COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

GREENING THE BUILT ENVIRONMENT

SUSTAINABLE DESIGN AT THE TEATOWN LAKE RESERVATION

CAPSTONE TEAM

Jocelyn Gan
Hector Hernandez
Jennifer Li
Grace Lin
Ruth Spencer
Joshua Wallin

TEATOWN

ADVISOR
Kizzy Charles-Guzman

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TEATOWN

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EXECUTIVE SUMMARY

Teatown Lake Reservation is a 1,000-acre nature preserve and education center located in the Lower Hudson Valley. Established in 1963, the reservation has various historic buildings, with two specifically in need of an energy remediation plan. To help develop this plan, Teatown contacted Columbia University's Sustainability Management program and enlisted its help in providing remediation solutions in conjunction with the program's Capstone workshop.

This report serves as a preliminary program study. It provides seven recommendations that will help Teatown reach their goals of energy efficiency and education. If Teatown implements the recommendations outlined in this study, it can realize up to 60% in energy savings based on each implementation measure. These savings will equate to a reduction in greenhouse gas emissions and financial savings, which can be used to support educational programs at Teatown.

To produce this study, an energy analysis of Teatown was conducted using its facilities data and a 2007 energy audit conducted by New York State Energy Research and Development Authority (NYSERDA). An inventory of the buildings' conditions and equipment was also performed prior to report development. Comparable case studies data was also used to determine remediation parameters and recommendations.

The seven recommendations account for 93.7% of energy used at Teatown. They can be implemented stand-alone or combined for further energy reduction. With the exception of lighting, it is suggested that Teatown improves the building envelope first. The first four recommendations address energy consumption. Both fifth and sixth recommendations address energy management. The seventh recommendation focuses on solar energy for educational purpose.

By following the measures mentioned below, Teatown can successfully become a 21st century model for energy efficiency in the small nonprofit sector, provide an educational experience for its visitors, and have a positive influence on the surrounding community.

1

Improve Building Envelope

- Sidewalk & Vestibule Enclosure
- Basic Weather Stripping & Caulking
- Air Sealing Test
- Efficient Windows & Doors

2

Improve Lighting Efficiency

- All Lighting to LEDs
- Lighting Control System
- Lighting Sensors

3

Improve HVAC Efficiency

- Nature Center Boiler
- Smart Home Thermostat System

4

Reduce Plug Load

- Employee Education
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5

Install Energy Management System

6

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7

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- Path Lighting
- Trailhead Signage
- Birdhouses
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INTRODUCTION

SECTION 02


TEATOWN
LAKE RESERVATION
NATURE PRESERVE
EDUCATION CENTER

Background

Teatown Lake Reservation, established in 1963, is a privately owned, not for profit organization located in Ossining, New York. It offers the public a 1,000-acre nature preserve, including 15 miles of hiking trails and a multi-building administrative and educational center.

Teatown's core mission is: *"To inspire our community to lifelong environmental stewardship".*[1] The organization is funded through the support of benefactors who aim to preserve the beauty and share the educational value of the preserve. The organization's impact on the community is far-reaching - serving 30,000 visitors annually, 20,000 which are students from the lower Hudson Valley. Currently, Teatown has 16 full-time, 11 part-time, and 30 seasonal employees. Every year, 250 volunteers perform trail maintenance, education, animal care, and clerical duties, as well as special event assistance, for a total of 5,000 cumulative hours of volunteer time.[2]

Teatown is currently undergoing strategic planning, and is launching a capital campaign for facilities expansion and redesign of interior spaces.

Within the next five to ten years, Teatown anticipates adding six to ten full-time employees and ten to twenty part-time employees. This organizational growth presents an opportunity for Teatown to assess and evaluate its impact on the environment, and formulate a long-term strategy to reduce energy consumption and its carbon footprint.

As a leader in environmental education, Teatown has the vision to teach their community about sustainability and has a duty to mitigate the threat of climate change by improving its energy efficiency and incorporating sustainability into its operation. Before they can do this however, Teatown must first address their own impact on the environment. This way, they can lead by example and provide their visitors a unique and engaging experience.

Teatown's Built Environment

Teatown is located in a one-family residential zone[3] and a historic district.[4]. Under the jurisdiction of the Town of Yorktown,[5] Teatown must adhere to local zoning ordinances which include, but are not limited to: worker square footage requirements,[6] limited changes to the exterior of buildings and cohesiveness with surrounding structures,[7] various employee parking requirements,[8] as well as energy conservation measures.[9] Exterior alterations to historic buildings, especially façade-based renovations, require approval of the Town of Yorktown, and will require an architectural review to ensure that buildings retain their original scale and architectural character.[10]

Teatown's structures were built without consideration for sustainability, energy efficiency, and climate change, all of which are essential considerations for an environmentally-conscious organization. The Nature Center and Carriage House are the two largest structures on the preserve and function as the center of their operations and educational programming.

The Nature Center and Carriage House are the focus of this project as the organization strives to improve its environmental performance by retrofitting its built infrastructure.

The Nature Center

Figure 1: *Exterior view of the Nature Center, a British Tudor style architecture; photo taken from the parking lot.*

The Nature Center is a 14,600 square-foot two-story building with a basement. It was originally constructed as a stable in 1917 and was converted to office space over time. In 1993, the building was expanded to include a staff wing with heating and cooling system separate from the rest of the Nature Center.

As the main building on the preserve, the Nature Center includes the administrative offices, classroom spaces, live-animal exhibits, a library, a visitor center, a reception area, and a gift shop. All public areas are on the first floor, which also includes restrooms and a kitchen.

The attic and basement serve as additional storage places. The attic houses the air handling unit for the staff office wing, including an external facing exhaust fan. The basement level houses an electric meter room, an intermediate distribution frame station, a water softener system, water heater, and a boiler room. The janitorial facilities are located in the basement as well and include a slop sink, washing machine, storage room, and the Facility Manager's office.

Teatown also rents an apartment to one residential tenant and a basement studio to a commercial photographer. The rental units account for approximately one-third of the building's area and approximately 25% of the total energy used at Teatown (See Appendix E). These tenants are not currently submetered for electricity use.

The Carriage House

Figure 2: *Interior view of the Carriage House event space, a rental facility. The space can accommodate 80 people auditorium style or 65 seated. (Source: Fresh Company)*

The Carriage House is a two-story building with a basement that was built in 1920 and upgraded in 1998. The entire building is approximately 5,500 square feet, which includes a rental facility of 1,250 square foot event space with audio-visual equipment, a kitchen, and restrooms.

The basement houses the boiler, water heaters, a washer and dryer for tenants, and bicycle storage. A mechanical room contains a heat pump, fan coil unit, and mechanical system. There are three apartments on the first and second floors that are not submetered for electricity.

Operations & Maintenance

Figure 3: *Teatown's main entrance has a mix of incandescent and compact fluorescent bulbs.*

The majority of Teatown's maintenance decisions are reactive rather than proactive. This leads to the purchase of equipment that may not be energy efficient, and a maintenance schedule that may not be consistent.

For example, a mix of incandescent and compact fluorescent bulbs, in both outdoor and indoor areas, have resulted in inconsistent illuminance level and poor color temperature. Teatown has a full-time Facilities Manager, who maintains all facilities at the reservation.

Teatown does not use natural gas, and relies entirely on Number 2 oil fuel and electricity. Between 300 and 400 gallons of oil are replenished every three weeks during the winter for the Nature Center's boiler. The age of the boiler is uncertain and is estimated to be around 50 years old.

The Carriage House has a modern boiler which was installed in 2012, and has a submetering feature for heat and hot water for all rental units in the building.

The indoor temperature in the public areas in both the Nature Center and Carriage House is typically kept under 72° F during winter, and around 78°F during summer. The thermostats in the staff office wing can be remotely regulated by Con Edison as part of their peak demand program to help prevent regional power disruptions.

Objective & Methodology

SECTION 03

Scope

Teatown approached Columbia University to assist in the identification of strategies that will improve the energy performance of its office spaces, classrooms, and meeting spaces.

- Measuring and assessing the current sustainability status of Teatown's built environment by conducting an energy-use analysis.
- Researching strategies to address organizational concerns such as budget limitation, educational opportunities and preservation of historic and cultural values.
- Providing energy efficiency recommendations for upgrading its built environment.
- Outlining educational opportunities as related to energy efficiency recommendations.

The main goal of this project is energy efficiency remediation. While Teatown as an organization will benefit from a comprehensive sustainability strategy, this was not possible within the timeline given for this capstone project. Energy efficiency is commonly seen as the first and most important step for sustainability in the built environment, and will pave the way for a more comprehensive sustainability plan in the future. In addition, Teatown has a potential gain from energy efficiency upgrades, as there are currently cracks and air leakage in the building envelope, outdated and inefficient lighting systems, and aging appliances that are inefficient and are visible to the public. The general building conditions may lead to uncomfortable working conditions for the staff.

Methodology

Given the client's objective of improving the energy performance of Teatown's main buildings, the team identified recommendations based on case study analysis, site survey, building data analysis, and a previously conducted NYSERDA (New York State Energy Research and Development Authority) energy audit (Figure 4).

***Figure 4**: Project inception to completion pathway*

Research of relevant case studies was conducted, focusing on historical retrofit projects, followed by staff interviews and an inventory survey of the target buildings to understand their physical conditions. The final list of most relevant case studies was consolidated utilizing an assessment criteria that centered on effectiveness and comparability to Teatown. An analysis of a NYSERDA energy audit conducted in 2007 (See Appendix F) was completed to understand the energy end use within Teatown.

Finally, guided by the previous analyses, a set of seven recommendation strategies were determined and ranked based on most effective implementation order.

This report will guide Teatown on energy efficiency strategies that will reduce their environmental impact, reap financial savings, and allow them to lead-by-example in their community.

Case Studies Criteria

The case studies served to identify a list of the most common and optimal energy efficiency strategies used in renovations of buildings similar to Teatown.

The assessment also provided data on other similar energy efficiency projects, the results they achieved, and the challenges that were encountered during their implementation.

Several respected organizations, such as the National Parks Service and the US Department of the Interior, identified best practices to guide implementation. These best practices were incorporated into the team's research and analysis as well. All best practice guidelines that were used are summarized in Appendix C. Finally, examples of how sustainability was taught by other organizations were included to provide ways Teatown could format educational programs that focused on energy efficiency strategies.

ESSENTIAL CRITERIA

The initial survey of energy efficiency projects resulted in a list of seventy-six potential resources, including both case studies and best practice guides. To ensure that the selected case studies were comparable to this project, the following criteria were developed, including both essential and nonessential criteria.

The essential criteria (Figure 5) included eight requirements, which fell into four categories: physical, financial, building age, and efficiency. Any case study that did not adhere to the essential criteria was removed from our analysis.

Category	Criteria	Requirement	Justification
Physical	RETROFIT / RENOVATION	Must be retrofit or renovation	-The process, technology, advantages, and challenges in constructing a newly built energy efficient building differ from those in renovation projects, where fewer choices exist and expenses can be higher.
	CLIMATE ZONE	Must be in zone 4, 5 or 6	-The ASHRAE climate zones[11] were developed to provide specific energy efficiency recommendations for buildings based on climate factors such as temperature and humidity.[12] -Teatown is in zone 5 (cool zone), so case studies were limited to between zones 4 (mixed warm and cool zone) and 6 (cool zone), as the temperatures are similar enough to require the same general building envelope requirements.[13]
	BUILDING USE	Must be office, residential and/or educational	-Having similar building functions as Teatown, would ensure comparable occupant behavior and infrastructure characteristics.
	SIZE	Under 100,000 sq/ft	-Although the Teatown buildings have a combined square footage of 20,000, this analysis considered projects with less than 100,000 square feet, because the majority of properties studied were found to be much larger than Teatown.
Financial	BUDGET	Must be under $35 million	-Few case studies had a budget as small as Teatown's $8 to $10 million goal, so the upper limit was increased to $35 million, which resulted in an average combined overall case study budget comparable to Teatown's estimated spend.
	PRICE/ SQ FT	Must be under $500/sq ft	-With an area of 20,000 square feet, Teatown's upper limit for price per square foot was calculated to be $500 /sq ft.
Building Age	YEAR BUILT	Must be built prior to 1993	- Teatown's latest addition was built in 1993, so projects needed to have been completed prior to 1993 for comparability of technologies and prevalent building practices.
Efficiency	ENERGY EFFICIENCY GAIN	Must be above 45%	-45% was chosen as a halfway point between the Energy Policy Act federal energy reduction goal of 30%, and the average from all case studies of 57%. The group deemed 30% to not be ambitious enough, but also found that the few net-zero case studies skewed the average of the efficiency gain. Therefore a midpoint between the two seemed reasonable.

***Figure 5**: Essential case study criteria*

NONESSENTIAL CRITERIA

The nonessential criteria included "nice to have" project aspects such as LEED certification and return on investment (ROI) that were deemed to not be critical in their comparability to Teatown (Figure 6). This analysis integrated these criteria to provide supplemental information where relevant.

Category	Physical	Financial		Age	Efficiency
Criteria	URBAN / SUBURBAN / RURAL	ROI	NONPROFIT / FOR PROFIT	YEAR RENOVATED COMPLETE	LEED CERTIFICATION

***Figure 6:** Nonessential case study criteria*

DATA FINDINGS

SECTION
04

Case Study Findings

Of the seventy-six case studies initially identified, ten case studies met the above-described criteria for further evaluation.

All ten of these retrofits implemented HVAC, window and door replacement, lighting upgrades, and control systems. Insulation, energy generation (i.e. solar, waste-to-energy), and measures such as solar shading, appliances, boiler and water heater replacement were less common (Figure 7). This assessment provided the basis for the list of potential energy efficiency options for Teatown, and will be described in the recommendations section of this report. In addition, for each of the ten aligned case studies, a one-page reference document was provided to Teatown for the organization's ease of review (see Appendix D). Nine of the ten were LEED certified.

The research also identified five best practice guidelines and four general sustainable education examples, which have been summarized in Appendix C and Appendix E, respectively.

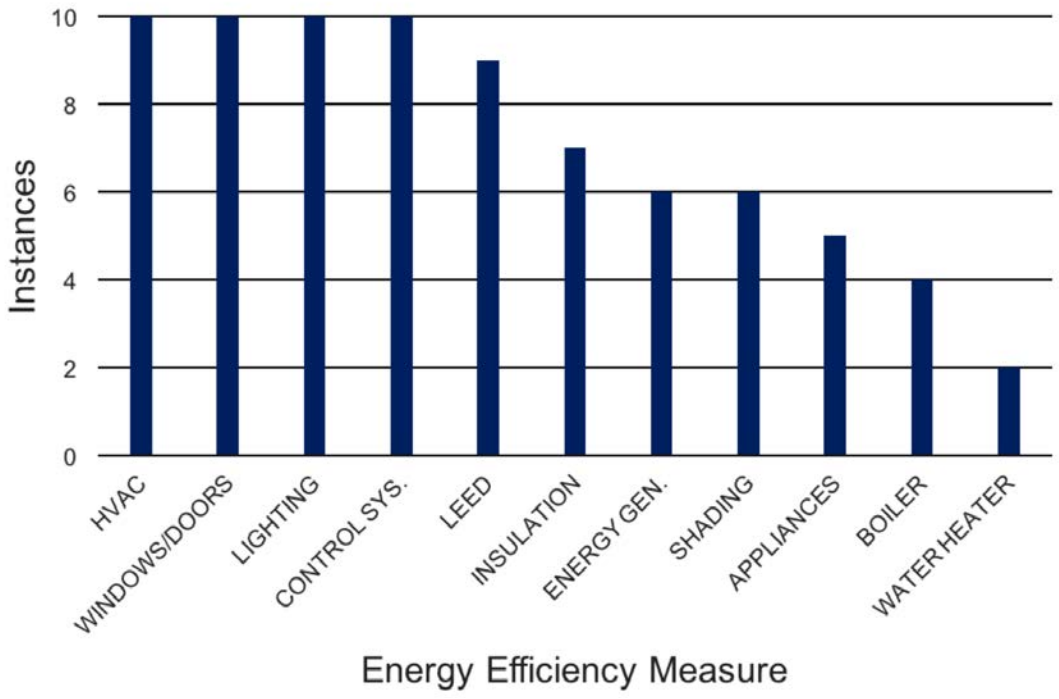


Figure 7: *Instances of energy efficiency strategies found in the 10 curated case studies.*

Energy Audit

Conducting an energy audit fell outside the scope of this capstone project. However, NYSERDA conducted an energy audit of the Nature Center and Carriage House in 2007, which has been referenced in the recommendations below.

NYSERDA's energy breakdown for each of the buildings (Figures 8 and 9) was useful for this project, as it details energy end-use by process. Due to technological changes in the past ten years, it was necessary for the team to evaluate NYSERDA's recommendations, and provide updated suggestions in line with current building innovations. The complete NYSERDA 2007 energy audit for the Nature Center and Carriage House has been included in Appendix B.

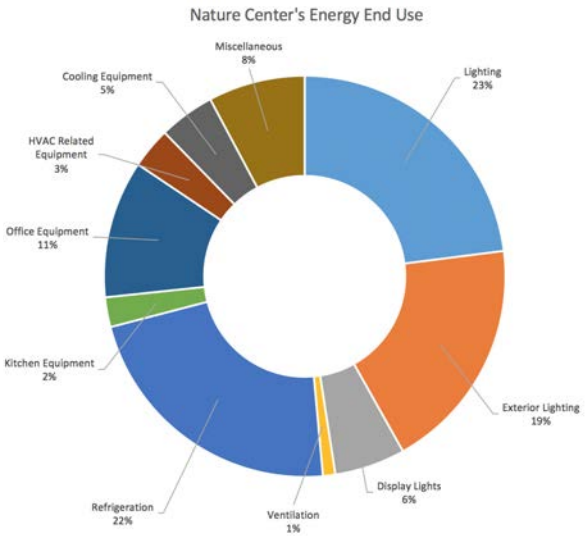


Figure 8: *Electricity end use in Nature Center showing that all lighting uses 47.6% of total electricity.*

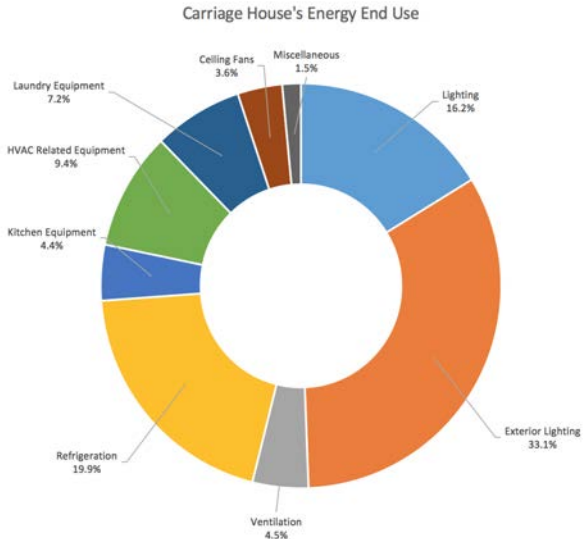


Figure 9: *Electricity end use in Carriage House showing that lighting 49.3% of total electricity.*

As shown in Figure 8, most of Teatown's energy load is used to power lighting. Lighting draws down approximately 48% of energy loaded into the Nature Center, and 49% of energy loaded into the Carriage House. As shown in Figure 9, Teatown's energy use was consistent for the past 13 years observed, even after a new and more-efficient boiler was installed in the Carriage House in 2012 (Figure 10).

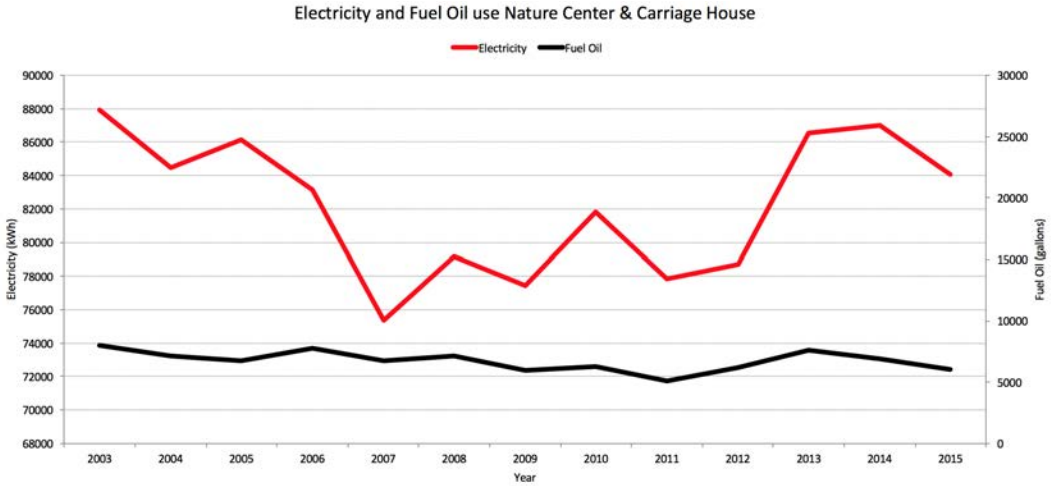


Figure 10: *Electricity use in both facilities showing the year-over-year variance in energy use.*

Public Education & Outreach Opportunities

Each year, Teatown has approximately 30,000 visitors, which includes students, families, and hikers that participate in their programs.

To ensure that Teatown is effectively integrating education about sustainability and energy efficiency into their programming, the team researched innovative programs for Teatown to consider. This set of examples can inspire possibilities of leveraging the organization's retrofit investments for public engagement and education. Similar to the retrofit case studies, the team developed criteria to evaluate the different educational programs (Figure 11) that were most similar to Teatown's goals. These educational examples, summarized in Appendix E, have been referenced throughout the recommendations section where appropriate, and included in the Implementation Pathways section.

Category	Content			Location
Criteria	EDUCATIONAL	SUSTAINABILITY / ENERGY EFFICIENCY RELATED	PROGRAMS ABOUT FACILITY	PROGRAMS TAKING PLACE INSIDE THE PROJECT FACILITY

Figure 11: *Educational criteria*

LEED

Teatown would like to consider Leadership in Energy and Environmental Design (LEED) certification through the U.S. Green Building Council (USGBC). LEED evaluates sustainable building design through a rating system which allows the building owner to receive one of four LEED certification levels: Certified, Silver, Gold, and Platinum.[14] To become LEED certified, a building must meet and exceed sustainability targets, address the needs of diverse building occupants, promote safety and healthy living, and foster the well-being of the community. All of these principles are aligned with Teatown's mission and goals. Because of this alignment, LEED certification potential was considered throughout the process.

Third-party verification is also a great way for Teatown to be recognized for its sustainability initiatives and investments. There are other certification options, such as WELL Building Standard,[15] Passive House,[16] and Living Building Challenge,[17] which all have sustainability focuses and standards. LEED is the most recognized certification program worldwide and can be a future goal for Teatown. This project focuses on energy efficiency strategies, which addresses one of the requirements to achieve LEED certification. For this report, the team referenced the requirements for LEED Operations and Maintenance to "set the stage" for Teatown to pursue pathway towards LEED certification and to promote long-term building performance.

RECOMMENDATIONS

SECTION 05

Recommendations

The Nature Center and Carriage House are the largest buildings on the preserve and are the primary points of contact with visitors. As such they should be Teatown's first priority for increasing energy efficiency. Energy-efficient facilities will reduce Teatown's impact on the environment, enhance Teatown's visibility in the community, increase education opportunities, and promote overall environmental stewardship.

Based on the case study and NYSERDA energy audit review, evaluation of the Nature Center and Carriage House's physical conditions, and Teatown's educational goals (Figure 12), seven recommendation categories have been proposed and are listed below. The first four recommendations address energy consumption. Both fifth and sixth recommendations address energy management. The seventh recommendation focuses on education.

Each category is ranked based on recommended order of implementation and includes one to five specific initiatives that can be used to realize energy savings.

Recommendation	Case Studies	NYSERDA Energy Audit	Site Visit	% Electrical Energy Use*
1. Improve Building Envelope	✔	✔	✔	
2. Improve Lighting Efficiency	✔	✔	✔	48.36%
3. Improve HVAC Efficiency	✔	✔	✔	11.33% (93% of fuel oil use)
4. Reduce Plug Load	✔	✔	✔	34.04%
5. Install EMS	✔	✔		
6. Install Tenant Submetering	✔	✔	✔	
7. Install Solar Energy for Education	✔	✔		
*Weighted average of Carriage House and Nature Center			**TOTAL:**	**93.72%**

Figure 12: *Table showing the alignment between the recommendations, the case study findings, the NYSERDA energy audit and the site visit findings. The percent electrical energy use, as calculated in the NYSERDA energy audit, has been included where applicable to show that the systems addressed contribute to the vast majority of Teatown's energy use.*

RECOMMENDATION 1 :

IMPROVE BUILDING ENVELOPE

Figure 13: *A survey of Teatown's building envelope was conducted and air leakages that occur in many places such as on doors and windows were found. Air infiltration causes thermal heat loss.*

ISSUE

There are gaps and cracks in the walls, roof, windows, and doors of the Nature Center and Carriage House that allow outside, unconditioned air to pass through the building envelope (Figure 13). This means that extra energy is expended to condition the space in order to bring the overall internal temperature to comfortable levels. Gaps and cracks in the envelope also lead to temperature imbalance throughout the space, which decreases occupant comfort. In addition, thermal heat loss results in a higher energy bills.

OVERVIEW

Any energy efficiency strategies implemented without sealing the building will be less effective and will result in a lower return on investment. Therefore, it is important that Teatown seals its buildings before moving on to implementing other energy efficiency measures. Improving the building envelope sealing can provide an average of 20% in energy savings.18 A study by North Carolina Energy Office found that air infiltration is responsible for ~13% heating load and ~4% cooling load.19 This is particularly important given the extreme temperature variations that occur throughout the year in Westchester County.

INITIATIVES

1 INSTALL WINTER SIDEWALK & VESTIBULE ENCLOSURE TO EXTERIOR DOORS

OVERVIEW: By installing a temporary winter sidewalk type vestibule enclosure - like those in front of restaurants - outside the Nature Center, Teatown will be able to reduce unconditioned air from entering the building through the door. (Figure 14)

ENERGY SAVINGS & COST: Based on the vestibule manufacturer's estimation, heating costs may be reduced by up to 50%.[20] Cost is estimated to be $2,000 and up.[21]

Figure 14: *Installing a sidewalk vestibule enclosure can prevent winter draft and help control indoor temperature to improve building occupants' thermal comfort.*
(Source: New York City Signs)

2 INSTALL BASIC WEATHER STRIPPING AND CAULKING

OVERVIEW: Weatherstripping is used to seal air leaks around movable building components, such as doors or operable windows.[22] Caulking is a technique used to seal the seam where two stationary parts of a building fixture meet, i.e. where the pane of a window meets the frame.[23]

ENERGY SAVINGS & COST: According to the Department of Energy, sealing drafty homes can save 20% or more on heating and cooling bills.[24] Weather stripping costs between $1 to $2 per linear foot.[25] The cost for caulking is low and includes the cost of the caulk ($2 to $10) and a caulk gun, which generally ranges in price from $5 to $20.[26] The Facilities Manager should be able to complete weather stripping and caulking without the help of a professional.

3

CONDUCT AIR-SEALING TEST AND SEAL LEAKS IN THE BUILDING ENVELOPE

OVERVIEW: In addition to visible gaps and cracks, there are presumably many areas in the envelope that leak air that cannot be seen with the naked eye. Air sealing tests are commonly used to detect these types of openings. To do this, a qualified technician must be hired to conduct a blower door test,[27] which depressurizes a building, revealing the location of hard to detect leaks.[28]

ENERGY SAVINGS & COST: Energy savings from air sealing depends on the number and size of the cracks and holes that the test finds. Given the fact that there are some visible cracks in the Nature Center and Carriage House, these savings will likely be significant for Teatown.

According to American Property Consultants, an energy rating and inspection company, a typical home blower door test costs $450.[29] This test would be necessary for both the Carriage House and Nature Center.

4

REPLACE OLD EXTERIOR DOORS AND WINDOWS WITH BETTER PERFORMING ALTERNATIVES

OVERVIEW: Teatown has many original doors and windows (Figure 15). Energy could be saved by installing new, energy efficient doors and dual pane windows. Replacing single pane windows with Energy Star windows will generate an average of between $101 and $583 in savings per year.[30]

ENERGY SAVINGS & COST: As with air sealing, the energy savings possible with window and door replacement depends on how much air is escaping through the existing windows and doors. Energy efficient windows usually cost between $450 and $1,000 for each window. This cost could further increase depending on the aesthetic requirements of Teatown. A single door typically costs $1,000 and up. While energy efficient, new windows and doors' payback periods can be up to 55 years.[31] A professional will need to be hired to determine the most appropriate doors and windows for Teatown.

Figure 15: *Original doors to the basement of the Nature Center have clear visible air leakage. Energy could be saved by installing energy efficient doors and weather stripping around the door.*

RECOMMENDATION 2:

IMPROVE LIGHTING EFFICIENCY

Figure 16: *Ceiling lighting in the Nature Center's largest education space is controlled by one on/off switch.*

ISSUE

Lighting accounts for 49.3% of Teatown's energy use in the Carriage House and 47.6% in the Nature Center (Appendix B). As lighting accounts for almost half of all electricity used, decreasing load and educating employees to turn off lights can save Teatown money and help reduce fossil fuel use and carbon emissions. In addition, ten out of the ten aligned case studies implemented updated lighting. In general, Teatown will need to consult with a lighting professional to ensure that they get the most energy savings from these recommendations. Although it is recommended that improvements be made to the building envelope before undertaking any other recommendations, lighting can be improved at any time.

INITIATIVES

1

UPGRADE ALL QUALIFIED LIGHTING TO LED

OVERVIEW: Teatown currently has 199 instances of CFL/fluorescent and incandescent lighting, which is inefficient compared to LED lighting, including outdoor lighting. There is also conventional exit signage throughout the space, which should be replaced with LED signage. By switching over to LED technology, Teatown will be able to reduce electricity use, maintenance time, the number of lamps purchased per year, and GHG emissions.[32]

LED lighting technology has advanced to the point where it is inexpensive and easy to move from conventional (CFL/fluorescent and incandescent) lighting to a longer lasting option.[33] Upgrading lighting is a common strategy to save electricity, and 10/10 case studies referenced used LED technology in their remediation methods. LEDs can be installed into many existing fixtures by using ballast bypass for fluorescent or similar 'plug and play' LED lamps. Installing LEDs will also allow Teatown to maintain a constant lamp color temperature leading to a more aesthetically pleasing environment.[34] LEDs are more environmentally friendly when compared to CFLs and fluorescent lamps as they do not contain mercury,[35] and it is therefore easier to dispose of used lamps. For estimated differences in different lighting technology energy drawdown, see Figure 17.

ENERGY SAVINGS & COST: Energy savings will vary depending on the number of lamps changed and the type of lamps used. T8 fluorescent lamps that are replaced with LED substitutes are estimated to use 20 watts (compared to 32 watts used by a T8) of energy (approximately a 37% savings) per hour over the existing conventional lamp. Energy savings over a comparable incandescent is even higher.[36] The cost to change a T8 fluorescent to an LED averages approximately $10 per lamp. If all 199 lamps are changed, estimated savings is approximately $3,300 per year, or about $17 per lamp per year. Payback is approximately 7 months from date of installation. This does not include calculations for halide and sodium lamps, which draw down a significant amount of energy (35, 50, and 100 watts) and will generate an even higher return if switched to LEDs.

IMPLEMENTATION

The first step to implementing this recommendation is to have the Facilities Manager do a lighting survey and determine which lamps have decreasing luminosity. For every lamp that is decreasing in luminosity, a substitute LED lamp should be purchased and installed. This process should continue until all lamps are replaced with LEDs.

Exit signage and outdoor lighting should also be changed from conventional bulbs to LED in the same manner as interior lighting.

When purchasing replacement lights, color temperature must remain consistent within a space. This will ensure that Teatown is more aesthetically pleasing for employees and visitors. A temperature range of approximately 3,500 to 4,100 Kelvins is the standard color temperature for office spaces.[37]

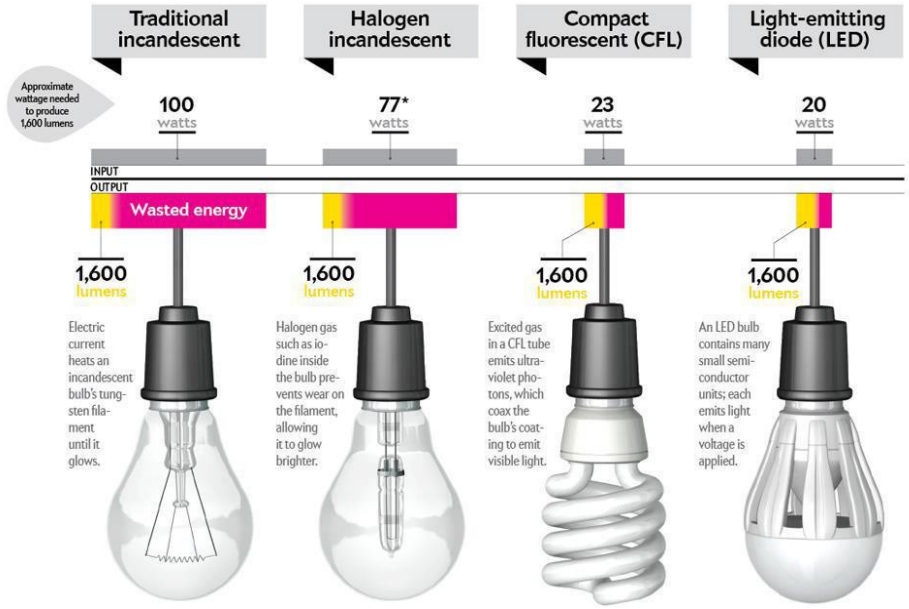


Figure 17: *A lamp type comparison with 1,600 lumens output shows LED at 20 watts while CFL is at 23 watts, halogen lamp is at 77 watts and incandescent lamp is at 100 watts. (Source: Energyzee)*

2 INSTALL A LIGHTING CONTROL SYSTEM

OVERVIEW: A lighting control system is an interconnected network that allows easy control over all aspects of the lights in a space. By installing a lighting control system, Teatown can program its lighting, and save greenhouse gas emissions by automatically dimming lights during set times, or turning lights off remotely. Lighting control systems can be as simple as a downloadable smartphone based app system like Philips Hue[38] or GE Wink,[39] or can be as complex as a Lutron,[40] Crestron,[41] or custom system created by a lighting designer. By installing one of these systems, Teatown will be able to maintain constant control over all aspects of the lights in both buildings.

ENERGY SAVINGS AND COST: Energy savings depends on the reduction in lighting use, but can generate over 30% electricity savings over systems without controls.[42, 43] Although the above mentioned smartphone app is free to download, specific lamps that work with each system must be purchased. These cost approximately $14 to $50 per lamp.[44] More expensive lighting control systems can run between $1 and $5 per square foot of lit space.[45]

IMPLEMENTATION

Teatown should decide what type of lighting control system to invest in. For cheaper options, bulbs like Philips Hue or GE Wink can be installed where applicable. Then the appropriate smartphone application should be downloaded, lighting levels should be set per the instructions, and managers should be given directions on how to operate the controls. If Teatown decides to install a more complex system, a lighting professional should be consulted.

3

INSTALL LIGHTING SENSORS THROUGHOUT

OVERVIEW: Teatown currently only has occupancy sensors installed in kitchens and bathrooms, and does not have daylighting sensors. Teatown should install occupancy or vacancy sensors throughout its facilities, and should install daylighting sensors where possible. By installing one or more of the above, Teatown will automatically decrease lighting use, save money, and reduce GHG emissions.

There are a variety of options when choosing a lighting sensor, including occupancy sensors, vacancy sensors and daylighting sensors. Occupancy and vacancy sensors are sensors that turn lighting on and off based on movement in a space. Daylight sensors are sensors that dim lighting by "harvesting" light entering the interior of a building or office through windows.[46] By installing this option, natural lighting will be maximized, which has been shown to improve workplace performance.

ENERGY SAVINGS & COST: By installing one or a mix of the three, Teatown can save up to 60% of energy used on lighting.[47] Occupancy and vacancy sensors cost $25 per sensor and up.[48] There should be one installed in every office and multiple installed in public areas. Daylighting sensors cost between $150 and $585 and up per sensor.[49, 50]

IMPLEMENTATION

Teatown should consult with a lighting professional to determine the best and most appropriate sensor to use. Once a decision is made, Teatown should purchase and install sensors in applicable areas. Sensors will then have to be calibrated and adjusted as necessary.

RECOMMENDATION 3:

IMPROVE HVAC EFFICIENCY

Figure 18: *The boiler in the Nature Center is past its recommended appliance life expectancy.*

ISSUE

Currently, 93% of oil use in Teatown is for boiler to heat the buildings, with only 7% being used for hot water generation (Appendix B). To reduce oil use, installing a more efficient heating system will make the biggest impact, saving Teatown money and reducing their carbon footprint. Based on interviews with Teatown employees, the building temperature is sporadic with employees regularly changing the thermostat, leading to uncomfortable conditions for employees and energy waste. Some staff have even resorted to portable heaters to find thermal comfort.

INITIATIVES

1 REPLACE NATURE CENTER BOILER

OVERVIEW: Based on information from Teatown, the current boiler in the Nature Center was installed approximately 50 years ago. The life expectancy of a cast iron boiler is 30 to 35 years, according to ASHRAE,[51] which means that the boiler is up for replacement. Additionally, the current boiler was installed before the most recent renovation. The increase in square footage resulting from this renovation, and subsequent change in building use, further necessitates the installation of a new boiler more suited to the size and use of the building. Out of the case studies identified, four out of ten replaced the boiler.

ENERGY SAVINGS & COST: The Department of Energy calculator for commercial boilers expects up to $48,000 lifetime savings based on a thermal efficiency of 80%, which is the ASHRAE standard.[52] As the current boiler efficiency is unknown, it is not possible to determine the exact energy efficiency increase a new boiler will have. However, the Department of Energy estimates that upgrading a boiler in a structure similar to the Nature Center from 56% to 90% efficiency will save 2.5 tons of carbon emissions each year.[53] A replacement boiler that meets the specifications of the Nature Center typically costs up to $8,000[54] and will have an estimated simple payback period of nine years [55, 56] (Appendix A). This is based on the assumption that the boiler efficiency is increased from 70% to 80% and the cost of oil is $2.78/ gallon.[57]

IMPLEMENTATION

The existing boiler should be replaced with a new high-efficiency hot water boiler in compliance with NYSERDA requirements as follows: boilers with a capacity over 300 kBtu/h can either be ENERGY STAR® certified or, if ENERGY STAR® is not available, must have minimum efficiencies ranging from 82-90% AFUE, 80-90% Et, and 83-93% Ec, depending on the boiler type and boiler size.[58] A consultant is recommended to determine the appropriate boiler capacity for the Nature Center. In addition, the boiler will need to be installed by a professional.

2 INSTALL A SMART HOME THERMOSTAT SYSTEM

OVERVIEW: Currently Teatown has wall mounted thermostats in the Nature Center and Carriage House. The current thermostat system must be manually adjusted for all temperature changes, which can lead to frequent temperature fluctuations and an uncomfortable work environment. By installing a smart home thermostat system, Teatown can optimize heating and cooling through a machine learning algorithm which will moderate temperature automatically and subsequently conserve energy. Based on Teatown's size and use, a smart home thermostat system is an affordable way to automate temperature control when compared to a comprehensive Energy Management System (EMS).

2

Nest[59] is specifically recommended for Teatown based on reviews from various publications.[60, 61, 62, 63] It is also the first smart home thermostat system to be certified by Energy Star.[64] Benefits include: the ability to control individual rooms within a building, wifi connectivity, and motion sensors, which improve the user experience and control. For example, with Nest, the temperature can be monitored and controlled remotely through a smartphone application.[65]

ENERGY SAVINGS AND COST: According the the Nest website, a programmable thermostat can reduce up to 15% of energy use.[66] Each Nest thermostat costs $249.[67]

IMPLEMENTATION

Contact Nest for a quote on installing a system for both Nature Center and Carriage House. In addition, ConEd has a rebate program called Nest Rush Hour Rewards, which will provide a $110 check when signing up for Nest. The Nest system will lower demand during peak energy rush hours by automatically heating or cooling the buildings before peak demand hours.[68]

Figure 19: *Beside thermostat system, Nest offers many user-friendly features such as a smoke and carbon monoxide detector. (Source: Nest)*

3

HVAC DUCT SEALING

OVERVIEW: The current HVAC ducts in the Nature Center and Carriage House may have air leaking through cracks in the metal work. HVAC duct sealing can be as simple as a visual survey and crack repair using mastic sealant or metal tape, or as complex as hiring consultant who can effectively search for deficiencies between walls and hard-to-reach areas.[69]

ENERGY SAVINGS & COST: HVAC duct sealing can lead to up to 20% energy savings depending on the number of holes found. The costs can range from $7.88[70] for a roll of metal tape to $450 and up to hire a professional to conduct a more thorough examination.[71]

IMPLEMENTATION

Teatown's Facilities Manager can easily start by conducting a visual survey of their duct work and patch any visible holes using the remediation methods mentioned above. An HVAC consultant should be hired for any further duct examination.

RECOMMENDATION 4:

REDUCE PLUG LOAD

Figure 20: *Appliances and equipment plugged into wall electricity sockets may often be on even if no staff is utilizing it, which increases wasted energy.*

ISSUE

Appliances and equipment use 33% and 35% of electricity in the Carriage House and Nature Center respectively (Appendix B). Most of these items are not as energy efficient as the current models on the market, and energy is wasted when they are left on. (Figure 20) Plug loads are energy used by equipment that is usually plugged into an outlet. This includes electricity used by, but not limited to, computer workstations, kitchen appliances, and telephones. Plug loads are not related to general lighting, ventilation, heating and cooling, and water heating.[72]

INITIATIVES

1 EDUCATE EMPLOYEES TO TURN OFF EQUIPMENT, COMPUTERS, AND APPLIANCES WHEN NOT IN USE

OVERVIEW: Engaging staff to turn off equipment when not in use is a simple initiative to decrease energy use. Training methods can include posters and a staff meeting about energy reduction. There are also opportunities to encourage energy conservation through competitions and challenges that may boost staff morale. This is a common practice adopted by many organizations, and various resources are available online. For example, the Energy Star Posters and Guides provides instructions on how to conduct such trainings, including methods like lunch and learns and email invitations. It should be noted that this is a behavioral strategy, and is highly dependent on staff participation. Therefore, the most effective way to decrease employee energy use from plug loads is to install automated controls.

ENERGY SAVINGS & COST: In a similar initiative implemented by Sony Electronics that encouraged employees to save on energy, there was an average of $85 cost savings per employee.[73, 74] For Teatown, with 16 full-time employees, this amounts to $1,275 total cost savings, which is four times greater than the implementation costs. In the same example with Sony's employee energy savings initiative, there was a $20 investment requirement per employee. The total cost will be $320 for Teatown.

IMPLEMENTATION: A staff member should be designated as the lead to implement employee training initiatives. This is a task ideal for a green team, if Teatown decides to create one.

2 REPLACE EXISTING APPLIANCES WITH MORE EFFICIENT ENERGY STAR OPTIONS

OVERVIEW: Major kitchen appliances at Teatown, including the refrigerators and microwave, were installed in 1993. Old appliances and equipment use more energy than current models on the market. There is substantial potential for Teatown to reduce that load by replacing older appliances with new Energy Star appliances.[75] Additionally, it is likely that these older appliances have outlived their useful lifespan.[76]

ENERGY SAVINGS & COST: Although Energy Star appliances usually have a higher upfront cost,[77] there are significant operating savings throughout the product's lifetime. For just the 2 refrigerators and 4 freezer chests, Teatown can save nearly 4,000 kWh each year, which is equivalent to $704 with a simple payback period of 4 years. (Refer to Appendix A for calculations).

RECOMMENDATION 5:

INSTALL ENERGY MANAGEMENT SYSTEM

ISSUE

Teatown currently does not have a comprehensive, central way to measure and control energy use. By installing an Energy Management System, energy savings can be realized through enhanced awareness of energy efficiency issues and the impact of different activities on energy load.

OVERVIEW: An Energy Management Software system (EMS) provides tools for reducing building energy costs and consumption for reporting, monitoring and engagement purposes. It can measure actual performance against targets to identify changes and to ensure that a building is operating at the most energy efficient levels.[78] It can monitor consumption by pulling data through a variety of connected tracking software for applications including HVAC and lighting control systems. Additionally, by installing controls for plug load management, the facilities manager will have the ability to turn off unused electricity throughout the Nature Center and Carriage House from one central control panel.

Figure 21: *Energy Management System can be accessed online and provides real-time energy use monitoring which can indicate any energy inefficiencies in the building. (Source: GPSIntegrated)*

Furthermore, the data collected by an EMS will allow for energy use measurement, verification and reporting. Monitoring may include trend analysis and tracking energy consumption to identify cost-saving opportunities. The EMS systems can also be configured to send real time alerts to the building manager to allow for remediation of building issues. One engagement method that has recently gained popularity is the real-time energy consumption display available in web applications or an onsite energy dashboard/display.[79]

ENERGY SAVINGS & COSTS: The typical energy savings realized is 13% percent per year with costs starting at $12,000, depending on the complexity of the software and the number of additional tracking software.[80]

IMPLEMENTATION

Conduct an updated energy audit to determine the proper EMS system requirements.

RECOMMENDATION 6:

INSTALL TENANT SUBMETERING

ISSUE

Based on current energy use, it is estimated that tenants use 25% of total energy in Teatown (See Appendix A for calculations). There are currently no strategies to reduce energy used by tenants. By submetering, Teatown will be able to accurately measure and track tenant energy use. This data will allow Teatown to monitor energy trends and determine energy inefficiencies from its tenants.

OVERVIEW: Submeters collect energy use data in specific areas of a building (Figure 22). With this data, Teatown can determine if there is a spike in energy use from the tenants that can be troubleshooted to determine further inefficiencies in the facility. For example, higher energy consumption in a tenant space during the summer could indicate a broken AC unit. A study by the Consortium for Energy Efficiency shows that providing feedback on energy use can generate a four to twelve percent reduction in use.[81] This is an effective behavioral strategy. In addition, submetered facilities can guide management strategies, operational and investment decisions, and tenant interaction that ultimately results in significant energy-reduction benefits.[82] In addition, this will give Teatown the option to charge tenants for their utility use if they see fit.

ENERGY SAVINGS & COSTS: Based on surveyed data, submetering can save up to $1,800 per year for Teatown, which has a payback period of up to two years with the assumption that tenants use approximately 25% of the electricity and heat. For Teatown, it is estimated that submetering will cost between $2,700 and $3,700, which includes equipment and installation.[83]

Figure 22: *Submetering tenants for heat and electricity will allow Teatown to determine if there are any energy inefficiencies in those spaces. (Source: Aquicore)*

IMPLEMENTATION

The Carriage House has already installed three wireless tenant submeters (Honeywell YTH5320) for heating. The same submeters should be used in the Nature Center for consistency. Since this is an installment that could indirectly affect tenants, it may require lease renegotiation if Teatown decides to charge for electricity. Submetering itself does not reduce energy use, but allows data collection, which can help manage energy use. There are two financing opportunities for submeters: NYSERDA's Advanced Submetering Program[84] and Con Ed's Smart Usage Reward.[85]

RECOMMENDATION 7:

INSTALL SOLAR ENERGY FOR EDUCATION

ISSUE

Teatown wants an avenue to demonstrate renewable energy on-site for educational purposes. To generate its own clean electricity, and to lower energy bills and reduce its carbon footprint, renewable solar energy is recommended for Teatown.

OVERVIEW: While Teatown's first priority is to improve energy efficiency in the Nature Center and Carriage House, installing solar panels represents an opportunity to educate visitors about solar energy and is a clear way to showcase Teatown's commitment to sustainability. Solar panels were also installed in five out of the ten case studies referenced.

ENERGY SAVINGS & COST: The payback period for solar panels installed in Westchester county is calculated to be less than ten years based on estimations from Think Solar's Residential Solar Power Report for Croton on Hudson[86] and the average life of a solar panel is approximately 25 to 30 years.[87] Installing solar panels of any kind has a high upfront cost, as well as continuous maintenance costs. Additionally, it may not be possible for Teatown to generate enough solar energy due to its location and/or the tree canopies that surrounds its buildings and covers its lot area. Teatown might not be allowed to install solar panels due to zoning and constraints imposed by the town as well as its financial cash flows.

FINANCING OPPORTUNITIES: Despite the high upfront costs, New York's Solar Tax Credit is one of the most flexible of its kind in the nation, and is equal to 25% of solar costs or $5,000 – whichever is lower.[88, 89]

IMPLEMENTATION

All of the following initiatives are overviews of potential locations for solar panels to optimize visitor engagement and education. To further pursue any solar energy project however, Teatown must seek consultation with a solar energy professional and determine whether solar panels would be allowed by Yorktown planning board and neighbors. Below are five suggested locations to install solar panels. Each of the locations are in public areas where visitors can see and learn about solar energy.

INITIATIVES

1 INSTALL SOLAR PATH LIGHTING

There are currently 10 outdoor bollard path lighting fixtures in front of the Nature Center and Carriage House (Figure 23). They all use compact fluorescent lighting and vary in color temperature, which causes blotchy asymmetric lighting effect. By installing path lighting that is solar powered, visitors can immediately experience the renewable energy technology as they are entering Teatown. In addition, replacing all the luminaires and lamps will allow standardization of lighting. There are many options in the market for solar-powered path lighting, including stand-alone lawn lighting that can be easily purchased in hardware and home improvement stores. However, the removal of the current path lighting may require an electrician and minor landscaping for the flowerbeds the lighting currently sits on.

Figure 23: *Outdoor path lighting in front of the Carriage House and Nature Center that has inconsistent and worn-out lighting fixtures. New fixtures powered by solar can improve energy efficiency and the aesthetics for Teatown's landscape.*

2 INSTALL SOLAR - POWERED SIGNAGE

There is currently no lighting for the trailhead information sign outside the Nature Center. Installing solar powered lighting on Teatown maps and signage will increase visibility during dawn and dusk, and can serve as an educational platform.

Figure 24: *Trailhead signage by the entrance of the Teatown Lake Reservation that does not have any lighting fixtures, which could make reading the signs difficult during dawn and dusk, and can serve as an educational platform.*

3 INSTALL SOLAR PANELS TO POWER LIGHTING IN BIRDHOUSES

Teatown's birdhouses (Figure 25) which are located to the north of the trailhead represent a prime opportunity for solar panel installation. Solar panels could be used to power heat lamps in bird cages, and solar education can easily be integrated with Teatown's existing wildlife curriculum. Before installation, however, it will be necessary to ensure that the roof is structurally sound to support solar panels and there is enough space for storage battery, and that there is sufficient photovoltaic (PV) light available to power the heat lamps on a constant basis.

Figure 25: *Animal ambassador shelters (birdhouses) and exhibits are an optimal location for educational programming.*

4 NATURE CENTER AND CARRIAGE HOUSE PV INSTALLATION

The Carriage House and Nature Center also present a solar installation opportunity that Teatown should consider, as they represent the largest roof area currently in existence. As with the birdhouses, the roof of the Carriage House and Nature Center will need to be checked for viability before installing solar panels.

Figure 26*: Installing solar panels on the roof of the Carriage House may be possible; however, the existing skylight that allows daylight and views must be retained.*

5

SOLAR-POWER CANOPY OVER PARKING LOTS

The existing parking lot is a simple asphalt field surrounded by full growth woods. In addition to the general benefits of solar panels discussed above, Teatown could also incorporate electric vehicle charging into this project, as a way to further its commitment to sustainability and supporting the community. The costs of this project will be higher, however, because it will be necessary to hire an architect to design the parking structure and a contractor to build it before the panels can be installed.

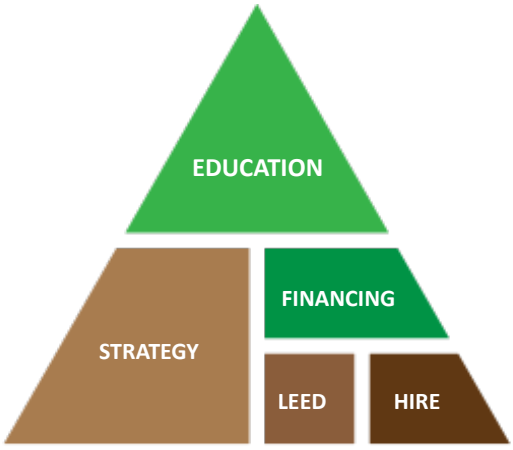
Figure 27: *Parking lot adjacent to the Nature Center is a prospective site to install a solar-powered canopy.*

IMPLEMENTATION PATHWAY

SECTION 06

Implementation Pathway

Prior to selecting energy efficiency measures for the Nature Center and Carriage House, key decisions must be made by Teatown. This will help Teatown further specify the project's scope and set up a framework to prioritize energy efficiency measures. These decisions have been organized into the following categories (Figure 27):



- Create a sustainability strategy
- Decide whether to pursue LEED
- Hire additional staff & consultants
- Finalize the project budget
- Integrate sustainability with educational programs

Figure 27: *Teatown's pathway for implementation starts from the bottom and moves towards the top of their pyramid logo. Teatown's strategic planning will need to integrate LEED, hire new staff and fundraise, all of which will form the foundation of their educational programing and core mission.*

STRATEGY

In order to achieve Teatown's long-term vision, a sustainability plan should be created. Although outside the scope of this project, a sustainability plan will ensure that Teatown considers and implements changes to address all aspects of sustainability, including water, waste, and transportation.

A sustainability plan will ensure that progress is continually made so that Teatown can stay at the forefront of sustainability in their operations and educational programs. Furthermore, this plan will allow Teatown to clearly signal to staff, stakeholders, and visitors that sustainability is a priority to the organization.

Stakeholders should be engaged as part of the sustainability plan process to understand any concerns and/or expectations they have and get stakeholder buy-in. Stakeholders who will need to be considered include Teatown executives, the Board of Planning and Architecture from the Town of Yorktown, and Teatown's neighbors, staff and volunteers. First, there must be buy-in from Teatown's executives. Then the Board of Planning and Architecture will need to be consulted to assess viability since Teatown is in an historic district. Teatown's neighbors should also be engaged in the planning phase to ensure that they are aware of any changes that will be made to the building facade and surrounding landscape. An employee survey will help Teatown understand which recommendations should be given a higher priority--i.e. daylight sensor vs. occupancy sensor vs. vacancy sensors. Finally, this could be a great opportunity to reach out to volunteers and visitors to share Teatown's sustainability vision.

In addition to a sustainability plan, Teatown should create a detailed renovation timeline and management plan. The timeline should include information as to whether 1) the space will be occupied during renovation, 2) the project will be broken up into different phases, and 3) the renovations will occur simultaneously or independently in the two facilities. These are important considerations because the prioritization of recommendations might change depending on whether the buildings will be occupied during the renovation. For instance, if staff occupies the space during renovation, less building-intensive energy efficiency recommendations might be prioritized (i.e., installing an Energy Management System, instead of replacing the boiler). If the renovations occur in both facilities simultaneously, educational programming may be postponed, or temporary outdoor classrooms installed.

A management plan is also essential to ensure that new energy efficient technology and systems are optimized and used correctly. This should include a product procurement plan to ensure energy efficient products are bought, a maintenance plan to ensure that equipment is working properly, and a employee feedback system to ensure that there are adequate channels for staff to voice their concerns about the physical space - i.e temperature is too warm, windows are drafty, etc.

LEED

To pursue LEED certification, it will be necessary for Teatown to hire a LEED accredited professional. This professional is mandatory for any project to be LEED certified and must be brought into the project from the beginning. Hiring a LEED consultant in the middle of renovation will add time and expense.

Based on the size and condition of the Nature Center and Carriage House, it is suggested that obtaining LEED certification for the Carriage House should be prioritized. This will lead to faster LEED certification because the Carriage House is a smaller, less complicated facility that has a recently upgraded boiler.

HIRE

To ensure the project is managed efficiently, a dedicated project manager should be hired to lead the renovation. This will streamline the process and ensure that the project meets all deadlines and objectives.

Teatown will also benefit from hiring and/or may be required to hire additional consultants for many of the recommendations. If, for instance, Teatown decides to install solar panels on its buildings, as discussed in the solar recommendation section, a solar consultant will be necessary. In addition, a building commissioning agent will be required to conduct an energy audit to improve energy efficiency, and a lighting designer will be required to improve lighting aesthetic and efficiency. Finally, as mentioned above, a consultant will be necessary if Teatown decides to pursue LEED or any other certification.

FINANCING

Teatown will need to secure funding. To assist Teatown in this task, information about financing opportunities, fundraising and partnerships have been included below.

NYSERDA FINANCING

New York State Energy Research Development Authority (NYSERDA) offers low-interest energy efficiency financing options for small businesses and not-for-profit clients that go through a Qualified Energy Assessment. Recommended assessment measures can be financed through the Small Commercial Energy Efficiency Financing program. The assessment can be conducted by NYSERDA contractors, utility programs or other Qualified Energy Consultants as long as the minimum requirements are met.[90]

The minimum energy audit requirements are:

- Building description of size, material, and occupant schedule
- Energy and fuel consumption data of minimum one year
- Existing building systems including type, model, age, size, quantity, and performance values of each system
- Required work scope information
- Labor and material cost estimates
- Energy and cost savings estimate methodology
- Summary of recommended measures

After receiving the Qualified Energy Assessment, a request for financing can be submitted to be approved by NYSERDA.[91, 92] Projects financed through the program are subject to on-site inspections after the projects are completed to verify that the NYSERDA-approved financing package is compliant after installation, and certify that the project is complete.

NYSERDA offers not-for-profit organizations two low-interest loan options to finance energy efficiency projects. The first option is a Participation Loan which provides access to low-interest financing through lenders across New York State for implementing energy efficiency improvement measures. Through this program, NYSERDA provides a loan for 50% of the finances (up to $50,000), at a 2% interest rate. The second option is On-Bill Recovery Financing, which is a program that makes it possible for small organizations to use savings on their energy bills to pay for energy efficiency upgrades. Customers of the following utilities are eligible: Central Hudson Gas and Electric, Con Edison, PSEG Long Island, New York State Electric and Gas Corporation, National Grid (upstate NY customers only), Orange and Rockland, and Rochester Gas and Electric Corporation.[93]

FUNDRAISING & GRANTS

Fundraising through a capital campaign or applying for qualified grants are two other financing options. Other not-for-profit organizations have successfully funded similar projects through these methods. The Alliance Center in Denver, CO, which provides tenant space for 35 sustainability focused nonprofit organizations, received a $25,000 grant through the Colorado Governor's Office of Energy Management and Conservation. This grant was used for installing educational signage throughout the building relating to energy upgrades,and providing self-guided tours and brochures.[94] Additionally, it was able to fund its solar project through a $11,200 grant from a local solar company.

PARTNERSHIPS

As Teatown raises funds and considers the financial implications of the renovation, it should also consider the potential for collaborations. There are local and federal programs that fund projects with an educational component, especially for those that focus on renewables and energy dashboards.[95] In addition, Teatown may consider collaborating with organizations it has worked with in the past, along with other local organizations.

EDUCATION

Figure 29: *San Bernardino Valley College sign used to educate students and visitors about their water efficiency measures. The QR code can also be scanned with a phone, as shown above, to learn more.*

Figure 30: *The Queens Botanical Garden interactive touch display depicting solar and geothermal generation in easy to understand charts and graphs.*

Teatown should consider installing educational signage throughout its buildings and outdoor spaces to educate visitors about the efficiency measures that have been put into place (Figure 29).[96]

Teatown may also want to consider installing an interactive screen to display its energy use. The Queens Botanical Garden has an interactive touch display that is located in the lobby of its visitor center that showcases environmental benefits, solar generation, geothermal generation, weather, carbon footprint saved, and emissions avoided (Figure 30). It also compares the new data to the botanical garden's old data to show improvement.[97] Teatown could leverage a system like this and even consider including a screen that allows visitors to select the type of home they live in to calculate what their savings would be if they installed all LED lights, etc. Most displays use Lucid dashboard, which also provides funding when applicable.

Although Teatown does have many community events such as Eagle Fest and pancake breakfasts, it could also begin hosting sustainability-focused events. The Atlantic County Utilities Authority (ACUA) has integrated environmental education into all of its interactions with the public. From educating visitors about its sustainability efforts during tours, to holding an Earth Day festival with educational booths, classes (Figure 31) and activities, the ACUA shows that it is possible to include elements of sustainability in everything that an organization does.[98]

Figure 31: *An educational demonstration at the ACUA's annual Earth Day festival.*

Once Teatown has upgraded its own buildings, an educational program about upgrading single family homes for energy efficiency using Teatown's data would be another possible way to integrate this project with Teatown's educational goals. Not only would a course like this inspire families to implement energy efficiency measures in their own homes, it would also align perfectly with Teatown's mission to create environmental stewards.

SECTION 07

CONCLUSION

The extent of Teatown's future renovation will include redesigning the interior spaces of the Nature Center including office expansion, relocation of the kitchen and bathrooms, accommodation of meeting spaces and improvement of the workplace environment. Presently, recommendations that extend beyond energy efficiency measures are too far out for Teatown's immediate goal due to the organizational desire to completely renovate the interior spaces after capital campaign fundraising.

Therefore, it may be in Teatown's best economic interest to hold off on full sustainability implementation until renovation plans have been finalized, due to the strong chance that many implementation measures will be dismantled to yield renovation or retrofit.

Looking forward, integrating LEED criteria into the recommended strategies will drive systematic and behavioral changes amongst the staff and visitors to help pave the way towards future LEED certification. LEED certification will also help promote sustainability across the entire Teatown Lake Reservation landscape.

Although Teatown is just one small organization, they have the potential to educate and inspire tens of thousands of visitors each year to become environmental stewards. This includes 20,000 students who represent the future of sustainability.

In conclusion, energy efficiency is not just about saving money or modernizing building systems. For Teatown, it is also about reducing their environmental impact and inspiring others to do the same. By following these recommendations, Teatown can successfully become a 21st century model for energy efficiency.

APPENDIX

SECTION
08

Appendix

Initiative	Assumptions	Calculations
Tenant Submetering Tenant Energy Use	**Hours of Operation:** Tenant: Weekdays: 5 hours/day Weekend: 8 hours/day Total: 41 hours/week Teatown: Carriage House: 10 hours/week Nature Center: 10 hours/weekday Total: 60 hours/week **Equipment & Service Costs:** Honeywell Meter: $184 Electrical Submeter - $300-$500 Electrician: $800 **Electrical use:** Average use from 2011-2016 = 82,841 kWh	Percentage of tenant energy use: Tenant area/Total area = 7,100sqft/20,100sqft = 34.8% Tenant area is nearly one third of total Teatown area in the Nature Center and Carriage House Assume that 1kWh is used per hour, how much energy goes into energy space use? (41 hours * 1 kWh/h * (⅓)) + (60 hours * 1kWh/h * (⅔)) = 53.69 kW (41hours * 1 kWh/h * (⅓))/53.69 kW = 25% Estimated tenant annual electrical use: (82,841 kWh) * 25% = 20,710 kWh
Plug loads - Energy Star Fridge/Freezer Energy Savings	Appliance Annual Energy Use Fridge: 1,266 kWh Freezer Chest: 911 kWh Energy Star Appliance Annual Energy Use Fridge: 366 kWh Freezer Chest: 434 kWh Cost Assume $500 for each appliance	There are 2 fridges, and 4 freezer chests. Total Energy Savings: (2 * (1,266-366)) + (4 * (911-434)) = 3,708 kWh

Project Type

Is this a new installation or a replacement?
New Replacement

What is the deliverable fluid type?
Water Steam

What fuel is used?
Gas Oil

How many boilers will you purchase?
1 unit(s)

Performance Factors

Existing

What is the capacity of the existing boiler?
521 MBtu/hr*

What is the thermal efficiency of the existing boiler?
70 % E_t

New

What is the capacity of the new boiler?
521 MBtu/hr*

What is the thermal efficiency of the new boiler?
80 % E_t

Cost Factors

What is the current cost of energy?
$2.78 per gallon*

What are the annual hours of operation?**
1500 hours

Energy Cost Savings

You only save $48,624

You Can Spend

Up to $7,727 more per unit

You could save $20,071more by buying at the required FEMP efficiency level. The minimum thermal efficiency for Federal purchases is 85%. Federal buyers are required to buy at the minimum thermal efficiency level unless they have a cost-effectiveness or functional exception.

	Existing Boiler	Base Model	FEMP Min. Efficiency Requirement	Best Available	Your Choice
Lifetime Energy Cost Savings*	$0	$60,968	$68,695	$99,390	$48,624
Lifetime Energy Costs	$389,270	$328,302	$320,575	$289,880	$340,646
Annual Energy Costs	$22,168	$18,696	$18,256	$16,508	$19,399
Annual Energy Use (gallon)	7,974	6,725	6,567	5,938	6,978
Thermal Efficiency (%)	70	83	85	96	80

Energy.gov calculator for cost savings from replacing boiler shows large lifetime energy cost savings

Boiler Payback Calculation

Recommendation	Replace boiler with 80% efficient model				
Installed Cost	$8,000.00			3770.9	Old Boiler
Annual energy savings	67.3375	MMBTU Saved		4713.625	New Boiler
Annual dollar savings	$875.39			673.38	Therms Saved
Simple payback period	9.14	Years		67337500	BTUs Saved
				67.3375	MMBTUS Saved

SEC B NYSERDA 2007 ENERGY AUDIT

Refer to attached PDF for the full NYSERDA 2007 Energy Audit

Technical Preservation Services Guide

Author Organization(s): National Parks Service & US Department of the Interior
Resource Link: www.nps.gov/tps/sustainability/energy-efficiency/weatherization.htm

LIST & SUMMARY OF BEST PRACTICES

This Guide Provides a Nine Step Plan:

1. Energy Audit: An energy audit should be undertaken before any energy-improvement measures are implemented. The audit evaluates the building's current thermal performance and identifies any deficiencies in the building envelope or mechanical systems.

2. Modify User Behavior: User behavior and climate have a great effect on energy use and should be considered before developing a weatherization and energy efficiency plan. For example, reducing air infiltration around a door will not be effective if a tenant has a habit of propping the door open.

3. Develop a Plan: Developing a plan tailored specifically to your building, site, climate, and occupancy will be an effective tool in reducing energy consumption.

4. Air Infiltration: Air infiltration is the exchange of air through cracks and gaps in the outside shell of a building. There are many simple, low-cost improvements that can reduce air infiltration in your historic building, such as caulking and weather-stripping.

5. Windows & Doors: Historic windows and doors can often be repaired or upgraded to improve energy efficiency and occupant satisfaction.

6. Efficient Systems: The efficiency of mechanical and electrical systems plays a large role in energy use. Ensuring that existing systems are functioning as efficiently as possible or upgrading to new, more-efficient systems can substantially reduce energy consumption with minimal impact on the historic building.

7. Install Insulation: Installing insulation in certain spaces can be a cost-effective solution to heat loss. However, determining where to install insulation can be a more complex decision than many people realize.

8. Efficient Appliances: When choosing new appliances for your historic building, select products labeled ENERGY STAR, which meet energy efficiency guidelines set by the Environmental Protection Agency and the Department of Energy.

9. Shading Devices: Installing appropriate awnings on your building or planting deciduous trees can provide shade in the summer and reduce energy needs.

MAIN TAKEAWAYS: These are best practices as developed by a respected agency, and great images to use in reports and presentations.

Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings

Author Organization(s): U.S. Department of the Interior, National Park Service & Technical Preservation Services
Resource Link: www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf

LIST & SUMMARY OF BEST PRACTICES

These are guidelines on recommendations and things to avoid, based on the following categories:

Planning: Identify pre-existing sustainable aspects of the building and prioritize improvements based on the level of intrusiveness

Maintenance: Maintain building regularly and use sustainable products where possible

Windows: Retain historic windows if possible and use caulking to ensure that they are airtight

Weatherization and Insulation: Use comprehensive energy audit (blower door tests, infrared thermography, energy modeling or daylight modeling)

Heating, Ventilating and Air Conditioning (HVAC) and Air Circulation: Repair or upgrade HVAC unit for increased efficiency

Solar Technology: Consider solar technology only after implementing all appropriate treatments to improve energy efficiency of the building, which often have greater life-cycle cost benefit

Wind Power: Wind Turbines and Windmills: Consider wind power only after implementing all appropriate treatments to improve energy efficiency of the building, which often have greater life-cycle cost benefit

Cool Roofs and Green Roofs: Ensure that the historic building can structurally accommodate the added weight of a green roof and sensitively improve the structural capacity, if necessary

Site Features and Water Efficiency: Landscape with native plants, if appropriate, to enhance the sustainability of the historic site

Daylighting: Retain features that provide natural light to corridors, such as partial glass partitions, glazed doors, and transoms, commonly found in historic office buildings

MAIN TAKEAWAYS: Ideas for energy efficiency measures in historic buildings with guidelines on how to implement them in order to maintain the historic character of the building.

A Search for Deep Energy Savings

Author Organization(s): Northwest Energy Efficiency Alliance & New Buildings Institute
Resource Link: newbuildings.org/sites/default/files/NEEA_Meta_Report_Deep_Savings_NBI_Final8152011.pdf

LIST & SUMMARY OF BEST PRACTICES

This report collects lessons learned from various building retrofit case studies:

Ratings and Awards: All building pursued LEED certifications for the following reasons: LEED provided a set of target criteria and a pre-made framework, as there was no incentive to explore or establish independent criteria, owners perceived a strong value to the third-party certification and market recognition of the label. Acknowledgment through both ratings and recognition from independent entities remained a theme for most of the Buildings.

Impetus: Energy efficiency was not the primary driver of renovations, but once the door was opened to major construction changes, owners considered energy efficiency an integral part of improving and updating their buildings.

Green Leadership: The majority of the buildings are owned by mission-driven organizations, firms or individuals. Their buildings serve as extensions of their core missions.

Money & Market: All projects considered and valued the economic and environmental benefits (the "two greens") that make energy efficiency a wise investment.

Energy Efficiency Measures: The energy efficiency measures include high efficiency lighting, daylighting, commissioning, high efficiency HVAC, lighting controls, energy or building management system, metering, high performance tinted glass, and cool roofs.

Costs: The whole-project costs for eight of the full-building renovations ranged from $100 to $176/sf, with one building with an addition and the most extensive building de-and re-construction running $445/sf.

Financing: The methods used to access capital were also diverse, but only one project identified them as a barrier.

Savings Estimates: The savings cited for the deeper energy renovations were near or beyond a 50% cost reduction in energy expenses, while the equipment retrofit project estimated 25% savings from the efficiency measures.

Barriers: These nine owners faced barriers and challenges similar to most construction projects with costs and maintaining historical attributes most often cited.

MAIN TAKEAWAYS: A few of case studies in this report were also included in our case study appendix.

Sustainability and Historic Federal Buildings

Author Organization(s): Advisory Council on Historic Preservation
Resource Link: www.achp.gov/docs/SustainabilityAndHP.pdf

LIST & SUMMARY OF BEST PRACTICES

This guide recommends the following approach to decision-making regarding federal historic buildings:

1. Consider reusing a historic building before constructing a new building or leasing space in a privately owned building
2. Rehabilitate a historic building by using, reclaiming, and enhancing historic sustainable features and by adding compatible sustainability improvements when needed
3. Design compatible new green construction in existing historic communities when needed
4. Consider disposing of a historic building only after other options are appropriately considered

In addition, the Advisory Council on Historic Preservation suggested following the Guiding Principles of Sustainability:

1. Employ integrated design principles through a collaborative, integrated planning and design process, and tailored total building commissioning practices
2. Optimize energy performance through energy efficiency and rigorous measurement and verification
3. Protect and conserve indoor and outdoor water
4. Enhance indoor environmental quality through the use of ventilation and thermal comfort, moisture control, daylighting, low emitting materials, and indoor air quality protection during construction
5. Reduce environmental impact of materials through the use of recycled and biobased content, limiting construction waste, and eliminating the use of ozone depleting compounds

MAIN TAKEAWAYS: These guidelines are general, but helpful best practices to keep in mind as Teatown moves forward with their renovation.

Retrofitting Historic Buildings

Author Organization(s): City of Westminster
Resource Link: Link to Report Download

LIST & SUMMARY OF BEST PRACTICES

This guide gives a list of primary questions to ask yourself when prioritizing technologies:

1. How is the building used? Can it be used more efficiently? Firstly you should ensure that you are already undertaking measures that can be implemented at no cost, which involve changes to behaviour rather than the building fabric, and low-cost minor alterations and additions to make the building more energy efficient. These will be quick and simple to implement, have limited impact on the historic fabric and in most circumstances will not require permissions from the City Council.

   Low cost measures include: lighting upgrades, insulate hot water tanks and pipes, draught proof doors and windows, repair and use original internal shutters, use removable chimney balloon to open/close chimney damper plates, select energy and water efficient appliances, use real time energy display

2. Consider the type of heritage protection that applies. i.e. local ordinances

3. What scope do you have to make changes? I.e. Landlord/tenant agreement, how will costs be distributed

4. What is the budget and payback period framework it will follow?

5. What permissions/consents do you need to obtain? i.e. permits

6. What measures do occupants need to understand? Current and future occupants must understand how to use any new systems to ensure efficiency. Also, there may be changes to the way a property is occupied. For example, with many types of internal solid wall insulation it is vital not to pierce the waterproof membrane behind the insulation, which might happen easily when putting up shelves or hanging a picture.

7. Monitor and undertake necessary maintenance.

MAIN TAKEAWAYS: Content is based on British laws and regulations but it gives a good outline of how to organize risks and opportunities.

Alliance Center

Author Organization: New Buildings Institute

www.newbuildings.org/wp-content/uploads/2015/11/Case_Study_Alliance-Center1.pdf

PROJECT DETAILS	
Location	Denver, Colorado
Building Type	Medium Office
Size (sf)	38,000 ft²
Project Completion	2006
Year Built	1908 (Historic Building)
Total Budget	$117,000; $3.07/sf (after incentives)
Recognitions	• LEED-EB Gold and LEED-CI Silver • Energy Star • USGBC National Award for Education • Colorado Energy Champion Award • Mayor's Design Award

ENERGY EFFICIENCY MEASURES
Direct digital HVAC control system
Increased insulation
High-efficiency glazing
Lighting
Occupancy sensors
Commissioning
Rooftop PV renewable
Photocells for daylight harvesting
Solar shades
Un-refrigerated water fountains
Retro-Commissioning

The Alliance for Sustainable Colorado is a nonprofit organization started in 2004 to "advance sustainability through collaboration among nonprofits, business, government and education." To advance this mission, the Alliance purchased a 100-year-old warehouse in Denver's historic Lower Downtown and completed a major renovation project in 2006. The building provides tenant space for 35 sustainably focused nonprofits, fostering communication and collaboration and serving as a demonstration project of advanced design strategies in a rehabilitated historic building.

The owner wanted the building to create synergies and foster partnerships that accelerate progress on issues that affect the Triple Bottom Line, ensuring consideration of impacts on Colorado's people, environment, and economy.

By converting an old warehouse with historic character and value into offices, the project focused on implementing strategies that would promote building health and energy and water efficiency while preserving historic integrity. The project consisted of reconfiguring the interior spaces, updating the building HVAC, telecom, and electric systems, and adding new finishes. The project was submitted for LEED certification (EB and CI) and ultimately received LEED-EB Gold and LEED-CI Silver.

In 2010, the Alliance Center completed this project by utilizing multiple grants, including a $15,000 grant from the State Historic Fund in Colorado to provide a historic structure assessment and preservation plan, including detailed guidance on historic renovations, upgrades, and general upkeep.

The renovation led to a 35% reduction in energy use in just one year, resulting in savings of over $250,000 and eliminating more than 1,200 metric tons of CO_2 emissions.

Center For Neighborhood Technology

Author Organization: Regional Green Building Case Study Project

www.usgbc-illinois.org/wp-content/uploads/2009/09/CNT09.pdf

PROJECT DETAILS	
Location	Chicago, IL
Building Type	Office
Size (sf)	14,964
Project Completion	2003
Year Built	1920s
Total Budget	$1,200,000
Recognition	• LEED-NC Platinum

ENERGY EFFICIENCY MEASURES
High-efficiency HVAC systems
Thermal ice chiller system
Building envelope
PV solar panel
Low flow water fixtures
Daylighting
Low VOC materials
Recycled content materials
Regionally sourced materials
Permeable parking lot
Public transit access
Outdoor and indoor bicycle parking
Car sharing membership

The Center for Neighborhood Technology (CNT) is a 30 year old nonprofit organization focused on urban sustainability. Their LEED® Platinum office in the Wicker Park community of Chicago serves as a physical example of its commitment to livable and sustainable communities. The building was the second LEED Platinum building completed in Chicago and the thirteenth in the country. The decision to renovate an older building in a dense neighborhood reflects the value the organization places on existing urban infrastructure, energy and materials of an existing building stock, and the value of location-efficient neighborhoods.

CNT had three primary goals for building green: 1) achieve LEED® Platinum at a cost comparable to conventional rehab, 2) prioritize energy efficiency, and 3) serve as a demonstration project for others. They chose to include two demonstration projects to support their goal of educating others: a thermal energy storage system and a 4.8kW photovoltaic (PV) solar panel array. Also they achieved LEED® Platinum certification by covering all of the green building basics, including low-flow water fixtures, low VOC paints and adhesives and using recycled materials.

Since 2005, CNT has realized approximately 45% annual energy savings compared to if the building was simply constructed to code, resulting in savings of approximately $18,000 per year. CNT attributes the savings to their focus on energy efficiency as a key component of the renovation. CNT achieved all 10 energy optimization points within LEED EA Credit 1 for a total of 14 of 17 points in the LEED Energy and Atmosphere category.

Home on the Range

Author Organization: New Buildings Institute
www.newbuildings.org/wp-content/uploads/2015/11/Case_Study_Home-on-the-Range1.pdf

PROJECT DETAILS	
Location	Billings, Montana
Building Type	Office
Size (sf)	8,500
Project Completion	2006
Year Built	1940
Total Budget	$1,435,243 ($169/sf after incentives)
Recognitions	• LEED-NC Platinum • Energy Star • AIA Top Ten Green Awards

ENERGY EFFICIENCY MEASURES
High-efficiency boiler
Radiant-floor hydronic system
Direct evaporative cooling system
Variable frequency drives
Demand control ventilation (CO^2 sensors)
Increased insulation
Low-E glazing
Commissioning
T8 fixtures with dimmable ballasts and daylighting controls
Light shelves
Occupancy sensors
HVAC controls
Photovoltaics

Home on the Range was completed by the Northern Plains Resource Council (NPRC), which organizes Montana citizens to protect the region's water quality, family farms and ranches, and unique quality of life. The staff director at the Northern Plains Resource Council felt it was important that the nonprofit become a model for green building for both the City of Billings and the State of Montana, with the ability to influence other buildings and owners.

The Home on the Range energy goals were to minimize demand, incorporate as much energy efficiency as possible, and maximize the use of renewable energy sources. This was accomplished through a combination of energy reduction measures such as installing a high-efficiency boiler, sealing the building envelope, replacing outdated lighting, installing lighting controls, and educating employees on sustainable practices. Employee education and installing monitoring systems were found to be the most impactful.

Member donations provided the bulk of initial funding, which was later supplemented by private foundation grants, a loan and grants from the Downtown Billings Partnership, and renewable energy incentives from Northwestern Energy.

The HOTR Building is an impressive example of investing in design and systems during a remodelling process that optimized energy efficiency and truly yielded measurable cost savings. Compared to the baseline, the building now uses 72% less energy than the Energy Star estimate, and ranks in the top 1% of office buildings in the U.S. with its Energy Star Score of 99/100.

Johnson Braund Design Group

Author Organization: New Buildings Institute
www.newbuildings.org/sites/default/files/Case_Study_Johnson-Braund-Design-Grp.pdf

PROJECT DETAILS	
Location	Seattle, WA
Building Type	Office
Size (sf)	8,000
Project Completion	Ongoing (2012 Retrofit)
Year Built	1984
Total Budget	$250,000 ($31/sf after incentives)
Recognitions	• Pursuing LEED - O&M Platinum • EPA Small Business Innovation Award • Energy Star

ENERGY EFFICIENCY MEASURES
High-efficiency HVAC heat pump
Heat recovery
Replaced entry doors
Sealed and caulked existing windows
Lighting upgrade to T5 fixtures
Daylighting controls
Occupancy sensors
Electricity management monitoring system
Rooftop PV renewable
Plug load management

Johnson Braund Design Group, Inc. is a full-service architecture, landscape architecture and interior design firm located in Seattle, Washington. In 2002, JBDG purchased a two-story office building built in 1984 to house its growing practice. The 8,000 square foot space consumed over 400 kWh of electricity per day, and the owners sought to reduce this by half while maintaining a realistic budget. JBDG developed the following goals for the building renovation: 1) reduce electrical grid consumption by 50%, 2) reduce water grid consumption by 50%, 3) receive a reasonable financial payback on all improvements, and 4) improve occupant comfort.

The owners chose to upgrade the HVAC system, lighting, and controls, and added a rooftop PV system in order to meet these goals. Since then, the building has seen continuous energy use improvements. Based on its energy utility billing data, JBDG reduced their energy use by 59%.

JBDG funded the upgrades through conventional bank financing, but was also able to take advantage of a 30% Federal Tax Credit for photovoltaic installation and a Washington Renewable Energy Production incentive of $5,000/year.

As a design firm, these projects and improvements have provided JBDG with what the owner calls “real world expertise” and a high level of legitimacy when it comes to encouraging clients to undertake such projects. In a case in which the design team was unable to convince a client to include a renewable energy source on its project, JBDG’s experience with photovoltaics helped the firm make the case for ensuring the project is solar-ready. Compared to the average office spaces in the U.S., the building now uses 69% less energy.

Mercy Corps

Author Organization: New Buildings Institute

www.newbuildings.org/sites/default/files/Case_Study_Mercy-Corps-HQ.pdf

PROJECT DETAILS	
Location	Portland, OR
Building Type	Office
Size (sf)	83,000
Project Completion	2009
Year Built	1892
Total Budget	$37 million
Recognition	• LEED-NC Platinum

ENERGY EFFICIENCY MEASURES
Variable speed compressor heat pump condensing units
Variable air volume box with CO^2 sensors
Increased insulation
Motorized clerestory windows to exhaust air
Low-E glazing
Direct/Indirect T8 fixtures with dimmable ballasts
Daylighting controls
Building Management System - controls
Commissioning

Mercy Corps is an international organization providing emergency relief service and sustainable economic development in 36 countries around the world. Its new global headquarters is located in the Packer-Scott building, a Portland landmark originally built in 1892. This building is 50% historic renovation and 50% new construction, with an energy retrofit that served both. The four-story building (with one floor below grade on the existing portion) includes corporate offices on the upper floors and a global learning center on the ground floor.

Mercy Corps describes its new headquarters as "a green building, reflecting our commitment to environmental sustainability". This is particularly important, as they see climate change as one of our planet's most critical challenges and is a consideration in many of their programs around the world. Mercy Corps' decision to build a new headquarters was based on the following goals: 1) a commitment to cost efficiency, 2) creating a smaller environmental footprint, 3) providing additional space and consolidation of employees in a single location, and 4) improved public involvement in its work.

In order to achieve these goals, the organization conducted various energy efficiency measures, including a large upgrade to natural ventilation. This consisted of installing new operable windows and motorized clerestory windows in the new design.

The majority of capital for the building came from a private fundraising campaign, as well as grants to incorporate efficiency measures into the project. Scheduling and cost controls were very important to the owners, who hired a construction manager to ensure the project remained on budget.

All in all, the estimated annual cost savings are $37,624 per year, a 35% savings over the baseline. The building uses 69% less energy per square foot than the average office in the U.S.

NW 14th & Everett

Author Organization: Skanska
www.skanska-sustainability-case-studies.com/index.php/latest-case-studies/item/199-nw-14th-everett-us

PROJECT DETAILS	
Location	Portland, OR
Building Type	Commercial
Size (sf)	183,000
Project Completion	2012
Year Built	1927 (Historic Building)
Total Budget	$27 million
Recognition	• LEED-NC Platinum

ENERGY EFFICIENCY MEASURES
Variable Refrigerant Volume HVAC system
Building insulation and windows replacement
High efficiency condensing boiler and hot water heaters
Daylighting and dimming controls
Occupancy sensors
Rooftop PV renewable a
Purchased Renewable Certificates
Low VOC materials
Recycled content materials
Construction waste management
Office waste management
Low flow fixtures and dual flush toilets
Stormwater management
Green roofing
Public Education Program

NW 14th & Everett is an historic building in Portland located in the Pearl District that was renovated into a modern and resource efficient commercial building that was certified to LEED Platinum. The building was built in 1927, and was previously used as a warehouse for a nearby furniture department store. The building is listed on the National Register of Historic Places, which required that the renovation design conform to regulations regarding the preservation of its historic character. For example, wind turbines could not be used, and the solar panels had to lie relatively flat on the roof in accordance with the regulations.

The project received several financial incentives, including Green Investment Funding, support from the Energy Trust of Oregon, Business Energy Tax Credits, Solar Investment Tax Credits, and an EPACT (Energy Policy Act) Deduction.

The redeveloped 14th & Everett building is designed to use 60% less energy than the ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) standard, and a roof-mounted solar array meets around 10 percent of the building's electricity needs. The energy and water efficiency measures reduce the building's annual operating costs by 69%, and ensure that the building's Green investments will be repaid in an estimated 7.5 years.

The project team implemented a Public Education Program aimed at raising public awareness of the building's green aspects and its specific solutions. As part of the program, comprehensive signage was posted around the building to inform occupants and visitors of specific green solutions, and public tours were provided of the building. Skanska is using the building as a case study for its participation in the Portland Development Commission's We Build Green Cities in order to raise awareness of green building successes in Portland. The program is intended to influence other US cities to build green buildings by providing tools and lessons learned.

The Beardmore Building

Author Organization(s): Northwest Energy Efficiency Alliance & New Building Institute
www.newbuildings.org/sites/default/files/Case_Study_Beardmore.pdf

PROJECT DETAILS	
Location	Priest River, Idaho
Building Type	Office/Mixed use
Size (sf)	28,800
Project Completion	2009
Year Built	1922 (Historic Building)
Total Budget	$2,600,000 ($105/sf after incentives)
Recognitions	• LEED-NC Gold • National Award of Merit for Restoration • Grand Award for Best Sustainable Adaptive Reuse • Merit Award for Outstanding Rehab Project • Orchid Award: Excellence in Historic Preservation

ENERGY EFFICIENCY MEASURES
High-efficiency HVAC package units with economizer controls
DCV with CO^2 sensors
Increased insulation
Improved roofing materials with high solar reflectance index
Low-E glazing
Lighting exceeds utility advanced lighting requirements
Lighting night set-back and occupancy sensors
Commissioning

Built in 1922 by Charles Beardmore, a timber and mining pioneer, the Beardmore Building in Priest River, Idaho housed offices, mercantile shops, a ballroom and a theater. After decades of neglect under outside ownership, Brian Runberg, an architect and great-grandson of Charles Beardmore, purchased the building in 2006 and began an extensive whole building historic restoration.

The project demonstrates a very successful renovation in terms of actual energy use compared to older buildings. The actual energy use of the occupied portion is currently 32 kBtu/sf/yr, 66% better than the average U.S. office building. A cost-benefit analysis was used to determine the economic impact of green building practices in terms of design, documentation, material salvage and construction. The owner/architect developed a methodology matrix to evaluate the sometimes contradictory requirements for federal and local incentives - LEED certification and preservation standards - focusing on the most cost-effective strategies for energy, water and material use.

The total cost excluding the theater was $2,600,000, which came down to $105/sf after factoring in incentives. This included $366,571 for construction costs from the National Park Service, since the building is on the historic register, as well as $71,079 provided by the local utility for a HVAC efficiency incentive program.

The LEED modeling analysis estimated an annual cost savings of $23,370 when the building is fully occupied, a reduction of more than 50% compared to the national average of buildings of same type, size, occupancy, and climate zone.

The Christman Building

Author Organization: New Buildings Institute
www.newbuildings.org/wp-content/uploads/2015/11/Case_Study_Christman1.pdf

PROJECT DETAILS	
Location	Lansing, MI
Building Type	Medium Office
Size (sf)	64,190 ft² (5 Stories)
Project Completion	2008
Year Built	1928 (Historic Building)
Total Budget	$ 8,913,000 ($138/sf after incentives)
Recognition	• Triple LEED Platinum - EBOM, C&S, CI

ENERGY EFFICIENCY MEASURES
High-efficiency HVAC units
Under-floor air distribution system
Increased insulation
Reflective roof
Insulated glazing
T-5 fluorescent lighting
Lighting program control panels
Occupancy sensors
Large windows for daylighting
BMS whole building controls
Commissioning
Computer network controls

The Christman Building in Lansing, Michigan, is the national headquarters for The Christman Company, a construction management and real estate development firm. Originally built in 1928 and registered as a historic landmark, the former Mutual Building had fallen into a state of disrepair under previous ownership. The Christman Company was inspired to renovate to: 1) represent the company's core values, people, energy, expertise, accomplishments and history, 2) encourage team collaboration internally, with branch offices and customers in both informal and formal settings, 3) create an environment that shares successes and energy and provides for mental and physical breaks, 4) maximize comfort with individual thermal and lighting controls, ergonomic workstations and daylighting, and 5) plan adaptively for growth, change and the space needs of short-term, on-site project personnel.

The project was financed with internally budgeted funds. Staff time required was incorporated into regular work schedules. The total project cost was $8,913,200, which was $138/sf after tax credits, included the Federal and State Historic Tax Credits and Property Tax Relief through establishment of a Federal Obsolete Property Rehabilitation Act (OPRA) District.

The Christman Building is one of the few Triple LEED Platinum buildings designated by the U.S. Green Building Council's (USGBC) Leadership in Energy and Environment (LEED) Program. The 2010 Performance Report indicated the energy use of this historic structure is 29% better than the average for offices in the U.S. This places the building in the top 20% of office buildings in the U.S. with an Energy Star score of 81/100. Implementation costs for the energy efficiency upgrades were $22,693, with a payback period of six months, and resulted in an estimated annual savings of $45,659.

THE JOSEPH VANCE BUILDING

Author Organization: New Buildings Institute

www.newbuildings.org/sites/default/files/Case_Study_Joseph-Vance.pdf

PROJECT DETAILS	
Location	Seattle, WA
Building Type	Office
Size (sf)	134,000
Project Completion	2007
Year Built	1929 (Historic Building)
Total Budget	$3,500,000
Recognitions	• LEED-EB Gold • AIA Regional Top 10 Awards • Energy Star

ENERGY EFFICIENCY MEASURES
Removed ducted heating systems
Recalibrated steam heating system
Localized thermostats
Operable windows
Automated sunshades
Lighting retrofit with automated controls
Light shelves
CO^2 sensors
Re-commissioning

In 2006, the Rose Smart Growth Investment Fund I, L.P., acquired the historic Joseph Vance Building in downtown Seattle with the purpose of transforming it into "the leading green and historic class B" building in the marketplace. The terra cotta Vance Building was constructed in 1929 and has 14 floors – 13 floors of offices over ground-floor retail, with a basement for mechanical equipment and storage.

The owner's goal is "upgrading the structure to be green, healthy, and attractive to current and future tenants who share a commitment to preservation, stewardship of the natural environment, and healthy indoor environments." The comprehensive renovation plan was developed to address both deferred maintenance items as well energy efficiency and aesthetic measures.

The owner considered a full range of retrofit strategies such as total glazing and HVAC replacement to address problems with original windows and an inefficient steam heating system; however, the design team soon recognized that substantial energy efficiency improvements could be made by thoughtfully optimizing the existing building features. The Vance Building now uses 58% less energy per square foot than the average for offices in the U.S. This places the building in the top 2% of office buildings nationally, with a score of 98/100.

The process of pursuing LEED EB forced the team to consider the most cost-effective and practical solutions for required retrofit measures. Additionally, the owner professionalized leasing and management practices, including green cleaning and integrated pest management, and created a green tenant improvement and operations manual to guide tenant behavior and tenant improvement work.

LOVE JOY BUILDING

Author Organization: New Buildings Institute
www.newbuildings.org/wp-content/uploads/2015/11/Case_Study_Lovejoy1.pdf

PROJECT DETAILS	
Location	Portland, OR
Building Type	Office
Owner	Lovejoy Building LLC
Size (sf)	20,000
Project Completion	2004
Year Built	1910 (Historic Building)
Total Budget	$2,300,000
Recognitions	• LEED-NC Gold • Energy Star

ENERGY EFFICIENCY MEASURES
High thermal-mass envelope
In-floor radiant slab with hydronic heating and cooling
Night cool air purge
Low-E glazing
Automated sunshades
Skylights
Dimmable ballasts with integrated daylight controls
Demand control ventilation with CO^2 sensors
Open office with light surfaces
Energy management control system
Plu load management
Commissioning

The Lovejoy building was originally built in 1910 as the stables for the Marshall-Wells Hardware Company and is now the home of Opsis, an architectural design firm practicing sustainable design. Opsis wanted to use the building to experience and demonstrate the technologies and practices it promotes with clients. Creating an open, comfortable and resource-efficient office space was a priority; incorporating upgraded efficiency features was considered an integral part of the project budget. The owners designed their space to formulate a living laboratory to showcase and experience the various energy-efficient and sustainable design features they incorporated.

The construction was financed with a loan, in addition to receiving an Oregon Business Energy Tax Credit (BETC), but Opsis felt they were not as aggressive as they could have been in pursuing additional tax credits. They decided against registering the building as a historic landmark, thus giving up the associated tax credits, in order to retain the flexibility to enlarge the exterior windows and add sunshades. Opsis also chose not to go beyond LEED-NC Gold due to cost.

The building's actual energy use is 40 kBtu/sf/yr, 57% better than the average for office buildings in the U.S. This places the building in the top 10% of office buildings nationally, with an Energy Star score of 92/100. The building also qualified for the U.S. Green Building Council's LEED Gold in 2006. 80% of employees surveyed "strongly agreed" that working in a building that uses less energy and fewer resources was important to them, and the balance (20%) "agreed" that it was important.

SEC E EDUCATIONAL CASE STUDIES

ATLANTIC COUNTY UTILITIES AUTHORITY

Organization type: Utilities Authority
Resource Link: www.acua.com
Audience: All
Education programs: Tours, Community Events, Competitions, Festivals, Career Programs

The ACUA is an interesting example of how a utility authority has integrated environmental education into all of its interactions with the public. From educating the public about their sustainability efforts during tours, to holding an earth day festival with educational booths, classes and activities, the ACUA shows this it is possible to include elements of sustainability in everything that an organization does.

SAN BERNANDINO VALLEY COLLEGE

Organization type: University
Resource Link: sbccd.org
Audience: Adults
Education programs: Signage in Sustainable Building

Signage throughout the building to explain their double pane windows, new ventilation system, lighting and even about the orientation of the building would be helpful in throughout the classrooms and entrance. Can also be utilized for other aspects of the building, such as the animals or upcoming events.

QUEENS BOTANICAL GARDEN

Organization type: City-owned garden
Resource Link: www.queensbotanical.org/103498/sustainable/interactive_flash
Audience: Visitors, primarily younger students
Education programs: Tours, Display touch screens, children

The interactive touch display is located in the lobby of their visitor center and showcases environmental benefits, solar generation, geothermal generation, weather, carbon footprint saved, and emissions avoided. It also compares to the botanical garden's old data to show improvement. To make these metrics approachable other displays give comparative metrics of the number of light bulbs saved. Teatown could leverage a system like this and include a screen that allows visitors to select the type of home they live in and what their savings would be if they installed all LEDs or a solar PV, etc. Most displays use Lucid dashboard, which also provides funding when applicable.

ZERO ENERGY PROJECT

Organization type: Nonprofit Educational Organization
Resource Link: zeroenergyproject.org/renovate
Audience: Homeowners, home builders, renovators, etc
Education programs: Online educational resource

The Zero Energy project could be a valuable resource for Teatown to use in creating an educational program around educating homeowners about completing their own retrofit for energy efficiency. They include extensive resources for homeowners and contractors, which can be leveraged to educate Teatown's visitors.

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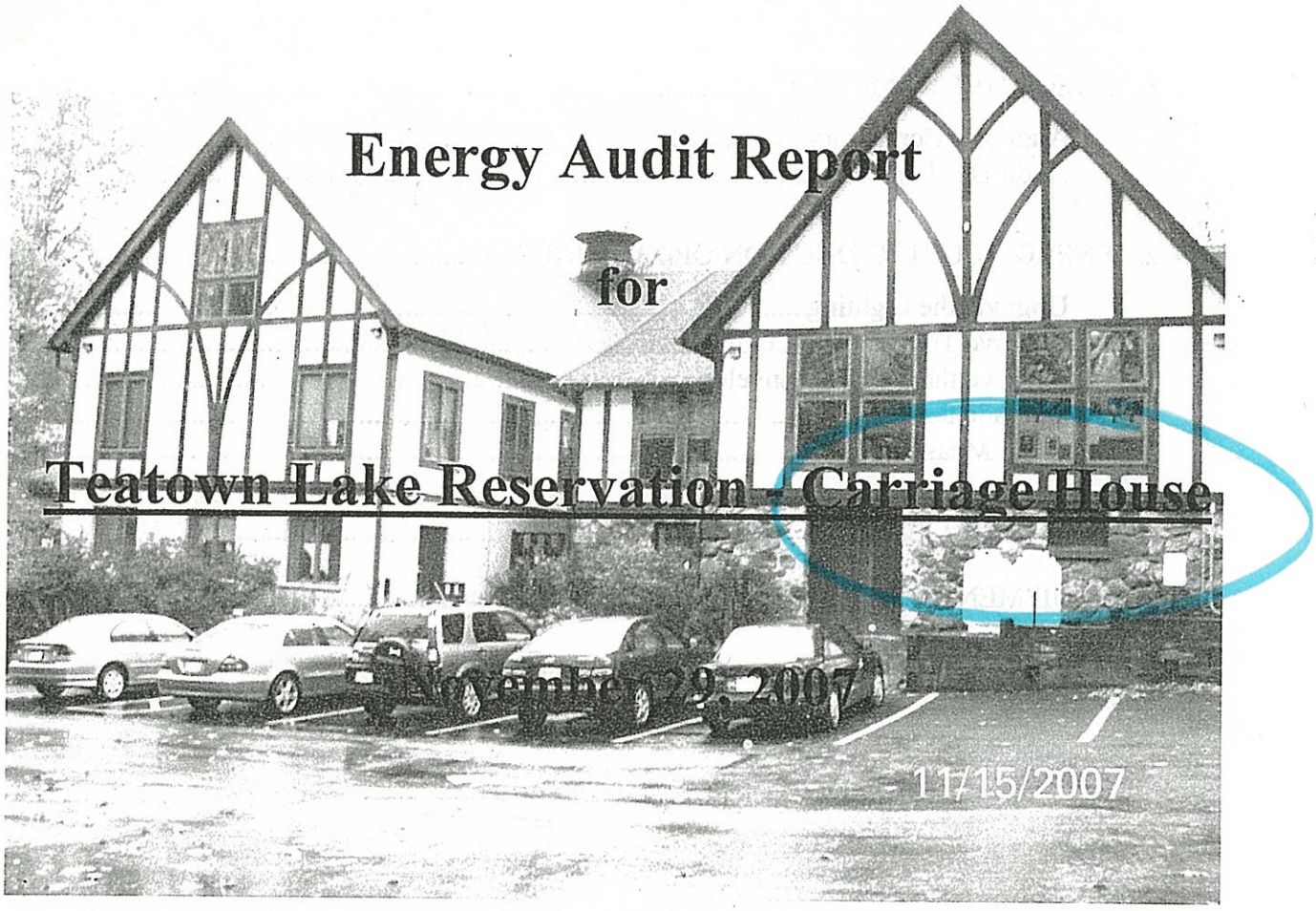
New York Energy $mart℠
PUBLIC SERVICE COMMISSION — NYSERDA

New York Energy $mart℠
Energy Audit Program

Energy Audit Report

for

Teatown Lake Reservation - Carriage House



Any questions regarding this energy report may be directed to The Daylight Savings Company at 1-800-337-2192.

New York State Energy Research and Development Authority
17 Columbia Circle • Albany, NY 12203-6399
voice 1-866-NYSERDA • fax (518) 862-1091
www.nyserda.org

NYSERDA

Table of Contents

1 Executive Summary

This report presents the findings of an energy survey conducted on November 15, 2007 by Yigit Guctas for:

Teatown Lake Reservation - Carriage House
1600 Spring Valley Road
Carriage House
Ossining, NY 10562
(914) 762-2912

Facility contact person: Dianne Barren
CONED account number(s): 58-8493-3440-0000-2

New York State Energy Research and Development Authority (NYSERDA) conducts energy surveys to promote NYSERDA's mission, which is to use innovation and technology to solve some of New York's most difficult energy and environmental problems in ways that improve the State's economy. This can be achieved through the wiser and more efficient use of energy.

The annual energy costs at this facility are as follows:

Fuel Oil	$2,601
Electricity	$1,730
Propane	$1,516
Total	$5,846

The potential annual energy cost savings are shown below in Table 1-1.

Table 1-1
Energy Cost Reduction Opportunities (ECRO's)

Description	Cost	Annual Savings	Payback (years)	% of Annual Energy Cost
Upgrade the Lighting	$975	$510	1.9	8.7%
Improve Temperature Control	$110	$570	0.2	9.8%
Improve the Building Envelope	$3,640	$242	15.0	4.1%
Upgrade the HVAC	$10,000	$435	23.0	7.4%
Other Measures	$750	$131	5.7	2.2%
Totals	**$15,475**	**$1,888**	**8.2**	**32.3%**

1 Executive Summary

An estimated cashflow analysis is shown below in Table 1-2. This analysis is based on the information found in Table 1-1.

Table 1-2
Estimated Cashflow Analysis

Year	Savings	Payment	Net	Cumulative
1	$1,888	($3,495)	($1,607)	($1,607)
2	$1,916	($3,495)	($1,579)	($3,186)
3	$1,945	($3,495)	($1,550)	($4,735)
4	$1,974	($3,495)	($1,521)	($6,256)
5	$2,004	($3,495)	($1,491)	($7,747)
Totals:	**$9,727**	**($17,475)**	**($7,747)**	

Assumptions: loan term of 5.0 years, principal of $15,475, average utility price increase of 1.5% annually, APR of 9.5% discounted 4.5% through NYSERDA's Loan Fund Program to 5.0%.

The estimated demand and energy savings are shown below in Table 1-3. The information in this table corresponds to the recommendations in Table 1-1.

Table 1-3
Estimated Energy Savings

Recommendation	Total kW Reduction	Total Annual kWh Reduction	Total Annual Gallons of Oil Reduced
Upgrade the Lighting	0.5	2,544	
Improve Temperature Control			244
Improve the Building Envelope			103
Upgrade the HVAC			186
Other Measures	0.4	655	
Totals	**0.9**	**3,199**	**533**

1 Executive Summary

The remainder of the report is organized as follows: Section 2 explains the details of the Energy Cost Reduction Opportunities, Section 3 shows the historical energy usage and costs for this facility. Section 4 gives an equipment inventory and discusses the building characteristics (architectural, mechanical, electrical, etc.), and Section 5 is the methodology used to survey and analyze your facility.

Auditor's Comments

Your building is used for events and meetings. There is a residential portion, which is not included in this audit report. We allocated a certain use for propane due to apartment use and subtracted that from the total annual use to compensate for the apartment use difference. Your building has a Weil McLain cast iron hot water boiler, utilizing hot water distribution system to provide heat. Your main thermostat is a White Rodgers digital programmable unit. You do not have any cooling in the public areas. Your windows in the main room are all single pane.

Audit Disclaimer

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2 Energy Cost Reduction Opportunities

Upgrade the Lighting

Upgrade the Fluorescent Lighting

New fluorescent lamps and ballasts are available as direct replacements for your existing lamps and ballasts. A simple change from the old to the new can provide substantial savings. A typical drop-ceiling layin fixture with four, 4-foot lamps (34 Watt lamps) has a total wattage of about 164 Watts. By using the new lamps and ballasts the total wattage would be about 110 Watts, the light levels would increase by about 15%, and the light quality would increase by 35%.

The new lamps are called T8 lamps and they can fit right into the existing fixtures without any fixture modifications. The lamps are 1" in diameter instead of the 1.5" diameter of the existing T12 lamps. (The number after the "T" indicates the diameter in 8ths of an inch. Hence, T8=8/8 or 1", while T12=12/8 or 1.5".) The reduced surface area allows the use of more costly inside coatings (phosphors). The improved phosphors provide a greatly improved color rendering index (CRI). A T12 typically has a CRI of about 55. A typical T8 has a CRI of about 75.

The new ballasts are called "electronic ballasts" and they, too, can fit right into the existing fixtures without any fixture modifications. The existing ballasts add wattage to the lighting system due to its operating characteristics. An electronic ballast subtracts wattage from the lighting system due to its operating characteristics. In addition, a single electronic ballast can operate one, two, three, or four lamps in a fixture. The existing ballasts can only operate up to two lamps. The electronic ballasts could reduce the amount of ballasts in your facility by half. This can be taken advantage of with "tandem wiring" of ballasts. Instead of using one electronic ballast for every one fixture it is sometimes feasible to use one ballast for every two or more fixtures. The electrician wires a single ballast to operate the lamps in adjacent light fixtures which further reduces the amount of ballasts needed.

Although the T8 lamps and the electronic ballasts can fit into your existing fixtures, it is sometimes recommended to replace the fixtures. The reflective surfaces degrade over time and as they reach the end of their useful life it becomes more practical to install new fixtures, especially since modern fixture designs are much more efficient - meaning they are more effective at getting the light "out" of the fixture.

NOTE: fluorescent ballasts that are to be used in cold locations need to be specified as such. These "cold temperature" ballasts can be rated as low as zero degrees Fahrenheit.

2 Energy Cost Reduction Opportunities

Install Compact Fluorescent Lighting

Compact fluorescent lamps (CFL's) were created to be replacements for the standard incandescent lamps that are common to table lamps, spot lights, hi-hats, bathroom vanity lighting, etc. The light output of the CFL has been designed to look like the incandescent lamp. The color rendering index (CRI) of the CFL is much higher than standard fluorescent lighting, and therefore provides a much "truer" light. In some instances, this is still not the desired ambiance, but in most cases the significant energy savings and the "near incandescent" effect is welcomed.

The CFL buyer should spend some time shopping around, since the CFL is available in a myriad of shapes and sizes depending on the specific application. But for almost any application, there is a lamp that fits the need. Typical replacements are: a 13-Watt CFL for a 60-Watt incandescent lamp, an 18-Watt CFL for a 75-Watt incandescent lamp, and a 25-Watt CFL for a 100-Watt incandescent lamp.

The CFL is also available for a number of "brightness colors" that is indicated by the Kelvin rating. A 2700K CFL is the "warmest" color available and is closest in color to the incandescent lamp. Then there is a 3000K, a 3500K, and a 4100K. The 4100K would be the "brightest" or "coolest" output. It would be wise to see an example of each before making a purchase, and even to see a sample of the lamp you are buying since Kelvin ratings vary between manufacturers.

A CFL can be chosen to screw right into your existing fixtures, or to be hardwired into your existing fixtures, or a new CFL fixture could be purchased.

NOTE: fluorescent ballasts that are to be used in cold locations need to be specified as such. These "cold temperature" ballasts can be rated as low as zero degrees Fahrenheit.

Install LED Exit Signs

LED stands for light-emitting-diode. LED's are very small light sources that people most readily associate with electronic equipment. LED exit signs have been made in a variety of shapes and sizes and there are also retrofit kits that allow you to simply modify your existing exit signs to accommodate the LED technology. The benefits of LED are twofold. First, you are installing an exit sign that will last for 20-30 years without maintenance. This results in tremendous maintenance savings because the incandescent or fluorescent lamps that you are currently using need to be replaced at a rate of 1-5 times per year. Lamp costs ($2-$7 each) and labor costs ($8-$20 per lamp) add up rapidly. The second benefit of LED is that it only uses 2 Watts. In comparison, your existing sign uses 10-40 or even 60 Watts! It is highly recommended that you install samples of the products that you are interested in purchasing. This will confirm that they are compatible with your electrical system.

The following table lists the details of the lighting upgrade. Applicable areas and the recommended action are shown. The first column identifies the line number that corresponds to the detailed lighting inventory at the end of this report.

2 Energy Cost Reduction Opportunities

It is strongly suggested that you contact a qualified contractor prior to implementing any of the recommendations outlined in this report. Many items are not included in our costs, such as removal and disposal of the existing equipment, bringing the new equipment installation up to code, asbestos abatement, lighting ballast PCB and lamp mercury handling, etc. In addition, the costs shown in this section are the basic costs you would incur if you were to install the project on your own. If you decide to use a contractor, then you most likely will see costs about 20-30% higher, plus the miscellaneous costs mentioned previously.

Upgrade the Lighting - Details

Line # - Area	Action	Costs and Savings
1 - Basement - Room	For the existing 1 flexible rope fixture using 60-Watt, incandescent lamps, retrofit with 20-Watt compact fluorescent screw-in lamps. (New qty: 1)	Mat'l Cost: $22 Labor Cost: $5 Total Cost: $27 Savings: $2
3 - Main Room	For the existing 4 pendant-mounted fixtures, each using 100-Watt metal halide lamps, install new 1X4 strip fixtures with 2-T8 lamps and high-power electronic ballasts. (New qty: 4)	Mat'l Cost: $216 Labor Cost: $140 Total Cost: $356 Savings: $45
4 - Main Room	For the existing 2 exit sign fixtures, each using 2, 15-Watt incandescent lamps , install new LED exit signs. (New qty: 2)	Mat'l Cost: $120 Labor Cost: $70 Total Cost: $190 Savings: $93
5 - Main Room	For the existing 2 pendant-mounted fixtures, each using 65-Watt, incandescent "flood" lamps, retrofit with 23-Watt compact fluorescent screw-in lamps. (New qty: 2)	Mat'l Cost: $44 Labor Cost: $10 Total Cost: $54 Savings: $8
6 - Main Room	For the existing 1 wall-mounted fixture using 60-Watt, incandescent lamps, retrofit with 20-Watt compact fluorescent screw-in lamps. (New qty: 1)	Mat'l Cost: $22 Labor Cost: $5 Total Cost: $27 Savings: $2
7 - Main Room Storage	For the existing 1 surface-mounted fixture using 60-Watt, incandescent lamps, retrofit with 20-Watt compact fluorescent screw-in lamps. (New qty: 1)	Mat'l Cost: $22 Labor Cost: $5 Total Cost: $27 Savings: $2

2 Energy Cost Reduction Opportunities

Line # - Area	Action	Costs and Savings
8 - Main Room Bathroom	For the existing 1 round fixture using 60-Watt, incandescent lamps, retrofit with 20-Watt compact fluorescent screw-in lamps. (New qty: 1)	Mat'l Cost: $22 Labor Cost: $5 Total Cost: $27 Savings: $2
9 - Main Room Bathroom	For the existing 1 round fixture using 60-Watt, incandescent lamps, retrofit with 20-Watt compact fluorescent screw-in lamps. (New qty: 1)	Mat'l Cost: $22 Labor Cost: $5 Total Cost: $27 Savings: $2
10 - Exterior*	For the existing 3 wall-pack fixtures, each using 150-Watt, incandescent "flood" lamps, retrofit with 65-Watt compact fluorescent screw-in lamps. (New qty: 3)	Mat'l Cost: $90 Labor Cost: $15 Total Cost: $105 Savings: $177
11 - Exterior*	For the existing 3 Lantern fixtures, each using 75-Watt, incandescent lamps, retrofit with 23-Watt compact fluorescent screw-in lamps. (New qty: 3)	Mat'l Cost: $66 Labor Cost: $15 Total Cost: $81 Savings: $106
12 - Exterior*	For the existing 2 bollard fixtures, each using 75-Watt, incandescent lamps, retrofit with 23-Watt compact fluorescent screw-in lamps. (New qty: 2)	Mat'l Cost: $44 Labor Cost: $10 Total Cost: $54 Savings: $71

Total Fixtures	
Unaffected Qty:	2
Affected Qty:	21
Total Existing Qty:	23

Totals	
Labor Cost:	$285
Material Cost:	$690
Total:	$975
Total Savings:	$510
Payback:	1.9 years.

2 Energy Cost Reduction Opportunities

Improve Temperature Control

It is the intention of almost all facilities to keep the thermostat set at the most economical position while providing an appropriate climate for the occupants. However, due to thermostat problems, too many people with access to the thermostat, or faulty setback equipment, many control systems fall short of the optimum energy cost savings.

Install Lock Boxes over the Thermostats

Excessive tampering of the thermostats causes inefficient cycling of the heating and cooling equipment, ineffective modulation of the occupied room temperature, and inconsistent setback/setforward settings. To avoid these problems lock boxes should be installed over the thermostats. Special lock boxes for thermostats have holes in them to allow room air to enter the box, but they limit control of the thermostat to those people with keys. This can result in a significant amount of energy cost savings at a very low initial cost.

The following tables show the existing setpoints for each area of the facility and also the recommended or "proposed" setpoints (shown in the shaded rows). It should be noted that the temperature setpoints in the facility may have varied greatly over the past twelve months. The information shown below for the "existing conditions" is based on data collected at the site and is adjusted up or down depending upon the amount of energy used over the past twelve months.

Zone 1		Occupied Periods From	Occupied Periods To	Days/ Week	Heating Profile Occupied	Heating Profile Unocc	Cooling Profile Occupied	Cooling Profile Unocc
All Areas Except Apartments	*existing*	9:00 AM	5:00 PM	7	70	62		
	proposed	9:00 AM	5:00 PM	7	~~70~~ 68	55		

Zone 1 Summary - All Areas Except Apartments	
Annual Heating Cost Savings (oil):	$570
Number of Lock Boxes Required:	1
Total Materials:	$70
Total Labor:	$40
Total Installation Cost:	$110
Payback:	0.2 years

2 Energy Cost Reduction Opportunities

Improve the Building Envelope

The word "envelope" refers to the "shell" of the building: walls, roof, windows, and doors. To improve the envelope would mean upgrading or adding materials or equipment to enhance the insulation or to reduce the amount of unconditioned outside air that enters the building.

In some cases, envelope improvements require a significant investment. Although the money gets recovered through energy savings, the payback is typically not very attractive. However, other considerations would add a great deal of value to the improvements. For example, in the case of a drafty building, adding insulation or upgrading the windows would improve human comfort. Human comfort affects your bottom line because uncomfortable or unhappy occupants will have a higher absentee rate and/or will require additional time from maintenance personnel as they search for stopgap solutions to the problem. Another example would be an undersized heating system. Instead of installing a new heating system, the building envelope could be improved to the point where the existing heating system is sufficient. These and other considerations must be taken into account when analyzing envelope measures. However, this report takes into account energy savings, only.

Improve the Windows and Doors

Window and door improvements include: adding storm windows/storm doors, adding window tinting, adding awnings, adding horizontal blinds, installing "night curtains", replace/install weatherstripping, re-install the windows/doors (where they have been improperly installed), installing air conditioner covers, installing vestibule doors, and installing new windows/doors.

Windows and doors can be a terrible source of drafts or sun-glare which directly affect the comfort of the residents. This should be the number one reason to consider window/door improvements. Energy savings are substantial, but usually so is the cost. Decreases in complaints (and, therefore, the associated decrease in time and money spent to respond to the complaints) can be significant, but are not accounted for in this "energy" report.

When considering horizontal blinds and night curtains remember that all energy savings calculations assume that the blinds will be down and blocking the direct sun in the summer and down and keeping in the heat during the winter nights.

2 Energy Cost Reduction Opportunities

The window and/or door improvement details are shown in the table below.

Install New Windows:	
Area:	Main Room Windows and Glass Doors
Action:	Replace all single-pane windows and glass doors with new low-emittance argon filled double-pane thermal windows and doors.
Sq Ft:	104
Condition:	Loose
Material Cost:	$1,040
Labor Cost:	$2,600
Total Cost:	$3,640
Savings:	$242
Payback (years):	15.0

2 Energy Cost Reduction Opportunities

Upgrade the HVAC

HVAC stands for heating, ventilation, and air conditioning. All of this equipment requires periodic maintenance that includes equipment adjustments and part replacements. By replacing parts it is possible to keep most HVAC equipment operating well beyond its economic life. At some point, however, the efficiency of the old equipment must be compared to newer models that incorporate the latest designs and state-of-the-art technologies. Based on energy savings alone, an investment in new equipment is often cost effective. But the analysis must go further to include maintenance savings, as well. This report is an "energy" report and considers only the portion of savings due to energy-efficiency. The recommendations that follow are suggestions to improve the efficiency of the HVAC systems.

Install a New Heating System

Older heating systems fall prey to the idea that if you maintain it, it will last forever. New technologies and more energy-efficient designs allow the efficiency of newer models to greatly surpass what was available over a decade ago. Investigate the possibility of installing new heating equipment as prescribed in the table below.

Heating Equipment Description	Proposed Action	Total Cost	Cost Savings
Laundry Room - Weil McLain Cast Iron Boiler - No Label*: 1 unit(s) @ 100 MBH each.	Install New High Efficiency Hot Water Boiler in Compliance with Applicable NYSERDA Incentives.	$10,000	$435
Totals:		***$10,000***	***$435***

2 Energy Cost Reduction Opportunities

Other Measures

Replace the Old Refrigerators

This recommendation suggests that you consider replacing your older refrigerators in light of the fact that a newer model will use a fraction of the electricity. A modern, high-efficiency refrigerator will use only 35% of the electricity that would have been used by a similar model manufactured in 1973. When purchasing the new equipment, pay attention to the yellow-and-black Energy Cost labels and compare the yearly energy cost of competing brands and models of similar size with similar features. The following equipment applies: JennAir Refrigerator*. This recommendation will require about $750. Annual savings are estimated to be $131. This yields a payback of 5.7 years.

3 Historical Energy Usage and Costs

Table 3-2 and Figure 3-1 represents the electrical energy usage for the surveyed building from Nov-06 to Oct-07. CONED provides electricity to the facility under Rate EL2. This electric rate has a component for consumption that is measured in kilowatt-hours (kWh). It is measured by multiplying the wattage of the equipment times the hours that it operates. For example, a 1,000-Watt lamp operating for 5 hours would measure 5,000 Watt-hours. Since one kilowatt is equal to 1,000 Watts, the measured consumption would be 5 kWh.

Rates used in this report reflect the most current rate structure available. Table 3-1 shows the annualized rate structure:

Table 3-1
Rate Structure for Rate EL2

Description	Summer	Winter	Average
Energy Charge	$0.2005/kWh	$0.2005/kWh	$0.2005/kWh

Figure 3-2 is a pie chart reflecting the electrical end-uses and their contribution to the total electricity usage. Table 3-3 is the electrical end-use in data format.

Annual oil usage is estimated to be 1,112 gallons at an annual cost of $2,601. Average cost per gallon is $2.34. Oil is used exclusively for heating.

Annual Propane usage is 512 gallons at an annual cost of $1,516. Average cost per gallons is $2.96. Propane is used exclusively for domestic hot water and laundry.

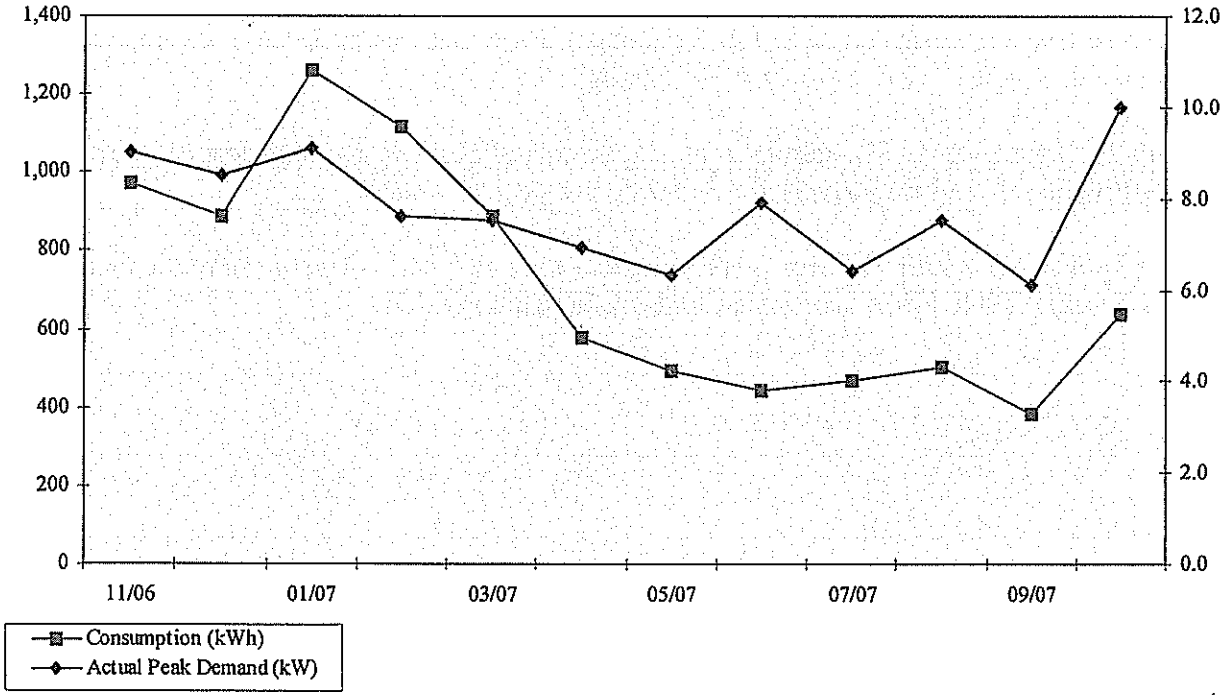
Figure 3-4 is a pie chart reflecting the propane end-uses and their contribution to the total propane usage. Table 3-5 is the propane end-use in data format.

3 Historical Energy Usage and Costs

Table 3-2
Electricity Billing Data

Month of Use	Days in Month	Consumption kWh	Peak Demand		Total Bill
			Actual	Billed	
11/06	34	972	9.0	9.0	$178
12/06	30	888	8.5	8.5	$164
01/07	32	1,260	9.1	9.1	$224
02/07	30	1,116	7.6	7.6	$210
03/07	29	888	7.5	7.5	$167
04/07	29	576	6.9	6.9	$119
05/07	32	492	6.3	6.3	$115
06/07	30	444	7.9	7.9	$106
07/07	29	468	6.4	6.4	$106
08/07	32	504	7.5	7.5	$118
09/07	30	384	6.1	6.1	$92
10/07	28	636	10.0	10.0	$132
Totals	***365***	***8,628***			***$1,730***

Figure 3-1
Electricity Usage Profile

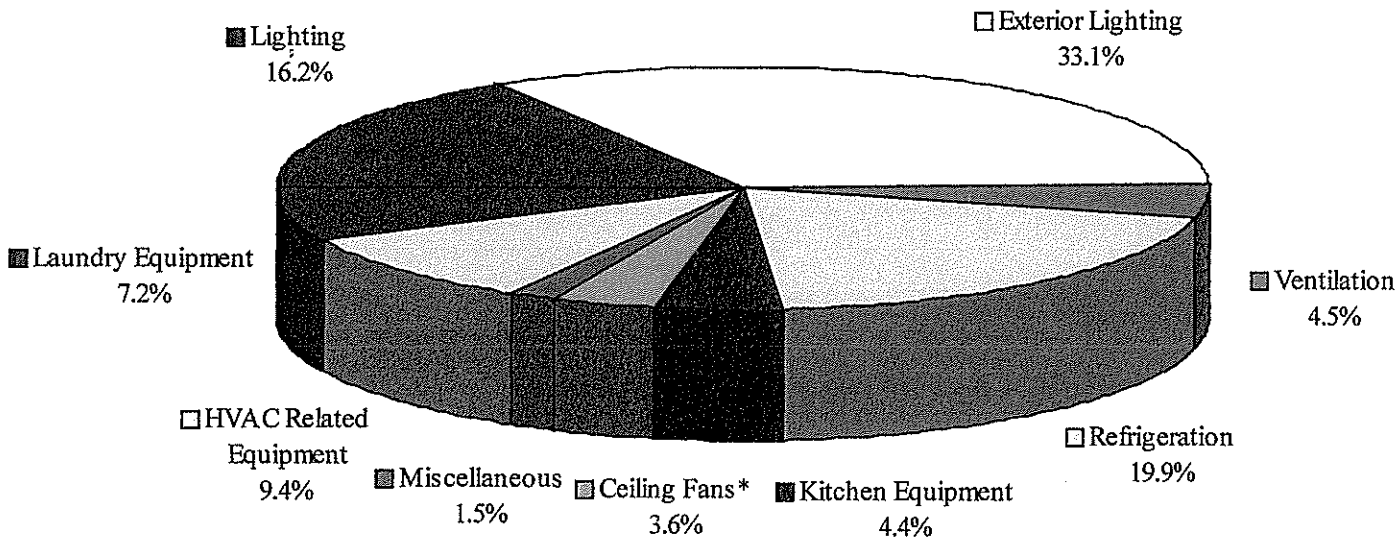


3 Historical Energy Usage and Costs

Table 3-3
Electricity End Use

End Use	Percent of Total
Lighting	16.2%
Exterior Lighting	33.1%
Ventilation	4.5%
Refrigeration	19.9%
Kitchen Equipment	4.4%
Ceiling Fans*	3.6%
Miscellaneous	1.5%
HVAC Related Equipment	9.4%
Laundry Equipment	7.2%
TOTAL	100.0%

Figure 3-2
Electricity End Use

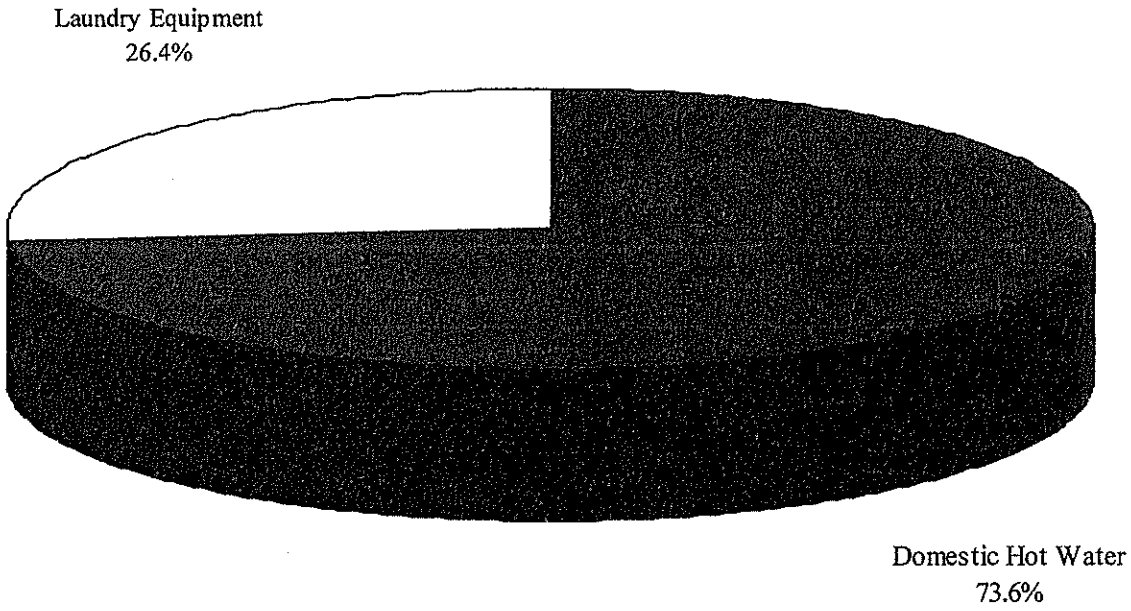


3 Historical Energy Usage and Costs

Table 3-5
Propane End Use

End Use	Percent of Total
Domestic Hot Water	73.6%
Laundry Equipment	26.4%
TOTAL	100.0%

Figure 3-4
Propane End Use



4 Equipment Inventory

Building Characteristics

Building Construction						
Description	**Age (yrs)**	**Wall Type**	**Wall Insulation**	**Roof Type**	**Roof Insulation**	**Window Type**
Entire Building	87	Stone/ Stucco/ Siding	None	Pitched	Unknown	Single Pane

Facility Name:	Teatown Lake Reservation - Carriage House
Total Square Footage:	2,000
Building Type:	Historical/ Meetings

Your building is approximately 87 years old. Your exterior walls are stone, stucco, and siding where applicable. Your public area windows are single pane. Your roof is pitched with unknown amount of attic insulation.

Equipment Inventory

Equipment denoted by an asterisk indicates an estimate of the equipment ratings due to equipment inaccessibility, worn nameplates, or a lack of nameplates. The Miscellaneous Equipment table ends with a column that shows that line's contribution to the total respective fuel bill (electricity, gas, oil, etc.)

Heating Equipment				
Description	**Qty**	**Capacity**	**Fuel**	**Age (yrs)**
Laundry Room - Weil McLain Cast Iron Boiler - No Label*	1	100 MBH	oil	25

Ventilation Equipment				
Description	**Qty**	**Capacity**	**Hrs/Wk Winter**	**Hrs/Wk Summer**
Magic Aire Fan Coil Unit (1993)*	1	0.5 HP	40	

Domestic Hot Water Systems			
Description	**Qty**	**Capacity**	**Fuel**
Maytag Performa Self Contained DHW Maker	1	55 MBH	other

4 Equipment Inventory

Miscellaneous Equipment						
Description	**Qty**	**Capacity**	**Fuel**	**Hrs/Wk Usage**	**% Fuel Usage**	**End-Use**
Miscellaneous Load	1	0.5 kW	elec	5	1.5%	Miscellaneous
Laundry Room - Boiler Beckett Burner*	1	0.125 HP	elec	40	2.3%	HVAC Related Equipment
Maytag Clothes Washer*	1	2 kW	elec	6	7.2%	Laundry Equipment
Maytag Clothes Dryer*	1	25 MBH	other	10	26.5%	Maytag Clothes Dryer*
Laundry Room - B&G HW Supply Pumps*	5	0.08 HP	elec	40	7.2%	HVAC Related Equipment
Ceiling Fans*	3	0.2 kW	elec	10	3.6%	Ceiling Fans*
Electric Stove*	1	1.5 kW	elec	1	0.5%	Kitchen Equipment
Dishwasher*	1	1 kW	elec	1	0.6%	Kitchen Equipment
JennAir Refrigerator*	1	0.7 kW	elec	30	12.7%	Refrigeration
Water Cooler*	1	0.4 kW	elec	30	7.2%	Refrigeration
Microwave*	1	1.2 kW	elec	1	0.4%	Kitchen Equipment
Coffee Machine*	1	1 kW	elec	5	3.0%	Kitchen Equipment

The second to the last column of the Miscellaneous Equipment Table shows the percentage of the total fuel usage (electricity, natural gas, or fuel oil) which corresponds with the pie charts on the previous pages. The "Hrs/Wk Usage" column values include the equipment load factor and duty cycling (i.e. an air compressor running at 80% capacity and cycling on 30% of the time during a 60 hour week would have an "Hrs/Wk Usage" value of 60*0.08*0.30 = 14 Hrs/Wk).

Lighting Equipment			
Line #	**Area**	**Description**	**Hrs/Wk Usage**
1	Basement - Room	1 flexible rope fixture using 60-Watt, incandescent lamps.	5
2	Basement - Laundry Room	2 surface-mounted fixtures, each using 23-Watt, compact fluorescent, screw-in lamps .	20
3	Main Room	4 pendant-mounted fixtures, each using 100-Watt metal halide lamps.	30
4	Main Room	2 exit sign fixtures, each using 2, 15-Watt incandescent lamps	168

4 Equipment Inventory

Lighting Equipment			
Line #	**Area**	**Description**	**Hrs/Wk Usage**
5	Main Room	2 pendant-mounted fixtures, each using 65-Watt, incandescent "flood" lamps.	10
6	Main Room	1 wall-mounted fixture using 60-Watt, incandescent lamps.	5
7	Main Room Storage	1 surface-mounted fixture using 60-Watt, incandescent lamps.	5
8	Main Room Bathroom	1 round fixture using 60-Watt, incandescent lamps.	5
9	Main Room Bathroom	1 round fixture using 60-Watt, incandescent lamps.	5
10	Exterior*	3 wall-pack fixtures, each using 150-Watt, incandescent "flood" lamps.	70
11	Exterior*	3 Lantern fixtures, each using 75-Watt, incandescent lamps.	70
12	Exterior*	2 bollard fixtures, each using 75-Watt, incandescent lamps.	70

5 Methodology

The first step in the energy analysis is the site survey. The auditor walks your entire site to inventory the building envelope (roof, windows, etc.), the heating, ventilation, and air conditioning equipment (HVAC), the lighting equipment, other facility-specific equipment, and to gain an understanding of how each facility is used.

The collected data is then processed with a software package from The Daylight Savings Company in Goshen, NY (1-800-337-2192) that calculates the anticipated energy usage. The actual energy usage is entered directly from your utility bills. The anticipated energy usage is compared to the actual usage. If necessary, corrections are made to the site-collected data until the anticipated energy usage matches the actual usage. This process develops an end-use baseline for all of the fuels used at the facility. The baseline is used to calculate the energy savings for the measures that are recommended in this report.

The savings in this report are not duplicative. The savings for each recommendation may actually be higher if the individual recommendations were installed instead of the entire project. For example, the lighting module calculates the change in wattage and multiplies it by the new operating hours instead of the existing operating hours (if there was a change in the hours at all). The lighting controls module calculates the change in hours and multiplies it by the new system wattage instead of the existing wattage. Therefore, if you chose to install the recommended lighting system but not the lighting controls, the savings achieved with the new lighting system would actually be higher because there would have been no reduction in the hours of use.

The same principal follows for heating, cooling, and temperature recommendations - even with fuel switching. If there are recommendations to change the temperature settings to reduce fuel use, then the savings for the heating/cooling equipment recommendations are reduced, as well.

Our thermal module calculates the savings for temperature reductions using ASHRAE's modified bin method. The savings are calculated in "output" values –meaning energy, not fuel savings. To show fuel savings we multiply the energy values times the fuel conversion factor (these factors are different for electricity, natural gas, fuel oil, etc.) and also take into account the heating/cooling equipment efficiency. The temperature recommendation savings are lower when the heating/cooling equipment is more efficient or is using a cheaper fuel. Also, you may see natural gas savings in this report even if you do not currently have natural gas. This happens when fuel switching was recommended for your heating/cooling equipment and you have temperature reduction recommendations, as well.

Thermal recommendations (insulation, windows, pipe insulation etc.) are evaluated by taking the difference in the thermal load due to reduced heat transfer. Again, the "thermal load" is the thermal load after the other recommendations have been accounted for.
Lastly, installation costs are then applied to each recommendation and simple paybacks are calculated. Costs are derived from Means Cost Data, other industry publications, and local contractors and suppliers.

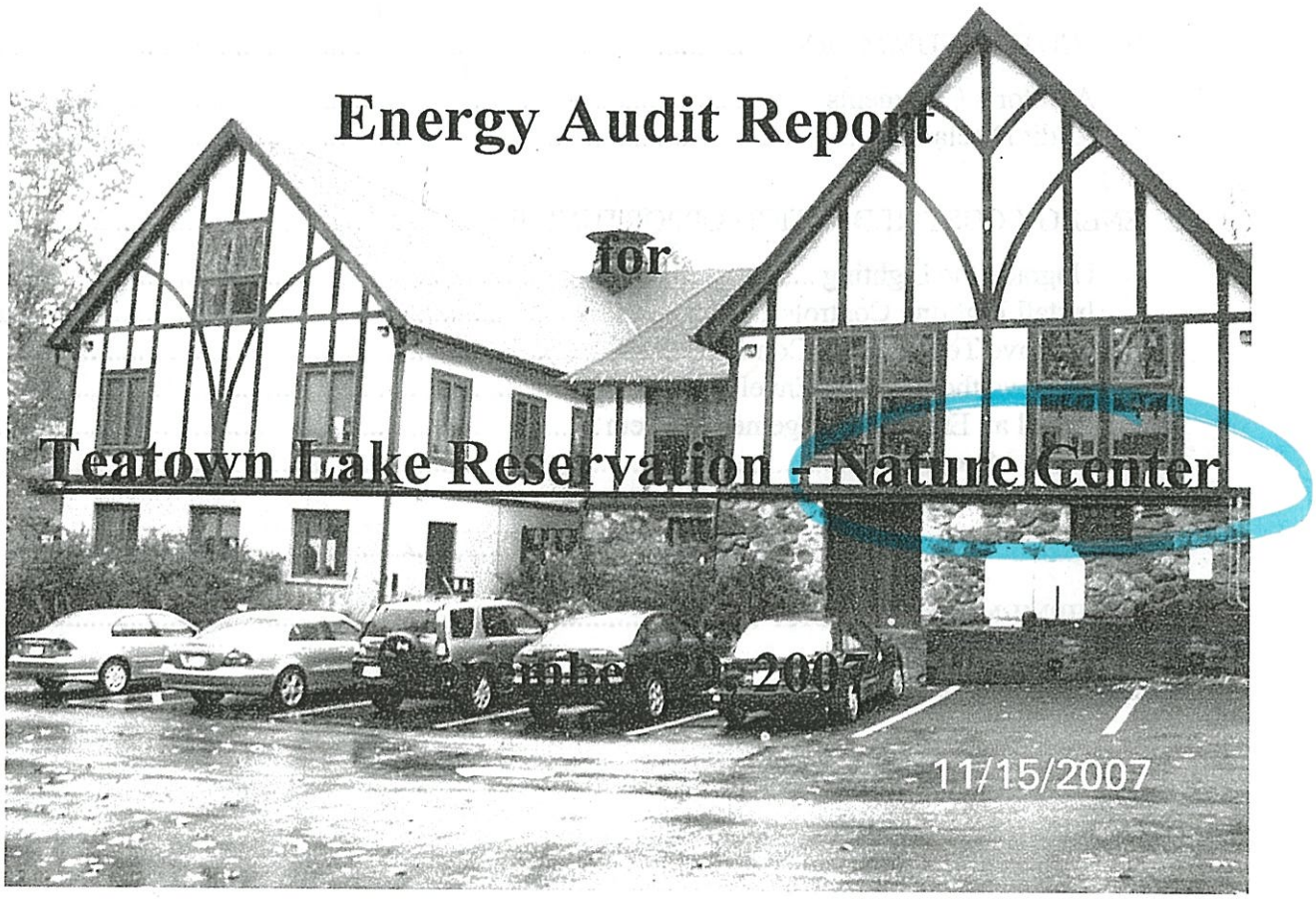
New York Energy $mart℠
PUBLIC SERVICE COMMISSION — NYSERDA

New York Energy $mart℠
Energy Audit Program

Energy Audit Report

for

Teatown Lake Reservation - Nature Center



Any questions regarding this energy report may be directed to The Daylight Savings Company at 1-800-337-2192.

New York State Energy Research and Development Authority
17 Columbia Circle • Albany, NY 12203-6399
voice 1-866-NYSERDA • fax (518) 862-1091
www.nyserda.org

NYSERDA

Table of Contents

1 Executive Summary

This report presents the findings of an energy survey conducted on November 15, 2007 by Yigit Guctas for:

Teatown Lake Reservation - Nature Center
1600 Spring Valley Road
Nature Center
Ossining, NY 10562
(914) 762-2912

Facility contact person: Dianne Barren
CONED account number(s): 58-8493-3425-0000-3

New York State Energy Research and Development Authority (NYSERDA) conducts energy surveys to promote NYSERDA's mission, which is to use innovation and technology to solve some of New York's most difficult energy and environmental problems in ways that improve the State's economy. This can be achieved through the wiser and more efficient use of energy.

The annual energy costs at this facility are as follows:

Fuel Oil	$9,410
Electricity	$12,099
Total	$21,508

The potential annual energy cost savings are shown below in Table 1-1.

Table 1-1
Energy Cost Reduction Opportunities (ECRO's)

Description	Cost	Annual Savings	Payback (years)	% of Annual Energy Cost
Upgrade the Lighting	$4,107	$1,478	2.8	6.9%
Install Lighting Controls	$300	$63	4.8	0.3%
Improve the Building Envelope	$2,625	$181	14.5	0.8%
Install an Energy Management System	$11,325	$1,187	9.5	5.5%
Other Measures	$750	$142	5.3	0.7%
Totals	**$19,107**	**$3,051**	**6.3**	**14.2%**

1 Executive Summary

An estimated cashflow analysis is shown below in Table 1-2. This analysis is based on the information found in Table 1-1.

Table 1-2
Estimated Cashflow Analysis

Year	Savings	Payment	Net	Cumulative
1	$3,051	($4,315)	($1,264)	($1,264)
2	$3,097	($4,315)	($1,218)	($2,483)
3	$3,143	($4,315)	($1,172)	($3,655)
4	$3,190	($4,315)	($1,125)	($4,780)
5	$3,238	($4,315)	($1,077)	($5,857)
Totals:	**$15,720**	**($21,576)**	**($5,857)**	

Assumptions: loan term of 5.0 years, principal of $19,107, average utility price increase of 1.5% annually, APR of 9.5% discounted 4.5% through NYSERDA's Loan Fund Program to 5.0%.

The estimated demand and energy savings are shown below in Table 1-3. The information in this table corresponds to the recommendations in Table 1-1.

Table 1-3
Estimated Energy Savings

Recommendation	Total kW Reduction	Total Annual kWh Reduction	Total Annual Gallons of Oil Reduced
Upgrade the Lighting	1.4	10,421	
Install Lighting Controls		602	
Improve Temperature Control		368	491
Improve the Building Envelope			77
Other Measures	0.5	1,248	
Totals	**1.9**	**12,640**	**568**

1 Executive Summary

The remainder of the report is organized as follows: Section 2 explains the details of the Energy Cost Reduction Opportunities, Section 3 shows the historical energy usage and costs for this facility. Section 4 gives an equipment inventory and discusses the building characteristics (architectural, mechanical, electrical, etc.), and Section 5 is the methodology used to survey and analyze your facility.

Auditor's Comments

An oil fired Crane 80 Series 80W-600-2 cast iron hot water boiler with 521MBH water rating heats your building. A Beckett burner with no information plate fires your boiler. A Bock 50-gallon indirect heater provides your domestic hot water. There are a total of 8 hot water heating supply pumps. Your main floor area is not cooled. A central A/C unit located in your attic cools your office areas.

Audit Disclaimer

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2 Energy Cost Reduction Opportunities

Upgrade the Lighting

Upgrade the Fluorescent Lighting

New fluorescent lamps and ballasts are available as direct replacements for your existing lamps and ballasts. A simple change from the old to the new can provide substantial savings. A typical drop-ceiling layin fixture with four, 4-foot lamps (34 Watt lamps) has a total wattage of about 164 Watts. By using the new lamps and ballasts the total wattage would be about 110 Watts, the light levels would increase by about 15%, and the light quality would increase by 35%.

The new lamps are called T8 lamps and they can fit right into the existing fixtures without any fixture modifications. The lamps are 1" in diameter instead of the 1.5" diameter of the existing T12 lamps. (The number after the "T" indicates the diameter in 8ths of an inch. Hence, T8=8/8 or 1", while T12=12/8 or 1.5".) The reduced surface area allows the use of more costly inside coatings (phosphors). The improved phosphors provide a greatly improved color rendering index (CRI). A T12 typically has a CRI of about 55. A typical T8 has a CRI of about 75.

The new ballasts are called "electronic ballasts" and they, too, can fit right into the existing fixtures without any fixture modifications. The existing ballasts add wattage to the lighting system due to its operating characteristics. An electronic ballast subtracts wattage from the lighting system due to its operating characteristics. In addition, a single electronic ballast can operate one, two, three, or four lamps in a fixture. The existing ballasts can only operate up to two lamps. The electronic ballasts could reduce the amount of ballasts in your facility by half. This can be taken advantage of with "tandem wiring" of ballasts. Instead of using one electronic ballast for every one fixture it is sometimes feasible to use one ballast for every two or more fixtures. The electrician wires a single ballast to operate the lamps in adjacent light fixtures which further reduces the amount of ballasts needed.

Although the T8 lamps and the electronic ballasts can fit into your existing fixtures, it is sometimes recommended to replace the fixtures. The reflective surfaces degrade over time and as they reach the end of their useful life it becomes more practical to install new fixtures, especially since modern fixture designs are much more efficient - meaning they are more effective at getting the light "out" of the fixture.

NOTE: fluorescent ballasts that are to be used in cold locations need to be specified as such. These "cold temperature" ballasts can be rated as low as zero degrees Fahrenheit.

2 Energy Cost Reduction Opportunities

Install Compact Fluorescent Lighting

Compact fluorescent lamps (CFL's) were created to be replacements for the standard incandescent lamps that are common to table lamps, spot lights, hi-hats, bathroom vanity lighting, etc. The light output of the CFL has been designed to look like the incandescent lamp. The color rendering index (CRI) of the CFL is much higher than standard fluorescent lighting, and therefore provides a much "truer" light. In some instances, this is still not the desired ambiance, but in most cases the significant energy savings and the "near incandescent" effect is welcomed.

The CFL buyer should spend some time shopping around, since the CFL is available in a myriad of shapes and sizes depending on the specific application. But for almost any application, there is a lamp that fits the need. Typical replacements are: a 13-Watt CFL for a 60-Watt incandescent lamp, an 18-Watt CFL for a 75-Watt incandescent lamp, and a 25-Watt CFL for a 100-Watt incandescent lamp.

The CFL is also available for a number of "brightness colors" that is indicated by the Kelvin rating. A 2700K CFL is the "warmest" color available and is closest in color to the incandescent lamp. Then there is a 3000K, a 3500K, and a 4100K. The 4100K would be the "brightest" or "coolest" output. It would be wise to see an example of each before making a purchase, and even to see a sample of the lamp you are buying since Kelvin ratings vary between manufacturers.

A CFL can be chosen to screw right into your existing fixtures, or to be hardwired into your existing fixtures, or a new CFL fixture could be purchased.

NOTE: fluorescent ballasts that are to be used in cold locations need to be specified as such. These "cold temperature" ballasts can be rated as low as zero degrees Fahrenheit.

Install LED Exit Signs

LED stands for light-emitting-diode. LED's are very small light sources that people most readily associate with electronic equipment. LED exit signs have been made in a variety of shapes and sizes and there are also retrofit kits that allow you to simply modify your existing exit signs to accommodate the LED technology. The benefits of LED are twofold. First, you are installing an exit sign that will last for 20-30 years without maintenance. This results in tremendous maintenance savings because the incandescent or fluorescent lamps that you are currently using need to be replaced at a rate of 1-5 times per year. Lamp costs ($2-$7 each) and labor costs ($8-$20 per lamp) add up rapidly. The second benefit of LED is that it only uses 2 Watts. In comparison, your existing sign uses 10-40 or even 60 Watts! It is highly recommended that you install samples of the products that you are interested in purchasing. This will confirm that they are compatible with your electrical system.

The following table lists the details of the lighting upgrade. Applicable areas and the recommended action are shown. The first column identifies the line number that corresponds to the detailed lighting inventory at the end of this report.

2 Energy Cost Reduction Opportunities

It is strongly suggested that you contact a qualified contractor prior to implementing any of the recommendations outlined in this report. Many items are not included in our costs, such as removal and disposal of the existing equipment, bringing the new equipment installation up to code, asbestos abatement, lighting ballast PCB and lamp mercury handling, etc. In addition, the costs shown in this section are the basic costs you would incur if you were to install the project on your own. If you decide to use a contractor, then you most likely will see costs about 20-30% higher, plus the miscellaneous costs mentioned previously.

Upgrade the Lighting - Details

Line # - Area	Action	Costs and Savings
1 - Main Lobby	For the existing 1 exit sign fixture using 2, 15-Watt incandescent lamps , install new LED exit signs. (New qty: 1)	Mat'l Cost: $57 Labor Cost: $33 Total Cost: $90 Savings: $32
2 - Main Lobby	For the existing 13 pendant-mounted fixtures, each using 100-Watt metal halide lamps, install new 1X4 strip fixtures with 2-T8 lamps and high-power electronic ballasts. (New qty: 13)	Mat'l Cost: $667 Labor Cost: $432 Total Cost: $1,099 Savings: $245
3 - Main Lobby Aquarium*	For the existing 2 Indirect fixtures, each using 1,4' energy-efficient lamp and ballasts, retrofit with T8 lamps and electronic ballasts.	Mat'l Cost: $52 Labor Cost: $48 Total Cost: $100 Savings: $11
6 - Moose Room	For the existing 6 pendant-mounted fixtures, each using 100-Watt metal halide lamps, install new 1X4 strip fixtures with 2-T8 lamps and high-power electronic ballasts. (New qty: 6)	Mat'l Cost: $308 Labor Cost: $200 Total Cost: $507 Savings: $113
7 - Moose Room	For the existing 1 exit sign fixture using 2, 15-Watt incandescent lamps , install new LED exit signs. (New qty: 1)	Mat'l Cost: $57 Labor Cost: $33 Total Cost: $90 Savings: $32
8 - Library	For the existing 2 pendant-mounted fixtures, each using 100-Watt metal halide lamps, install new 1X4 strip fixtures with 2-T8 lamps and high-power electronic ballasts. (New qty: 2)	Mat'l Cost: $103 Labor Cost: $67 Total Cost: $169 Savings: $28

2 Energy Cost Reduction Opportunities

Line # - Area	Action	Costs and Savings
10 - Janitor's Closet	For the existing 1 surface-mounted fixture using 60-Watt, incandescent lamps, retrofit with 20-Watt compact fluorescent screw-in lamps. (New qty: 1)	Mat'l Cost: $21 Labor Cost: $5 Total Cost: $26 Savings: $12
13 - Loft	For the existing 4 pendant-mounted fixtures, each using 100-Watt metal halide lamps, install new 1X4 strip fixtures with 2-T8 lamps and high-power electronic ballasts. (New qty: 4)	Mat'l Cost: $205 Labor Cost: $133 Total Cost: $338 Savings: $48
15 - Large Storage	For the existing 1 surface-mounted fixture using 60-Watt, incandescent lamps, retrofit with 20-Watt compact fluorescent screw-in lamps. (New qty: 1)	Mat'l Cost: $21 Labor Cost: $5 Total Cost: $26 Savings: $13
17 - Office Hallway	For the existing 1 exit sign fixture using 2, 15-Watt incandescent lamps , install new LED exit signs. (New qty: 1)	Mat'l Cost: $57 Labor Cost: $33 Total Cost: $90 Savings: $32
18 - Office Hallway	For the existing 1 recessed lensed 2X2 fixture using 2, 4' "U" energy-efficient lamps and ballasts, retrofit with T8 lamps and electronic ballasts.	Mat'l Cost: $41 Labor Cost: $24 Total Cost: $65 Savings: $6
28 - Mike's Office	For the existing 2 surface-mounted lensed 1X4 fixtures, each using 2,4' energy-efficient lamps and ballasts, retrofit with T8 lamps and electronic ballasts.	Mat'l Cost: $57 Labor Cost: $48 Total Cost: $104 Savings: $12
36 - Basement	For the existing 2 surface-mounted lensed 1X4 fixtures, each using 2,4' energy-efficient lamps and ballasts, retrofit with T8 lamps and electronic ballasts.	Mat'l Cost: $57 Labor Cost: $48 Total Cost: $104 Savings: $12
39 - Basement Boiler Room	For the existing 1 surface-mounted fixture using 60-Watt, incandescent lamps, retrofit with 20-Watt compact fluorescent screw-in lamps. (New qty: 1)	Mat'l Cost: $21 Labor Cost: $5 Total Cost: $26 Savings: $13
40 - Basement Retreat Room	For the existing 2 pendant-mounted open industrial 1X4 fixtures, each using 2,4' energy-efficient lamps and ballasts, retrofit with T8 lamps and electronic ballasts.	Mat'l Cost: $57 Labor Cost: $48 Total Cost: $104 Savings: $12

2 Energy Cost Reduction Opportunities

Line # - Area	Action	Costs and Savings
41 - Cellar	For the existing 2 surface-mounted fixtures, each using 60-Watt, incandescent lamps, retrofit with 20-Watt compact fluorescent screw-in lamps. (New qty: 2)	Mat'l Cost: $42 Labor Cost: $10 Total Cost: $51 Savings: $23
43 - Finished Basement - Hallway	For the existing 2 recessed lensed 2X2 fixtures, each using 2, 4' "U" energy-efficient lamps and ballasts, retrofit with T8 lamps and electronic ballasts.	Mat'l Cost: $82 Labor Cost: $48 Total Cost: $129 Savings: $12
46 - Finished Basement - Lower Classroom	For the existing 3 exit sign fixtures, each using 2, 15-Watt incandescent lamps , install new LED exit signs. (New qty: 3)	Mat'l Cost: $171 Labor Cost: $100 Total Cost: $271 Savings: $95
47 - Exterior*	For the existing 10 wall-pack fixtures, each using 150-Watt, incandescent "flood" lamps, retrofit with 65-Watt compact fluorescent screw-in lamps. (New qty: 10)	Mat'l Cost: $285 Labor Cost: $48 Total Cost: $333 Savings: $397
48 - Exterior*	For the existing 8 bollard fixtures, each using 75-Watt, incandescent lamps, retrofit with 26-Watt compact fluorescent screw-in lamps. (New qty: 8)	Mat'l Cost: $167 Labor Cost: $38 Total Cost: $205 Savings: $176
49 - Exterior*	For the existing 6 Lantern fixtures, each using 75-Watt, incandescent lamps, retrofit with 26-Watt compact fluorescent screw-in lamps. (New qty: 6)	Mat'l Cost: $125 Labor Cost: $29 Total Cost: $154 Savings: $132
51 - Exterior*	For the existing 1 pendant-mounted fixture using 75-Watt, incandescent lamps, retrofit with 26-Watt compact fluorescent screw-in lamps. (New qty: 1)	Mat'l Cost: $21 Labor Cost: $5 Total Cost: $26 Savings: $22

Total Fixtures	
Unaffected Qty:	93
Affected Qty:	72
Total Existing Qty:	165

Totals	
Labor Cost:	$1,440
Material Cost:	$2,674
Total:	$4,107
Total Savings:	$1,478
Payback:	2.8 years.

2 Energy Cost Reduction Opportunities

Install Lighting Controls

Install Lighting Controls to Reduce the Lighting Use

In some areas the lighting is left on unnecessarily. Many times this is due to the idea that it is better to keep the lights on rather than to continuously switch them on and off. The on/off dilemma was studied and it was found that the best option is to turn the lights off whenever possible. Although this does reduce the lamp life, the energy savings far outweigh the lamp replacement costs. The cutoff for when to turn the lights off is around two minutes. If the lights can be off for only a two minute interval, then it pays to shut them off.

Lighting controls come in many forms. Sometimes an additional switch is all it would take. In some cases a wind-up timer is what is required. Another type is the timeclock which allows the user to set an on/off schedule. Timeclocks can be a dial clock with on/off indicators on it, or a timeclock can be a small box the size of a thermostat where the user programs the on/off schedule in a digital format like setting the alarm on a wristwatch. Occupancy sensors detect motion and will switch the lights on when the room is occupied. They can either be mounted in place of the current wall switch, or they can be mounted on the ceiling to cover large areas. Lastly, photocells are a lighting control that sense light levels and will turn the lights off when there is adequate daylight. These are mostly used outside, but they are becoming much more popular in energy-efficient office designs as well.

Details of the lighting controls recommendation are shown in the following table.

Line #	Location	Exist. Hrs.	New Hrs.	Type of Control to Install	Qty	Mat'l Cost	Labor Cost	Total Cost	Annual Savings
9	Kitchen	40	20	Wall Occupancy Sensor	1	$50	$25	$75	$13
11	Men's Room	40	10	Wall Occupancy Sensor	1	$50	$25	$75	$19
12	Ladies Room	40	10	Wall Occupancy Sensor	1	$50	$25	$75	$19
14	Large Storage ?	40	10	Wall Occupancy Sensor	1	$50	$25	$75	$9
15	Large Storage ?	40	10						$3
Totals:					**4**	**$200**	**$100**	**$300**	**$63**
Payback: 4.8 years.									

2 Energy Cost Reduction Opportunities

Improve Temperature Control

It is the intention of almost all facilities to keep the thermostat set at the most economical position while providing an appropriate climate for the occupants. However, due to thermostat problems, too many people with access to the thermostat, or faulty setback equipment, many control systems fall short of the optimum energy cost savings.

The following tables show the existing setpoints for each area of the facility and also the recommended or "proposed" setpoints (shown in the shaded rows). It should be noted that the temperature setpoints in the facility may have varied greatly over the past twelve months. The information shown below for the "existing conditions" is based on data collected at the site and is adjusted up or down depending upon the amount of energy used over the past twelve months.

Zone 1		Occupied Periods From	Occupied Periods To	Days/ Week	Heating Profile Occupied	Heating Profile Unocc	Cooling Profile Occupied	Cooling Profile Unocc
Entire Building	*existing*	9:00 AM	5:00 PM	7	70	65		
	proposed	9:00 AM	5:00 PM	7	70	62		

Zone 1 Summary - Entire Building	
Annual Heating Cost Savings (oil):	$1,148
Payback:	Immediately.

Zone 2		Occupied Periods From	Occupied Periods To	Days/ Week	Heating Profile Occupied	Heating Profile Unocc	Cooling Profile Occupied	Cooling Profile Unocc
Offices	*existing*	9:00 AM	5:00 PM	7	70	65	78	82
	proposed	9:00 AM	5:00 PM	7	70	62	78	

Zone 2 Summary - Offices	
Annual Cooling Cost Savings:	$39
Payback:	Immediately.

Totals for All Zones

Total savings:	$1,187
Payback (yrs):	Immediately.

*The cost and savings shown above are included with the recommendation for "Install an Energy Management System". For this reason, this recommendation does not appear in the Executive Summary.

2 Energy Cost Reduction Opportunities

Improve the Building Envelope

The word "envelope" refers to the "shell" of the building: walls, roof, windows, and doors. To improve the envelope would mean upgrading or adding materials or equipment to enhance the insulation or to reduce the amount of unconditioned outside air that enters the building.

In some cases, envelope improvements require a significant investment. Although the money gets recovered through energy savings, the payback is typically not very attractive. However, other considerations would add a great deal of value to the improvements. For example, in the case of a drafty building, adding insulation or upgrading the windows would improve human comfort. Human comfort affects your bottom line because uncomfortable or unhappy occupants will have a higher absentee rate and/or will require additional time from maintenance personnel as they search for stopgap solutions to the problem. Another example would be an undersized heating system. Instead of installing a new heating system, the building envelope could be improved to the point where the existing heating system is sufficient. These and other considerations must be taken into account when analyzing envelope measures. However, this report takes into account energy savings, only.

Improve the Windows and Doors

Window and door improvements include: adding storm windows/storm doors, adding window tinting, adding awnings, adding horizontal blinds, installing "night curtains", replace/install weatherstripping, re-install the windows/doors (where they have been improperly installed), installing air conditioner covers, installing vestibule doors, and installing new windows/doors.

Windows and doors can be a terrible source of drafts or sun-glare which directly affect the comfort of the residents. This should be the number one reason to consider window/door improvements. Energy savings are substantial, but usually so is the cost. Decreases in complaints (and, therefore, the associated decrease in time and money spent to respond to the complaints) can be significant, but are not accounted for in this "energy" report.

When considering horizontal blinds and night curtains remember that all energy savings calculations assume that the blinds will be down and blocking the direct sun in the summer and down and keeping in the heat during the winter nights.

2 Energy Cost Reduction Opportunities

The window and/or door improvement details are shown in the table below.

Install New Windows:	
Area:	Discovery Room
Action:	Replace all single-pane windows with low-emittance argon filled double-pane thermal windows.
Sq Ft:	75
Condition:	Loose
Material Cost:	$750
Labor Cost:	$1,875
Total Cost:	$2,625
Savings:	$181
Payback (years):	14.5

2 Energy Cost Reduction Opportunities

Install an Energy Management System

The term "energy management system" (EMS) describes equipment as simple as a 24-hour timeclock and as complicated as a high-speed computer monitoring building systems via the Internet. This report considers an EMS to be a wall-mounted panel or a desktop PC that monitors and controls facility equipment. It should have remote access so that the settings and readings can be accessed off-site by qualified technicians.

The most common use of an EMS is to control your heating, ventilation, and air conditioning (HVAC). It can also be used to control lighting and plug circuits (i.e. electrical outlets). The EMS can monitor occupancy, temperature, humidity, air flow, air toxin concentrations for indoor air quality issues, run time, peak demand, electricity consumption, static pressure, pump flow, water temperatures, etc. In responding to the input data the EMS reduces energy and maintenance costs by starting/stopping equipment, opening/closing valves and dampers, etc.

An EMS can also be used to reduce your Peak Demand. High demand takes place when a lot of equipment operates at the same time. The only way to reduce the demand is to limit the simultaneous operation of equipment. For example, if you have two 10 HP motors then they would each contribute about 7.5 kW to your peak demand. Therefore, you could reduce your demand by 7.5 kW by not running them simultaneously. In most instances this is a very difficult task because your equipment needs to run for you to be making a profit. However, sometimes there is a process, an air conditioning unit, an electric water heater, or some other electrical device that can wait until some of the other equipment is idle before it is cycled on. The EMS can monitor the ongoing demand and alert you to a rise in demand or a high demand situation. The alert can be a flashing light, a bell, a pager, a network message, etc. In addition the EMS can begin cycling off equipment in a predetermined priority (e.g. the coffee maker, the water cooler, the refrigerator, electric hot water heaters, non-essential lighting and other non-essential equipment, cycling of the air conditioners, etc.) until you can make equipment operation adjustments necessary to limit the demand (e.g. re-schedule certain low-priority equipment, etc.). This device will require a lot of pre-thinking and a lot of attention to its alarms once it is installed. However, significant savings can be achieved.

NOTE: The following table includes savings that may be shown elsewhere in this report for lighting control, temperature control and fan control. However, they are only accounted for once in the executive summary of this report.

	Material Cost	Labor Cost	Total Cost	Annual Savings
Install an Energy Management System	$5,025	$6,300	$11,325	$1,187
Payback: 9.5 years. ***Number of Points Used for this Analysis: 15.***				

2 Energy Cost Reduction Opportunities

Other Measures

Replace the Old Refrigerators

This recommendation suggests that you consider replacing your older refrigerators in light of the fact that a newer model will use a fraction of the electricity. A modern, high-efficiency refrigerator will use only 35% of the electricity that would have been used by a similar model manufactured in 1973. When purchasing the new equipment, pay attention to the yellow-and-black Energy Cost labels and compare the yearly energy cost of competing brands and models of similar size with similar features. The following equipment applies: Basement Classroom Refrigerator*. This recommendation will require about $750. Annual savings are estimated to be $142. This yields a payback of 5.3 years.

3 Historical Energy Usage and Costs

Table 3-2 and Figure 3-1 represents the electrical energy usage for the surveyed building from Nov-06 to Oct-07. CONED provides electricity to the facility under Rate EL9. This electric rate has a component for consumption that is measured in kilowatt-hours (kWh). It is measured by multiplying the wattage of the equipment times the hours that it operates. For example, a 1,000-Watt lamp operating for 5 hours would measure 5,000 Watt-hours. Since one kilowatt is equal to 1,000 Watts, the measured consumption would be 5 kWh. This rate has another component for Peak Demand that is measured in kilowatts (kW). Following the example above, if your facility had nothing else in it except for the 1,000-Watt lamp, then your monthly Peak Demand would be 1.0 kW. Your meter averages your demand constantly over 15 or 30-minute intervals (depending upon the utility and the specific rate). At the end of the month you are charged for the highest "average" and this is called your Peak Demand. Based on these definitions of consumption and Peak Demand it can be shown that keeping equipment off whenever it is not in use will reduce your consumption, while not operating equipment simultaneously will reduce your Peak Demand.

Rates used in this report reflect the most current rate structure available. Table 3-1 shows the annualized rate structure:

Table 3-1
Rate Structure for Rate EL9

Description	Summer	Winter	Average
Demand Charge	$23.00/kW	$23.00/kW	$23.00/kW
Energy Charge	$0.1050/kWh	$0.1050/kWh	$0.1050/kWh

Figure 3-2 is a pie chart reflecting the electrical end-uses and their contribution to the total electricity usage. Table 3-3 is the electrical end-use in data format.

Annual oil usage is 4,023 gallons at an annual cost of $9,410. Average cost per gallon is $2.34. Oil is used exclusively for heating and domestic hot water production.

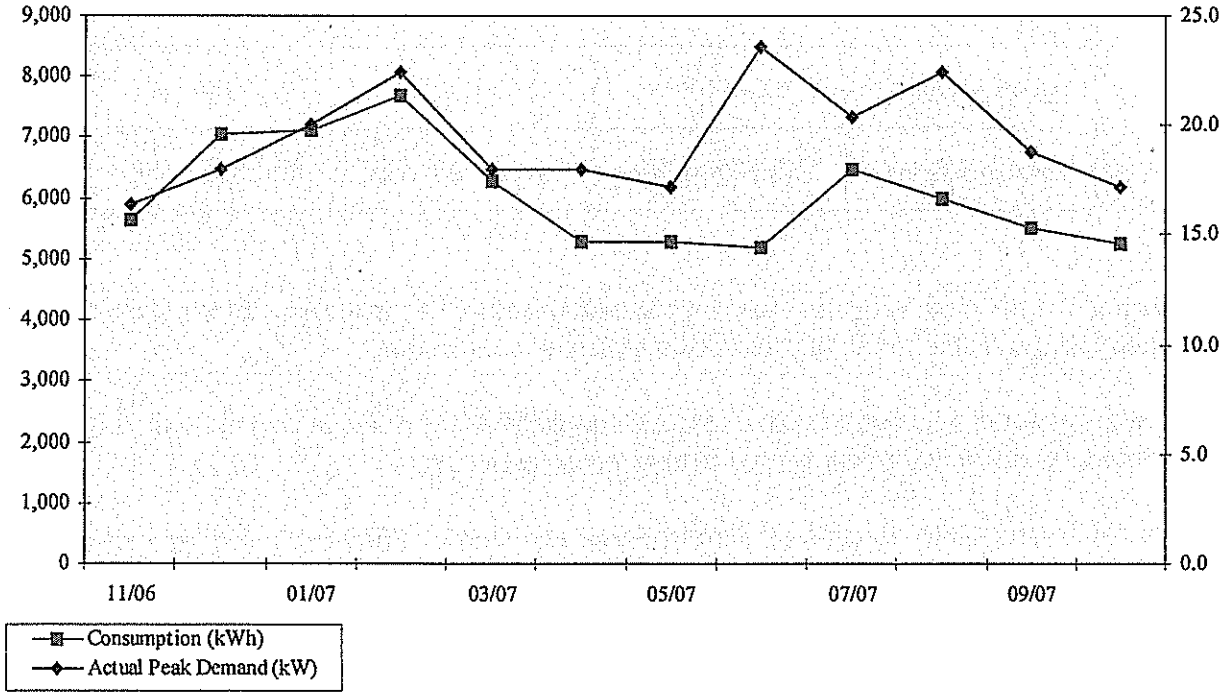
Figure 3-3 is a pie chart reflecting the oil end-uses and their contribution to the total oil usage. Table 3-4 is the oil end-use in data format.

3 Historical Energy Usage and Costs

Table 3-2
Electricity Billing Data

Month of Use	Days in Month	Consumption kWh	Peak Demand		Total Bill
			Actual	Billed	
11/06	34	5,640	16.4	16.4	$855
12/06	30	7,040	18.0	18.0	$1,023
01/07	32	7,120	20.0	20.0	$1,065
02/07	30	7,680	22.4	22.4	$1,195
03/07	29	6,280	18.0	18.0	$927
04/07	29	5,280	18.0	18.0	$864
05/07	32	5,280	17.2	17.2	$974
06/07	30	5,200	23.6	23.6	$1,083
07/07	29	6,480	20.4	20.4	$1,101
08/07	32	6,000	22.4	22.4	$1,171
09/07	30	5,520	18.8	18.8	$1,000
10/07	28	5,240	17.2	17.2	$842
Totals	***365***	***72,760***			***$12,099***

Figure 3-1
Electricity Usage Profile

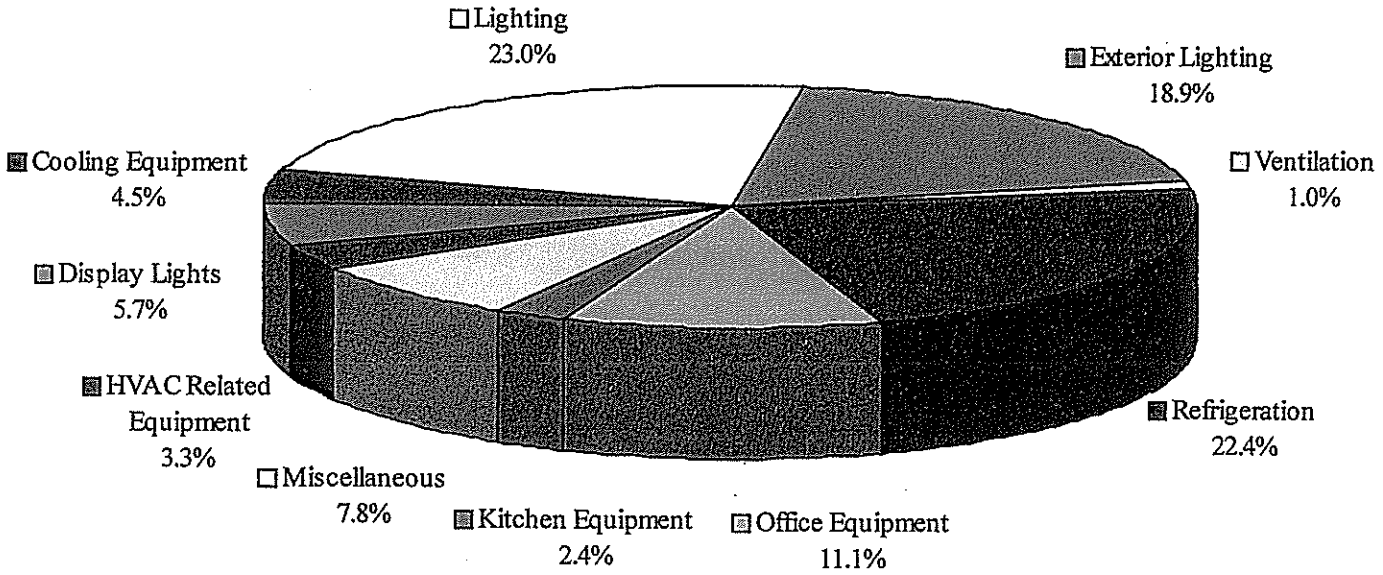


3 Historical Energy Usage and Costs

Table 3-3
Electricity End Use

End Use	Percent of Total
Cooling Equipment	4.5%
Lighting	23.0%
Exterior Lighting	18.9%
Ventilation	1.0%
Refrigeration	22.4%
Office Equipment	11.1%
Kitchen Equipment	2.4%
Miscellaneous	7.8%
HVAC Related Equipment	3.3%
Display Lights	5.7%
TOTAL	100.0%

Figure 3-2
Electricity End Use

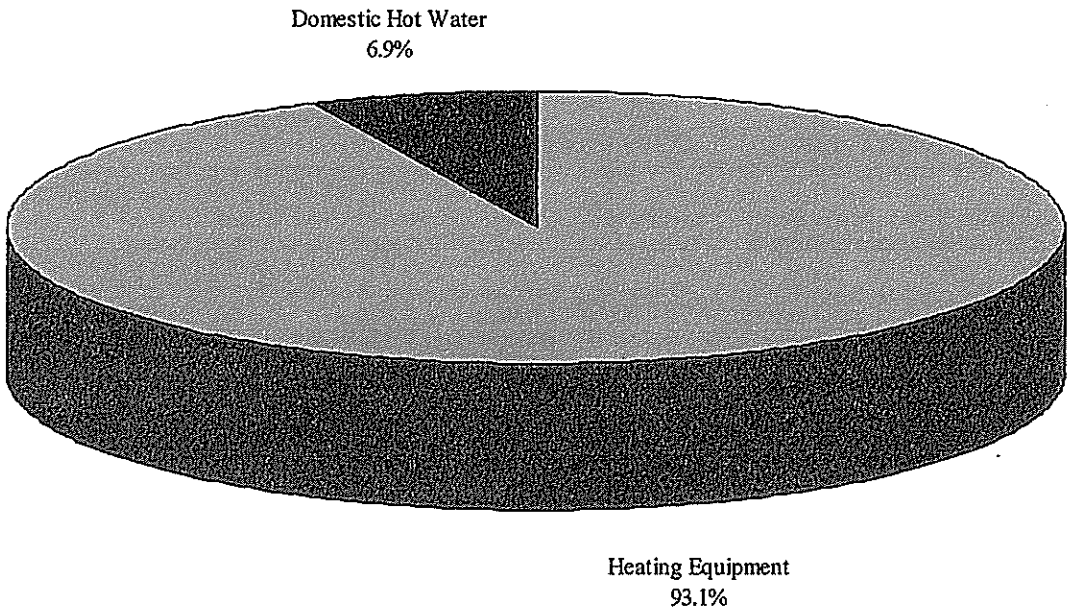


3 Historical Energy Usage and Costs

Table 3-4
Oil End Use

End Use	Percent of Total
Heating Equipment	93.1%
Domestic Hot Water	6.9%

Figure 3-3
Oil End Use



4 Equipment Inventory

Building Characteristics

Building Construction						
Description	**Age (yrs)**	**Wall Type**	**Wall Insulation**	**Roof Type**	**Roof Insulation**	**Window Type**
Entire Building	87	Stone/ Stucco/ Siding	None	Pitched	Unknown	Double Pane

Facility Name:	Teatown Lake Reservation - Nature Center
Total Square Footage:	11,000
Building Type:	Nature Center/ Museum

Your building is an old farm converted to a nature center. Your building is approximately 87 years old with stone, stucco, and siding on the exterior. Your windows are double pane. Your roof is pitched. Amount of attic insulation is unknown.

Equipment Inventory

Equipment denoted by an asterisk indicates an estimate of the equipment ratings due to equipment inaccessibility, worn nameplates, or a lack of nameplates. The Miscellaneous Equipment table ends with a column that shows that line's contribution to the total respective fuel bill (electricity, gas, oil, etc.)

Heating Equipment				
Description	**Qty**	**Capacity**	**Fuel**	**Age (yrs)**
Boiler Room - Crane 80 Series 80W-600-2 Cast Iron Hot Water Boiler	1	521 MBH	oil	15

Cooling Equipment			
Description	**Qty**	**Capacity**	**Age (years)**
Attic - Trane A/C Unit (2000)	1	4 Tons	7

Ventilation Equipment				
Description	**Qty**	**Capacity**	**Hrs/Wk Winter**	**Hrs/Wk Summer**
Attic - Trane A/C Unit (2000) Fan	1	0.75 HP		50

4 Equipment Inventory

Domestic Hot Water Systems			
Description	**Qty**	**Capacity**	**Fuel**
Bock Indirect 50-Gallon DHW Maker*	1	50 Gallons	oil

Miscellaneous Equipment						
Description	**Qty**	**Capacity**	**Fuel**	**Hrs/Wk Usage**	**% Fuel Usage**	**End-Use**
Miscellaneous Load	1	2 kW	elec	35	5.0%	Miscellaneous
Boiler Room - Beckett Burner*	1	0.25 HP	elec	50	0.7%	HVAC Related Equipment
Boiler Room - HW Supply Pumps*	8	0.125 HP	elec	50	2.7%	HVAC Related Equipment
Water Coolers*	3	0.6 kW	elec	45	5.8%	Refrigeration
PCs*	17	0.2 kW	elec	45	10.9%	Office Equipment
Printers*	2	0.3 kW	elec	1	0.0%	Office Equipment
Fax/Copy Combo*	2	0.3 kW	elec	1	0.0%	Office Equipment
Stamp Machines*	1	0.1 kW	elec	1	0.0%	Office Equipment
Main Lobby - Kenmore Wall A/C (Rarely Used)*	1	0.7 kW	elec	10	0.5%	Miscellaneous
Main Lobby - Small Glass Door Soda Refrigerator*	1	0.6 kW	elec	45	1.9%	Refrigeration
Hallway - Soda Vending Machine*	1	0.8 kW	elec	45	2.6%	Refrigeration
Moose Room - All Display Lights (Est)*	1	1 kW	elec	80	5.7%	Display Lights
Ceiling Fans*	8	0.2 kW	elec	20	2.3%	Miscellaneous
Copy Machines*	3	0.4 kW	elec	1	0.1%	Office Equipment
Kitchen - Dishwasher*	1	2 kW	elec	4	0.6%	Kitchen Equipment
Kitchen - Electric Stove*	1	2 kW	elec	12	1.7%	Kitchen Equipment
Kitchen - Hotpoint Refrigerator*	1	0.7 kW	elec	50	2.5%	Refrigeration
Kitchen - Microwave*	1	1.2 kW	elec	1	0.1%	Kitchen Equipment
Basement - Freezers*	3	0.8 kW	elec	40	6.9%	Refrigeration

4 Equipment Inventory

Miscellaneous Equipment						
Description	**Qty**	**Capacity**	**Fuel**	**Hrs/Wk Usage**	**% Fuel Usage**	**End-Use**
Basement Classroom Refrigerator*	1	0.8 kW	elec	50	2.9%	Refrigeration

The second to the last column of the Miscellaneous Equipment Table shows the percentage of the total fuel usage (electricity, natural gas, or fuel oil) which corresponds with the pie charts on the previous pages. The "Hrs/Wk Usage" column values include the equipment load factor and duty cycling (i.e. an air compressor running at 80% capacity and cycling on 30% of the time during a 60 hour week would have an "Hrs/Wk Usage" value of 60*0.08*0.30 = 14 Hrs/Wk).

Lighting Equipment			
Line #	**Area**	**Description**	**Hrs/Wk Usage**
1	Main Lobby	1 exit sign fixture using 2, 15-Watt incandescent lamps .	168
2	Main Lobby	13 pendant-mounted fixtures, each using 100-Watt metal halide lamps.	45
3	Main Lobby Aquarium*	2 Indirect fixtures, each using 1,4' energy-efficient lamp and ballasts.	45
4	Hallway	7 track lighting fixtures, each using 23-Watt, compact fluorescent, screw-in lamps .	45
5	Hallway	2 hi-hat fixtures, each using 2-lamp,13-Watt, compact fluorescent, hard-wired fixtures.	45
6	Moose Room	6 pendant-mounted fixtures, each using 100-Watt metal halide lamps.	45
7	Moose Room	1 exit sign fixture using 2, 15-Watt incandescent lamps .	168
8	Library	2 pendant-mounted fixtures, each using 100-Watt metal halide lamps.	20
9	Kitchen	2 surface-mounted lensed 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	40
10	Janitor's Closet	1 surface-mounted fixture using 60-Watt, incandescent lamps.	5
11	Men's Room	2 surface-mounted lensed 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	40
12	Ladies Room	2 surface-mounted lensed 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	40

4 Equipment Inventory

Lighting Equipment			
Line #	**Area**	**Description**	**Hrs/Wk Usage**
13	Loft	4 pendant-mounted fixtures, each using 100-Watt metal halide lamps.	10
14	Large Storage	1 surface-mounted lensed 1X4 fixture using 2, 4' T8 lamps and electronic ballasts.	40
15	Large Storage	1 surface-mounted fixture using 60-Watt, incandescent lamps.	40
16	Discovery Room	4 surface-mounted lensed 1X4 fixtures, each using 1,4' T8 lamp and electronic ballast's.	40
17	Office Hallway	1 exit sign fixture using 2, 15-Watt incandescent lamps .	168
18	Office Hallway	1 recessed lensed 2X2 fixture using 2, 4' "U" energy-efficient lamps and ballasts.	45
19	Office Hallway	4 recessed lensed 2X4 fixtures, each using 4, 4' T8 lamps and electronic ballasts.	45
20	Beth's Office	3 recessed paracube 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	45
21	Fred's Office	3 recessed paracube 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	45
22	Dianne D's Office	2 recessed paracube 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	45
23	Barbara's Office	2 recessed paracube 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	45
24	Ann's Office	2 recessed paracube 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	45
25	Phillis' Room	2 recessed paracube 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	45
26	Dianne B's Office	2 recessed paracube 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	45
27	Linsey's Office	2 recessed paracube 2X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	45
28	Mike's Office	2 surface-mounted lensed 1X4 fixtures, each using 2,4' energy-efficient lamps and ballasts.	45
29	Attic	15 surface-mounted lensed 1X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	10

4 Equipment Inventory

Lighting Equipment			
Line #	**Area**	**Description**	**Hrs/Wk Usage**
30	Attic	4 pendant-mounted fixtures, each using 100-Watt metal halide lamps.	10
31	Attic Storage	1 surface-mounted lensed 1X4 fixture using 2, 4' T8 lamps and electronic ballasts.	10
32	Attic Storage	1 surface-mounted lensed 1X4 fixture using 2, 4' T8 lamps and electronic ballasts.	10
33	Attic Storage	4 surface-mounted lensed 1X4 fixtures, each using 2, 4' T8 lamps and electronic ballasts.	10
34	Staircase to Basement	1 wall-pack fixture using 23-Watt, compact fluorescent, screw-in lamps .	40
35	Basement	6 surface-mounted fixtures, each using 23-Watt, compact fluorescent, screw-in lamps .	45
36	Basement	2 surface-mounted lensed 1X4 fixtures, each using 2,4' energy-efficient lamps and ballasts.	45
37	Basement Tool Room	1 wall-mounted fixture using 23-Watt, compact fluorescent, screw-in lamps .	45
38	Basement Boiler Room	5 surface-mounted fixtures, each using 23-Watt, compact fluorescent, screw-in lamps .	10
39	Basement Boiler Room	1 surface-mounted fixture using 60-Watt, incandescent lamps.	10
40	Basement Retreat Room	2 pendant-mounted open industrial 1X4 fixtures, each using 2,4' energy-efficient lamps and ballasts.	45
41	Cellar	2 surface-mounted fixtures, each using 60-Watt, incandescent lamps.	5
42	Cellar	1 surface-mounted fixture using 23-Watt, compact fluorescent, screw-in lamps .	5
43	Finished Basement - Hallway	2 recessed lensed 2X2 fixtures, each using 2, 4' "U" energy-efficient lamps and ballasts.	45
44	Finished Basement - Hallway - Bathroom	2 recessed lensed 2X4 fixtures, each using 4, 4' T8 lamps and electronic ballasts.	10
45	Finished Basement - Lower Classroom	6 surface-mounted lensed 1X4 fixtures, each using 4, 4' T8 lamps and electronic ballasts.	45
46	Finished Basement - Lower Classroom	3 exit sign fixtures, each using 2, 15-Watt incandescent lamps	168

4 Equipment Inventory

Lighting Equipment			
Line #	**Area**	**Description**	**Hrs/Wk Usage**
47	Exterior*	10 wall-pack fixtures, each using 150-Watt, incandescent "flood" lamps.	90
48	Exterior*	8 bollard fixtures, each using 75-Watt, incandescent lamps.	90
49	Exterior*	6 Lantern fixtures, each using 75-Watt, incandescent lamps.	90
50	Exterior*	4 wall-pack fixtures, each using 100-Watt metal halide lamps.	90
51	Exterior*	1 pendant-mounted fixture using 75-Watt, incandescent lamps.	90

5 Methodology

The first step in the energy analysis is the site survey. The auditor walks your entire site to inventory the building envelope (roof, windows, etc.), the heating, ventilation, and air conditioning equipment (HVAC), the lighting equipment, other facility-specific equipment, and to gain an understanding of how each facility is used.

The collected data is then processed with a software package from The Daylight Savings Company in Goshen, NY (1-800-337-2192) that calculates the anticipated energy usage. The actual energy usage is entered directly from your utility bills. The anticipated energy usage is compared to the actual usage. If necessary, corrections are made to the site-collected data until the anticipated energy usage matches the actual usage. This process develops an end-use baseline for all of the fuels used at the facility. The baseline is used to calculate the energy savings for the measures that are recommended in this report.

The savings in this report are not duplicative. The savings for each recommendation may actually be higher if the individual recommendations were installed instead of the entire project. For example, the lighting module calculates the change in wattage and multiplies it by the new operating hours instead of the existing operating hours (if there was a change in the hours at all). The lighting controls module calculates the change in hours and multiplies it by the new system wattage instead of the existing wattage. Therefore, if you chose to install the recommended lighting system but not the lighting controls, the savings achieved with the new lighting system would actually be higher because there would have been no reduction in the hours of use.

The same principal follows for heating, cooling, and temperature recommendations - even with fuel switching. If there are recommendations to change the temperature settings to reduce fuel use, then the savings for the heating/cooling equipment recommendations are reduced, as well.

Our thermal module calculates the savings for temperature reductions using ASHRAE's modified bin method. The savings are calculated in "output" values –meaning energy, not fuel savings. To show fuel savings we multiply the energy values times the fuel conversion factor (these factors are different for electricity, natural gas, fuel oil, etc.) and also take into account the heating/cooling equipment efficiency. The temperature recommendation savings are lower when the heating/cooling equipment is more efficient or is using a cheaper fuel. Also, you may see natural gas savings in this report even if you do not currently have natural gas. This happens when fuel switching was recommended for your heating/cooling equipment and you have temperature reduction recommendations, as well.

Thermal recommendations (insulation, windows, pipe insulation etc.) are evaluated by taking the difference in the thermal load due to reduced heat transfer. Again, the "thermal load" is the thermal load after the other recommendations have been accounted for.
Lastly, installation costs are then applied to each recommendation and simple paybacks are calculated. Costs are derived from Means Cost Data, other industry publications, and local contractors and suppliers.