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Local Government Energy Program
Energy Audit Report-FINAL

The Township of Millburn

Cora Hartshorn Arboretum
324 Forest Dr South
Millburn, NJ 07041

Project Number: LGEA58

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EXECUTIVE SUMMARY

The Cora Hartshorn Arboretum Building is a two-story (incl. a partial basement), 5210 square feet constructed in 1931 with additions/alterations completed in 2006. The following chart provides an overview of current energy usage in the building based on the analysis period of December 2008 through November 2009:

Table 1: State of Building—Energy Usage

	Electric Usage, kWh/yr	Gas Usage, therms/yr	Other fuel usage, gal/yr	Current Annual Cost of Energy, $	Site Energy Use Intensity, kBtu/sq ft yr	Joint Energy Consumption, MMBtu/yr
Current	28,512	3,286	N/A	8,799	82.0	426
Proposed	26,143	3,122	N/A	8,197	77.3	402
Savings	2,369	164	N/A	602	4.7	24
% Savings	8.3	5.0	N/A	6.8	5.7	5.7

There may be electricity procurement opportunities for the Cora Hartshorn Arboretum to reduce annual electricity costs, which are $627 higher when compared to the average estimated NJ commercial electricity rates.

SWA has also entered energy information about the Cora Hartshorn Arboretum in the U.S. Environmental Protection Agency's (EPA) *ENERGY STAR® Portfolio Manager* energy benchmarking system. This public assembly facility is comprised of "Other" space type. The building did not receive a performance rating due to it's categorization as "Other" space type. SWA recommends the Township of Millburn continue to insert utility billing information as the building may receive a rating as the (EPA) *ENERGY STAR® Portfolio Manager* database grows. The site energy use intensity is 82.0 kBtu/ft^2/yr when compared to the national average site energy use intensity of 104.0 kBtu/ft^2/yr.

Based on the current state of the building and its energy use, SWA recommends implementing various energy conservation measures from the savings detailed in Table 1. The measures are categorized by payback period in Table 2 below:

Table 2: Energy Conservation Measure Recommendations

ECMs	First Year Savings ($)	Simple Payback Period (years)	Initial Investment, $	CO2 Savings, lbs/yr
0-5 Year	474	2.1	1,012	3,998
5-10 Year	218	10.0	2,180	2,051
Total	692	4.6	3,192	6,049

(Please note that first year savings in the table above include both utility costs and maintenance costs savings).

SWA estimates that implementing the recommended ECMs is equivalent to avoiding the need of 10 trees to absorb the annual CO_2 generated.

Other recommendations to increase building efficiency pertaining to operations and maintenance and capital improvements are listed below:

Further Recommendations:

SWA recommends that the Township of Millburn further explore the following list for the Cora Hartshorn Arboretum building:

- Capital Improvements
  - Investigate and insulate original roof of the old historic section. SWA suggests applying spray-foam and/or rigid foam board insulation (R-30 min.) under and/or on top of the wood decking surface.
  - Replace all single-glazed windows with a historically and architecturally accurate low-E, double glazed type.

- Operations and Maintenance
  - Overgrown ground vegetation should be trimmed to not touch or block exterior wall surfaces
  - Inspect and maintain all roof surfaces on a regular basis.
  - Maintain weather-stripping around all exterior doors and roof hatches.
  - Maintain sealants and caulks at all windows for airtight performance.
  - Perform and maintain air-sealing
  - Provide water-efficient fixtures and controls
  - Replace appliances as needed with ENERGY STAR® labeled appliances
  - Perform preventative exterior wall maintenance
  - Maintain downspouts and cap flashing
  - Use smart power electric strips
  - Create an energy educational program

Financial Incentives and Other Program Opportunities

The recommended ECMs and the list above are cost-effective energy efficiency measures and building upgrades that will reduce operating expenses for the Township of Millburn. Based on the requirements of the LGEA program, Township of Millburn must commit to implementing some of these measures, and must submit paperwork to the Local Government Energy Audit program within one year of this report's approval to demonstrate that they have spent, net of other NJCEP incentives, at least 25% of the cost of the audit (per building). The minimum amount to be spent, net of other NJCEP incentives, is $652. The table below summarizes the recommended ECMs that Township of Millburn can undertake for achieving this purpose. It is important to note that the required 25% expenditure is per building and after the other implementation incentive amounts.

Table 3: Next Steps for the BUILDING

Recommended ECMs	Incentive Program (Please refer to Appendix F for details)
41 New CFL fixtures to be installed	NJ Smart Start

There are various incentive programs that the Township of Millburn could apply for that could help lower the cost of installing the ECMs. For the Cora Hartshorn Arboretum, and contingent upon available funding, SWA recommends the following incentive programs:

Smart Start: Majority of energy saving equipment and design measures have moderate incentives under this program; however, this is the best choice among the alternatives available.

Renewable Energy Incentive Program: Receive up to $0.8/Watt toward installation cost for PV panels upon available funding. For each 1,000 kWh generated by renewable energy, receive a credit between $475 and $600.

Please refer to Appendix F for further details.

INTRODUCTION

Launched in 2008, the Local Government Energy Audit (LGEA) Program provides subsidized energy audits for municipal and local government-owned facilities, including offices, courtrooms, town halls, police and fire stations, sanitation buildings, transportation structures, schools and community centers. The Program will subsidize up to 100% of the cost of the audit. The Board of Public Utilities (BPUs) Office of Clean Energy has assigned TRC Energy Services to administer the Program.

Steven Winter Associates, Inc. (SWA) is a 38-year-old architectural/engineering research and consulting firm, with specialized expertise in green technologies and procedures that improve the safety, performance, and cost effectiveness of buildings. SWA has a long-standing commitment to creating energy-efficient, cost-saving and resource-conserving buildings. As consultants on the built environment, SWA works closely with architects, developers, builders, and local, state, and federal agencies to develop and apply sustainable, 'whole building' strategies in a wide variety of building types: commercial, residential, educational and institutional.

SWA performed an energy audit and assessment for the Cora Hartshorn Arboretum building at 324 Forest Dr South, Millburn, NJ 07041. The process of the audit included facility visit on March 23, 2010, benchmarking and energy bills analysis, assessment of existing conditions, energy modeling, energy conservation measures and other recommendations for improvements. The scope of work includes providing a summary of current building conditions, current operating costs, potential savings, and investment costs to achieve these savings. The facility description includes energy usage, occupancy profiles and current building systems along with a detailed inventory of building energy systems, recommendations for improvement and recommendations for energy purchasing and procurement strategies.

The goal of this Local Government Energy Audit is to provide sufficient information to the Township of Millburn to make decisions regarding the implementation of the most appropriate and most cost-effective energy conservation measures for the Cora Hartshorn Arboretum.

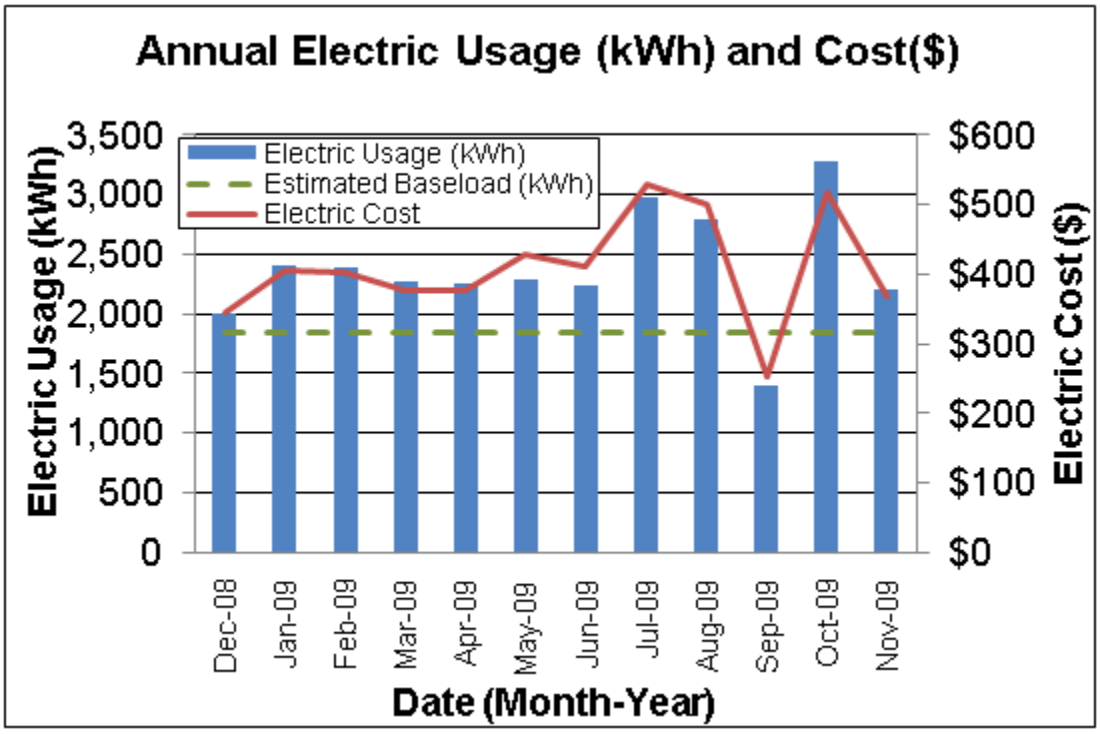
HISTORICAL ENERGY CONSUMPTION

Energy usage, load profile and cost analysis

SWA reviewed utility bills from December 2008 through November 2009 that were received from the utility companies supplying the Cora Hartshorn Arboretum building with electric and natural gas. A 12 month period of analysis from December 2008 through November 2009 was used for all calculations and for purposes of benchmarking the building.

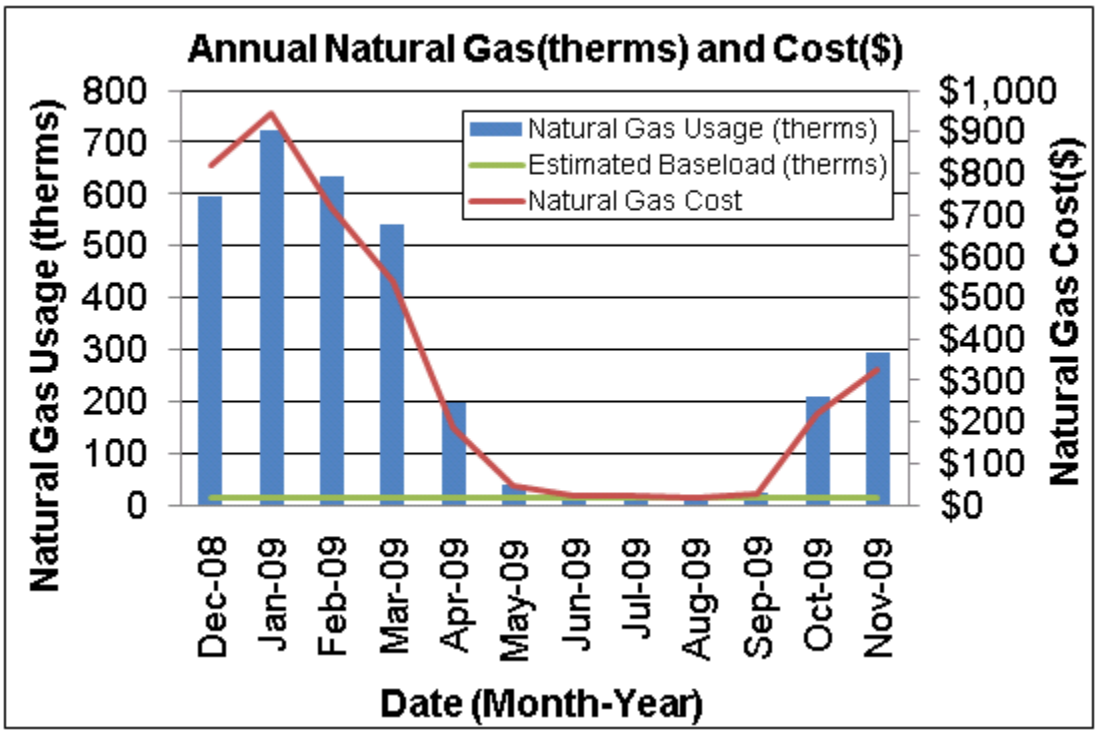
Electricity - The Cora Hartshorn Arboretum building is currently served by one electric meter. The Township currently buys electricity for the Cora Hartshorn Arboretum building from JCP&L at **an average aggregated rate of $0.172/kWh**. The Township purchased **approximately 28,512 kWh, or $4,904 worth of electricity,** for the Cora Hartshorn Arboretum building in the previous year.

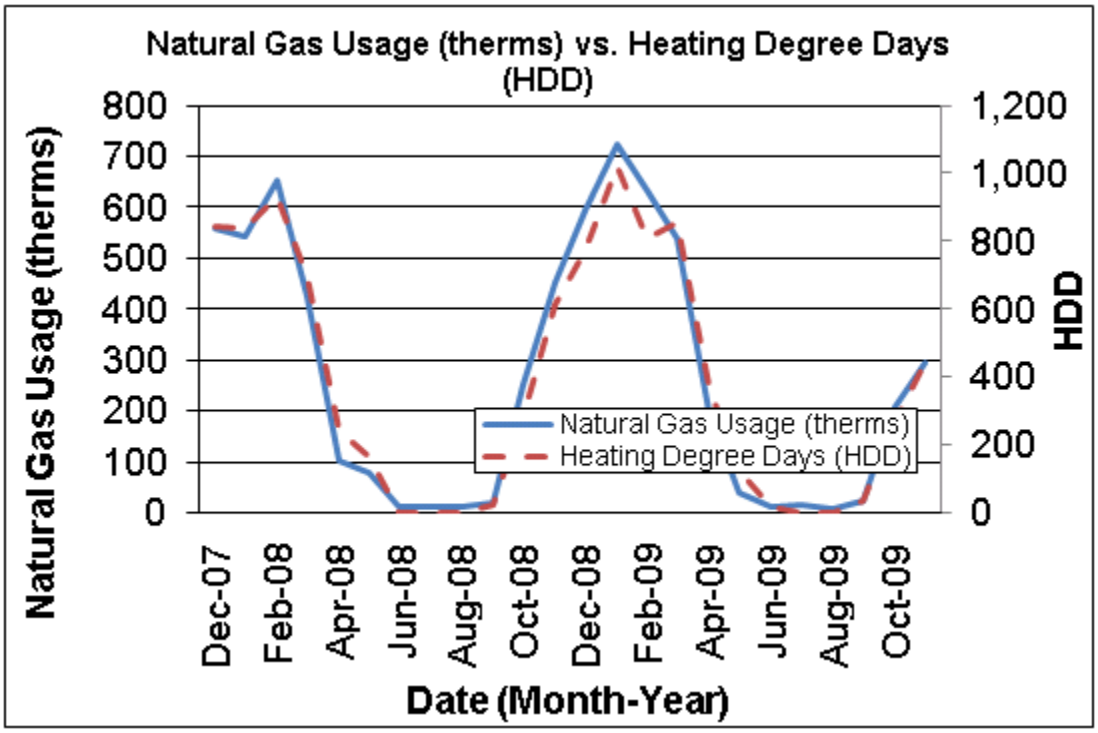
The chart below shows the monthly electric usage and costs. The dashed green line represents the approximate baseload or minimum electric usage required to operate the Cora Hartshorn Arboretum building.



Natural gas - The Cora Hartshorn Arboretum building is currently served by one meter for natural gas. The Township currently buys natural gas from PSE&G for the Cora Hartshorn Arboretum building at **an average aggregated rate of $1.185/therm**. The Township purchased **approximately 3,286 therms, or $3,895 worth of natural gas,** in the previous year for the Cora Hartshorn Arboretum building.

The chart below shows the monthly natural gas usage and costs. The green line represents the approximate baseload or minimum natural gas usage required to operate the Cora Hartshorn Arboretum building.

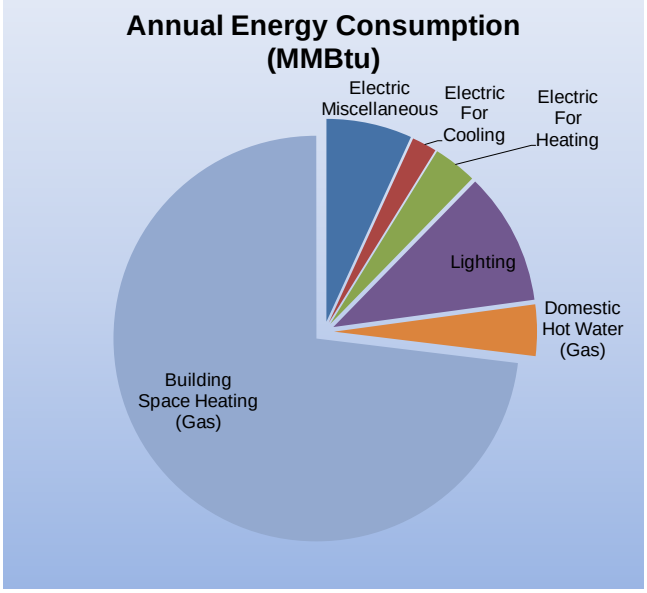


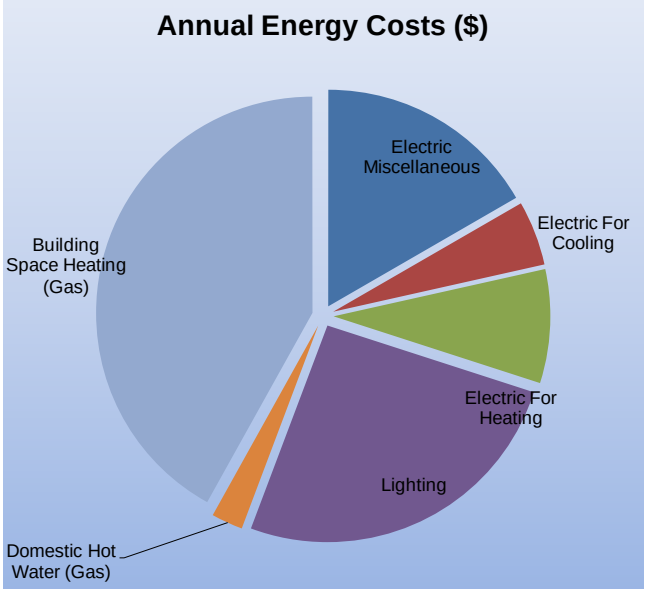


The chart above shows the monthly natural gas usage along with the heating degree days or HDD. Heating degree days is the difference of the average daily temperature and a base temperature, on a particular day. The heating degree days are zero for the days when the average temperature exceeds the base temperature. SWA's analysis used a base temperature of 65 degrees Fahrenheit.

The following graphs, pie charts, and table show energy use for the Cora Hartshorn Arboretum building based on utility bills for the 12 month period. Note: electrical cost at $50/MMBtu of energy is 4.1 times as expensive as natural gas at $12/MMBtu

Annual Energy Consumption / Costs					
	MMBtu	% MMBtu	$	% $	$/MMBtu
Electric Miscellaneous	29	7%	$1,465	17%	50
Electric For Cooling	8	2%	$426	5%	50
Electric For Heating	15	3%	$747	8%	50
Lighting	45	11%	$2,265	26%	50
Domestic Hot Water (Gas)	17	4%	$207	2%	12
Building Space Heating	311	73%	$3,689	42%	12
Totals	426	100%	$8,799	100%	
Total Electric Usage	97	23%	$4,904	56%	50
Total Gas Usage	329	77%	$3,895	44%	12
Totals	426	100%	$8,799	100%	

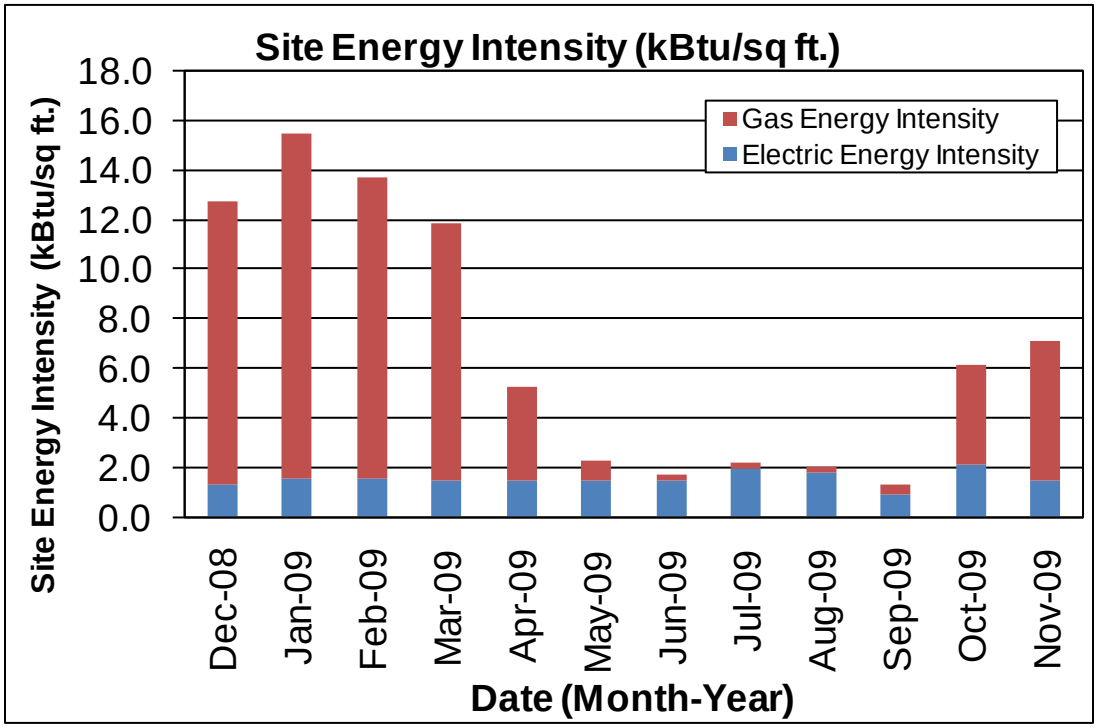




Energy benchmarking

SWA has entered energy information about the Cora Hartshorn Arboretum in the U.S. Environmental Protection Agency's (EPA) *ENERGY STAR® Portfolio Manager* energy benchmarking system. The building did not receive a performance rating due to it's categorization as "Other" space type. SWA recommends the Township of Millburn continue to insert utility billing information as the building may receive a rating as the (EPA) *ENERGY STAR® Portfolio Manager* database grows.

The Site Energy Use Intensity is 82.0 kBtu/ft^2-yr compared to the national average of an "Other - Recreation" building consuming 104.0 kBtu/ft^2-yr. See ECM section for guidance on how to improve the building's rating.



Per the LGEA program requirements, SWA has assisted the Township to create an *ENERGY STAR® Portfolio Manager* account and share the Cora Hartshorn Arboretum building facilities information to allow future data to be added and tracked using the benchmarking tool. SWA has shared this Portfolio Manager account information with the Municipality (user name of "MillburnTownship" with a password of *"*MILLBURNTOWNSHIP*")* and TRC Energy Services (user name of "TRC-LGEA")

Tariff analysis

As part of the utility bill analysis, SWA evaluated the current utility rates and tariffs. Tariffs are typically assigned to buildings based on size and building type.

Tariff analysis is performed to determine if the rate that a municipality is contracted to pay with each utility provider is the best rate possible resulting in the lowest costs for electric and gas provision. Typically, the natural gas prices increase during the heating months when natural gas is used by the hot water boiler units. Some high gas price per therm fluctuations in the summer may be due to high energy costs that recently occurred and low use caps for the non-heating months. Typically, electricity prices also increase during the cooling months when electricity is used by the HVAC condensing units and air handlers.

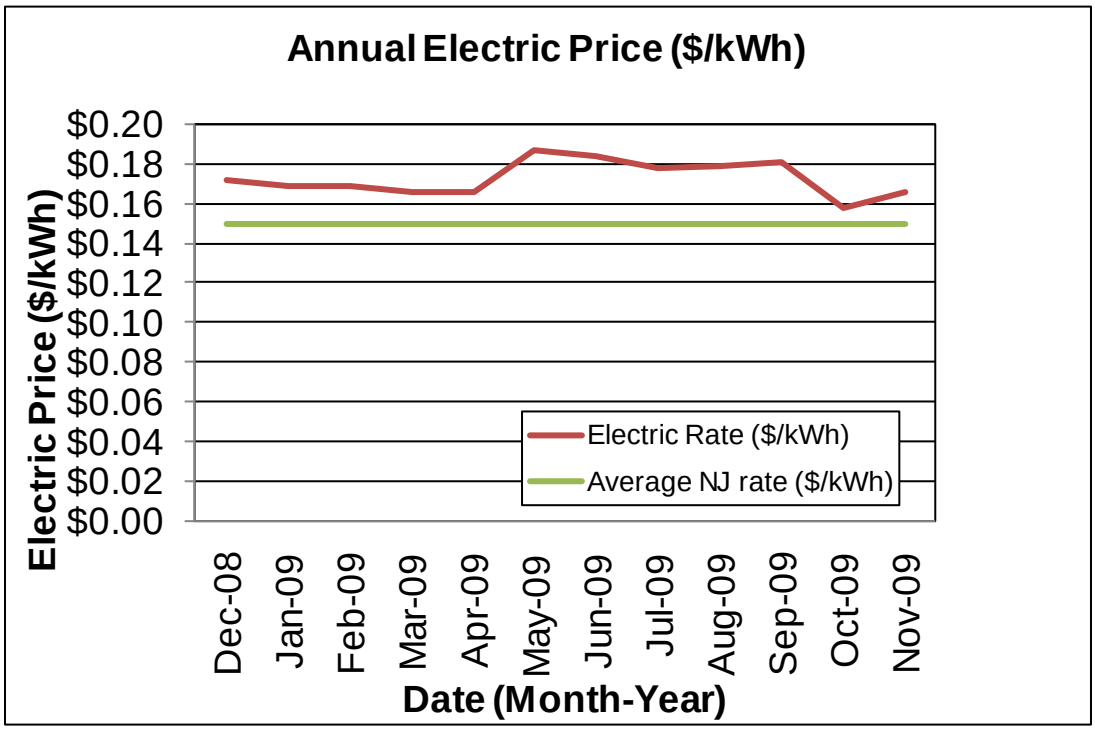
The supplier charges a market-rate price based on use, and the billing does not break down demand costs for all periods because usage and demand are included in the rate. Currently, the Township is paying a general service rate for natural gas. Demand is not broken out in the bill. Thus the building pays for fixed costs such as meter reading charges during the summer

months. The building is direct metered and currently purchases electricity at a general service rate for usage with an additional charge for electrical demand factored into each monthly bill. There general service rate for electric charges are market-rate based on use. Demand prices are reflected in the utility bills and can be verified by observing the price fluctuations throughout the year.

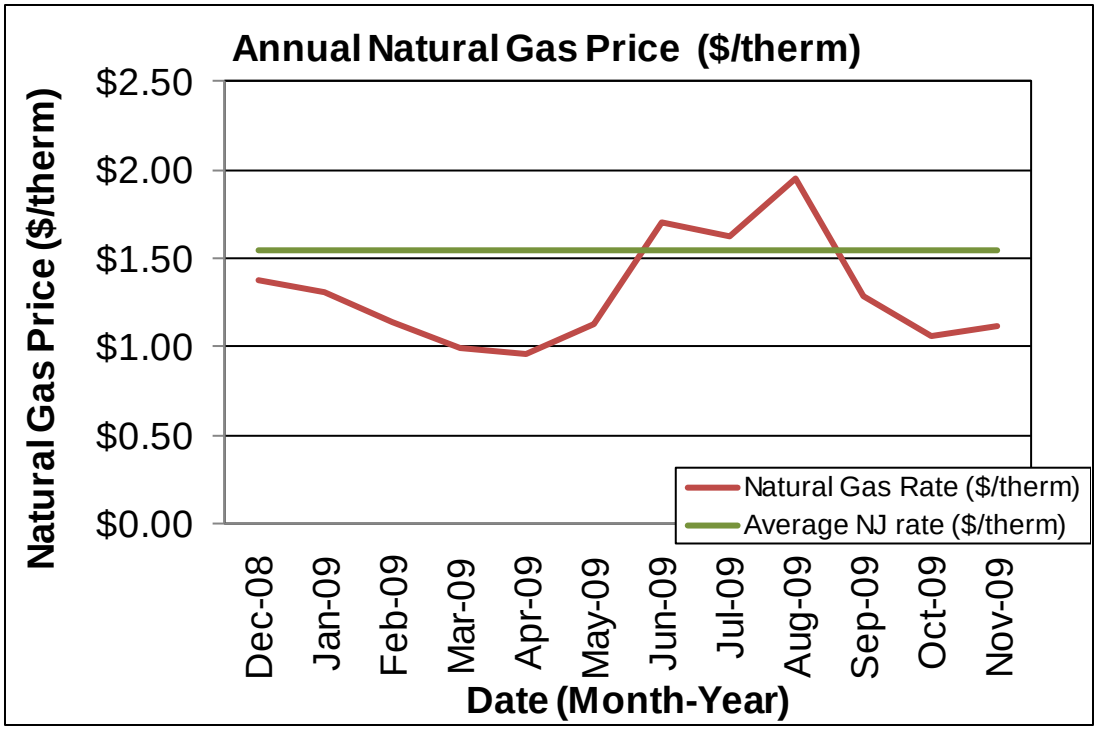
Energy Procurement strategies

Billing analysis is conducted using an average aggregated rate that is estimated based on the total cost divided by the total energy usage per utility per 12 month period. Average aggregated rates do not separate demand charges from usage, and instead provide a metric of inclusive cost per unit of energy. Average aggregated rates are used in order to equitably compare building utility rates to average utility rates throughout the state of New Jersey.

The average estimated NJ commercial utility rates for electric are $0.150/kWh, while the Township pays a rate of $0.172/kWh for the Cora Hartshorn Arboretum building. The Cora Hartshorn Arboretum building annual electric utility costs are $626 higher, when compared to the average estimated NJ commercial utility rates. Electric bill analysis shows fluctuations up to 16% over the most recent 12 month period.



The average estimated NJ commercial utility rates for gas are $1.550/therm, while the Township pays a competitive rate of $1.185/therm for the Cora Hartshorn Arboretum building. Natural gas bill analysis shows fluctuations up to 66% over the most recent 12 month period.



Utility rate fluctuations may have been caused by adjustments between estimated and actual meter readings; others may be due to unusual high and recent escalating energy costs. Summer rates are greatly affected by low gas consumption and fixed meter charges.

SWA recommends that the Township further explore opportunities of purchasing electricity from third-party suppliers in order to reduce rate fluctuation and ultimately reduce the annual cost of energy for the Cora Hartshorn Arboretum building. Appendix C contains a complete list of third-party energy suppliers for the Millburn service area.

EXISTING FACILITY AND SYSTEMS DESCRIPTION

This section gives an overview of the current state of the facility and systems. Please refer to the Proposed Further Recommendations section for recommendations for improvement.

Based on a visit from SWA on March 23, 2010, the following data was collected and analyzed.

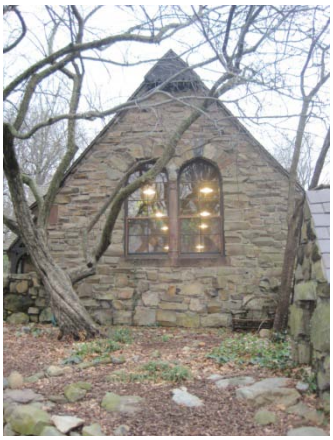
Building Characteristics

The two-story (incl. a partial basement), 5210 square feet the Cora Hartshorn Arboretum Building was originally constructed in 1931 with additions/alterations done in 2006. It houses a display/classroom area, offices, a meeting room and a small library.

Partial Front Façade (typ.)

Partial Rear Façade (typ.)

Partial Right Side Façade (typ.)



Partial Left Side Façade (typ.)

Building occupancy profiles

The building occupancy is approximately three staff daily from 8 AM – 5 PM Mon-Sat and 40 visitors daily.

Building envelope

Due to unfavorable weather conditions (min. 18 deg. F delta-T in/outside and no/low wind), no exterior envelope infrared (IR) images were taken during the field audit.

Exterior Walls

The exterior wall envelope of the new addition is constructed of fiber cement clapboard siding and a natural stone veneer accent over 5-1/2" wood stud framing. There is 5 inches of fiberglass batt cavity insulation. The old original building is constructed of a solid stone wall with no detectable insulation. The interior is mostly painted gypsum wallboard and stone.

Note: Wall insulation levels could not be verified in the field and are based on available construction plans.

During the field audit exterior and interior wall surfaces were inspected. They were found/reported to be in overall good condition with no major signs of uncontrolled moisture, air-leakage and/or other energy-compromising issues detected on all facades. Vegetation is allowed to grow up against exterior walls which could cause future damage.

The following specific exterior wall problem spots and areas were identified:

Ground vegetation allowed to grow against exterior wall surfaces could cause damage to building

Roof

The building's new addition roof (constructed in 2006) is predominantly a steep-pitch gable type over a wood structure with an asphalt shingle finish. Roof insulation levels could visually be partially verified in the field by non-destructive methods. Approximately 10 inches of fiberglass batt attic/ ceiling and 4 inches of XPS (extruded polystyrene) foam board roof insulation were recorded. The old original building is also covered by a steep-pitch gable type over a wood structure with a asphalt shingle finish. The insulation in this section of the building could not be detected due to access and no drawings were available.
During the field audit roofs, related flashing, gutters and downspouts were inspected. They were found/reported to be in overall good condition with no signs of uncontrolled moisture, air-leakage and/or other energy-compromising issues.

Base

The building's base is composed of a below-grade basement with a slab floor with a perimeter footing with poured concrete foundation walls and a slab edge/perimeter insulation. Slab/perimeter insulation levels could not be verified in the field and are based on available construction plans.

The building's base and its perimeter were inspected. Judging from very few signs of uncontrolled moisture or water presence and other energy compromising issues, overall the base was found/reported to be in good condition with no signs of uncontrolled moisture, air-leakage and/or other energy-compromising issues.

Windows

The building contains several different types of windows.

1. Double-hung type windows with an aluminum clad wood frame, low-E coated/gas filled double glazing and interior roller blinds. The windows are located on the addition. They are new and have never been replaced.
2. Fixed type windows with a wood frame, low-E coated/gas filled double glazing and no interior or exterior shading devices. The windows are new and located on the addition.
3. Double-hung type windows with a wood frame, clear single glazing and no interior or exterior shading devices. The windows are located on the original historic building. Installation date was not confirmed. When it is time for replacement, consider low-E coated/gas filled double glazed windows.
4. Fixed type windows with a wood frame, clear single glazing and no interior or exterior shading devices. The windows are located on the original historic building and year of installation could not be confirmed. When it is time for replacement, consider low-E coated / gas filled double glazed windows.

Windows, shading devices, sills, related flashing and caulking were inspected from the exterior and interior as far as accessibility allowed. Based on signs of moisture, air-leakage and other energy compromising issues, overall the windows were found and/or reported to be in good condition with no signs of uncontrolled moisture, air-leakage and/or other energy-compromising issues.

The following specific window problem spots and areas were identified:

Single glazed windows

Exterior doors

The building contains several different types of exterior doors.

1. One metal type exterior door, located on the side of the building and installed in 2007.
2. Two wood type exterior doors, located in the front and rear of the building, installed in 2007.
3. One wood with glass type exterior door, located in the rear of the building, installed in 2007.

All exterior doors, thresholds, related flashing, caulking and weather-stripping were inspected. Based on signs of moisture, air-leakage and other energy compromising issues, overall the doors were found/reported to be in good condition with no signs of uncontrolled moisture, air-leakage and/or other energy-compromising issues.

Building air tightness

Overall the field auditors found the building to be reasonably air-tight, considering the building's use and occupancy, as described in more detail earlier in this chapter.

The air tightness of buildings helps maximize all other implemented energy measures and investments and minimizes potentially costly long term maintenance/ repair/replacement expenses. In addition to all the above mentioned findings SWA recommends maintaining air sealing, caulking and/or insulation around all structural members, recessed lighting fixtures, electrical boxes and chimney walls that are part of or penetrate the exterior envelope and where air-leakage can occur.

Mechanical Systems

Heating Ventilation Air Conditioning

Cora Hartshorn HVAC systems were upgraded in 2007 and are state of art. There are two split units and one heating boiler serving hot water through parts of the building. HVAC systems have separate programmable thermostats for heating and cooling, which was the only complaint from building occupants. Currently, unoccupied mode settings on thermostats exclude weekends because the building is occupied on Saturdays. As a result, HVAC systems operate in normal occupied mode even on Sundays.

Equipment

The Cora Hartshorn Arboretum building contains split air conditioning units, a gas fired furnace, a condensing boiler, and related accessories. A comprehensive Equipment List can be found in Appendix A.

There are two energy efficient Carrier split air conditioning units rated 15 SEER each. Condensing units are located on grade, behind the building. A 1.5 ton split unit serves the second floor meeting room, and a 3 ton split unit serves the first floor offices. These units were in good condition and have approximately 80% of useful operating life left.

There is a Stonehouse on first floor which is served by a gas fired furnace with no cooling. This is where birds are kept and school children visit for occasional classes and gatherings. Although the Stonehouse is not cooled, it must be maintained above 72 deg F throughout the year for the comfort of the animals. There is a large centrifugal fan for ventilation which is manually operated from a wall mounted switch. The fan was designed to be turned on during summers for forced ventilation, but reportedly, it never got so hot inside that there was ever a need to turn it on. The fan is in excellent condition with 80% of its useful life remaining. The furnace was installed in 2007, and is in good condition. The nameplate of the unit was inaccessible; however, the construction drawings show that this unit was replaced in kind in 2007 and is believed to have 80% of its useful life still remaining.

Heating systems include hot water distribution from a boiler plant located in the basement. Hot water is generated by a condensing boiler manufactured by Lochinvar which seemed brand new, with 88% of its useful life remaining. The estimated thermal efficiency of this boiler is 90%, which is extremely good. Hot water is distributed in two zones: first and second floors respectively. Each zone is served hot water by means of small pipe mounted Taco pumps which are good condition as well.

Controls

The two split units serve two cooling zones, and the heating boiler serves hot water to two heating zones. Each zone has its own programmable thermostats for heating and cooling. Currently, unoccupied mode settings on thermostats exclude weekends because the building is occupied on Saturdays. As a result, HVAC systems operate in normal occupied mode even on Sundays. Occupied mode settings for summers is maintained between 66 and 72 deg F, and for winters at 66 deg F. Unoccupied mode settings (which is after 5.00pm on all days) is maintained at 62 deg F in winters, and all equipment is off in summer and shoulder seasons.

The Stonehouse is maintained to keep comfort temperatures throughout the year – there is no cooling.

Domestic Hot Water

The domestic hot water (DHW) for the Cora Hartshorn Arboretum building is provided by a gas fired, Lochivar Knight PRN050 with 40 gal storage and 60MBH input. This heater has 77% estimated useful operating life remaining and appears to be in good condition.

Electrical systems

Lighting

See attached lighting schedule in Appendix B for a complete inventory of lighting throughout the building including estimated power consumption and proposed lighting recommendations.

Interior Lighting - The Millburn Arboretum building currently consists of efficient CFL bulbs and T8, T5 bulbs with electronic ballasts. In addition, many occupancy sensors are installed, which further reduce power use for lighting. In general the lighting system was found to be highly energy efficient. A number of fixtures were found to contain screw-in incandescent type bulbs (in the attic, restroom and janitor closet in the auditorium), SWA recommends replacing these bulbs with screw-in compact fluorescent bulbs (CFLs).

Even though the T8 fixtures are new and relatively efficient, it itself can be upgraded with newer, more efficient T8 lamps. SWA recommends considering replacing the standard 32W T8 lamps with energy-saving 25W, 28W and 30W T8 lamps. **Limitations:** Energy-saving T8 lamp types (25W, 28W and 30W) are designed for use with instant-start ballasts.

Passive infrared occupancy sensors were found in many of the rooms surveyed. Some occupancy sensors were found to be faulty and require replacement. Building occupants complained about false triggering of the occupancy sensors and long delay times until shutoff. The shut-off time can be set to fewer minutes. False triggering can be avoided by up-grading the occupancy sensor to newer hybrid sensors that utilize both infrared in combination with ultra-sonic or micro-phonic technologies. SWA recommends commissioning the occupancy sensors to function properly.

Based on measurements of day light and artificial lighting levels for each space, there are not any vastly over-illuminated areas.

Exit Lights - Exit signs were found to be LED type fixtures. SWA does not recommend any changes to the exit signs at this time.

Exterior Lighting - The exterior lighting surveyed during the building audit was found to consist of compact fluorescent (CFLs) bulb type fixtures. The exterior lighting is controlled by an automatic timer. SWA does not recommend any changes to the fixtures or controls at this time.

Appliances and process

SWA has conducted a general survey of larger, installed equipment. Appliances and other miscellaneous equipment account for a significant portion of electrical usage within the building. Typically, appliances are referred to as “plug-load” equipment, since they are not inherent to the building’s systems, but rather plug into an electrical outlet. Equipment such as process motors, computers, computer servers, radio and dispatch equipment, refrigerators, vending machines, printers, etc. all create an electrical load on the building that is hard to separate out from the rest of the building’s energy usage based on utility analysis.

Elevators

The Cora Hartshorn Arboretum building does not have an installed elevator.

Other electrical systems

There are not currently any other significant energy-impacting electrical systems installed at the Cora Hartshorn Arboretum building.

RENEWABLE AND DISTRIBUTED ENERGY MEASURES

Renewable energy is defined as any power source generated from sources which are naturally replenished, such as sunlight, wind and geothermal. Technology for renewable energy is improving, and the cost of installation is decreasing, due to both demand and the availability of state and federal government-sponsored funding. Renewable energy reduces the need for using either electricity or fossil fuel, therefore lowering costs by reducing the amount of energy purchased from the utility company. Technology such as photovoltaic panels or wind turbines, use natural resources to generate electricity on the site. Geothermal systems offset the thermal loads in a building by using water stored in the ground as either a heat sink or heat source. Solar thermal collectors heat a specified volume of water, reducing the amount of energy required to heat water using building equipment. Cogeneration or CHP allows you to generate electricity locally, while also taking advantage of heat wasted during the generation process.

Existing systems

Currently there are no renewable energy systems installed in the building.

Evaluated Systems

Solar Photovoltaic

Photovoltaic panels convert light energy received from the sun into a usable form of electricity. Panels can be connected into arrays and mounted directly onto building roofs, as well as installed onto built canopies over areas such as parking lots, building roofs or other open areas. Electricity generated from photovoltaic panels is generally sold back to the utility company through a net meter. Net-metering allows the utility to record the amount of electricity generated in order to pay credits to the consumer that can offset usage and demand costs on the electric bill. In addition to generation credits, there are incentives available called Solar Renewable Energy Credits (SRECs) that are subsidized by the state government. Specifically, the New Jersey State government pays a market-rate SREC to facilities that generate electricity in an effort to meet state-wide renewable energy requirements.

Based on utility analysis and a study of roof conditions, the Cora Hartshorn Arboretum building is a good candidate for a 5.2 kW Solar Panel installation. See ECM# 3 for details.

Solar Thermal Collectors

Solar thermal collectors are not cost-effective for this building and would not be recommended due to the insufficient and intermittent use of domestic hot water throughout the building to justify the expenditure.

Geothermal

The Cora Hartshorn Arboretum building is not a good candidate for geothermal installation since it would require replacement of the entire existing HVAC system, of which major components still have between 70% and 80% remaining useful life.

Combined Heat and Power

The Cora Hartshorn Arboretum building is not a good candidate for CHP installation and would not be cost-effective due to the size and operations of the building. Typically, CHP is best suited for buildings with a high electrical base-load to accommodate the electricity generated, as well as a means for using waste heat generated

PROPOSED ENERGY CONSERVATION MEASURES

Energy Conservation Measures (ECMs) are recommendations determined for the building based on improvements over current building conditions. ECMs have been determined for the building based on installed cost, as well as energy and cost-savings opportunities.

Recommendations: Energy Conservation Measures

ECM #	Description	net est. ECM cost with incentives, $	kWh, 1st yr savings	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	total 1st yr savings, $	life of measure, yrs	simple payback, yrs	annual return on investment, %	CO_2 reduced, lbs/yr
1	41 New CFL fixtures to be installed	1,012	2,233	0	1.5	474	5	2.1	36	3,998
2	Install (2) new thermostats along with controller	2,180	136	164	3.2	218	15	10	3	2,051

Assumptions: Discount Rate: 3.2%; Energy Price Escalation Rate: 0%
Notes:

1. A 0.0 electrical demand reduction/month indicates that it is very low/negligible
2. In order to clearly present the overall energy opportunities for the building and ease the decision and choice of which ECM to implement, SWA calculated each ECM independently and did not incorporate slight/potential interaction between retrofits between some of the listed ECMs (i.e. lighting change influence on heating/cooling.

ECM#1: *Building Lighting Upgrades*

On the days of the site visit, SWA completed a lighting inventory of the Cora Hartshorn Arboretum building (see Appendix B). The existing lighting consists of mostly high performance T8 and T5 fluorescent fixtures with electronic ballasts. Occupancy sensors were found in many areas of the building. SWA recommends replacing incandescent and halogen lamps with CFL lamps. The labor in all these installations was evaluated using prevailing electrical contractor wages. The Township of Millburn may decide to perform this work with in-house resources from its Maintenance Department on a scheduled, longer timeline than otherwise performed by a contractor, to obtain savings.

Installation cost:

Estimated installed cost: $1,012 (includes $400 of labor)
Source of cost estimate: RS *Means; Published and established costs, NJ Clean Energy Program*

Economics:

ECM #	ECM description	est. installed cost, $	est. incentives, $	net est. ECM cost with incentives, $	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr sawings, $	total 1st yr savings, $	life of measure, yrs	est. lifetime cost savings, $	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, $	CO_2 reduced, lbs/yr
1	41 New CFL fixtures to be installed	1,012	0	1,012	2,233	0.5	0	1.5	90	474	5	2,370	2.1	179	36	37	1,147	3,998

Assumptions: SWA calculated the savings for this measure using measurements taken the days of the field visits and using the billing analysis. SWA also assumed an aggregated 1/2 hrs/yr to replace aging burnt out lamps vs. newly installed.

Rebates/financial incentives:

There are no incentives available at this time for installing CFL lamps.

Please see Appendix F for more information on Incentive Programs.

ECM#2: Install (2) New Thermostats along with Controller

There are two cooling zones in the building served by DX split units and two heating zones. Each heating and each cooling zone has individual, separate programmable thermostats, which have been programmed for occupied and unoccupied modes. The building is occupied on Saturdays and is closed on Sundays. Currently, thermostats cannot be programmed for a Sunday setting alone and hence work in occupied mode on Sundays.

Further, second floor meeting room zone is mostly unoccupied throughout the day but continues to be conditioned as an occupied mode. In this light, SWA proposes occupancy sensor based temperature settings for second floor to cut down energy usage.

SWA recommends that the Township install (2) new thermostats, a new central controller that can be programmed infinitely from a computer, one new occupancy sensors for second floor, an outside air stat, and new control wiring. In the new proposed settings, most equipment would operate at minimum settings and remain off during unoccupied hours in summer and shoulder seasons. These settings would revert to occupied mode settings on receiving occupancy signal, and stay here as long as the occupants are being detected.

The proposed temperature settings without the occupancy override are as follows:

	Summer		**Winter**		**Shoulder**	
	Occupied	**Unoccupied**	**Occupied**	**Unoccupied**	**Occupied**	**Unoccupied**
Proposed settings	78F	Off	62F	62F	Off	Off

Occupancy override, and first floor zone occupied mode setting during summer is proposed 72 deg F. This schedule cannot be achieved with the existing thermostats as they have limited programming capability and would require intervention at the onset of a new season.

Installation cost:

Estimated installed cost: $2,200 (includes $1,200 of labor)
Source of cost estimate: Manufacturer's data and similar projects

Economics:

ECM #	ECM description	est. installed cost, $	est. incentives, $	net est. ECM cost with incentives, $	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, $	total 1st yr savings, $	life of measure, yrs	est. lifetime cost savings, $	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, $	CO_2 reduced, lbs/yr
2	Install (2) new thermostats along with controller	2,200	20	2,180	136	0	164	3.2	0	218	15	3,266	10.0	50	3	3	382	2,051

Assumptions: SWA calculated the savings for this measure using nameplate data taken and using the billing analysis. SWA estimated 5% savings in equipment hours of operation resulting in heating and cooling electric and gas savings conservatively.

Rebates/financial incentives:

NJ Clean Energy – Occupancy sensors ($20 per control) - Maximum incentive amount is $20

ECM#3: *Install 5.2 kW PV System*

Description:

Currently, the Cora Hartshorn building does not use any renewable energy systems. Renewable energy systems such as photovoltaic panels, can be mounted on the building roofs, and can offset a portion of the purchased electricity for the building. Power stations generally have two separate electrical charges: usage and demand. Usage is the amount of electricity in kilowatt-hours that a building uses from month to month. Demand is the amount of electrical power that a building uses at any given instance in a month's period. During the summer periods, when electric demand at a power station is high due to the amount of air conditioners, lights, equipment, etc… being used within the region, demand charges go up to offset the utility's cost to provide enough electricity at that given time. Photovoltaic systems not only offset the amount of electricity use by a building, but also reduce the building's electrical demand, resulting in a higher cost savings as well. It is recommended at this time that the Cora Hartshorn building further review installing a 5.2 kW PV system to offset electrical demand and reduce the annual net electric consumption for the building, and review guaranteed incentives from NJ rebates to justify the investment. The Township may consider applying for a grant and/or engage a PV generator/leaser who would install the PV system and then sell the power at a reduced rate. JCP&L provides the ability to buy SREC's at $600/MWh or best market offer.

The building has sloping roof sections with many locations for portions of a 5.2 kW PV installation on the building roof. Building demand is a limiting factor in determining the size of the PV system that can be deployed. A commercial crystalline 123 watt panel has 10.7 square feet of surface area (11.5 watts per square foot). A 5.2 kW system needs approximately 42 panels which would take up 500 square feet. The installation of a renewable Solar Photovoltaic power generating system could serve as a good educational tool and exhibit for the community.

Installation cost:

Estimated installed cost: $32,240 (including $12,480 total labor cost)
Source of cost estimate: Similar projects

Economics:

ECM #	ECM description	Cost Source	Est. installed cost, $	Est. incentives, $	Net est. cost with incentives, $	kWh, 1st year savings	kW, demand reduction	therms, 1st year savings	kBtu/sq ft, 1st year savings	Est. operating cost, 1st year savings, $	Total 1st year savings, $	Life of measure, years	Est. lifetime energy cost savings, $	Simple payback, years	Lifetime return-on-investment, %	Annual return-on-investment, %	Internal rate of return, %	Net present value, $	CO_2 reduced, lbs/year
3	Install 5.2 kW Solar Photovoltaic system	Similar Projects	36,400	4,160	32,240	6,136	5	0	4.0	0	4,655	25	80,385	6.9	149	597	10	$28,096	10,987

Cash Flow Year 0	-$32,240									
Cash Flow Year 1	$4,655	Cash Flow Year 6	$4,655	Cash Flow Year 11	$4,655	Cash Flow Year 16	$1,055	Cash Flow Year 21	$1,055
Cash Flow Year 2	$4,655	Cash Flow Year 7	$4,655	Cash Flow Year 12	$4,655	Cash Flow Year 17	$1,055	Cash Flow Year 22	$1,055
Cash Flow Year 3	$4,655	Cash Flow Year 8	$4,655	Cash Flow Year 13	$4,655	Cash Flow Year 18	$1,055	Cash Flow Year 23	$1,055
Cash Flow Year 4	$4,655	Cash Flow Year 9	$4,655	Cash Flow Year 14	$4,655	Cash Flow Year 19	$1,055	Cash Flow Year 24	$1,055
Cash Flow Year 5	$4,655	Cash Flow Year 10	$4,655	Cash Flow Year 15	$4,655	Cash Flow Year 20	$1,055	Cash Flow Year 25	$1,055

Assumptions: SWA estimated the cost and savings of the system based on past PV projects. SWA projected physical dimensions based on a typical Polycrystalline Solar Panel (123 Watts, model #ND-U230C1). PV systems are sized based on Watts and physical dimensions for an array will differ with the efficiency of a given solar panel (W/sq ft).

Rebates/financial incentives:

NJ Clean Energy - Renewable Energy Incentive Program, Incentive based on $0.80 / watt Solar PV application for systems 50 kW or less.

http://www.njcleanenergy.com/renewable-energy/programs/renewable-energy-incentive-program

NJ Clean Energy - Solar Renewable Energy Certificate Program. Each time a solar electric system generates 1,000kWh (1MWh) of electricity, a SREC is issued which can then be sold or traded separately from the power. The buildings must also become net-metered in order to earn SRECs as well as sell power back to the electric grid. A total annual SREC credit of $3,600 has been incorporated in the above costs however it requires proof of performance, application approval and negotiations with the utility.

PROPOSED FURTHER RECOMMENDATIONS

Capital Improvements

Capital Improvements are recommendations for the building that may not be cost-effective at the current time, but that could yield a significant long-term payback. These recommendations should typically be considered as part of a long-term capital improvement plan. Capital improvements should be considered if additional funds are made available, or if the installed costs can be shared with other improvements, such as major building renovations. SWA recommends the following capital improvements for the Cora Hartshorn Arboretum building:

- Investigate and insulate original roof of the old historic section. SWA suggests applying spray-foam and/or rigid foam board insulation (R-30 min.) under and/or on top of the wood decking surface.

- Replace all single-glazed windows with a historically and architecturally compliant low-E, double glazed type.

Operations and Maintenance

Operations and Maintenance measures consist of low/no cost measures that are within the capability of the current building staff to handle. These measures typically require little investment, and they yield a short payback period. These measures may address equipment settings or staff operations that, when addressed will reduce energy consumption or costs.

- Overgrown ground vegetation should be trimmed to not touch or block exterior wall surfaces from access, ventilation and sunlight. For best practice, SWA recommends plants minimum installation distance to be no less than 24” from the building. This will help to maintain a better distance between root systems potentially causing damage to foundation walls.

- Inspect and maintain all roof surfaces on a regular basis. SWA recommends investigating the roof for leaks, deteriorating roof finishes and damaged or compromised roof and valley flashing. Inspect and maintain all roof surfaces on a regular basis.

- Maintain weather-stripping around all exterior doors and roof hatches. Doors and vestibules should be observed annually for deficient weather-stripping and replaced as needed.

- Maintain sealants and caulks at all windows for airtight performance. The perimeter of all window frames should also be regularly inspected, and any missing or deteriorated caulking should be re-caulked to provide an unbroken seal around the window frames.

- Perform and maintain air-sealing - Penetrations in the thermal envelope should be sealed with caulk or spray foam. Areas to investigate include top-plates, HVAC, plumbing, and electrical penetrations, chimney and duct chases, bottom-plates, and around windows and doors. Air sealing will help to reduce energy loss of expensive conditioned air and prevent rodents or pests from entry into the building.

- Provide water-efficient fixtures and controls - Adding controlled on/off timers on all lavatory faucets is a cost-effective way to reduce domestic hot water demand and save water. Building staff can also easily replace 2.2gpm faucet aerators with 0.5gpm faucet aerators and/or low-flow

fixtures to reduce water consumption. There are many retrofit options, which can be installed now or incorporated as equipment is replaced. Routine maintenance practices that identify and quickly address water leaks are a low-cost way to save water and energy. Retrofitting with more efficient water-consumption fixtures/appliances will reduce energy consumption for water heating, while also decreasing water/sewer bills.

- SWA recommends that the building considers purchasing the most energy-efficient equipment, including ENERGY STAR® labeled appliances, when equipment is installed or replaced. More information can be found in the "Products" section of the ENERGY STAR® website at: http://www.energystar.gov.

- Preventative exterior wall maintenance - SWA recommends as part of the maintenance program to install proper flashing, correct masonry efflorescence and seal wall cracks and penetrations wherever necessary in order to keep insulation dry and effective. SWA recommends having any deteriorated or missing stone and masonry cavities filled or re-pointed with mortar or appropriate caulk to minimize and prevent water and moisture infiltration into the envelope assemblies.

- Maintain downspouts and cap flashing - Slope perimeter grade away from building to maximize site drainage. Especially at door locations to prevent water from flooding into building. Install gutters, downspouts and downspout deflectors in the rear of the building to minimize uncontrolled roof water run-off to help direct water away from building doorways. Repair/install missing downspouts and cap flashing as needed to prevent water/moisture infiltration and insulation damage. SWA recommends round downspout elbows to minimize clogging.

- Use smart power electric strips - in conjunction with occupancy sensors to power down computer equipment when left unattended for extended periods of time.

- Create an energy educational program - that teaches how to minimize their energy use. The US Department of Energy offers free information for hosting energy efficiency educational programs and plans, for more information please visit: http://www1.eere.energy.gov/education/

APPENDIX A: EQUIPMENT LIST

Inventory

Building System	Description	Location	Model#	Fuel	Space served	Year Equip Installed	Remaining useful life %
Cooling	Indoor split unit, 208/1/60, 1/2hp blower motor, R410A, 1.5 ton capacity	Attic	Carrier, Model FV4BNF002, S/N 2406A84656	Elec.	Second floor meeting room	2007	80%
Cooling	Condensing unit, R410A, 208-230/1/60, MCA11.7, 15SEER	Outside, on grade	Carrier, Model 24ABA318A300, S/N0507e13581	Elec.	Second floor meeting room	2007	80%
Ventilation	Exhaust fan,EF-1, 1 hp est. blower motor	Attic	Greenheck, Model SWB-213-5-CW-TH-X, S/N 07A04820	Elec.	Animal stonehouse	2007	80%
Cooling	Indoor split unit, 208/1/60, 1/2hp blower motor, R410A	Basement	Carrier, Model FV4BNF005, S/N 4306A82854	Elec.	First floor	2007	80%
Cooling	Condensing unit, R410A, 208-230/1/60, MCA19	Outside, on grade	Carrier, Model 24ABA336A300, S/N0807E10257	Elec.	First floor	2007	80%
Heating	Heating boiler, condensing, direct vented, 210/191 MBH in/out, est. 90% efficiency	Basement	Lochinvar, Knight, Model KBN210, S/N L06H10024996	Gas	Whole building	2007	88%
DHW	40 Gallon domestic hot water heater; I/P 60000 Btu/hr, est. 84% efficiency	Basement	Lochinvar, Model PRN050, S/N DA8640581 D/N	Gas	Whole building	2007	77%
Heating	Horizontol in line pump, pipe mounted, 115/1/60, 1/8hp, 2 nos.	Basement	Taco, Model 0011-F4	Elec.	First floor and second floor respectively	2007	80%
H/V	Heating and ventilation unit, replaced old unit in kind in 2007	Above toilet in animal stonehouse	Nameplate N/A	Gas/Elec.	Animal stonehouse	2007	80%

Note: The remaining useful life of a system (in %) is an estimate based on the system date of built and existing conditions derived from visual inspection.

Appendix B: Lighting Study

Location			Existing Fixture Information												Retrofit Information												Annual Savings		
Marker	Floor	Room Identification	Fixture Type	Ballast	Lamp Type	# of Fixtures	# of Lamps per Fixture	Watts per Lamp	Controls	Operational Hours per Day	Operational Days per Year	Ballast Wattage	Total Watts	Energy Use kWh/year	Category	Fixture Type	Lamp Type	Ballast	Controls	# of Fixtures	# of Lamps per Fixture	Watts per Lamp	Operational Hours per Day	Operational Days per Year	Ballast Watts	Total Watts	Energy Use kWh/year	Fixture Savings (kWh)	Controls Savings (kWh)	Total Savings (kWh)
1	2	Attic (201)	Ceiling Mounted	S	Inc	2	1	60	Sw	0.5	313	0	120	19	CFL	ng Mou	CFL	S	Sw	2	1	20	1	313	0	40	6	13	0	13
2	2	Library (202)	Recessed	S	CFL	2	2	17	Sw	2	313	0	68	43	N/A	ecesse	CFL	S	Sw	2	2	17	2	313	0	68	43	0	0	0
3	2	Library (202)	Ceiling Suspended	E	4'T5HO	2	3	54	Sw	2	313	8	339	212	N/A	g Suspe	4'T5	E	Sw	2	3	54	2	313	8	339	212	0	0	0
4	2	Conference Room (203)	Ceiling Suspended	E	4'T5HO	3	3	54	OS	2	313	8	509	319	N/A	g Suspe	4'T5	E	OS	3	3	54	2	313	8	509	319	0	0	0
5	2	Conference Room (203)	Exit Sign	S	LED	1	1	5	N	24	365	1	6	48	N/A	Exit Sigi	LED	S	N	1	1	5	24	365	1	6	48	0	0	0
6	2	Staircase (204)	Sconce	S	CFL	5	2	26	Sw	9	313	0	260	732	N/A	Sconce	CFL	S	Sw	5	2	26	9	313	0	260	732	0	0	0
7	2	Staircase (204)	Chandelier	S	CFL	1	4	26	Sw	9	313	0	104	293	N/A	handeli	CFL	S	Sw	1	4	26	9	313	0	104	293	0	0	0
8	2	Staircase (204)	Exit Sign	S	LED	1	1	5	N	24	365	1	6	48	N/A	Exit Sigi	LED	S	N	1	1	5	24	365	1	6	48	0	0	0
9	Bsmt	Storage Rm (b1)	Ceiling Mounted	E	4'T8	8	2	32	OS	1	313	5	552	173	N/A	ng Mou	4'T8	E	OS	8	2	32	1	313	5	552	173	0	0	0
10	Bsmt	Storage Rm (b1)	Ceiling Mounted	E	4'T8	1	4	32	OS	1	313	5	133	42	N/A	ng Mou	4'T8	E	OS	1	4	32	1	313	5	133	42	0	0	0
11	Bsmt	Mechanical Rm (b2)	Ceiling Mounted	E	4'T8	2	2	32	Sw	1	313	5	138	43	N/A	ng Mou	4'T8	E	Sw	2	2	32	1	313	5	138	43	0	0	0
12	Bsmt	Electrical Rm (b3)	Ceiling Mounted	E	4'T8	1	2	32	Sw	1	313	5	69	22	N/A	ng Mou	4'T8	E	Sw	1	2	32	1	313	5	69	22	0	0	0
13	1	Shared Office (101)	Recessed	E	CFL	8	2	40	OS	9	313	0	640	1,803	N/A	ecesse	CFL	E	OS	8	2	40	9	313	0	640	1803	0	0	0
14	1	Office (102)	Recessed	S	CFL	2	2	26	OS	9	313	0	104	293	N/A	ecesse	CFL	S	OS	2	2	26	9	313	0	104	293	0	0	0
15	1	Bird Watching Room (103)	Ceiling Suspended	E	4'T5HO	2	3	54	Sw	9	313	8	339	956	N/A	g Suspe	4'T5	E	Sw	2	3	54	9	313	8	339	956	0	0	0
16	1	Bird Watching Room (103)	Wall Mounted	E	4'T5HO	4	3	54	Sw	9	313	8	679	1,912	N/A	ll Moun	4'T5	E	Sw	4	3	54	9	313	8	679	1912	0	0	0
17	1	Bird Watching Room (103)	Exit Sign	S	LED	1	1	5	N	24	365	1	6	48	N/A	Exit Sigi	LED	S	N	1	1	5	24	365	1	6	48	0	0	0
18	1	Lobby (104)	Recessed	S	CFL	9	2	26	Sw	9	313	0	468	1,318	N/A	ecesse	CFL	S	Sw	9	2	26	9	313	0	468	1318	0	0	0
19	1	Lobby (104)	Exit Sign	S	LED	3	1	5	N	24	365	1	17	145	N/A	Exit Sigi	LED	S	N	3	1	5	24	365	1	17	145	0	0	0
20	1	Bathroom (105)	Recessed	S	CFL	1	2	13	OS	9	313	0	26	73	N/A	ecesse	CFL	S	OS	1	2	13	9	313	0	26	73	0	0	0
21	1	Bathroom (105)	Recessed	E	2'T8 U-Shaped	1	2	17	OS	9	313	2	36	101	N/A	ecesse	U-Sha	E	OS	1	2	17	9	313	2	36	101	0	0	0
22	1	Classroom/Exhibition (106)	Pendant	S	CFL	10	1	42	Sw	9	313	0	420	1,183	N/A	Pendan	CFL	S	Sw	10	1	42	9	313	0	420	1183	0	0	0
23	1	Classroom/Exhibition (106)	Track	S	Hal	36	1	20	Sw	9	313	4	878	2,474	CFL	Track	CFL	S	Sw	36	1	5	9	313	0	180	507	1967	0	1967
24	1	rear entrance (107)	Pendant	S	CFL	1	1	13	Sw	9	313	0	13	37	N/A	Pendan	CFL	S	Sw	1	1	13	9	313	0	13	37	0	0	0
25	1	Cloak room (108)	Ceiling Mounted	S	Inc	1	1	75	Sw	1	313	0	75	23	CFL	ng Mou	CFL	S	Sw	1	1	25	1	313	0	25	8	16	0	16
26	1	rear entrance (107)	Exit Sign	S	LED	1	1	5	N	24	365	1	6	48	N/A	Exit Sigi	LED	S	N	1	1	5	24	365	1	6	48	0	0	0
27	1	Bathroom (109)	Sconce	S	Inc	1	2	60	Sw	9	313	0	120	338	CFL	Sconce	CFL	S	Sw	1	2	20	9	313	0	40	113	225	0	225
28	1	Janitor's Closet (110)	Ceiling Mounted	S	Inc	1	1	60	Sw	1	313	0	60	19	CFL	ng Mou	CFL	S	Sw	1	1	20	1	313	0	20	6	13	0	13
29	Ext	Exterior	Pole Mounted	S	CFL	1	1	18	T	12	313	0	18	68	N/A	e Moun	CFL	S	T	1	1	18	12	313	0	18	68	0	0	0
30	Ext	Exterior	Wall Mounted	S	CFL	5	1	18	T	12	313	0	90	338	N/A	ll Moun	CFL	S	T	5	1	18	12	313	0	90	338	0	0	0
Totals:						117	55	926				60	6,298	13,172						117	55	741			55	5,349	10,938	2,233	0	2,233
Rows Highlighed Yellow Indicate an Energy Conservation Measure is recommended for that space																													

Legend

Fixture Type		Lamp Type			Control Type	Ballast Type	Retrofit Category
Ceiling Suspended	Recessed	CFL	3'T12	8'T5	Autom. Timer (T)	S (Self)	N/A (None)
Exit Sign	Sconce	Inc	3'T12 U-Shaped	8'T5 U-Shaped	Bi-Level (BL)	E (Electronic)	T8 (Install new T8)
High Bay	Spotlight	LED	3'T5	8'T8	Contact (Ct)	M (Magnetic)	T5 (Install new T5)
Parabolic Ceiling Mounted	Track	HPS	3'T5 U-Shaped	8'T8 U-Shaped	Daylight & Motion (M)		CFL (Install new CFL)
Parabolic Ceiling Suspended	Vanity	MH	3'T8	Circline - T5	Daylight & Switch (DLSw)		LEDex (Install new LED Exit)
Pendant	Wall Mounted	MV	3'T8 U-Shaped	Circline - T8	Daylight Sensor (DL)		LED (Install new LED)
Recessed Parabolic	Wall Suspended	1'T12	4'T5	Circline - T12	Delay Switch (DSw)		D (Delamping)
Ceiling Mounted	Wallpack	1'T12 U-Shaped	4'T5 U-Shaped	Fl.	Dimmer (D)		C (Controls Only)
Chandelier		1'T5	6'T12	Hal	Motion Sensor (MS)		PSMH (Install new Pulse-Start Metal Halide)
Equipment / Fume Hood		1'T5 U-Shaped	6'T12 U-Shaped	Induction	Motion& Switch (MSw)		
Flood		1'T8	6'T5	Infrared	None (N)		
Landscape		1'T8 U-Shaped	6'T5 U-Shaped	LPS	Occupancy Sensor (OS)		
Low Bay		2'T12 U-Shaped	6'T8	Mixed Vapor	Occupancy Sensor - CM (OSCM)		
Parabolic Wall Mounted		2'T5	6'T8 U-Shaped	Neon	Photocell (PC)		
Pole Mounted		2'T5 U-Shaped	8'T12	Quartz Halogen	Switch (Sw)		
Pole Mounted Off Building		2'T8 U-Shaped	8'T12 U-Shaped				

APPENDIX C: THIRD PARTY ENERGY SUPPLIERS

http://www.state.nj.us/bpu/commercial/shopping.html

Third Party Electric Suppliers for JCPL Service Territory	Telephone & Web Site
Hess Corporation 1 Hess Plaza Woodbridge, NJ 07095	(800) 437-7872 www.hess.com
BOC Energy Services, Inc. 575 Mountain Avenue Murray Hill, NJ 07974	(800) 247-2644 www.boc.com
Commerce Energy, Inc. 4400 Route 9 South, Suite 100 Freehold, NJ 07728	(800) 556-8457 www.commerceenergy.com
Constellation NewEnergy, Inc. 900A Lake Street, Suite 2 Ramsey, NJ 07446	(888) 635-0827 www.newenergy.com
Direct Energy Services, LLC 120 Wood Avenue, Suite 611 Iselin, NJ 08830	(866) 547-2722 www.directenergy.com
FirstEnergy Solutions 300 Madison Avenue Morristown, NJ 07926	(800) 977-0500 www.fes.com
Glacial Energy of New Jersey, Inc. 207 LaRoche Avenue Harrington Park, NJ 07640	(877) 569-2841 www.glacialenergy.com
Integrys Energy Services, Inc. 99 Wood Ave, South, Suite 802 Iselin, NJ 08830	(877) 763-9977 www.integrysenergy.com
Liberty Power Delaware, LLC Park 80 West Plaza II, Suite 200 Saddle Brook, NJ 07663	(866) 769-3799 www.libertypowercorp.com
Liberty Power Holdings, LLC Park 80 West Plaza II, Suite 200 Saddle Brook, NJ 07663	(800) 363-7499 www.libertypowercorp.com
Pepco Energy Services, Inc. 112 Main St. Lebanon, NJ 08833	(800) 363-7499 www.pepco-services.com
PPL EnergyPlus, LLC 811 Church Road Cherry Hill, NJ 08002	(800) 281-2000 www.pplenergyplus.com
Sempra Energy Solutions 581 Main Street, 8th Floor Woodbridge, NJ 07095	(877) 273-6772 www.semprasolutions.com
South Jersey Energy Company One South Jersey Plaza, Route 54 Folsom, NJ 08037	(800) 756-3749 www.southjerseyenergy.com
Suez Energy Resources NA, Inc. 333 Thornall Street, 6th Floor Edison, NJ 08837	(888) 644-1014 www.suezenergyresources.com
UGI Energy Services, Inc. 704 East Main Street, Suite 1 Moorestown, NJ 08057	(856) 273-9995 www.ugienergyservices.com

Third Party Gas Suppliers for PSEG Service Territory	Telephone & Web Site
Cooperative Industries 412-420 Washington Avenue Belleville, NJ 07109	(800) 628-9427 www.cooperativenet.com
Direct Energy Services, LLC 120 Wood Avenue, Suite 611 Iselin, NJ 08830	(866) 547-2722 www.directenergy.com
Dominion Retail, Inc. 395 Highway 170, Suite 125 Lakewood, NJ 08701	(866) 275-4240 www.retail.dom.com
Gateway Energy Services Corp. 44 Whispering Pines Lane Lakewood, NJ 08701	(800) 805-8586 www.gesc.com
UGI Energy Services, Inc. 704 East Main Street, Suite 1 Moorestown, NJ 08057	(856) 273-9995 www.ugienergyservices.com
Great Eastern Energy 116 Village Riva, Suite 200 Princeton, NJ 08540	(888) 651-4121 www.greateastern.com
Hess Corporation 1 Hess Plaza Woodbridge, NJ 07095	(800) 437-7872 www.hess.com
Hudson Energy Services, LLC 545 Route 17 South Ridgewood, NJ 07450	(877) 483-7669 www.hudsonenergyservices.com
Intelligent Energy 2050 Center Avenue, Suite 500 Fort Lee, NJ 07024	(800) 724-1880 www.intelligentenergy.org
Keil & Sons 1 Bergen Blvd. Fairview, NJ 07002	(877) 797-8786 www.systrumenergy.com
Metro Energy Group, LLC 14 Washington Place Hackensack, NJ 07601	(888) 536-3876 www.metroenergy.com
MxEnergy, Inc. 510 Thornall Street, Suite 270 Edison, NJ 08837	(800) 375-1277 www.mxenergy.com
NATGASCO (Mitchell Supreme) 532 Freeman Street Orange, NJ 07050	(800) 840-4427 www.natgasco.com
Pepco Energy Services, Inc. 112 Main Street Lebanon, NJ 08833	(800) 363-7499 www.pepco-services.com
PPL EnergyPlus, LLC 811 Church Road Cherry Hill, NJ 08002	(800) 281-2000 www.pplenergyplus.com
Sempra Energy Solutions 581 Main Street, 8th Floor Woodbridge, NJ 07095	(877) 273-6772 www.semprasolutions.com
South Jersey Energy Company One South Jersey Plaza, Route 54 Folsom, NJ 08037	(800) 756-3749 www.southjerseyenergy.com
Sprague Energy Corp. 12 Ridge Road Chatham Township, NJ 07928	(800) 225-1560 www.spragueenergy.com
Stuyvesant Energy LLC 10 West Ivy Lane, Suite 4 Englewood, NJ 07631	(800) 646-6457 www.stuyfuel.com
Woodruff Energy 73 Water Street Bridgeton, NJ 08302	(800) 557-1121 www.woodruffenergy.com

APPENDIX D: GLOSSARY AND METHOD OF CALCULATIONS

Net ECM Cost: The net ECM cost is the cost experienced by the customer, which is typically the total cost (materials + labor) of installing the measure minus any available incentives. Both the total cost and the incentive amounts are expressed in the summary for each ECM.

Annual Energy Cost Savings (AECS): This value is determined by the audit firm based on the calculated energy savings (kWh or Therm) of each ECM and the calculated energy costs of the building.

Lifetime Energy Cost Savings (LECS): This measure estimates the energy cost savings over the lifetime of the ECM. It can be a simple estimation based on fixed energy costs. If desired, this value can factor in an annual increase in energy costs as long as the source is provided.

Simple Payback: This is a simple measure that displays how long the ECM will take to break-even based on the annual energy and maintenance savings of the measure.

ECM Lifetime: This is included with each ECM so that the owner can see how long the ECM will be in place and whether or not it will exceed the simple payback period. Additional guidance for calculating ECM lifetimes can be found below. This value can come from manufacturer's rated lifetime or warranty, the ASHRAE rated lifetime, or any other valid source.

Operating Cost Savings (OCS): This calculation is an annual operating savings for the ECM. It is the difference in the operating, maintenance, and / or equipment replacement costs of the existing case versus the ECM. In the case where an ECM lifetime will be longer than the existing measure (such as LED lighting versus fluorescent) the operating savings will factor in the cost of replacing the units to match the lifetime of the ECM. In this case or in one where one-time repairs are made, the total replacement / repair sum is averaged over the lifetime of the ECM.

Return on Investment (ROI): The ROI expresses the percentage return of the investment based on the lifetime cost savings of the ECM. This value can be included as an annual or lifetime value, or both.

Net Present Value (NPV): The NPV calculates the present value of an investment's future cash flows based on the time value of money, which is accounted for by a discount rate (assumes bond rate of 3.2%).

Internal Rate of Return (IRR): The IRR expresses an annual rate that results in a break-even point for the investment. If the owner is currently experiencing a lower return on their capital than the IRR, the project is financially advantageous. This measure also allows the owner to compare ECMs against each other to determine the most appealing choices.

Gas Rate and Electric Rate ($/therm and $/kWh): The gas rate and electric rate used in the financial analysis is the total annual energy cost divided by the total annual energy usage for the 12 month billing period studied. The graphs of the monthly gas and electric rates reflect the total monthly energy costs divided by the monthly usage, and display how the average rate fluctuates throughout the year. The average annual rate is the only rate used in energy savings calculations.

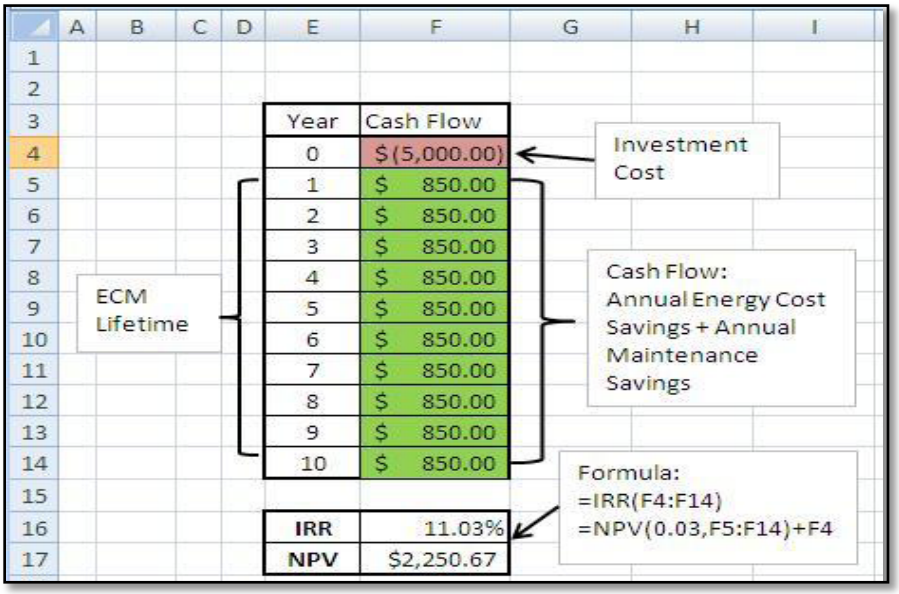
Calculation References

Term	Definition
ECM	Energy Conservation Measure
AOCS	Annual Operating Cost Savings
AECS	Annual Energy Cost Savings
LOCS*	Lifetime Operating Cost Savings
LECS	Lifetime Energy Cost Savings
LCS	Lifetime Cost Savings
NPV	Net Present Value
IRR	Internal Rate of Return
DR	Discount Rate
Net ECM Cost	Total ECM Cost – Incentive
LECS	AECS X ECM Lifetime
AOCS	LOCS / ECM Lifetime
LCS	LOCS+LECS
Simple Payback	Net ECM Cost / (AECS + AOCS)
Lifetime ROI	(LECS + LOCS – Net ECM Cost) / Net ECM Cost
Annual ROI	(Lifetime ROI / Lifetime) = [(AECS + OCS) / Net ECM Cost – (1 / Lifetime)]

* The lifetime operating cost savings are all avoided operating, maintenance, and/or component replacement costs over the lifetime of the ECM. This can be the sum of any annual operating savings, recurring or bulk (i.e. one-time repairs) maintenance savings, or the savings that comes from avoiding equipment replacement needed for the existing measure to meet the lifetime of the ECM (e.g. lighting change outs).

Excel NPV and IRR Calculation

In Excel, function =IRR (values) and =NPV(rate, values) are used to quickly calculate the IRR and NPV of a series of annual cash flows. The investment cost will typically be a negative cash flow at year 0 (total cost - incentive) with years 1 through the lifetime receiving a positive cash flow from the annual energy cost savings and annual maintenance savings. The calculations in the example below are for an ECM that saves $850 annually in energy and maintenance costs (over a 10 year lifetime) and takes $5,000 to purchase and install after incentives:



Solar PV ECM Calculation

There are several components to the calculation:

Costs:	Material of PV system including panels, mounting and net-metering + Labor
Energy Savings:	Reduction of kWh electric cost for life of panel, 25 years
Incentive 1:	NJ Renewable Energy Incentive Program (REIP), for systems of size 50kW or less, $1/Watt incentive subtracted from installation cost
Incentive 2:	Solar Renewable Energy Credits (SRECs) – Market-rate incentive. Calculations assume $600/Megawatt hour consumed per year for a maximum of 15 years; added to annual energy cost savings for a period of 15 years. (Megawatt hour used is rounded to nearest 1,000 kWh)
Assumptions:	A Solar Pathfinder device is used to analyze site shading for the building and determine maximum amount of full load operation based on available sunlight. When the Solar Pathfinder device is not implemented, amount of full load operation based on available sunlight is assumed to be 1,180 hours in New Jersey.

Total lifetime PV energy cost savings =
kWh produced by panel * [$/kWh cost * 25 years + $600/Megawatt hour /1000 * 15 years]

ECM and Equipment Lifetimes

Determining a lifetime for equipment and ECM's can sometimes be difficult. The following table contains a list of lifetimes that the NJCEP uses in its commercial and industrial programs. Other valid sources are also used to determine lifetimes, such as the DOE, ASHRAE, or the manufacturer's warranty.

Lighting is typically the most difficult lifetime to calculate because the fixture, ballast, and bulb can all have different lifetimes. Essentially the ECM analysis will have different operating cost savings (avoided equipment replacement) depending on which lifetime is used.

When the bulb lifetime is used (rated burn hours / annual burn hours), the operating cost savings is just reflecting the theoretical cost of replacing the existing case bulb and ballast over the life of the recommended bulb. Dividing by the bulb lifetime will give an annual operating cost savings.

When a fixture lifetime is used (e.g. 15 years) the operating cost savings reflects the avoided bulb and ballast replacement cost of the existing case over 15 years minus the projected bulb and ballast replacement cost of the proposed case over 15 years. This will give the difference of the equipment replacement costs between the proposed and existing cases and when divided by 15 years will give the annual operating cost savings.

New Jersey Clean Energy Program Commercial & Industrial Lifetimes

Measure	Life Span
Commercial Lighting — New	15
Commercial Lighting — Remodel/Replacement	15
Commercial Custom — New	18
Commercial Chiller Optimization	18
Commercial Unitary HVAC — New - Tier 1	15
Commercial Unitary HVAC — Replacement - Tier 1	15
Commercial Unitary HVAC — New - Tier 2	15
Commercial Unitary HVAC — Replacement Tier 2	15
Commercial Chillers — New	25
Commercial Chillers — Replacement	25
Commercial Small Motors (1-10 HP) — New or Replacement	20
Commercial Medium Motors (11-75 HP) — New or Replacement	20
Commercial Large Motors (76-200 HP) — New or Replacement	20
Commercial VSDs — New	15
Commercial VSDs — Retrofit	15
Commercial Comprehensive New Construction Design	18
Commercial Custom — Replacement	18
Industrial Lighting — New	15
Industrial Lighting — Remodel/Replacement	15
Industrial Unitary HVAC — New - Tier 1	15
Industrial Unitary HVAC — Replacement - Tier 1	15
Industrial Unitary HVAC — New - Tier 2	15
Industrial Unitary HVAC — Replacement Tier 2	15
Industrial Chillers — New	25
Industrial Chillers — Replacement	25
Industrial Small Motors (1-10 HP) — New or Replacement	20
Industrial Medium Motors (11-75 HP) — New or Replacement	20
Industrial Large Motors (76-200 HP) — New or Replacement	20
Industrial VSDs — New	15
Industrial VSDs — Retrofit	15
Industrial Custom — Non-Process	18
Industrial Custom — Process	10
Small Commercial Gas Furnace — New or Replacement	20
Small Commercial Gas Boiler — New or Replacement	20
Small Commercial Gas DHW — New or Replacement	10
C&I Gas Absorption Chiller — New or Replacement	25
C&I Gas Custom — New or Replacement (Engine Driven Chiller)	25
C&I Gas Custom — New or Replacement (Gas Efficiency Measures)	18
O&M savings	3
Compressed Air (GWh participant)	8

APPENDIX E: STATEMENT OF ENERGY PERFORMANCE FROM ENERGY STAR®

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Township of Millburn - Cora Hartshorn Arboretum

Building ID: 2243421
For 12-month Period Ending: November 30, 2009[1]
Date SEP becomes ineligible: N/A
Date SEP Generated: April 15, 2010

Facility	Facility Owner	Primary Contact for this Facility
Township of Millburn - Cora Hartshorn Arboretum 324 Forest Drive South Short Hills, NJ 07041	N/A	N/A

Year Built: 1931
Gross Floor Area (ft²): 5,210

Energy Performance Rating[2] (1-100) N/A

Site Energy Use Summary[3]	
Electricity - Grid Purchase(kBtu)	97,057
Natural Gas (kBtu)[4]	330,479
Total Energy (kBtu)	427,536

Energy Intensity[5]	
Site (kBtu/ft²/yr)	82
Source (kBtu/ft²/yr)	129

Emissions (based on site energy use)	
Greenhouse Gas Emissions ($MtCO_2e$/year)	32

Electric Distribution Utility
FirstEnergy - Jersey Central Power & Lt Co

National Average Comparison	
National Average Site EUI	104
National Average Source EUI	213
% Difference from National Average Source EUI	-40%
Building Type	Other

Stamp of Certifying Professional

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate.

Certifying Professional
N/A

Meets Industry Standards[6] **for Indoor Environmental Conditions:**	
Ventilation for Acceptable Indoor Air Quality	**N/A**
Acceptable Thermal Environmental Conditions	**N/A**
Adequate Illumination	**N/A**

Notes:
1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Natural Gas values in units of volume (e.g. cubic feet) are converted to kBtu with adjustments made for elevation based on Facility zip code.
5. Values represent energy intensity, annualized to a 12-month period.
6. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

EPA Form 5900-16

APPENDIX F: INCENTIVE PROGRAMS

New Jersey Clean Energy Pay for Performance

The NJ Clean Energy Pay for Performance (P4P) Program relies on a network of Partners who provide technical services to clients. LGEA participating clients who are not receiving Direct Energy Efficiency and Conservation Block Grants are eligible for P4P. SWA is an eligible Partner and can develop an Energy Reduction Plan for each project with a whole-building traditional energy audit, a financial plan for funding the energy measures and an installation construction schedule.

The Energy Reduction Plan must define a comprehensive package of measures capable of reducing a building's energy consumption by 15+%. P4P incentives are awarded upon the satisfactory completion of three program milestones: submittal of an Energy Reduction Plan prepared by an approved Program Partner, installation of the recommended measures and completion of a Post-Construction Benchmarking Report. The incentives for electricity and natural gas savings will be paid based on actual savings, provided that the minimum 15%performance threshold savings has been achieved.

For further information, please see: http://www.njcleanenergy.com/commercial-industrial/programs/pay-performance/existing-buildings .

Direct Install 2010 Program

Direct Install is a division of the New Jersey Clean Energy Programs' Smart Start Buildings. It is a turn-key program for small to mid-sized facilities to aid in upgrading equipment to more efficient types. It is designed to cut overall energy costs by upgrading lighting, HVAC and other equipment with energy efficient alternatives. The program pays **up to 80%** of the retrofit costs, including equipment cost and installation costs.

Eligibility:

- Existing small and mid-sized commercial and industrial facilities with peak electrical demand **below 200 kW** within 12 months of applying
- Must be located in New Jersey
- Must be served by one of the state's public, regulated or natural gas companies
    - Electric: Atlantic City Electric, Jersey Central Power & Light, Orange Rockland Electric, PSE&G
    - Natural Gas: Elizabethtown Gas, New Jersey Natural Gas, PSE&G, South Jersey Gas

For the most up to date information on contractors in New Jersey who participate in this program, go to: http://www.njcleanenergy.com/commercial-industrial/programs/direct-install

Smart Start

New Jersey's SmartStart Building Program is administered by New Jersey's Office of Clean Energy. The program also offers design support for larger projects and technical assistance for smaller projects. If your project specifications do not fit into anything defined by the program, there are even incentives available for custom projects.

There are a number of improvement options for commercial, industrial, institutional, government, and agricultural projects throughout New Jersey. Alternatives are designed to enhance quality while building in energy efficiency to save money. Project categories included in this program are New Construction and Additions, Renovations, Remodeling and Equipment Replacement.

For the most up to date information on how to participate in this program, go to: http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/nj-smartstart-buildings.

Renewable Energy Incentive Program

The Renewable Energy Incentive Program (REIP) provides incentives that reduce the upfront cost of installing renewable energy systems, including solar, wind, and sustainable biomass. Incentives vary depending upon technology, system size, and building type. Current incentive levels, participation information, and application forms can be found at the website listed below.

Solar Renewable Energy Credits (SRECs) represent all the clean energy benefits of electricity generated from a solar energy system. SRECs can be sold or traded separately from the power, providing owners a source of revenue to help offset the cost of installation. All solar project owners in New Jersey with electric distribution grid-connected systems are eligible to generate SRECs. Each time a system generates 1,000 kWh of electricity an SREC is earned and placed in the customer's account on the web-based SREC tracking system.

For the most up to date information on how to participate in this program, go to: http://www.njcleanenergy.com/renewable-energy/home/home.

Utility Sponsored Programs

Check with your local utility companies for further opportunities that may be available.

Federal and State Sponsored Programs

Other federal and state sponsored funding opportunities may be available, including BLOCK and R&D grant funding. For more information, please check http://www.dsireusa.org/.

APPENDIX G: ENERGY CONSERVATION MEASURES

ECM Counter		ECM description	est. installed cost, $	est. incentives, $	net est. ECM cost with incentives, $	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, $	total 1st year cost savings, $	life of measure, yrs	est. lifetime cost savings, $	simple payback, yrs	lifetime return on investment, %	annual return on investment, %	internal rate of return, %	net present value, $	CO2 reduced, lbs/yr
1	0 to 5 Year Payback ECM	41 New CFL fixtures to be installed	1,012	0	1,012	2,233	0.5	0	1.5	90	474	5	2,370	2.1	179	36	37	1,147	3,998
		TOTALS	**1,012**	**0**	**1,012**	**2,233**	**1**	**0**	**2**	**90**	**474**		**2,370**	**2.1**	**-**	**-**	**-**	**-**	**3,998**
2	5 to 10 Year Payback	Install (2) new thermostats along with controller	2,200	20	2,180	136	0.0	164	3.2	0	218	15	3,266	10.0	50	3	3	382	2,051
		TOTALS	**2,200**	**20**	**2,180**	**136**	**0.0**	**164**	**3.2**	**0**	**218**		**3,266**	**10.0**	**-**	**-**	**-**	**-**	**2,051**

APPENDIX H: METHOD OF ANALYSIS

Assumptions and tools

Energy modeling tool:	Established/standard industry assumptions
Cost estimates:	RS Means 2009 (Facilities Maintenance & Repair Cost Data) RS Means 2009 (Building Construction Cost Data) RS Means 2009 (Mechanical Cost Data) Published and established specialized equipment material and labor costs Cost estimates also based on utility bill analysis and prior experience with similar projects

Disclaimer

This engineering audit was prepared using the most current and accurate fuel consumption data available for the site. The estimates that it projects are intended to help guide the owner toward best energy choices. The costs and savings are subject to fluctuations in weather, variations in quality of maintenance, changes in prices of fuel, materials, and labor, and other factors. Although we cannot guarantee savings or costs, we suggest that you use this report for economic analysis of the building and as a means to estimate future cash flow.

THE RECOMMENDATIONS PRESENTED IN THIS REPORT ARE BASED ON THE RESULTS OF ANALYSIS, INSPECTION, AND PERFORMANCE TESTING OF A SAMPLE OF COMPONENTS OF THE BUILDING SITE. ALTHOUGH CODE-RELATED ISSUES MAY BE NOTED, SWA STAFF HAVE NOT COMPLETED A COMPREHENSIVE EVALUATION FOR CODE-COMPLIANCE OR HEALTH AND SAFETY ISSUES. THE OWNER(S) AND MANAGER(S) OF THE BUILDING(S) CONTAINED IN THIS REPORT ARE REMINDED THAT ANY IMPROVEMENTS SUGGESTED IN THIS SCOPE OF WORK MUST BE PERFORMED IN ACCORDANCE WITH ALL LOCAL, STATE, AND FEDERAL LAWS AND REGULATIONS THAT APPLY TO SAID WORK. PARTICULAR ATTENTION MUST BE PAID TO ANY WORK WHICH INVOLVES HEATING AND AIR MOVEMENT SYSTEMS, AND ANY WORK WHICH WILL INVOLVE THE DISTURBANCE OF PRODUCTS CONTAINING MOLD, ASBESTOS, OR LEAD.