energy performance. According to the eGuide, it is beneficial to compare the actual and predicted EnPIs because it shows the direction and rate of change in organizational energy performance.

Develop Objectives, Targets, and Action Plans – eGuide Step 3

After the energy performance indicators have been developed and compared to the baseline, Georgia Tech should implement energy objectives and targets and establish time frames for the achievement of its energy goals. Energy management action plans define the activities, resources, and responsibilities required to meet the energy objectives and targets. It is important to note the difference between energy objectives and targets. Objectives state the desired outcome in terms of a specific performance improvement and how it might be accomplished. Targets define the specific and quantified performance requirements that need to be met to achieve the energy objectives. A comparison of objectives and targets is provided in Table 3.1.

Table 3.1 – Comparison of Energy Objectives and Targets

Term	Definition	Examples
Objectives	Desired outcome in terms of a specific performance improvement and how it might be accomplished.	• Reduce total energy use by 25% by 20XX. • Reduce greenhouse gas emissions by 10% over the next five years.
Targets	Define the specific and quantified performance requirements that need to be met to achieve the energy objectives.	• Reduce average electrical demand for 20XX by 30kW as compared to 20XX baseline • By January 20XX reduce annual carbon emissions from main boiler by 25% as compared to baseline year of 20XX

Source: eGuide Step 3.1.3. https://ecenter.ee.doe.gov/EM/SPM/Pages/Step3_1_3.aspx

The combination of objectives, targets, and action plans will be the main driver for Georgia Tech to move forward with continual improvement in energy performance.

Much like the creation of the energy policy, it is important to assemble the right group of people to develop the objectives and targets that will define how Georgia Tech moves forward with its energy management system. A wide variety of campus stakeholders should be involved in the development process, including students, faculty members, Auxiliary Services members (Housing, Dining, etc), maintenance staff, upper management, public relations, and members of the Energy Conservation Team. It may be helpful to create an organizational chart to determine the appropriate personnel that should be involved in developing energy objectives and targets.

The objectives and targets should be consistent with the energy policy, but they can change depending on the scale of implementation. The objectives and targets for a specific building will be different than those for the entire campus, especially because the Climate Action Plan already contains future energy and greenhouse gas objectives for the entire campus. This step in the energy management process will give the Energy Conservation Team the opportunity to look closely at the Climate Action Plan objectives and develop a set of targets that will allow the Institute to continually improve its energy performance to the point that it reaches these long-term goals. It also provides an opportunity to integrate various campus documents into a framework that is focused on a few overreaching goals. The energy policy, Climate Action Plan, ISO 50001 documents, and the yellow book of design/construction guidelines can all be coordinated to include energy efficiency and greenhouse gas reductions as a focal point of campus planning for the foreseeable future.

Once energy objectives and targets are created based on the existing energy policy and goals outlined in the Climate Action Plan, the energy conservation team can begin formulating energy management action plans. These action plans determine how the team will achieve its energy goals by including the activities to be completed, necessary resources, responsibilities, and how verification of the results will be done. Energy action plans can be some of the strongest efficiency tools that come from ISO implementation—the Climate Action Plan provides overall energy goals and the Yellow Book has design and construction guidelines, but neither document supplies Georgia Tech with a step by step guide to achieving these goals. Energy action plans that are created for the ISO 50001 standard will give the conservation team tangible steps to achieve long-term energy efficiency. An example energy management action plan is included in both the DOE eGuide and the Appendix of this paper.

Management Review

Check the System – eGuide Step 6

When the previous steps have been completed, it will be important for the Energy team to check the EnMS and ensure that appropriate monitoring and measuring activities are in place to make sure the EnMS is in line with the energy policy and the targets and objectives. The ISO 50001 Standard says that the key characteristics to be measured are the significant energy uses and relevant variables, energy performance indicators, effectiveness of the action plans in achieving objectives and targets, and evaluation of actual versus expected energy consumption.

This step of the process is important because changes in energy use can occur over time, and the key components of the energy management system must operate efficiently regardless of these changes. For example, a significant energy use in a particular building (such as a server room) may undergo some changes from the building manager or information technology staff that may not be communicated directly to the energy conservation team. If the team does not continuously check the energy use, the server room may grow and consume even more energy than previously, which costs money and detracts from the objectives and targets outlined in the energy management system. Constant monitoring and measurement can prevent spikes in energy consumption and ensure that the EnMS moves forward according to the energy policy and objectives.

In addition to monitoring and measuring key characteristics of the EnMS, Georgia Tech will have to perform an internal audit of the system. An internal audit is a systematic process for “objectively evaluating evidence to determine whether a set of requirements is being met” (eGuide Step 6.4). The audit is necessary to ensure that the EnMS meets the requirements and arrangements that have already been established, as well as to check on whether it has been effectively implemented and maintained and that it actually results in energy performance improvements. Therefore, the internal audit assesses both the effectiveness of the management system and the energy performance.

Internal audits should be conducted at planned intervals, and the energy conservation team should prepare a schedule that addresses both the energy performance and the management system. Before an audit is conducted, the team should create a plan or agenda that includes information about the date, objective, processes, auditors, timing, and requirements. An example internal audit is provided in the Appendix, and the ISO 50001 eGuide has an audit template that can be filled out by whoever is conducting the internal audit.

Sustain and Improve the System – eGuide Step 7

The final step of implementing the ISO 50001 energy management system is the "ACT" part of the Plan-Do-Check-Act continual improvement cycle. After the previous steps have been taken, top management will review the system and make decisions regarded any needed changes. This is important for the future of the EnMS because it will ensure its continuing suitability, adequacy and effectiveness. In the case of Georgia Tech, the role of top management can either be assumed by the Associate Director of Energy Conservation or someone who does not work for Facilities, such as one of the top campus administrators.

The ISO 50001 standard requires some inputs to the management review. Top management will analyze these inputs about the system and its performance, and they will make decisions that should lead to continual improvement of Georgia Tech's EnMS and energy performance. The required inputs to the management review include:

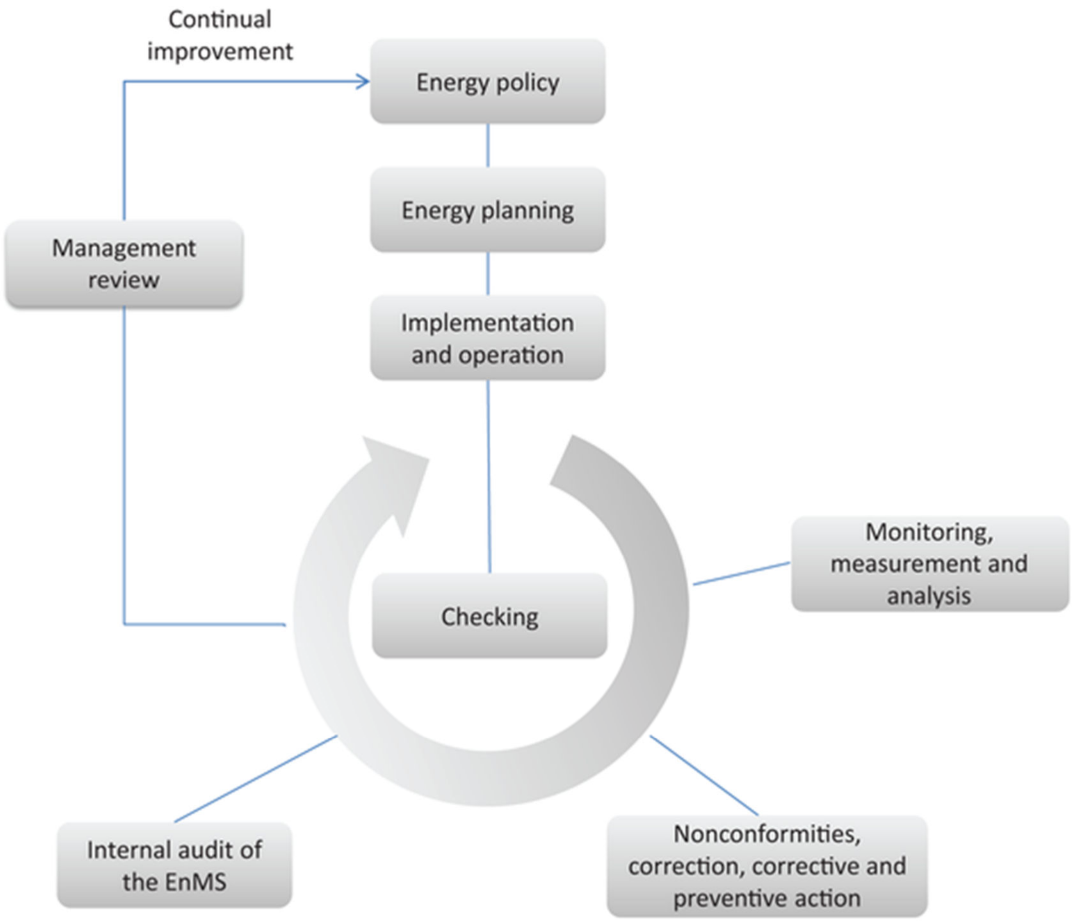
- Follow-up actions from previous management reviews
- Review of the energy policy
- Review of energy performance and related EnPIs
- The extent to which energy objectives and targets have been met
- EnMS audit results
- Projected energy performance for the following period
- Recommendations for improvement

An example management review preparation form is included in the Appendix. It outlines the types of information needed by top management, potential sources of information, and provides spaces for the energy team to input the people responsible for collecting the data and the due dates. A management review preparation form like the one provided can be an excellent resource for organizing all of the information needed for the review.

Once top management meets with the energy conservation team and reviews the key characteristics of the EnMS, they will make decisions that lead to specific actions aimed at improving the system. It is up to the management representative to decide the best way to present the necessary data to top management, as well as distribute it to the rest of the energy team or anyone else that will be participating in the presentation. Examples of actions leading from the management review include changes in the energy performance of the organization, energy policy, EnPIs, and energy objectives.

At this point, the EnMS is fully implemented, and the Plan-Do-Check-Act cycle repeats itself. This cycle is seen in Figure 3.2.

Figure 3.2 – ISO 50001 Plan-Do-Check-Act System



Source: https://www.iso.org/obp/ui/#iso:std:iso:50001:ed-1:v1:en

If implemented, Georgia Tech would have a system that completely embeds the ISO continual improvement process into its daily operations. The management review leads to an improvement in energy performance, which completes the loop seen in Figure 3.2. It is important to note that the documents created during the implementation of ISO 50001 should be updated frequently to reflect the ever-changing energy consumption and efficiency situation at Georgia Tech. A successful management review means further actions can be taken to improve the energy policy, energy planning process, and implementation of the energy management system. Additionally, Georgia Tech can use management reviews to slowly work on expanding the system from one or more buildings to the entire campus.

Conclusion

The Georgia Tech Facilities energy conservation team can follow the steps outlined above for a successful implementation of the ISO 50001 energy management standard. If the energy management system is created according to these guidelines, it will provide numerous long-term benefits to the campus, including reduced energy consumption, increased energy efficiency, proactive energy management, and an increased reputation as an Institute that is committed to sustainability and innovation. Additionally, the EnMS will give the energy conservation team the opportunity to integrate the existing climate action plan, yellow book, and other documents that address energy efficiency with an overarching energy policy and action plans that enable the team to achieve these energy goals.

The ISO 50001 EnMS will also give Georgia Tech the chance to actively engage the entire campus community in the energy planning process. This aspect of public participation is becoming commonplace among public decision making, and it will benefit Georgia Tech greatly to set the stage for involving all stakeholders in decisions that will affect the future of the Institute. Campus community members (students, faculty, and staff) can provide a great deal of assistance to the energy team—they can add their input to energy planning and they can use their science and technology prowess to help the energy team create innovative programs that result in large energy performance improvements.

Implementation of the ISO 50001 standard could also result in greater transparency of energy data to the general campus community. This will be helpful to students, faculty, and staff because they will have access to the amount of energy being consumed in their buildings each day. A knowledge of this energy consumption will make them more aware of energy efficiency and may increase their desire to achieve the energy objectives and goals created by the energy conservation team.

References – Chapter 3

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Chapter 4 – Cost Benefit Analysis for ISO 50001 Implementation

Introduction

The planning and implementation process for ISO 50001 will not be a small undertaking, and Georgia Tech will incur some costs along the way. This guide includes a cost-benefit analysis (CBA) that provides a method for categorizing and quantifying the costs and benefits that are associated with ISO 50001 implementation. Also included in this chapter is an evaluation matrix that compares the costs and benefits energy management implementation with the alternative of the current status quo. To evaluate the costs versus benefits, the analysis uses the benefit-cost ratio method. This method places both benefits and costs in present value terms, then it divides costs by the benefits to obtain a ratio. Typically a higher benefit-cost ratio means a project is more suitable to pursue.

Before the cost-benefit analysis is presented, some strengths and limitations of the method are explored. These are followed by the cost-benefit procedure:

- Determine the costs of each alternative
- Determine the benefits of each alternative
- Quantify the costs and benefits of each alternative

- Evaluate the costs versus the benefits
- Evaluate the equity impacts

where the alternatives in this case are ISO 50001 implementation or business as usual (incremental energy audits and efficiency projects performed by the GT energy conservation team). After the procedure, the results are shown along with the evaluation matrix.

CBA Strengths and Limitations

The cost-benefit analysis employs a certain type of economic efficiency, called *Kaldor-Hicks efficiency*, as its theoretical background. According to this standard, some people are made better off, some are made worse off, but it is possible (in theory) for the gainers to fully compensate the losers, so that at least one person is better off and no person is worse off (Steinemann, pg. 324, 2005). For example, as long as the net benefits of ISO 50001 are positive, the decision is a potential improvement

There are some strengths and limitations to CBA that should be noted before the analysis is performed. One of its biggest strengths is that it provides a straightforward, systematic approach for organizing information and evaluating programs by using money as a single metric (Steinemann, pg. 344, 2005). It also provides the decision makers with future costs and benefits discounted to net present values, which makes it simple to evaluate the differences and make a decision based on quantitative, objective information.

While the strengths of CBA make it a straightforward, simple approach for evaluating programs, it has some corresponding shortcomings that should be taken into account. Although the single metric of money provides ease of evaluation, all benefits and costs do not necessarily have monetary equivalents (Steinemann, pg. 345, 2005). Some projects have social and environmental repercussions that cannot be converted to monetary amounts, and if they can be converted, it can be difficult and subject to inaccuracies. Additionally, some impacts that do not have monetary values are omitted from the analysis. In the case of ISO 50001 implementation at Georgia Tech, some of the social and environmental benefits have not been considered in the CBA because of the difficulty of assigning monetary values to them.

Another limitation with cost-benefit analysis is the amount of uncertainty that surrounds it. According to Steinemann (2005), it is practically impossible to predict all the future impacts of a program, let alone their magnitudes and their probabilities of occurrence (pg. 345). Part of this limitation is the idea that collapsing all benefits and costs into a single number does not reveal the assumptions on which that number is based on, which leads to the uncertainty of critical information. However, this CBA will provide a list of assumptions related to both Georgia Tech Facilities and the energy management process. This list of assumptions will attempt to predict some of the future impacts of ISO implementation, but it is impossible for it to predict all of them.

CBA Procedure

Determine the costs of each alternative

The costs to Georgia Tech for implementing the ISO 50001 Energy Management standard will be almost entirely direct project costs. Although GT Facilities already has an energy conservation team, the personnel on this team will need to devote extra time for creating an energy policy, performing the energy review, developing energy performance indicators, and creating energy objectives and targets. The amount of time required by the team for these administrative duties will make up the bulk of the costs. The other costs will be those associated with the energy efficiency projects, like motion sensors and upgraded HVAC equipment, that directly lead to a continual improvement in energy performance.

When estimating the project costs for ISO implementation, only those costs that are incremental as a result of the project will be included. For example, the personnel costs of the energy conservation team due to their current levels of work will not be included, but the costs of additional work hours or new personnel will be a part of the project costs. This guide makes some assumptions about current and future costs that should be noted by Georgia Tech:

- The energy conservation team already has the equipment that they need for measuring baseline energy performance and conducting energy audits.
- Energy audits and efficiency projects will be performed by the energy conservation team, not third-party contractors.
- ISO 50001 implementation will result in objectives and targets that meet the first goal of the Climate Action Plan: a 15% reduction of energy consumption per square foot by 2020 from 2007 levels.
- Implementation at the single-building scale will take the same amount of time as MIT's process: fourteen months of development and six person-months of work time (Parrish & Ledewitz, pg. 3-280, 2012).
- Maintenance costs of any new energy efficiency equipment (upgraded lighting, HVAC, motion sensors, etc) will be the same as existing equipment.

Certain overhead costs that may be allocated to the project, but which would exist regardless of the project will *not* be included in the analysis. Examples include:

- Winning management approval for the project
- Identifying, selecting, and coordinating with engineers and contractors
- Identifying sources for an procurement of project equipment and supplies (Elliott et al, pg. 2145)

Determine the Benefits of each alternative

Much like project costs, the benefits calculated for the CBA will be incremental to the project. The main benefit used in this analysis will be the energy savings due to increased efficiency from the ISO 50001 Energy Management system. Some other benefits that are beyond the scope of this analysis are:

- Reduced costs of environmental compliance
- Reduced pollution and greenhouse gas emissions due to less fossil fuel combustion
- Social benefits of increased community involvement in energy planning
- Increased reputation as a green and environmentally responsible Institute

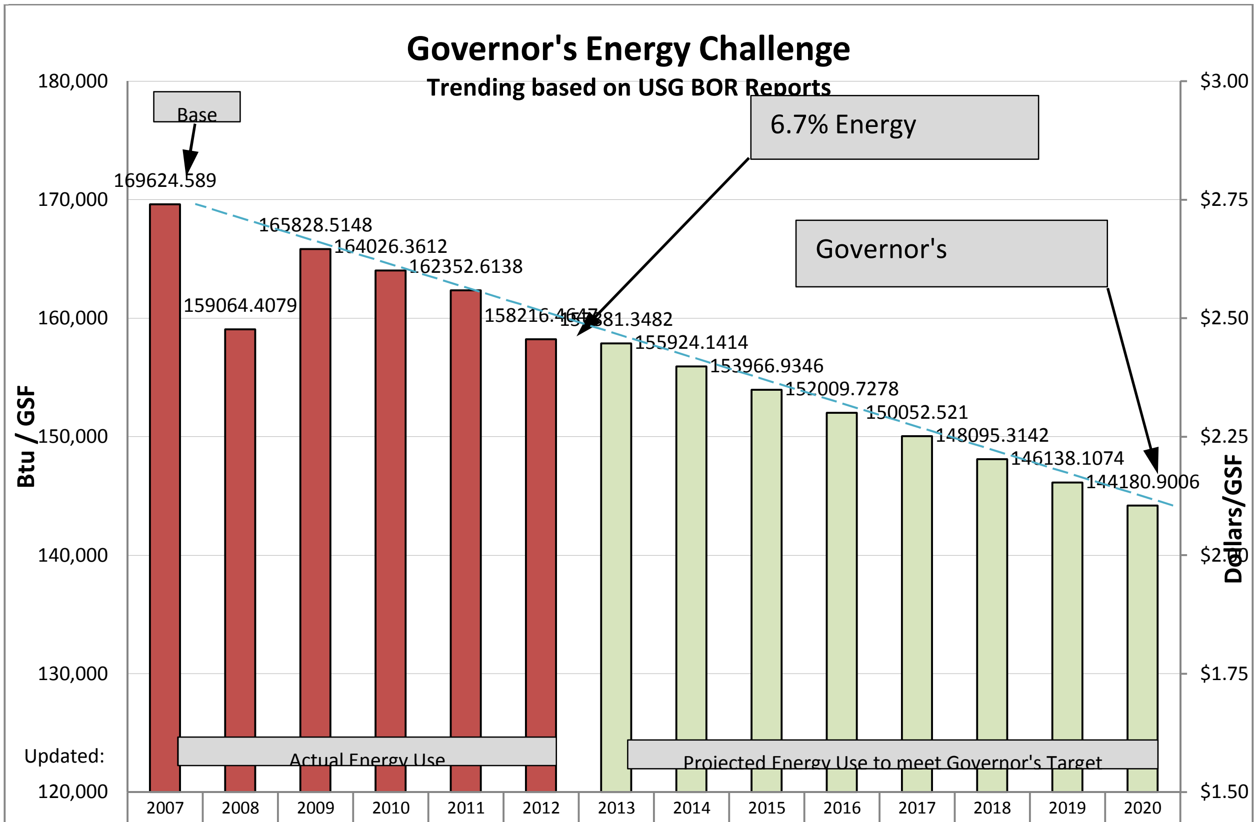
- Greater availability and transparency of energy data
- Greater knowledge of future energy use and consumption on campus

It is assumed that the EnMS will result in an EUI reduction of 15% over an eight year period, based on the FY 2012 EUI. This is because the EnMS will focus the Conservation Team's efforts on improving energy performance substantially in a short amount of time. The next section of the paper goes into more detail about how this performance will be achieved.

Quantify the Benefits

Georgia Tech has already created a chart that shows the campus EUI trending toward this goal with the incremental energy efficiency efforts being pursued by the conservation team. This chart includes data up to Fiscal Year 2012, and it shows a continuous 4.3% decrease in campus EUI, even with an overall increase in gross square footage of campus buildings. The energy consumption projection created by Georgia Tech Facilities is shown in Figure 4.1.

Figure 4.1 – GT Facilities Projection to Meet Energy Goals



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Btu/GSF	169624.6	159064.4	165828.5	164026.4	162352.6	158216.5	157881.3	155924.1	153966.9	152009.7	150052.5	148095.3	146138.1	144180.9
GSF	9558342	10627156	10704669	11255173	11563971	11563971								

Source: Jennifer Krajewski, GT Facilities

It can be seen from Figure 4.1 that the Energy Conservation Team has created a projection from the base year of 2007, and the actual energy consumption (shown in red) is on track to meet the Governor's Energy Challenge by 2020. A 15% reduction in EUI from 2007 levels will be 144,181 Btu/GSF, and the projection assumes that this will be achieved with a 2020 EUI of 144,180 Btu/GSF. This scenario is assumed to be the "business as usual" situation—if the Conservation Team does not implement any kind of comprehensive energy management, they will achieve the goal of a 15% EUI reduction from 2007 levels by 2020.

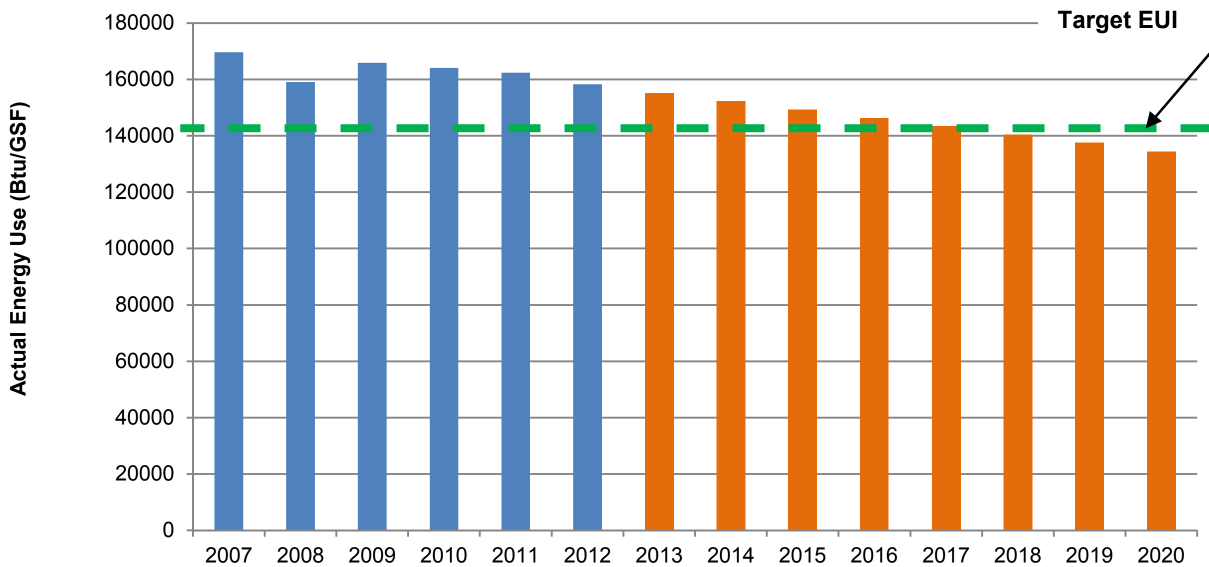
Without implementing the ISO 50001 standard, the energy conservation team will conduct their energy audits as usual, and it is assumed that energy performance will improve in the same manner as pre-2012. The data point for 2012 should not be looked at as an outlier—campus square footage stayed the same and overall energy consumption decreased slightly, resulting in a 6.7% decrease in EUI. However, new buildings continue to be constructed at Georgia Tech, thus increasing the square footage and energy consumption.

Georgia Tech's energy expenditures for each year from 2013 to 2020 can be projected by assuming energy costs (price per Btu will stay at 2012 levels until 2020. This is a conservative estimate because costs have been trending upwards in the past several years, and the benefits would be even greater with higher energy costs. The projection shown in Figure 4.2 is assumed to be the "business as usual" energy consumption, and will be used as a baseline to calculate the benefits of the ISO 50001 system.

As previously mentioned, it is assumed in this analysis that ISO 50001 implementation will result in Georgia Tech reducing its EUI 15% from 2012 levels by 2020. The base year of 2012 was chosen because it is assumed to be the most recent year before ISO implementation. If the Energy Team implements the EnMS in 2013, they will immediately see savings similar to those of over organizations that have developed an ISO EnMS in the past. Savings of this magnitude from ISO 50001 have been attained by numerous organizations—Chapter 1 of this paper includes a few examples of organizations that have improved energy performance by 15-20%. Georgia Tech will probably see savings of an even greater magnitude than this assumption—MIT is expecting a 12-15% reduction in **whole building** energy consumption with their ISO implementation. This would translate to much greater EUI savings at Georgia Tech if new buildings continue to be built during the eight year period from 2012 to 2020.

For the projection of campus energy consumption with the ISO EnMS, energy data provided by the Energy Conservation Team is used until 2012. After that, a linear projection was used to estimate EUI in each subsequent year. The projection is shown in Figure 4.2.

Figure 4.2 – Projection of Energy Use with ISO 50001 Implementation



For this projection, a linear interpolation was created between the most recent 2012 EUI and the 15% reduction from 2012, which is projected to occur in 2020.The data for 2013-2020, which is shown in orange, was set to match this interpolation. This shows a gradual reduction in EUI from 2012 to 2020. It is important to note that the EUI reduction as required by the Governor's Energy Challenge, labeled in Figure 4.2 as the Target EUI, will be achieved by 2018. This is two years earlier than the Energy Conservation Team's current projections of future energy consumption on campus.

The energy savings benefits were calculated using data provided by Georgia Tech Facilities Management. The two models shown above provide energy intensity, but this data had to be converted into pure dollars. Some assumptions were made to obtain this information:

- Energy costs, in Dollars/MMBtu, will remain constant from 2012-2020.
- Gross square footage (GSF) of campus buildings will remain constant from 2012-2020.

Using these assumptions, an equation was created to obtain the annual cost of energy from 2013 to 2020. This method is seen in Equation (4.1):

(Equation 4.1)

$$\frac{\$}{year} = \frac{Btu}{GSF} \times GSF \times \frac{MMBtu}{1{,}000{,}000\ Btu} \times \frac{\$}{MMBtu}$$

where $\frac{Btu}{GSF}$ is the energy use index provided by the models and $\frac{\$}{MMBtu}$ is the average 2012 energy price provided by GT Facilities.

Equation 4.1 provided estimates of annual energy costs based on each model. Because the benefits calculated in a CBA are incremental, the energy costs from the new projection (Figure 4.3) were subtracted from those of the business as usual projection (Figure 4.2) to determine the annual savings from implementing the ISO 50001 standard. The energy savings from implementing the ISO 50001 standard start at about $440,000 in year one of the analysis (2013) and increase to about $1.6 million in year eight (2020).

Quantify the Costs

The costs of ISO implementation will be attributed to both personnel time and the upfront capital expenditures for energy efficiency measures. It is assumed that, like MIT, it will require GT Facilities six person-months to complete the administrative duties associated with the standard, and achieve implementation for one building on campus. After the framework is created, it is assumed that each additional campus building will require one-third of that time (2 person-months) to get the Energy Management System up and running. This is because the energy policy, targets, objectives, and other aspects of the system will already exist, making implementation much simpler additional buildings on campus. Equation 4.2 is used to determine the total personnel time to achieve campus-wide ISO implementation.

$$Time = \frac{6\text{ person-months} + (163\text{ buildings}) \times (2\text{ person-months})}{12\text{ months/year}} = 27.67\text{ person-years} \quad \text{(Equation 4.2)}$$

Because the time period to achieve the President's Climate Challenge goal of 20% reduction in EUI is eight years (2013-2020), GT Facilities will either have to realign some of their workload to focus on ISO implementation or hire new personnel. This analysis assumes that Facilities will hire four new employees who will commit their workload entirely to ISO implementation until 2020. With an average annual salary of $50,000, this comes out to a personnel cost of $200,000 per year.

It is more difficult to estimate the cost of energy efficiency improvements to the actual buildings, because campus buildings vary so much in terms of size, use, occupancy, and energy consumption. Georgia Tech's 163 campus buildings range in age from over 120 years old to brand new. Some of the buildings house energy intensive lab and research functions and are in use 24 hours a day, and others are only used as offices that are occupied 40 hours a week.

Although there is so much variation between buildings, the cost of energy improvements can be estimated by using an existing energy audit for a fairly typical building on campus. The Facilities Energy Conservation Team has already completed an energy audit for the Sustainable Education Building (SEB), which houses computer labs, classrooms, a server room, offices, and research labs. At 33,000 gross square feet, the SEB is slightly smaller than some other campus buildings, and it was built with some innovative construction techniques that kept energy efficiency in mind (GT Facilities, 2011). It also has an EUI that is slightly lower than that of the entire campus, which means it is more energy efficiency than the average campus building, but it is not "out of line with the Tech campus or other regional educational institutions" (GT Facilities, 2011).

The GT Facilities energy audit of the SEB identified six energy projects that would reduce overall energy consumption by 25% with a simple payback of less than 3 years. The total cost for all projects, which included installing occupancy sensors, optimizing air distribution, and installing improved equipment controls, was about $37,000 (GT Facilities, 2011). From interviews with members of the Energy Conservation Team, it became apparent that the SEB is smaller and more energy efficient than most buildings on campus. They recommended doubling the project costs for the SEB in order to get a more accurate estimate of energy upgrades to a more typical campus building. Therefore, it is assumed that energy efficiency upgrades for one building on campus will cost about $74,000.

During the eight year period from 2013 to 2020, it is assumed that the Energy Conservation Team will upgrade as many buildings with energy improvements as possible. However, this process takes time because the buildings must be audited and significant energy uses need to be determined. Additionally, the Conservation Team will have to make energy recommendations, calculate simple paybacks, and install the necessary retrofits. It would be impossible for the Team to upgrade all 163 buildings on campus during this short period. It is more likely for them to complete audits and upgrades for two buildings each year, which comes to a total of 16 buildings. The total capital expenditure is assumed to be $74,000 x 16 buildings, or about $1.18M. This expenditure will not happen in one single year, so it is broken up into equal annual payments of $148,000 during the eight-year period. This calculation assumes that all energy audits will be performed in-house with equipment that is already owned by GT Facilities, and the associated personnel costs have already been captured in Equation 4.2.

A comparison of all costs and benefits determined and quantified in this section is shown in Table 4.1.

Table 4.1 – Comparison of Costs & Benefits Included in CBA

Project	Cost or Benefit?	Type	Amount
Improved Energy Performance	Benefit	Gradient	$440k in 1st year up to $1.6M in 8th year
Personnel Costs	Cost	Annual	$200,000 per year
Energy Efficiency Projects	Cost	Annual	$148,000 per year

It should be noted that the costs and benefits in Table 4.1 do not represent all of the factors involved in ISO 50001 implementation, but they were the most appropriate and most measurable for a cost-benefit analysis.

Determining a Social Discount Rate

Before these costs and benefits can be analyzed at a net present value (NPV), a social discount rate must be determined. There is no clear consensus in government and academia on the appropriate social discount rate for economic analyses (Steinemann et al, pg. 334, 2005). Because of this, the calculation will be provided for three discount rates that will be labeled low, medium, and high. The “low” discount rate of 2% is called the “social rate of time preference,” which is the rate at which society is willing to trade off present consumption for future benefits. It values the well-being of future generations as less but nearly equal to the well-being of the present generation (Steinemann et al, pg. 334, 2005).

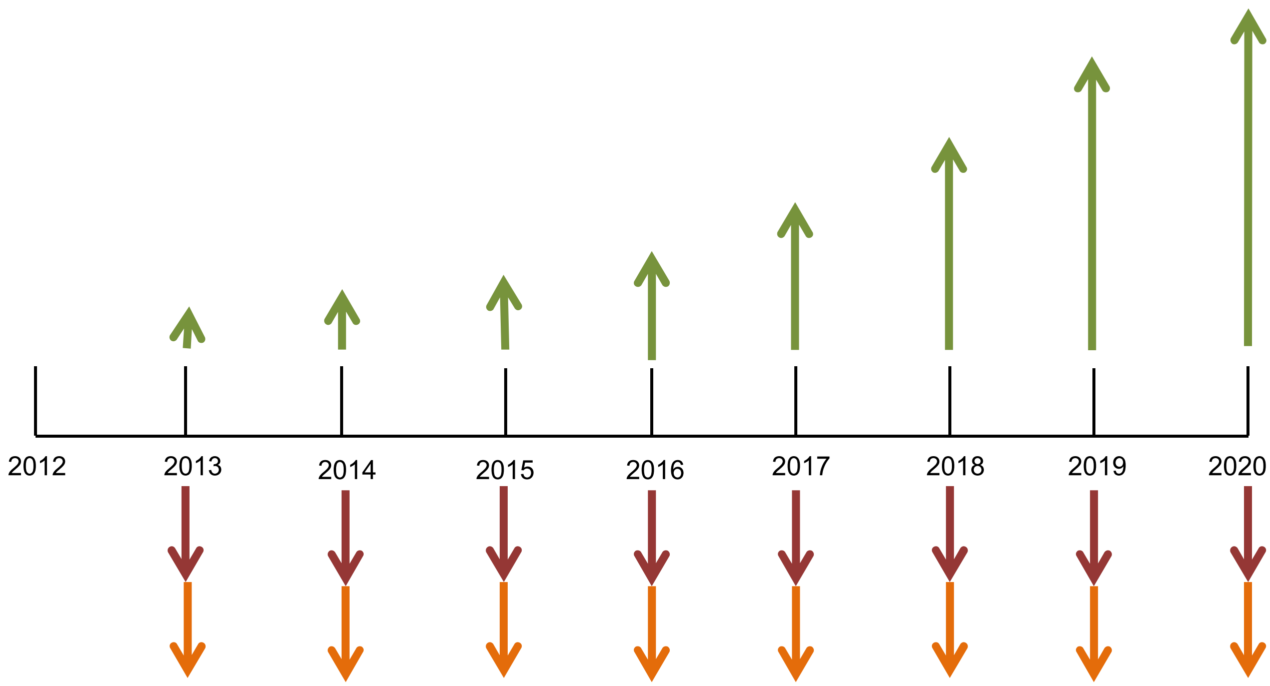
The “medium” discount rate will be 5%, which appears to be in the middle range of commonly used public sector discount rates. The “high” rate, 7%, is commonly used in government and is what the U.S. Office of Management and Budget (OMB) directs federal agencies to use (Steinemann et al, pg. 335, 2005). The range of discount rates provided in this analysis will give GT Facilities the ability to compare rates and make the best decision based on alternatives.

Evaluating the Costs versus the Benefits

The costs and benefits determined in the previous sections must be placed in equivalent terms so they can be weighed against each other. This will be done by calculating the net present value (NPV) of each cost or benefit, then finding the benefit cost ratio by dividing the benefits by the costs. The typical decision criterion is that if the benefit-cost ratio is greater than 1, the project is justified.

A cash flow diagram, which is shown in Figure 4.3, is a useful tool for visualizing and calculating the CBA.

Figure 4.3 – Cash Flow Diagram of ISO 50001 Implementation



In Figure 4.3, the benefits to Georgia Tech are upwards-pointing arrows in green, and the costs are downwards-pointing arrows in red and orange. The green arrows symbolize improved energy performance each year, red arrows symbolize annual personnel costs, and orange arrows symbolize annual capital expenditures on energy efficiency projects.

The cash flows shown in Figure 4.3 can be converted to NPVs by using the factor method outlined in the textbook *Microeconomics for Public Decisions* (2005). The factors are derived from equations of the time value of money and provide a simple reference table for various discount rates and interest periods, depending on the situation. The factor equations for the benefits and costs sections of the analysis are shown in Equations 4.3 and 4.4:

$$P = \$X[P/F\,, R, 8\,] \qquad \text{(Equation 4.3)}$$

$$P = \$X[P/A\,, R, 8\,] \qquad \text{(Equation 4.4)}$$

where *$X* is the initial cost or benefit, *[P/F]* is a present worth factor of a future cash flow, *R* is the discount rate, and *[P/A]* is a present worth factor of an annual cash flow.

Table 4.2 categorizes the cost-benefit analysis by the 2%, 5%, and 7% discount rates mentioned previously. For each rate, the total costs and benefits are shown, as well as the benefit-cost ratio that can be used in the decision making process.

Table 4.2 – Cost Benefit Analysis for Three Discount Rates

	Social Discount Rates		
	2%	**5%**	**7%**
P/F Factor (Year 8)	0.8535	0.6768	0.582
P/A Factor	7.3255	6.4632	5.9713
Energy Savings	$7,428,951	$6,388,857	$5,803,763
Personnel Costs	$1,465,100	$1,292,640	$1,194,260
Energy Project Costs	$1,084,174	$956,554	$883,752
Total Costs	$2,549,274	$2,249,194	$2,078,012
B/C	2.91	2.84	2.79

Not all calculations used for the cost-benefit analysis are shown in Table 4.2, but they are included in spreadsheet form in Table A.8 of the Appendix. The last row of Table 4.2, *B/C*, is the benefit-cost ratio, which was calculated by dividing the energy savings by the total costs (personnel and energy project costs). It can be seen that even for the highest discount ratio, the present value of the benefits is over 2.5, which means the present value of the benefits is at least 2.5 times that of the costs. A B/C ratio of 1.0 is the minimum threshold for determining if a project is justified. The “low” discount rate has a benefit-cost ratio of 2.79, the “medium” rate has a ratio of 2.84, and the “high” rate has a ratio of 2.91.

Conclusion

The benefit-cost ratios resulting from this analysis clearly show that the monetary advantages from implementing the ISO 50001 standard outweigh the costs. Comparing business as usual with a comprehensive energy management system, the energy performance improvements will save the Institute at least 2.79 times the amount that it will invest in personnel and energy efficiency improvements over the next eight years.

This analysis is a good place to start in the decision-making process for an energy management system. Many assumptions were made for this analysis, and only a limited amount of data was made available for the calculations. Perhaps the biggest limitation was the lack of information for energy efficiency project costs. The assumption in the analysis was based on an existing energy audit for the Sustainable Education Building, but each building on campus varies so much in size and function that there could be a greater variation of project costs for building energy upgrades. Given Georgia Tech Facilities' wealth of building data and energy information, it may be useful for GT Facilities to use this analysis as a template and guide for some more in-depth cost-benefit calculations.

As stated previously, not all benefits and costs from ISO 50001 can be converted to a single metric of net present value. There are numerous social and environmental benefits that were beyond the scope of this analysis, but they should still be noted. The positive effects of ISO 50001 go well beyond simple reductions in EUI over an eight year period—the campus will remain more energy efficient for many years beyond that because the standard lays the framework for continual energy performance improvement. Therefore, GT Facilities will keep this trend of efficiency moving forward into the future to eventually meet the goals for 2040 and 2050 outlined in the Climate Action Plan.

References – Chapter 4

Steinemann, Anne C., William C. Apgar, and H. James Brown. "Cost-Benefit Analysis."*Microeconomics for Public Decisions*. Mason, OH: Thomson/South-Western, 2005. 321-47. Print.

Elliott, R. Neal, Skip Laitner, and Miriam Pye. Considerations in the Estimation of Costs and Benefits of Industrial Energy Efficiency Projects. Rep. no. 97-551. Washington, DC: American Council for an Energy-Efficient Economy, Print.

Parrish, Kristen, and Julia Ledewitz. "Early Lessons Learned from Building an ISO 50001: Conformant Energy Management System for MIT." 2012.

Chapter 5 – Conclusion

This paper has offered all of the information necessary for Georgia Tech to become certified for the ISO 50001 Energy Management standard. The Standard provides guidance for Georgia Tech to integrate energy efficiency into its management practices, which would enable the Institute to establish the systems and processes necessary to continuously improve energy performance, thus increasing efficiency and reducing costs in a transparent and sustainable fashion.

With the creation and prominence of the energy conservation team at Georgia Tech Facilities, the Institute has the resources and abilities to implement the comprehensive energy management system included in the ISO 50001 standard. One of the key characteristics of the standard is the creation of an organization-wide energy policy, which would galvanize support from the various stakeholders on campus for specific energy reduction targets and objectives. The Institute has already committed to achieve goals of a 15% energy intensity reduction by 2020 from the 2007 baseline, along with a 50% reduction by 2040 and carbon neutrality by 2050. While the energy conservation team is making some notable efforts toward achieving these goals, the incremental nature of their projects will not result in achieving any of those goals at the current rate of energy consumption.

The case studies shown in Chapter 2 of this paper are useful for the decision-making process—organizations similar to Georgia Tech, including MIT and University College Cork (Ireland), have successfully implemented the ISO 50001 standard and are already seeing significant energy performance improvements. At the time of writing, MIT had implemented the energy management system in one campus building and was expecting a 12-15% improvement in whole-building energy performance (McKane 2009), and University College Cork had seen a 5% improvement in the first six months of implementation (Enerit 2012).

Chapter 3 provided a road map for ISO 50001 implementation at Georgia Tech, and it included recommendations specifically tailored for Georgia Tech for defining the scope and boundaries, creating an energy policy with input from the campus community, baselining energy data, creating energy performance indicators, developing energy objectives and targets, and sustaining and improving the system, among others. While the steps and recommendations cover many aspects of the ISO 50001 standard, it is recommended that GT Facilities visit the DOE eGuide (https://ecenter.ee.doe.gov/EM/SPM/Pages/Home.aspx) for additional guidance and resources. The energy conservation team can also obtain more guidance and resources from Bill Meffert, who helped develop the ISO Standard and works for the Energy & Sustainability Services group at Georgia Tech's Enterprise Innovation Institute (bill.meffert@innovate.gatech.edu).

The analysis in Chapter 4 quantified the costs and benefits that Georgia Tech will incur for the next eight years from ISO 50001 implementation. This was done by developing models of energy consumption for the next eight years—one model assumed efficiency projects would continue at a "business as usual" rate with a 4.3% decrease in the campus energy use (EUI) per year. The other model assumed Georgia Tech implemented a comprehensive energy management system that allows the campus to reach the Governor's Energy Challenge of a 15% reduction in EUI by 2020 from a 2007 baseline. The difference in energy performance between the two models was used to determine cost savings over the eight year period. Two main costs were also included in the analysis: personnel costs and capital expenditures for energy efficiency projects in campus buildings. Personnel costs were determined based on information from ISO 50001 implementation on MIT's campus. Capital expenditures for energy efficiency projects were estimated from a previous energy audit that the GT Facilities conservation team performed on the Sustainable Education Building (SEB).

The costs and benefits in the analysis were discounted into net present values for a simple comparison. The net present values were calculated for three different social discount rates, and benefit-cost ratios were presented to aid in the decision making process. The benefit-cost ratio for ISO 50001 implementation was over 3.0 for all social discount rates, which means the benefits to the Institute greatly outweigh the costs.

This paper is intended to be an initial guide to creating a comprehensive energy management system at Georgia Tech. The Institute has already prioritized energy conservation and sustainability, and GT Facilities has made impressive progress with its energy initiatives. The next step to achieving the goals outlined in the campus climate action plan is developing an energy management system, and the ISO 50001 system will lead to sustainable and continuous improvements in energy performance, while allowing the campus community to participate in the energy planning process.

Appendix

Table A.1 - Scope and Boundaries Worksheet

Some questions to consider in defining the scope and boundaries of your energy management system include:

- Do you have a building or location that you are not including?
    - Can you isolate the energy use of those locations?
- Do you have a process or product line you are not including?
    - Can you isolate or subtract out the energy use of the process or product line?
- Is there an area on which you do not have energy information?
- Is there an area where you cannot gain employee involvement or participation?
- Are there areas that have a different management team or decision structure?
- What are the physical limitations of the areas that are included?
- What are the physical limitations of the areas that are NOT included?
- How do the areas that are included and are not included compare to the site map or plat?

Worksheet for Defining Scope		
Topic	**What is Included?**	**What is Excluded?**
Property/Sites		
Facilities/Buildings		
Activities/Operations		
Management Team		

Worksheet for Defining Boundaries			
Topic	**What is Included?**	**What is Excluded?**	**Do you have energy information available?**
Energy Systems			☐Yes ☐ No
Processes			☐Yes ☐ No
Equipment			☐Yes ☐ No
People/Functions			☐Yes ☐ No

Based on the information above formulate a scope and boundary statement.

Table A.2 - Energy Policy Worksheet

Use this worksheet to help compose an energy policy.

1. Write a sentence or phrase that describes the business of your organization.
2. Think about how your organization uses energy. Consider, for example: How much energy does the organization use? What type(s) of energy does the organization use? What are the effects of the organization's energy use: on the environment; on the community; on the organization?
3. Write a sentence or phrase committing your organization to continual improvement in energy performance.
4. Write a sentence or phrase that commits your organization to providing the resources and information needed to achieve your energy objectives and targets.
5. Write a sentence or phrase committing your organization to comply with legal requirements and other requirements which relate to your organization's energy use.
6. Write a sentence or phrase committing your organization to the use of energy objectives and targets.
7. Write a sentence or phrase committing your organization to the purchase of energy efficient products and services.
8. Considering your response to item #2, combine your statements from items 1, 3-7 into a short paragraph to form a draft policy statement. Consider the use of bullets, mnemonics, etc.

Table A.3 - Alternate Energy Policy Worksheet

Organizations that already have a draft or approved energy or other management system policy can use this alternate worksheet to evaluate whether their policy meets the basic expectations for an energy management system policy .

Yes	Requirements
☐	1. Did top management define the policy?
☐	2. Does the policy reflect the manner, amount and the results of the organization's energy use?
☐	3. Does the policy contain a commitment to continual improvement in energy performance?
☐	4. Does the policy commit to providing the resources and information needed to achieve the energy objectives and targets?
☐	5. With respect to the organization's energy use, does the policy commit to complying with legal requirements?
☐	6. With respect to the organization's energy use, does the policy commit to compliance with any other requirements the organization undertakes?
☐	7. Is the setting and reviewing of the objectives and targets outlined by the policy?
☐	8. Is the purchase of energy efficient products and services supported by the policy?
☐	9. Is the energy policy documented?
☐	10. Is the policy communicated to employees and others working on behalf of the organization (e.g. on-site contractors and suppliers)?
☐	11. Is the policy regularly reviewed and updated as needed?

Table A.4 - Example Energy Policy

As an energy intense manufacturer of specialty glass, XYZ Company strives to reduce its energy consumption and costs and promote the long-term environmental and economic sustainability of its operations. We are committed to:

- **R**educe energy use per unit of production by 25% in 10 years in our manufacturing operations
- **E**nsure continual improvement in our energy performance
- **D**eploy information and resources to achieve our objectives and targets
- **U**phold legal and other requirements regarding energy
- **C**onsider energy performance improvements in design and modification of our facilities, equipment, systems and processes
- **E**ffectively procure and utilize energy-efficient products and services

Table A.5 - Example Energy Management Action Plan

Example Energy Management Action Plan

Objective: Reduce natural gas use by 5% compared to baseline FY 2006	**Original Issue Date:** 12/22/11
Target: Reduce boiler natural gas use 2.5% compared to baseline FY 2006	**Revision Date:**
Energy Management Project: Preheat boiler combustion air from 90^{o}F to 110^{o}F	

Project Planning

Action Items	Person Responsible	Due Date	Required Resources/Comments
Assign project team	Management Rep.	2/14/11	Design, maintenance and procurement representatives
Collect data	Joe Mechanic	3/1/11	Assistance from maintenance
Design heat exchanger	Ima Engineer	5/8/11	Autocad access
Install system	Acme Contracting	6/14/11	Overhaul boiler during installation (See boiler plan)
Test and commissioning	Joe Mechanic and Ima Engineer	6/28/11	
Savings validation	Ima Engineer	7/1/11 – 6/30/12	Maintenance to collect data daily See Project Verification Plan

Target Verification Plan

Item	Information/Resource Requirements
Calculate EnPI in Btu/lb of product each month for baseline year	Boiler gas meter data and production and temperature data for FY 2006
Calculate EnPI in Btu/lb of product each month for 12 months after installation	Boiler gas meter, production and temperature data for 12 months after installation
Calculate average annual EnPI for each 12 month period	
Calculate percentage difference in average annual EnPI for baseline year and 12 months after installation	
Calculate average monthly savings for bottom up analysis	M&V requirements, documented savings

Actual Results/Comments: Based on production records and meter readings the project resulted in an energy savings of 300 Btu/lb based on production and a 1,570,000 Btu/hr (25.4 CFM) savings of natural gas.

Prepared by: Earnest Brown	**Date: 12/22/2011**
Approved by:	**Date:**

Table A.6 - Example Internal Audit Plan

Organization: ABC Company
Audit Date: 4/2/2011
Scope: Significant Energy Use-Melting Operations
Objective: Evaluate and determine the implementation and effectiveness of management of the Significant Energy Use-Melting Operations
Audit Team: Carol Brown (Lead); Dianna Johnson

Process or Area to be Audited	Start Time/ End Time	Auditor(s)	Requirements (Criteria) to be Audited	References
Energy Management Representative	1:30 – 2:30 PM	Carol	Energy Planning – process for determining significance, Energy Planning – objectives, targets, and action plans	Energy Planning Procedure Record of SEUs Objectives and targets setting
Human Resources (Training Coordinator and EHS Coordinator)	1:30 – 3:00 PM	Dianna	Competence, awareness and training	Training procedure Training records Awareness records Contractor training records Sign–in sheets Visitor and contractor video
Maintenance (Technicians) Melting Operations (Supervisors and Operators)	2:30 – 4:00 PM	Carol	Operational control and maintenance	PM System Melting Operations Procedures
Construction & Facilities Management Purchasing	3:00 – 3:45 PM	Dianna	Design and Procurement	Design process – Gate 2 and 3 Purchasing specs Supplier evaluation criteria
Melting Operations Management	3:45 – 4:30 PM	Dianna	Monitoring, measurement and analysis	Measurement plan 2011 Melter VI monitoring records and analysis records
Operations VP Plant Manager	4:00 – 4:30 PM	Carol	Management review	Management review records Management review procedure

Table A.7 - Management Review Preparation Form			
Types of Information Needed by Management	**Potential Sources of Information**	**Person Responsible for Collecting Data**	**Due Date**
What is the status of the energy management system?	➢ Action items from previous management reviews from records of management review ➢ Energy review – Current energy performance ➢ Energy review - Current significant energy uses ➢ Measuring and monitoring – EnPIs ➢ Energy objectives, targets, and action plans - Status of action plans ➢ Evaluation of legal and other requirements – Evaluation results ➢ Nonconforming, correction, corrective, preventive action - Status of correction, corrective, and preventive actions		
What strategic changes or modifications are needed to the program direction we are taking (e.g., a policy change), if any?	➢ Energy policy - Review of the energy policy ➢ Objectives, targets, action plans - Review of the objectives and targets ➢ Legal and other requirements - Review of changes to legal requirements ➢ Energy review –Review of energy sources and potential for renewable energy sources or other technologies		
What changes are needed, expected or have resulted in terms of energy performance?	➢ EnPIs- EnPIs ➢ Measuring and monitoring – Results of measuring and monitoring of key characteristics of energy performance ➢ Objectives, targets and action plans - Status of action plans		
Are there any changes in external requirements that will affect the energy management system?	➢ Changes in legal requirements ➢ Changes in other requirements ➢ Changes in stakeholder expectations		
Are there any changes internally that will affect the energy management system?	➢ Internal audit results ➢ Energy review – Review and update ➢ Design – Planned changes ➢ Procurement – Planned changes		
Do the current measures provide the correct information?	➢ Review of current EnPIs ➢ Review of current baseline ➢ Review of actual versus expected energy consumption achieved		

Table A.7 - Management Review Preparation Form			
Types of Information Needed by Management	**Potential Sources of Information**	**Person Responsible for Collecting Data**	**Due Date**
Is there a need to change, add, or delete any current improvement objective?	➢ Prioritized list of opportunities		
What resources are needed for the energy management system?	➢ Recommendations of employees and stakeholders for improvement ➢ Future energy consumption of the SEUs ➢ Internal audit Schedule ➢ Projected energy performance for the following period		
Is the energy management system suitable for the organization?	➢ Energy policy – Review of the energy policy ➢ Internal audit results ➢ Changes in stakeholders expectations ➢ Status of the action plans and the actual vs. expected performance of those plans ➢ Current performance of the facilities, systems, processes and equipment		
Is the energy management system working?	➢ Status of the action plans and the actual vs, expected performance of those plans ➢ Current performance of the facilities, systems, processes and equipment		
Is the energy management system providing continual improvement in energy performance?	➢ Achievement of the objectives ➢ Management of the SEUs ➢ Measurement of the relevant variables		

Table A.8 – Energy Savings Calculations

		2% Discount Rate		5% Discount Rate		7% Discount Rate	
Year	Energy performance Cost Savings	P/F Factor (2%)	Energy performance NPV (2%)	P/F Factor (5%)	Energy performance NPV (5%)	P/F Factor (7%)	Energy performance NPV (7%)
One (2013)	$583,172	0.9804	$571,742	0.9524	$555,413	0.9346	$545,033
Two (2014)	$1,249,236	0.9612	$1,200,766	0.907	$1,133,057	0.8734	$1,091,083
Three (2015)	$1,993,014	0.9423	$1,878,018	0.8638	$1,721,566	0.8163	$1,626,898
Four (2016)	$2,811,164	0.9238	$2,596,954	0.8227	$2,312,745	0.7629	$2,144,637
Five (2017)	$3,700,488	0.9057	$3,351,532	0.7835	$2,899,333	0.713	$2,638,448
Six (2018)	$4,657,926	0.888	$4,136,238	0.7462	$3,475,744	0.6663	$3,103,576
Seven (2019)	$5,680,548	0.8706	$4,945,485	0.7107	$4,037,165	0.6227	$3,537,277
Eight (2020)	$6,765,551	0.8535	$5,774,398	0.6768	$4,578,925	0.582	$3,937,551
Total	**$27,441,100**		**$24,455,132**		**$20,713,948**		**$18,624,502**