Managing Energy Use in the Nantucket Municipal System

Nantucket Project Center 2013

A Worcester Polytechnic Institute Interactive Qualifying Project

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ABSTRACT:

This project aimed to assist the Nantucket Energy Office in promoting responsible energy use and management in municipal facilities, through use of the MassEnergyInsight (MEI) toolkit and a survey assessment of employee conservation awareness. MassEnergyInsight generates reports on energy consumption in municipal facilities, which can supplement the materials of the SEE the Light energy conservation education toolkit. Continued maintenance of the MassEnergyInsight toolkit, and quarterly distribution of the generated reports, is recommended to improve monitoring, communication, and education of municipal energy use to employees.

EXECUTIVE SUMMARY:

The purpose of this project was to assist the Nantucket Energy Office in promoting responsible energy usage on the island of Nantucket by tracking and measuring the energy consumption trends of Town departments. With the help of the MassEnergyInsight (MEI) municipal energy management software tool, our team analyzed liquid fuel and electricity consumption trends in municipal facilities, identified instances of efficiency and inefficiency, and generated reports, graphs, and other visuals that can be used to inform municipal employees about their energy use. Surveys were distributed to assess town employees' attitudes towards energy conservation. Our team made recommendations to the Nantucket Energy Office on how to most effectively promote efficient energy use within municipal facilities.

The scope of this project initially extended only to the municipal system and its employees. However, the project developed to benefit the community of Nantucket by promoting energy management efforts in the municipal system to support a broader sustainable energy consumption paradigm for the island, to prevent a foreseeable need for infrastructure expansion. The structure of background research, proposed methodology, and deliverables, as outlined in Figure A, allowed us to assist the Nantucket Energy Office. Through the decoration of a Christmas tree with energy saving tips we created our first energy educational visuals. This tree was located outside of the Nantucket Energy Office and was viewed by town residents during Christmas stroll.

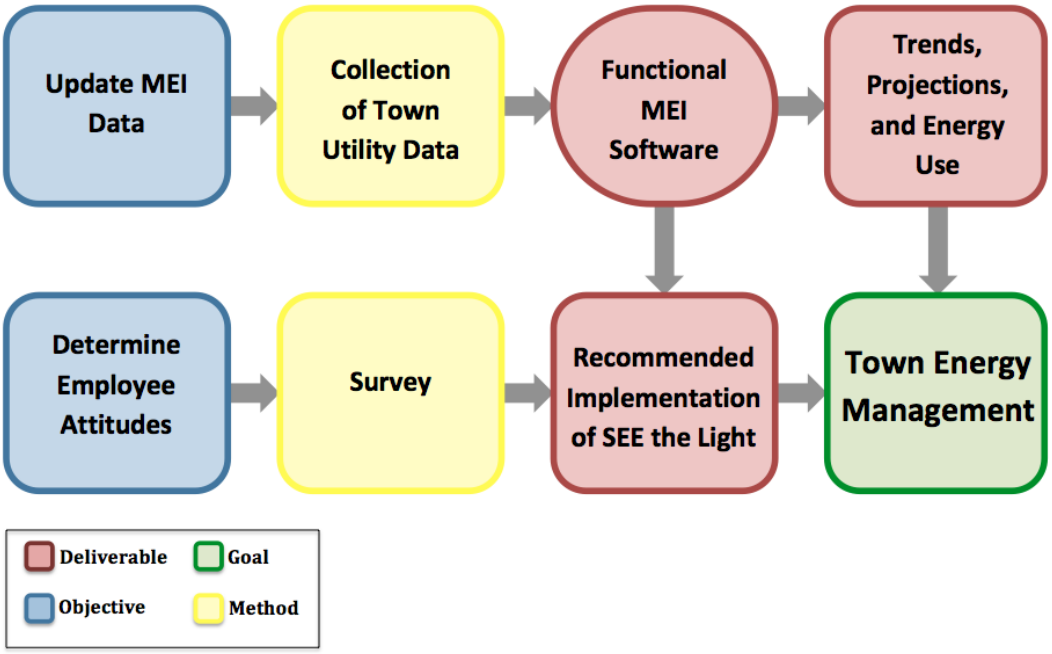

Figure A: Outline of Objectives and Deliverables

The Nantucket Energy Office and Nantucket Memorial Airport had previously secured use of the MEI toolkit, available for free to all Massachusetts municipalities through the Department of Energy and Resources, in late 2012. However, much of the user-defined data within the software was either out of date or disorganized. Following initial research, we had learned how to use the MEI tool, which called for the acquisition of accurate information on utility accounts and facility identification, accomplished through site visits to many town-owned buildings, and reconciliation of Town financial records, National Grid bills, Harbor fuel, and Yates Gas invoices. With the updated toolkit we generated reports, such as that seen in Figure B, showing energy consumption over varying periods of time for buildings, complexes, and the entire municipal system.

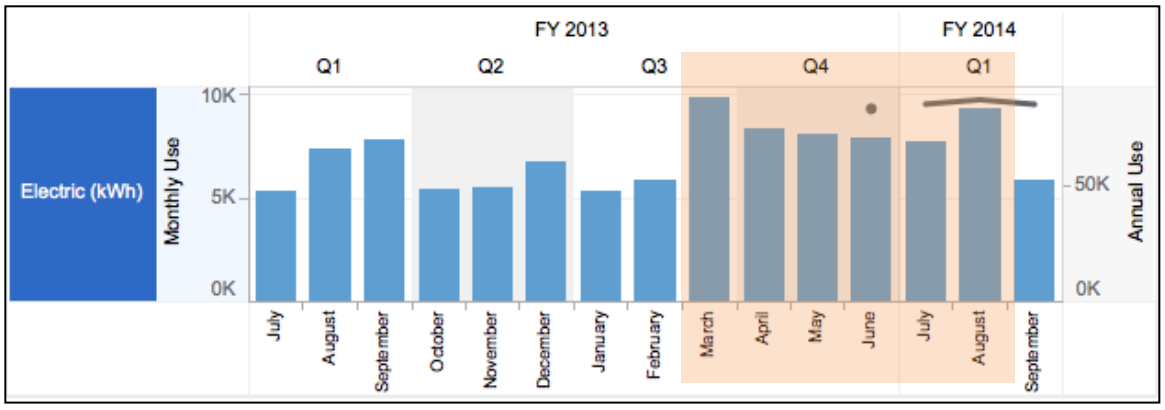

Figure B: MEI report of monthly consumption, with highlighted deviation from baseline trend

In order to assess employees' attitudes towards energy conservation in the work place, our team distributed a survey, designed to study employees' perception of accountability for managing energy, the awareness of town employees towards energy costs and payment, daily energy use routines at work compared to home, and the employees' awareness of the Nantucket Energy Office's current conservation efforts and programs. Questions about possible incentives and contests were included to determine effective ways to promote and sustain more conscientious energy usage in the municipal system.

Based on the survey results, municipal employees are generally conscientious of their energy usage in facilities, but room for improvement on an individual basis remains. There exists a need to make current energy initiatives, such as promotion of the Mass Save residential incentive program, more visible to employees. Survey respondents also expressed a desire for visible reminders of energy efficient methods in the work place, and the need for energy conservation education. The town had previously procured use of the SEE the Light Toolkit, which contains materials and plans to educate and motivate employees to promote energy conservation in the work place. A focal point of SEE the Light is incentivizing employees' conservation efforts. Although material rewards are suggested by the toolkit, survey results indicated that Town employees would be most motivated if they could clearly see the positive impact made through their conservation efforts.

Deployment of an employee education plan, including education for current employees, new employees (as part of Human Resources orientation), and continued education, is a logical starting point to promote conservation efforts. A primary means of continued education and information is through distribution of a quarterly newsletter to town employees, containing monthly usage reports specific to each building, seasonal conservation tips, and any Energy Office news such as the availability of upcoming free energy audits for Nantucket residents. Furthermore, placement of stickers, posters, and informational tools, such as thermometers provided by SEE the Light, around town facilities, and the appointment of "Energy Champions" in each facility, defined as volunteers whom assist in promoting the goals of conservation and efficiency on a daily basis with specific knowledge of their building's infrastructure, serve to provide employees with positive reminders to remain conscious of their usage habits.

Survey responses support the proposal of discrete monitoring and budgeting of energy use for Town departments. By making departments individually responsible for payment and management of energy bills, as opposed to the current system of centralized budgeting and payment by the Town finance department, conservation is motivated through increasing awareness of energy expenses, and allowing any savings made through conservation to be utilized within the department, thus directly benefitting the employees who made the savings possible. Implementing sub-meters on accounts serving multiple departments in different buildings, such as the meter serving the Town hall and outlying buildings, would be vital to measuring and managing energy consumption by each department, and allow the Energy Office to monitor the energy usage of individual facilities to better pinpoint sites of efficient and inefficient usage.

Nantucket could benefit from National Grid's Deep Energy Retrofit (DER) Pilot Program to meet the municipal system's needs while managing its energy usage. Participation in this program would allow the Town to tailor existing programs to meet Nantucket's unique needs, and provide access to grants and incentives that would otherwise only be made available to Green Communities. For example, no incentives currently exist for weatherization in municipalities, as the majority of Town facilities in mainland communities are designed as large commercial structures, in which

weatherization does not prove effective. However, many of Nantucket's municipal buildings are converted residential structures, which could benefit greatly from weatherization, such as that provided for residential consumers under the Mass Save program. Appropriate local candidates for such a program are 37 Washington Street (Finance office), 3 East Chestnut Street (NRTA Office), and 16 Broad Street (Town Hall).

Our team is leaving the Town of Nantucket with a foundation for continued energy management that can be implemented throughout the municipal system. By implementing the SEE the Light Toolkit in Town facilities, municipal employees will have access to educational resources that will help increase their awareness of day to day energy usage and methods of conservation. Maintaining the MEI database with accurate and up-to-date account information will allow for continued reporting of energy consumption at all municipal levels, and provide graphical resources for newsletter communications from the Energy office to municipal employees.

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CHAPTER 1: INTRODUCTION

In 2010, the United States consumed approximately 3.7 million kWh of energy and approximately 12.1 thousand kWh of energy per-capita ("U.S. Per Capita Electricity by State," 2010), making the country the eleventh highest per-capita energy consumer, and the second highest total energy consumer in the world (Barr, 2012). By participating in energy efficiency programs, habitual changes in daily energy consumption has been made to reduce expenditure on, and subsequently, the costs of energy. Without action being taken to reduce energy consumption, the global economy will continue to see the effects of such inefficiencies in the form of increased prices, as demand climbs amidst depleting supplies (Abrahamse, 2005). Energy efficiency programs have given individuals the incentive to reduce their energy consumption by making a change in their everyday behaviors.

The island of Nantucket, situated 30 miles off the coast of Cape Cod, Massachusetts, presents a unique set of logistical challenges regarding the sourcing of energy due to the remote location, resulting in abnormally high costs to the consumer. Electricity is supplied to the island by two undersea cables, delivering a combined 74 MW of power, at a price of roughly $0.17 per kWh for residential meters, compared to the average cost of $0.14 per kWh for mainland Massachusetts (Beliveau, Hesler, Jaskolka, & Sigety, 2010; Jiang, 2011). Gasoline and diesel arrives on Nantucket via barges, which are offloaded to a tank farm downtown for storage and distribution to consumers, at a current cost of $4.57 per gallon for octane 87, compared to a $3.44 average cost per gallon for mainland Massachusetts (reported on October 11, 2013). Although the average cost of gasoline in Massachusetts does occasionally approach similar levels, the lengthened supply chain that the liquid fuels must endure to reach Nantucket consistently adds roughly $1 per gallon in price. Propane, which is used on island in lieu of centralized natural gas, must travel by commercial ferry lines capable of transporting only a limited number of tanker trucks with each trip, resulting in a price of $3.40 per gallon ("Nantucket Energy FAQs", 2006). Aviation fuel for the airport arrives

through the same means, adding a hefty upcharge for both commercial and residential consumers. Nantucket's 77 municipal energy accounts represent the largest consolidated consumer of energy on the island, resulting in a collective expenditure of $3 million in 2012 ("Establishing Nantucket's Energy Baseline", 2012).

Prior to the installation of a second undersea electrical transmission line in 2006, the regional electric utility company, National Grid, excluded large-scale conservation education on Nantucket as a means of reducing demand, as there are no large corporate sites on island, which typically demonstrate greater response to conservation incentives and subsequently, a large decrease in energy consumption (Beliveau et al., 2010). However, as the largest consolidated consumer of electricity on Nantucket, an energy audit and implementation of conservation education within municipal facilities could decrease municipal expenditure on energy. The Nantucket Energy Plan (NEP) was drafted in 2010 to lower energy costs on the island, but was not enacted. Nantucket selectmen did not approve of the proposed model of the NEP due to a lack of specific goals and metrics (Bannon, Ellsworth, & Musselman, 2010). In light of recent increases in peak loading during the summer months, the forecasted need for a third transmission cable to be run from the Cape to Nantucket has become a pressing issue, with electrical demand expected to surpass current supply capabilities before 2023. Thus, the reduction of collective electrical consumption between commercial, residential, and municipal consumers is of great interest to all individuals on Nantucket, who would pay for the construction of a third transmission line in the form of surcharges on electric bills, further raising the cost of energy on island (Sinatra, L., Personal Communication, 11/13/13).

In recent years, implementation of the Mass Save program, directed by the Town of Nantucket Energy Office, successfully reduced residential energy consumption on island. Subsequently, homeowners now have easy access to home energy audits, which provide recommendations to consumers on how energy use can be reduced. Across the island, over 7,000 light bulbs have been replaced with energy-efficient and LED bulbs, and upwards of 300 programmable thermostats were installed in homes. However, there has been limited research on energy consumption or conservation within the municipal system. Further work was necessary to identify trends in municipal energy usage and better understand how to reduce the town of Nantucket's expenditure on energy. The

Nantucket Energy Office procured use of the MassEnergyInsight software (MEI) as a tool developed for usage in tracking consumption trends in municipal metered accounts for electricity and liquid fuels. Prior to the completion of our project, data in MEI was not up-to-date with all records, and was incapable of being utilized to the fullest extent, as meaningful reports could not be generated with the provided data ("WPI Nantucket Project Center", 2013).

Our project team assisted the Town in promoting responsible energy usage on the island of Nantucket by equipping the Nantucket Energy Office to track the energy consumption trends of Town facilities. With the help of the MassEnergyInsight tool, our team analyzed liquid fuel and electricity use by municipal facilities, identified instances of efficiency and inefficiency, and generated reports, graphs and other visuals that can be used to inform municipal employees about their energy use. We also distributed surveys to assess town employees' attitudes towards energy conservation. Subsequently, recommendations were made to the Nantucket Energy Office and other department heads on how to best promote efficient energy use by Town employees. Moving forward, the municipal system will be able to stand as a model of efficient energy use for all consumers on Nantucket.

CHAPTER 2: BACKGROUND

2.1 Introduction

This chapter explores the connection between energy consumption, logistics, and cost with regard to the US and the island of Nantucket. Details of energy consumption at a variety of levels, and possible means of reducing consumption, are discussed, as well as the function and integration of energy analysis tools, such as the MassEnergyInsight and SEE the Light toolkits, into energy efficiency programs. The community agencies that are involved with energy sourcing and regulation are also discussed in this section in order to provide insight into local energy consumption, as well as various measures used previously on the island to reduce energy usage by individuals and organizations on Nantucket.

2.2 Energy Usage

2.2.1 Global Energy Consumption

In 2010, the world consumed approximately 524 quadrillion British Thermal Units (BTU) of energy ("Energy Information Administration: Energy Outlook," 2013). The historic coupling between energy consumption and economic growth has led to increased energy consumption as a matter of economic and development policy. Developing countries, also known as non-OECD (Organization for Economic Cooperation and Development) countries, experienced a 90% increase in energy use between 2011 and 2012, while OECD countries experienced a 17% increase over the same time period ("Energy Information Administration: Energy Outlook," 2013).

Fossil fuels account for approximately 80% of world energy use, of which the three main forms are petroleum, coal, and natural gas ("Energy Information Administration: Energy Outlook," 2013). Each form of fossil fuel generally serves a specific purpose. Petroleum is refined to make gasoline, diesel, and other liquid fuels for transportation and industrial purposes, coal is burned to produce electricity, and natural gas is consumed in an increasingly broad scope in the transportation, residential, and commercial sectors ("Fossil Fuels," 2013).

On a global scale, there is concern about energy security and the impact of fossil fuel emissions on the environment (Lefevre, 2010). Energy security is the availability of sufficient supplies at affordable prices (Yergin). Because there are few assessments that give information about energy security, it is difficult for policy changes to be implemented when it comes to energy consumption. As a result, policy makers have relied on expert opinions to determine whether or not government intervention is necessary to reduce energy insecurity. By measuring the price implications of fossil fuel resource concentration in competitive markets, and determining whether or not the depletion of fossil fuels is a matter of physical availability concern, government policies and incentives have been implemented to improve security forecasting for non-fossil fuel energy sources in countries (Lefevre, 2010).

Per-capita energy consumption is defined as the amount of energy that is consumed per unit of population whereas total energy consumption takes all members of the population into account. According to Figure 1, data retrieved from the Energy Information Administration shows that the United States ranked as the world's eleventh highest energy consumer per-capita in 2011, consuming approximately 312 million BTU's of energy per-capita compared to 316 million BTU's of energy per-capita in 2010.

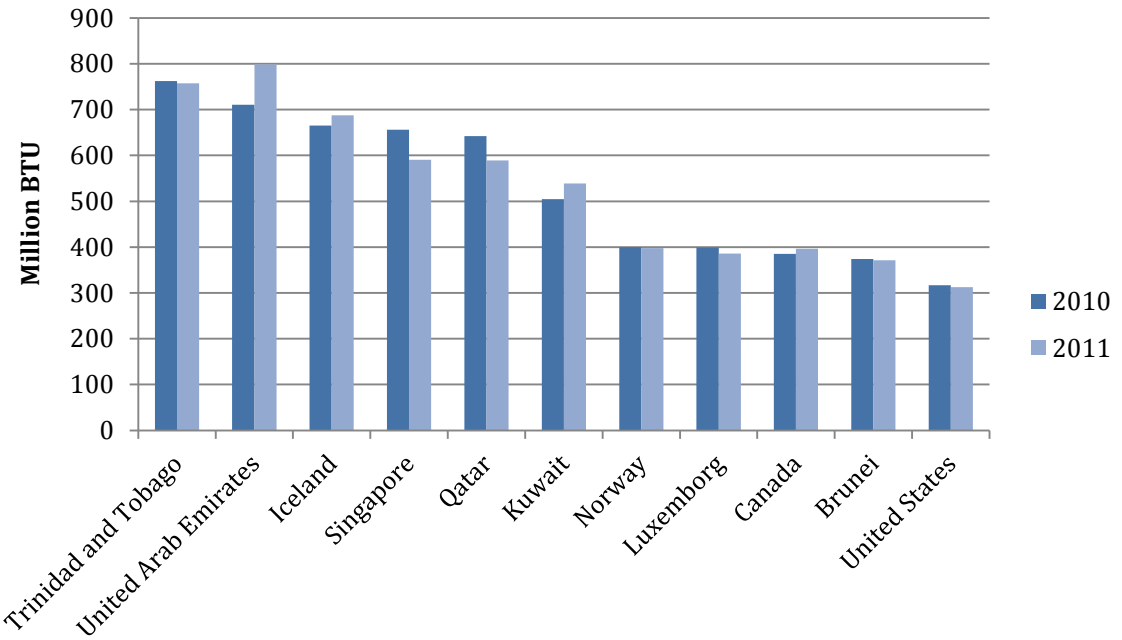

Figure 1: Energy Information Administration, Energy consumption per-capita

The United States is the world's second highest total energy consumer, utilizing approximately 85 quadrillion BTU's in 2012, following China at approximately 107 quadrillion BTU's in 2012, as shown in Figure 2 ("Enerdata," 2013).

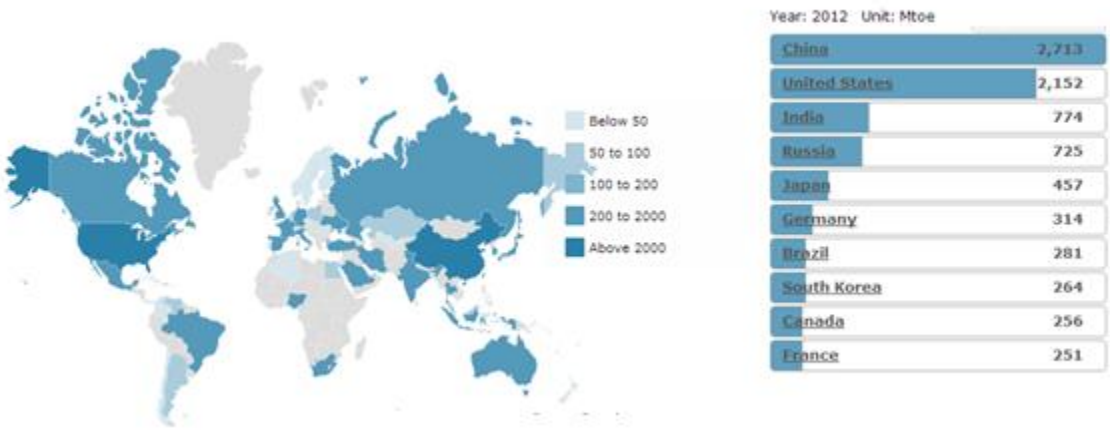

Figure 2: Enerdata's Global Energy Statistical Yearbook 2013, Total Energy Consumption 2012

Four major sectors of energy consumption in the United States are the industrial sector, the transportation sector, the residential sector, and the commercial sector. Of these sectors, the transportation sector and the industrial sector are the largest contributors to the high rates of energy consumption in the United States ("Energy Outlook: Industrial Sector Energy Consumption," 2013). In 2012, approximately 40% of the total United States energy consumption occurred in residential and commercial buildings ("How much energy is consumed").

An increase in energy consumption has resulted in the increase of energy costs in the United States. According to 2010 state electricity profiles reported by the Energy Information Administration, the retail price for electricity increased to 9.83 cents per kilowatt hour (kWh) compared to 9.80 cents per kWh in 2009 ("State Electricity Profiles," 2009). A country's Gross Domestic Product (GDP) measures the total value of goods and services produced in said country. As the GDP per capita increases, the amount of energy consumed per person also increases, demonstrating that an increase in the cost of energy does not directly correlate to an increase in consumers' income (Pisupati).

The United States' economy is capable of reducing its annual energy consumption by 23% by the year 2020 if obstacles can be overcome ("Energy Outlook 2013"). Through incentives and financing, and the implementation of educational programs, steps can be taken to reduce energy consumption. To successfully promote energy conservation initiatives, energy efficiency has been accepted as a vital step towards a sustainable future for the United States. To demonstrate the potential benefits of energy efficient practices, a portfolio that concisely outlines energy use statistics and possible benefits of reduced consumption has been created and launched at the local and national levels to prove the effectiveness of energy efficient practices (McKinsey, 2009). A connection has also been made between government agencies, producers, and consumers to ensure an orchestrated effort at all levels. To ensure long-term success, the implementation of energy efficient technologies has taken place through different initiatives, such as the installation of energy efficient appliances in homes (McKinsey, 2009). Not only has it been helpful for consumers for energy efficient technologies to be implemented, but individuals have also been willing to change their habits, and made use of conservation tactics on a day-to-day basis, by taking part in energy efficiency programs that have been promoted in their communities (Section 2.2.2).

2.2.2 Energy Efficiency Programs

Energy efficiency programs are designed to reduce a community's energy usage. Such programs, provided by utility companies, have resulted in energy and economic benefits, as seen through the changes in a homeowner's utility bill after an energy audit ("Energy Efficiency Programs," 2002). Energy efficiency programs, when implemented by corporations or communities, have also resulted in job growth, particularly in the industry of building trades and increased monetary savings ("Energy Efficiency Programs," 2002).

In 2000, Efficiency Vermont was established to provide technical assistance and financial incentives to Vermont households and businesses in an effort to reduce energy costs that resulted from high energy consumption. Overall, the program provides

Vermont homes and businesses with special incentives to become and remain energy efficient. Efficiency Vermont also provides information to consumers regarding energy issues and trends in energy efficiency. This information is thus used by the government, policy makers, and the residents of the community. Through Efficiency Vermont, gains in energy efficiency offset projected increases in electricity consumption. These operations are financed by a surcharge on consumers' bills. Efficiency Vermont provides a number of initiatives, including the Property Assessed Clean Energy (PACE) initiative which allows homeowners to invest in renewable energy improvements to their homes, and the Energy Savings Account (ESA) Program, which allows Vermont businesses to use a portion of their Energy Efficiency Charge to support energy conservation initiatives in their facilities ("Energy and Efficiency Initiatives," 2000). Over the years, annual savings that resulted from Efficiency Vermont have increased, as seen in Figure 3, with electricity supply requirements having been reduced by 2% between 2009 and 2010 due to energy efficiency installations. The annual savings expressed in Figure 3 indicate the savings that result from reducing energy consumption. The decrease in annual savings indicates a reduction in energy consumption by residents as they take advantage of what is offered by Efficiency Vermont, such as energy audits. CO_2 emissions also were reduced as a result of Efficiency Vermont by 718,000 tons ("Success Stories and Performance," 2010).

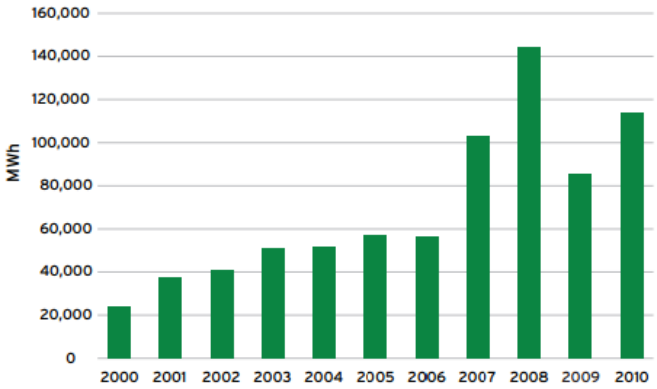

Figure 3: Efficiency Vermont's Annual MWh Savings

Funded by the Solid Waste Fund, the Long Island Green Homes Program was established in 2008. The Long Island Green Homes Program was created to support the upgrading of green efficiency technologies in homes in the town of Babylon, New York.

The program provides homeowners the opportunity to make necessary improvements to reduce areas of energy inefficiency and to assess whether a cost benefit had resulted from such efforts. Rather than pay for the services, such as the installation of energy efficiency upgrades, up front, the program allows homeowners to pay for the costs of these services over time. Although the expenses are paid for by the homeowners, even if the homeowners change over time, the value of the property used to compute property tax does not increase as a result of the upgrade. Once the homeowners sign up for participation in the program, they will have the opportunity to have an energy audit performed on their home to determine what upgrades are necessary to increase efficiency ("Long Island Green Homes Program," 2012). As a result of the Long Island Green Homes Program, 98 homes have been retrofitted, providing new energy efficiency upgrades ("Long Island Green Homes Program in Babylon, New York," 2012).

2.2.3 Green Communities Designation and Grant Program

The Green Communities Division of the Department of Energy Resources offers financial incentives as well as educational and technical support to communities in Massachusetts ("Green Communities Grant Program," 2013). In 2008, Massachusetts enacted the Green Communities Act, a legislation that promotes energy efficiency and encourages investment in renewable energy. Under the Green Communities Act, funding is provided for communities that are investing in energy efficiency upgrades and policies, renewable energy technologies, and demand-side reduction programs ("Green Communities Act: MA,").

When the Green Communities Act was enacted in 2008, approximately 64,000 clean energy jobs were created, from weatherization technicians to photovoltaic engineers. Such an increase in jobs has resulted in Massachusetts moving from 47th in the nation in job creation in 2006 to 5th in the nation in the past two years. The Green Communities Act has contributed to this economic growth by supporting policies that address energy efficiency, net meters, and designating green communities ("Green Communities Act," 2012). The communities involved in this program are pictured in Figure 4.

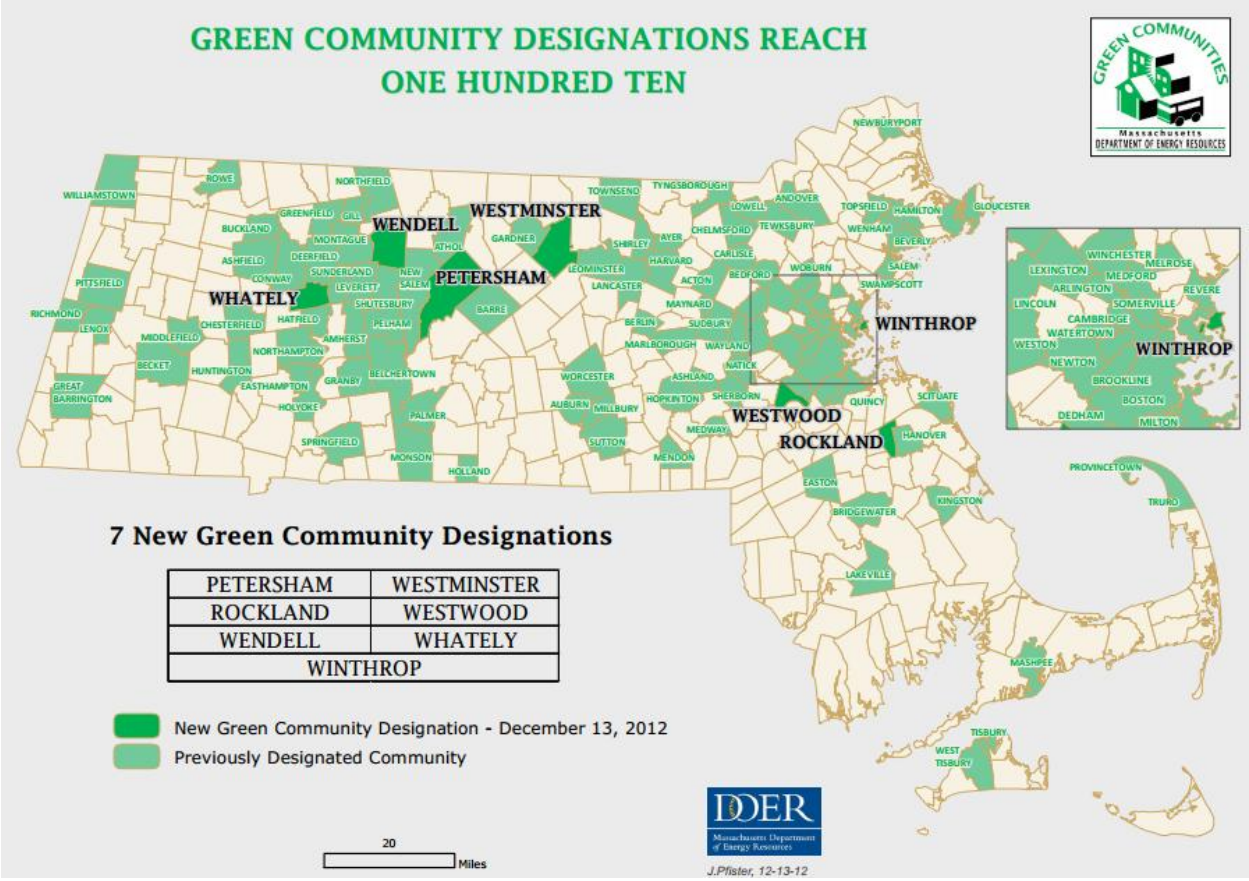

Figure 4: Green Community Designations

In order for a community to be eligible and achieve designation as a Green Community, the following criteria must be satisfied:

- Criterion 1 – "Provide as-of-right siting in designated locations for renewable/alternative energy generation, research and development, or manufacturing facilities."
- Criterion 2 – "Adopt an expedited application and permit process for as-of-right energy facilities."
- Criterion 3 – "Establish an energy use baseline and develop a plan to reduce energy use by 20% within 5 years."
- Criterion 4 – "Purchase only fuel-efficient vehicles."
- Criterion 5 – "Set requirements to minimize life-cycle energy costs for new construction; one way to meet these requirements is to adopt the new Board of Building Regulations and Standards Stretch Code."

A baseline is established through an assessment that focuses on a community's quality of life, environment, and economic strength ("Green Communities Designation and Grant Program," 2013).

2.2.4 Energy On Nantucket

As a remote spit of sand resting dozens of miles out to sea, isolation has long shaped the history of Nantucket. For centuries, Native Americans resided on the island in peace, out of reach of English settlers who swarmed to Cape Cod. However, in 1659, the first settlers made their way to the island, and initially attempted to raise sheep, which met with little success due to the lack of resources to sustain livestock populations. Shortly thereafter, a Right whale wandered into the harbor of Nantucket and was captured by settlers, who reveled in the newfound resource of whale oil, which fueled early lamps and could be exported for profit. The Nantucket whaling industry rapidly developed, establishing the island as a primary supplier of energy and resources for much of the soon to be United States.

The Nantucket whaling industry prospered until the year of 1840, when the isolation of the island, and the additional costs associated with exporting commodities to the mainland, drove the whaling trade to the town of New Bedford, Massachusetts, from which shipments could be made throughout the United States with relative ease thanks to the development of railroads. Despite its prominence as an energy producer, the logistical challenges presented by the isolation of Nantucket once again brought about the end of an industry by which the island had survived ("Nantucket Facts," 2008).

Although difficult for transportation of goods and energy, the isolation of Nantucket has long presented a stunning allure for year-round residents and vacationers alike. Tourism has stood as the primary source of income for the island following the demise of the whaling industry, with roughly 400,000 visitors annually (Gautam, 1999). In addition to the 10,000 year- round residents, the influx of energy consumers to the isolated market presents a large demand for energy in the forms of electricity and liquid

fuels. Prior to 1996, an Electro-Motive Diesel (EMD) power plant, located downtown, provided roughly 20 Mega Watts (MW) of electricity to the island. Demand rapidly surpassed this facility's ability to supply electricity, resulting in frequent outages, particularly during peak tourism months. In 1996, National Grid laid a single 36MW transmission cable, thus tying Nantucket into the Cape Cod power grid. Yet within the following decade, demand once again surpassed the capabilities of the established infrastructure, and a second 38MW cable was laid in 2006, at a cost of $41 million, which was paid for by the addition of a surcharge on the cost of electricity (Beliveau et al., 2010). In the event of peak loading that surpasses the 74MW supply capability of the submarine transmission cables, or a service interruption, 6MW of electrical generation capability exist on Nantucket to meet demand. However, the two EMD generators, located on Bunker Road, have not been brought online in recent history (C. Raymond, personal communication, November 13, 2013).

Regardless of what form imported energy takes on Nantucket, surcharges are added to subsidize the companies that must overcome logistical hurdles to provide modern conveniences to such a remote destination. Residents of Nantucket consistently pay some of the highest prices in the United States for gas ($4.50 / gallon), propane ($3.40 / gallon), and electricity ($0.18 / kWh). Liquid fuels, namely propane and petroleum products, present a logistical challenge to Nantucket because no pipelines exist from the mainland for fear of leaks that could spill toxic fuels into the sound. Diesel and gasoline are supplied to Nantucket via barges, which offload to a tank farm in the downtown area for storage and distribution to facilities around the island roughly 11 times every year to meet demand, whereas propane and aviation fuel must reach the island via tanker trucks transported over on freighter lines operated by the Steamship Authority, which is the only company providing transportation for vehicles to Nantucket. Yet due to the hazardous nature of the cargo, voyages made with a propane truck aboard cannot transport any other vehicles or passengers. This results in exceptionally high rates for propane, which is used in lieu of residential natural gas on Nantucket ("Nantucket Energy FAQs," 2006).

While the costs of energy certainly raise the living expenses of residential consumers, the cost to the Town of Nantucket, the largest consumer of energy on island, is staggering, with nearly $3.0 million spent annually on liquid fuels and electricity ("Town of Nantucket Energy Office," 2013). There are 76 municipal electricity accounts, spread between nearly 30 sites across the island, in addition to roughly 80 motor vehicles owned and operated by the Town. Prior to the aforementioned construction of the second underwater electrical transmission cable, National Grid determined that conservation initiatives would not lower the demand for electricity enough as to avoid such a large infrastructure expansion project. However, current forecasts of electricity demand indicate that the island will require a third cable to meet peak loading demands before 2023 (Raymond, C., Personal Communication, 11/13/13). Thus, the island of Nantucket is on the precipice of attempting a concerted effort to lower demand among all consumers.

2.3 The Town of Nantucket

2.3.1 Socio-Political Challenges of Nantucket

Due to the level of engagement and lobbying power that many residents have with the Nantucket community, tensions arise between public goals and private interests, as in the case with Cape Wind, an offshore wind farm composed of 150 wind turbines (Section 2.4.5). Although publicly most individuals are in support of renewable energy and projects that will reduce the cost of electricity, many powerful stakeholders on island have opposed the erection of wind turbines due to the capital expenditure that is necessary, and an unwillingness to tarnish the landscape they revel in with looming machinery (Zeller, 2013). In lieu of wide-scale energy production projects, a possible means of reducing costs of energy is to target energy conservation education towards consumers, in hopes of decreasing the demand placed on energy supply systems, known as demand-side management (Jiusto & McCauley, 2010). Although such a possibility requires little to no expenditure on the part of the consumer, implementing energy-efficient practices often calls for a change in daily routines. If a population of consumers is not receptive to conservation education, and unwilling to make individual concessions

in the pursuit of a shared sustainable future for Nantucket, such initiatives would prove to have little impact on the overall energy consumption of the island (Abrahamse, 2005).

2.3.2 The Town of Nantucket Energy Office

In 2011, the Town of Nantucket founded the Energy Office in order to assist the Town in the implementation and assessment of energy conservation measures on the island. The Energy Office is funded through an annual grant from ReMain Nantucket, which is a local organization founded in 2008 by Wendy Schmidt, president of the Schmidt Family Foundation, to implement new paradigms of resource consumption, and make investments in the Town of Nantucket ("Remain Nantucket," 2013). The office advises, and provides recommendations to, the Town of Nantucket Board of Selectmen and Town Administration regarding energy policy and practice. The office is composed of senior technical advisor George Aronson, an innovator in business development and implementation of small-scale energy generation facilities, and Lauren Sinatra, a specialist in sustainable resource management and policy.

Due to the challenges faced when attempting to implement alternative energy generation on the island as a means of deferring costs to the consumer, the Nantucket Energy Office focuses on reducing energy usage on Nantucket, rather than converting to alternative energy sources. Through the consolidation work of Ms. Sinatra, the Town has completed nearly 500 energy audits, made available through the Mass Save program and provided by National Grid, on various commercial and residential structures. Such audits allow for consumers to take note of where energy is lost or inefficiently used in their facility, and provide recommendations on how usage can be reduced (National Grid, 2013).

2.3.3 Organization of Town Finances

The Town of Nantucket utilizes a hierarchical budgeting arrangement, in which budgeting for a given entity occurs at an administrative level. The Town of Nantucket takes direction from the voting constituency, from which the Board of Selectmen gains an understanding of how taxpayers would like their tax money to be spent. The Town Administration's budget is approved through these means, from which line items are divided between 7 departments, being Public Safety, Public Works & Parks, Human Services, General Admin, Finance and Budget, Natural Resources, and Planning and Land Use Services. Each department commands numerous complexes and facilities, as seen in Figure 5. However, all bills and expenses for these departments are accounted for within the central Town Administration budget. Additionally, four independently-managed Enterprise Funds exist within the Town system. Individually-managed internal expenditure are the Nantucket Planning & Economic Commission, Nantucket Public Schools, Nantucket Memorial Airport and Wannacomet Water Company. These four Enterprise Funds are thus paid for by the Town, yet fall outside of the financial jurisdiction of the Town Administration. Having an understanding of this cash flow paradigm is crucial for proper evaluation of energy expenditure within the municipal system (Sinatra, L., Personal Communication, 10/29/2013).

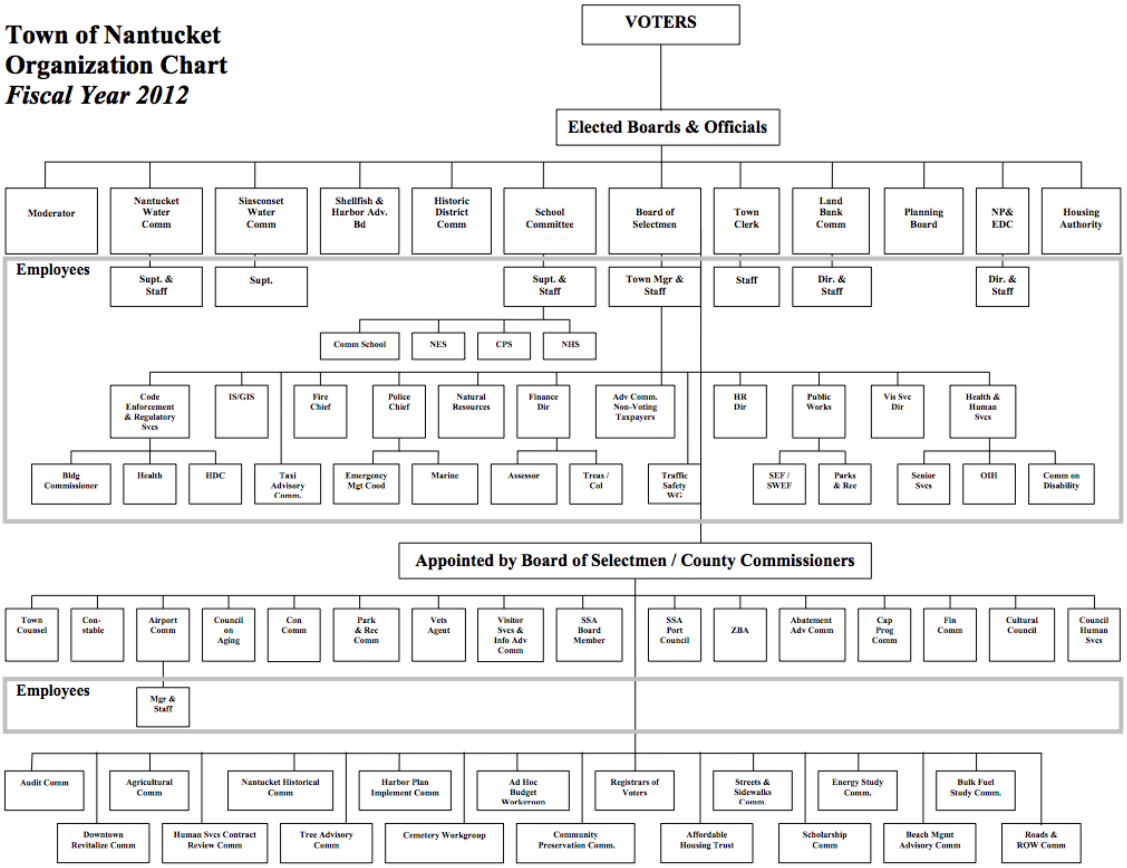

Figure 5: Town Department Organizational Chart 2012

2.4 Energy Analysis

2.4.1 Energy Analysis Tools

Energy analysis tools are computer software packages in which energy data, such as cost and usage of oil, propane, and electric energy, can be input. The software displays the data in tables and graphs for the user to determine trends in energy consumption. The use of energy analysis software tools in the U.S. began in the 1970's, in the aftermath of multiple energy crises. The tools have improved in many aspects since then, including the addition of detailed simulations in the 1980's, and online calculators in the 1990's. Before the advancements, audits were costly and completed by hand. However, with the help of computational tools, the cost of providing audits to consumers was reduced by a factor of 500 (Mills, 2004). Currently hundreds of energy tools exist

globally, and over 250 in the U.S. are catalogued by the U.S. Department of Energy (Building Technologies Office, 2013) as part of an effort to promote demand-side management. Demand-side management is the practice of distributing consumer electricity loads over time, to minimize peak loading of the supply infrastructure. Additional demand-side programs include residential and commercial energy audits (Section 2.4.7), lighting and insulation incentives, appliance energy standards and labeling requirements, and enhanced building energy codes (Jiusto & McCauley, 2010, p. 561). Energy analysis tools are used to reduce energy costs by indicating areas of greatest improvement for energy consumption. The user is educated on efficient use of energy and how to solve related problems. According to Witkin (2012), "savings are possible…as long as the technology is easy for the average consumer to use, and clearly shows what actions can reduce consumption."

Mills (2004) states, "energy analysis software is an essential component of efforts to foster increased energy efficiency in buildings" (p. 865). SchoolDude is an energy education platform of Cloud Solutions, with such global partners as ENERGY STAR, implemented in educational institutions around the world. The web-based energy tracking and management software is not only a database for utility bills, but also an analysis tool where "energy managers [can] analyze years of data at a granular level, looking at each meter, building, and cost per square foot" ("SchoolDude Solutions Overview," 2012). Such tools help schools identify spikes in energy, possibly indicating a billing error. In addition, the software promotes awareness and encourages the sharing of data between managers to streamline energy management. Schools often implement this tool alongside ENERGY STAR's energy monitoring program with minimal operating cost (Worrell, Angelini, & Masanet, 2010). As a result, ENERGY STAR schools cost 50 cents less per square foot, and they use 35% less energy per square foot while producing 35% fewer greenhouse gases per square foot than the average U.S. school ("SchoolDude Solutions Overview," 2012).

2.4.2 Energy Audit Overview

National Grid provides free energy audits in the state of Massachusetts as paid for by the Mass Save Program. Common residential audits are performed by a professional, trained in determining what points of inefficiency to look for, through the use of tools such as Infra-red imaging devices, thermometers, light meters, and Kill-a-watt electricity use meters. Some audits focus on the usage of energy for heating, wherein the auditor will set up a thermal imaging device to see where the building in question is losing the most heat energy. Other audits measure the individual energy usage within rooms or departments in order to determine if a larger than expected amount of energy is used. The auditor will ultimately make recommendations on how to increase the energy efficiency on location, such as weatherization by upgrading windows, or retrofitting existing systems such as appliances, thermostats, or HVAC units. According to the U.S. Energy Office, when efficiency upgrades suggested by an auditor are followed, energy consumption can be reduced by between 5% and 30% of pre-upgraded usage (Gerrity, S., 2013).

2.4.3 Previous Energy Audits on Nantucket

In 2011, a team from Worcester Polytechnic Institute performed a high-level energy audit of the Town of Nantucket, in a project titled *Analyzing and Operationalizing the Nantucket Energy Plan*. Based upon the findings of this project, which assessed consumption across municipal, commercial, and residential sectors, but not at individual sites or facilities, the project group developed a table of options for the Town to implement in order to reduce energy consumption, ranging from revisions in traffic route design, to the construction of a biodiesel rendering facility. Of the recommendations made, the Mass Save program and revisions to lighting systems are among the successfully implemented measures (Bannon et al., 2011).

In the past, few residential energy audits were performed on Nantucket due to the cost of transporting assessment trucks on the ferry. Mass Save is an initiative, sponsored

by energy providers throughout Massachusetts, to provide conservation services and resources to residential, commercial, and governmental consumers. Through the work of the Energy Office, the Town of Nantucket has been able to consolidate energy audits, allowing National Grid to send two trucks to the island for a few days at a time to conduct numerous audits. Roughly 500 audits have been conducted through these means, providing customers with the necessary knowledge to reduce energy consumption, although the implementation of recommended measures remains the responsibility of the individual consumer ("Town of Nantucket Energy Office," 2013; National Grid, 2013; "EnergySaversTips," 2011).

2.4.4 Behavioral Implications of Audits

As previously stated in Section 2.4.1, an energy audit does not directly translate to reduced energy consumption. The deliverable provided to the audited party by the auditor is merely a list of systemic improvements that could be made, and a set of behavioral recommendations, that if both executed, could lead to vast savings and reduced demand. Studies conducted at Cornell University indicate that strong direction and motivation to adhere from superiors and managers is the most effective means of shifting behavior throughout a hierarchical power structure (Bin, 2012).

2.4.5 MassEnergyInsight

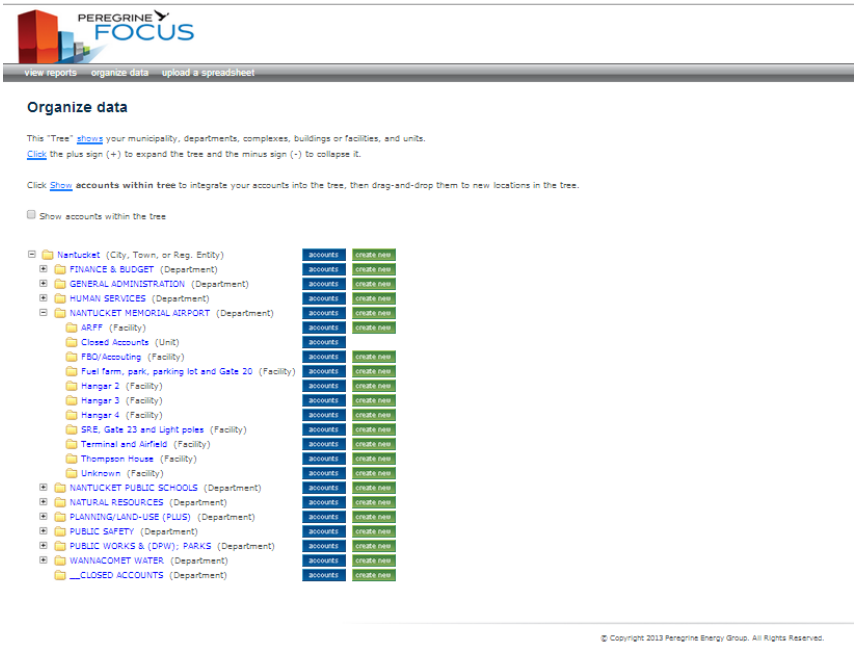

Figure 6: MassEnergyInsight Organization Tree

MassEnergyInsight (MEI) is an energy analysis tool provided to all of Massachusetts' 351 cities and towns for free by the Green Communities Division for Massachusetts, the Peregrine Energy Group, and the U.S. Department of Energy, to encourage efficient energy consumption within municipal buildings. The purpose of MEI is to enable the consolidation and analysis of data regarding energy costs, conservation, and, efficiency by town energy office employees ("MassInsightEnergy Overview," 2013). Town departments, facilities, complexes, and buildings are organized in a tree, as seen in Figure 6. Energy usage and cost data for oil, propane, diesel and electricity is uploaded to the software tool by the user. Important reports that are generated for analysis include the "Baseline Dashboard" to see how much energy is used in each department, the "Use and Cost Table" for the town energy usage, "Buildings to Target," to determine the highest priority buildings for energy conservation, and "Use and Cost This Year to Last" to compare year-to year energy cost data ("MassEnergyInsight User Guide," 2013).

According to the April 2011 Annual Report to the Massachusetts General Court, 390 individuals from 215 municipalities have been trained on the system through 12 classroom trainings and 14 webinar trainings ("Annual Report to the Massachusetts General Court," 2011). MEI has been implemented in several Massachusetts communities including Williamstown, Harvard, and Millbury. Williamstown, MA, uses MEI to detect equipment maintenance issues. For example, the cost of electricity for water usage increased, but actual water usage did not rise. Jason McNair, a municipal staff member for Williamstown, MA, stated that MEI "led to the discovery of some issue where the pumps were recirculating water unnecessarily" ("Overview of a Success," 2012, p. 2). Members of the Harvard, MA, Energy Advisory committee have found MEI easy enough to use with little or no training. The town uses the tool to focus on small buildings consuming large amounts of energy. Overall, Harvard has reduced its energy usage by 20% from its energy baseline in 2008 ("Overview of a Success," 2012, p. 3). Millbury, MA spent over one million dollars of its total municipal budget of $36 million on energy. Town Planner Laurie Connors decided to implement MEI. The town now has renovated the high school's refrigerators and converted the light bulbs in streetlights to LED bulbs. Future plans for the Millbury include studying the middle and elementary schools and other town buildings that are large energy consumers ("Overview of a Success," 2012, p. 6).

2.4.6 SEE the Light Toolkit

Figure 7: SEE the Light Energy Toolkit Web Homepage

The SEE the Light Energy Toolkit was created by National Grid and New Jersey Natural Gas to focus on educating consumers about energy conservation. It is designed to promote energy efficiency for residential, hospitality, commercial, municipal, and healthcare sectors, as seen in Figure 7. The Toolkit contains a collection of tips and instructional guides to help employees conserve energy to reduce energy consumption costs. Tips are given on each room depending on the square-footage to help the user reduce electric, water, and heating bills in targeted buildings ("SEE the Light Energy Toolkit," 2013).

The SEE the Light Toolkit is available in three implementation options, which can be chosen depending on the user's needs, budget, and business model. The three options focus on allowing the user to implement the Toolkit by without assistance from the Kilojolts Consulting Group, receive coaching from the Kilojolts Consulting Group, or for the Kilojolts Consulting to provide complete implementation services for the Toolkit.

The chosen implementation option is useful for deploying the Toolkit through

internal projects. Each municipal employee can be assigned to specific tasks in order to utilize the Toolkit. Department heads can prepare for an initial program launch and provide support to other municipal employees who are involved in the internal project. An operations resource can be assigned to an employee who specializes in technology, in order to take responsibility of the maintenance and the energy benchmarking software, which in this case is MassEnergyInsight. Responsibilities of the operations resource include installing the software on a Windows operating system, establishing an energy consumption baseline by using previous bills for departments that have made use of the Toolkit, and generating monthly reports to ensure that any deviations from baseline trends in energy consumption are clearly depicted. Yet in the case of a technical issue or need for guidance, remote coaching can be done via online communication tools if the users need assistance with software application.

SEE the Light has helped businesses reduce their energy costs. Brae Burn Country Club in West Newton, Massachusetts experienced a 15% energy expense increase from 2008 to 2009. Subsequently, the country club implemented the SEE the Light and started an energy awareness program. With the help of SEE the Light, the company was trained on best-use practices to teach their employees. The country club focused on turning lights off, checking for leaking faucets, and temperature control. By the end of 2009, and continuing in 2010, a successful 7.8% reduction in energy costs and consumption was achieved ("SEE the Light Success Story," 2013). SEE the Light has also impacted schools, such as the Spofford Pond Elementary School in Boxford, MA. The Toolkit was approved by the Superintendent and maintained by a 6th grade teacher and a head executive. The educational tool encouraged eager students to form a Green Team club. The tool educated students and staff on reducing consumption by turning off lights and computers, and monitoring temperature, as well as reporting instances of inefficient energy consumption. The school also purchased a new water pump and heating systems to successfully reduce its energy usage. Based on the SEE the Light Toolkit, the school's new awareness program resulted in an 11% energy consumption reduction from the previous year, totaling a $25,600 cost savings ("SEE the Light Success Story," 2013).

2.4.7 Energy Projects on Island

Over the past three years, the Town of Nantucket has successfully implemented three prominent energy initiatives to reduce reliance on fuels sourced from the mainland, including the installation of a wind turbine at the high school, an LED lighting overhaul in August 2013, and energy audits being made available to residents in 2012 ("Town of Nantucket Energy Office," 2013). The high school of Nantucket first proposed a wind turbine to reduce energy consumption from National Grid in 2008, however the proposal was not approved until 2010. The 100 kW wind turbine, which became operational in October of 2011, was constructed through a donation from the Schmidt Family Foundation. This turbine has produced over 500,000 kWh of electricity for the Town high school, saving the school $103 per day of operation. Figure 8 displays the electricity output each month over the past two calendar years. This turbine harnesses the abundant winds on the island, which are the highest sustained sea-level wind speeds in the United States, providing 15% of electricity consumed by the school annually (Northern Power, 2013).

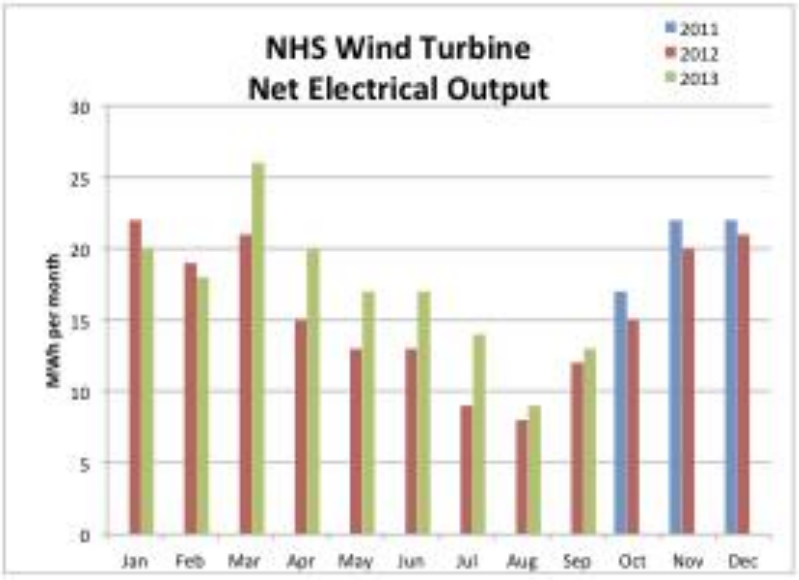

Figure 8: Monthly Output of NHS Wind Turbine

2.4.8 Cape Wind

By the end of 2013, the construction of America's first offshore wind farm will commence. The Cape Wind facility will be composed of 150 turbines, located on a shoal in Nantucket Sound. The power supplied by the wind turbines will enter the power grid at the Barnstable, MA transfer station, where it will then supply the islands of Martha's Vineyard and Nantucket, as well as parts of Cape Cod. The wind farm is slated to begin power production in 2015 and is expected to lower electricity costs on the Cape and Islands by reducing costs associated with transmission of electricity from distant electrical generation plants. Cape Wind is expected to provide power to over 200,000 homes per year. Wind energy is more predictable in terms of costs of the generated electricity as, following capital expenditure to establish the wind farm, no fuel must be purchased. Hence, the only operating costs are those associated with maintenance and upkeep ("Cape Wind," 2013).

2.5 Summary of Background Research

Although prior energy audits and consumption case studies have been enacted on Nantucket, municipal facilities have been excluded, due to the lack of available data, and the political hurdles that must be overcome to make progress in a bureaucratic system. Prior to the installation of the second undersea electrical transmission line in 2006, National Grid forwent large-scale conservation education on Nantucket as a means of reducing demand, as there are no large corporate sites on the island, which typically demonstrate greater responsiveness to conservation practices and subsequently, a large decrease in energy consumption (Beliveau et al., 2010).

CHAPTER 3: METHODOLOGY

The purpose of this project was to assist the Nantucket Energy Office in promoting responsible energy usage on the island of Nantucket by tracking and measuring the energy consumption trends of Town departments. With the help of the MassEnergyInsight (MEI) tool, our team analyzed liquid fuel and electricity use by municipal facilities to track consumption trends, identified instances of efficiency and inefficiency, and generated reports, graphs, and other informational visuals that can be used to inform municipal employees about their energy use. Surveys were distributed to assess town employees' attitudes towards energy conservation. Our team made recommendations to the Nantucket Energy Office and Town department heads on how to most effectively promote efficient energy use within municipal facilities.

The project was completed on Nantucket from October 29 to December 18. To complete this project, we had identified the following objectives:

- Update the MassEnergyInsight Tool with complete and accurate energy data for municipal accounts on Nantucket.
- Identify instances of inefficient energy consumption amongst Town facilities, and measure energy savings from previously implemented energy efficiency projects.
- Determine municipal employee attitudes towards energy conservation and efficiency.
- Make recommendations to the Nantucket Energy Office and Town Administration about how to implement the SEE the Light Energy Toolkit to encourage energy conservation by Town employees within municipal buildings.

3.1 Update the MassEnergyInsight Tool

Our first objective was to update the MassEnergyInsight tool for the town of Nantucket. The MEI tool had been previously used by the Energy Office, but the majority of the data within it was either out of date or disorganized. (Sinatra, L., Personal Communication, 9/24/2013). Following initial background research, we had learned how to use the MEI tool, which called for the acquisition of accurate and current data. This was accomplished through site visits to most of the facilities operated by the town, reconciliation of Town financial records, National Grid reports, Harbor fuel and Yates Gas invoices, and discussion with numerous regulatory and technical experts in the field of energy consumption.

Once updated, the toolkit enabled us to generate reports, graphs and other visuals that illustrated consumption trends in a hierarchical order. Analysis began with building an understanding of the software's "Baseline Dashboard", which displays macroscopic consumption data for all included accounts. The "Usage Trends by Town", and "Buildings to Target" dashboards were then referenced to examine consolidated consumption data for all accounts over time, and identify any facilities that exceed the baseline value for energy usage per square footage. The "School Benchmarks," and "Building Dashboard" reports were then referenced to assess consumption in town schools, which present a unique set of demands and must thus be interpreted individually, and within individual accounts for buildings.

Furthermore, the efficacy of prior municipal energy efficiency projects, primarily lighting retrofits (as outlined in Figure 9), was assessed through comparison of building usage records with the projected savings provided by auditors. The "Building Dashboard," which displays energy usage trends of all years for which data is provided, was used to assess single buildings in easy-to-interpret graphs. For notes on this analysis, please refer to Appendix A.

ENERGY REDUCTION ROADMAP: Reducing Energy at the Top Energy Consuming Municipal Facilities*

Electricity data provided by National Grid, and supplemented by data from online accounts

* Does not include lift stations, water pumps, electric panels or streetlights

#	KWh FY 2012	% OF TOTAL	DESCRIPTION	ENERGY EFFICIENCY MEASURES	EE Project Status
1	2368800	19.8%	**Surfside Wastewate Treatment Plant**	Energy Audit & Scoping Study completed (2011). National Grid working with Town Consultants Woodard & Curran on implementation measures based on CWMP. Scheduled for lighting audit in September 2013 report.	**In progress**
2	1753800	14.6%	**Landfill Composter Building**	Comprehensive Energy Audit completed in May-2012. Lighting upgrade project began on 10/09/12 and completed on 12/11/12. Estimated annual savings= $16,113.87; Annual Cost Reduction= 53.71%.	**Completed**
3	1517778	12.7%	**Nantucket High School**	Energy Audit completed on December-15-2012. Estimated annual savings= $20,317; Annual Cost Reduction= 40%. Lighting (interior & exterior lights) contract signed March-18-2013, project to take place in September 2013.	**Lighting upgrade project scheduled for September 2013. Pursue "comprehensive audit" to address HVAC and weatherization opportunities**
4	1445760	12.1%	**Nantucket Memorial Airport (Terminal)**	Lighting & "non-lighting" audit completed on December 19, 2012. Airport Commission executes contract for work on 1/16/13. Estimated annual savings: $24,275.04; Annual Cost Reduction: 54.68%. Lighting upgrade project completed in March 2013. Additional LED replacement bulbs to be installed by April 2013.	**Completed**
5	767600	6.4%	**Public Safety Facility - 4 Fairgrounds Road**	Post commisssioning study to assess current energy systems to be performed in 2013. Will receive LED replacement bulbs in February 2013.	**Post-commissioning study to take place in 2013.**
6	443520	3.7%	**Nantucket Elementary School**	Lighting audit completed on 10/23/12, non-lighting EE audit completed on 12/19/12. Lighting (interior & exterior lights) contract signed March-18-2013, project to take place in Summer 2013.	**Completed**
7	414160	3.5%	**Our Island Home, 142 Orange St ET**	Lighting audit completed on 4/28/11. Recommendations installed. Estimated annual savings (electric) = $3,665.24; payback period 13 months.	**Non-lighting audit for 2013/2014.**
8	372480	3.1%	**Airport "Rescue & Fire Building"**	Energy Audit completed on 12/19/12; lighting project completed in March 2013. LED replacement bulbs in Main terminal installed in April 2013.	**Completed**
9	365040	3.0%	**Siasconset Wastewater Treatment Plant**	Town is moving forward with two non-lighting energy efficiency measures from prior scoping studies; with overall use as part of CWMP report.	**In progress**
10	261241	2.2%	**Wannacomet Water Co. (Plant)**	Lighting Project completed on 10/06/10. All pumps and mechanics are highly efficient. No further opportunities for non-lighting efficiency savings according to Bob Gardner (10/23/12 meeting with Energy Analyst). Will receive LED replacement bulbs in March 2013.	**Completed**
11	231280	1.9%	**Materials Recycling Facility (Landfill)**	Energy Audit completed in May-2012. Project Installation began on 10/09/12 and completed on 12/11/12. Estimated annual savings= $16,113.87; Annual Cost Reduction= 53.71%.	**Completed**
12	211520	1.8%	**Planning & Land Use - 2 Fairgrounds Road**	LED replacement bulbs installed in April 2013.	**Completed**
13	167040	1.4%	**Nantucket Town Building, 16 Broad St**	LED replacement bulbs installed in March 2013.	**Completed**
14	92400	0.8%	**DPW Compound,188 Madaket Rd**	LED replacement bulbs installed in April 2013.	**Completed**
15	70365	0.59%	**Nantucket Memorial Airport,30 Macy's Ln FAA**	LED replacement bulbs installed in April 2013.	**Completed**
16	69557	0.58%	**Nantucket Fire Dept, 135 Pleasant St**	LED replacement bulbs installed in April 2013.	**Completed**
17	42360	0.35%	**Town of Nantucket, 37 Washington St**	LED replacement bulbs installed in April 2013.	**Completed**
18	28953	0.24%	**NRTA- Nantucket Regional Transit Authority; 11 Bunker Rd**	Scheduled for lighting audit in September 2013	**In progress**
19	28336	0.24%	**LORAN BLDG, 56 Low Beach Rd**	Scheduled for lighting audit in September 2013	**In progress**
20	27058	0.23%	**Saltmarsh Senior Center, 81 Washington**	Energy Audit completed on 12/15/12. Lighting upgrades completed in February 2013. Annual Savings: $1,456.80	**Completed**
SUBTOTAL	10,679,048	89.1%			
All other Town meters (21-77):	1,299,649	10.9%			
Town Total Electicity Consumption:	11,978,697	100%			

Figure 9: Description of previously implemented lighting retrofits

3.2 Determine Municipal Employee Attitudes

The success of energy conservation within Town buildings depends largely on the actions of the employees. Surveys created by the WPI team were designed to study the employees' perception of accountability for managing energy, the awareness of town employees towards energy costs and payment, daily energy use routines at work compared to home, and the employees' awareness of the Nantucket Energy Office's current Town conservation efforts and programs. Questions about possible incentives and contests were needed to determine effective ways to promote and sustain smarter energy usage in the municipal system. The Likert Scale was used for questions to measure the participants' opinion on Nantucket Employee energy use in the work place.

Demographic questions were asked, such as building location, highest level of education, the respondent's age, and residential status. Location was asked so specific Town buildings can be compared to one another. Similar responses from employees at the same location may indicate the need for certain energy audits to be performed. The highest level of education and age were important to ask so employees can be compared and contrasted depending on their backgrounds. The residential status question asked the employee if they were a year-round property owner, year-round renter, commuter, or other. If renting, the follow-up question was if they were responsible for certain energy bills such as electric, propane, or oil. The responses were important to determine if residential status had an impact on the employee's energy conservation at home.

Once the goals of the survey were established, questions were consolidated and organized and survey drafts were edited by Lauren Sinatra and demographer, Peter Morrison. Beta testing was completed with help from the Town Administration and the Town Clerk. Initial surveys were completed and commented on to ensure questions asked were clear and that the survey directions were easy to follow. After beta testing, the survey was updated and edited by taking the beta testing participants' suggestions.

The finalized survey was then brought to Town Administration for approval and can be found in Appendix C. The distribution of surveys was completed by the team. Surveys were dropped off at the Town Finance Department, Fire Department, Planning and Land Use Services, the Nantucket Memorial Airport, and Wannacomet Water Company. Surveys were emailed to Human Resources and the Town Clerk, and administered personally by the team to employees at the Sheriff's office, Department of Public Works, Registry of Deeds, Town Administration, Visitor Services, and the Nantucket Regional Transit Authority. Our team allowed one week for respondents to complete the survey.

A grading system was established in order to interpret the survey results and compare the employee's attitudes. To best evaluate the responses from each survey, a scaling method was created that allowed each respondent's energy conscientiousness to be quantified to a single number. This number is derived by weighting questions on the survey along a plus/minus scale as defined by the rubric seen in Appendix D. Each grade starts at a score of 0 and deviates in the positive or negative direction, with more positive values indicating conscientiousness regarding energy use, and more negative values suggesting a lack of energy use awareness.

For further evaluation, the graded survey responses were then entered into the web-based Qualtrics tool, allowing for analysis of responses as grouped by demographics, and generation of statistical reports. A screenshot of the Qualtrics tool used in this project can be viewed in Appendix C.

3.3 Summary of Methods

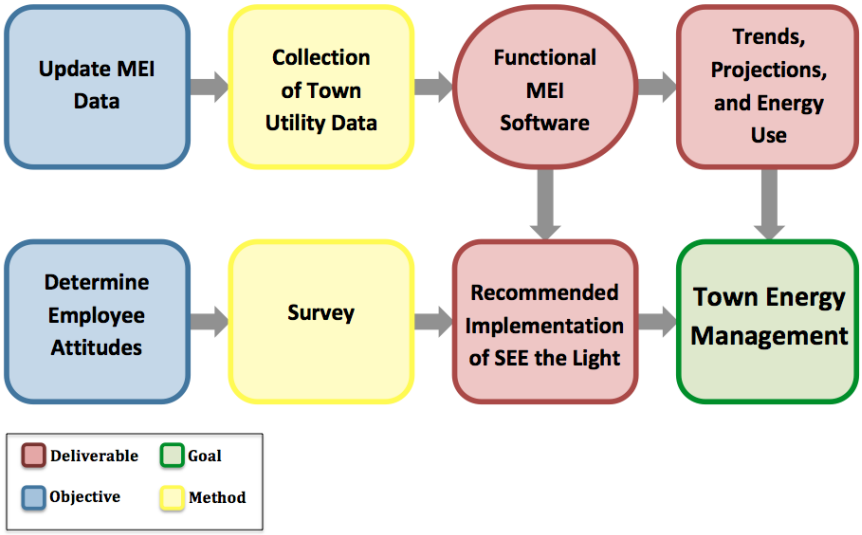

Figure 10: Outline of Objectives and Deliverables

The scope of this project initially extended only to the municipal system and its employees. However, the project developed to benefit the community of Nantucket by promoting energy management efforts in the municipal system to support a broader sustainable energy consumption paradigm for the island, to prevent a foreseeable need for infrastructure expansion. The structure of background research, proposed methodology, and deliverables, as outlined in Figure 10, allowed us to assist the Nantucket Energy Office. Through the decoration of a Christmas tree with energy saving tips we created our first energy educational visuals. This tree was located outside of the Nantucket Energy Office and was viewed by town residents during Christmas stroll.

CHAPTER 4: FINDINGS, RECOMMENDATIONS, & CONCLUSIONS

An evaluation of municipal employees' attitudes towards energy efficiency in the workplace resulted in determining employees' perception of accountability for managing energy costs, their awareness of energy usage costs and their energy use behaviors. Using the results from the municipal employee energy questionnaire, our team was able to assess effective ways to promote and sustain energy efficiency in the work place. Energy usage trends, as shown in MassEnergyInsight, also allowed our team to determine instances of inefficiency and improvements that could be made. Based on these findings, our team has made recommendations on how to maintain energy efficiency in the work place by maintaining energy usage data in MassEnergyInsight, implementing the SEE the Light Toolkit in town departments, and exploring energy efficiency programs that are offered by National Grid.

4.1 Findings

4.1.1 Survey Findings

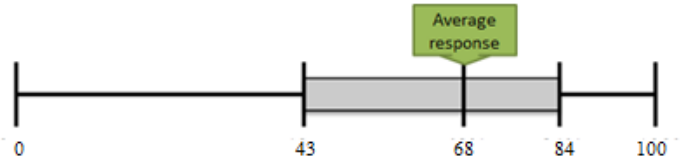

Figure 11: Energy Awareness Grade for Town Employees

The Respondent Awareness Ratings were converted to a 100-point grading system. The average score, as seen in Figure 11, indicated that Nantucket employees are conscientious about their energy consumption. However, the 68th percentile score of "D+" also indicates that there is room for improvement on the individual basis.

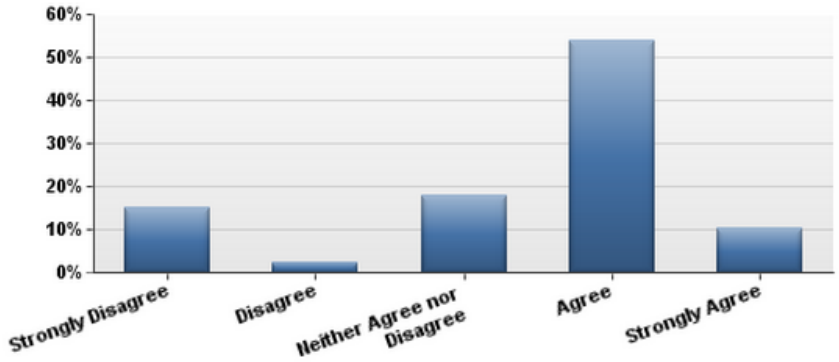

Figure 12: Question 7a. – "The Town administration is committed to energy conservation."

As displayed in Figure 12, 64% of Town employees agreed or strongly agreed with the statement "The Town administration is committed to energy conservation." This indicated that most employees thought that Town administration had a focus on energy conservation, but more could be done by the administration to promote energy conservation in the workplace.

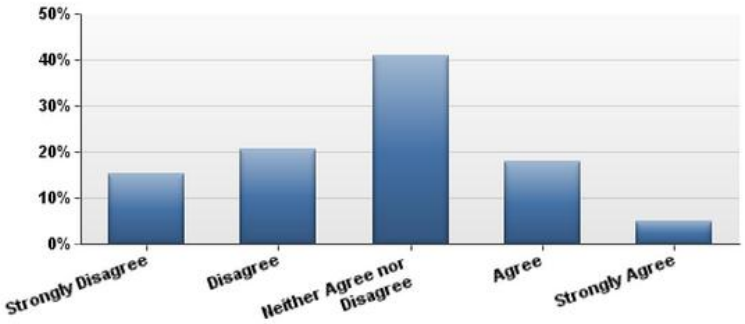

Figure 13: Question 7f. – "Current energy initiatives are visible and recognizable"

There exists a need for the Town to make energy initiatives visible and recognizable for employees, as indicated by Figure 13. Although the employees believed the Town was committed to energy conservation, only 5% of respondents strongly agreed that those efforts were recognizable.

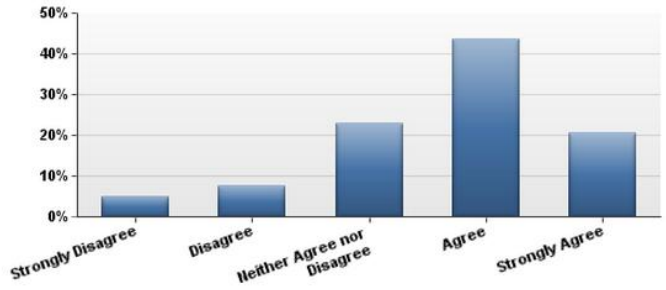

Figure 14: Question 7n. – "Visible reminders on how to best conserve energy would be helpful"

It is clear from Figure 14 that employees desire visible reminders in the work place to help them conserve energy. Over 60% of employees responded positively (agree or strongly agree) in favor of visible energy tip reminders.

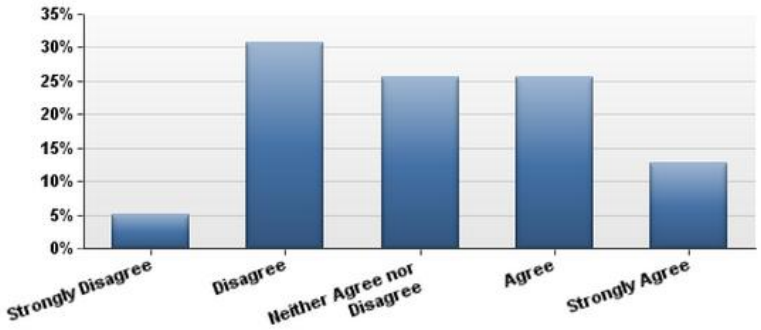

Figure 15: Question 7m. – "I feel I have been adequately educated on how to conserve energy in the workplace."

Figure 15 indicates the need for more energy education in the workplace. Although more than 10% strongly agreed that they had enough education, 30% disagreed and 5% strongly disagreed, indicating the need for education.

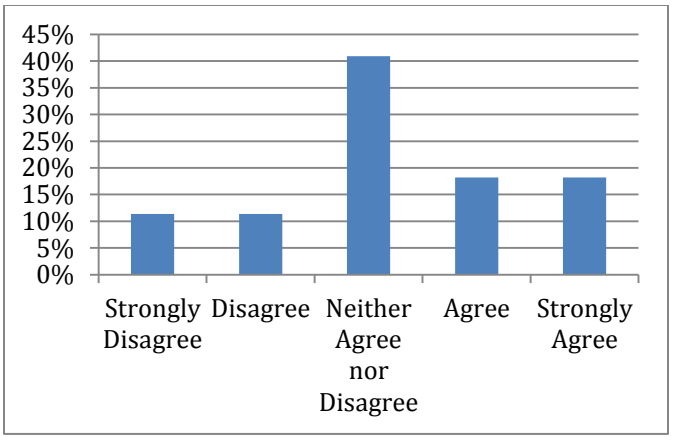

Figure 16: Question 7o. – "I would volunteer to participate in energy conservation projects at work"

Figure 16 indicates only 22% of employees responded that they wouldn't volunteer for energy conservation initiatives at work, thus there is a high interest for volunteering for such a role. The large amount of indifference indicates the possibility of more volunteers, as they did not definitively disagree.

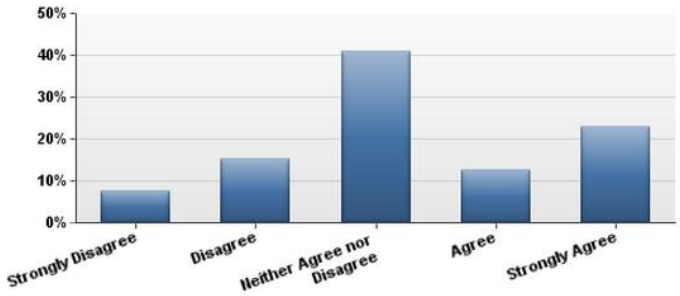

Figure 17: Question 7j. – "Nantucket employees would try to conserve more energy in the workplace if their department was responsible for its own energy budget"

The idea of budgeting being handed to individual departments was proposed to Town employees and resulted in a mixed response. More employees supported this idea than not, as seen in Figure 17. The most popular response was "neither agree nor disagree" indicating this is an idea that could be considered in the future. The percent of those who strongly agreed (23%) indicates that there are employees who could improve their energy conservation in the workplace.

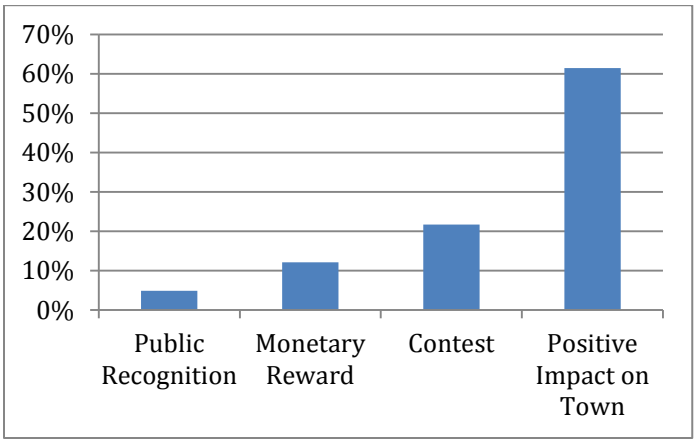

Figure 18: Question 9 – Incentive to conserve energy at work

For Question 9, "If you were asked to change your everyday habits at work to reduce municipal energy consumption what would motivate you the most?" the most popular response, displayed in Figure 18, was a positive impact on the town budget and environment. This indicated that Nantucket employees cared little for personal incentives, such a public recognition or monetary rewards, but instead were motivated by something beneficial for all.

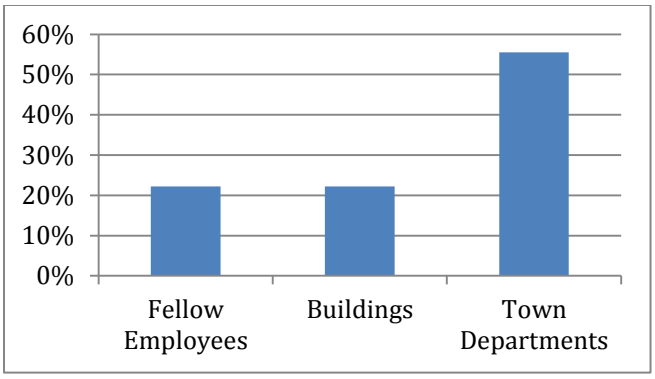

Figure 19: Question 9 – Ideas for Energy Conservation Contest in the Workplace

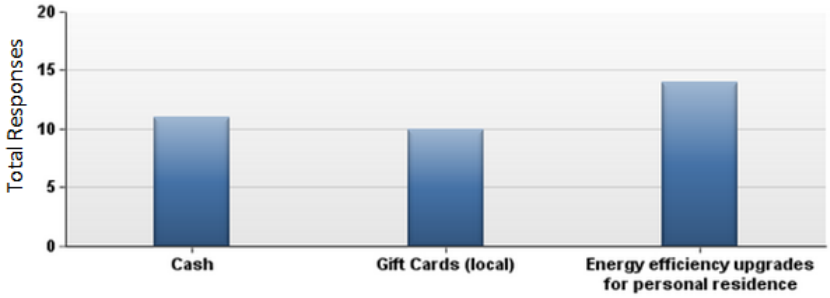

Figure 20: Question 10 – Most popular responses to contest prize

Holding an energy conservation contest was second for an incentive to save energy, as seen in Figure 18. Three contest ideas were proposed and are displayed in Figure 19. The most popular choice by employees was a contest between departments, with the prize being energy efficiency upgrades for personal residences, as indicated by Figure 20.

4.2 Recommendations

4.2.1 Discrete Energy Monitoring

Survey responses support the proposal of discrete monitoring and budgeting of energy use for Town departments. By making departments individually responsible for payment and management of energy bills, as opposed to the current system of centralized budgeting and payment by the Town finance department, conservation is motivated through increasing awareness of energy expenses, and allowing any savings made

through conservation to be utilized within the department, thus directly benefitting the employees who made the savings possible. Implementing sub-meters on accounts serving multiple departments in different buildings, such as the meter serving the Town hall and outlying buildings, would be vital to measuring and managing energy consumption by each department, and allow the Energy Office to monitor the energy usage of individual facilities to better pinpoint sites of efficient and inefficient usage.

4.2.2 Deep Energy Retrofit Pilot Program

On December 4, 2013, National Grid's Director of Distribution Facility Planning, Ryan Constable, gave a presentation titled, "National Grid and the Nantucket Community: A Partnership in Energy Solutions." Important points of the presentation that were addressed were the existing two cable configuration on Nantucket, how Nantucket's load has grown in recent years, what happens if a cable fails, and alternative approaches to meeting future energy needs. During the presentation, National Grid representatives, Ryan Constable and Tim Rowan, discussed the possibility of implementing a pilot program for Nantucket (Constable, 2013).

The Deep Energy Retrofit (DER) pilot program can be offered to homes and municipal facilities in Massachusetts and Rhode Island. Through the DER pilot program, homes are transformed to high performance homes to improve energy performance ("2013 Deep Energy Retrofit Measure Guidelines," 2013). Rhode Island is currently taking advantage of National Grid's DER program by tracking high electric growth rates, working collectively to determine a solution for reducing energy consumption, and focusing on upgrading to energy efficient technologies. Through the implementation of the DER pilot program on Rhode Island, National Grid has offered incentives such as free recycling for air conditioning units and rebates for purchasing energy efficient air conditioning units ("National Grid and the Nantucket Community: A Partnership in Energy Solutions," 2013).

Nantucket could benefit from National Grid's Deep Energy Retrofit (DER) Pilot Program to meet the municipal system's needs while managing their energy usage. Participation in this program would allow the Town to tailor existing programs to meet Nantucket's unique needs, and provide access to grants and incentives that would otherwise only be made available to Green Communities. For example, no incentives currently exist for weatherization in municipal, as the majority of Town facilities in mainland communities are designed as large commercial structures, in which weatherization does not prove effective. However, many of Nantucket's municipal buildings are constructed using residential methods, which could benefit greatly from weatherization, such as that provided for residential electrical consumers under the Mass Save program. Nantucket municipal facilities that would be strong pilots for such a program, as indicated by survey comments, are 37 Washington Street (Finance Department), 3 East Chestnut Street (NRTA Office), and 16 Broad Street (Town Hall) ("National Grid and the Nantucket Community: A Partnership in Energy Solutions," 2013).

4.2.3 Implementation of SEE the Light Toolkit

Survey results indicated that there is a need for more energy conservation education in the workplace (Figure 15). The educational materials provided by SEE the Light (Section 2.4.6) can be used for the Energy Office to hold energy conservation classes. These classes would be beneficial for current employees so that they can learn how to improve their energy conservation practices. Part of new-employee training during HR orientation should be dedicated to teaching how to conserve energy in a new setting for the employee. Education classes should be offered on a yearly basis to confirm best practices are always in effect.

Town employees expressed great interest in having visible reminders in their workplace to help understand how to conserve energy (Figure 14). We recommend the Energy Office uses the materials provided by the SEE the Light Toolkit. To implement these visible reminders, we recommend using stickers for reminding employees to turn

lights off, posters with energy facts to be hung in offices, hallways, and common spaces, and magnetic thermometers for temperature monitoring.

The SEE the Light Toolkit recommends holding a contest as an incentive to conserve energy in the workplace. Although this approach is questionable due to neutral responses (Figure 18), it is an option to be explored. If the Energy Office decides to follow this recommendation, the contest should be between Town departments and energy efficiency upgrades for personal homes should be the prize, as indicated by the survey (Figure 20).

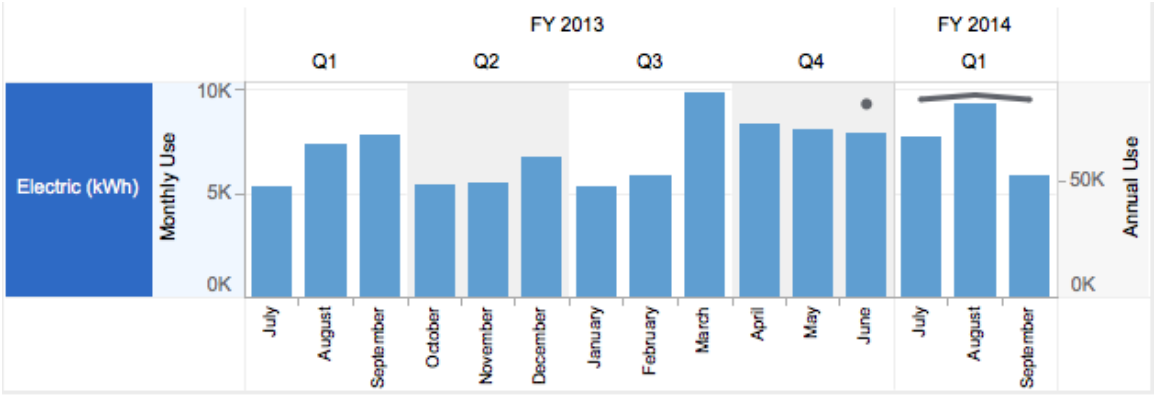

Figure 21: Example of MEI report showing building use for Nantucket Fire Department

The survey indicated that Town employees would be most motivated to conserve energy if they knew they were positively impacting the Town (Figure 18). We recommend that the Energy Office distribute a quarterly newsletter to employees, displaying MEI reports, such as the building report for the Nantucket Fire Station seen in Figure 21. The MEI reports can show how the efforts being made through SEE the Light are positively impacting energy consumption in their building. Newsletters should also provide seasonal energy saving tips, such as removing window air conditioning units in the Fall, or checking for drafts in the Winter.

To assist the Energy Office with the aforementioned efforts, our team recommends that Town departments assign "Energy Champions," defined in the SEE the Light toolkit as employees who volunteer to be figureheads for energy conservation in the workplace. Through special training provided by the Energy Office, these Energy

Champions will be adequately educated in order to lead energy projects and provide energy tips to fellow employees. As they are the ones most familiar with their facility, it would be best if they distributed the visible energy saving reminders provided by SEE the Light. From the survey, and displayed in Figure 16, only 22% of employees responded that they wouldn't volunteer for energy conservation initiatives at work.

CONCLUSION

The goal of this project was to fully update the data within the MassEnergyInsight software, as well as make recommendations on how to implement the SEE the Light educational toolkit in the Town of Nantucket. After working on this project, we feel that that our team has left the Nantucket Energy Office adequately equipped to measure and interpret energy usage trends, as well as educate employees on proper energy conservation practices.

The data within the MassEnergyInsight tool is now fully up-to-date and organized within the system. This will allow easier maintenance as current data is propagated throughout the system. The Energy Office can now use the software in order to most effectively identify inefficient buildings to target with energy conservation initiatives so that future projects have the greatest effect possible, as well as to track the effectiveness of past projects. Graphs and charts of energy consumption and trends can now be easily exported from the software for use by the Energy Office. These tables and graphs can be used to educate employees about their energy use and serve as an effective means to promote conservation efforts.

Secondly, with the SEE the Light Toolkit, the Nantucket Energy Office will be able to foster energy education for Town employees. With adequate education, Town employees will become more conscientious of their energy use. As the Town municipality reduces their energy consumption through their conservation efforts, the Town can serve as model for the entire island to follow.

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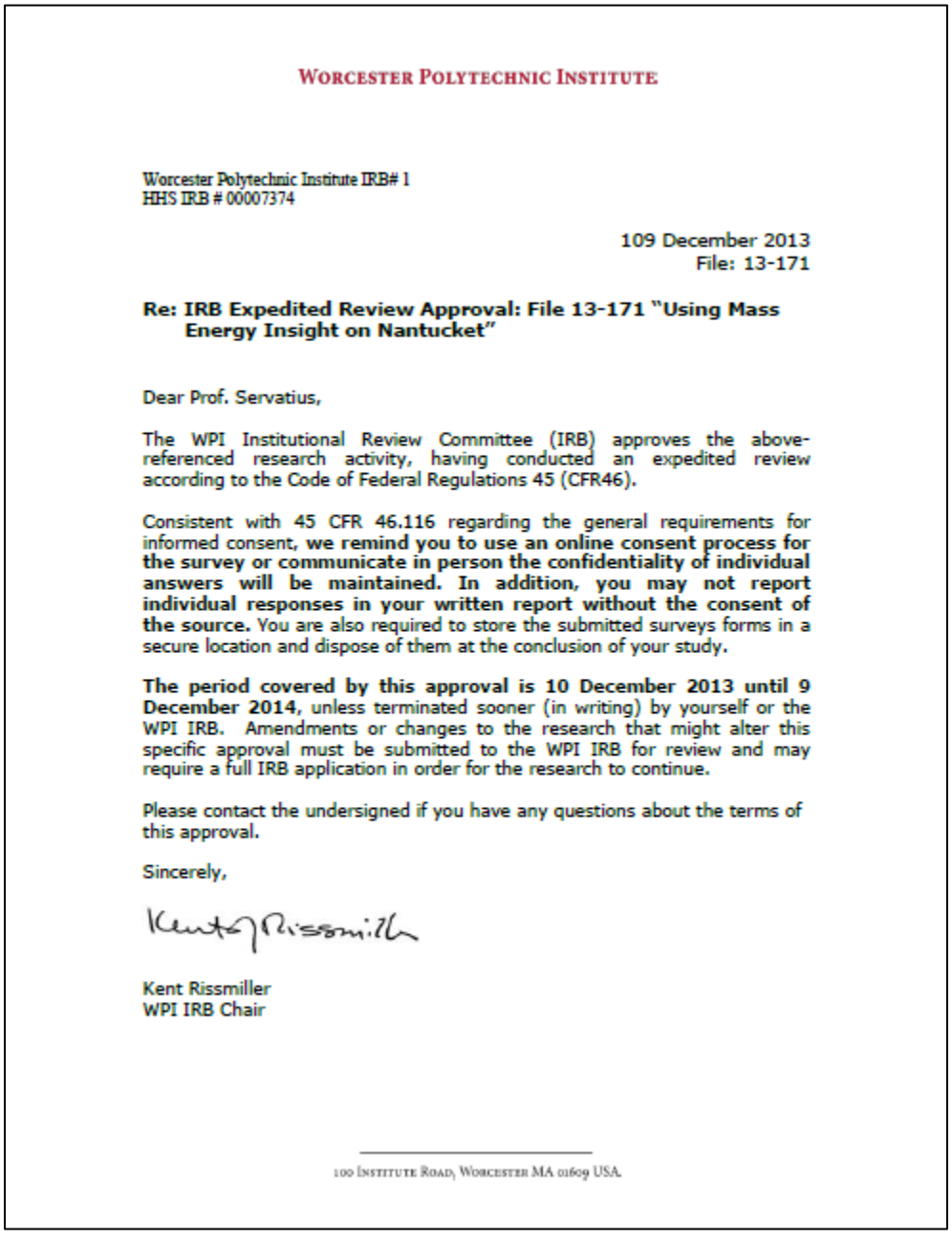
APPENDIX

A. Efficacy of Prior Lighting upgrades

The following figure displays all energy efficiency upgrades implemented in Nantucket municipal facilities between 2010 and 2013. A primary objective of this project was to assess the efficacy of these lighting upgrades, and compare forecasted savings to actual measured savings. Once the MassEnergyInsight toolkit was fully updated, reports on the specific sites of implementation were viewed in hopes of tracking any savings made. However, upon closer examination, no conclusive deductions could be drawn at the time of the research. This is largely due to the lack of reliable consumption data for averaging purposes. For example, the numerous lighting upgrades completed in 2013 could not be conclusively judged, as usage patterns fluctuate with seasons on yearly basis. With only 3 months of available data following the implementation of upgrades, the influence on a years worth of usage cannot yet be deduced. Furthermore, at facilities such as the Composter and Materials Recovery Facility, yearly fluctuations in electrical consumption of at least 5% are seen year to year, thus the forecasted 3.71% savings can not be measured without sufficient data for averaging usage before and after installation of lighting upgrades. Subsequently, we recommend that assessment of lighting upgrade efficacy be performed after allowing adequate time for data collection, possibly in late 2014 or early 2015.

B. Survey Confidentiality

The WPI Institutional Review Committee approved the survey, as seen in Figure 22. The confidentiality of individuals surveyed was maintained by aggregating responses. Individual responses were not written in this report or presented on, so individuals cannot be identified. Paper surveys were shredded and emailed surveys were encrypted and not shared.



WORCESTER POLYTECHNIC INSTITUTE

Worcester Polytechnic Institute IRB# 1
HHS IRB # 00007374

109 December 2013
File: 13-171

Re: IRB Expedited Review Approval: File 13-171 "Using Mass Energy Insight on Nantucket"

Dear Prof. Servatius,

The WPI Institutional Review Committee (IRB) approves the above-referenced research activity, having conducted an expedited review according to the Code of Federal Regulations 45 (CFR46).

Consistent with 45 CFR 46.116 regarding the general requirements for informed consent, **we remind you to use an online consent process for the survey or communicate in person the confidentiality of individual answers will be maintained. In addition, you may not report individual responses in your written report without the consent of the source.** You are also required to store the submitted surveys forms in a secure location and dispose of them at the conclusion of your study.

The period covered by this approval is 10 December 2013 until 9 December 2014, unless terminated sooner (in writing) by yourself or the WPI IRB. Amendments or changes to the research that might alter this specific approval must be submitted to the WPI IRB for review and may require a full IRB application in order for the research to continue.

Please contact the undersigned if you have any questions about the terms of this approval.

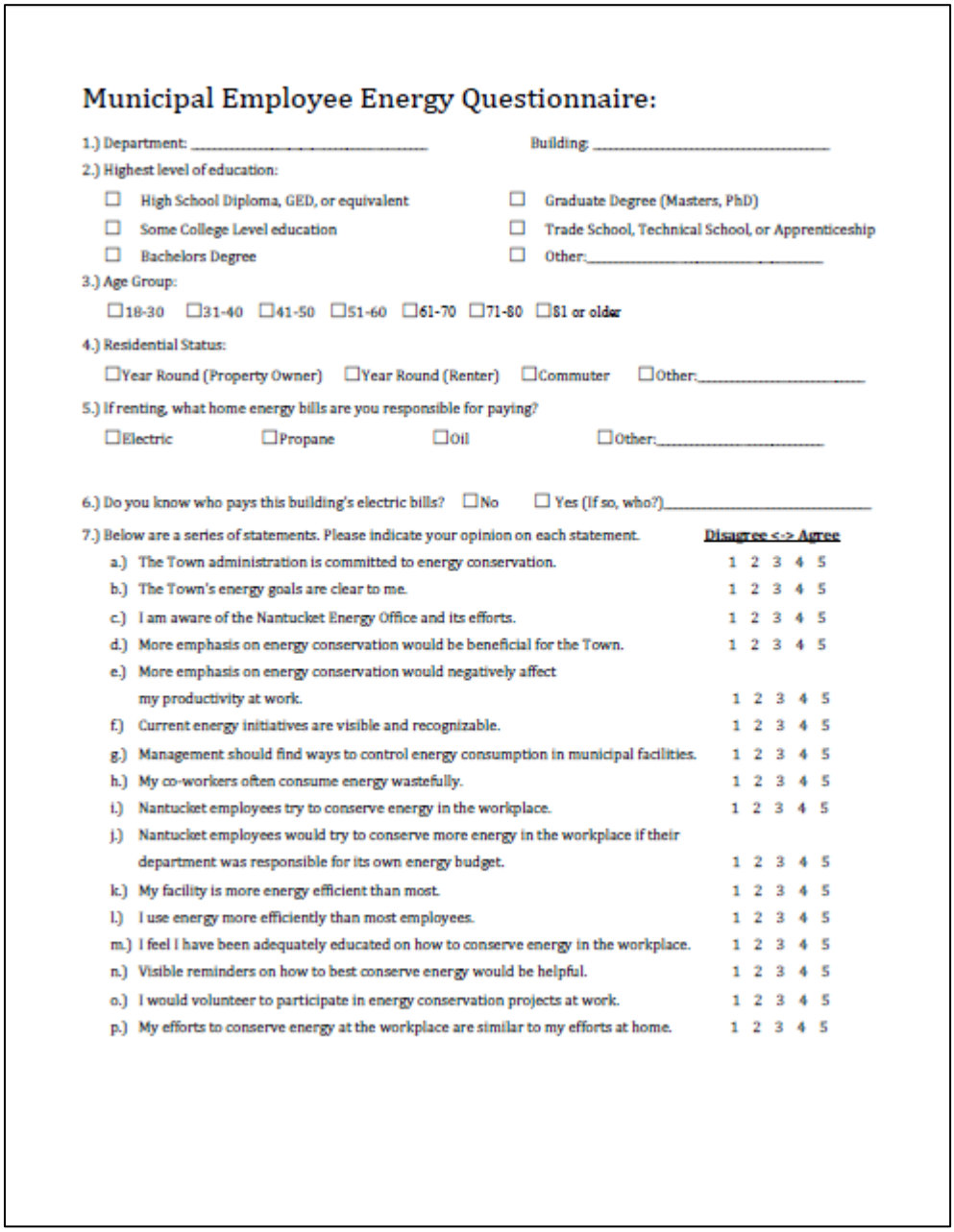
Sincerely,

Kent Rissmiller
WPI IRB Chair

100 INSTITUTE ROAD, WORCESTER MA 01609 USA

Figure 22: 13-171 IRB Approval Letter

C. Survey and Qualtrics Tool



Municipal Employee Energy Questionnaire:

1.) Department: _____ Building: _____

2.) Highest level of education:

- ☐ High School Diploma, GED, or equivalent
- ☐ Some College Level education
- ☐ Bachelors Degree
- ☐ Graduate Degree (Masters, PhD)
- ☐ Trade School, Technical School, or Apprenticeship
- ☐ Other:_____

3.) Age Group:

☐18-30 ☐31-40 ☐41-50 ☐51-60 ☐61-70 ☐71-80 ☐81 or older

4.) Residential Status:

☐Year Round (Property Owner) ☐Year Round (Renter) ☐Commuter ☐Other:_____

5.) If renting, what home energy bills are you responsible for paying?

☐Electric ☐Propane ☐Oil ☐Other:_____

6.) Do you know who pays this building's electric bills? ☐No ☐ Yes (If so, who?)_____

7.) Below are a series of statements. Please indicate your opinion on each statement.	Disagree <-> Agree
a.) The Town administration is committed to energy conservation.	1 2 3 4 5
b.) The Town's energy goals are clear to me.	1 2 3 4 5
c.) I am aware of the Nantucket Energy Office and its efforts.	1 2 3 4 5
d.) More emphasis on energy conservation would be beneficial for the Town.	1 2 3 4 5
e.) More emphasis on energy conservation would negatively affect my productivity at work.	1 2 3 4 5
f.) Current energy initiatives are visible and recognizable.	1 2 3 4 5
g.) Management should find ways to control energy consumption in municipal facilities.	1 2 3 4 5
h.) My co-workers often consume energy wastefully.	1 2 3 4 5
i.) Nantucket employees try to conserve energy in the workplace.	1 2 3 4 5
j.) Nantucket employees would try to conserve more energy in the workplace if their department was responsible for its own energy budget.	1 2 3 4 5
k.) My facility is more energy efficient than most.	1 2 3 4 5
l.) I use energy more efficiently than most employees.	1 2 3 4 5
m.) I feel I have been adequately educated on how to conserve energy in the workplace.	1 2 3 4 5
n.) Visible reminders on how to best conserve energy would be helpful.	1 2 3 4 5
o.) I would volunteer to participate in energy conservation projects at work.	1 2 3 4 5
p.) My efforts to conserve energy at the workplace are similar to my efforts at home.	1 2 3 4 5

Figure 23: Municipal Employee Energy Questionnaire Page 1 of 2

8.) Please indicate how often you perform the following at work. Typically, how often do you…

	Never <-> Always	N/A
a.) Turn off monitors for computers overnight?	1 2 3 4 5	☐
b.) Activate sleep mode on computers when away for more than an hour?	1 2 3 4 5	☐
c.) Turn off air conditioning units when not in use?	1 2 3 4 5	☐
d.) Work by natural light when available?	1 2 3 4 5	☐
e.) Turn off lights when leaving a room?	1 2 3 4 5	☐
f.) Turn off lights when found on in an unoccupied room?	1 2 3 4 5	☐
g.) Close doors and windows when using heating/cooling devices?	1 2 3 4 5	☐
h.) Use a space heater?	1 2 3 4 5	☐
i.) Add a layer of clothing when feeling cold instead of adjusting the temperature of the room?	1 2 3 4 5	☐
j.) Unplug small electronics and chargers when not in use?	1 2 3 4 5	☐

9.) If you were asked to change your everyday habits at work to reduce municipal energy consumption what would motivate you the most? (Check all that apply and circle your top choice)

- ☐ Positive impact on municipal budget.
- ☐ Positive impact on the environment.
- ☐ Contest between **fellow employees.**
- ☐ Contest between **buildings.**
- ☐ Contest between town **departments.**
- ☐ Public recognition for doing a good job.
- ☐ Monetary reward for doing a good job.
- ☐ Nothing could motivate me. I don't really care about energy/environmental issues.
- ☐ Other: _____

10.) Let's assume we set up a contest among employees to see which buildings reduce energy consumption the most (as measured with benchmarking software). What kind of rewards would motivate you to compete to win? Select no more than 2 options.

- ☐ Cash
- ☐ Gift Cards
- ☐ Recognition at town meeting
- ☐ Article in local paper
- ☐ Energy efficient upgrades for personal residence
- ☐ Drawing for a large prize for one employee
- ☐ Other: _____

** Please write any comments regarding energy in the workplace below:

Figure 24: Municipal Employee Energy Questionnaire Page 2 of 2

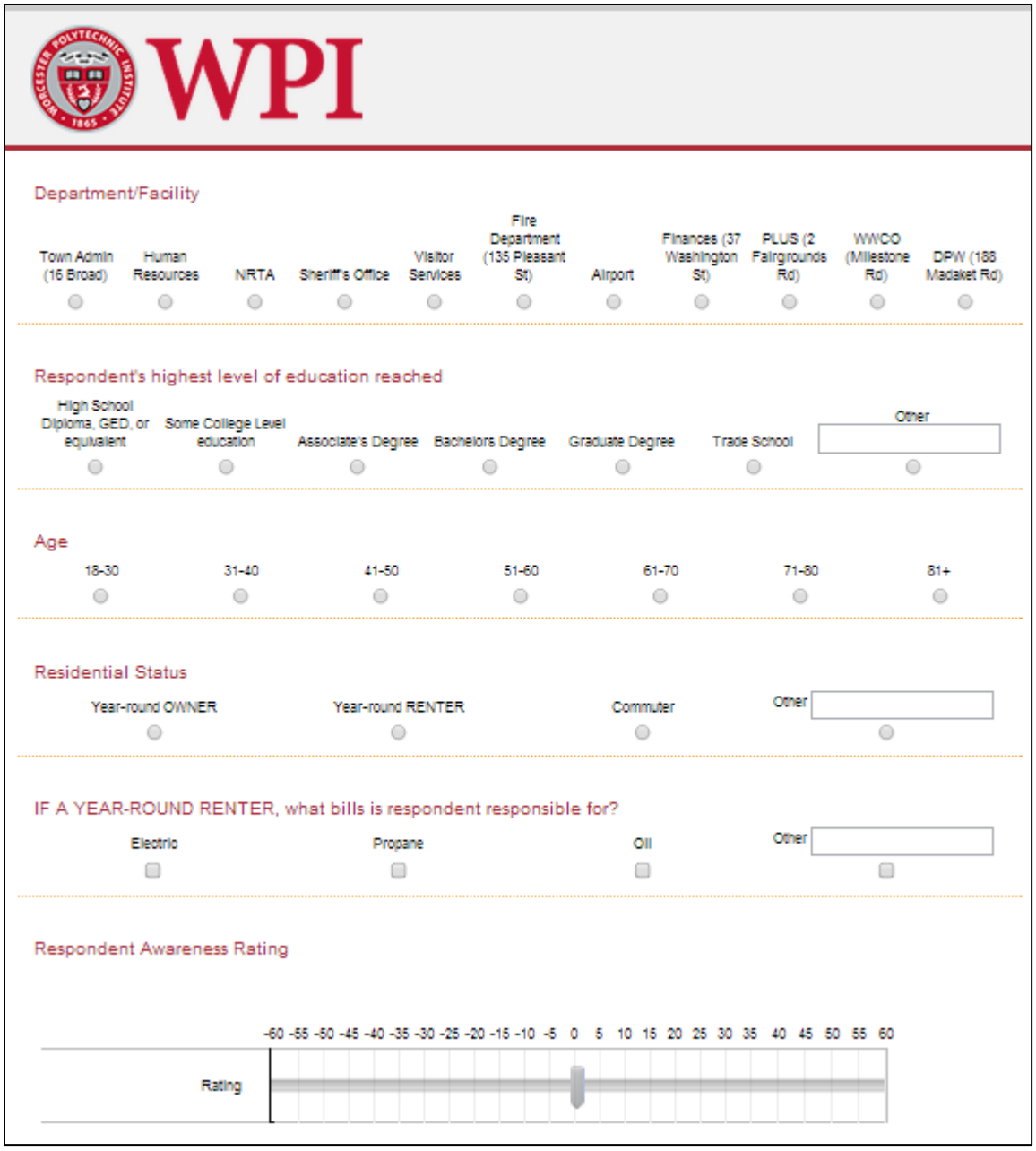


Figure 25: Qualtrics Survey Page 1 of 3

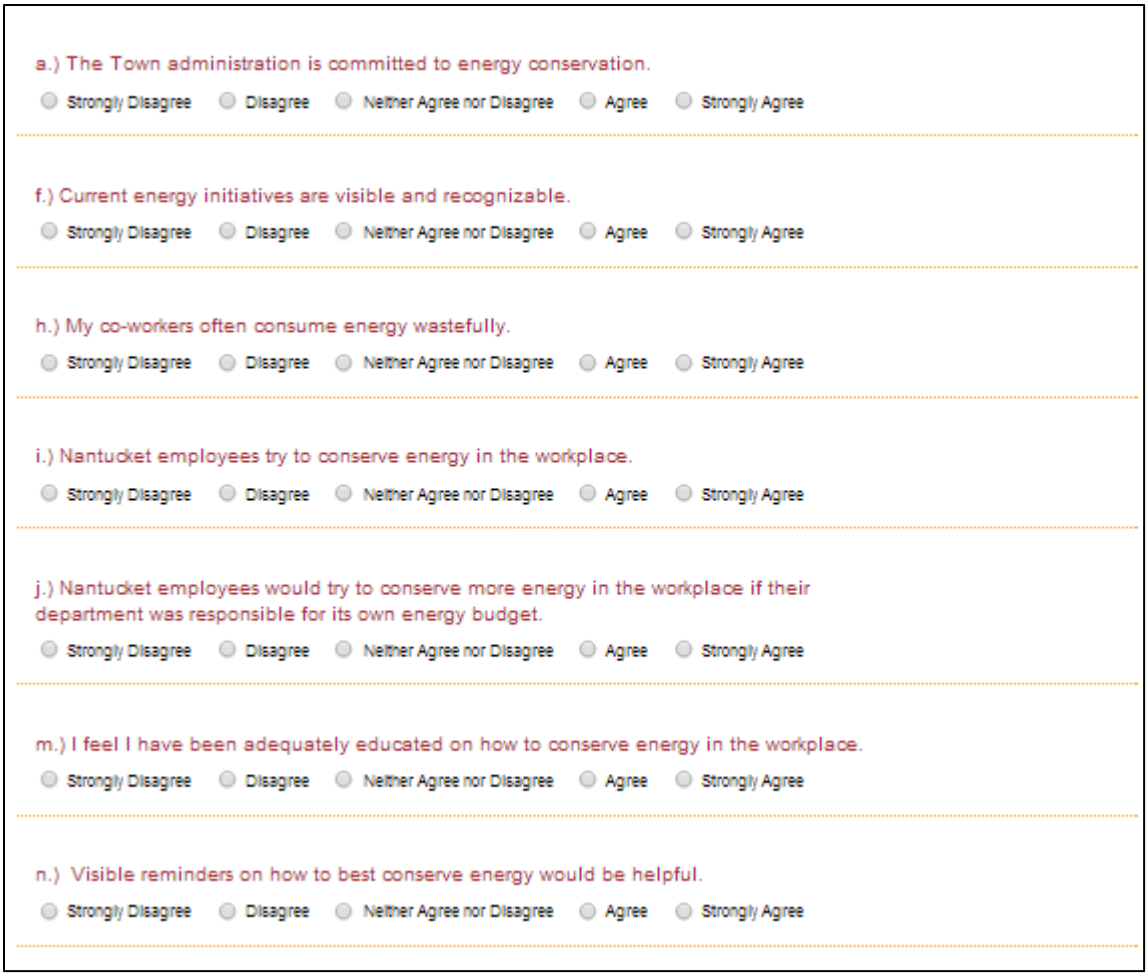


Figure 26: Qualtrics Survey Page 2 of 3

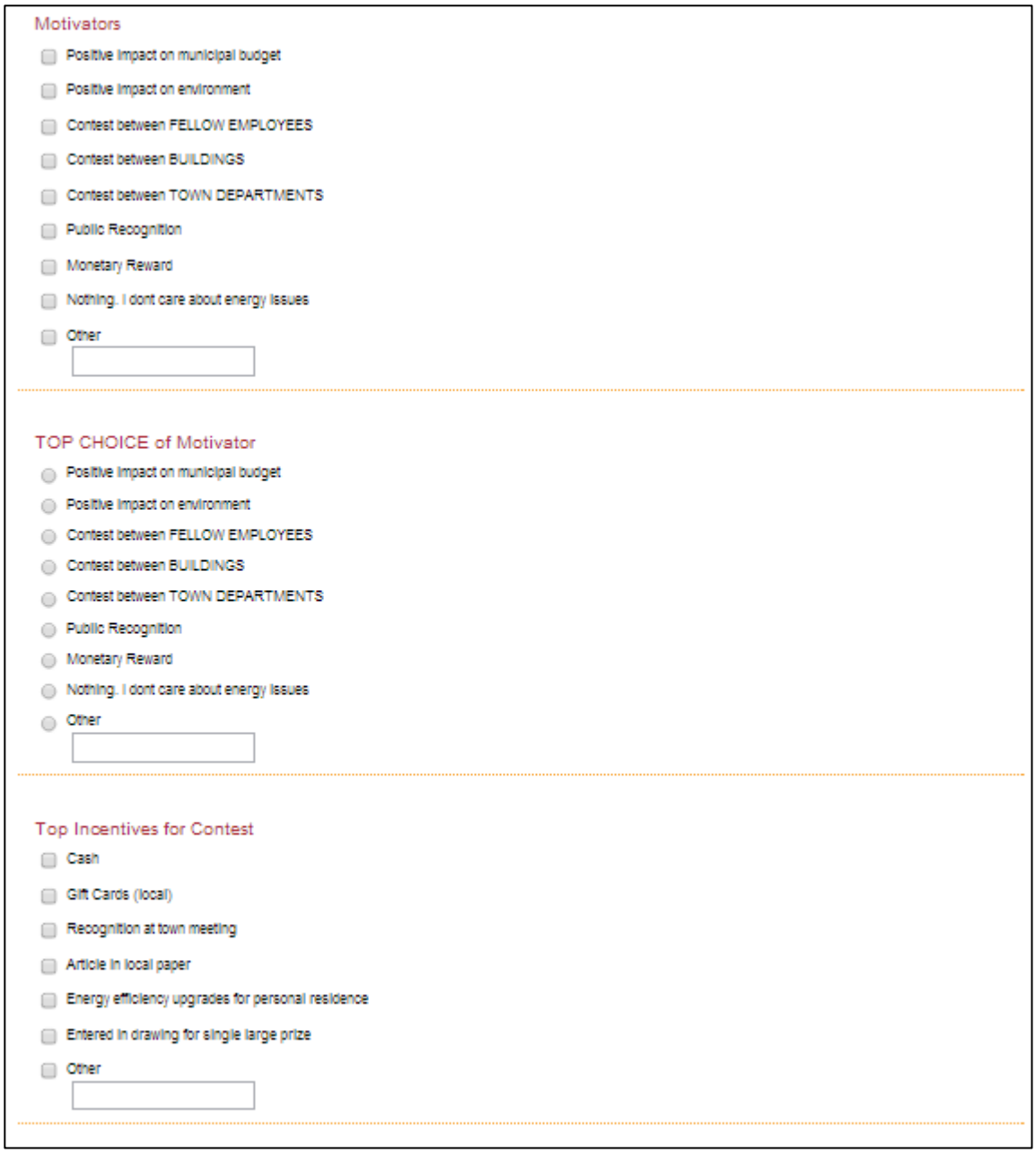


Figure 27: Qualtrics Survey Page 3 of 3

D. Survey Analysis

Surveys were analyzed by implementing a grading system to score the respondents' energy awareness. The participants' grade from the scored questions represented their "Respondent Awareness Rating." All of the surveys, but not all of the questions, were entered into the software Qualtrics. This includes:

- Demographic Questions 1-5
- Responses to Question 7 that were not a part of the grading system
- Respondent Awareness Rating
- Motivation Questions 9 and 10

The following is an explanation of the grading system for the Respondent Awareness Rating. Each question that is a part of this system will be presented and an explanation will follow.

6.) Do you know who pays this building's electric bill?

The possible answers for this question were yes or no. If the respondent said yes, they listed the name of the person that they believed was responsible for paying the building's electric bills. The participant will receive zero points if they respond no, 5 points if they respond yes with the correct answer, and -5 points if they respond yes with an incorrect answer. The grading scale for this question was chosen to reflect a high level of awareness of accountability for energy with a high score, zero points for not knowing, and a negative score for thinking accountability lay elsewhere.

7.) Below are a series of statements. Please indicate your opinion on each statement.

The Likert Scale was used for question 7, from 1 (Strongly Disagree) to 5 (Strongly Agree). Each response was scaled individually. The scoring rubric is displayed in Figure 28.

Statement	1 Strongly Disagree	2	3	4	5 Strongly Agree
b.) The Town's energy goals are clear to me.	-2	-1	0	+1	+2
c.) I am aware of the Nantucket Energy Office and its efforts.	-4	-2	0	+2	+4
d.) More emphasis on energy conservation would be beneficial for the Town.	-2	-1	0	+1	+2
e.) More emphasis on energy conservation would negatively affect my productivity at work.	+2	+1	0	-1	-2
g.) Management should find ways to control energy consumption in municipal facilities.	-2	-1	0	+1	+2
k.) My facility is more energy efficient than most.	-2	-1	0	+1	+2
l.) I use energy more efficiently than most employees.	-2	-1	0	+1	+2
o.) I would volunteer to participate in energy conservation projects at work.	-4	-2	0	+2	+4
p.) My efforts to conserve energy at the workplace are similar to my efforts at home.	-2	-1	0	+1	+2

Figure 28: Scoring Rubric for Question 7

8.) Please indicate how often you perform the following at work. Typically, how often do you…

The Likert Scale was also used for these routine questions, ranging from 1 (Never) to 5 (Always). All questions except for "h.) Use a space heater?" was scored from 1-5 by -2, 0, +1, +2, and +3. This grading scale was chosen so answering

negatively to conserving energy would result in a negative score, but any response other than 'Never' would be positive or zero depending on the frequency of the action. Never using a space heater is a positive answer and the grading from 1-5 is opposite: -2, 0, +1, +2, +3.

9.) If you were asked to change your everyday habits at work to reduce municipal energy consumption what would motivate you the most? (Check all that apply and circle your top choice).

If "Nothing could motivate me...I don't really care about energy/environmental issues," was selected as the response, 5 points were deducted. All other responses were given no point value.

E. Potential Projects for Next Year

Incinerator on Site

In 1996, Nantucket attempted to alleviate the issues of waste disposal by implementing a solid waste disposal program with the help of Waste Options, Inc., a Rhode Island-based company. As a result of the program, issues with landfill clean-up, recycling, and composting were addressed. However, over the years the issues of waste disposal have accumulated due to the island's lack of space. Major contributions to this issue include the island's growth in population as well as the fact that the island is bounded by protected wetlands and a sensitive ecosystem that could be affected by waste ("A System at Work – The Nantucket Story," 2013). Negative environmental impacts include soil and water contamination, as well as air pollution with the release of methane. Although Nantucket is known for achieving the highest recycling rate in the state ("A System at Work – The Nantucket Story" 2013), the disposal of wastes into the landfill is a current issue. The on-site composter is helpful for reducing organic wastes, but the idea of an incinerator that produces energy should be researched further. With the help of a WPI project team, the feasibility of an incinerator on site can be studied. The U.S. Environmental Protection Agency (EPA) found that "incinerating a ton of trash emits at least 35% less greenhouse gas and yields 10 times more electricity than burying it and capturing the methane" (Gutierrez, 2013). Incineration is a waste treatment process that has the potential for energy recovery, mainly in the form of high temperature heat. The WPI team could study the beneficial impacts of the incinerator in Austria ("Thermal Waste Treatment Plant") and determine if incineration is a possibility on the island of Nantucket.

Hospital Audit

Similar to the audit of the Nantucket Public School performed by a WPI team in 2013, an audit should be done on Nantucket Cottage Hospital. Each year the hospital pays $1.5 million in energy bills, which is equal to half of the town's total bill (Hartmann, 2013). This is largely due to the building's failing heating and cooling systems. In addition to more energy, the equipment also requires more maintenance, especially the cleaning and replacing of air strippers. Currently there is no room available for new, energy efficient equipment. Because there is a risk for exposure to asbestos if equipment is moved, it is necessary to take measures towards proposing the construction of a new facility. It is important for a new hospital to be constructed, but approval of the plan should be the first step. An energy audit on the hospital has the potential to justify the need for a new facility.

Implications of a Third Cable

Nantucket is currently experiencing an average electrical systems load growth that lies between 6% and 7% yearly. Additionally, peak loading between 5PM and 10PM during July and August have put an even greater demand upon the existing cables. A WPI team could be dispatched to assess the implications of the proposed third cable project, and other proposals influencing electrical demand, such as that of Nantucket becoming an all-electric island. A study on the stresses to the current supply systems that a third cable would pose, as well as if the need for such a project is truly present, could allow the island to clearly evaluate its energy outlook for the next decade.

National Grid Insurance Plans

In 2005, National Grid was prompted to construct a second undersea cable when it was seen that the capacity of the existing cable would be reached as Nantucket's population increased by 58% between 1990 and 2000 ("Nantucket Cable Project"). Under normal conditions, each undersea cable serves about half of Nantucket's electric demand.

However, there are instances where peak electric demand is greater than the capacity of a single cable, such as during summer months where seasonal homeowners vacation on the island. In the summer of 2013, peak electric demand reached 45 MW, higher than the demand of a single cable. In the event of a loss of a cable, National Grid has an insurance plan to serve customers. In the event of a loss of a cable, electric demand can be supplied by the cable that is still in service. If the demand for power is greater than the capacity of one cable, on-island and roll-on diesel generation will be utilized to ensure that customers are still being served. As a WPI project, students can investigate alternate insurance plans for National Grid to meet peak loading demand in case of failure. Alternate insurance plans could include load management, user-owned generation, and grid modernization (Constable, 2013).

F. Additional Recommendations

Recommendation 1: Assign the task of managing MEI to a full-time town employee, such as the Energy Coordinator of the Energy Office or a facilities manager.

The role of an Energy Coordinator for the Nantucket Energy Office consists of identifying instances of energy inefficiency, recommending ways to implement energy efficient practices, and promoting energy efficiency programs. The position of facilities manager involves maintaining the buildings of an organization, directing employees when it comes to ensuring that facilities are taken care of, and overseeing the upkeep of supplies. Facilities managers are also responsible for scheduling renovation projects, buildings improvements, and safety inspections. Lauren Sinatra, the Energy Coordinator as of 2011, is currently not a town employee, but rather her position is paid for by ReMain Nantucket, as outlined in Section 2.3.2. Due to the importance of maintaining the data in MassEnergyInsight to track energy usage trends in municipal buildings, a full-time employee should be assigned the task of managing the database. However, it is a time-consuming task, and it would be helpful for the Energy Coordinator and Facilities Manager to collaborate on completing the tasks that are necessary to keep the energy usage data in MassEnergyInsight accurate and up-to-date. Both of these positions would be able to work together in order to reduce energy consumption in the municipal system, as well as to keep buildings efficient and fully up-to-date on energy efficient upgrades and practices.

Recommendation 2: Recommendations on how to best target seasonal homeowners.

Due to the fact that they are not year-round residents, seasonal homeowners can be seen as a difficult audience to target with energy use programs. Some ways in which seasonal homeowners could be effectively targeted are: variable rates during the peak season, seasonal energy surcharges, and energy conservation initiatives. With variable energy rates during the peak season the charges for energy would be increased during the "peak" usage times of the day, which would encourage lower energy consumption during

these times. There are a few ways in which a variable rate could be implemented, either through the energy provider, or through locally imposed town taxation. The town could enact a tax that takes effect after a user passes a specific amount of energy consumption during peak hours. The money collected from this tax could then be placed into a town energy efficiency fund to be used for town energy upgrades, or a capital fund to offset future third cable costs. Seasonal energy surcharges would cause the price of energy to go up during the peak season, which would offset the eventual need for a third cable, as well as decrease the demand. Seasonal energy surcharges would affect everyone on the island, not only the largest energy users. This surcharge could also be made up of either a charge from the energy provider, a local tax, or both. Seasonal homeowners would be far more likely to participate in energy conservation programs if they were to receive noticeable savings. The current MassSave programs and initiatives on island are mainly targeted towards year-round residents. With the huge influx of people to the island in the peak months, which increases the islands population from an average 10,000 to 60,000, the seasonal homeowners are a huge target audience. With the large number of seasonal homes on the island, small energy efficiency upgrades on these properties can have an effect on energy use on the island.

G. Acknowledgements and Biographies

We would like to thank the following people and have included their biographies below. First and foremost, thank you to our sponsor, Ms. Lauren Sinatra, of the Nantucket Energy Office, for this opportunity to help the Town of Nantucket.

In addition, we would like to thank our WPI advisors: Professor Fred Looft and Brigitte Servatius, Professor Stephen McCauley, Kathy Richen of the Nantucket Finance Department, Noah Karberg of the Nantucket Memorial Airport, Peter Morrison, and the Town of Nantucket employees who took part in our survey.

George Aronson

A founder and principal of Commonwealth Resource Management Corporation (CRMC), Mr. Aronson has been developing small power production facilities for more than 25 years, with special expertise in feasibility assessments, acquiring power sales arrangements, managing permit acquisition and developing and implementing innovative business development approaches and financing strategies. Prior to joining CommonWealth, Mr. Aronson was a senior consultant at a national firm specializing in the development of waste-to-energy facilities for public sector clients. Mr. Aronson has a bachelor's degree in mechanical engineering from the Massachusetts Institute of Technology and a master of public policy degree from the John F. Kennedy School at Harvard University. He is a member of the Massachusetts Wind Working Group, the Northeast Energy and Commerce Association, the Solid Waste Association of North America, and the MIT Enterprise Forum.

Michael Berry

A results-driven manager at ICF International working in Demand-Side Management New Construction Programs working directly with utility, non-utility partners, state and local agencies. Creating synergies with all major market actors within the construction community to influence energy efficient building and remodeling practices that impact the new and retrofit construction markets by providing innovative program designs that increase participation rates and exceed client goals.

Joseph A. Cardinal

Joseph is currently a Manager of Community and Customer Management at National Grid. He has worked at National Grid for the past 25 years, the last 2 in his current position and as an account manager prior to that. He graduated from UMass Boston in 1985 with a BS/BA, Business and Marketing. He started working for National Grid 3 years later in 1988. Joe mainly works as a company liaison and a storm response manager.

Seth Pickering

Seth Pickering is the Massachusetts Department of Energy Resources, Green Communities Division Southeast Regional Coordinator. He is a Massachusetts Maritime Academy graduate with a degree in Marine Engineering and has lived in Massachusetts for most of his life. He supports the Green Communities Division by working directly with city and town officials and volunteers to achieve Division objectives and municipal energy goals. Division objectives include the implementation of grant programs, energy efficiency technical assistance, municipal energy tracking software and other energy related services. The Green Communities Division's mission is to assist cities and towns in maximizing opportunities to save energy in schools, city halls, fire and police stations and all municipal operations.

Christopher Raymond

Christopher started work as a Nantucket Engineer for National Grid in 2006 after graduation with a B.S. in Electrical Engineering Technology from Wentworth Institute of Technology. He then went to school part time in 2008, earning a MS from Suffolk University in 2012. In 2009 he became a senior engineer for National Grid and then in 2011 he took over the position of Supervising Lead Engineer. Chris mostly works with power distribution systems and design at National Grid.

Lauren Sinatra

Prior to her work with the Nantucket Energy Office, Lauren served as Special Assistant to Yale Environmental Law & Policy expert Dan Esty--who is currently Connecticut's Commissioner for the Department of Energy & Environmental Protection--and led the logistics, corporate communication and client management efforts for his corporate environmental strategy consulting firm, Esty Environmental Partners. Lauren also worked several years at o.s.Earth, Inc. a start-up firm based upon the philosophies of R. Buckminster Fuller, for which she traveled extensively to facilitate sustainable resource management exercises for schools, universities and corporations. Lauren is also a co-founder of Nantucket Solar LLC, established in 2007, where she spearheads the company's renewable energy policy research, and manages the "Nantucket Solar EXPRESS: Mobile Solar Generator" solar powered events. Lauren graduated Magna Cum Laude from Tufts University and has called Nantucket home since 2005.

In 2013, Lauren was the recipient of the 2013 Leading by Example Award and received a citation from Representative Tim Madden for her outstanding contributions to the Town's energy and sustainability efforts as Energy Project and Outreach Coordinator.