Optimizing Affordable Housing on Nantucket

An Interactive Qualifying Project Report

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by

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Abstract

Housing Nantucket aims to provide low and moderate income residents of Nantucket with comfortable, affordable housing that is also energy efficient. The goal of this project was to research ways in which Housing Nantucket could improve the energy efficiency of their rental properties, expand their current property maintenance database, and plan a new eco-friendly office site to meet their ever growing demands. The final recommendations to housing Nantucket include a newly designed Access database, a list of improvements to be made to rental properties, an energy behaviors brochure to be distributed to tenants with Island wide applications, and suggested improvements to their office site plans.

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Executive Summary

Affordable housing is a problem in many communities in the United States, and Nantucket is no exception. On Nantucket, the median home price is over a million dollars and the average home sells for 2.4 million (United States Census Bureau, 2012). Nantucket's status as a summer getaway location creates a very high demand for the limited number of properties available on the island. When a great number of wealthy individuals are willing to pay large sums for any available property this drives up value of all properties on Nantucket.

Housing Nantucket, the island's sole non-profit dedicated to providing affordable housing, oversees 27 affordable rentals for island residents. In order to increase the affordability of these properties, Housing Nantucket has made it their goal to make these homes as energy efficient as possible. Being the only on island organization dedicated to this cause, they have been expanding in order to fulfill the growing need for affordable housing; their current office and database could no longer support their needs as an organization.

This project aims to help Housing Nantucket increase the energy efficiency of their existing rentals and address resulting from their expansion. The project has three main goals: 1) To evaluate the Housing Nantucket property database and provide suggestions on its improvement; 2) To assess tenant knowledge of energy saving behaviors and create educational materials that can be distributed to tenants and/or island residents, and 3) to assist Housing Nantucket in the development of their new office building by providing suggestions on viable energy saving technologies that could be incorporated into the building.

1) Housing Nantucket's existing database had no 'search' function, limited room for future expansion, and lacked definitive logical structure. For these reasons, we recommended the creation of a new database using the Microsoft Access database program and then designed the database for Housing Nantucket. The new Access database includes several sources of information, including energy related property data and provides a more functional and effective property management tool.

- Our recommendation is that Housing Nantucket use the database frequently and keep it up-to-date in order to ensure it will remain useful and functional.

2) We conducted a survey of tenants to assess energy saving attitudes and behaviors and to identify potential energy saving options. Eighteen of the twenty-seven tenants returned completed surveys. Based on the survey findings, we conclude:

- Housing Nantucket tenants are fairly responsible when it comes to saving energy. Nearly all tenants said they turn lights off when they are not in the room, and many of them turn the thermostat down before leaving their house and add or remove layers of clothing to get comfortable rather than change the temperature.
- Housing Nantucket properties suffer from many drafts, leading to a lack of comfort for tenants and wasted money and energy.
- Many tenants do not unplug device chargers when they are not in use, even though they continue to draw power ('phantom loads').
- Most tenants do not turn their cable boxes off when they are not watching television, even though these devices draw a lot of power.
- Many properties include appliances that are not Energy Star™ certified.
- The majority of tenants who responded said they are satisfied with Housing Nantucket as a landlord.

Based on these conclusions, we recommend that Housing Nantucket:

- Consider providing tenants with appropriate weather stripping for free or at a reduced cost.
- Consider purchasing 'smart power strips' and providing them to tenants at reduced cost to prevent 'phantom loads' associated with device chargers.
- Encourage tenants and advise them as necessary to program cable remotes to turn both the television and cable boxes off with one press. Most modern cable remotes support this feature.
- Consider replacing all future appliances with Energy Star™ certified products.
- Distribute the brochure on energy saving tips for tenants developed and designed by the team in response to the survey findings.
- Consider developing a more generalized pamphlet for seasonal renters that could help reduce the large peaks of energy usage during summer months.
- Housing Nantucket periodically gather testimonials from tenants in order to promote their program to others.
- All future acquired properties should also be audited as it is a proven way to save energy.

At the end of the survey, we also asked if the survey taker would like to talk to us more about how Housing Nantucket, energy efficiency and the energy audits have improved their lives. Many tenants indicated they would like to meet with us, however only three replied. The tenants we interviewed shared truly interesting stories with us – we heard from tenants with highly seasonal work, lifelong residents, and single parents – all of whom have benefited greatly from Housing Nantucket.

3) Based on inspections of the Clifford House, discussions with Housing Nantucket staff and board members, and extensive review of the costs and benefits of different technologies, we recommend that Housing Nantucket should:

- Redesign Clifford House in the following ways: The first floor should consist of two or more offices, one large conference room, a receptionist's area, a children's play space and a break/lunch room. The four bedrooms on the second floor should become offices with one of the rooms possibly becoming a storage room for files and paper records.
- Rent the unused office space to other nonprofit organizations, allowing Housing Nantucket to earn back some of the renovation costs.
- Place the building on an ICF foundation, which will save substantial amounts of energy in the long term and prevent mold. This will incur higher costs up front, which will eventually be paid off by lower energy expenses.
- Include a 3.5 kW Photovoltaic system that will allow the office to produce 18% of its electricity a year for an installation cost of $20,000. The system will have paid for itself after 10 years due to the energy bill savings and the full payment of the ten year incentive plan. The office can expect a 25 year lifetime return on investment of $14,924.
- Install missing weather stripping and insulation.
- Install CFLs throughout as they will provide $143.20 in savings per year and reduce energy consumption on lighting by 80%.
- Install low flow fixtures, toilets and programmable thermostats. All of these items are comparable in cost to their inefficient counterparts, and will provide noticeable savings in water and energy use.

Authorship

This report was written as a collaboration of all three group members: Ethan Forbes, Casey Hayes, and Alex Kafantis. The research for this report was divided evenly among all group members. While each section was revised and edited by all group members to ensure the writing was clear, accurate, and represented the opinions of the project team, the list below displays the primary author for each section and task.

Alex: 1.6, 1.7, 1.8, 2.4, 3.0, 3.3, 3.5
Other Tasks: Website Designer, Interviewer, Pamphlet Information, Grammatical Editor

Casey: 1.1, 1.3, 2.1, 2.2, 3.1, 3.2,
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Other Tasks: Access Database Programmer, PV Cost/Benefits Calculations, New Office AutoCAD Drawings, Pamphlet Designer

All: 1.0, 1.12, 2.5, 4.0
Other Tasks: Preambles, Cover pages, Survey Distribution and Collection, Outreach for Housing Nantucket

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Introduction

The need for affordable housing has expanded in recent years as property prices have increased faster than household incomes and a prolonged national recession has elevated unemployment and reduced labor force participation. Together, these developments have proven especially distressing for Nantucketers who rent, as property values have increased as renters' disposable incomes have shrunk.

People need access to affordable housing; without it, the quality of life in any community decreases. Affordable housing greatly improves property values of the surrounding area as well as the quality of life and appearance of the community as a whole (Bradshaw, Connelly, Cook, Goldstein, & Pauly, 2005). On Nantucket, affordable housing is especially important given the extreme income disparities among island residents. Housing has become so expensive that a family of four with an annual income of $155,345 would qualify for affordable housing provisions on Nantucket (NHA Properties Inc.). Though Nantucket residents earn more than 150% the median income of those living on the mainland, their housing costs are almost three times as high; Nantucket's residents are being forced to move off the island because they can no longer afford to live there. These are people who are essential to Nantucket's continued vitality--teachers, police officers, and service workers with modest incomes derived from multiple jobs tied to the Island's tourism and construction industries.

Housing Nantucket was formed in 1994 to create affordable housing options on Nantucket. Its commitment to energy efficiency is one way that it promotes affordability by lowering renters' monthly costs for high-priced electricity on the island (which is significantly more expensive than elsewhere in Massachusetts and the nation)[1].

To fulfill its mission and protect the environment, Housing Nantucket requested that National Grid conduct energy audits of Housing Nantucket's properties. Building on these recent audits is the first goal of our project-- to survey the current rental properties and their tenants to identify ways to reduce their energy use and costs and develop educational materials to show renters easy ways to save money. A second goal of the project was to assist Housing Nantucket in the redesign of their new office (a donated building known as the Clifford House) and to explore prospects for obtaining energy efficiency certifications and grants. Through our research, Housing Nantucket will have outreach materials to help educate its tenants and will benefit from reduced energy costs across all its properties. This document details our research and methods for helping Housing Nantucket to become more energy efficient, and thereby to promote housing affordability for the Islanders it serves.

[1] In the summer of 2011, prices of electricity reached as high as 21.9 cents per kilowatt-hour (Nantucket, Regular Residential (R-1), 2012).

1.0 Literature Review

Nantucket has a great need for energy efficient, affordable homes. In this section, we examine the nature of the affordable housing problem on Nantucket and how Housing Nantucket is addressing the problem. We also discuss Housing Nantucket's commitment to alternative energy and energy conservation and explore certification programs that can lead to more energy efficient homes.

1.1 Nantucket Island Context

Nantucket is a small island off Cape Cod in Massachusetts, renowned for its rich whaling history and its beautiful landscapes and beaches (Figure : The Island of Nantucket).

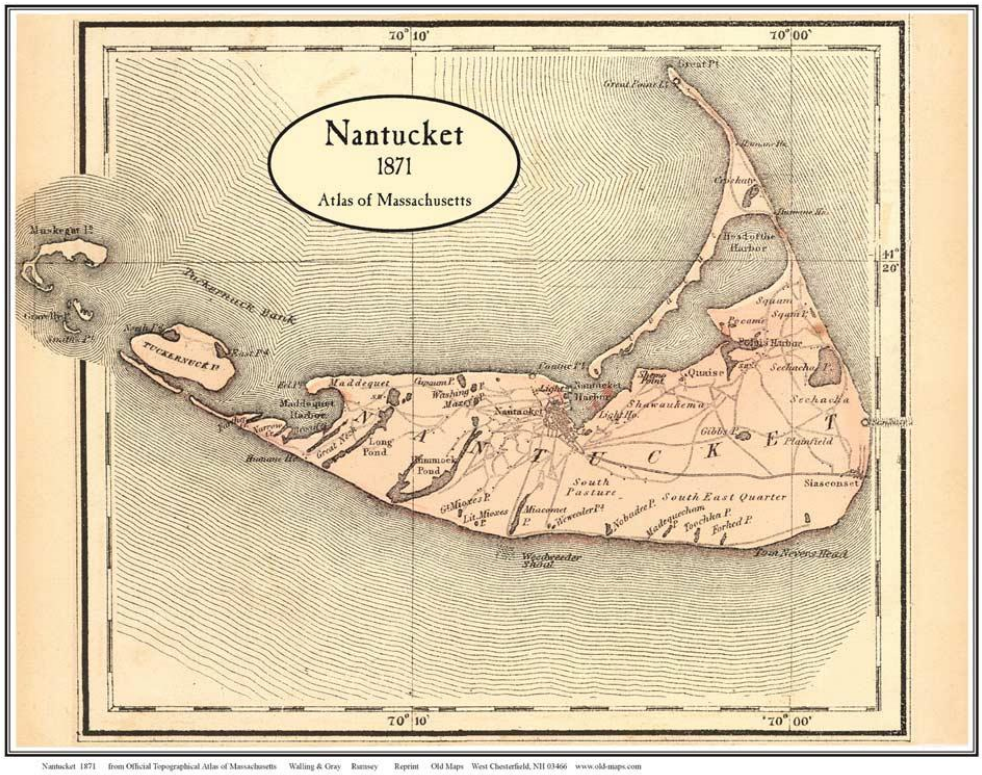

Figure : The Island of Nantucket (Walling & Grey, 2005)

After the collapse of its whaling industry, the Island experienced a localized economic depression. Walter Beinecke, "a savvy developer [and] dedicated preservationist" (Gertner, 2001) recognized the Island's charm and saw its potential investment value; his influence greatly affected the development of Nantucket into the center of wealth and luxury it is today. During the 1960's through the 1980's Beinecke purchased and sold many properties and parcels of land

on the island. He selectively sold and rented to high-end shops and businesses offering expensive goods tailored to attract a wealthy clientele. He staunchly supported preservation of the old town and protection of the Nantucket's open, undeveloped spaces (Gertner, 2001).Under Beinecke's influence, Nantucket's economy was revitalized as the island evolved into a destination popular among the wealthy.

Today, Nantucket experiences a massive influx of tourists and seasonal residents during the summer months. The year-round population is just over 10,000 but this figure increases dramatically during summer, peaking at 50,000-60,000 in July-August (About Nantucket, 2012). Nantucket residents depend on this yearly influx of people and consumer dollars to support their economy. According to the United States Census Bureau, retail sales were $30,997 per capita in Nantucket in 2007, compared with retail sales of $13,553 per capita in Massachusetts during the same year (United States Census Bureau, 2012). The island depends on tourism, but catering to wealthy tourists and seasonal residents has dramatically raised the cost of living on the island. The cost of housing is a particular problem for those of modest means.

1.2 High housing costs cause issues for Island Residents

The high cost of living associated with Island's tourist economy makes it difficult for year-round residents like teachers, firefighters and policemen to afford to buy homes. In any other community, these people would be able to afford houses and live comfortably. The median value of a Nantucket house between 2006 and 2010 was $1,000,001 compared with $352,300 for Massachusetts as a whole. During this same time period, the median income of Nantucket households was $53,410 compared with $33,966 for all Massachusetts households (United States Census Bureau, 2012). Although Nantucket residents earn more than 150% of the median household income of Massachusetts mainland residents, Nantucketers' housing costs are nearly three times as high. This means that for the 50% of residents with household incomes below the median,, housing for many is unaffordable based on national standards (e.g., HUD's standard that housing costs should represent about 30% of a household's income).

Nantucket's abnormally high housing costs are attributable in part to the discrepancy between the supply and demand of available real estate Nantucket is a small island and approximately half the total land area of 45 ml^2 is protected for conservation and cannot be

developed (About Us. History, 2012). Finding parcels of land that can be developed is extremely difficult, and competition among wealthy potential purchasers has driven prices up dramatically.

As a result, "...Vacationers (particularly seasonal homeowners) now compete directly with Nantucketers for much of the same housing stock. Since prospective seasonal homeowners drawn to Nantucket typically are wealthy enough to afford a second home, they have bid the cost of housing up to a point where Nantucket residents and their offspring no longer can afford to buy homes here (Manville, Pagini, & Russell, 2000). Most of these homes sit vacant for most of the year, narrowing the number of homes available to islanders and only providing rental opportunities at inflated prices set by homeowners. Once a small group of people are willing to pay inflated prices for any parcel, the price of all parcels tends to rise—real estate values are appraised with reference to "comparables." This appreciation in land value affects homeowners all across the island, whether they are looking to build new or have lived there for many years. Furthermore, increased property values can result in higher property taxes for homeowners, thereby intensifying financial strain on people who already own a home, potentially forcing them to leave the island in search of more affordable accommodations.

Many people who live on the island are forced to find ways to compensate for these high prices. Some residents partake in what is locally known as "the Nantucket Shuffle," whereby Nantucket homeowners vacate their residences during the summer, renting their property for a princely sum, then reoccupy their homes again in fall. Were more affordable housing options available on the island, fewer residents would need to leave during the summers to get by on payments for the rest of the year. For residents who earn their living at full-time island jobs, the "Nantucket Shuffle" imposes great hardship, forcing families to double up in cramped quarters or commute to work from Hyannis. Many workers in construction and other services are forced to live on the mainland and commute to the island by ferry either on a daily or weekly basis. Nantucket's economy is dependent on people who can work in the restaurants and shops, which account for much of the Island's tourist revenue. Many employers (town departments, cultural organizations, inns and restaurants) can only attract employees if they provide free or substantially subsidized housing. This means that businesses must charge customers more to compensate for these added costs of doing business on Nantucket.

1.3 High energy prices on Nantucket

Nantucket receives nearly all of its electricity through two submarine cables from the Massachusetts mainland. The extra transmission charge incurred means that Nantucketers pay among the highest electric service rates in the nation, with a summer high rate of 21.9¢/kWh (Nantucket, Regular Residential (R-1), 2012). Electricity is not the only thing that is more expensive on Nantucket, living on a secluded island means most goods and many services are imported. This makes everything from food, to building materials, to fuel more expensive owing to transportation costs. The high cost of living on Nantucket is especially problematic for moderate- or low-income year-round residents.

1.4 The Importance of Affordable Housing

Affordable housing is defined as costing less than 30% of a household's monthly income (Bradshaw, Connelly, Cook, Goldstein, & Pauly, 2005), a threshold many island residents exceed. Without affordable housing provisions, Nantucket could lose segments of the workforce that make the Island a prime tourist destination and lose its heritage as island-dwelling families look elsewhere for living space. Its economy relies on year-round residents who work in public offices, restaurants, and other businesses that support the tourist industry. Without these members of the community, the island would be unable to function.

Affordable housing is necessary for the safety and well-being of any community. "Substantial scientific evidence gained in the past decade has shown that various aspects of the built environment can have profound, directly measurable effects on both physical and mental health" (Hood, 2005). Without suitable housing, families are more likely to suffer from illness, anxiety, and instability, all of which can be dangerous to the health of children. Affordable housing allows those who are struggling to make ends meet to get jobs and start careers; people who benefit from affordable housing can move on to become important parts of their community and worthwhile additions to a town's workforce.

With the assistance provided by affordable housing provisions, community members in need can get on their feet and no longer need such provisions, meaning others can then benefit from the same resources later on. Affordable housing also limits or and may reduce a community's homeless population when implemented successfully. Investing in affordable housing is important because it helps people become valuable members of their community and

contributors to the local workforce. It also means younger community members will have better access to schools and employment, thereby reducing the long term need for further affordable housing provisions. With the aid of funding from the government and independent sources, many programs have been created to help these individuals in need of a home.

1.5 Nantucket's Efforts to Remedy the Problem

As the need for affordable housing became more apparent during the 1990's, concerned members of the community collaborated with the Nantucket Housing Authority to address the housing crisis on Nantucket. Public funding for housing projects was drying up, and it was determined that a better approach to the problem was to form a nonprofit and seek private funding. Stemming from this idea, NHA Properties Inc. (d/b/a Housing Nantucket) was created in 1994. Its mission was to promote "purchase, leasing, financing development, construction, management, control, and regulation" of housing for persons of "low, moderate, and middle income" within the town of Nantucket (NHA Properties Inc. Articles of Organization).

Today Housing Nantucket is comprised of seven board members who are year round residents with profession backgrounds in field including finance, law, real estate, building, and engineering. The organization has two full time employees (Executive Director Anne Kuszpa and Office Manager Milen Tsvetkov) and one part time office assistant. The organization's goal has stayed true to the original plan as they continue to provide affordable housing for Nantucket families earning less than 150% of the island's median income; about $155,000 for a family of four in 2012 (NHA Properties Inc.).

One of Housing Nantucket's most utilized programs is its affordable rental program. When the Town of Nantucket's leaders designate certain land should be used for affordable housing, it requests proposals (RFP) from non-profit corporations to develop the land for that specific purpose. Responders are awarded the opportunity based on fulfilling certain criteria outlined in the RFP. Housing Nantucket has been awarded land in scattered sites around the island by responding to these RFP's. Once awarded the land, Housing Nantucket either constructs a new dwelling or moves a house via flatbed truck onto the lot from another location. All units are designed or renovated to provide tenants with a quality living environment. Housing Nantucket is able to fund this program through private donations and grants, and the organization has created 27 affordable rental units on scattered sites in this way. The qualifications for these

homes vary according to the size of each family and their yearly incomes (Table 1: (U.S Department of Housing and Urban Developement).

	Income Verification 2012				
	1 person	***2 ppl***	***3 ppl***	***4 ppl***	***5 ppl***
80%	**$58,000**	**$66,300**	**$74,600**	**$82,850**	**$89,500**
100%	$72,500	$82,875	$93,250	$103,563	$111,875
112%	$81,200	$92,820	$104,440	$115,990	$125,300

Table : Income Verification Chart (U.S Department of Housing and Urban Developement)

In addition to its rental program, Housing Nantucket plays an instrumental role in the creation of affordable home-ownership opportunities for year round residents. In 2002, the Nantucket Housing Needs Covenant Program was introduced. This program allows property owners to sub-divide a lot that otherwise would not be dividable. One of the homes on the lot is sold in the open market, and the other is a restricted covenant unit designated for income qualified year round residents. Over forty-seven permanently affordable homes have been created in this way since 2002.

Housing Nantucket also provides education for those looking to find a new home. A nine hour course is offered twice a year to help future homeowners learn about buying a home including understanding the intricacies of mortgages and credit which can save new homeowners from unseen debt and other financial pitfalls.

With the current nation-wide economic recession, the need for affordable housing has skyrocketed. To meet these needs, Housing Nantucket staff is growing but sufficient office space is lacking. As a rapidly expanding organization, they plan to create an invaluable new resource center. This new building will become the center of Housing Nantucket's operations, and a shining example of the organization's commitment to energy efficiency.

1.6 Housing Nantucket's Commitment to Energy Efficiency

Housing Nantucket is committed to improving energy efficiency as part of its commitment to protecting the environment while providing affordable housing. This commitment can help the organization to attract potential donations and grants. Housing Nantucket's tenants pay for their own utilities, so providing them with the most energy efficient homes can reduce their overall living expenses--especially important on Nantucket, where fuel and electricity are very costly. Housing Nantucket encourages energy conservation by recycling

buildings and using energy efficient technologies such as CFL lighting and solar thermal water heating. In order to get the most efficient energy use from each home, Housing Nantucket also arranges to have its homes audited by energy specialists to highlight improvements that can be made. However, more could be done to reduce energy consumption and the costs of utilities for the organization and its patrons.

Seeking certification from one of the efficiency rating boards is one of the ways Housing Nantucket can ensure it is recognized for its efforts to save energy in the resource center as well as its existing rental properties. By becoming certified, Housing Nantucket will be able to prove its commitment to protecting the environment and reduce its costs of operation. Saving energy will also help tenants to save money on their utility bills.

1.7 National Grid Energy Audit

National Grid, the sole provider of electricity on Nantucket, has already conducted an energy audit of Housing Nantucket's existing properties, adding energy efficient light bulbs and conducting examinations of the insulation and plumbing of each home. This means that the properties have already been analyzed and improved by National Grid. Our research group will have an existing database of information to reference when conducting our own surveys.

While being energy efficient benefits the island's ecosystem, it also holds potential for Housing Nantucket's budget. While some energy saving products, materials and building techniques may cost more initially, they will often end up generating returns for their owners by greatly reducing their energy bills. Products that generate their own energy might also create an energy surplus, allowing Housing Nantucket to sell the excess electricity to a local power company for even further returns on their investment. Being energy efficient also holds great potential for obtaining additional funding, since energy efficiency certification is sure to attract donations and grants alike.

1.8 Housing Nantucket Resource Center Proposal

Housing Nantucket has been working out of a "closet sized office at the Housing Authority and then in a small rented office for the past six years. The organization now recognizes it is the time to take the next step and begin to develop their own office space – a resource center that will serve the entire community" (Request for Design Service Qualifications, 2008). This new Housing Resource Center (HRC) is meant to be the central location for all

Housing Nantucket activities, as well as providing them with a location for both offices and residential living areas. The project looks to set the standards for energy efficiency on the Island of Nantucket and will be used as a model for future environmentally friendly construction. The site looks to take every aspect into account in order to create a site that will meet the goals of the community as well as Housing Nantucket. With the help of funding from the Town of Nantucket's Community Preservation Committee and the US Department of Housing and Urban Development, they hope to open the HRC at 75 Old South Road within two years.

In its new Resource Center, Housing Nantucket wants to achieve the highest level of energy efficiency and "Green" principles possible, while staying true to its goal of providing affordable housing to residents of the Island. They strive to achieve the highest energy efficiency possible in order to become Energy Star™ certified, while taking into account the views of the community and the HDC. Housing Nantucket hopes that the success of this project will raise awareness of Nantucket's housing needs as well as showing the public the "green technologies" they advocate in their housing classes. The new office spaces are to be constructed on two parcels of land totaling 40,536 square feet that were dedicated by the island for the purposes of affordable housing and housing support, both of which have been rezoned to RC-2 i.e. residential commercial 2. Through generous donations, Housing Nantucket has acquired a new building, formerly the "Clifford House" (Figure : Clifford House Front View).

Figure : Clifford House Front View (NHA Properties Inc.)

This two story colonial style residence, built in 2004, will be re-designed into a suitable office for Housing Nantucket and its employees. The "Clifford House" is currently located on Clifford Street and will need to be moved two miles to the new site on Old South Road. The house was given to Housing Nantucket at no cost to the organization, but the estimated cost of the move is about $40,000. By moving this structure instead of building new, they will save significant money as well as limiting the transportation energy expended to deliver new construction materials to Nantucket. The current layout of the house does not meet the needs of Housing Nantucket, so will be reconfigured into a suitable work environment (Figure : Clifford House First Level Floor Plan and Figure : Clifford House Second Level Floor Plan). The building will need to incorporate multiple offices and a conference area. At least one of these offices will have an internal confidential meeting space for meeting with clients. The offices should be made as open, airy and as bright as possible to provide employees with a healthy working environment. Along with the office, they are looking to incorporate a filing room with locking and fireproof storage options.

More research needs to be done in the way of specific products and technologies that will allow the new office to be as "green" as possible.

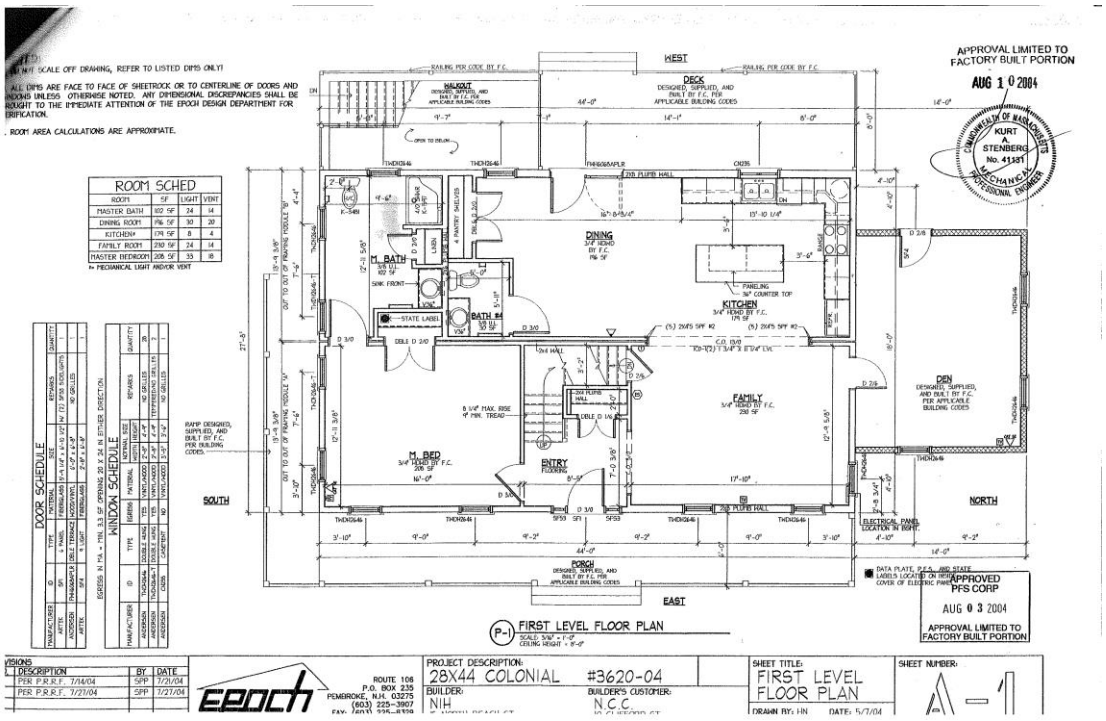

Figure : Clifford House First Level Floor Plan (NHA Properties Inc.)

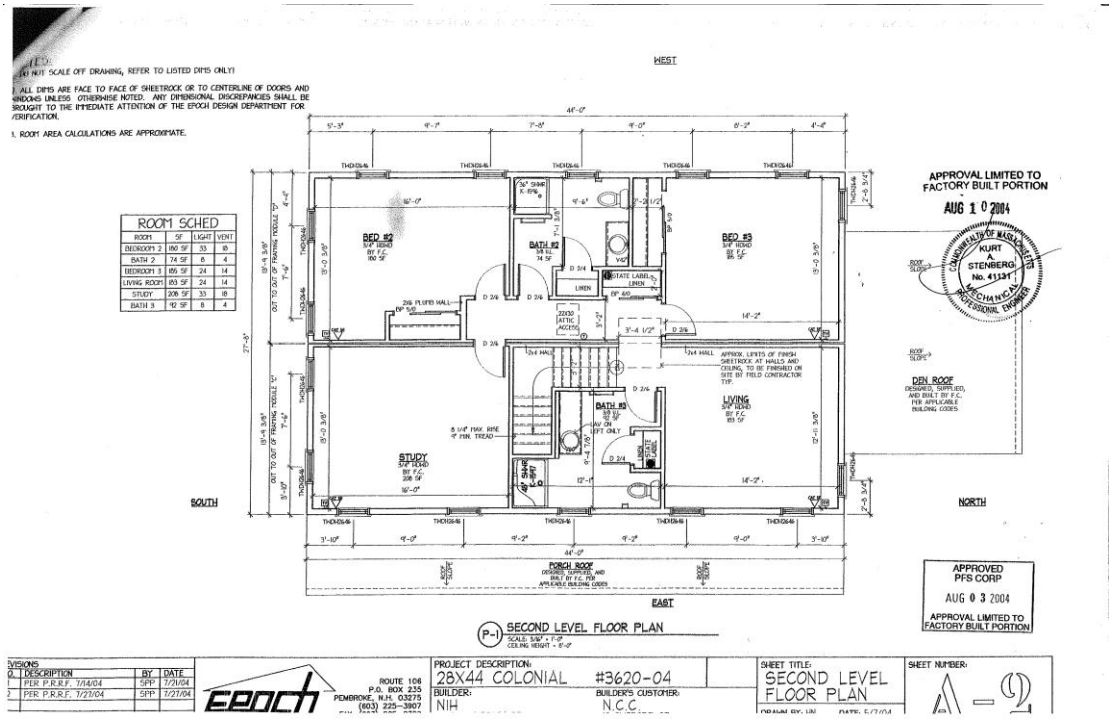

Figure : Clifford House Second Level Floor Plan (NHA Properties Inc.)

1.9 Certification Programs and Grants

1.9.1 LEED Certification

The Leadership in Engineering and Environmental Design, or LEED, is a coalition of different ratings systems that evaluate the environmental friendliness of buildings and award them one of four ratings, from bronze to platinum. LEED differs from other ratings boards in that it is specifically designed to rate buildings both existing and in conception as well as its ratings process, which emphasizes transparency of methods and a quick turnaround, allowing building managers and homeowners to know their rating faster than other with other rating systems (U.S. Green Building Council, 2011).

When LEED rates a building or building plan, it considers seven factors, and awards points for each (Figure : LEED rating criteria for new construction (U.S. Green Building Council, 2011)). The factors include Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality, Locations & Linkages, Awareness & Education, Innovation in Design, and Regional Priority. Regional priority is especially important as it can reward up to four "bonus" points based on whether the site can accomplish additional goals unique to its area (U.S. Green Building Council, 2011). In Nantucket, bonus points emphasize reducing waste and energy usage, as well as minimizing environmental impact, all of which are very important given Nantucket's remote location and its dependence on the mainland's energy supply. Another consideration unique to the LEED certification system is recycled buildings. Housing Nantucket's Resource Center will be a recycled halfway house, which will be a great help in attaining a high LEED rating. In order to reach the highest practical certification, Housing Nantucket will also have to focus on earning regional priority points, which can make a sizable difference in a building's LEED score.

Figure : LEED rating criteria for new construction (U.S. Green Building Council, 2011)

1.9.2 Energy Star™

Energy Star™ is another program dedicated to recognizing energy efficiency.[2] While Energy Star™ primarily focuses on the promotion of products and appliances they deem efficient, it is possible for a building to become Energy Star™ certified as well. The certifications for Energy Star™ are simpler and less stringent than for LEED certification. Essentially, the building must use 15% less energy than a compliant building built in 2004 (Environmental Protection Agency; Department of Energy). Furthermore, Energy Star™ incorporates EPA's Indoor AirPlus, a program designed to greatly improve indoor air quality of a building. If the resource center is to achieve high marks in LEED's Indoor environmental quality standards, use of the Indoor AirPlus program will be critical.

1.9.3 The HERS Index

The Residential Energy Services Network (RESNET) Home Energy Rating System (HERS) index is another industry standard in energy use certification programs. The HERS index has benefits over LEED and Energy Star™ in that it is much simpler to understand and to rate a home or building. A HERS index score may be as high as 150 or as low as 0. A score of 100 means that the building uses exactly the expected energy for an "American Standard Building", while a score of 0 means the building spends no money on energy (making it a net-

[2] Energy Star™ was created by the EPA and Department of Energy in 1992. It is now an international rating standard.

zero energy building) (Residential Energy Services Network, 2012). In contrast, a score of 150 means the building consumes 50% more energy than the standard building. In order to attain an official HERS index score for a building, a HERS-certified energy rater must perform an assessment of the building, including insulation efficiency, ratios of walls to windows, and testing for duct leakage. Because the HERS index is simple and easy to understand, it is a great match for Housing Nantucket. This is especially true as the index rates homes based on their energy efficiency as well as comfort, striving for a practical balance between the two and emphasizing energy saving technologies that impact tenants as little as possible. This makes it a perfect match for Housing Nantucket's energy evaluation.

1.10 State of the Art in Energy Saving Technologies

An important component in the creation of affordable housing is the conservation and efficiency of energy in the home. There are many technologies available today that allow homeowners to save money by reducing energy and heating costs, which in return reduce their total living costs. It is important to understand that many of these technologies have a higher cost when initially installed compared to the standard means, but all have the potential to provide a higher return investment. In order to provide people with long term affordable housing, it is important to consider these technologies and weigh how effective they will be at reducing net costs over the life span of the house.

The ultimate goal for any "green" sustainable building is the idea of net zero energy. "In a zero energy home annual energy consumption is equal to the annual energy production using one or more available renewable energy resources" (Iqbal, 2004). Zero net energy homes are self-sustaining and do not need to rely on non-renewable energies such as fossil fuels. Through the combination of commercially available renewable energies, such as photovoltaic solar panels, and the most efficient energy conserving techniques, a zero net energy home can make the most of the energy it produces. When a zero energy home is connected to a power grid, it supplies the grid with as much power as it consumes, meaning that it is at net zero energy. In some cases the home can even provide the grid with the excess energy that is not used, allowing the owner to sell energy back to the power company and in return save more money for the home owner (Iqbal, 2004).

In order to reach this net zero status, the home may use any combination of energy creating and saving techniques. Most net zero houses create their energy through the use of a wind turbine, micro hydro systems or photovoltaic cells. Due to Nantucket's housing codes and regulations, wind turbines would not be allowed. Photovoltaic solar seems to be the best option available due to the islands high amount of sun exposure and limited quantity of fast flowing water sources.

The most notable example of a net zero solar building that would translate well to the needs of Housing Nantucket's buildings in the Housing Resource Center is The Vandemusser Residence in Ashville, North Carolina. The combined office and living space of the Vandemusser residence received a 2011 LEED Platinum home rating. The engineers who also own the house created a report of the project that outlines many key things to think about when looking at creating an affordable sustainable home.

> Money is almost always the limiting factor when constructing a new home, but it shouldn't preclude someone from improving the energy efficiency of their home down the road when additional funding becomes available. Ultimately, the State, Federal, and utility incentives that were available at the time allowed us to move forward with the installation of both the solar thermal and photovoltaic panels during construction of this home (Vandemusser, 2012).

It is important to keep in mind that photovoltaic systems are the most expensive part of any net zero house; there are many other technologies that provide a large benefit which are cheaper and easy to install. "Even without the active solar component that was added on at the end of the project, we were able to get the HERS Index down to 44, which equates to 56% more efficient than code. That's from building a tight, well-insulated envelope and orienting and designing the house to effectively use the sun's energy" (Vandemusser, 2012). The Vandemusser residence was able to create a building that was twice as efficient as code using conventional building practices that require no maintenance, and do not involve the use of any mechanical and electrical devices. These passive solar techniques are most easily implemented in new houses, but can also be retro-fitted into existing properties. The idea behind passive solar is to trap the heat from the sun inside the home during the winter months, and to keep the heat from the sun

out during summer months (Figure : Diagram of a Passive Solar Heating System (Environmental Protection Agency; Department of Energy)).

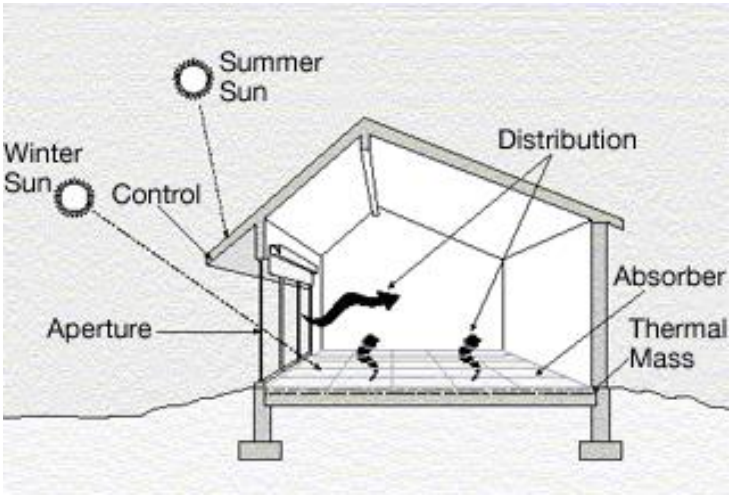

Figure : Diagram of a Passive Solar Heating System (Environmental Protection Agency; Department of Energy)

"In terms of long-term value, it's hard to express how important it is to have access to natural light. The additional benefit to a passive solar home, beyond reduction of energy usage, is the quality of light gained. We rarely use lights in our house by day, even on cloudy days (Vande & Musser, 2011). With the passive solar systems working to limit many of the needs for energy use in the home, the active systems need to create less energy to provide the homeowner with a normal user experience. "Once the active solar was incorporated at the end of construction, we were able to get the HERS Index down to 16, and efficient use of utilities got us the rest of the way to net-zero (Vandemusser, 2012). This means that in theory a homeowner could potentially make their home 72% more efficient than the national requirement for homes by simply implementing a combination of passive solar techniques, thermal materials, proper insulation, low flow piping, LED lighting and responsible monitoring of energy use. "Through careful design and system integration, along with carefully navigating the various local, state, and Federal incentives available for energy efficiency, we were able to build the home for the same cost or less than what other people have built similar-sized homes in the area (Vandemusser, 2012) [sic].

Although we may not be able to achieve complete net zero status in the "Clifford House", it is important to know what strategies are used by buildings of the highest green certifications.

Many of the technologies incorporated into these new homes can be retrofitted into existing properties. The historically designed homes already incorporate the ideas of passive solar, as well as unique room layouts in order to keep the homes warmer. When residents were dependent on fireplaces for heating, they needed ways to increase the amount of heat being trapped inside. "Another technique was the use of low ceilings with smaller rooms separated by interior walls and doors" (Way, 2009). They also incorporated passive solar planning in many early designs. "Traditionally southern walls have more windows and openings are typically larger, in order to take better advantage of the solar-heat gain available during the cooler months. Conversely, a building's northern walls typically had the least amount of glass (and sometimes wall area) due to the harsh winter winds (Way, 2009).

For many of Housing Nantucket's properties, net zero is not a feasible option. A majority of their rental units come from donations of properties that are in need of relocation. These properties range in age, but are all built in historic styles. Older homes often have poor energy efficiency due to factors such as old technologies and poor sealing. The easiest way to make these old homes more efficient is to address the issues of air infiltration and focusing on creating a well-sealed space resistant to outside temperatures. Major areas of focus are windows, doors and insulation. The Nantucket Historic District Commission is a firm believer in embodied energy, and urge homeowners to preserve as much of the existing materials as possible. There are many non-evasive techniques that can be used to update these homes without needing to replace existing windows and doors. By adding storm windows and doors over existing fixtures, the homeowner can increase the homes efficiency. "Storm windows are the least invasive and most appropriate way to increase the energy efficiency of historic windows. All storm windows enclose a thermal air space that approximately cuts heat loss in half" (Way, 2009). Storm windows also have other benefits, such as protecting the windows from Nantucket's harsh environment. "A single glazed, traditional window combined with a 'low-emissivity' coated storm window can have a similar "U-value"[3] as a new double-paned" (Way, 2009). Along with the storm windows, it is important to make sure that all windows and doors have proper weatherization in order to maximize effectiveness. Weatherization can be any form of rubber, metal, and sealants that ensure the window or door is keeping out water and cold air. Creating a

[3] U-Value: "a measure of thermal transmission through window materials and the boundary air films"(way,2009)

tightly sealed home with good thermal properties is very effective in reducing the heating and cooling costs of the home.

Aside from addressing the weather proofing issues, these older homes can also reduce their energy consumption by reducing the consumption of electricity. This can be done by replacing standard light bulbs with CFLs or (preferably) LEDs. Both such bulbs, although more expensive, last much longer and are more efficient then their standard incandescent counterparts. Simple things such as updating to newer more efficient appliances, using outlets with off switches, and unplugging items in the home that are not being used can all add up, reducing energy waste. In most cases the occupants' habits are among the most important factors governing overall energy consumption. If homeowners have the extra funds, and are willing to pursue the best efficiency in their home, they can also incorporate any of the active solar options, as they are applicable to almost any existing property. This method may require extensive re-wiring in order to take full advantage of the power gained.

There are many ways to increase the energy efficiency of an existing building; some involve serious work and could take months to install, while others are as simple as replacing a light bulb. All these options mean that any property can increase its energy efficiency regardless of age, location, or use. The key to making a building as efficient as possible is to understand the pros and cons of each product and create a plan for each building according to its individual needs.

1.11 Conclusion

Housing Nantucket is an organization created to provide island residents with affordable housing options. It manages 27 affordable rental properties and endeavors to maximize their energy efficiency insofar as possible. Although an energy audit was already performed, Housing Nantucket lacks certain information that would be beneficial to improving their energy efficiency. Current information on these properties is kept in a database, which needs to be refined and expanded upon to better aid Housing Nantucket in its energy assessment. As the demand for affordable housing rises, Housing Nantucket is looking to expand to a larger office to meet their needs. A building donated to Housing Nantucket for this purpose will be moved and renovated in order to adequately fulfill office requirements. Housing Nantucket hopes to achieve

the highest level of energy efficiency possible for this building. The next chapter describes how we will address these issues.

2.0 Methodology

In order to assist Housing Nantucket in creating and exploring strategies to increase energy efficiency in its rental properties and the new Housing Nantucket offices, we outlined a set of four objectives. The project team:

- Updated the existing inventory of Housing Nantucket's rental units, with an emphasis on energy use and conservation.
- Evaluated tenant knowledge, understanding, and behavior in regards to energy use and conservation following the recent energy audits.
- Developed outreach materials for Housing Nantucket tenants regarding energy and energy conservation.
- Evaluated possible site plans and building options for the Resource Center.

2.1 Objective 1: Update housing inventory

For the project team to recommend ways to improve the energy efficiency of Housing Nantucket's properties, we needed to identify the current condition and energy-related characteristics of these rental units. Housing Nantucket has an existing database of its rental units outlining basic information about the location and tenants. In order to aid Housing Nantucket in analyzing ways to make these units more energy efficient, we added information to the database that will provide insights about possible energy conserving options.

We evaluated the existing database (an Excel spreadsheet) to assess its structure and content. We determined that it lacked the capability for expansion and desired inclusion of diversified tiers of information. Following discussion with Housing Nantucket staff, we developed a new Microsoft Access database better suited to Housing Nantucket's current and future needs. Microsoft Access supports searchable queries as well as more advanced options for displaying and organizing the data sets for Housing Nantucket's record keeping. All of the information from the older Excel database was deemed viable and was transferred into the new Access database. Expanding upon this information, we included results from the National Grid energy audits as well as data from Housing Nantucket's QuickBooks files. Additionally, we discussed the types of information Housing Nantucket wanted from their tenants and reformulated our survey to ask questions that would elicit this information (). The results of our survey were then incorporated into the Access database. The Access program worked to

incorporate all of the necessary information, and we encountered little trouble during the creation process.

2.2 Objective 2: Evaluate tenant knowledge of energy issues

In order to help Housing Nantucket's tenants save energy, one must first understand how they use energy and how knowledgeable they are about ways to save energy. Once their needs and energy-related behaviors are understood, we can envision ways to improve their energy efficiency through behavior changes and the use of energy-efficient technologies.

We developed a preliminary survey instrument designed to elicit information from Housing Nantucket's tenants. This initial survey instrument was then refined by iterative discussion with Housing Nantucket staff, Peter Morrison, and our advisor, Professor Golding, until a final version was agreed upon (Appendix A: Survey Materials). Many of our original questions were modified, as we were addressing subjects in which many tenants would not know the answer such as type of heating and insulation. Housing Nantucket has 27 rental units; we initially planned to mail the survey to each address, however all mail on Nantucket goes off island even if its destination is still on Nantucket. Mailing out the survey, waiting for mail to return, and then sending follow-up surveys to encourage better response rates would therefore have taken a considerable amount of time. This lead us to forgo mailing, instead we chose to hand-deliver our survey and cover letter in weather-proof packaging and attached it to the door of each property. The cover letter (Appendix A: Survey Materials) explained who we are and the purpose of our project as well as detailing the ways in which the survey could be returned, namely by leaving it on their door on a specified day so we could collect it, or by dropping the completed survey off at Housing Nantucket's office (many tenants drop off rent checks and visit the office for a variety of reasons so this was not considered burdensome). To increase the response rate, we made follow up calls to all the tenants who we were unable to collect surveys from on the first collection day. We read these tenants the preamble (Appendix B: Survey Follow-up Calls) allowing them more time to complete the survey and dealt with problems of misplaced or lost surveys by delivering new surveys. This process was repeated until we reached a satisfactory number of survey responses and were no longer receiving any response from tenants.

After surveying the willing tenants, we compiled the information and added it to the Access database. The first section of the survey addressed specifics about the properties in

regards to energy usage, such as the type of water heaters, windows, and insulation. The data collected in the second section of the survey, which covers personal habits in regards to energy use, were formatted into a digital spreadsheet for analysis and group comparison. We used simple descriptive statistics in conjunction with graphs, such as histograms, to identify trends in the data. Interpreting these trends, gave us a better understanding of tenant habits and which areas we should focus on addressing in our outreach materials as well as identifying key areas in which Housing Nantucket could improve efficiency in the units themselves. The third section of the survey includes questions addressing opinions and knowledge acquired by the tenants from the recent energy audits. This section was analyzed in a similar fashion. The final question of the survey asks the tenants to indicate if they would like to meet with us in person to help us create outreach materials, including testimonials regarding their experiences with Housing Nantucket. We had a high positive response rate for this question so we got to select which tenants to interview based on feedback from the staff at Housing Nantucket. Once these data were collected and reviewed, we used them to create the outreach materials detailed in Objective three.

2.3 Objective 3: Creation of outreach materials

To help educate Housing Nantucket tenants about energy efficient behaviors and technologies, we created a pamphlet to give to current and future Housing Nantucket renters. This pamphlet recommends ways that could best aid Housing Nantucket tenants in saving energy. Our recommendations build on what other conservation programs and outreach materials teach with the data collected from surveys and interviews with the tenants. The Access program worked to incorporate all of the necessary information, and we ran into very little trouble during the creation process. The Access program worked to incorporate all of the necessary information, and we encountered little trouble during the creation process. It was developed in conjunction with Housing Nantucket staff, with advice from other organizations such as the Nantucket Energy Office, Housing Nantucket board members and staff at the Historic District Commission. Using the survey, we were able to ensure that our recommendations will be appropriate for Housing Nantucket tenants, increasing the chances our recommendations would be put to use. We found the pamphlet was limiting in the amount of information that could be included, so we overcame this shortfall with a supplementary article on Housing Nantucket's website. The website address was included in the pamphlet so that tenants looking for more information on energy efficiency could look at this page and find links and further reading.

We used testimonials collected from tenant interviews to create an article for Housing Nantucket (Appendix C). This article includes tenant stories of how Housing Nantucket has helped them as low income renters afford a home on Nantucket. There is also a section on energy conservation successes and what specific renters did to reduce their utility bills. Quotations and longer testimonials from tenants are incorporated into the article, but only with the express consent and permission of the tenants in question (Appendix C). We also include photographs of relevant materials in the article and for Housing Nantucket's future published works.

As part of our effort to reach out to the Housing Nantucket community, we used tenant electricity bill information to track electricity use before and after the energy audits were conducted. These findings and our pamphlet on energy savings were presented to the Board of Selectmen detailing how Nantucket rentals can become more energy efficient. We made a recommendation that our pamphlet or a similar document could be distributed to the summer renters in a similar way that the recycling guideline is distributed. We also made a case that the Nantucket energy office is a worthwhile use of island resources. The Board of Selectmen should continue to promote residents to take part in energy saving measures such as the National Grid energy audits to prevent or at least delay the construction on a third undersea cable further driving up island electricity costs.

2.4 Objective 4: Evaluate Resource Center options

In order to assist Housing Nantucket with their site plans and building options for the Resource Center, we gathered information about what we planned to include in the site. In order to do this, we attended the monthly Housing Nantucket Board meetings and talked to Housing Nantucket staff to determine the needs of the new center. During these meetings, we used the following discussion outline questions to determine Housing Nantucket's goals for the new site:

- Do you still wish to include Housing options at the new site? If so, what are your ideas for these units?
- What do you hope to achieve in terms of energy efficiency for the property?
- What certifications do you hope to get for the site? LEED, Energy Star™ or HERS?
- Are you familiar with the term Net Zero Energy? If so, do you think it is something you would like to pursue?

- Are there any specific technologies you would like to see implemented in the new Clifford House? For instance: photovoltaic, solar thermal water heating, rainwater collection, etc.
- What specific requirements do you want in the office spaces? For instance: conference rooms, file storage, etc.

According to the information obtained during these meetings, we reviewed the current site plans (Figure : Current Site Plan for New Housing Nantucket Office) and compared them to past proposals for the site. We toured the site to assist in determining the best way to convert it into an office space for Housing Nantucket and a Resource Center for the Nantucket community. Using the information gained during our initial meetings, we continued our research of possible technologies and discussed their application to the Clifford House in our weekly sponsor meetings. Once a technology was highlighted as being feasible and within the new site's budget, we worked to incorporate it into our final proposal plan. During the first few weeks working with Housing Nantucket, a large Siasconset Home was donated to the organization. After assessing ways to move this property onto the new lot, we determined that it would fit appropriately into the lots un-used space.

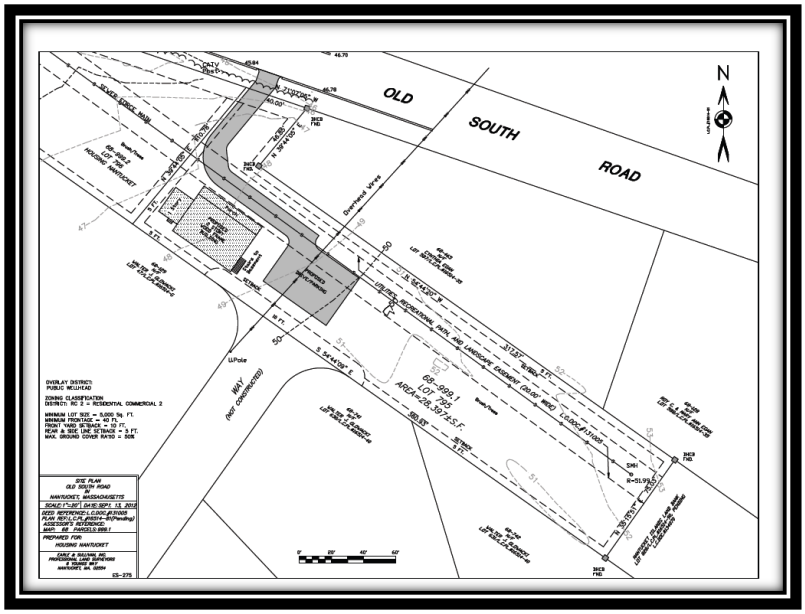

Figure : Current Site Plan for New Housing Nantucket Office

Once we had ascertained the needs and requirements of the Resource Center as well as thoroughly investigated the Clifford House (Figure : The Clifford House) and Old South Site (Figure : Current Site Plan for New Housing Nantucket Office), we used our knowledge gained in the literature review and other research to suggest the best plan of action in order to achieve maximum energy efficiency as well as grant opportunities for the Resource Center. This plan included a revised floor plan of the Clifford House, as well as an outline of specific energy saving strategies to be implemented in the renovations of the building. We provided Housing Nantucket with a plan and information on achieving Energy Star™ certification. Along with the proposal we created a cost-benefit analysis for different types of energy saving technologies included in our design. These were only estimates, as it was difficult to ascertain actual figures due to the fact that most costs are site and contractor specific. There are an overwhelming number of factors which contribute to cost variances, which cannot be assessed without a direct quote from an energy certified contractor. We then proposed this plan to Housing Nantucket's board and staff in order to the gain feedback for possible changes to the site.

Figure : The Clifford House

2.5 Conclusion

To assist Housing Nantucket in creating and exploring strategies to increase energy efficiency in its rental properties and the new Housing Nantucket offices, we interviewed and surveyed tenants and other pertinent organizations. This allows Housing Nantucket to determine the effectiveness of the recent energy audits at encouraging the adoption of energy conservation

measures. This survey provides important data about each specific property to be included in the existing database. We use the results of this survey as well as input from Housing Nantucket and other island organizations to develop outreach materials. These materials include documents to be given to current and future tenants outlining energy saving strategies, as well as promotional materials for Housing Nantucket to raise awareness of what they are doing. Through interviews with Housing Nantucket staff, the Housing Nantucket Board, the Nantucket Planning Board, and the Housing District Commission we will assist in the planning of the new Resource Center.

3.0 Findings & Conclusions

Our group successfully updated Housing Nantucket's database while analyzing tenants' energy use habits and making informed recommendations for the Clifford House. For Housing Nantucket's database, we were able to upgrade and improve the format and migrate all data to Microsoft Access 2010, which is better suited to the information storage and retrieval needs of Housing Nantucket. The Access database will be easier to edit from any computer in the Housing Nantucket office without sacrificing ubiquity across client computers. While our efforts fell short of attaining an ideal percentage of survey responses, we managed to gather enough data to discern patterns within tenant behavior and knowledge of energy saving technologies. This helped us to design an educational pamphlet for the tenants as well as write an in-depth informative article for Housing Nantucket to add to their website. After surveying the Clifford House and consulting with Housing Nantucket staff, we were able to find many ways to help them save energy and meet their goals for Energy Star™ certification. We were able to confirm multiple energy saving (and energy producing) technologies will be viable to help Housing Nantucket save money and energy at the same time. We hope Housing Nantucket will find our results helpful and that they will meet their Energy Star™ certification goals.

3.1 Finalized Database

The existing Housing Nantucket database was a spreadsheet in Microsoft Excel. It utilized the grid structure of the program with information groups in the top column and data in the rows below. It contained information on the tenants such as contact information and income. The database also contained information on the properties such as needed maintenance and age of the property; however this information was often vague and inconsistent across rows. Additionally, the entire database was one sheet within Excel, making searching for specific information or groups of information difficult. In assessing the structure and content of this database we determined that it lacked the capability for expansion and the desired inclusion of diversified tiers of information. After discussion with the staff

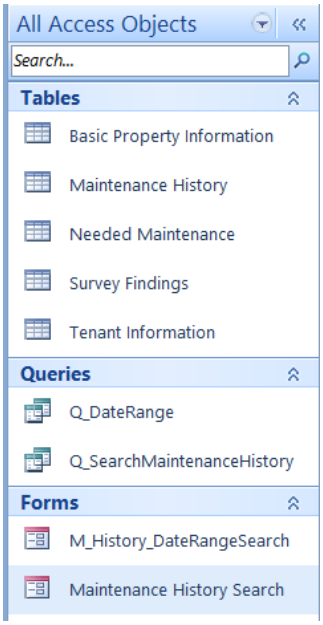

Figure : Contents of the Access Database

of Housing Nantucket we decided to create a new database using Microsoft Access, a program specifically designed to handle databases. The new database (Figure : Contents of the Access Database) includes all of the information from the older Excel database under a new table entitled needed maintenance as well as new tables consisting of information helpful to Housing Nantucket's daily work. Entering new information into the Access database is simplified by the inclusion of drop down menus that display standardized responses simply by typing the first letters of a word, which greatly speeds up the data entry process and allows for information in the database to be changed at any time.

The Access database comprises 5 different tables of categorized information. The tenant information table compiles information about tenant contacts, income verifications, and their enrollment in fuel assistance allowing Housing Nantucket quick access to tenant contact information. The basic property information table combines information such as year of construction and size of property with information from the National Grid energy audits, which outline specifics about technologies in the home and energy consumption figures. The original excel spread sheet was reformatted under the required maintenance table which allows Housing Nantucket to write notes about what needs to be fixed in each property. Once the maintenance is completed on a property they can delete it from the required maintenance table and enter it into the completed maintenance records. We were able to compile the existing maintenance records of jobs performed at Housing Nantucket properties via QuickBooks and included them in the database with the ability to add new information as needed. Access supports searchable queries as well as more advanced options for displaying and organizing the data sets which will be helpful to Housing Nantucket's' record keeping (Figure : Form for Searching Database by selection criteria). Now Housing Nantucket can search their entire maintenance record: by the contractor hired to do the work, by the property the work was performed on, by the cost, and by the date performed. There is a separate form that allows for displaying all work performed between two date ranges. These features will allow Housing Nantucket to access all of their records through one database that is easy to navigate and expand upon.

Figure : Form for Searching Database by selection criteria

3.2 Survey Findings

Housing Nantucket's 27 tenants were our survey population. We designed a preliminary survey, which was then refined and improved many times over through iterative discussion with Housing Nantucket Staff, Professor Golding, and Peter Morrison. The final copy covers three sections: the house, the tenants, and the energy audit. Originally we planned to conduct the survey by mail but instead settled on door-to-door survey delivery and pick up as the most expeditious strategy to reduce response time. To increase response rate, we made follow up calls to tenants who hadn't filled out the survey and provided multiple ways for the survey to be returned. These tactics yielded 18 completed surveys, for a respectable 67% response rate.

3.2.1 Opportunities for Improvement

Two survey questions were designed to gauge tenant satisfaction. Figure : I am generally satisfied with my current house/apartment (n= 18)shows that 12 tenants agreed or strongly agreed that they were satisfied with their current house/apartment. Figure : Housing Nantucket meets my needs as a tenant (n= 18)shows that 10 tenants agreed or strongly agreed that Housing Nantucket meets their needs as a tenant. From these response levels, we conclude that Housing Nantucket has been doing a respectable job by their tenant's standards.

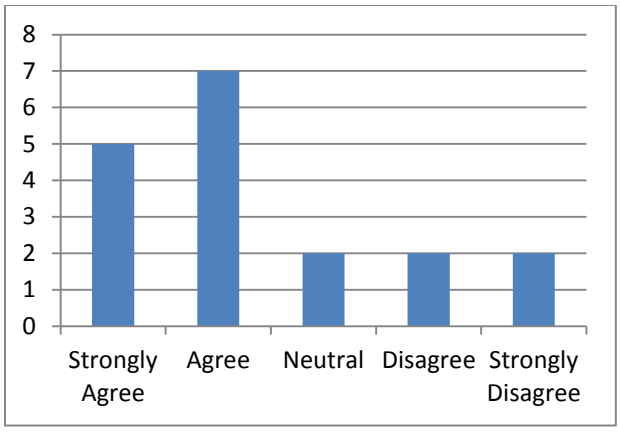

Figure : I am generally satisfied with my current house/apartment (n= 18)

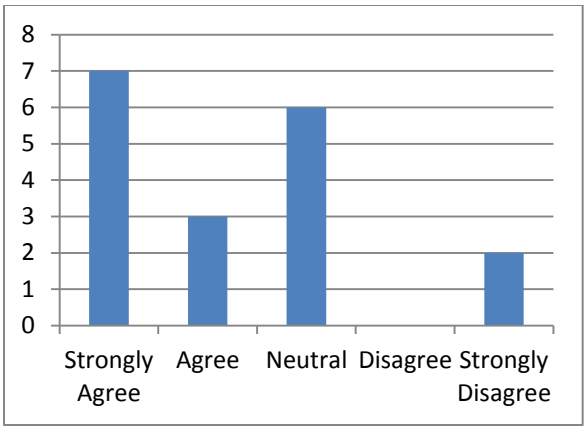

Figure : Housing Nantucket meets my needs as a tenant (n= 18)

However, there are potential improvements that Housing Nantucket can consider pursuing. Nearly 4 in 5 tenants (Figure : Do you regularly notice drafts in your house (n= 18)) tenants reported drafts in their homes. These drafts came from many different locations, but the most common was drafts around or near windows and doors (Figure : Compilation of locations which drafts were noticed (n= 18)). When asked if they had weather stripping, many tenants were unsure. Of those that knew, the majority did not have weather stripping around many or any of the windows while a few needed weather stripping around the doors.

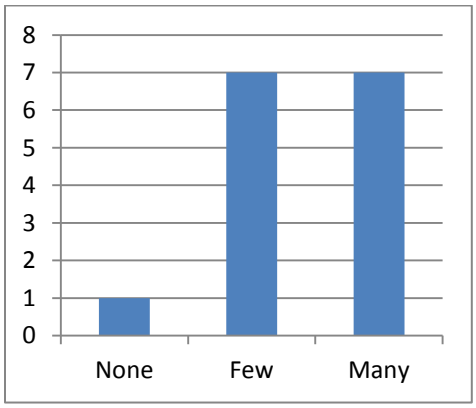

Figure : Do you regularly notice drafts in your house (n= 18)

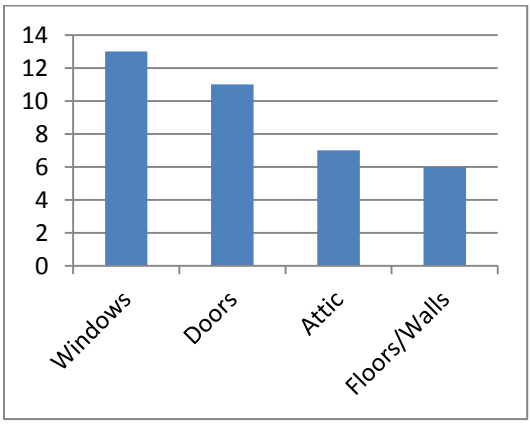

Figure : Compilation of locations which drafts were noticed (n= 18)

Products that save energy without necessitating any behavioral change on the part of the user are highly desirable. For example, programmable power strips to help eliminate the ghost load of electronic devices; low-flow faucets reduce hot water use during a fixed time period (e.g., a 10-minute shower). Nearly 9 in 10 respondents do not use programmable power strips (Figure :

Do you use 'smart' or programmable power strips (n= 18)) and 3 in 5 do not use low-flow faucets (Figure : Do you use 'low-flow' water facets designed to save water (n= 18)). Installing these passive technologies offer Housing Nantucket obvious ways to advance the goal of improving energy efficiency to lower tenants' monthly utility bills.

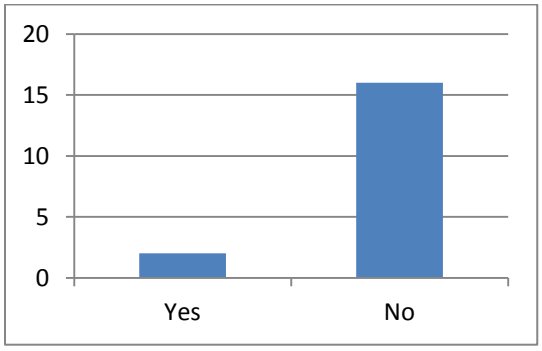

Figure : Do you use 'smart' or programmable power strips (n= 18)

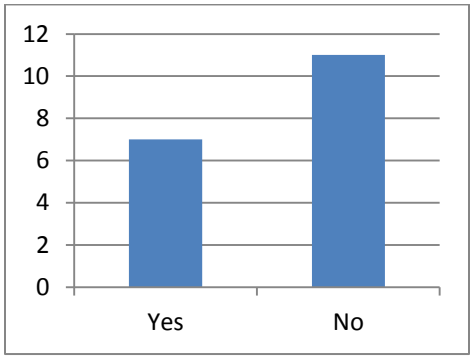

Figure : Do you use 'low-flow' water facets designed to save water (n= 18)

A further opportunity to improve energy efficiency is to provide tenants with Energy Star™ certified appliances. Typically, Housing Nantucket installs energy efficient refrigerators when old ones fail, as they are often are older, inefficient models that fall short of the Energy Star™ rating. Ten tenants indicated (Figure : Number of respondents reporting the use of Energy Star™ Appliances (n= 18)) that they had no Energy Star™ rated appliances in their home, but this may reflect a lack of knowledge about the nature of the appliances rather than the reality, since it is not always easy to identify listed appliances.

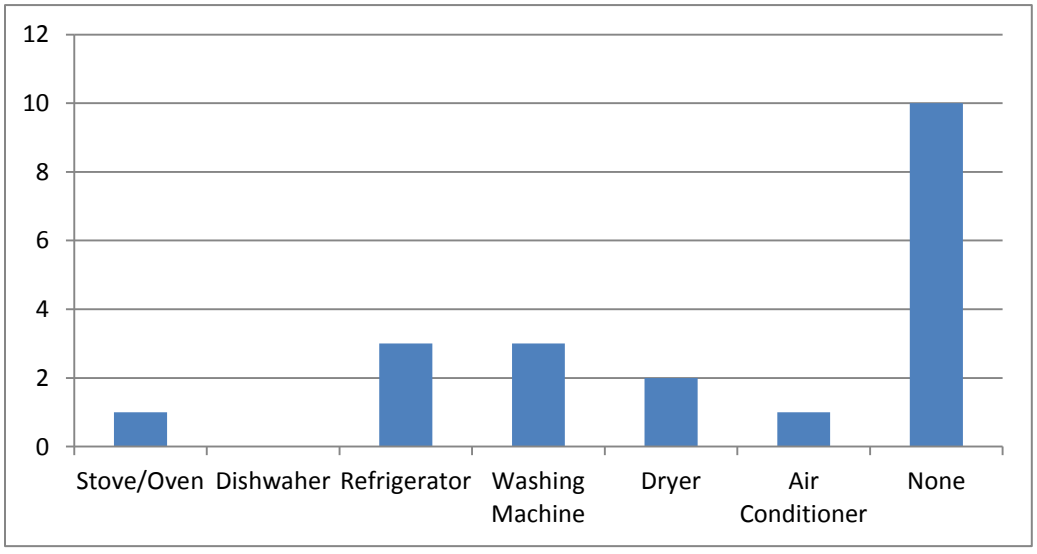

Figure : Number of respondents reporting the use of Energy Star™ Appliances (n= 18)

3.2.2 How Tenants Can Improve Energy Efficiency

In some ways, the tenants were much more energy conscious than we first anticipated. For example, the vast majority (Figure : When I leave a room or the house, I turn off the lights (n= 18)) said they always turn off the lights when they leave a room for long periods. Of course, reported behavior may differ from actual behavior, and previous studies have found respondents tend to over-report 'desired' behaviors.

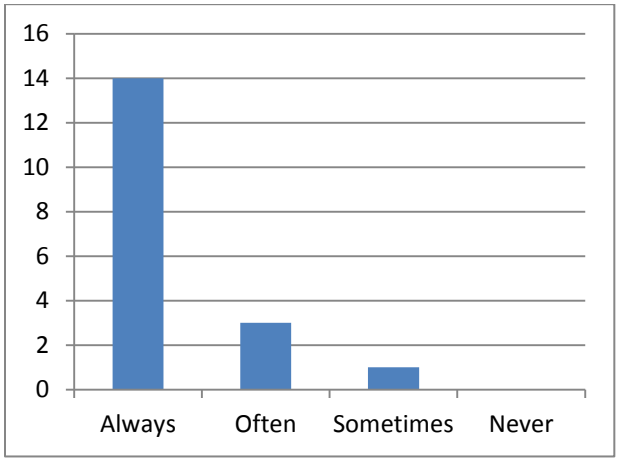

Figure : When I leave a room or the house, I turn off the lights (n= 18)

Tenants were less attentive to other electric devices in the home, such as computers, televisions/cable boxes and device chargers. As shown in Figure : Do you shut down your computer and turn the monitor (n= 18), 8 tenants "always" or "often" turn off their computers, whereas 10 did "sometimes" or "never". Figure : I leave chargers plugged in when not in use (n= 18) shows a similarly bimodal distribution with 7 tenants who always leave chargers plugged in and 7 who say they never do. Evidently, there are educational opportunities here to promote energy saving behaviors.

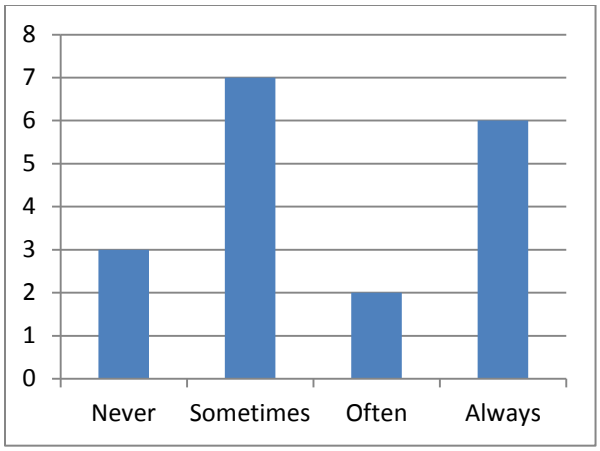

Figure : Do you shut down your computer and turn the monitor (n= 18)

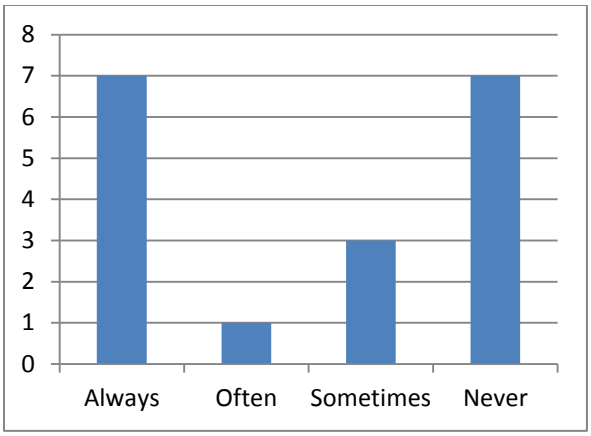

Figure : I leave chargers plugged in when not in use (n= 18)

Figure : How many televisions do you have in your home (n= 18) shows that the vast majority (83%) of tenants have two or more televisions. The average number of televisions owned by the tenants is 2.4 per household, slightly under the national average of 2.5 (Nielsen Company, 2011). Additionally most tenants (56%) never turn their cable boxes off (Figure : Do you also turn off your cable box as well when not watching television (n= 18)) when not watching television.

It is impractical to urge people to reduce the number of their devices that consume electricity, but televisions and cable boxes together use significant amounts of electricity in the typical household.

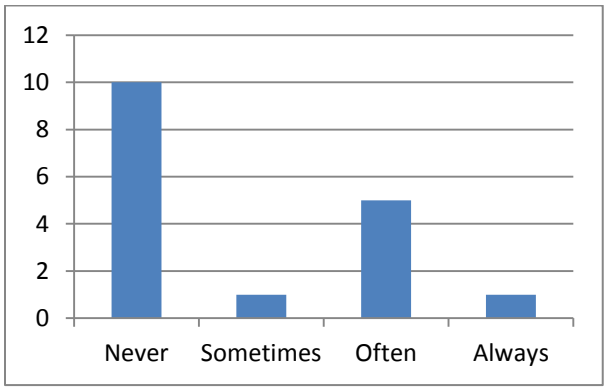

Figure : Do you also turn off your cable box as well when not watching television (n= 18)

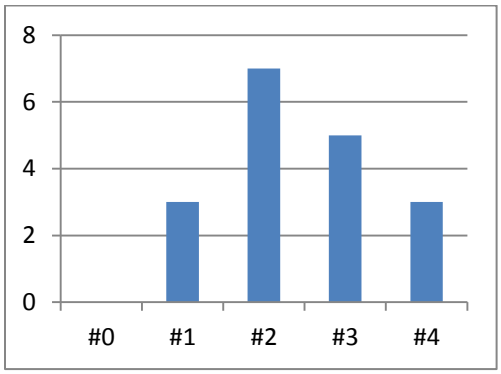

Figure : How many televisions do you have in your home (n= 18)

We queried tenants about how warm they keep their home: during the day when they are not there (Figure : Temperature preference when not home (n= 18)), when they are there (Figure : Temperature preference while home (n= 18)), and at night (Figure : Temperature preferences at night

(n= 18)). All three graphs cluster the majority of the response around the 60-65°F with slightly lower results noticeable for ‘not home’ and ‘at night’ compared with ‘home during the day’. The results are lower than we expected, considering that several tenants are accustomed to warmer climates. Respondents possibly answered in ways that portray them positively as well as playing to the specific question being asked, and the actually temperature in these houses may be higher. Additionally, 11/18 (61%) of the tenants responded saying they would change clothes before adjusting the thermostat to get comfortable. Lowering the temperature a few degrees from the 70’s to the 60’s provides substantial energy savings without drastically reducing the comfort of a home. For most people, however, lowering the temperature below 60 degrees is intolerable. If these results are accurate, then the tenants are quite energy conscientious and there is little room for improvement.

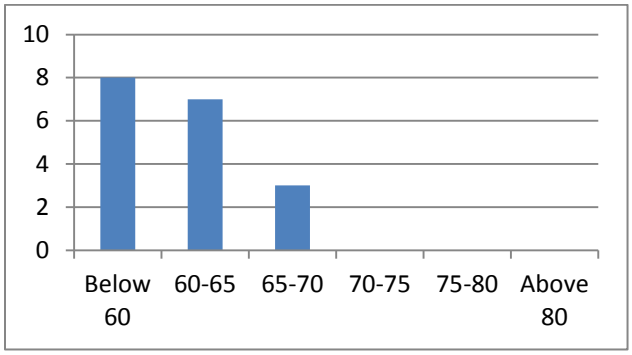

Figure : Temperature preference when not home (n= 18)

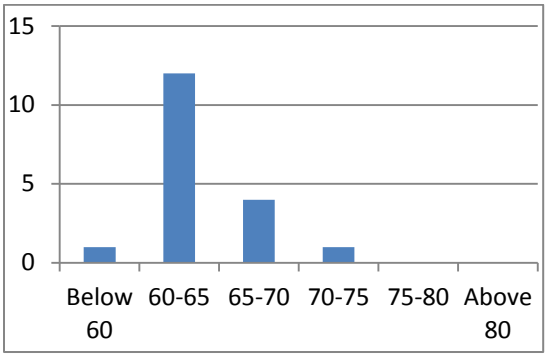

Figure : Temperature preference while home (n= 18)

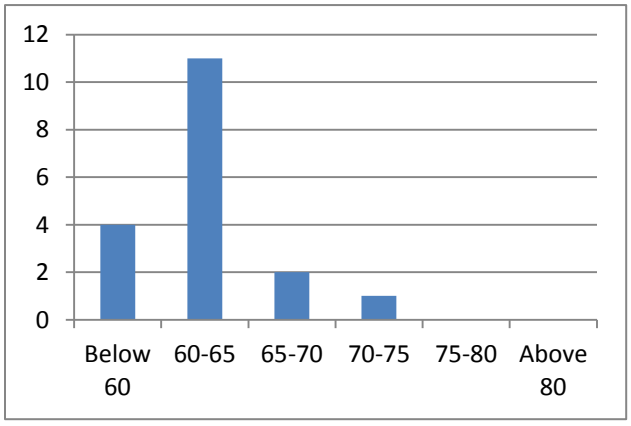

Figure : Temperature preferences at night (n= 18)

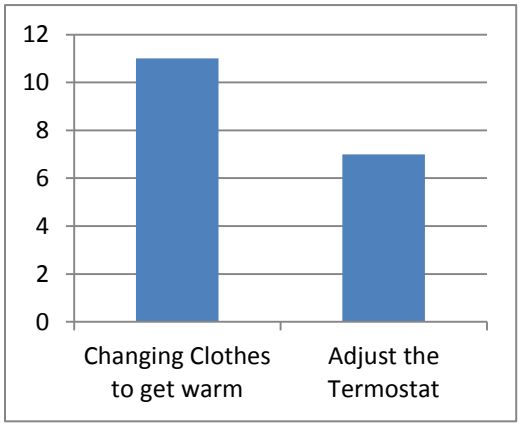

Figure : When it gets too cold in my home, I am more likely to get comfortable by (n= 18)

Only one tenant in 10 opens windows in the winter if it is too hot inside, indicating that tenants realize that opening a window in winter wastes heat. The tenants likely lower the thermostat to regulate temperature rather than wasting heat by opening windows.

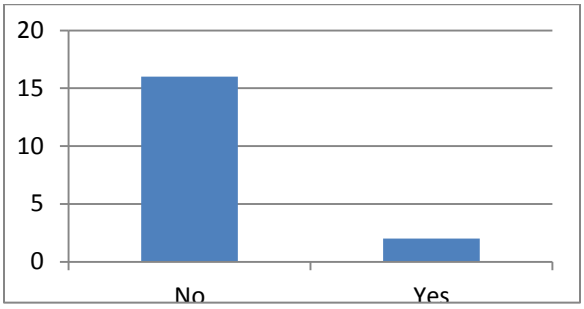

Figure : During the winter, I sometime open a window if it is too hot inside (n= 18)

Tenants are also good at conserving water; all tenants responded saying they prefer showers to baths and as long as a shower is kept short, it will use less water than a full bath. No tenants reported taking showers longer than 20 minutes. 14/18 (78%) of tenants reported taking brisk showers of 5 to 10 minutes (Figure : Length of tenant showers (n= 18)). The only improvement here would be to install low-flow shower heads. Some tenants reported having such facilities, but a nearly half, 8/18 (45%), of them were unsure as low-flow fixtures often lack identifying marks.

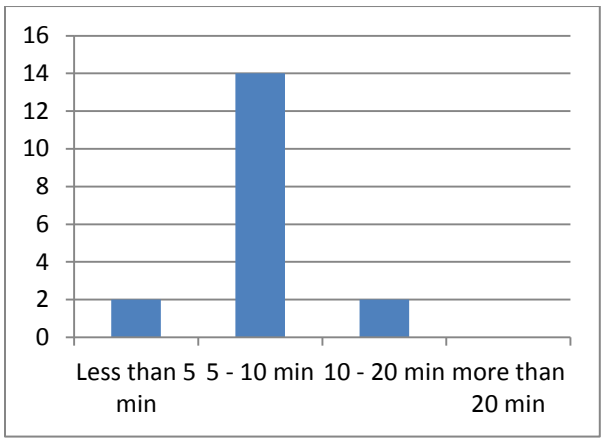

Figure : Length of tenant showers (n= 18)

A few individual tenants may need some advice on how best to conserve energy and save money, but overall the tenants are quite energy conscious and there appears to be little that can be done to reduce their energy consumption by changing behavior. Of course, reported behavior may differ considerably from actual behavior, and periodic reinforcement of energy saving strategies for old and new tenants may be desirable.

3.2.3 Recommendations

Since 78% of tenants reported some form of drafts in their house, we recommend that Housing Nantucket provide tenants with weather stripping. Weather stripping is cheap in bulk and is an effective way to reduce the draftiness and improve a home's thermal efficiency. Housing Nantucket could stockpile a supply of weather stripping to furnish their tenants for free (or at a reduced market rate) to be installed in their home.

This stockpiling initiative could also be used for other commonly needed household items such as light bulbs. While most of the tenants are using CFL light bulbs (as these were installed during the energy audits) not every house has had an audit performed yet, and tenants with only one or two incandescent bulbs many have replaced what used to be a CFL with an initially cheaper option. If Housing Nantucket provided light bulbs for their tenants they could prevent this, helping their tenants save money in the long run while keeping true to their promise of energy efficiency. Outreach to other energy organizations may help in the procurement of subsidized energy efficient lighting.

The first round of National Grid Energy Audits took place in January 2012. We asked tenants if they noticed any changes in their monthly electric bill after the audit was performed, the results are below in Figure . As the graph shows, there are no negative consequences from the audits. Tenants either saw a decrease in their energy use and bill, or the improvement was slight and not as directly noticeable. In fact, 25% of respondents reported very significant savings after the audit was performed. Other island residents have yet to have this valuable and free audit performed; they are missing out on a great opportunity to improve their home and reduce their bills. To prevent or delay the construction of a third highly expensive undersea cable bringing power to Nantucket, we highly recommend that the board of directors strongly encourages all Nantucketers to contact the Energy Office and Lauren Sinatra so that they may set up a time to have this free and highly beneficial audit performed on their property.

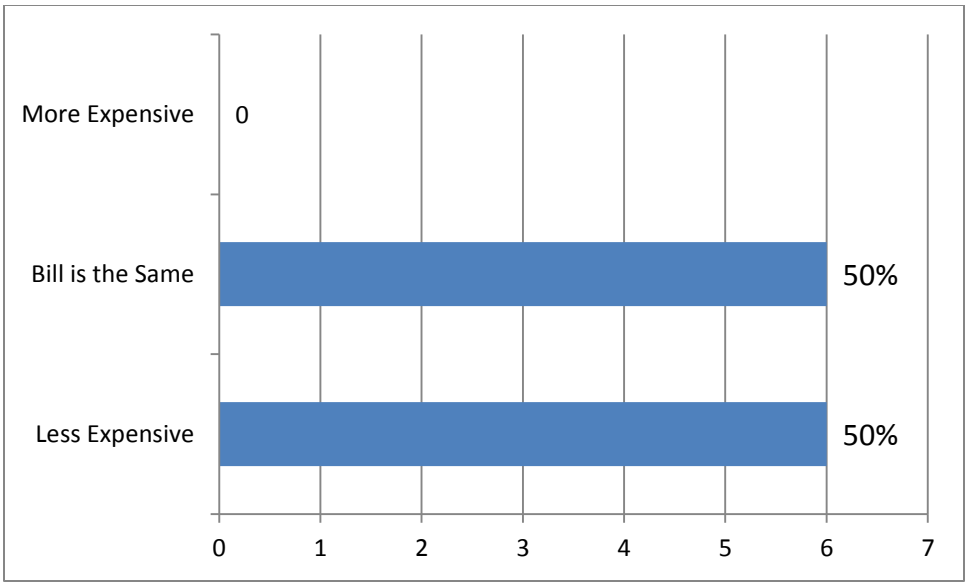

Figure : Have you noticed any changes to your electricity bill since the audit? (n=18)

During our interviews with the tenants we asked if they would provide us with a copy of their latest energy bill. Energy bills record the last year of electric usage history. Below is one such bill from a tenant, Figure . We used this information to calculate the energy saved by performing the audit.

$$The\ average\ electricity\ use\ before\ the\ audit\ was: \frac{388 + 448 + 398}{3} = 424.7\,{}^{kWh}/_{month}$$

$$The\ average\ electricity\ use\ after\ the\ audit\ was:$$

$$\frac{206 + 165 + 223 + 180 + 274 + 205 + 207 + 312 + 252 + 230}{10} = 225.4\,{}^{kWh}/_{month}$$

$$This\ is\ a\ reduction\ in\ energy\ use\ by\ almost\ half! \quad : \quad 1 - \frac{225.4}{424.7} = .47 = 47\%$$

Electric Usage History

Month	kWh	Month	kWh
Oct 11	388	May 12	274
Nov 11	448	Jun 12	205
Dec 11	398	Jul 12	207
Jan 12	206	Aug 12	312
Feb 12	165	Sep 12	252
Mar 12	223	Oct 12	230
Apr 12	180		

Figure : Energy use data of a tenant

Housing Nantucket holds educational outreach programs several times a year to teach Nantucket residents about affordable housing on the island and how to save money in the home. These programs could include a technology expo that would acquaint residents with the newest and best technologies to assist in saving energy in the home as well and helping them learn to use them. Not only would this be beneficial to island residents, it would help Housing Nantucket stay up to date in the energy saving field and would clearly demonstrate their commitment to energy efficiency. This expo may be too large an event to be run by a single organization, so perhaps it could be a joint effort put forward by both Housing Nantucket and the Nantucket Energy Office. By increasing island awareness of the benefits of such technologies, Housing Nantucket can help provide affordable housing for more residents than just their tenants.

3.3 Creation of Outreach Materials

3.3.1 Education Materials

Based on our survey findings, we created a pamphlet for current and future Housing Nantucket tenants (Appendix C: Pamphlet and Webpage Link). This pamphlet details simple and easy ways to save energy in the home, focusing on specific tenant habits which waste resources. The pamphlet is divided into three categories: electronics, water, and climate. Each section lists different ideas for saving energy and includes interesting, quick facts about energy usage and energy efficient appliances. The pamphlet is written in an easy to understand manner with bright graphics in order to capture and retain reader interest. It also includes a web address and QR code for the accompanying online information page we wrote for Housing Nantucket's website (Appendix C: Pamphlet and Webpage Link). Ideally, tenants will find the pamphlet both interesting and informative and it will encourage those who read it to try some of the ideas included within.

We hope tenants will notice a decrease in their energy usage after trying our ideas and might even tell others about it so our research can benefit as many people as possible.

This pamphlet may well be applicable beyond Housing Nantucket, as well. A more general version could hold great potential when distributed to real estate agents and leasers. These people could leave the pamphlet in a visible location for seasonal renters to review. Because renters make up a large part of the island's population in the summer, any effort on their part could yield large energy savings for the island as a whole. This strategy is analogous to one familiar to anyone who has stayed in a hotel recently – the signs and notices about re-using towels in order to save water, detergent, and energy. While not all hotel guests can be expected to comply with the request, those who do will still make a sizeable difference. Similarly, while not all seasonal visitors can be expected to make a change, those who do will contribute to a greater effort that could hold real benefits for the island.

Our web article (Appendix C: Pamphlet and Webpage Link goes further in depth than the pamphlet and includes more ways tenants can save energy in their homes as well as more facts and links to further reading. The article also includes figures and tables which would not fit on the pamphlet in order to further flesh out our findings. The article is also useful as it will not require printing and therefore may outlast the pamphlet supply. We hope the page will remain long after we leave the island to help future tenants save energy and inspire other island residents to try the techniques we write about as well.

3.3.2 Stories of Tenants

At the end of our survey, we asked whether the tenant would agree to talk to us about how Housing Nantucket and energy efficiency have benefited their lives. While many of tenants answered "yes," few actually responded to our subsequent inquiries. Though we only interviewed a few tenants, their stories were all interesting and affirmed to Housing Nantucket's value in the community. Among them were parents who were thankful to have stable housing to raise their children in, workers with seasonal workflow who were able to stay on the island during the off season, lifelong island dwellers and other deserving, appreciative people.

One tenant in particular was already very conscious of their energy usage; they had been using CFL lights for years and even hung clear plastic in front of their windows in an effort to

insulate them further. This tenant has been living on the island for four years and works as a painter. Because the majority of their work comes in the summer, they have to work very hard in order to provide for their family year round. Ordinarily, their family would only be able to live on the island in the summer. Housing Nantucket allows their children to have one stable home where they can play with other children they know from school. This is very important and valuable to them as a parent. As most of their extended family lives in New York, they also love the peace, tranquility, security, and unique culture the island offers.

Another tenant claims that their home was severely lacking in proper insulation. After the energy audits, their home felt much warmer and they no longer felt as if they were wasting heat. They mentioned the cost of their heating bill decreased significantly after the insulation was installed. One tenant, who has worked with Housing Nantucket since 1995, told us their house was completely devoid of insulation prior to the audits; their home is much warmer now and their bill has significantly decreased after the insulation was applied. The auditors also changed their light bulbs and their thermostat, which contribute to their recent energy savings as well.

3.4 Project Site Proposal

As discussed in Section 1.8 Housing Nantucket Resource Center Proposalof the Literature Review, Housing Nantucket is planning to create a new Housing Resource center. The new Housing Resource Center (HRC) is meant to be the central location for all Housing Nantucket activities, as well as providing them with a location for both offices and residential living areas. In order to ensure Housing Nantucket's new Resource Center will be successful in its goal of Energy Star™ certification; our project team has created a Resource Center Proposal plan. This plan will cover the goals for the new site, how Housing Nantucket can meet these goals, and the potential financial commitment of achieving these goals.

3.4.1 Ascertaining Housing Nantucket's Needs

In order to create a resource center proposal for Housing Nantucket, we conducted informal interviews of what staff wanted from the new Resource Center. Using the questions from 2.4 Objective 4: Evaluate Resource Center options as the basis of our conversations, we were able to get a better understanding of the organizations needs and ideas for the new office. Through our preliminary discussions and follow up interviews we were able to create a list of things to be included in the new site:

- Housing Nantucket wants to include two residential units on the Old South Road lot, which will be used as part of their affordable rental program. One house will be a transplant of an existing Housing Nantucket rental property on Clifford Street, and the other will be the newly donated Siasconset House.
- The Clifford House will be strictly for office space, but Housing Nantucket hopes to rent the extra space in the Clifford House to other nonprofit organizations on the island.
- The interior space of the Clifford House will need to be redesigned in order to provide an appropriate office environment.
- Housing Nantucket hopes to be as efficient as possible while keeping within their budget, which is highly influenced by grants and incentives.
- After discussion with Housing Nantucket staff, we decided to pursue an Energy Star™ certification since it is the easiest to obtain and doesn't include yearly membership fees to maintain like LEED does.
- Housing Nantucket was not familiar with net zero; we explained the concept and expenses to them. After this discussion they decided that producing most of their own energy would be too expensive an option to pursue at this time. They were willing to look into solar water heating and supplementary PV panels, which would reduce the energy impact rather than eliminate it.
- A large storage tank has been donated to Housing Nantucket and they hope to re-purpose it as a rainwater collection tank, but they are unsure how to implement it at the site.

3.4.2 Potential Revised site and Floor Plans

The final Resource center plans (Figure : Project site layout) will incorporate the Clifford House Office, and the 2 residential properties. The Clifford and Sherman Houses will be relocated to the Old South Road site from their existing locations off Clifford Street. These two moves will happen first, followed by the Siasconset House as they are still finalizing the movement plans. Due to roadway setbacks and town zoning, much of the space on the lot will be used by these properties.

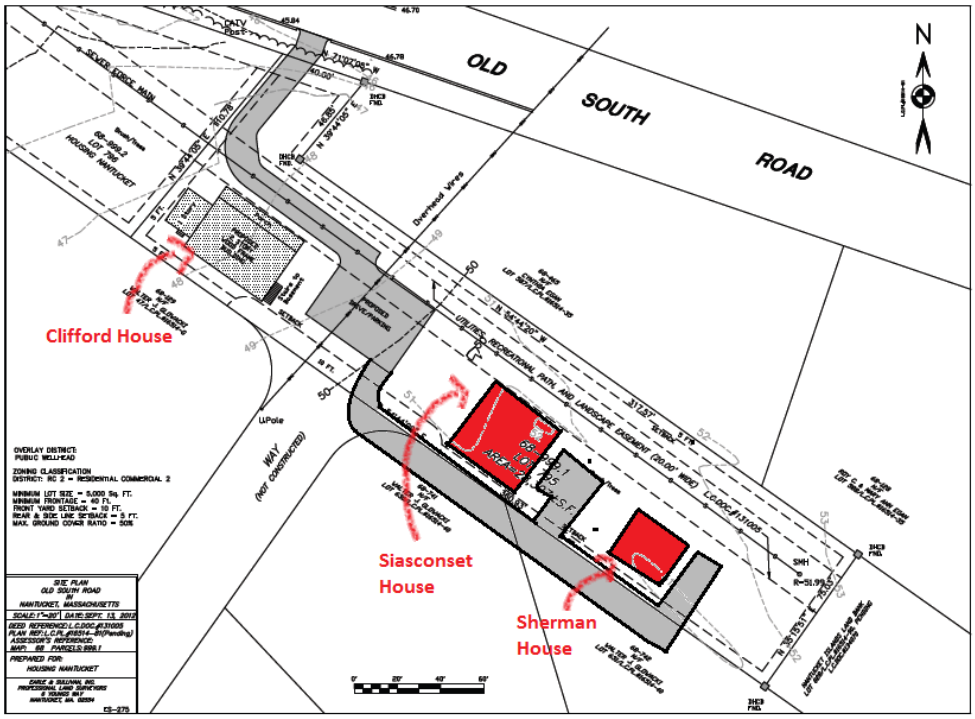

Figure : Project site layout

After reviewing the floor plans and touring the Clifford House with Housing Nantucket staff, we decided that the building should be redesigned in the following ways: the first floor will consist of two or more offices, one large conference room, a receptionist's area, a children's play space and a break/lunch room. The four bedrooms on the second floor should become offices with one of the rooms possibly becoming a storage room for files and paper records. Certain office spaces within the building are planned to be rented offices to other nonprofits, as labeled below. This redesign of the Clifford House's residential space will provide Housing Nantucket With adequate room to meet their personal needs, as well as allowing them to make back some renovation costs through rented un-used space. The proposed plans will allow Housing Nantucket to expand as much as they need to accommodate any new staff members they may gain in the future. The following floor plans (Figure : Revised first floor plans and Figure : Revised second floor plans) show our redesign of this space to appropriate scale:

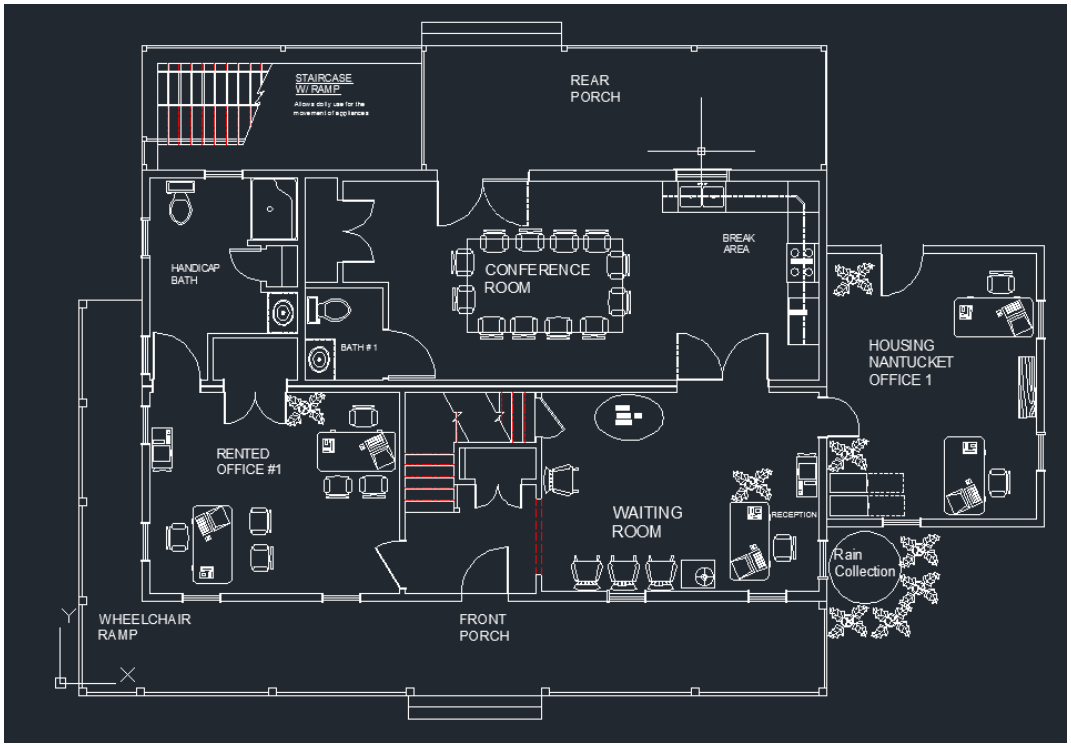

Figure : Revised first floor plans

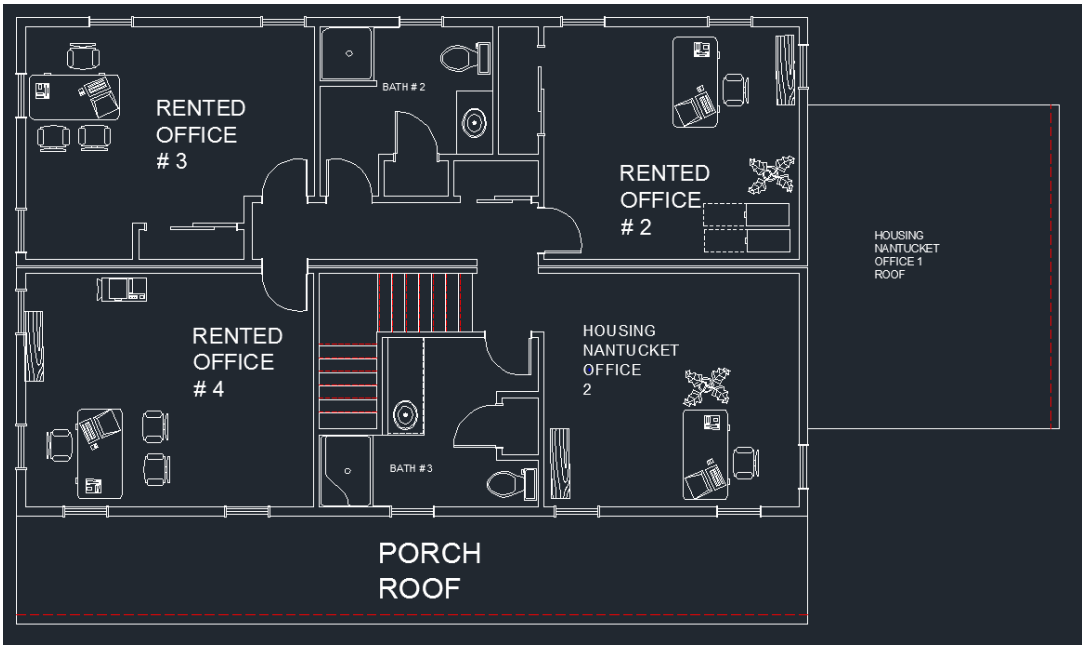

Figure : Revised second floor plans

3.4.3 Potentially Implemented Energy Saving Technologies

Based on multiple meetings with Housing Nantucket, our Project team has created an outline of technologies which could be implemented into the re-design of the Clifford House. Since the Clifford House is already a complete building, many of our suggestions are aimed at keeping as much of the existing property intact in order to preserve the embodied energy of the building while increasing overall energy efficiency. Since the Clifford House was built in 2004, many of the materials used to create the building need only minor improvements, while others will need to be completely renovated. The list below examines the technologies and their applications within the new office:

1. Insulated Concrete Forms (ICF) - The Clifford House is going to be lifted from its original foundation and moved onto the new site by way of flatbed trucks. This means a new foundation must be poured upon which the frame of the building will be placed. Through our research, we have found that ICFs are very beneficial in many aspects of a home. An insulated concrete form is a block of foam which can be stacked and pieced together in order to form the base of a building's foundation. The blocks are placed on site and then filled with concrete to create a foundation that is totally insulated. The conventional method for foundations would consist of using wooden forms to create the foundation, then removing them to leave exposed concrete. The foundation is then back filled with dirt after an insulated sheet is pressed against the wall. ICFs, although more expensive up front, have many benefits which outweigh the initial increase in price. The net cost to implement ICFs is decreased by the amount of energy efficiency it adds to the home and the money it saves on heating and cooling costs. ICFs also have added benefits of quicker construction time, less on-site waste, and quieter interior spaces. ICFs provide less transmission and growth of mold and fungus particles, which is a current issue in the Clifford House's basement. According to Table : ICF Life Cycle Cost Analysis, which gives cost estimates for Toronto Canada, ICFs are the most efficient in reducing lifecycle energy costs but are not the most cost effective. Even though the price estimates are for Canada, this study shows that ICFs will be more cost effective with higher energy prices. After getting a basic verbal quote form a contractor, we were told that the ICFs would add a cost of around $5,000 more than standard exterior insulation. Because of Nantucket's high energy prices we used the high cost life cycle estimate under the LLC of Basement System section. Under these assumptions, it shows that ICFs are comparable or less expensive than all

of the exterior insulation options. Due to these estimates, as well as the added benefits not directly related to cost, our Project team suggests the use of ICFs in the Clifford House.

Table 4 Life-cycle cost assessment of large basement in Toronto – 80 per cent efficiency natural gas

Toronto—Natural gas 80 per cent efficiency, large basement										
Class A-3 Basement—Full-height insulation, unfinished										
Basement option	R-Value	Annual GJ	Capital Cost	Annual energy	LCC of energy			LCC of Basement System		
					Low	Current	High	Low	Current	High
Ext. XPS	12	17.6	$23,874	$330	$13,575	$18,869	$31,342	$37,450	$42,744	$55,216
Ext. Fibre	9.9	18.8	$23,200	$353	$14,501	$20,156	$33,479	$37,701	$43,356	$56,679
Ext. EPS	11.25	17.9	$22,916	$336	$13,807	$19,191	$31,876	$36,723	$42,107	$54,792
Ext. SPF	12	17.6	$25,080	$330	$13,575	$18,869	$31,342	$38,656	$43,950	$56,422
Int. Fibre	12	17.2	$20,928	$323	$13,267	$18,441	$30,630	$34,195	$39,368	$51,558
Int. Cell.	12	17.2	$21,019	$323	$13,267	$18,441	$30,630	$34,285	$39,459	$51,648
Int. Batt	20	14.3	$21,334	$268	$11,030	$15,331	$25,465	$32,364	$36,665	$46,799
Int. XPS	10	18.4	$23,182	$345	$14,193	$19,727	$32,767	$37,374	$42,909	$55,948
Int. EPS	9	18.9	$22,397	$355	$14,578	$20,263	$33,657	$36,975	$42,660	$56,054
Int. SPF	12	17.2	$25,271	$323	$13,267	$18,441	$30,630	$38,537	$43,711	$55,900
ICFs	22	13.0	$29,941	$244	$10,027	$13,938	$23,150	$39,968	$43,878	$53,091
Class B basement—Partial-height insulation										
Int. Fibre	12	23.5	$16,803	$441	$18,126	$25,195	$41,849	$34,929	$41,998	$58,651
Int. Cell.	12	23.5	$16,842	$441	$18,126	$25,195	$41,849	$34,968	$42,037	$58,691
Int. Batt	20	21.7	$16,978	$407	$16,738	$23,265	$38,643	$33,715	$40,243	$55,621
Int. XPS	10	24.3	$17,773	$456	$18,743	$26,053	$43,273	$36,517	$43,826	$61,047
Int. EPS	9	24.7	$17,435	$463	$19,052	$26,482	$43,986	$36,487	$43,917	$61,421
Class C basement—Uninsulated cellar										
Gas 80%	N/A	53.7	$15,575	$1,008	$41,421	$57,573	$95,629	$56,996	$73,148	$111,204

Table : ICF Life Cycle Cost Analysis (Canada Morgage and Housing Corporation, 2007)

2. Solar Thermal Water Heating – The Clifford House currently heats its interior space using a standard forced hot water heating system powered by a gas furnace. This system uses hot water pumped through baseboard heaters. These systems are more efficient in their use of fuel when compared to oil furnaces, but still use expensive fuel which must be transported to the island by ship. This makes heating much more expensive when compared to off island prices and is not a green solution for heating the home. Our project team has analyzed the new office building's potential use of solar hot water heating to provide heat for the building. The Clifford House will require very little domestic hot water when compared to a residential building; so much of the thermal energy gained could be used towards heating the building. The original gas system can be kept as a backup in the event of limited solar heat, but would primarily be run by the solar roof panels (Figure : Water Damage Around Clifford House Door).

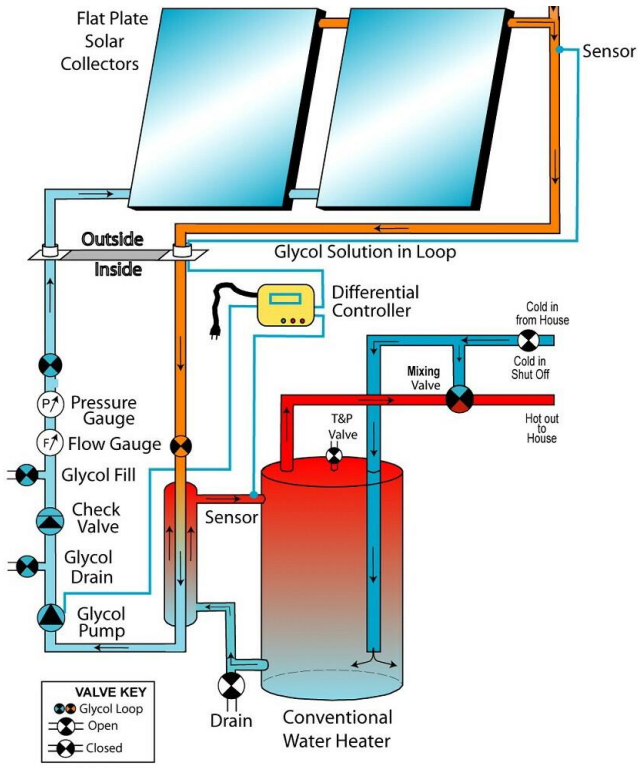

Figure : Solar thermal schematic (Chris, 2012)

For Massachusetts, these systems, although green, can take over 20 years to pay for themselves without any grants or funding. The average cost of a system is between $8,000 -$10,000, and can yield between 50 %-55% of a home's hot water needs. This means that if your annual bill is $500, you would only be saving around $250 a year (Wilson, 2012). Our research on the subject has shown that solar thermal hot water systems are not very effective in heating forced hot water base board systems to the right temperature, and should mostly be used for heating domestic hot water. Due to Nantucket's location very little heat would be generated during winter months when heating will be most necessary. Due to these factors we came to the conclusion that Solar Thermal Water heating is not going to be effective in saving large amounts of energy and is not cost effective for the project.

3. Photovoltaic Systems- After deeming that solar thermal heating was not a viable option for the Clifford House the project team researched the benefits and disadvantages of adding PV Panels to the southern roof of the building. Solar systems seemed that they would be more beneficial to the needs of Housing Nantucket. The system would provide the building with a

percentage of its total energy use, decreasing the buildings dependence on the power grid. Unlike the solar thermal system, the energy harvested from the sun will be completely used during both the winter and summer months. After using a kWh calculator to determine the Clifford House's approximate monthly energy usage, it was determined that the building would require 1,858 kWh per month or 22,296 kWh per year (Appendix D: Photovoltaic Calculations). After we determined the energy needs for the new system, we used a solar PV cost analysis calculator (Appendix D: Photovoltaic Calculations) in order to better understand the costs involved in the installation of the unit. Using the information gained from budgeting discussion with housing Nantucket Staff we determined that they would be able to budget for a unit around $20,000. On this budget not including nonprofit incentives, Housing Nantucket could install a 3.5kW solar PV system capable of producing 4,206 kWh of energy per year. After the inclusion of grant opportunities available to all businesses, the system would have a net cost of $20,428 at installation and a net cost of $7,826 after the 10 year incentives are fully paid to the organization. Housing Nantucket can expect to see a return on investment 10 years after the system has been installed. The energy produced by this system could reduce the new buildings electricity use by 18% a year, corresponding to annual energy savings of $1,008 and a 25 year lifetime return on investment of $14,924. If the organization is able to find incentives and grants specific for non-profits, then the potential for savings or the installation of a larger system could increase immensely.

4. Improved insulation and weather-stripping- In order to take full advantage of the heating systems placed in the new office, it is important to conserve as much of the heat produced. Preventing air infiltration will have a large effect on the overall energy efficiency of the office throughout the year. This will ensure that the internal temperature regulating devices will not have to work harder than necessary. During our investigation of the Clifford House, we found water damage around doors and windows (Figure : Water Damage Around Clifford House Door).

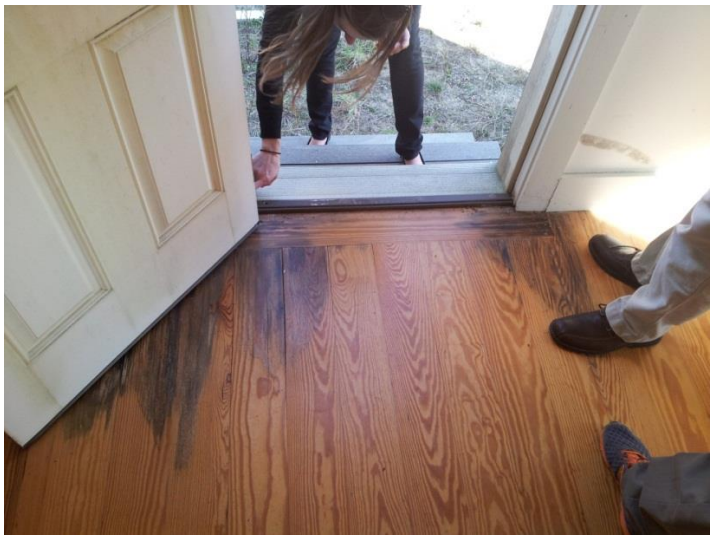

Figure : Water Damage Around Clifford House Door

This is strong indication that the weather stripping and insulation is not properly preventing the outside environment from penetrating the interior living space. It will be necessary to evaluate every instance, in which the building could allow the outside environment in, and properly seal and insulate it. This will cost very little money in the overall scale of the project, but can provide some of the biggest tradeoffs in savings.

5. Storm doors and windows- Another step important for providing more efficient heat usage is improving the insulating properties of doors and windows. Storm doors and windows provide an extra layer of glass and air that decreases heat loss. The Clifford House does not currently have any storm windows or doors on the property. By adding storm doors, they will increase the efficiency of the building with relatively low costs. The Clifford House currently uses double paned windows, which provide adequate insulation from the outside environment and may not benefit greatly from storm windows. The investment in new storm windows will likely have little impact in overall efficiency and HN should focus their efforts on sealing the existing windows as effectively as possible.

6. Programmable thermostats/ lighting- Behavior can be an important factor in the success of energy efficient technologies. There are some technologies which can be implemented in the office that do not require human interaction in order to be effective at saving energy. Devices such as controllable thermostats and lights can be installed in order to set ideal temperatures

automatically and turn off lights that were accidentally left on. By implementing these devices, Housing Nantucket can ensure that the office is not using excess energy when there is no one inside. The automated nature of these systems means that Housing Nantucket staff can focus on their work while the passive systems take care of energy saving habits, which can often be overlooked during a busy day. These items, although slightly more expensive than their traditional counterparts, can help save more energy and are much easier for the end user. Some thermostats have "smart" features which learn your habits over time and will automatically change to your preferences. These smart technologies will be viable in creating the most efficient office possible, however they are not yet cost effective enough to recommend for the Clifford House. While many sources quote a potential energy savings of between 10% and 30% through the use of programmable thermostats, these savings are often unrealized by owners. According to a 2004 Energy Star™ study, "...programmable thermostats may be achieving considerably lower savings than their estimated potential. In particular, a study from the Energy Center of Wisconsin showed no statistical difference in heating intensity among their sample of single-family houses when comparing households with programmable thermostats and those without." Energy Star™ also identified four key issues which prevent programmable thermostat users from saving as much as they could:

- Many households (perhaps 30% or higher) with programmable thermostats may be unable, unwilling, afraid, uninterested, or otherwise reluctant to deploy default programs or to create or deploy custom programs;
- Many households (about 50%) set back or set up their thermostats manually, thus leaving less savings possibilities to be garnered by a programmable thermostat;
- The automatic program used with the thermostat may not be any more conservative than use of manual thermostats setback or setup by hand;
- Many consumers have mental models of heating and cooling that lead them to believe they will not save energy from setting up or setting back other than long periods of time.

Because it is up to the user to save energy with a programmable thermostat, it is not definite that a programmable thermostat will ultimately yield any savings, especially if the owner is unwilling to learn how to use it properly. However we still recommend Housing Nantucket utilize programmable thermostats in their new office building, as they can be quite effective at saving energy if used properly.

7. Low Flow Fixtures and Toilets- Low-flow amenities aim to reduce the water usage of showers and toilets. While there are the obvious benefits of lowered water usage, they also reduce the energy needed to heat water. Showers and faucets with low-flow units use less hot water, meaning less strain on the water heater and less energy used to heat the water. Recently, low-flow shower heads and faucets have incorporated the ability to oxygenate the water passing through them, making showers feel more substantial and refreshing.

Low-flow or dual-flush toilets are another option for reducing a building's water usage. Low-flow toilets use less than half the water per flush of a conventional toilet without a reduction in performance; their bowl shapes are optimized to remove waste with as little water as possible (http://tinyurl.com/cbck3fk). While low-flow toilets are a great way to save water, they require replacing existing toilets, making them less than attractive to those looking to modernize an existing building. Instead, a dual flush system can be installed in an existing toilet (http://tinyurl.com/cxg65sq). Dual flush systems generally allow the user to perform a half flush for liquid waste or a full flush for solid waste by either lifting or depressing the toilet's handle. When used properly, these dual flush systems can help an existing toilet use less water and lead to reduced water bills.

If Housing Nantucket wishes to replace the existing toilets at the Clifford House, then high-efficiency toilets are a great way to help them save water and achieve Energy Star™ certification. If not, then dual-flush conversion kits are a great alternative; they install easily and allow regular toilets to flush with less water depending on the need. Either way, Housing Nantucket has multiple easy and simple options for saving water at the Clifford House. If they also do not wish to replace low flow faucets, then they can simply replace the aerators with energy efficient ones designed to increase the amount of air in the water while limiting flow.

8. LED/ CFL Lighting- Compact fluorescent lamps, or CFL bulbs, are a fairly common form of energy-saving lighting today. They are coiled or folded to fit in the space of a typical incandescent bulb, and many of them are also dimmable. CFL lamps use between 1/3rd and 1/5th the electricity of incandescent bulbs while lasting 8 to 15 times longer. These characteristics make CFL lighting much more cost effective than incandescent bulbs, which cost less but use more electricity and need to be replaced more frequently. The Clifford House

would benefit greatly from CFL lighting despite the greater up front cost. Not only would it help the building achieve Energy Star™ certification, it would reduce energy costs for the building and reduce necessary maintenance to replace the lights. While CFL bulbs are a viable alternative to incandescent lighting for their energy efficiency and longer life, there is an even better alternative emerging in the consumer market today: LED lighting.

Light emitting diode (LED) lights have only recently appeared in an affordable, practical package; however, they offer even greater benefits over CFL and incandescent lights. LED lights are even more efficient than their CFL equivalents and last about 30 times longer than an incandescent bulb at around 30,000 hours. LED lights are free of toxic mercury, unlike CFL bulbs, and retain light output capacity better over their lifetime. The main disadvantage to LED lights is their increased cost, however their lifespan and decreased energy use still make them a better investment than incandescent or CFL lights.

The Clifford House has seven exterior lights, twenty one first floor lights and twelve second floor lights, bringing the number of light fixtures to forty. On our visits we noticed all of these lights were traditional incandescent bulbs. According to figures from green-energy-efficient-homes.com, this would mean an annual cost (including the cost of bulbs) of $190 if the lights are used two hours per day. If the lights in the Clifford House were replaced with CFL light bulbs, these costs would be only $46.80 a year - a total savings of $143.20 per year. This is a substantial decrease in total cost, but there are additional benefits to efficient lights as well. The electricity usage of the Clifford House's lights would be 43.8 kW/h per year with traditional lighting; this usage would be cut by 34.3 kW/h per year to just 9.5 kW/h with CFL lights. These savings would be greatly increased, in theory, since one can expect the Clifford House to be lit for more than two hours per day. This change would help Housing Nantucket reach their goal of reducing their total energy usage by 15%, as CFL lights would reduce the energy usage of their lighting by about 78%. These figures prove that switching the Clifford House to energy efficient lights would hold only benefits to Housing Nantucket - not only through cost reduction, but also by helping them achieve Energy Star™ certification. Switching to LED lighting would yield an even higher yearly savings, but would require a significantly larger initial investment on Housing Nantucket's part - one that is harder to recommend given that it will take longer for them to receive a return in the form of energy

savings. In addition, LED lighting is still a fairly new technology and as such can be expected to become much more affordable in the years to come. It would be a better idea to consider LED lighting once it is time to begin replacing the Clifford House's CFL bulbs.

3.4.4 Energy Star™ Certification Plan

The process of certifying the Clifford House has multiple steps to it. We found that the building will need to be in use for at least eleven months before its energy use can be evaluated; Energy Star™ certification requires a comprehensive profile of the building including gross floor area. Once the energy use information has been entered into Energy Star™'s online Portfolio Manager (Environmental Protection Agency; Department of Energy) the building receives a score from 1-100. Buildings with scores greater than 75 meet Energy Star™'s performance target and must be evaluated by a professional engineer or registered architect in order to ensure the building is up to industry standards. The building will be checked for problems with light levels, ventilation, climate comfort, and pollutants among other things depending on the individual building. The specialist will also verify the energy usage and square footage of the building have been recorded accurately. The evaluator must sign the building's Statement of Energy Performance (Environmental Protection Agency; Department of Energy)before sending it to the EPA along with a letter of agreement. The EPA will then review the application and ideally approve the building as an Energy Star™ building.

Energy Star™ certification is awarded for a specific year; however, a building becomes eligible to reapply one year after the last energy data entered for the previous year's application. Energy Star™ also conducts occasional random inspections to ensure their buildings remain up to code. Though the application is free, the professional evaluation should be considered part of the yearly cost to maintain certification.

Being an Energy Star™ building holds many benefits. Compared to a standard building of the same size and purpose, Energy Star™ certified buildings use less energy for climate control and water heating. This reduction in energy use means substantially lower gas and electricity bills each year a building maintains Energy Star™ certification. These savings add up quickly; if Housing Nantucket maintains this standard of efficiency, they could save considerable amounts of money in the long run. In addition to savings on energy bills, Energy Star™ certification makes Housing Nantucket much more appealing to potential grants and donors; the organization might

even be eligible for additional grants because of their certification. Despite the work needed to retain certification, the benefits should outweigh the cost of yearly inspection, especially if Housing Nantucket works to acquire grants for Energy Star™ certified nonprofits.

3.5 Pursuing Grant Opportunities

Large nonprofit organizations often have a designated employee who is tasked with researching grants and incentives that are applicable to the organization and its goals. There are so many grants available at one time and in so many locations for different types of organizations that tracking down and applying to appropriate grants is a full time job for some non-profit organizations. Unfortunately many smaller organizations, such as Housing Nantucket, do not have the resources to devote a full time employee to grant research.

Housing Nantucket has the potential to benefit greatly from programs such as Mass Save incentives, but these can be difficult to find. While they can be helpful, they only provide rebates for specific products and technologies. Because the Clifford House will be refreshed with all new amenities, this makes it inconvenient for Housing Nantucket to seek rebates for every individual light bulb and toilet installed in the building, especially since Mass Save generally gives organizations a choice of specific models and brands for each incentive. Because Housing Nantucket lacks the resources to find grants on its own, it would be much more helpful for them to outsource the task.

Luckily, there are many non-profit organizations dedicated to helping other non-profits find and apply to appropriate grants. Through our research, we found grantgopher.com to be an excellent resource for Housing Nantucket. For $50 per year ($10 a month or $30 for six months) Grant Gopher will track over 100,000 grant providing foundations as well as city, county, state and federal grant programs and email Housing Nantucket when grants they are eligible for are open for application. The website even provides subscribers with templates they can use to apply for various grants. While there are other, similar websites which will help in a similar fashion, Grant Gopher offers the most tools for the lowest price and we hope Housing Nantucket will find a subscription beneficial.

4.0 Final Conclusions and Recommendations

Through our research, we were not only able to improve upon Housing Nantucket's database – we were also able to research possible ways to save energy at the Clifford House and create informative outreach materials for Housing Nantucket tenants. We also found which energy efficiency ratings boards would work best for Housing Nantucket and found that Energy Star™ certification would be most appropriate.

The improvements we made to the Housing Nantucket database yielded many new and improved features over the original. Not only does it enforce much greater consistency over spelling and terminology, it also allows for multiple users to edit the database without transferring a single file back and forth. Furthermore, the simplicity offered by the search forms makes retrieving desired information faster and easier, even for inexperienced users. The project team suggests that Housing Nantucket continues to expand upon on our provided database with any information they feel we have failed to include or becomes relevant in the future. Using the Database will allow them to become more efficient in data storage and access. We suggest that Housing Nantucket transfer there QuickBooks data into the access database once a quarter in order to have a searchable record of housing maintenance. Periodic updates of the database will ensure that it does not get outdated and require more work to fix later down the road. If new properties are acquired or existing properties are audited, the team suggests that the appropriate data be added.

After assessing the needs and intended usage of the Clifford House, we were able to research several opportunities in which it could save energy. While not all avenues we researched are ones that we would recommend to Housing Nantucket, we still feel that energy efficient CFL lighting, photovoltaic panels, an ICF foundation, improving weather stripping and insulation, and low flow plumbing fixtures would be very beneficial and help the building achieve Energy Star™ certification. The Project team suggests the following items be considered for the re-design of the Clifford House:

- The building should be redesigned according to the plans provided by the project team. We feel that this layout will provide the best use of space and interaction between office staff.
- The unused office space should be rented to other organizations, allowing Housing Nantucket to earn back some renovation costs through unused space.
- The Building should utilize an ICF foundation, as it will save considerable energy and prevent mold. This will incur higher costs up front which will eventually be paid off by lower energy

prices. In order to gain similar insulation ratings as ICF's using traditional insulation, the building would need to finish the basement space completely. This means that having to finish the basement to installs ICF's, should not be considered as added costs. Housing Nantucket should make sure that it advertises the use of the products in the building when applying for grants or energy star certification as it will show their commitment to energy efficiency.

- The inclusion of a 3.5 kW Photovoltaic system will allow the office to produce 18% of its electricity a year for an installation cost of $20,000. The system will have paid for itself after 10 years due to the energy bill savings and the full payment of the ten year incentive plan. The office can expect a 25 year lifetime return on investment of $14,924. This system will be much more effective than solar thermal water heating, as it will allow them to utilize the energy gained during all months of the year. This system can be expanded in the future with the addition of more roof panels if Housing Nantucket wishes to increase their energy returns.
- The building should be audited by a professional in order to address the issues of missing weather stripping and insulation. The suggestions by the auditor will be subsidized, meaning that any changes that need to be made will have lower costs than if installed through other means. The auditor may also provide CFL light bulbs at lower costs.
- All lights in the building should be changed to CFL's as they will provide the building with $143.20 in savings per year and a reduction of energy used for lighting by 80%. Compared to the overall costs of the project, these fees will be very small for the amount of benefit they will provide to reducing energy use.
- The building should incorporate low flow fixtures and toilets as they will drastically reduce the amount of water used in the building. If Housing Nantucket wishes to replace the fixtures completely they should purchase new products rated for high efficiency. If they wish to keep the existing fixtures, they should install low flow aerators in sinks and dual flush conversion kits in toilets.

- The implementation of programmable thermostats has the potential to save potential energy savings of between 10% and 30% in heating costs. These figures are dependent on the existing energy habits within the office. If staff are already efficient in controlling the thermostat than minimal savings will be seen. All of these items are only slightly more or equal in cost to their inefficient counterparts, and will disregard any human errors in temperature control.

Through our survey, we were able to successfully discover trends in tenants' behaviors, such as their tendency to leave cable boxes on or the general lack of window insulation in their homes. With this knowledge, we were able to refine the tips in the pamphlet to address specific areas in which tenants could improve their energy use habits. We feel that a more general version of our pamphlet could benefit summer renters on the island and as such have created a version better suited to them as well (Appendix E: Generalized Energy Saving Pamphlet). This way our research could benefit more of the island if it were successfully implemented. From the data collected in the survey, we have cleaned the following recommendations:

Recommendations for Energy Efficiency in Rental Properties

- Most tenants are reasonably aware about energy saving measures (take short showers, turn off lights, keep thermostats at <65 and where warm clothes, turn down thermostat at night or when leave house, etc.). These behaviors should be continually reinforced by directing them to the energy website via pamphlet.

- Housing Nantucket properties suffer from many drafts, leading to wasted money and energy on heat, which escapes the house. We recommend Housing Nantucket either provide or encourage weather stripping be installed in homes where tenants notice drafts because it is cheap, effective, and easy to install. They can provide the materials to tenants, as well as a set of brief instructions of installation.
- Many tenants do not unplug device chargers when they are not in use. The use of "smart" power strips, which automatically turn individual outlets off when there is little power drawn from them, would be helpful in preventing this unnecessary power draw. If possible Housing Nantucket should look to buy these cheaply and provide to tenants at reduced costs.
- Most tenants do not turn their cable boxes off when they are not watching television. Because these devices draw a lot of power, it is important to turn them off when the television is not on; this can be made easier by programming the cable remote to turn both the television and cable boxes off with one press. Most modern cable remotes support this feature.
- Housing Nantucket should begin replacing old or broken appliances in tenants' homes with Energy Star™ certified appliances; most of the tenants indicated they had no such appliances in their home.
- Housing Nantucket tenants are fairly responsible when it comes to saving energy. Nearly all tenants said they turn lights off when they are not in the room, and many of them turn the thermostat down before leaving their house and add or remove layers of clothing to get comfortable rather than change the temperature.

- The project team suggests that Housing Nantucket continue the education of existing and future tenants through the distribution of the brochure, website, and other materials.

- All properties acquired in the future should be energy audited.

Tenants' satisfaction with HN

- Survey reveals high level of support for Housing Nantucket.
- Testimonials indicate value of what Housing Nantucket does for its tenants and the community.
- Housing Nantucket should continue what it is currently doing in order to keep tenants satisfied as well as conducting periodic tenant surveys to gauge satisfaction and concerns.

- Housing Nantucket should use the testimonials gained to bolster support for their program.

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Appendices

Appendix A: Survey Materials

Cover Page

Good Day,

We are Worcester Polytechnic Institute undergraduates working on a project in order to fulfill our requirements for Graduation.

We are collaborating with Housing Nantucket and would like to understand your energy use habits, knowledge of energy saving practices, and knowledge of energy saving technologies. The information gained from the survey will be used by Housing Nantucket, to identify renovations that could help you save money on your energy bills. The information collected will be kept confidential. Your name or other identifying information will not appear in any of our reports. Please complete the attached survey and leave it next to your doormat [sealed in the protective plastic bag] on Friday 11.9.12 so that we may collect the completed surveys. You may also drop the completed survey off at Housing Nantucket's office at 15 Teasdale Circle.

If you are interested in learning more please contact: HNIQPB12@wpi.edu or call Housing Nantucket at 508.228.4422

Sincerely,

Ethan Forbes, Casey Hayes, and Alex Kafantis

Survey

Please indicate your name, e-mail, and daytime phone below. This survey is confidential and your name will not appear in any of our reports, this information will be used to update Housing Nantucket's records.

Housing Nantucket

Name _____

Email _____

Phone (_____) - _____ - _____

Please rate the following statements based on your personal opinion.

I AM GENERALLY SATISFIED WITH MY CURRENT HOUSE/APARTMENT.

Strongly Disagree ☐ *Disagree* ☐ *Neutral* ☐ *Agree* ☐ *Strongly Agree* ☐

HOUSING NANTUCKET MEETS MY NEEDS AS A TENANT.

Strongly Disagree ☐ *Disagree* ☐ *Neutral* ☐ *Agree* ☐ *Strongly Agree* ☐

Property Information

DO YOU REGULARLY NOTICE COLD DRAFTS IN YOUR HOUSE?

None ☐ *Few* ☐ *Many* ☐

If so, please indicate where the drafts originate? (check all that apply)

Around Doors ☐ *Around Windows* ☐ *From the attic* ☐ *From the walls* ☐ *Other* ☐ _____

Weather Stripping is a narrow strip of material to cover the joints of windows and doors to exclude the cold.

PLEASE INDICATE HOW MANY DOORS AND WINDOWS DO NOT HAVE WEATHER STRIPPING.

Doors _____ *Windows* _____ *Not Sure* ☐

HOW MANY EXTERIOR DOORS DO YOU HAVE IN YOUR HOME AND HOW MANY OF THESE ARE STORM DOORS?

Doors _____ *Storm Doors* _____ *Not Sure* ☐

HOW MANY WINDOWS DO YOU HAVE IN YOUR HOME AND HOW MANY OF THESE ARE STORM WINDOWS?

Windows _____ *Storm Windows* _____ *Not Sure* ☐

ARE ANY OF YOUR SHOWER HEADS, FAUCETS, OR TOILETS THE TYPE THAT ARE "LOW-FLOW"? (DESIGNED TO REDUCED WATER USE)

Yes ☐ *No* ☐ *Not Sure* ☐

Smart plug strips look similar to typical plug strips, but also incorporate additional technologies to automatically disconnect power to certain equipment when not in use.

DO YOU USE ANY "SMART" OR PROGRAMMABLE POWER STRIPS?

Yes ☐ *No* ☐ *Not Sure* ☐

APPROXIMATELY HOW MANY OF EACH TYPE OF THE FOLLOWING LIGHT BULBS DO YOU USE IN YOUR HOME: CFL, LED, OR INCANDESCENT.

CFL bulbs _____ LED bulbs _____ *Incandescent* _____

This is a CFL bulb
Compact Fluorescent (CFL) bulb

This is an LED bulb
Light Emitting Diode (LED)

HOW MANY OF THE LIGHTS IN YOUR HOME OPERATE ON A "DIMMER" SWITCH?

Number of Dimmers _____

HOW MANY OF THE LIGHTS IN YOUR HOME OPERATE ON A TIMER OR A MOTION SENSOR?

Number of Timers _____

ARE ANY OF THE FOLLOWING APPLIANCES IN YOUR HOME ENERGY STAR CERTIFIED?

Energy Star Certified products will carry the Energy Star logo

○ Stove/Oven ○ Dishwasher ○ Dryer

○ Washing Machine ○ Refrigerator ○ Air Conditioner

ENERGY STAR

WHO PROVIDES YOUR GAS?

Yates ☐ Nantucket Energy ☐

ARE YOU ON A HEATING ASSISTANCE FUEL PROGRAM?

Yes ☐ No ☐ *Not Sure* ☐

IN AN AVERAGE MONTH, WHAT IS YOUR APPROXIMATE BILL FOR?

Gas $ _____

Electric $ _____

The next questions focus on people's day-to-day habits in using energy. Check the answer that best represents you.

WHEN I LEAVE A ROOM OR LEAVE THE HOUSE, I TURN OFF THE LIGHTS.

Never ☐ Sometimes ☐ *Often* ☐ Always ☐

IF YOU HAVE A COMPUTER, DO YOU SHUT IT DOWN AND TURN THE MONITOR OFF WHEN THEY'RE NOT IN USE?

Never ☐ Sometimes ☐ Often ☐ *Always* ☐ I do not own a computer ☐

I LEAVE CHARGERS (E.G. CELL PHONE, LAPTOP) PLUGGED IN WHEN NOT IN USE.

Never ☐ Sometimes ☐ *Often* ☐ Always ☐

HOW MANY TELEVISIONS DO YOU HAVE IN YOUR HOME?

I do not own a television ☐ *Number of Televisions* _____

Does your television use a cable box to receive broadcast? If so, do your turn it off as well when you are not watching television?

Never ☐ Sometimes ☐ Often ☐ Always ☐

WHAT TEMPERATURE DO YOU KEEP YOUR HOME AT:

a) During the day when your are **Not** home?

Below 60 ☐ 60 - 65 ☐ *65 - 70* ☐

70 - 75 ☐ *75 - 80* ☐ *Above 80* ☐

b) During the Day when your are home?

Below 60 ☐ 60 - 65 ☐ *65 - 70* ☐

70 - 75 ☐ *75 - 80* ☐ *Above 80* ☐

c) At night?

Below 60 ☐ 60 - 65 ☐ *65 - 70* ☐

70 - 75 ☐ *75 - 80* ☐ *Above 80* ☐

WHEN IT GETS TOO WARM OR COLD IN MY HOME, I AM MORE LIKELY TO GET COMFORTABLE BY:

Adjusting the thermostat ☐ Changing clothes to get comfortable ☐

DURING THE WINTER, I SOMETIMES OPEN A WINDOW IF IT IS TOO HOT INSIDE.

Yes ☐ No ☐

I PREFER TO TAKE:

Full Bath ☐ Shower ☐

When you take a shower, how long do you typically take?

< 5 minutes ☐ 5-10 minutes ☐ 10-20 minutes ☐ > 20 minutes ☐

Do you perform other activities like brushing your teeth or shaving while in the shower?

Yes ☐ No ☐

National Grid Energy Audit

1. WAS AN ENERGY AUDIT RECENTLY CONDUCTED ON YOUR PROPERTY?

Yes ☐ No ☐ Not Sure ☐

If your Answer is No, you may skip the remainder of this section.

1a. Were you provided any information from the audit?

Yes ☐ No ☐ Not Sure ☐

1b. Do you feel you benefited from any of the changes the auditor recommended or implemented?

Yes ☐ No ☐ Not Sure ☐

1c. Do you feel you inconvenienced by these changes that were implemented?

Yes ☐ No ☐ Not Sure ☐

2. HAVE YOU NOTICED ANY CHANGES TO YOUR ELECTRICITY BILL SINCE THE AUDIT?

Much less expensive ☐ *Less expensive* ☐ Bill is the same ☐ *More expensive* ☐ Much more expensive ☐

3. WHAT CHANGES, IF ANY, DID THE AUDITOR RECOMMEND?

4. WHAT RECOMMENDED CHANGES DO YOU THINK YOU MIGHT MAKE IN THE NEXT FEW MONTHS?

5. WHAT RECOMMENDED CHANGES WOULD YOU LIKE TO SEE HOUSING NANTUCKET MAKE IN THE NEXT FEW MONTHS?

Follow up

MAY WE CONTACT YOU AGAIN TO LEARN ABOUT ANY WAYS THAT HOUSING NANTUCKET HAS HELPED IMPROVE YOUR LIFE?

Yes ☐ *No* ☐

TELL US BELOW HOW HOUSING NANTUCKET COULD IMPROVE ITS SERVICES?

Appendix B: Survey Follow-up Calls

Preamble for Tenants who have not returned survey

"Good ___ (morning/afternoon), ___ (sir/madam). My name is (name), and I am a student from the Worcester Polytechnic Institute in Worcester, Massachusetts. I am currently working in conjunction with Housing Nantucket to conduct an assessment on the energy use of their rental properties. We hope to help you save money by conserving energy in your home through the use of efficient technologies as well as energy saving habits. We have recently mailed a survey to your address but have not received a response yet. We were wondering if you have time to possibly take the survey by phone (work with tenant to create appropriate time/extension for paper survey), or if you have received the survey, we would appreciate it if you could complete it and send it back to us at your earliest convenience. All the information collected will be completely confidential and anonymous, unless you wish otherwise. Thank you for willingness to help.

Preamble for Tenants who have agreed to give their testimonials and stories

"Good ___ (morning/afternoon), ___ (sir/madam). My name is (name), and I am a student from the Worcester Polytechnic Institute in Worcester, Massachusetts. I am currently working in conjunction with Housing Nantucket to conduct an assessment on the energy use of their rental properties. We are pleased to have received your survey, which indicated your willingness to conduct a follow-up interview with us. We would like to set up a time to talk with you at your earliest convenience. All the information collected will be completely confidential and anonymous, unless you wish otherwise. (Discussion about meeting time) Your testimonial and stories will be helpful for Housing Nantucket to bring awareness to the work of their organization. Thank you for willingness to help.

Why go green?

With the high cost of energy on Nantucket, going green and saving energy can save residents a lot of money with little effort. This pamphlet was written to help residents like you save money on their energy bills. By following the helpful tips within, we hope you will be able to reduce your energy usage without inconveniencing yourself or making drastic changes to your daily routine. If you would like to learn more, please visit

http://homeenergysaving.20fr.com/Webpage.htm

or scan the tag below with your preferred mobile device.

To learn **more**,

scan this tag with

your mobile device!

More ways to save

Did you know you may qualify for a Massachusetts fuel assistance program? The chart below can help you decide whether or not you qualify.

Fuel Assistance Income Limits
Winter 2012-2013

People in household	Gross annual income
1	< $31,271
2	< $40,893
3	< $50,515
4	< $60,137
5	< $69,759

For more information, visit

www.massresources.org/liheap.html

This pamphlet was created in cooperation with Housing Nantucket by students from the Worcester Polytechnic Institute.

Housing Nantucket

"...housing Nantucket people since 1994."

Energy Savings Guide

www.housingnantucket.org

(508) 228-4422

Electricity

- Mobile device chargers use electricity whenever they are plugged in, even if your device is disconnected! You can save money by unplugging these chargers when not in use.
- Install compact fluorescent (CFL) or light-emitting-diode (LED) lights in your home. These lights use far less electricity and last 7-15 times longer than traditional bulbs!

Did You Know?

A typical HD set top box with DVR capability uses more electricity in a year than a new Energy Star™ refrigerator.

- If you use a cable box to receive television broadcasts, be sure to turn it off when you're done watching TV.
- Some remote controls can turn your TV and cable box on and off with a single button press! consult your cable box manual for more information.

Water

- Dual-flush toilet conversion kits are affordable, easy to install and help your existing toilet use less water.
- If you like long showers, consider taking a bath instead; a typical bath uses as much water as an eight minute shower!
- Use the energy saving mode on your dishwasher and washing machine; these modes often save water and electricity and get the job done just as well.
- Try washing your clothes in cold water or skipping the dry cycle on your dishwasher to use less hot water

Did You Know?

Brushing your teeth in the shower actually consumes more water than brushing in the sink and turning the water off when not in use.

Climate

- Do you notice drafts in your home? Install weather stripping in window and door frames to help insulate and save money!
- If you have a programmable thermostat, program it to let the house cool down when you're typically away and warm back up when you return.
- Some thermostats let you create a weekly or monthly schedule!

Did You Know?

Weather stripping also helps keep your home cooler in the summer.

- Try turning your thermostat down an extra 2 degrees; you will save energy and most people cannot notice the difference in temperature.
- Change the filter in your air conditioner once a month to keep it running as efficiently as possible.

Did You Know?

You save about 3% on your heating bill for every degree you turn your heating down.

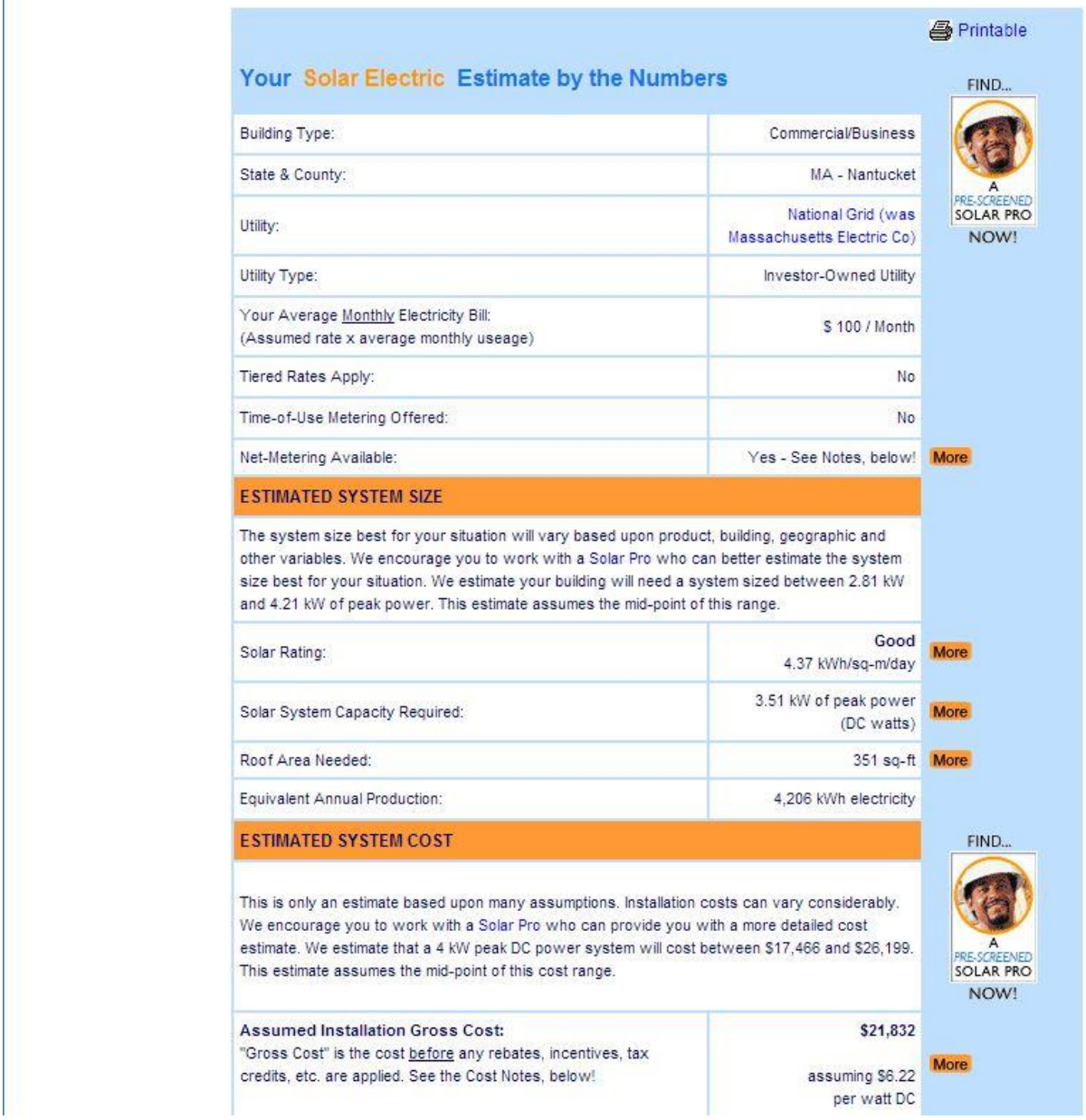
Appendix D: Photovoltaic Calculations

STEP ONE

This step outlines appliance usage that does not vary greatly regardless of the number of people in the household.

Appliance	Number of appliances in house	Average monthly x usage kwh	= Total
Electric furnace			
Approximately 1,100-2,0	1	x 1,460	1,460
Electric central air			
Extra heat (space, block, etc.)		x 180	
Baseboard heat			
Furnace fan		x 102	
Freezer		x 100	
Flat-panel TV		x 95	
Cooktop		x 43	
Range/oven		x 43	
Refrigerator-freezer	1	x 36	36
Clothes dryer		x 33	
Dishwasher	1	x 30	30
Cable TV set-top box		x 18	
Computer	6	x 12	72
Coffee maker	1	x 12	12
Game system		x 11	
Clothes washer		x 10	
Microwave	1	x 8	8
Lights	40	x 6	240
		Total estimate kwh of step one→	1,858

(Pacific Power, 2012)



Printable

Your Solar Electric Estimate by the Numbers

FIND... A PRE-SCREENED SOLAR PRO NOW!

Building Type:	Commercial/Business	
State & County:	MA - Nantucket	
Utility:	National Grid (was Massachusetts Electric Co)	
Utility Type:	Investor-Owned Utility	
Your Average Monthly Electricity Bill: (Assumed rate x average monthly useage)	$ 100 / Month	
Tiered Rates Apply:	No	
Time-of-Use Metering Offered:	No	
Net-Metering Available:	Yes - See Notes, below!	More

ESTIMATED SYSTEM SIZE

The system size best for your situation will vary based upon product, building, geographic and other variables. We encourage you to work with a Solar Pro who can better estimate the system size best for your situation. We estimate your building will need a system sized between 2.81 kW and 4.21 kW of peak power. This estimate assumes the mid-point of this range.

Solar Rating:	Good 4.37 kWh/sq-m/day	More
Solar System Capacity Required:	3.51 kW of peak power (DC watts)	More
Roof Area Needed:	351 sq-ft	More
Equivalent Annual Production:	4,206 kWh electricity	

ESTIMATED SYSTEM COST

FIND... A PRE-SCREENED SOLAR PRO NOW!

This is only an estimate based upon many assumptions. Installation costs can vary considerably. We encourage you to work with a Solar Pro who can provide you with a more detailed cost estimate. We estimate that a 4 kW peak DC power system will cost between $17,466 and $26,199. This estimate assumes the mid-point of this cost range.

Assumed Installation Gross Cost: "Gross Cost" is the cost before any rebates, incentives, tax credits, etc. are applied. See the Cost Notes, below!	**$21,832** assuming $6.22 per watt DC	More

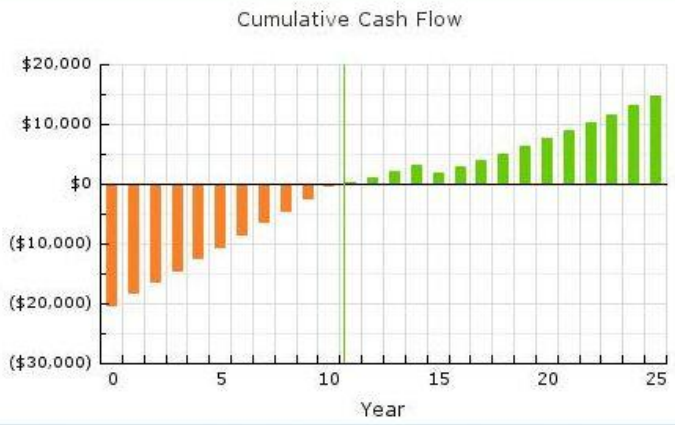
(Solar Energy Matters LLC, 2012)

FINANCIAL INCENTIVES

Financial incentives shown are totals across all years. So, if an incentive spans multiple years then the value shown is the total of all years. For details, please refer to the table below "Cash Flow by Year and Cumulative Across Years"

MA DOER - Solar Renewable Energy Credits (SRECs) $ 0.30 per kWh x 10 yrs. » link	$ 12,612
MassCEC - Commonwealth Solar II Rebates (Non-Residential base incentive < 15 kW) » link	$ 1,404
Modified Accelerated Cost Recovery System (MACRS) Depreciation (5 yr) » link	YES More
ESTIMATED NET COST:	**$7816** More
ESTIMATED NET COST AT INSTALLATION:	**$ 20,428** More
Cash & Loan Amounts:	$ 20,428 Cash $ 0 Borrowed
Loan Monthly Payment (6.5% apr, 30 years):	$ 0

CASH FLOW



Cash Flow Breakeven is where the chart crosses the $0 point - this is when your investment has paid itself back in cash.

The chart above is a summary of the net cash flow you can expect over time. Net Cash Flow is the total cash after all costs (out-flows of cash) are reduced by financial incentives, annual utility savings and tax effects (in-flows of cash).

Average values are used together with your assumed income tax rate (0%). Any property appreciation has not been included, as this is generally not a cash flow (it's an investment). The loan modeled, if any, is included. Because this is a business, we have assumed utility savings do not result in loss of some expense write offs against income. And Modified Accelerated Cost Recovery System (MACRS) Depreciation applies (an income tax benefit). Because individual tax situations vary, we have not included Federal income tax liabilities that may result from having received non-federal incentives, if any (e.g. state rebate programs) as they are usually not taxed as earned income.

(Solar Energy Matters LLC, 2012)

SAVINGS & BENEFITS		
First-year Utility Savings:	$601	More
Average Monthly Utility Savings: *over 25-year expected life of system*	$84	More
Average Annual Utility Savings: *over 25-year expected life of system*	$1,008	More
25-year Utility Savings:	$25,198	More
Levelized Cost of your Solar Energy: $7,816 cost / 105,150 kWh electricity replaced by solar	$0.07 per kWh	More
Return on Investment (ROI):	73%	More
Internal Rate of Return (IRR):	5.7%	More
Net Present Value (NPV):	$1,071	More
Profitability Index:	1.1	More
Greenhouse Gas (CO2) Saved: *over 25-year system life*	86 tons 172,000 auto miles	More

Cash Flow by Year and Cumulative Across Years

This cash flow table includes tax effects applied to utility savings and loan interest payments (if any). For commercial (business) situations we assume utility savings do not result in loss of some expense write offs against income. "Tax Savings from MACRS depreciation" (below) is the net cash saved on income taxes after the depreciation expense is written off. So the amount that was depreciated would be the cash value shown divided by the Income Tax Rate (more info.). Because individual tax situations vary, we have not included Federal income tax liabilities that may result from having received non-federal incentives, if any (e.g. state rebate programs) as they are usually not taxed as earned income. Any income from your system (e.g. performance-based incentives and "SREC's") may be taxed as income (also not shown).

Year of Operation:	at Install	1	2	3	4	5
Gross Cost	($21,832)					
MA DOER - Solar Renewable Energy Credits (SRECs) $ 0.30 per kWh x 10 yrs.	$0	$1,262	$1,262	$1,261	$1,261	$1,261
MassCEC - Commonwealth Solar II Rebates (Non-Residential base incentive < 15 kW)	$1,404	$0	$0	$0	$0	$0
Tax savings from MACRS Depreciation	$0	$0	$0	$0	$0	$0
Utility Savings	$0	$623	$647	$671	$697	$723
ANNUAL CASH FLOW	$-20,428	$1,885	$1,909	$1,932	$1,958	$1,984
Cumulative Cash Flow	$-20,428	$-18,543	$-16,634	$-14,702	$-12,744	$-10,760

(Solar Energy Matters LLC, 2012)

Year of Operation:	6	7	8	9	10	11
Gross Cost						
MA DOER - Solar Renewable Energy Credits (SRECs) $ 0.30 per kWh x 10 yrs.	$1,261	$1,261	$1,261	$1,261	$1,261	$0
MassCEC - Commonwealth Solar II Rebates (Non-Residential base incentive < 15 kW)	$0	$0	$0	$0	$0	$0
Tax savings from MACRS Depreciation	$0	$0	$0	$0	$0	$0
Utility Savings	$750	$779	$808	$839	$870	$903
ANNUAL CASH FLOW	$2,011	$2,040	$2,069	$2,100	$2,131	$903
Cumulative Cash Flow	$-8,749	$-6,709	$-4,640	$-2,540	$-409	$494 Breakeven

Year of Operation:	12	13	14	15	16	17
Gross Cost				($2,457) Inverter Replaced		
MA DOER - Solar Renewable Energy Credits (SRECs) $ 0.30 per kWh x 10 yrs.	$0	$0	$0	$0	$0	$0
MassCEC - Commonwealth Solar II Rebates (Non-Residential base incentive < 15 kW)	$0	$0	$0	$0	$0	$0
Tax savings from MACRS Depreciation	$0	$0	$0	$0	$0	$0
Utility Savings	$937	$973	$1,009	$1,048	$1,087	$1,128
ANNUAL CASH FLOW	$937	$973	$1,009	$-1,409	$1,087	$1,128
Cumulative Cash Flow	$1,431	$2,404	$3,413	$2,004	$3,091	$4,219

Year of Operation:	18	19	20	21	22	23	24	25
Gross Cost								
MA DOER - Solar Renewable Energy Credits (SRECs) $ 0.30 per kWh x 10 yrs.	$0	$0	$0	$0	$0	$0	$0	$0
MassCEC - Commonwealth Solar II Rebates (Non-Residential base incentive < 15 kW)	$0	$0	$0	$0	$0	$0	$0	$0
Tax savings from MACRS Depreciation	$0	$0	$0	$0	$0	$0	$0	$0
Utility Savings	$1,171	$1,215	$1,261	$1,309	$1,358	$1,410	$1,463	$1,518
ANNUAL CASH FLOW	$1,171	$1,215	$1,261	$1,309	$1,358	$1,410	$1,463	$1,518
Cumulative Cash Flow	$5,390	$6,605	$7,866	$9,175	$10,533	$11,943	$13,406	$14,924

(Solar Energy Matters LLC, 2012)

Appendix E: Generalized Energy Saving Pamphlet

Why go green?

With the high cost of energy on Nantucket, going green and saving energy can make a big difference for the island. This pamphlet was written to help visitors like you conserve valuable island resources. By following the helpful tips within, we hope you will be able to reduce your energy usage without inconveniencing yourself or making drastic changes to your daily routine. If you would like to learn more, please visit:

http://homeenergysaving.20fr.com/Webpage.htm

or scan the tag below with your preferred mobile device.

To learn **more**,

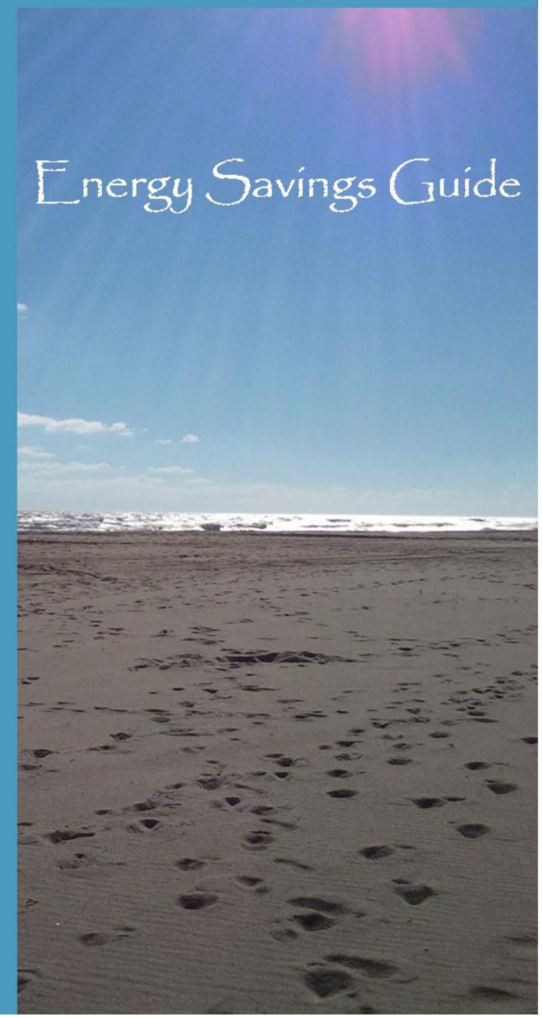
scan this tag with

your mobile device!

This pamphlet was created by students
from the Worcester Polytechnic Institute
as part of a required project.

Welcome to beautiful

Nantucket!



Electricity

- If you use a cable box to receive television broadcasts, be sure to turn it off when you're done watching TV.
- Set your computer to turn the screen off before displaying your screen saver. These are no longer necessary with modern flat screen displays and waste power.

Did You Know?

A typical HD set top box with DVR capability uses more electricity in a year than a new Energy Star™ refrigerator.

- Mobile device chargers use electricity whenever they are plugged in, even if your device is disconnected! You can save money by simply disconnecting these chargers when not in use.
- Try a new smart power strip, which can sense which outlets are using power and shut the others off automatically!

Water

- If you like long showers, consider taking a relaxing bath instead; a typical bath uses as much water as an eight minute shower!
- Use the energy saving mode on dishwashers and washing machines these modes often save water and electricity and get the job done just as well.
- Try washing your clothes in cold water or skipping the dry cycle on your dishwasher to use less hot water.

Did You Know?

Brushing your teeth in the shower actually consumes more water than brushing in the sink and turning the water off when not in use.

Climate

- If you have a programmable thermostat, program it to let the house warm up when you're typically away and cool back down when you return.
- Some thermostats let you create a weekly or monthly schedule; set yours to fit your daily routine and save time!

Did You Know?

Weather stripping also helps keep your home cooler in the summer.

- Try turning your thermostat up an extra 2 degrees in the summer; you will save energy and most people cannot notice the difference in temperature.
- Ensure unused air vents are closed to prevent cooling rooms that are unoccupied.

Did You Know?

You save about 3% on your heating bill for every degree higher you set your thermostat in the summer.