LOCAL GOVERNMENT ENERGY AUDIT PROGRAM: ENERGY AUDIT REPORT

PREPARED FOR:

MORRIS COUNTY DEPARTMENT OF PUBLIC WORKS
HAGGERTY EDUCATION CENTER
53 E. HANOVER AVE.
WHIPPANY, NJ 07962
ATTN: WILLIAM HUDZIK
SENIOR ENGINEERING AIDE

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I. EXECUTIVE SUMMARY

This report presents the findings of the energy audit conducted for:

Morris County Department of Public Works
Haggerty Education Center at the Frelinghuysen Arboretum
53 East Hanover Ave.
Morristown, NJ 07692

Municipal Contact Person: William Hudzik
Facility Contact Person: Wallace Chang, PE

This audit is performed in connection with the New Jersey Clean Energy - Local Government Energy Audit Program. The energy audit is conducted to promote the mission of the office of Clean Energy, which is to use innovation and technology to solve energy and environmental problems in a way that improves 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:

Electricity	$ 25,084
Natural Gas	$ 7,341
Total	$ 32,425

The potential annual energy cost savings for each energy conservation measure (ECM) and renewable energy measure (REM) are shown below in Table 1. Be aware that the ECM's and REM's are not additive because of the interrelation of some of the measures. This audit is consistent with an ASHRAE level 2 audit. The cost and savings for each measure is ± 20%. The evaluations are based on engineering estimations and industry standard calculation methods. More detailed analyses would require engineering simulation models, hard equipment specifications, and contractor bid pricing.

Table 1
Financial Summary Table

ENERGY CONSERVATION MEASURES (ECM's)					
ECM NO.	**DESCRIPTION**	**NET INSTALLATION COST[A]**	**ANNUAL SAVINGS[B]**	**SIMPLE PAYBACK (Yrs)**	**SIMPLE LIFETIME ROI**
ECM #1	High Efficiency Boiler Replacement	$30,235	$1,264	23.9	25.4%
ECM #2	Condensing Unit Replacement	$27,195	$3,515	7.7	93.9%
ECM #3	New Indoor Air Handling Units	$22,078	$434	50.9	-70.5%
ECM #4	Domestic Hot Water Heater	$4,050	$77	52.6	-71.5%
ECM #5	Lighting Upgrade	$8,339	$2,629	3.2	372.9%
ECM #6	Lighting Controls	$1,820	$776	2.3	539.6%
RENEWABLE ENERGY MEASURES (REM's)					
ECM NO.	**DESCRIPTION**	**NET INSTALLATION COST**	**ANNUAL SAVINGS**	**SIMPLE PAYBACK (Yrs)**	**SIMPLE LIFETIME ROI**
REM #1	Covered Parking Solar Array	$2,254,230	$133,640	16.9	48.2%
Notes:	A. Cost takes into consideration applicable NJ Smart StartTM incentives.				
	B. Savings takes into consideration applicable maintenance savings.				

The estimated demand and energy savings for each ECM and REM is shown below in Table 2. The descriptions in this table correspond to the ECM's and REM's listed in Table 1.

Table 2
Estimated Energy Savings Summary Table

ENERGY CONSERVATION MEASURES (ECM's)				
ECM NO.	DESCRIPTION	ANNUAL UTILITY REDUCTION		
		ELECTRIC DEMAND (KW)	ELECTRIC CONSUMPTION (KWH)	NATURAL GAS (THERMS)
ECM #1	High Efficiency Boiler Replacement	0.00	0.0	1015.0
ECM #2	Condensing Unit Replacement	20.80	19970.0	0.0
ECM #3	New Indoor Air Handling Units	0.60	2463.1	0.0
ECM #4	Domestic Hot Water Heater	0.0	0.0	67.0
ECM #5	Lighting Upgrade	6.59	13348.0	0.0
ECM #6	Lighting Controls	2.19	4409.0	0.0
RENEWABLE ENERGY MEASURES (REM's)				
ECM NO.	DESCRIPTION	ANNUAL UTILITY REDUCTION		
		ELECTRIC DEMAND (KW)	ELECTRIC CONSUMPTION (KWH)	NATURAL GAS (THERMS)
REM #1	Covered Parking Solar Array	125.35	138873.0	0.0

Concord Engineering Group (CEG) recommends proceeding with the implementation of all ECM's that provide a calculated simple payback at or under ten (10) years. The following Energy Conservation Measures are recommended for the facility:

- **ECM #2:** Condensing Unit Replacement
- **ECM #5:** Lighting Upgrade
- **ECM #6:** Lighting Controls

ECM's #1 & #4 do not have a simple payback of less than ten (10) years. However, both the existing hot water boiler and domestic hot water heater have both surpassed their useful service life. Once this type of equipment reaches the end of its useful service life, the overall performance and efficiency of the equipment declines and in turn, the operating expenses increase to the point where it is no longer feasible to keep the equipment in operation. In addition, the risk of complete equipment failure is greater once the end of useful service life is reached. It is our recommendation to proceed with the implementation of these ECM's as they provide valuable and much needed infrastructure improvements for the facility.

In addition, ECM #3 also does not have a simple payback of less than ten (10) years. However, if this ECM is combined with ECM#2, it would provide a simple payback of 12.1 years.

In addition to the ECMs, there are maintenance and operational measures that can provide significant energy savings and provide immediate benefit. The ECMs listed above represent investments that can be made to the facility which are justified by the savings seen overtime. However, the maintenance items and small operational improvements below are typically achievable with on site staff or maintenance contractors and in turn have the potential to provide substantial operational savings compared to the costs associated. The following are recommendations which should be considered a priority in achieving an energy efficient building:

1. Chemically clean the condenser and evaporator coils periodically to optimize efficiency. Poorly maintained heat transfer surfaces can reduce efficiency 5-10%.
2. Maintain all weather stripping on entrance doors.
3. Clean all light fixtures to maximize light output.
4. Provide more frequent air filter changes to decrease overall system power usage and maintain better IAQ.

Renewable Energy Measures (REMs) were also reviewed for implementation at the Haggerty Education Center. CEG utilized a parking lot solar array to house a substantial PV system. The recommended 125.35 kW PV system will produce approximately 138,873 kWh of electricity annually and will reduce the facility's electrical consumption from the grid by 97%. The system's calculated simple payback of 15.4 years is past the standard 10 year simple payback threshold; however, with alternative funding this payback could be lessened. CEG recommends the Owner review all funding options before deciding to not implement this renewable energy measure.

Overall, the Haggerty Education Center appears to be operating at a high efficiency level compared to other buildings of similar occupancy and usage. With the implementation of the above recommended measures the County will realize further energy savings at this facility.

II. INTRODUCTION

The comprehensive energy audit covers the 16,220 square foot Haggerty Education Center which includes the following spaces: Auditorium, Carriage House, Lobby, Gallery, Classrooms, Library, Offices and Restrooms.

Electrical and natural gas utility information is collected and analyzed for one full year's energy use of the building. The utility information allows for analysis of the building's operational characteristics; calculate energy benchmarks for comparison to industry averages, estimated savings potential, and baseline usage/cost to monitor the effectiveness of implemented measures. A computer spreadsheet is used to calculate benchmarks and to graph utility information (see the utility profiles below).

The Energy Use Index (EUI) is established for the building. Energy Use Index (EUI) is expressed in British Thermal Units/square foot/year (BTU/ft^2/yr), which is used to compare energy consumption to similar building types or to track consumption from year to year in the same building. The EUI is calculated by converting the annual consumption of all energy sources to BTU's and dividing by the area (gross square footage) of the building. Blueprints (where available) are utilized to verify the gross area of the facility. The EUI is a good indicator of the relative potential for energy savings. A low EUI indicates less potential for energy savings, while a high EUI indicates poor building performance therefore a high potential for energy savings.

Existing building architectural and engineering drawings (where available) are utilized for additional background information. The building envelope, lighting systems, HVAC equipment, and controls information gathered from building drawings allow for a more accurate and detailed review of the building. The information is compared to the energy usage profiles developed from utility data. Through the review of the architectural and engineering drawings a building profile can be defined that documents building age, type, usage, major energy consuming equipment or systems, etc.

The preliminary audit information is gathered in preparation for the site survey. The site survey provides critical information in deciphering where energy is spent and opportunities exist within a facility. The entire site is surveyed to inventory the following to gain an understanding of how each facility operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Facility-specific equipment

The building site visit is performed to survey all major building components and systems. The site visit includes detailed inspection of energy consuming components. Summary of building occupancy schedules, operating and maintenance practices, and energy management programs provided by the building manager are collected along with the system and components to determine a more accurate impact on energy consumption.

III. METHOD OF ANALYSIS

Post site visit work includes evaluation of the information gathered, researching possible conservation opportunities, organizing the audit into a comprehensive report, and making recommendations on HVAC, lighting and building envelope improvements. Data collected is processed using energy engineering calculations to anticipate energy usage for each of the proposed energy conservation measures (ECMs). The actual building's energy usage is entered directly from the utility bills provided by the owner. The anticipated energy usage is compared to the historical data to determine energy savings for the proposed ECMs.

It is pertinent to note, that the savings noted in this report are not additive. The savings for each recommendation is calculated as standalone energy conservation measures. Implementation of more than one ECM may in some cases affect the savings of each ECM. The savings may in some cases be relatively higher if an individual ECM is implemented in lieu of multiple recommended ECMs. For example implementing reduced operating schedules for inefficient lighting will result in a greater relative savings. Implementing reduced operating schedules for newly installed efficient lighting will result in a lower relative savings, because there is less energy to be saved. If multiple ECM's are recommended to be implemented, the combined savings is calculated and identified appropriately.

ECMs are determined by identifying the building's unique properties and deciphering the most beneficial energy saving measures available that meet the specific needs of the facility. The building construction type, function, operational schedule, existing conditions, and foreseen future plans are critical in the evaluation and final recommendations. Energy savings are calculated base on industry standard methods and engineering estimations. Energy consumption is calculated based on manufacturer's cataloged information when new equipment is proposed.

Cost savings are calculated based on the actual historical energy costs for the facility. Installation costs include labor and equipment costs to estimate the full up-front investment required to implement a change. Costs are derived from Means Cost Data, industry publications, and local contractors and equipment suppliers. The NJ Smart Start Building® program incentives savings (where applicable) are included for the appropriate ECM's and subtracted from the installed cost. Maintenance savings are calculated where applicable and added to the energy savings for each ECM. The life-time for each ECM is estimated based on the typical life of the equipment being replaced or altered. The costs and savings are applied and a simple payback, simple lifetime savings, and simple return on investment are calculated. See below for calculation methods:

ECM Calculation Equations:

$$Simple\ Payback = \left(\frac{Net\ Cost}{Yearly\ Savings} \right)$$

$$Simple\ Lifetime\ Savings = \left(Yearly\ Savings \times ECM\ \ Lifetime \right)$$

$$Simple\ Lifetime\ ROI = \frac{(Simple\ Lifetime\ Savings - Net\ Cost)}{Net\ Cost}$$

$$Lifetime\ Maintenance\ Savings = \left(Yearly\ Maintenance\ Savings \times ECM\ \ Lifetime \right)$$

$$Internal\ \ Rate\ of\ \ Return = \sum_{n=0}^{N} \left(\frac{\text{Cash Flow of Period}}{(1 + \text{IRR})^{n}} \right)$$

$$Net\ \ Present\ Value = \sum_{n=0}^{N} \left(\frac{\text{Cash Flow of Period}}{(1 + \text{DR})^{n}} \right)$$

Net Present Value calculations based on Interest Rate of 3%.

IV. HISTORIC ENERGY CONSUMPTION/COST

A. Energy Usage / Tariffs

The energy usage for the facility has been tabulated and plotted in graph form as depicted within this section. Each energy source has been identified and monthly consumption and cost noted per the information provided by the Owner.

The electric usage profile represents the actual electrical usage for the facility. Jersey Central Power and Light (JCP&L) provides electricity to the facility under their General Service Secondary Three-Phase rate structure. A Third Part Supplier (TPS) has not been contracted. The electric utility measures consumption in kilowatt-hours (KWH) and maximum demand in kilowatts (KW). One KWH usage is equivalent to 1000 watts running for one hour. One KW of electric demand is equivalent to 1000 watts running at any given time. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges. Rates used in this report reflect the historical data received for the facility.

The gas usage profile shows the actual natural gas energy usage for the facility. Public Service Electric and Gas (PSE&G) provides natural gas to the facility under the General Supply Service (GSG) rate structure. A Third Part Supplier (TPS) has not been contracted. The gas utility measures consumption in cubic feet x 100 (CCF), and converts the quantity into Therms of energy. One Therm is equivalent to 100,000 BTUs of energy.

The overall cost for utilities is calculated by dividing the total cost by the total usage. Based on the utility history provided, the average cost for utilities at this facility is as follows:

Description	Average
Electricity	17.6¢ / kWh
Natural Gas	$1.15 / Therm

Table 3
Electricity Billing Data

ELECTRIC USAGE SUMMARY

Utility Provider: JCP&L
Rate: General Service Secondary 3-Phase
Meter No: G21057330
Account # 10 00 05 4022 90
Third Party Utility Provider: N/A
TPS Meter / Acct No: N/A

MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Jan-10	12,230	64.2	$2,057
Feb-10	10,880	64.2	$1,849
Mar-10	10,240	45.6	$1,769
Apr-10	9,760	64.2	$1,672
May-10	12,880	53.4	$2,356
Jun-10	11,200	54.7	$2,062
Jul-10	10,800	74.2	$2,138
Aug-10	14,160	55.4	$2,514
Sep-10	11,280	53.1	$2,002
Oct-10	10,880	50.4	$1,926
Nov-10	11,200	51.9	$1,982
Dec-10	16,640	53.0	$2,758
Totals	**142,150**	**74.2 Max**	**$25,084**

AVERAGE DEMAND **57.0 KW average**

AVERAGE RATE **$0.176** **$/kWh**

Figure 1
Electricity Usage Profile

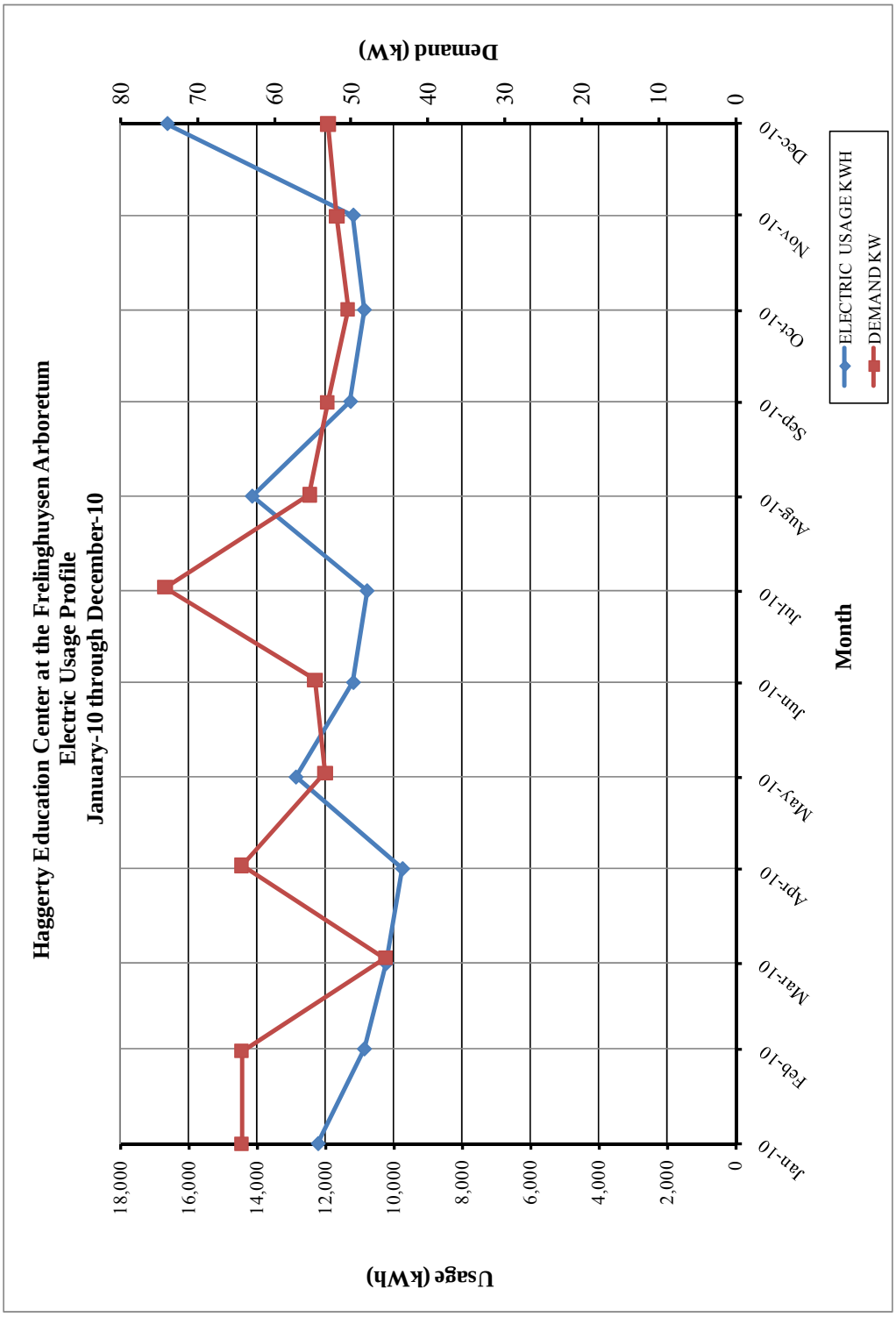
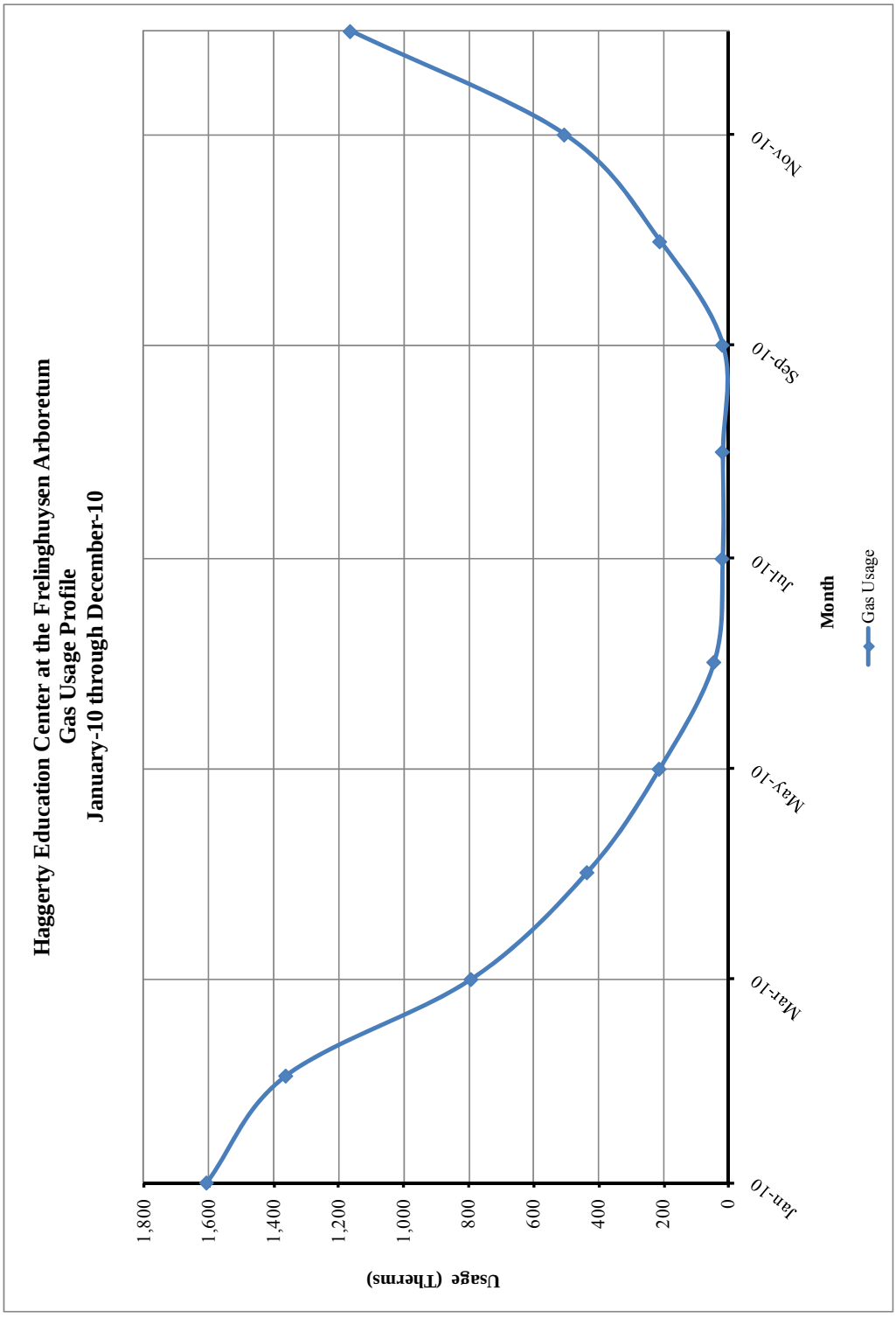


Table 4
Natural Gas Billing Data

NATURAL GAS USAGE SUMMARY		
Utility Provider: PSE&G		
Rate: GSG		
Meter No: 2278719		
Point of Delivery ID: PG0000008554873382122		
Third Party Utility Provider: N/A		
TPS Meter No: N/A		
MONTH OF USE	**CONSUMPTION (THERMS)**	**TOTAL BILL**
Jan-10	1,605.67	$1,962.41
Feb-10	1,361.80	$1,648.58
Mar-10	791.70	$919.20
Apr-10	434.86	$429.52
May-10	212.65	$220.26
Jun-10	44.39	$53.91
Jul-10	18.65	$29.90
Aug-10	18.00	$27.16
Sep-10	18.10	$27.59
Oct-10	210.78	$213.05
Nov-10	504.67	$526.60
Dec-10	1,163.55	$1,283.23
TOTALS	**6,384.81**	**$7,341.41**
AVERAGE RATE:	**$1.15**	**$/THERM**

Figure 2
Natural Gas Usage Profile



B. Energy Use Index (EUI)

Energy Use Index (EUI) is a measure of a building's annual energy utilization per square foot of building. This calculation is completed by converting all utility usage consumed by a building for one year, to British Thermal Units (BTU) and dividing this number by the building square footage. EUI is a good measure of a building's energy use and is utilized regularly for comparison of energy performance for similar building types. The Oak Ridge National Laboratory (ORNL) Buildings Technology Center under a contract with the U.S. Department of Energy maintains a Benchmarking Building Energy Performance Program. The ORNL website determines how a building's energy use compares with similar facilities throughout the U.S. and in a specific region or state.

Source use differs from site usage when comparing a building's energy consumption with the national average. Site energy use is the energy consumed by the building at the building site only. Source energy use includes the site energy use as well as all of the losses to create and distribute the energy to the building. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, which allows for a complete assessment of energy efficiency in a building. The type of utility purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the most comparable unit for evaluation purposes and overall global impact. Both the site and source EUI ratings for the building are provided to understand and compare the differences in energy use.

The site and source EUI for this facility is calculated as follows:

$$Building\ Site\ EUI = \frac{(Electric\ Usage\ in\ kBtu + Gas\ Usage\ in\ kBtu)}{Building\ Square\ Footage}$$

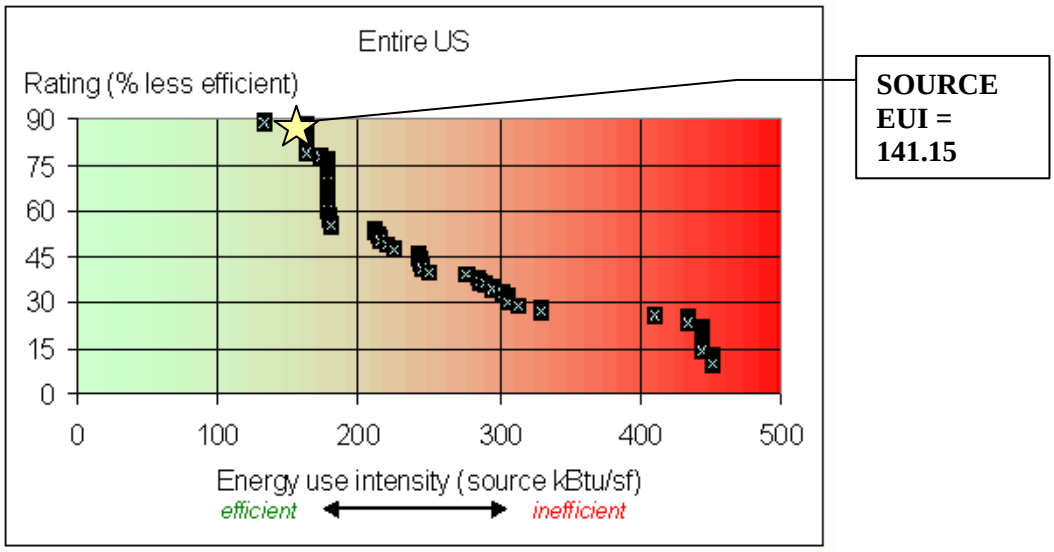
$$Building\ Source\ EUI = \frac{(Electric\ Usage\ in\ kBtu\ X\ SS\ Ratio + Gas\ Usage\ in\ kBtu\ X\ SS\ Ratio)}{Building\ Square\ Footage}$$

Table 5
Facility Energy Use Index (EUI) Calculation

ENERGY USE INTENSITY CALCULATION						
ENERGY TYPE	**BUILDING USE**			**SITE ENERGY**	**SITE-SOURCE RATIO**	**SOURCE ENERGY**
	kWh	**Therms**	**Gallons**	**kBtu**		**kBtu**
ELECTRIC	142,150.0			485,300	3.340	1,620,902
NATURAL GAS		6,384.8		638,481	1.047	668,490
TOTAL				1,123,781		2,289,392
*Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued Dec 2007.						
BUILDING AREA		16,220	SQUARE FEET			
BUILDING SITE EUI		*69.28*	kBtu/SF/YR			
BUILDING SOURCE EUI		*141.15*	kBtu/SF/YR			

Figure 3 below depicts a national EUI grading for the source use of *Public Order and Safety Buildings*.

Figure 3
Source Energy Use Intensity Distributions: Public Order Buildings



C. EPA Energy Benchmarking System

The United States Environmental Protection Agency (EPA) in an effort to promote energy management has created a system for benchmarking energy use amongst various end users. The benchmarking tool utilized for this analysis is entitled Portfolio Manager. The Portfolio Manager tool allows tracking and assessment of energy consumption via the template forms located on the ENERGY STAR website (www.energystar.gov). The importance of benchmarking for local government municipalities is becoming more important as utility costs continue to increase and emphasis is being placed on carbon reduction, greenhouse gas emissions and other environmental impacts.

Based on information gathered from the ENERGY STAR website, Government agencies spend more than $10 billion a year on energy to provide public services and meet constituent needs. Furthermore, energy use in commercial buildings and industrial facilities is responsible for more than 50 percent of U.S. carbon dioxide emissions. It is vital that local government municipalities assess facility energy usage, benchmark energy usage utilizing Portfolio Manager, set priorities and goals to lessen energy usage and move forward with priorities and goals.

The client had previously created a Portfolio Manager Account for all of their facilities. CEG utilized the current information contained in the online account for the purposes of this report. The login page for the account can be accessed at the following web address; the username and password are also listed below:

https://www.energystar.gov/istar/pmpam/index.cfm?fuseaction=login.login

User Name: MorrisCounty
Password: CMORR001

The utility bills and other information gathered during the energy audit process are entered into the Portfolio Manager. The following is a summary of the results for the facility:

Table 6
ENERGY STAR Performance Rating

ENERGY STAR PERFORMANCE RATING		
FACILITY DESCRIPTION	**ENERGY PERFORMANCE RATING**	**NATIONAL AVERAGE**
Haggerty Education Center	71	50

Refer to **Statement of Energy Performance Appendix** for the detailed energy summary.

V. FACILITY DESCRIPTION

The Haggerty Education Center is a two story facility with approximately 16,220 SF of floor space. The original portion of the building was constructed in 1902, and was used as a private residence. In 1989, the Education Center portion of the facility was constructed. This portion of the building is comprised of a main lobby, an auditorium, classrooms, a library and offices. The typical hours of operation of the facility are Sunday thru Saturday from 9:00am to 4:30 pm. During the week, the maintenance staff is in the building from 8:00 am to 10:00 pm regularly.

The building's upper level exterior walls are constructed of 6" studs with insulation. The outside of the building is a painted wood siding. Portions of the original building have a stone façade. The interior walls of the building are painted GWB. The lower level walls are constructed of 10" masonry blocks. The amount of insulation in the wall cavity is unknown. The windows throughout the facility are in good condition and appear to be maintained. Typical windows in throughout the facility are double pane, ¼" clear glass with wooden frames. Blinds are utilized through the facility per occupant comfort. The blinds are valuable because they help to reduce heat loss in the winter and reduce solar heat in the summer. The main lobby windows are a single pane, ½" un-insulated glass with wooden frames. The roof is a sloped, wooden frame roof with shingles. The roof appears to be standard asphalt shingles. The amount of insulation below the roof is unknown.

HVAC Systems

The newer portion of the building is heated and cooled by three indoor air handling units of varying capacity. These units are located in the lower level mechanical room. All three units utilize a split system D/X cooling coil and a hot water heating coil. This air handling units are original and appear to be in fair condition.

There is a gas fired hot water boiler with associated circulator pump located in the lower level mechanical room. This boiler supplies heating hot water to the air handling unit heating coils, perimeter finned-tube radiation located on both levels and several unit heaters. This boiler is the original unit placed in service with the new addition and appears to be in fair condition.

Conditioned air is distributed throughout the newer portion of the facility via insulated ductwork and ceiling and wall mounted diffusers. The older portion of the facility is not conditioned.

The three main heating and cooling air handling units are controlled via wall mounted programmable thermostats. At the time of the survey the thermostats were set between 68°F and 70°F for heating mode and between 70°F and 72°F in cooling mode.

Exhaust System

Air is exhausted from the toilet rooms through the roof exhausters. Toilet room exhaust fans are operated via room mounted wall switches. There is also an exhaust hood located on the training kitchen. It was noted at the time of the survey that this hood is only used for cooking demonstrations and is not used that often.

HVAC System Controls

The three main heating and cooling air handling units are controlled via wall mounted programmable thermostats. At the time of the survey the thermostats were set between 68°F and 70°F for heating mode and between 70°F and 72°F in cooling mode.

Domestic Hot Water

Domestic hot water for the restrooms, office lounge and kitchen is provided by a 40 gallon A.O. Smith gas fired hot water heater, with a heating capacity of 32.5 MBH and a recovery rate of 32.8 gallons per hour. The domestic hot water heater, distribution piping and piping insulation appeared to be in good condition.

Lighting

Typical lighting throughout building is fluorescent tube lay-in fixtures with T-12 lamps and magnetic ballasts. Storage rooms and closets lit with a mixture of incandescent lamps and compact fluorescent lamps. The parking lot is lit with light poles and high pressure sodium lamps.

VI. MAJOR EQUIPMENT LIST

The equipment list contains major energy consuming equipment that through implementation of energy conservation measures could yield substantial energy savings. The list shows the major equipment in the facility and all pertinent information utilized in energy savings calculations. An approximate age was assigned to the equipment in some cases if a manufactures date was not shown on the equipment's nameplate. The ASHRAE service life for the equipment along with the remaining useful life is also shown in the Appendix.

Refer to the **Major Equipment List Appendix** for this facility.

VII. ENERGY CONSERVATION MEASURES

ECM #1: High Efficiency Boiler Replacement

Description:

Space heating for the building is provided with hot water coils in the building air handling units and hot water baseboard radiators. The source of hot water for this equipment is a single hot water boiler located in the lower level mechanical room.

The boiler is a 450 MBH, Weil McLain standard efficiency, hot water boiler. This boiler is in fair condition and is approximately 25 years old, which is approaching its useful life of 30 years per ASHRAE guidelines.

Typically, standard (non-condensing) boilers provide lower than nominal efficiency compared to condensing boilers. Standard boilers suffer further efficiency losses at part load operating conditions mainly due to limitations in the reduction of the flue gas temperature. Current average combustion efficiency of each boiler is estimated to be 75% due to standard non-condensing boiler technology, limited turn down ratio, cycling losses and outdated design and controls. A new condensing boiler could substantially improve the operating efficiency of the heating system of the building. Condensing boiler's peak efficiency tops out at 99% depending on return water temperature.

CEG recommends replacing the Weil McLain boiler with a condensing hot water boiler to provide building with heating throughout the year. The annual average operating efficiency of the proposed boiler is expected to be 90%, which gives the heating system an approximate 15% increase in efficiency. This ECM is based on variable supply water temperature adjusted based on outdoor temperature.

This ECM includes installation of a single, new condensing gas fired boiler to replace the existing hot water boiler based on following summary.

BOILER REPLACEMENT SUMMARY		
EXISTING UNIT	**LOCATION**	**PROPOSED UNITS**
(1) 450 MBH Boilers	Lower Level Mechanical Room	(1) 606 MBH Condensing Boiler

The basis for this ECM is Aerco Modulex MLX606H condensing hot water boiler or equivalent. The owner is recommended to retain a professional engineer to confirm equipment sizing and finalize design.

Energy Savings Calculations:

Currently there is a boiler and gas fired hot water heater on the gas meter. The boilers' gas usage is not separately metered. Therefore, annual energy consumption of the boilers has to be estimated. In this calculation, it is assumed that the energy consumption of the boilers will be in proportion with the ratio of the total heating capacity of each equipment.

First, domestic hot water usage is estimated and subtracted from the total usage in order to estimate the net natural gas usage for space heating.

Current total hot water usage can be found in the table below:

ANNUAL GAS USAGE				
MONTH	**TOTAL USAGE THERMS**	**DOMESTIC HW USAGE**	**HEATING ONLY**	**COST**
Jan-10	1,606	25	1,581	$2,266
Feb-10	1,362	25	1,337	$1,688
Mar-10	792	25	767	$1,016
Apr-10	435	25	410	$522
May-10	213	25	188	$199
Jun-10	44	25		$0
Jul-10	19	25		$0
Aug-10	18	25		$0
Sep-10	18	25		$0
Oct-10	211	25	186	$205
Nov-10	505	25	480	$509
Dec-10	1,164	25	1,139	$1,178
TOTAL	**6,385**	**297**	**6,087**	**$7,584**

Baseline Domestic Hot Water Gas Use = 25 Therms (Average from June-September Gas Use)

Existing Natural Gas Use for Heating = 6,385 Therms – (25 Therms x 12 Months)
= 6,085 Therms

$$\text{Bldg Heat Required} = \text{Heating Nat. Gas (Therm)} \times \text{Heating Eff (\%)} \times \text{Fuel Heat Value } \left(\frac{\text{BTU}}{\text{Therm}}\right)$$

$$\text{Proposed Heating Gas Usage} = \frac{\text{Bldg. Heat Required (BTU)}}{\text{New Heating Eff (\%)} \times \text{Fuel Heat Value } \left(\frac{\text{BTU}}{\text{Therm}}\right)}$$

$$\text{Energy Cost} = \text{Heating Gas Usage (Therms)} \times \text{Ave Fuel Cost } \left(\frac{\$}{\text{Therm}}\right)$$

Energy savings calculations are summarized in the table below:

CONDENSING BOILER CALCULATIONS			
ECM INPUTS	**EXISTING**	**PROPOSED**	**SAVINGS**
ECM INPUTS	Existing Hot Water Boiler	New Condensing Boiler	-
Existing Nat Gas (Therms)	6,087	-	-
Boiler Efficiency (%)	75%	90%	15%
Nat Gas Heat Value (BTU/Therm)	100,000	100,000	-
Equivalent Building Heat Usage (MMBTUs)	457	457	-
Ave. Gas Cost ($/Therm) (Heating season only)	1.15	1.15	-
ENERGY SAVINGS CALCULATIONS			
ECM RESULTS	**EXISTING**	**PROPOSED**	**SAVINGS**
Natural Gas Usage (Therms)	6,087	5,073	1,015
Energy Cost ($)	$7,583	$6,319	$1,264
COMMENTS:			

Project Cost, Incentives and Maintenance Savings

Estimated cost for removing the existing boilers and installing (1) 606 MBH condensing hot water boiler with advanced controls is $32,500.

From the **New Jersey Smart Start® Program Incentives Appendix**, installation of a high efficiency hot water boiler falls under the category "Gas Heating" and warrants an incentive based on efficiency at or above 84% for this type of equipment. The program incentives are calculated as follows:

GAS FIRED BOILER REBATE SUMMARY					
UNIT DESCRIPTION	**UNIT EFFICIENCY**	**REBATE $/MBH**	**PROPOSED CAPACITY, MBH**	**NUMBER OF UNITS**	**TOTAL REBATE, $**
≥ 300 MBH - 1500 MBH	84% AFUE for Hot Water boilers	$1.75	1,500	1	$2,625
TOTAL					**$2,625**

Maintenance savings associated with this ECM is estimated to be minimal.

Energy Savings Summary:

ECM #1 - ENERGY SAVINGS SUMMARY	
Installation Cost ($):	$32,500
NJ Smart Start Equipment Incentive ($):	$2,265
Net Installation Cost ($):	$30,235
Maintenance Savings ($/Yr):	$0
Energy Savings ($/Yr):	$1,264
Total Yearly Savings ($/Yr):	$1,264
Estimated ECM Lifetime (Yr):	30
Simple Payback	23.9
Simple Lifetime ROI	25.4%
Simple Lifetime Maintenance Savings	$0
Simple Lifetime Savings	$37,920
Internal Rate of Return (IRR)	2%
Net Present Value (NPV)	($5,460.04)

ECM #2: Condensing Unit Replacement

Description:

Direct expansion cooling is provided to the building indoor air handlers by three (3) outdoor split condensing units. The split system units are in fair to poor condition and have already reached the end of their useful service life of 15 years as outlined by ASHRAE.

Usually, energy savings derived from replacing condensing units does not have a reasonable payback term. Nevertheless, as the equipment ages, it loses efficiency due to clogged condensers, internal parts wear and deposits of oil and other contaminants on the heat exchangers. Replacing an older condensing unit avoids these issues along with some energy savings. In addition, new high-end condensing units have significantly higher full load and part load efficiencies.

This energy conservation measure includes replacement of the outdoor condensing units with new high efficiency condensing units utilizing 410A refrigerant and replacement of the DX coils in the Air Handling Units AHU-1, 2 & 3 to accommodate higher pressure refrigerant. The cost of this ECM also includes running new refrigerant lines. The basis for this ECM is TRANE Odyssey air cooled condensing Unit.

It must be noted that manufacturing of the refrigerant gas R-22 is phased out as of 2010. Although, the HVAC manufacturers continue to produce condensers and heat pumps using R22 from pre-existing R22 supplies, the availability of R22 gas will decline over the next years and R22 equipment will be more expensive to maintain.

Cooling Energy Savings Calculations:

Current Condensing Unit Full Load Efficiency	= 8.5 EER (when new)
Proposed Efficiency	= 12.2 EER (10 Ton)
	= 12.6 EER (15 Ton)
Current Condensing Unit Part Load Efficiency	= 8.9 IPLV* (when new)
Proposed Load Efficiency	= 15.9 IPLV (10 Ton)
	= 17.3 IPLV (15 Ton)

** Integrated Part Load Value*
The part load efficiency values are used in the energy savings calculation except demand savings calculations, since majority of operation hours of these units occur at part load conditions.

Annual Cooling Hours of Operation = 960 hrs/yr (4 months, 20 days/month, 12 hours/day)

$$\text{Energy Savings, kWh} = \frac{\text{Total Cooling Capacity, } \frac{\text{BTU}}{\text{RT}}}{1000\,\frac{\text{W}}{\text{kW}}} \times \left[\frac{1}{\text{IPLV}_{\text{Old}}} - \frac{1}{\text{IPLV}_{\text{New}}}\right] \times \text{Total Cooling Hours}$$

$$\text{Demand Savings, kW} = \frac{\text{Total Cooling Capacity, } \frac{\text{BTU}}{\text{RT}}}{1000\frac{\text{W}}{\text{kW}}} \times \left[\frac{1}{\text{EER}_{\text{Old}}} - \frac{1}{\text{EER}_{\text{New}}}\right]$$

$$\text{Utility Cost Savings} = \text{Total Electric Energy Savings, kWh} \times \text{Cost of Electricity}\frac{\$}{\text{kWh}}$$

Results of the energy savings calculations are summarized below:

AIR COOLED CONDENSING UNITS							
EXISTING UNIT	**COOLING CAPACITY, BTU/Hr**	**ANNUAL COOLING HOURS**	**IPLV EXISTING UNIT**	**IPLV PROPOSED UNIT**	**# OF UNITS**	**ENERGY SAVINGS kWh**	**DEMAND SAVINGS kW**
CU-1	120,000	960	8.9	15.9	1	5,699	5.9
CU-2	102,000	960	8.9	15.9	1	4,844	5.0
CU-3	180,000	960	8.9	17.3	1	9,427	9.8
Total					3	19,970	20.8

Equipment Cost and Incentives:

Estimated installed cost of a three (3) new cooled condensing units with varying capacity, new R410a evaporator coils, controls and piping is $29,750.

From the **New Jersey Smart Start® Program Incentives Appendix**, installation of a high efficiency split condensing units falls under the category "Electric Unitary HVAC" and warrants an incentive based on efficiency this type of equipment. The program incentives are calculated as follows:

SPLIT AC CONDENSING UNITS REBATE SUMMARY				
UNIT DESCRIPTION	**UNIT EFFICIENCY**	**REBATE $/TON**	**PROPOSED CAPACITY TONS**	**TOTAL REBATE $**
Unitary AC and Split Systems	≥10.5 EER	$73	35	$2,555
TOTAL			**35**	**$2,555**

Energy Savings Summary:

ECM #2 - ENERGY SAVINGS SUMMARY	
Installation Cost ($):	$29,750
NJ Smart Start Equipment Incentive ($):	$2,555
Net Installation Cost ($):	$27,195
Maintenance Savings ($/Yr):	$0
Energy Savings ($/Yr):	$3,515
Total Yearly Savings ($/Yr):	$3,515
Estimated ECM Lifetime (Yr):	15
Simple Payback	7.7
Simple Lifetime ROI	93.9%
Simple Lifetime Maintenance Savings	$0
Simple Lifetime Savings	$52,725
Internal Rate of Return (IRR)	10%
Net Present Value (NPV)	$14,766.84

ECM #3 – New Indoor Air Handling Units

Description:

Three (3) indoor air handling units with hot water heating coils that have surpassed there expected service life of fifteen (15) years as outlined in Chapter 36 of the 2007 ASHRAE Applications Handbook. These units appear to be 1988 vintage, and are excellent candidates for replacement. Due to escalating owning and maintenance costs, these units should be replaced. Each of these units contains a hot water heating section and D/X coil and savings can we yielded from year round operation. The units range from 3,000 CFM (cubic feet per minute) to 4,800 cfm capacity.

This energy conservation measure would replace air handling units with fan motors equal to or greater than 1 HP with new air handling units having NEMA Premium® Efficient Motors. NEMA Premium® is the most efficient motor designation in the marketplace today. The Trane M-series or equivalents were utilized as a basis of design. Because many units operate 40-80 hours per week, even small increases in efficiency can yield substantial energy and dollar savings.

Energy Savings Calculations:

Annual Hours of Operations = 4368 (Average)
1 HP = 0.746 Watt
Load Factor = 75%
Cost of electricity = $0.176 / kWh

AHU Motor Operating Cost =
{0.746 Watt/HP x Motor HP x Load Factor x Hours of Operation x Cost of Electricity] ÷ Motor Efficiency

New AHU with NEMA Premium Motor Efficiency = 86.5%

Results of the energy savings calculations are summarized below:

AHU W/ NEMA PREMIUM EFFCIENCY MOTOR REPLACEMENT								
UNIT NO.	**MOTOR HP**	**QTY**	**EXISTING EFFICIENCY**	**NEMA PREMIUM EFFICIENCY**	**KW SAVINGS**	**KWH SAVINGS**	**COST SAVINGS**	**TOTAL SAVINGS**
AHU-1	3	1	78.0%	86.5%	0.21	924	$163	$163
AHU-2	2	1	78.0%	86.5%	0.14	616	$108	$108
AHU-3	3	1	78.0%	86.5%	0.21	924	$163	$163
					0.6	**2,463.1**	**$434**	**$434**

Installed Cost of a 3000 CFM AHU with a 2 HP NEMA Premium® Efficiency Motor = $6,000
The SmartStart Building® incentive of 2hp x $54/motor is $54
Net installed Cost = $6,000 - $54 = $5,946.

Installed Cost of a 4000 CFM AHU with a 3 HP NEMA Premium® Efficiency Motor = $8,000
The SmartStart Building® incentive of 3hp x $54/motor is $54
Net installed Cost = $8,000 - $54 = $7,946.

Installed Cost of a 4800 CFM AHU with a 3 HP NEMA Premium® Efficiency Motor = $12,000
The SmartStart Building® incentive of 3hp x $54/motor is $54
Net installed Cost = $8,000 - $54 = $7,946.

Energy Savings Summary:

ECM #3 - ENERGY SAVINGS SUMMARY	
Installation Cost ($):	$22,240
NJ Smart Start Equipment Incentive ($):	$162
Net Installation Cost ($):	$22,078
Maintenance Savings ($/Yr):	$0
Energy Savings ($/Yr):	$434
Total Yearly Savings ($/Yr):	$434
Estimated ECM Lifetime (Yr):	15
Simple Payback	50.9
Simple Lifetime ROI	-70.5%
Simple Lifetime Maintenance Savings	$0
Simple Lifetime Savings	$6,510
Internal Rate of Return (IRR)	-12%
Net Present Value (NPV)	($16,896.94)

ECM #4 – Condensing Domestic Hot Water Heater

Description:

The primary source for domestic hot water for the building is provided by a 40 Gallon, 32.5 MBH gas fired hot water heater. The heater provides hot water for the lavatories, utility sinks and the kitchenette. The existing hot water heater is approximately 23 years old and has far surpassed its useful life. The original thermal efficiency of the hot water heater was 80%, however, based on the heater's age it can be assumed that the efficiency of the unit has degraded over time. For the purpose of this ECM calculation, we have assumed an actual thermal efficiency of 75%. Condensing hot water heaters provide substantially improved operating costs over standard efficiency hot water heaters. The thermal efficiency of condensing hot water heaters is approximately 95%.

This ECM includes installation of a new central tank type condensing hot water heater to replace the existing standard efficiency hot water heater. The basis for this ECM is the AO Smith condensing hot water heater model number BTX 80 to replace the existing tank style hot water heater.

Energy Savings Calculations:

$$\text{Dom. HW Gas Usage} = \frac{\text{Dom HW Heat Cons.}(\text{Btu})}{\text{Heating Eff.}(\%) \times \text{Fuel Heat Value}\left(\frac{\text{BTU}}{\text{Therm}}\right)}$$

$$\text{Gas Energy Cost} = \text{Heating Gas Usage}(\text{Therms}) \times \text{Ave Fuel Cost}\left(\frac{\$}{\text{Therm}}\right)$$

CONDENSING DOM. HOT WATER HEATER CALCULATIONS			
ECM INPUTS	**EXISTING**	**PROPOSED**	**SAVINGS**
ECM INPUTS	Existing Hot Water Heater	High Efficiency Condensing HW Heater	
Number of People (Average)	45	45	
Lavatory Sink Time (Minutes)	0.25	0.25	
Sink Uses per Day per Person	4	4	
Faucet Gallons Per Minute (GPM)	2.5	2.5	
Domestic Water Temperature Change (°F)	70	70	
Sink Usage (BTU)	23,943,544	23,943,544	
Heating Efficiency	75%	95%	
Total Usage (BTU)	23,943,544	23,943,544	
Nat Gas Cost ($/Therm)	1.15	1.15	
ENERGY SAVINGS CALCULATIONS			
ECM RESULTS	**EXISTING**	**PROPOSED**	**SAVINGS**
Electric Consumption (kWh)		0	0
Nat Gas Consumption (Therms)	319	252	67
Energy Cost ($)	$367	$290	$77
COMMENTS:	*Savings are based on LEED-NC Version 2.2 Reference Guide for faucet and shower flow rates. Usage per person is estimated.		

Typical installed cost for a condensing hot water heater is estimated to be $4,100.

From the NJ Smart Start® Program appendix, the hot water heater installation falls under the category "Gas Water Heating" and warrants an incentive as follows:

$$\text{Smart Start®}\ Incentive = (\#\ of\ \ HWHs \times\ \$\ 50) = (1 \times \$50) = \$50$$

Energy Savings Summary:

ECM #4 - ENERGY SAVINGS SUMMARY	
Installation Cost ($):	$4,100
NJ Smart Start Equipment Incentive ($):	$50
Net Installation Cost ($):	$4,050
Maintenance Savings ($/Yr):	$0
Energy Savings ($/Yr):	$77
Total Yearly Savings ($/Yr):	$77
Estimated ECM Lifetime (Yr):	15
Simple Payback	52.6
Simple Lifetime ROI	-71.5%
Simple Lifetime Maintenance Savings	$0
Simple Lifetime Savings	$1,155
Internal Rate of Return (IRR)	-13%
Net Present Value (NPV)	($3,130.78)

ECM #5: Lighting Upgrade - General

Description: General

The lighting in the Haggerty Education Center is primarily made up of fluorescent fixtures with T-12 lamps and magnetic ballasts. There are a few areas of the building that utilize incandescent lighting and compact fluorescent fixtures.

This ECM includes replacement of the existing fixtures containing T12 lamps and magnetic ballasts with fixtures containing T8 lamps and electronic ballasts. The new energy efficient, T8 fixtures will provide adequate lighting and will save the owner on electrical costs due to the better performance of the lamp and ballasts. This ECM will also provide maintenance savings through the reduced number of lamps replaced per year. The expected lamp life of a T8 lamp is approximately 30,000 burn-hours, in comparison to the existing T12 lamps which is approximately 20,000 burn-hours. The facility will need 33% less lamps replaced per year.

This ECM also includes replacement of all incandescent lamps to compact fluorescent lamps. The energy usage of an incandescent compared to a compact fluorescent approximately 3 to 4 times greater. In addition to the energy savings, compact fluorescent fixtures burn-hours are 8 to 15 times longer than incandescent fixtures ranging from 6,000 to 15,000 burn-hours compared to incandescent fixtures ranging from 750 to 1000 burn-hours.

Energy Savings Calculations:

The **Investment Grade Lighting Audit Appendix – ECM#1** outlines the proposed retrofits, costs, savings, and payback periods.

NJ Smart Start® Program Incentives are calculated as follows:

From the **Smart Start Incentive Appendix**, the following incentives are warranted:

Retrofit fluorescent T12 lamps and magnetic ballast with T-5 or T-8 lamps w/electronic ballast (1-2 lamp retrofitted) = $25 per fixture.

$$\text{Smart Start®}\ \textit{Incentive} = \left(\#\ \textit{of}\ 1-2\ \textit{lamp fixtures retrofitted} \times\ \$\ 25\right)$$
$$\text{Smart Start®}\ \textit{Incentive} = \left(24 \times\ \$\ 25\right) = \underline{\$600}$$

Retrofit fluorescent T12 lamps and magnetic ballast with T-5 or T-8 lamps w/electronic ballast (3-4 lamp retrofitted) = $30 per fixture.

$$\text{Smart Start®}\ \textit{Incentive} = \left(\#\ \textit{of}\ 1-2\ \textit{lamp fixtures retrofitted} \times\ \$\ 25\right)$$
$$\text{Smart Start®}\ \textit{Incentive} = \left(57 \times\ \$\ 30\right) = \underline{\$1710}$$

Replacement of incandescent bulbs with screw-in PAR38 or PAR30 (CFL) bulbs = $7 per bulb.

$$\text{Smart Start® } Incentive = (\#\ of\ \ PAR38\ or\ PAR30 CFL Bulbs \times\ \$\ 7)$$
$$\text{Smart Start® } Incentive = (27 \times\ \$\ 7) = \underline{\$189}$$

Total Incentive:

$$\text{Total Smart Start® } Incentive = \$1{,}710 + \$600 + \$189 = \underline{\$2{,}499}$$

Replacement and Maintenance Savings are calculated as follows:

$$Savings = (reduction\ in\ lamps\ replaced\ \ per\ \ year) \times (repacment\ \$\ per\ lamp + Labor\ \$\ per\ lamp)$$

$$Savings = (35\ lamps\ \ per\ \ year) \times (\$2.00 + \$5.00) = \$280$$

Energy Savings Summary:

ECM #5 - ENERGY SAVINGS SUMMARY	
Installation Cost ($):	$10,838
NJ Smart Start Equipment Incentive ($):	$2,499
Net Installation Cost ($):	$8,339
Maintenance Savings ($/Yr):	$280
Energy Savings ($/Yr):	$2,349
Total Yearly Savings ($/Yr):	$2,629
Estimated ECM Lifetime (Yr):	15
Simple Payback	3.2
Simple Lifetime ROI	372.9%
Simple Lifetime Maintenance Savings	$4,200
Simple Lifetime Savings	$39,435
Internal Rate of Return (IRR)	31%
Net Present Value (NPV)	$23,045.83

ECM #6: Lighting Controls Upgrade – Occupancy Sensors

Description:

Some of the lights in the building are left on unnecessarily. In many cases the lights are left on because of the inconvenience to manually switch lights off when a room is left or on when a room is first occupied. This is common in rooms that are occupied for only short periods and only a few times per day. In some instances lights are left on due to the misconception that it is better to keep the lights on rather than to continuously switch lights on and off. Although increased switching reduces lamp life, the energy savings outweigh the lamp replacement costs. The payback timeframe for when to turn the lights off is approximately two minutes. If the lights are expected to be off for at least a two minute interval, then it pays to shut them off.

Lighting controls come in many forms. Sometimes an additional switch is adequate to provide reduced lighting levels when full light output is not needed. Occupancy sensors detect motion and will switch the lights on when the room is occupied. Occupancy sensors can either be mounted in place of a current wall switch, or on the ceiling to cover large areas.

The U.S. Department of Energy sponsored a study to analyze energy savings achieved through various types of building system controls. The referenced savings is based on the "Advanced Sensors and Controls for Building Applications: Market Assessment and Potential R&D Pathways," document posted for public use April 2005. The study has found that commercial buildings have the potential to achieve significant energy savings through the use of building controls. The average energy savings are as follows based on the report:

- Occupancy Sensors for Lighting Control 20% - 28% energy savings.

Savings resulting from the implementation of this ECM for energy management controls are estimated to be 20% of the total light energy controlled by occupancy sensors and daylight sensors (The majority of the savings is expected to be after business hours when rooms are left with lights on)

This ECM includes installation of ceiling or switch mount sensors for individual offices, classrooms, large bathrooms, and libraries. Sensors shall be manufactured by Sensorswitch, Watt Stopper or equivalent. The **Investment Grade Lighting Audit Appendix** of this report includes the summary of lighting controls implemented in this ECM and outlines the proposed controls, costs, savings, and payback periods. The calculations adjust the lighting power usage by the applicable percent savings for each area that includes lighting controls.

Energy Savings Calculations:

$$\text{Energy Savings} = (\%\ \text{Savings} \times \text{Controlled Light Energy}\ (\text{kWh/Yr}))$$

$$\text{Savings.} = \text{Energy Savings}\,(\text{kWh}) \times \text{Ave Elec Cost}\left(\frac{\$}{\text{kWh}}\right)$$

Cost and Incentives:

Installation cost per dual-technology sensors (Basis: Sensor switch or equivalent) are as follows:

Dual Technology Occupancy Sensor - Remote Mount	$250 per installation
Dual Technology Occupancy Sensor - Switch Mount	$150 per installation
Dual Technology Occupancy Sensor with 2 Pole Powerpack Remote mount	$300 per installation

Cost includes material and labor.

From the **NJ Smart Start® Program Incentives Appendix**, the installation of a lighting control device warrants the following incentive:

Occupancy Sensor Wall or Switch Mounted (existing facility only) = $20 per sensor

$$\text{Smart Start® Incentive} = (\#\ \text{of wall mount} \times \$\ 20)$$
$$\text{Smart Start® Incentive} = (14\ \text{wall mount} \times \$\ 20) = \$280$$

Energy Savings Summary:

ECM #6 - ENERGY SAVINGS SUMMARY	
Installation Cost ($):	$2,100
NJ Smart Start Equipment Incentive ($):	$280
Net Installation Cost ($):	$1,820
Maintenance Savings ($/Yr):	$0
Energy Savings ($/Yr):	$776
Total Yearly Savings ($/Yr):	$776
Estimated ECM Lifetime (Yr):	15
Simple Payback	2.3
Simple Lifetime ROI	539.6%
Simple Lifetime Maintenance Savings	0
Simple Lifetime Savings	$11,641
Internal Rate of Return (IRR)	42%
Net Present Value (NPV)	$7,444.91

VIII. RENEWABLE/DISTRIBUTED ENERGY MEASURES

Globally, renewable energy has become a priority affecting international and domestic energy policy. The State of New Jersey has taken a proactive approach, and has recently adopted in its Energy Master Plan a goal of 30% renewable energy by 2020. To help reach this goal New Jersey created the Office of Clean Energy under the direction of the Board of Public Utilities and instituted a Renewable Energy Incentive Program to provide additional funding to private and public entities for installing qualified renewable technologies. A renewable energy source can greatly reduce a building's operating expenses while producing clean environmentally friendly energy. CEG has assessed the feasibility of installing renewable energy measures (REM) for the Haggerty Education Center utilizing renewable technologies and concluded that there is potential for solar energy generation. The solar photovoltaic system calculation summary will be concluded as **REM#1** within this report.

Solar Generation

Solar energy produces clean energy and reduces a building's carbon footprint. This is accomplished via photovoltaic panels which are mounted on all south and southwestern facades of the building. Flat roof, as well as sloped areas can be utilized; flat areas will have the panels turned to an optimum solar absorbing angle. (A structural survey of the roof would be necessary before the installation of PV panels is considered). Parking lots can also be utilized for the installation of a solar array. A truss system can be installed that is high enough to park vehicles under the array and no parking lot area is lost.

The state of NJ has instituted a program in which one Solar Renewable Energy Certificate (SREC) is given to the Owner for every 1000 kWh of generation. SREC's can be sold anytime on the market at their current market value. The value of the credit varies upon the current need of the power companies. The average value per credit is around $350, this value was used in our financial calculations. This equates to $0.35 per kWh generated.

CEG has reviewed the existing roof area and site of Haggerty Education Center for the purposes of determining a potential for a photovoltaic system. CEG believes a ground mounted parking lot canopy system is best suited for this site. An area of 8,000 S.F. can be utilized for a PV system as depicted in the **Renewable / Distributed Energy Measures Calculation Appendix**. Using this square footage it was determined that a system size of 125.35 kilowatts could be installed. A system of this size has an estimated kilowatt hour production of 138,873 KWh annually, reducing the overall utility bill by approximately 97.7% percent, or nearly all of the facility's electrical consumption. A detailed financial analysis can be found in the **Renewable / Distributed Energy Measures Calculation Appendix**. This analysis illustrates the payback of the system over a 25 year period. The eventual degradation of the solar panels and the price of accumulated SREC's are factored into the payback.

The proposed photovoltaic array layout is designed based on the specifications for the Sun Power SPR-230 panel on a ProtekPark covered parking solar structure. The solar panel has a "DC" rated full load output of 230 watts, and has a total panel conversion efficiency of 18%. Although panels rated at higher wattages are available through Sun Power and other various

manufacturers, in general most manufacturers who produce commercially available solar panels produce a similar panel in the 200 to 250 watt range. This provides more manufacturer options to the public entity if they wish to pursue the proposed solar recommendation without losing significant system capacity.

The array system capacity was sized on available parking lot space at the existing facility as well as overall electrical demand of the facility. There is a substantial amount of area for additional covered parking panels, but the analysis was done to balance overall cost of the system with the needs of the building. Estimated solar array generation was then calculated based on the National Renewable Energy Laboratory PVWatts Version 1.0 Calculator. In order to calculate the array generation an appropriate location with solar data on file must be selected. In addition the system DC rated kilowatt (kW) capacity must be inputted, a DC to AC de-rate factor, panel tilt angle, and array azimuth angle. The DC to AC de-rate factor is based on the panel nameplate DC rating, inverter and transformer efficiencies (95%), mismatch factor (98%), diodes and connections (100%), dc and ac wiring(98%, 99%), soiling, (95%), system availability (95%), shading (if applicable), and age(new/100%). The overall DC to AC de-rate factor has been calculated at an overall rating of 81%. The PVWatts Calculator program then calculates estimated system generation based on average monthly solar irradiance and user provided inputs. The monthly energy generation and offset electric costs from the PVWatts calculator is shown in the **Renewable/Distributed Energy Measures Calculation Appendix**.

The proposed solar array is qualified by the New Jersey Board of Public Utilities Net Metering Guidelines as a Class I Renewable Energy Source. These guidelines allow onsite customer generation using renewable energy sources such as solar and wind with a capacity of 2 megawatts (MW) or less. This limits a customer system design capacity to being a net user and not a net generator of electricity on an annual basis. Although these guidelines state that if a customer does net generate (produce more electricity than they use), the customer will be credited those kilowatt-hours generated to be carried over for future usage on a month to month basis. Then, on an annual basis if the customer is a net generator the customer will then be compensated by the utility the average annual PJM Grid LMP price per kilowatt-hour for the over generation. Due to the aforementioned legislation, the customer is at limited risk if they generate more than they use at times throughout the year. With the inefficiency of today's energy storage systems, such as batteries, the added cost of storage systems is not warranted and was not considered in the proposed design.

Direct purchase involves the County paying for 100% of the total project cost upfront via one of the methods noted in the Installation Funding Options section below. Calculations include a utility inflation rate as well as the degradation of the solar panels over time. Based on our calculations the following is the payback period:

Table 7
Financial Summary – Photovoltaic System

FINANCIAL SUMMARY - PHOTOVOLTAIC SYSTEM			
PAYMENT TYPE	**SIMPLE PAYBACK**	**SIMPLE ROI**	**INTERNAL RATE OF RETURN**
Direct Purchase	15.44 Years	6.5%	4.8%

*The solar energy measure is shown for reference in the executive summary Renewable Energy Measure (REM) table

Given the large amount of capital required by the County to invest in a solar system through a Direct Purchase CEG does not recommend the County pursue this route. It would be more advantageous for the County to solicit Power Purchase Agreement (PPA) Providers who will own, operate, and maintain the system for a period of 15 years. During this time the PPA Provider would sell all of the electric generated by Solar Arrays to the County at a reduced rate compared to their existing electric rate.

Wind Generation

In addition to the Solar Analysis, CEG also conducted a review of the applicability of wind energy for the facility. Wind energy production is another option available through the Renewable Energy Incentive Program. Wind turbines of various types can be utilized to produce clean energy on a per building basis. Cash incentives are available per kWh of electric usage. Based on CEG's review of the applicability of wind energy for the facility, it was determined that the average wind speed of <4.5 m/s is not adequate for purchase of a commercial wind turbine. Therefore, wind energy is not a viable option to implement.

IX. ENERGY PURCHASING AND PROCUREMENT STRATEGY

Load Profile:

Load Profile analysis was performed to determine the seasonal energy usage of the facility. Irregularities in the load profile will indicate potential problems within the facility. Consequently based on the profile a recommendation will be made to remedy the irregularity in energy usage. For this report, the facility's energy consumption data was gathered in table format and plotted in graph form to create the load profile. Refer to The Electric and Natural Gas Usage Profiles included within this report to reference the respective electricity and natural gas usage load profiles.

Electricity:

The electricity usage profile demonstrates a load profile that has the majority of usage occurring during On Peak (8am-10pm – Monday thru Friday) usage. This facility does have some Off Peak usage occurring during the weekend from 9am-4:30pm. Historical usage is relatively steady throughout the year with an average monthly usage of 11,846 kWh and an average monthly demand of 57kW. Largest consumption months were January, May, August and December.

The historical usage profile is beneficial and will allow for more competitive energy prices when shopping for Third Party Energy Suppliers. Third Party Energy Supplier (TPS) electric commodity contracts that offer's a firm, fixed price for 100% of the facilities electric requirements and are lower than the JCP&L's BGS-FP default rate are recommended.

Natural Gas:

The Natural Gas Usage Profile demonstrates a very typical natural gas (heat load) profile. The summer months have little consumption. The average winter (Nov-Mar) consumption is 1,085 therms and the average summer (Apr-Oct) consumption is 137 therms. The largest consumption month is January at 1,606 therms.

This load profile will yield less favorable natural gas pricing when shopping for alternative suppliers. This is because the higher winter month consumption will yield higher pricing which will not be offset by the summer month consumption. Nymex commodity pricing is generally higher in the winter months of November – March and lower in the summer months of April – October. Obtaining a flat load profile, (usage is similar each month), will yield optimum natural gas pricing when shopping for alternative suppliers. Third Party Supplier (TPS) natural gas commodity contracts that offer product structures that include either 1) a firm, fixed price or 2) market based rate with basis lock in for 100% of the facility's natural gas requirements are recommended due to current low market pricing.

Tariff Analysis:

Electricity:

This facility receives electrical service through Jersey Central Power & Light (JCP&L) on a GS-Sec (General Service Secondary) rate. Service classification GS-Sec is available for general service purposes on secondary voltages not included under Service Classifications RS, RT, RGT or GST. This facility's rate is a single or three phase service at secondary voltages. This facility has not contracted a Third Party Supplier (TPS) to provide electric commodity service. For electric supply (generation) service, the client has a choice to either use JCP&L's default service rate BGS-FP or contract with a Third Party Supplier (TPS) to supply electric.

Each year since 2002, the four New Jersey Electric Distribution Companies (EDCs) - Public Service Gas & Electric Company (PSE&G), Atlantic City Electric Company (ACE), Jersey Central Power & Light Company (JCP&L), and Rockland Electric Company (RECO) - have procured several billion dollars of electric supply to serve their Basic Generation Service (BGS) customers through a statewide auction process held in February.

BGS refers to the service of customers who are not served by a third party supplier or competitive retailer. This service is sometimes known as Standard Offer Service, Default Service, or Provider of Last Resort Service.

The Auction Process has consisted of two auctions that are held concurrently, one for larger customers on an hourly price plan (BGS-CIEP) and one for smaller commercial and residential customers on a fixed-price plan (BGS-FP). This facility's rate structure is based on the fixed-price plan (BGS-FP).

The facility's current BGS-FP average price to compare for GS-Sec rate is $0.1246/kWh.

The utility, JCP&L will continue to be responsible for maintaining the existing network of wires, pipes and poles that make up the delivery system, which will serve all consumers, regardless of whom they choose to purchase their electricity or natural gas from.

JCP&L's Delivery Service rate includes the following charges: Customer Charge, Supplemental Customer Charge, Distribution Charge (kW Demand), kWh Charge, Non-utility Generation Charge, TEFA, SBC, SCC, Standby Fee and RGGI.

Natural Gas:

This facility currently receives natural gas distribution service through Public Service Electric and Gas (PSE&G) on rate schedule GSG (General Service Gas) and has not contracted a Third Party Supplier (TPS) to provide natural gas commodity service.

PSE&G provides basic gas supply service (BGSS) to customers who choose not to shop from a Third Party Supplier (TPS) for natural gas commodity. The option is essential to protect the reliability of service to consumers as well as protecting consumers if a third party supplier

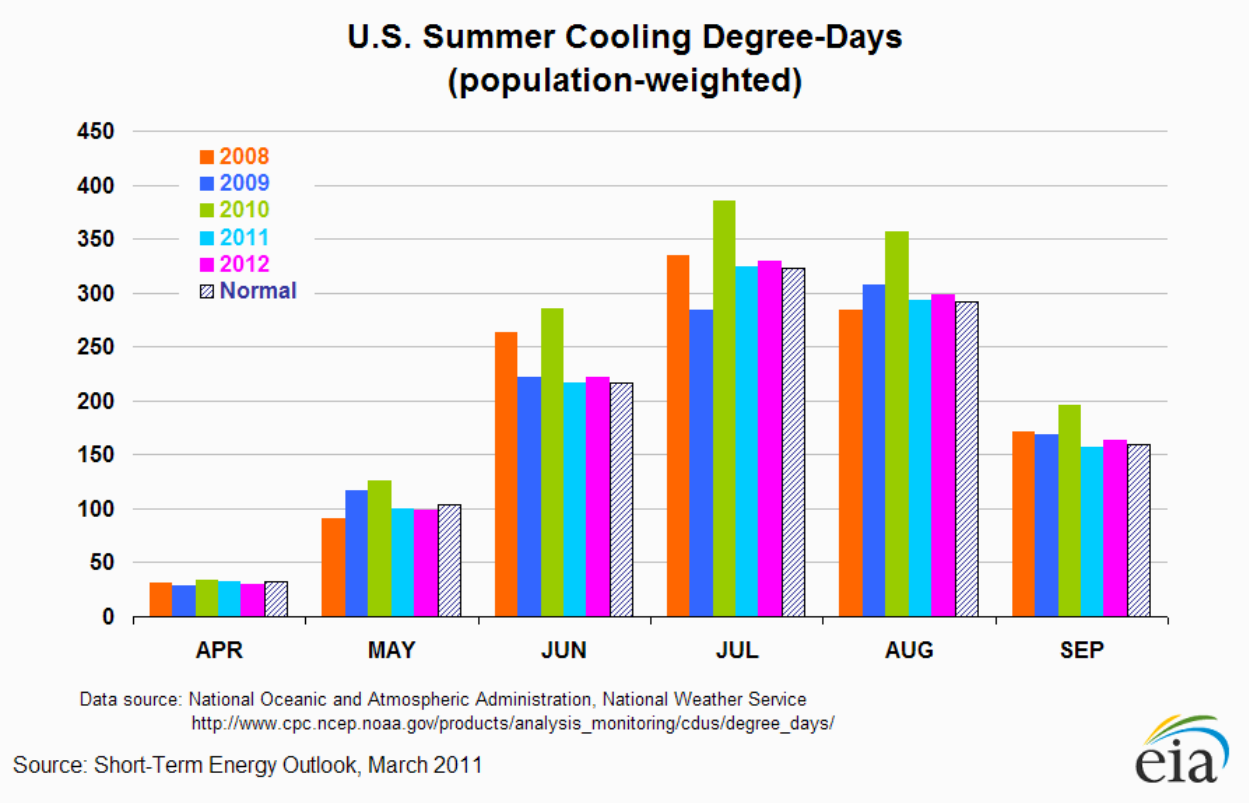
defaults or fails to provide commodity service. Please refer to the link below for a recap of natural gas BGSS charges from PSE&G for rate schedule GSG.
http://pseg.com/family/pseandg/tariffs/gas/pdf/commodity.pdf

The utility, PSE&G is responsible for maintaining the existing network of wires, pipes and poles that make up the delivery system, which will serve all consumers, regardless of whom they choose to purchase their electricity or natural gas from. PSE&G's delivery service rate includes the following charges: Customer Service Charge, Distribution Charge, & Societal Benefits Charge (SBC).

Electric and Natural Gas Commodities Market Overview:

Current electricity and natural gas market pricing has remained relatively stable over the last year. Commodity pricing in 2008 marked historical highs in both natural gas and electricity commodity. Commodity pricing commencing spring of 2009 continuing through 2010, has decreased dramatically over 2008 historic highs and continues to be favorable for locking in long term (2-5 year) contracts with 3rd Party Supplier's for both natural gas and electricity supply requirements.

It is important to note that both natural gas and electric commodity market prices are moved by supply and demand, political conditions, market technicals and trader sentiment. This market is continuously changing Energy commodity pricing is also correlated to weather forecasts. Because weather forecasts are dependable only in the short-term, prolonged temperature extremes can really cause extreme price swings.



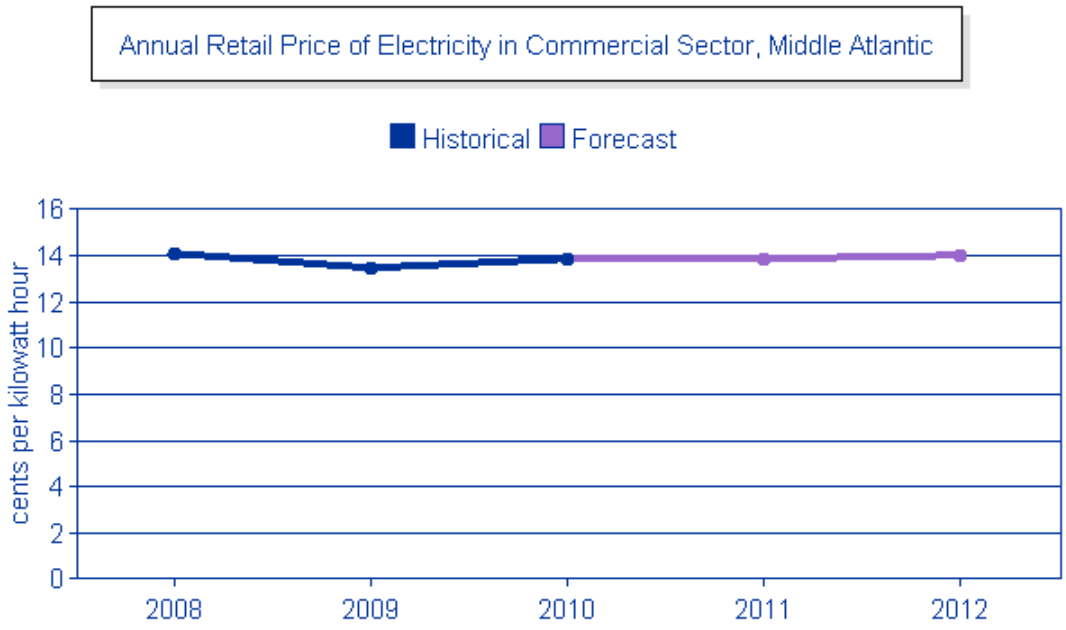
Short Term Energy Outlook - US Energy Information Administration (3/08/2011):

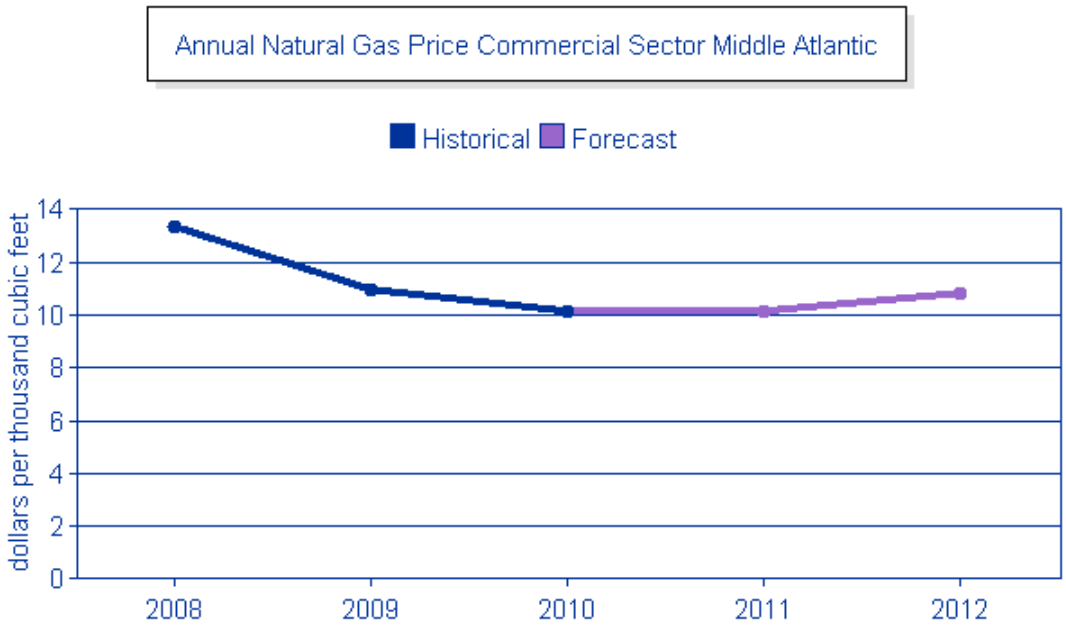
U.S. Natural Gas Prices. *The Henry Hub spot price averaged $4.09 per MMBtu in February 2011, $0.40 per MMBtu less than the average spot price in January 2011. EIA expects that the Henry Hub spot price will average $4.10 per MMBtu in 2011, a drop of $0.29 per MMBtu from the 2010 average. EIA expects the natural gas market to begin to tighten in 2012, with the Henry Hub spot price increasing to an average of $4.58 per MMBtu.*

Uncertainty over future natural gas prices is slightly lower this year compared with last year at this time. Natural gas futures for May 2011 delivery (for the 5-day period ending March 3) averaged $3.98 per MMBtu, and the average implied volatility over the same period was 33 percent. This produced lower and upper bounds for the 95-percent confidence interval for May 2011 contracts of $3.09 per MMBtu and $5.11 per MMBtu, respectively. At this time last year, the natural gas May 2010 futures contract averaged $4.77 per MMBtu and implied volatility averaged 39 percent. The corresponding lower and upper limits of the 95-percent confidence interval were $3.57 per MMBtu and $6.39 per MMBtu.

U.S. Electricity Retail Prices. *During 2010, retail prices for electricity distributed to the residential sector averaged 11.58 cents per kilowatthour, about the same level as in 2009. EIA expects residential prices to rise by 1.0 percent in 2011, followed by an increase of 0.5 percent in 2012. The effect of lower generation fuel costs in 2011 should be more evident in retail prices*

for electricity distributed to the industrial sector, which EIA projects will fall 1.6 percent during 2011 and then rise 0.2 percent next year.





Pricing in the chart above includes both utility distribution and energy commodity charges.

Recommendations:

1. CEG recommends an aggregated approach for 3rd party commodity supply procurement strategies for electric and natural gas supply service. Aggregating all County facilities for electricity and natural gas supply service would allow this facility to achieve a reduction in both electric and natural gas supply costs. Energy commodities are among the most volatile of all commodities, however at this point and time, energy is extremely competitive. This facility could realize up to a 20% reduction in energy supply costs, if it were to aggregate usage with the other County facilities and take advantage of these current market prices quickly, before energy increases.

   Overall, after review of the utility consumption, billing, and current commodity pricing outlook, CEG recommends that the County explore the utilization and advisement of a 3rd party unbiased Energy Consulting Firm experienced in the procurement of electricity and natural gas, New Jersey procurement laws, aggregation of facilities and energy supply risk and commodity management. In addition, the firm should be able to provide full service advisement over the term of the contract to identify additional opportunities to further reduce costs. Many of these opportunities may include: energy rates; utility bill auditing; energy data analytics; and efficiency improvements.

   It is important that a rational, defensible strategy for purchasing commodity in volatile markets is incorporated. Examples include:

   - Budgets that reflect sound market intelligence
   - An understanding of BGS historical prices and trends
   - Awareness of seasonal opportunities (e.g. shoulder months)
   - Negotiation of fair contractual terms
   - An aggressive, market based price

2. CEG recommends that the County consider utilizing a third party utility billing-auditing service to further analyze historical utility invoices such as water, sewer, natural gas and electric for incorrect billings and rate tariff optimization services. This service can be based on a shared savings model with no cost to the County. The service could provide refunds on potential incorrect billings that may have been passed through by the utilities and paid by the County.

X. INSTALLATION FUNDING OPTIONS

CEG has reviewed various funding options for the facility owner to utilize in subsidizing the costs for installing the energy conservation measures noted within this report. Below are a few alternative funding methods:

i. *Energy Savings Improvement Program (ESIP)* – Public Law 2009, Chapter 4 authorizes government entities to make energy related improvements to their facilities and par for the costs using the value of energy savings that result from the improvements. The "Energy Savings Improvement Program (ESIP)" law provides a flexible approach that can allow all government agencies in New Jersey to improve and reduce energy usage with minimal expenditure of new financial resources.

ii. *Municipal Bonds* – Municipal bonds are a bond issued by a city or other local government, or their agencies. Potential issuers of municipal bonds include cities, counties, redevelopment agencies, school districts, publicly owned airports and seaports, and any other governmental entity (or group of governments) below the state level. Municipal bonds may be general obligations of the issuer or secured by specified revenues. Interest income received by holders of municipal bonds is often exempt from the federal income tax and from the income tax of the state in which they are issued, although municipal bonds issued for certain purposes may not be tax exempt.

iii. *Power Purchase Agreement* – Public Law 2008, Chapter 3 authorizes contractor of up to fifteen (15) years for contracts commonly known as "power purchase agreements." These are programs where the contracting unit (Owner) procures a contract for, in most cases, a third party to install, maintain, and own a renewable energy system. These renewable energy systems are typically solar panels, windmills or other systems that create renewable energy. In exchange for the third party's work of installing, maintaining and owning the renewable energy system, the contracting unit (Owner) agrees to purchase the power generated by the renewable energy system from the third party at agreed upon energy rates.

iv. *Pay For Performance* – The New Jersey Smart Start Pay for Performance program includes incentives based on savings resulted from implemented ECMs. The program is available for all buildings that were audited as part of the NJ Clean Energy's Local Government Energy Audit Program. The facility's participation in the program is assisted by an approved program partner. An "Energy Reduction Plan" is created with the facility and approved partner to shown at least 15% reduction in the building's current energy use. Multiple energy conservation measures implemented together are applicable toward the total savings of at least 15%. No more than 50% of the total energy savings can result from lighting upgrades / changes.

Total incentive is capped at 50% of the project cost. The program savings is broken down into three benchmarks; Energy Reduction Plan, Project Implementation, and Measurement and Verification. Each step provides additional incentives as the energy reduction project continues. The benchmark incentives are as follows:

1. Energy Reduction Plan – Upon completion of an energy reduction plan by an approved program partner, the incentive will grant $0.10 per square foot between $5,000 and $50,000, and not to exceed 50% of the facility's annual energy expense. (Benchmark #1 is not provided in addition to the local government energy audit program incentive.)

2. Project Implementation – Upon installation of the recommended measures along with the "Substantial Completion Construction Report," the incentive will grant savings per KWH or Therm based on the program's rates. Minimum saving must be 15%. (Example $0.11 / kWh for 15% savings, $0.12/ kWh for 17% savings, … and $1.10 / Therm for 15% savings, $1.20 / Therm for 17% saving, …) Increased incentives result from projected savings above 15%.

3. Measurement and Verification – Upon verification 12 months after implementation of all recommended measures, that actual savings have been achieved, based on a completed verification report, the incentive will grant additional savings per kWh or Therm based on the program's rates. Minimum savings must be 15%. (Example $0.07 / kWh for 15% savings, $0.08/ kWh for 17% savings, … and $0.70 / Therm for 15% savings, $0.80 / Therm for 17% saving, …) Increased incentives result from verified savings above 15%.

v. *Direct Install Program* – The New Jersey Clean Energy's Direct Install Program is a state funded program that targets small commercial and industrial facilities with peak demand of less than 100 kW. This turnkey program is aimed at providing owners a seamless, comprehensive process for analysis, equipment replacement and financial incentives to reduce consumption, lower utility costs and improve profitability. The program covers up to 60% of the cost for eligible upgrades including lighting, lighting controls, refrigeration, HVAC, motors, variable speed drives, natural gas and food service. Participating contractors (refer to www.njcleanenergy.com) conduct energy assessments in addition to your standard local government energy audit and install the cost-effective measures.

vi. *Energy Efficiency and Conservation Block Grants* – The EECGB rebate provides supplemental funding up to $20,000 for counties and local government entities to implement energy conservation measures. The EECGB funding is provided through the American Recovery and Reinvestment Act (ARRA). The local

government must be among the eligible local government entities listed on the NJ Clean Energy website as follows - http://njcleanenergy.com/commercial-industrial/programs/eecbg-eligible-entities. This program is limited to municipalities and counties that have not already received grants directly through the US department of Energy.

This incentive is provided in addition to the other NJ Clean Energy program funding. This program's incentive is considered the entity's capital and therefore can be applied to the LGEA program's requirements to implement the recommended energy conservation measures totaling at least 25% of the energy audit cost. Additional requirements of this program are as follows:

1. The entity must utilize additional funding through one or more of the NJ Clean Energy programs such as Smart Start, Direct Install, and Pay for Performance.

2. The EECBG funding in combination with other NJ Clean Energy programs may not exceed the total cost of the energy conservation measures being implemented.

3. Envelope measures are applicable only if recommended by the LGEA energy audit and if the energy audit was completed within the past 12 months.

4. New construction and previously installed measures are not eligible for the EECBG rebate.

5. Energy conservation measures eligible for the EECBG must fall within the list of approved energy conservation measures. The complete list of eligible measures and other program requirements are included in the "EECBG Complete Application Package." The application package is available on the NJ Clean Energy website - http://njcleanenergy.com/commercial-industrial/programs/energy-efficiency-and-conservation-block-grants.

CEG recommends the Owner review the use of the above-listed funding options in addition to utilizing their standard method of financing for facilities upgrades in order to fund the proposed energy conservation measures.

XI. ADDITIONAL RECOMMENDATIONS

The following recommendations include no cost/low cost measures, Operation & Maintenance (O&M) items, and water conservation measures with attractive paybacks. These measures are not eligible for the Smart Start Buildings incentives from the office of Clean Energy but save energy none the less.

A. Chemically clean the condenser and evaporator coils periodically to optimize efficiency. Poorly maintained heat transfer surfaces can reduce efficiency 5-10%.

B. Maintain all weather stripping on windows and doors.

C. Clean all light fixtures to maximize light output.

D. Provide more frequent air filter changes to decrease overall system power usage and maintain better IAQ.

XII. ENERGY AUDIT ASSUMPTIONS

The assumptions utilized in this energy audit include but are not limited to following:

A. Cost Estimates noted within this report are based on industry accepted costing data such as RS Means™ Cost Data, contractor pricing and engineering estimates. All cost estimates for this level of auditing are +/- 20%. Prevailing wage rates for the specified region has been utilized to calculate installation costs. The cost estimates indicated within this audit should be utilized by the owner for prioritizing further project development post the energy audit. Project development would include investment grade auditing and detailed engineering.
B. Energy savings noted within this audit are calculated utilizing industry standard procedures and accepted engineering assumptions. For this level of auditing, energy savings are not guaranteed.
C. Information gathering for each facility is strongly based on interviews with operations personnel. Information dependent on verbal feedback is used for calculation assumptions including but not limited to the following:
    a. operating hours
    b. equipment type
    c. control strategies
    d. scheduling
D. Information contained within the major equipment list is based on the existing owner documentation where available (drawings, O&M manuals, etc.). If existing owner documentation is not available, catalog information is utilized to populate the required information.
E. Equipment incentives and energy credits are based on current pricing and status of rebate programs. Rebate availability is dependent on the individual program funding and applicability.
F. Equipment (HVAC, Plumbing, Electrical, & Lighting) noted within an ECM recommendation is strictly noted as a **basis for calculation** of energy savings. The owner should use this equipment information as a benchmark when pursuing further investment grade project development and detailed engineering for specific energy conservation measures.

Utility bill annual averages are utilized for calculation of all energy costs unless otherwise noted. Accuracy of the utility energy usage and costs are based on the information provided. Utility information including usage and costs is estimated where incomplete data is provided.

ECM COST & SAVINGS BREAKDOWN

CONCORD ENGINEERING GROUP

Haggerty Education Center

ECM ENERGY AND FINANCIAL COSTS AND SAVINGS SUMMARY														
ECM NO.	DESCRIPTION	INSTALLATION COST				YEARLY SAVINGS			ECM LIFETIME	LIFETIME ENERGY SAVINGS	LIFETIME MAINTENANCE SAVINGS	LIFETIME ROI	SIMPLE PAYBACK	INTERNAL RATE OF RETURN (IRR)	NET PRESENT VALUE (NPV)
		MATERIAL	LABOR	REBATES, INCENTIVES	NET INSTALLATION COST	ENERGY	MAINT. / SREC	TOTAL		(Yearly Saving * ECM Lifetime)	(Yearly Maint Svaing * ECM Lifetime)	(Lifetime Savings - Net Cost) / (Net Cost)	(Net cost / Yearly Savings)	$\sum_{n=0}^{N} \frac{C_n}{(1+IRR)^n}$	$\sum_{n=0}^{N} \frac{C_n}{(1+DR)^n}$
		($)	($)	($)	($)	($/Yr)	($/Yr)	($/Yr)	(Yr)	($)	($)	(%)	(Yr)	($)	($)
ECM #1	High Efficiency Boiler Replacement	$15,000	$17,500	$2,265	$30,235	$1,264	$0	$1,264	30	$37,920	$0	25.4%	23.9	1.53%	($5,460.04)
ECM #2	Condensing Unit Replacement	$17,850	$11,900	$2,555	$27,195	$3,515	$0	$3,515	15	$52,725	$0	93.9%	7.7	9.70%	$14,766.84
ECM #3	New Indoor Air Handling Units	$15,568	$6,672	$162	$22,078	$434	$0	$434	15	$6,510	$0	-70.5%	50.9	-12.43%	($16,896.94)
ECM #4	Domestic Hot Water Heater	$2,800	$1,300	$50	$4,050	$77	$0	$77	15	$1,155	$0	-71.5%	52.6	-12.71%	($3,130.78)
ECM #5	Lighting Upgrade	$8,670	$2,168	$2,499	$8,339	$2,349	$280	$2,629	15	$39,435	$4,200	372.9%	3.2	30.98%	$23,045.83
ECM #6	Lighting Controls	$1,680	$420	$280	$1,820	$776	$0	$776	15	$11,641	$0	539.6%	2.3	42.43%	$7,444.91
REM RENEWABLE ENERGY AND FINANCIAL COSTS AND SAVINGS SUMMARY															
REM #1	Covered Parking Solar Array	$2,254,230	$0	$0	$2,254,230	$44,716	$88,924	$133,640	25	$3,341,000	$2,223,100	48.2%	16.9	3.29%	$72,863.06

Notes: 1) The variable Cn in the formulas for Internal Rate of Return and Net Present Value stands for the cash flow during each period.
2) The variable DR in the NPV equation stands for Discount Rate
3) For NPV and IRR calculations: From n=0 to N periods where N is the *lifetime of ECM* and Cn is the *cash flow during each period* .

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SmartStart Building Incentives

The NJ SmartStart Buildings Program offers financial incentives on a wide variety of building system equipment. The incentives were developed to help offset the initial cost of energy-efficient equipment. The following tables show the current available incentives as of February, 2010:

Electric Chillers

Water-Cooled Chillers	$12 - $170 per ton
Air-Cooled Chillers	$8 - $52 per ton

Energy Efficiency must comply with ASHRAE 90.1-2004

Gas Cooling

Gas Absorption Chillers	$185 - $400 per ton
Gas Engine-Driven Chillers	Calculated through custom measure path)

Desiccant Systems

$1.00 per cfm – gas or electric

Electric Unitary HVAC

Unitary AC and Split Systems	$73 - $93 per ton
Air-to-Air Heat Pumps	$73 - $92 per ton
Water-Source Heat Pumps	$81 per ton
Packaged Terminal AC & HP	$65 per ton
Central DX AC Systems	$40- $72 per ton
Dual Enthalpy Economizer Controls	$250
Occupancy Controlled Thermostat (Hospitality & Institutional Facility)	$75 per thermostat

Energy Efficiency must comply with ASHRAE 90.1-2004

Ground Source Heat Pumps

Closed Loop & Open Loop	$450 per ton, EER ≥ 16 $600 per ton, EER ≥ 18 $750 per ton, EER ≥ 20

Energy Efficiency must comply with ASHRAE 90.1-2004

Gas Heating

Gas Fired Boilers < 300 MBH	$300 per unit
Gas Fired Boilers ≥ 300 - 1500 MBH	$1.75 per MBH
Gas Fired Boilers ≥1500 - ≤ 4000 MBH	$1.00 per MBH
Gas Fired Boilers > 4000 MBH	(Calculated through Custom Measure Path)
Gas Furnaces	$300 - $400 per unit, AFUE ≥ 92%

Variable Frequency Drives

Variable Air Volume	$65 - $155 per hp
Chilled-Water Pumps	$60 per hp
Compressors	$5,250 to $12,500 per drive

Natural Gas Water Heating

Gas Water Heaters ≤ 50 gallons	$50 per unit
Gas-Fired Water Heaters > 50 gallons	$1.00 - $2.00 per MBH
Gas-Fired Booster Water Heaters	$17 - $35 per MBH
Gas Fired Tankless Water Heaters	$300 per unit

Prescriptive Lighting

Retro fit of T12 to T-5 or T-8 Lamps w/Electronic Ballast in Existing Facilities	$10 per fixture (1-4 lamps)
Replacement of T12 with new T-5 or T-8 Lamps w/Electronic Ballast in Existing Facilities	$25 per fixture (1-2 lamps) $30 per fixture (3-4 lamps)
Replacement of incandescent with screw-in PAR 38 or PAR 30 (CFL) bulb	$7 per bulb
T-8 reduced Wattage (28w/25w 4', 1-4 lamps) Lamp & ballast replacement	$10 per fixture
Hard-Wired Compact Fluorescent	$25 - $30 per fixture
Metal Halide w/Pulse Start	$25 per fixture
LED Exit Signs	$10 - $20 per fixture
T-5 and T-8 High Bay Fixtures	$16 - $284 per fixture
HID ≥ 100w Retrofit with induction lamp, power coupler and generator (must be 30% less watts/fixture than HID system)	$50 per fixture
HID ≥ 100w Replacement with new HID ≥ 100w	$70 per fixture
LED Refrigerator/Freezer case lighting replacement of fluorescent in medium and low temperature display case	$42 per 5 foot $65 per 6 foot

Lighting Controls – Occupancy Sensors

Wall Mounted	$20 per control
Remote Mounted	$35 per control
Daylight Dimmers	$25 per fixture
Occupancy Controlled hi-low Fluorescent Controls	$25 per fixture controlled

Lighting Controls – HID or Fluorescent Hi-Bay Controls

Occupancy hi-low	$75 per fixture controlled
Daylight Dimming	$75 per fixture controlled
Daylight Dimming - office	$50 per fixture controlled

Premium Motors

Three-Phase Motors	$45 - $700 per motor
Fractional HP Motors Electronic Communicated Motors (replacing shaded pole motors in refrigerator/freezer cases)	$40 per electronic communicated motor

Other Equipment Incentives

Performance Lighting	$1.00 per watt per SF below program incentive threshold, currently 5% more energy efficient than ASHRAE 90.1-2004 for New Construction and Complete Renovation
Custom Electric and Gas Equipment Incentives	not prescriptive
Custom Measures	$0.16 KWh and $1.60/Therm of 1st year savings, or a buy down to a 1 year payback on estimated savings. Minimum required savings of 75,000 KWh or 1,500 Therms and a IRR of at least 10%.
Multi Measures Bonus	15%

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
FRELINGHUYSEN ARBORETUM_HAGGERTY

Building ID: 2383885
For 12-month Period Ending: December 31, 2009[1]
Date SEP becomes ineligible: N/A
Date SEP Generated: April 21, 2011

Facility
FRELINGHUYSEN
ARBORETUM_HAGGERTY
53 EAST HANOVER AVENUE
MORRISTOWN, NJ 07960

Facility Owner
N/A

Primary Contact for this Facility
N/A

Year Built: 1902
Gross Floor Area (ft²): 16,220

Energy Performance Rating[2] (1-100) 71

Site Energy Use Summary[3]

Electricity - Grid Purchase(kBtu)	496,154
Natural Gas (kBtu)[4]	729,324
Total Energy (kBtu)	1,225,478

Energy Intensity[5]

Site (kBtu/ft²/yr)	76
Source (kBtu/ft²/yr)	149

Emissions (based on site energy use)

Greenhouse Gas Emissions ($MtCO_2e$/year)	109

Electric Distribution Utility
Jersey Central Power & Light Co [FirstEnergy Corp]

National Average Comparison

National Average Site EUI	98
National Average Source EUI	193
% Difference from National Average Source EUI	-23%
Building Type	Office

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. Values represent energy intensity, annualized to a 12-month period.
5. 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.

The government estimates the average time needed to fill out this form is 6 hours (includes the time for entering energy data, Licensed Professional facility inspection, and notarizing the SEP) and welcomes suggestions for reducing this level of effort. Send comments (referencing OMB control number) to the Director, Collection Strategies Division, U.S., EPA (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460.

MAJOR EQUIPMENT LIST

Concord Engineering Group

Haggerty Education Center

Boilers

Tag	B-1		
Unit Type	Gas Fired Boiler		
Qty	1		
Location	Lower Level MER		
Area Served	AHU Heating Coils and Radiant Coils		
Manufacturer	Weil McLain		
Model #	EGH-105, Series 2		
Serial #	-		
Input Capacity (MBH)	450 MBH		
Rated Output Capacity (MBH)	360 MBH		
Approx. Efficiency %	75%		
Fuel	Nat. Gas		
Approx Age	25		
ASHRAE Service Life	30		
Remaining Life	5		
Comments	Boiler is in fair condition		

MAJOR EQUIPMENT LIST

Concord Engineering Group

Haggerty Education Center

Pumps

Tag	HWP-1		
Unit Type	Pipe Mounted, In-Line		
Qty	1		
Location	Lower Level MER		
Area Served	B-1, Heating Hot water loop		
Manufacturer	Bell & Gossett		
Model #	60-13		
Serial #	-		
Horse Power	1/3		
Flow	42		
Motor Info	-		
Electrical Power	120 / 1/ 60		
RPM	1750		
Motor Efficiency %	-		
Approx Age	23		
ASHRAE Service Life	20		
Remaining Life	(3)		
Comments			

MAJOR EQUIPMENT LIST

Concord Engineering Group

Haggerty Education Center

Split AC Units

Indoor Air Handling Units

Tag	AHU #1	AHU #2	AHU #3
Unit Type	Split AC unit	Split AC unit	Split AC unit
Qty	1	1	1
Location	Lower Level MER	Lower Level MER	Lower Level MER
Area Served	Lower Level	Upper Level Offices and Lobby	Upper Level Auditorium
Manufacturer	McQuay	McQuay	McQuay
Model #	LSL 108CH	LSL 106CH	LSL 111CH
Serial #	3TJ00427-06	3TJ00428-06	3TJ00429-06
Cooling Type	D/X	D/X	D/X
Cooling Capacity (MBH)	106	83.7	134.5
Supply Flow, CFM	4,000	3,000	4,800
Heating Type	Hot Water	Hot Water	Hot Water
Heating Capacity (MBH)	99.9	83.7	145.5
Supply Motor HP	3	2	3
Supply Motor Efficiency	Standard	Standard	Standard
Volts / Phase	208 / 3	208 / 3	208 / 3
Approx. Age	23	23	23
ASHRAE Service Life	15	15	15
Comments	Unit is in fair to poor condition	Unit is in fair to poor condition	Unit is in fair to poor condition

MAJOR EQUIPMENT LIST

Concord Engineering Group

Haggerty Education Center

Condensing Units

Tag	CU #1	CU #2	CU #3
Qty	1	1	1
Unit Served	AHU #1	AHU #2	AHU #3
Location	Outside, SE Side of Building	Outside, SE Side of Building	Outside, SE Side of Building
Manufacturer	Luxaire	McQuay	McQuay
Model #	HCHB-T120AA	C0806	CUF-150
Serial #	(S)N0G6634061	-	-
Cooling Capacity	10 Tons	8.5 Tons	15 Tons
Cooling Eff., EER	8.5	8.5	8.5
Refrigerant	R22	R22	R22
Volts / Phase / Amps	208 / 3	208 / 3	208 / 3
Approx Age	23	23	23
ASHRAE Service Life	15	15	15
Remaining Life	(8)	(8)	(8)
Comments	Unit is in fair to poor condition	Unit is in fair to poor condition	Unit is in fair to poor condition

MAJOR EQUIPMENT LIST

Concord Engineering Group

Haggerty Education Center

Domestic Water Heaters

Tag	HWH-1		
Unit Type	Tank Type		
Qty	1		
Location	Lower Level MER		
Area Served	Building Restrooms and Break Rooms		
Manufacturer	A.O. Smith		
Model #	FSG-40-206		
Serial #	MJ88-0082451-206		
Size (Gallons)	40		
Input Capacity (MBH)	32.5		
Recovery (Gal/Hr)	32.8		
Efficiency %	80%		
Fuel	Nat. Gas		
Approx Age (Years)	23		
ASHRAE Service Life	12		
Remaining Life	(11)		
Comments	Unit is in fair condition		

Investment Grade Lighting Audit

CEG Job #: 9C10084
Project: Morris County DPW
Address: 53 E. Hanover Ave
Morristown, NJ 07963
Building SF: 16,220

Haggerty Education Center

KWH COST: $0.176

ECM #1: Lighting Upgrade - General

EXISTING LIGHTING										PROPOSED LIGHTING										SAVINGS			
CEG Type	Fixture Location	Yearly Usage	No. Fixts	No. Lamps	Fixture Type	Fixt Watts	Total kW	kWh/Yr Fixtures	Yearly $ Cost	No. Fixts	No. Lamps	Retro-Unit Description	Watts Used	Total kW	kWh/Yr Fixtures	Yearly $ Cost	Unit Cost (INSTALLED)	Total Cost	kW Savings	kWh/Yr Savings	Yearly $ Savings	Yearly Simple Payback
12	Auditorium Track 8 x 6 Lamps	2080	48	1	1-Lamp Compact Flourescent	13	0.62	1,297.9	$228.43	48	0	No Change	13	0.62	1297.92	$228.43	$0.00	$0.00	0.00	0	$0.00	0.00
10	Auditorium High Hats on Dimmer	2080	18	1	1-Lamp Incandescents	75	1.35	2,808.0	$494.21	18	0	18 W CFL Lamp	18	0.32	673.92	$118.61	$5.75	$103.50	1.03	2134.08	$375.60	0.28
20	Auditorium Chandeliers 4 x 12 Lamps	2080	48	1	1 Lamp Incandescents	25	1.20	2,496.0	$439.30	48	0	18 W CFL Lamp	18	0.86	1797.12	$316.29	$5.75	$276.00	0.34	698.88	$123.00	2.24
20	Auditorium Sconces 4 x 3 Lamps	2080	12	1	1 Lamp Incandescents	25	0.30	624.0	$109.82	12	0	18 W CFL Lamp	18	0.22	449.28	$79.07	$5.75	$69.00	0.08	174.72	$30.75	2.24
12	Stalls Track 3 x 5 Lamps	2080	15	1	1-Lamp Compact Flourescent	13	0.20	405.6	$71.39	15	0	No Change	13	0.20	405.6	$71.39	$0.00	$0.00	0.00	0	$0.00	0.00
10	Stalls 1 High Hat	2080	1	1	1-Lamp Incandescents	75	0.08	156.0	$27.46	1	0	18 W CFL Lamp	18	0.02	37.44	$6.59	$5.75	$5.75	0.06	118.56	$20.87	0.28
10	Stalls Standard Bulbs	2080	8	1	1-Lamp Incandescents	75	0.60	1,248.0	$219.65	8	0	18 W CFL Lamp	18	0.14	299.52	$52.72	$5.75	$46.00	0.46	948.48	$166.93	0.28
12	Carriage House Track 4 x 5 Lamps	2080	20	1	1-Lamp Compact Flourescent	13	0.26	540.8	$95.18	20	0	No Change	13	0.26	540.8	$95.18	$0.00	$0.00	0.00	0	$0.00	0.00
12	Carriage House Track 1 x 4 Lamps	2080	4	1	1-Lamp Compact Flourescent	13	0.05	108.2	$19.04	4	0	No Change	13	0.05	108.16	$19.04	$0.00	$0.00	0.00	0	$0.00	0.00
32	Lobby (upstairs) Chandelier 1 x 21 Lamps	2080	21	1	1-Lamp Incandescents Candlelabra	60	1.26	2,620.8	$461.26	21	0	0	0	0.00	0	$0.00	$0.00	$0.00	0.00	0	$0.00	0.00
20	Lobby (upstairs) Sconces 3 x 3 Lamps	2080	9	1	1 Lamp Incandescents	25	0.23	468.0	$82.37	9	0	18 W CFL Lamp	18	0.16	336.96	$59.30	$5.75	$51.75	0.06	131.04	$23.06	2.24
12	Lobby (upstairs) 4 Drop Lights	2080	4	1	1-Lamp Compact Flourescent	13	0.05	108.2	$19.04	4	0	No Change	13	0.05	108.16	$19.04	$0.00	$0.00	0.00	0	$0.00	0.00
22	Lobby (upstairs) T12 8 x 4 Lamps	2080	8	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic Lens	160	1.28	2,662.4	$468.58	8	3	2'x4' 3-Lamp 32W T-8 Prismatic Lens / Elect Ballast; Metalux M/N 2GC8	91	0.73	1514.24	$266.51	$140.00	$1,120.00	0.55	1148.16	$202.08	5.54
1	Gallery T12 7 x 2 u Shape Lamps	2080	7	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic Lens	80	0.56	1,164.8	$205.00	7	2	1'X4' 2-Lamp 32W T-8 Prism Lens/Elect Ballast; Metalux M/N GC	55	0.39	800.8	$140.94	$100.00	$700.00	0.18	364	$64.06	10.93
12	Gallery Track 1 x 6 Lamps Dimmer	2080	6	1	1-Lamp Compact Flourescent	13	0.08	162.2	$28.55	6	0	No Change	13	0.08	162.24	$28.55	$0.00	$0.00	0.00	0	$0.00	0.00
22	Classroom A 12 x 4 Lamps	2080	12	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic	160	1.92	3,993.6	$702.87	12	3	2'x4' 3-Lamp 32W T-8 Prismatic Lens / Elect Ballast; Metalux M/N 2GC8	91	1.09	2271.36	$399.76	$140.00	$1,680.00	0.83	1722.24	$303.11	5.54
22	Classroom B 12 x 4 Lamps	2080	12	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic Lens	160	1.92	3,993.6	$702.87	12	3	2'x4' 3-Lamp 32W T-8 Prismatic Lens / Elect Ballast; Metalux M/N 2GC8	91	1.09	2271.36	$399.76	$140.00	$1,680.00	0.83	1722.24	$303.11	5.54
22	Library 9 x 4 Laps	2080	9	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic Lens	160	1.44	2,995.2	$527.16	9	3	2'x4' 3-Lamp 32W T-8 Prismatic Lens / Elect Ballast; Metalux M/N 2GC8	91	0.82	1703.52	$299.82	$140.00	$1,260.00	0.62	1291.68	$227.34	5.54

Investment Grade Lighting Audit

22	Staff Office 6 x 4 Lamps	2080	6	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic Lens	160	0.96	1,996.8	$351.44	6	3	2'x4' 3-Lamp 32W T-8 Prismatic Lens / Elect Ballast; Metalux M/N 2GC8	91	0.55	1135.68	$199.88	$140.00	$840.00	0.41	861.12	$151.56	5.54
22	Friends Office 7 x 4 Lamps	2080	7	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic Lens	160	1.12	2,329.6	$410.01	7	3	2'x4' 3-Lamp 32W T-8 Prismatic Lens / Elect Ballast; Metalux M/N 2GC8	91	0.64	1324.96	$233.19	$140.00	$980.00	0.48	1004.64	$176.82	5.54
22	Auditorium Kitchen 2 x 4 Lamps	2080	2	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic Lens	160	0.32	665.6	$117.15	2	3	2'x4' 3-Lamp 32W T-8 Prismatic Lens / Elect Ballast; Metalux M/N 2GC8	91	0.18	378.56	$66.63	$140.00	$280.00	0.14	287.04	$50.52	5.54
1	Upstairs Mens Room 3 x 2 Lamps	2080	3	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic Lens	80	0.24	499.2	$87.86	3	2	1'X4' 2-Lamp 32W T-8 Prism Lens/Elect Ballast; Metalux M/N GC	55	0.17	343.2	$60.40	$100.00	$300.00	0.08	156	$27.46	10.93
1	Upstairs Womens Room 4 x 2 Lamps	2080	4	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic Lens	80	0.32	665.6	$117.15	4	2	1'X4' 2-Lamp 32W T-8 Prism Lens/Elect Ballast; Metalux M/N GC	55	0.22	457.6	$80.54	$100.00	$400.00	0.10	208	$36.61	10.93
1	Downstairs Mens Room 2 x 2 Lamps	2080	2	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic Lens	80	0.16	332.8	$58.57	2	2	1'X4' 2-Lamp 32W T-8 Prism Lens/Elect Ballast; Metalux M/N GC	55	0.11	228.8	$40.27	$100.00	$200.00	0.05	104	$18.30	10.93
1	Downstairs Womens Room 3 x 2 Lamps	2080	3	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic Lens	80	0.24	499.2	$87.86	3	2	1'X4' 2-Lamp 32W T-8 Prism Lens/Elect Ballast; Metalux M/N GC	55	0.17	343.2	$60.40	$100.00	$300.00	0.08	156	$27.46	10.93
22	Maintenance Closet (by Classroom A) 1 x 4 Lamps	520	1	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic Lens	160	0.16	83.2	$14.64	1	3	2'x4' 3-Lamp 32W T-8 Prismatic Lens / Elect Ballast; Metalux M/N 2GC8	91	0.09	47.32	$8.33	$140.00	$140.00	0.07	35.88	$6.31	22.17
10	Maintenance Closet (by downstairs bathroom) 1 Hight Hat Lamp	520	1	1	1-Lamp Incandescents	75	0.08	39.0	$6.86	1	0	18 W CFL Lamp	18	0.02	9.36	$1.65	$5.75	$5.75	0.06	29.64	$5.22	1.10
1	Boiler Room 4 x 2 Lamps	520	4	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic Lens	80	0.32	166.4	$29.29	4	2	1'X4' 2-Lamp 32W T-8 Prism Lens/Elect Ballast; Metalux M/N GC	55	0.22	114.4	$20.13	$100.00	$400.00	0.10	52	$9.15	43.71
	Totals		295	58			17.31	35,130.7	$6,183.00	295	36			9.459	19161.48	$3,372.42		$10,837.75	6.59	13348.4	$2,349.32	4.61

NOTES: 1. Simple Payback noted in this spreadsheet does not include Maintenance Savings and NJ Smart Start Incentives.
2. Lamp totals only include T-12 tube replacment calculations

CEG Job #: 9C10084
Project: Morris County DPW
Address: 53 E. Hanover Ave
Morristown, NJ 07963
Building SF: 16220

Haggerty Education Center

KWH COST: $0.176

ECM #2: Lighting Controls

EXISTING LIGHTING										PROPOSED LIGHTING CONTROLS										SAVINGS			
CEG Type	Fixture Location	Yearly Usage	No. Fixts	No. Lamps	Fixture Type	Fixt Watts	Total kW	kWh/Yr Fixtures	Yearly $ Cost	No. Fixts	No. Cont.	Controls Description	Watts Used	Total kW	Reduction (%)	kWh/Yr Fixtures	Yearly $ Cost	Unit Cost (INSTALLED)	Total Cost	kW Savings	kWh/Yr Savings	Yearly $ Savings	Yearly Simple Payback
12	Auditorium Track 8 x 6 Lamps	2080	48	0	1-Lamp Compact Flourescent	13	0.62	1,297.9	$228.43	48	0	No Change	13	0.62	0%	1297.92	$228.43	$0.00	$0.00	0.00	0	$0.00	0.00
10	Auditorium High Hats on Dimmer	2080	18	0	1-Lamp Incandescents	75	1.35	2,808.0	$494.21	18	0	No Change	75	1.35	0%	2808	$494.21	$0.00	$0.00	0.00	0	$0.00	0.00
20	Auditorium Chandeliers 4 x 12 Lamps	2080	48	0	1 Lamp Incandescents	60	2.88	5,990.4	$1,054.31	48	0	No Change	60	2.88	0%	5990.4	$1,054.31	$0.00	$0.00	0.00	0	$0.00	0.00
20	Auditorium Sconces 4 x 3 Lamps	2080	12	0	1 Lamp Incandescents	60	0.72	1,497.6	$263.58	12	0	No Change	60	0.72	0%	1497.6	$263.58	$0.00	$0.00	0.00	0	$0.00	0.00
12	Stalls Track 3 x 5 Lamps	2080	15	0	1-Lamp Compact Flourescent	13	0.20	405.6	$71.39	15	0	No Change	13	0.20	0%	405.6	$71.39	$0.00	$0.00	0.00	0	$0.00	0.00
10	Stalls 1 High Hat	2080	1	0	1-Lamp Incandescents	75	0.08	156.0	$27.46	1	0	No Change	75	0.08	0%	156	$27.46	$0.00	$0.00	0.00	0	$0.00	0.00
10	Stalls Standard Bulbs	2080	8	0	1-Lamp Incandescents	75	0.60	1,248.0	$219.65	8	0	No Change	75	0.60	0%	1248	$219.65	$0.00	$0.00	0.00	0	$0.00	0.00
12	Carriage House Track 4 x 5 Lamps	2080	20	0	1-Lamp Compact Flourescent	13	0.26	540.8	$95.18	20	0	No Change	13	0.26	0%	540.8	$95.18	$0.00	$0.00	0.00	0	$0.00	0.00
12	Carriage House Track 1 x 4 Lamps	2080	4	0	1-Lamp Compact Flourescent	13	0.05	108.2	$19.04	4	0	No Change	13	0.05	0%	108.16	$19.04	$0.00	$0.00	0.00	0	$0.00	0.00
32	Lobby (upstairs) Chandelier 1 x 21 Lamps	2080	21	0	1 Lamp Incandescents	100	2.10	4,368.0	$768.77	21	0	No Change	100	2.10	0%	4368	$768.77	$0.00	$0.00	0.00	0	$0.00	0.00
20	Lobby (upstairs) Sconces 3 x 3 Lamps	2080	9	0	1 Lamp Incandescents	60	0.54	1,123.2	$197.68	9	0	No Change	60	0.54	0%	1123.2	$197.68	$0.00	$0.00	0.00	0	$0.00	0.00
12	Lobby (upstairs) 4 Drop Lights	2080	4	0	1-Lamp Compact Flourescent	13	0.05	108.2	$19.04	4	0	No Change	13	0.05	0%	108.16	$19.04	$0.00	$0.00	0.00	0	$0.00	0.00
22	Lobby (upstairs) T12 8 x 4 Lamps	2080	8	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic	160	1.28	2,662.4	$468.58	8	1	Dual Technology Occupancy Sensor - Switch Mnt.	160	1.02	20%	2129.92	$374.87	$150.00	$150.00	0.26	532.48	$93.72	1.60
1	Gallery T12 7 x 2 u Shape Lamps	2080	7	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic	80	0.56	1,164.8	$205.00	7	1	Dual Technology Occupancy Sensor - Switch Mnt.	80	0.45	20%	931.84	$164.00	$150.00	$150.00	0.11	232.96	$41.00	3.66
12	Gallery Track 1 x 6 Lamps Dimmer	2080	6	0	1-Lamp Compact Flourescent	13	0.08	162.2	$28.55	6	0	No Change	13	0.08	0%	162.24	$28.55	$0.00	$0.00	0.00	0	$0.00	0.00
22	Classroom A 12 x 4 Lamps	2080	12	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic	160	1.92	3,993.6	$702.87	12	1	Dual Technology Occupancy Sensor - Switch Mnt.	160	1.54	20%	3194.88	$562.30	$150.00	$150.00	0.38	798.72	$140.57	1.07
22	Classroom B 12 x 4 Lamps	2080	12	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic	160	1.92	3,993.6	$702.87	12	1	Dual Technology Occupancy Sensor - Switch Mnt.	160	1.54	20%	3194.88	$562.30	$150.00	$150.00	0.38	798.72	$140.57	1.07
22	Library 9 x 4 Laps	2080	9	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic	160	1.44	2,995.2	$527.16	9	1	Dual Technology Occupancy Sensor - Switch Mnt.	160	1.15	20%	2396.16	$421.72	$150.00	$150.00	0.29	599.04	$105.43	1.42
22	Staff Office 6 x 4 Lamps	2080	6	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic	160	0.96	1,996.8	$351.44	6	1	Dual Technology Occupancy Sensor - Switch Mnt.	160	0.77	20%	1597.44	$281.15	$150.00	$150.00	0.19	399.36	$70.29	2.13
22	Friends Office 7 x 4 Lamps	2080	7	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic	160	1.12	2,329.6	$410.01	7	1	Dual Technology Occupancy Sensor - Switch Mnt.	160	0.90	20%	1863.68	$328.01	$150.00	$150.00	0.22	465.92	$82.00	1.83
22	Auditorium Kitchen 2 x 4 Lamps	2080	2	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic	160	0.32	665.6	$117.15	2	1	Dual Technology Occupancy Sensor - Switch Mnt.	160	0.26	20%	532.48	$93.72	$150.00	$150.00	0.06	133.12	$23.43	6.40
1	Upstairs Mens Room 3 x 2 Lamps	2080	3	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic	80	0.24	499.2	$87.86	3	1	Dual Technology Occupancy Sensor - Switch Mnt.	80	0.19	20%	399.36	$70.29	$150.00	$150.00	0.05	99.84	$17.57	8.54

1	Upstairs Womens Room 4 x 2 Lamps	2080	4	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic	80	0.32	665.6	$117.15	4	1	Dual Technology Occupancy Sensor - Switch Mnt.	80	0.26	20%	532.48	$93.72	$150.00	$150.00	0.06	133.12	$23.43	6.40
1	Downstairs Mens Room 2 x 2 Lamps	2080	2	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic	80	0.16	332.8	$58.57	2	1	Dual Technology Occupancy Sensor - Switch Mnt.	80	0.13	20%	266.24	$46.86	$150.00	$150.00	0.03	66.56	$11.71	12.80
1	Downstairs Womens Room 3 x 2 Lamps	2080	3	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic	80	0.24	499.2	$87.86	3	1	Dual Technology Occupancy Sensor - Switch Mnt.	80	0.19	20%	399.36	$70.29	$150.00	$150.00	0.05	99.84	$17.57	8.54
22	Maintenance Closet (by Classroom A) 1 x 4	520	1	4	4-Lamp, T12, Magnetic Ballast, Recessed Mounted, Prismatic	160	0.16	83.2	$14.64	1	1	Dual Technology Occupancy Sensor - Switch Mnt.	160	0.13	20%	66.56	$11.71	$150.00	$150.00	0.03	16.64	$2.93	51.22
10	Maintenance Closet (by downstairs	520	1	0	1-Lamp Incandescents	75	0.08	39.0	$6.86	1	0	No Change	75	0.08	0%	39	$6.86	$0.00	$0.00	0.00	0	$0.00	0.00
1	Boiler Room 4 x 2 Lamps	520	4	2	2-Lamp, T12, Magnetic Ballast, Surface Mounted, Prismatic	80	0.32	166.4	$29.29	4	1	Dual Technology Occupancy Sensor - Switch Mnt.	80	0.26	20%	133.12	$23.43	$150.00	$150.00	0.06	33.28	$5.86	25.61
	Totals		295	44			20.56	41,901.1	$7,374.59	295	14			18.369		37491.48	$6,598.50		$2,100.00	2.19	4409.6	$776.09	2.71

NOTES: 1. Simple Payback noted in this spreadsheet does not include Maintenance Savings and NJ Smart Start Incentives.

2. Lamp totals only include T-12 tube replacment calculations

Project Name: Morris County LGEA
Location: Haggerty Education Center - Covered Parking Array
Description: Photovoltaic System - Direct Purchase

Simple Payback Analysis

	Photovoltaic System - Direct Purchase
Total Construction Cost	$1,128,150
Annual kWh Production	138,873
Annual Energy Cost Reduction	$24,442
Annual SREC Revenue	$48,606
First Cost Premium	**$1,128,150**
Simple Payback:	**15.44** **Years**

Life Cycle Cost Analysis

Analysis Period (years):	25	Financing %:	0%
Financing Term (mths):	120	Maintenance Escalation Rate:	3.0%
Average Energy Cost ($/kWh)	**$0.176**	Energy Cost Escalation Rate:	3.0%
Financing Rate:	0.00%	SREC Value ($/kWh)	$0.350

Period	Additional Cash Outlay	Energy kWh Production	Energy Cost Savings	Additional Maint Costs	SREC Revenue	Net Cash Flow	Cumulative Cash Flow
0	$1,128,150	0	0	0	$0	(1,128,150)	0
1	$0	138,873	$24,442	$0	$48,606	$73,047	($1,055,103)
2	$0	138,179	$25,175	$0	$48,363	$73,537	($981,565)
3	$0	137,488	$25,930	$0	$48,121	$74,051	($907,515)
4	$0	136,800	$26,708	$0	$47,880	$74,588	($832,926)
5	$0	136,116	$27,509	$1,402	$47,641	$73,748	($759,178)
6	$0	135,436	$28,335	$1,395	$47,403	$74,342	($684,836)
7	$0	134,759	$29,185	$1,388	$47,165	$74,962	($609,874)
8	$0	134,085	$30,060	$1,381	$46,930	$75,609	($534,265)
9	$0	133,414	$30,962	$1,374	$46,695	$76,283	($457,983)
10	$0	132,747	$31,891	$1,367	$46,462	$76,985	($380,998)
11	$0	132,084	$32,848	$1,360	$46,229	$77,716	($303,281)
12	$0	131,423	$33,833	$1,354	$45,998	$78,477	($224,804)
13	$0	130,766	$34,848	$1,347	$45,768	$79,269	($145,535)
14	$0	130,112	$35,893	$1,340	$45,539	$80,092	($65,442)
15	$0	129,462	$36,970	$1,333	$45,312	$80,948	$15,506
16	$0	128,814	$38,079	$1,327	$45,085	$81,838	$97,343
17	$0	128,170	$39,222	$1,320	$44,860	$82,761	$180,105
18	$0	127,529	$40,398	$1,314	$44,635	$83,720	$263,825
19	$0	126,892	$41,610	$1,307	$44,412	$84,715	$348,540
20	$0	126,257	$42,859	$1,300	$44,190	$85,748	$434,288
21	$1	125,626	$44,144	$1,294	$43,969	$86,819	$521,108
22	$2	124,998	$45,469	$1,287	$43,749	$87,930	$609,038
23	$3	124,373	$46,833	$1,281	$43,530	$89,082	$698,120
24	$4	123,751	$48,238	$1,275	$43,313	$90,276	$788,396
25	$5	123,132	$49,685	$1,268	$43,096	$91,513	$879,909
	Totals:	3,271,286	$891,125	$28,015	$1,144,950	$2,008,059	($3,107,128)
				Net Present Value (NPV)		**$879,934**	
				Internal Rate of Return (IRR)		**4.8%**	

Building	Roof Area (sq ft)	Panel	Qty	Panel Sq Ft	Panel Total Sq Ft	Total KW_{DC}	Total Annual kWh	Panel Weight (33 lbs)	W/SQFT
Covered Parking Lot	8000	Sunpower SPR230	545	14.7	8,014	125.35	138,873	17,985	15.64

.= Proposed PV Layout

PVWatts AC Energy & Cost Savings

Cautions for Interpreting the Results

Haggerty Parking Lot Array

Station Identification	
City:	Newark
State:	New_Jersey
Latitude:	40.70° N
Longitude:	74.17° W
Elevation:	9 m
PV System Specifications	
DC Rating:	225.4 kW
DC to AC Derate Factor:	0.810
AC Rating:	182.6 kW
Array Type:	Fixed Tilt
Array Tilt:	10.0°
Array Azimuth:	135.0°
Energy Specifications	
Cost of Electricity:	0.2 ¢/kWh

Results			
Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	2.24	12510	22.02
2	3.04	15646	27.54
3	3.96	22356	39.35
4	4.76	25100	44.18
5	5.66	29882	52.59
6	5.93	29556	52.02
7	5.71	29048	51.12
8	5.32	26796	47.16
9	4.54	22848	40.21
10	3.48	18481	32.53
11	2.26	11710	20.61
12	1.90	10136	17.84
Year	4.07	254069	447.16

Notes:
1. Estimated kWH based on the National Renewable Energy Laboratory PVWatts Version 1 Calculator Program.