

**ENERGY AUDIT – FINAL REPORT
JANUARY 6, 2010**

**UNION COUNTY COLLEGE
CRANFORD CAMPUS
SPERRY OBSERVATORY
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CEG PROJECT No. 9C08144

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I. EXECUTIVE SUMMARY

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

Union County College – Cranford Campus
Sperry Observatory
1033 Springfield Avenue
Cranford, NJ 07016

College Contact Person: Henry Key and John Hone
Facility Contact Person: Bob Curtiss

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	\$16,118
Natural Gas	\$0
Total	\$16,118

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' 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 $\pm 20\%$. 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	Lighting Upgrade	\$137	\$103	1.3	1031.2%
ECM #2	AHU Replacement - Air to Air HP	\$7,447	\$1,943	3.8	421.8%
ECM #3	AHU Replacement - Geothermal	\$17,240	\$2,190	7.9	154.1%
ECM #4	Thru-the-Wall AC Unit Replacement	\$810	\$106	7.6	96.3%
ECM #5	Parking Lot Fixture Upgrade - LED	\$18,705	\$312	60.0	-75.0%
RENEWABLE ENERGY MEASURES (REM's)					
ECM NO.	DESCRIPTION	NET INSTALLATION COST	ANNUAL SAVINGS	SIMPLE PAYBACK (Yrs)	SIMPLE LIFETIME ROI
REM #1	28.3 kW PV System	\$254,610	\$17,294	14.7	69.8%
Notes:	A. Cost takes into consideration applicable NJ Smart Start™ 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	Lighting Upgrade	0.3	535	0
ECM #2	AHU Replacement - Air to Air HP	6.6	10,857	0
ECM #3	AHU Replacement - Geothermal	7.5	12,230	0
ECM #4	Thru-the-Wall AC Unit Replacement	0.4	591	0
ECM #5	Parking Lot Fixture Upgrade - LED	0.8	1,741	0
RENEWABLE ENERGY MEASURES (REM's)				
ECM NO.	DESCRIPTION	ANNUAL UTILITY REDUCTION		
		ELECTRIC DEMAND (KW)	ELECTRIC CONSUMPTION (KWH)	NATURAL GAS (THERMS)
REM #1	28.3 kW PV System	0	32,690	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 #1:** Lighting Upgrade
- **ECM #2:** AHU Replacement – Air to Air Heat Pump
- **ECM#3:** AHU Replacement – Geothermal
- **ECM#4:** Thru-the-Wall AC Unit Replacement

The lighting upgrade is strictly a basic lamp replacement for incandescent bulbs with compact fluorescent lamps. ECM#1 is a basic change-out that can be accomplished by the Owner's staff and has a rather quick payback.

It is pertinent to note that ECM#2 and ECM#3 are similar in that they both pertain to the replacement of the Classroom air handling unit. The Owner should select whichever ECM suits their goals and requirements. However, based on energy and first cost ECM#2 would be recommended by our firm for implementation.

ECM#4 is recommended for implementation and can also, be completed by the Owner's staff. The payback is slightly extended because of the lack of usage of the Office by the College in addition to the high-cost of energy efficient thru-the-wall AC units.

ECM#5 is not recommended at this time due to its high cost and extended payback period. The existing 175W HID fixtures the Owner is currently utilizing are efficient for their duty and with the correct operation of the photo-cell and time clock prove to be very difficult to retro-fit with what is considered an energy saving fixture. It is recommended the Owner stay on top of the maintenance on the photo-cells and check time clocks periodically for correct operation.

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.

II. INTRODUCTION

The comprehensive energy audit covers the 2,834 square foot Sperry Observatory, which includes the following spaces: optical room, photography room, office and adjacent parking lot.

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/ft²/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:

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

$$\text{Simple Lifetime Savings} = (\text{Yearly Savings} \times \text{ECM Lifetime})$$

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

$$\text{Lifetime Maintenance Savings} = (\text{Yearly Maintenance Savings} \times \text{ECM Lifetime})$$

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

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

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. Public Service Electric and Gas (PSE&G) provides electricity to the facility under their General Lighting and Power (GLP) rate structure. 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.

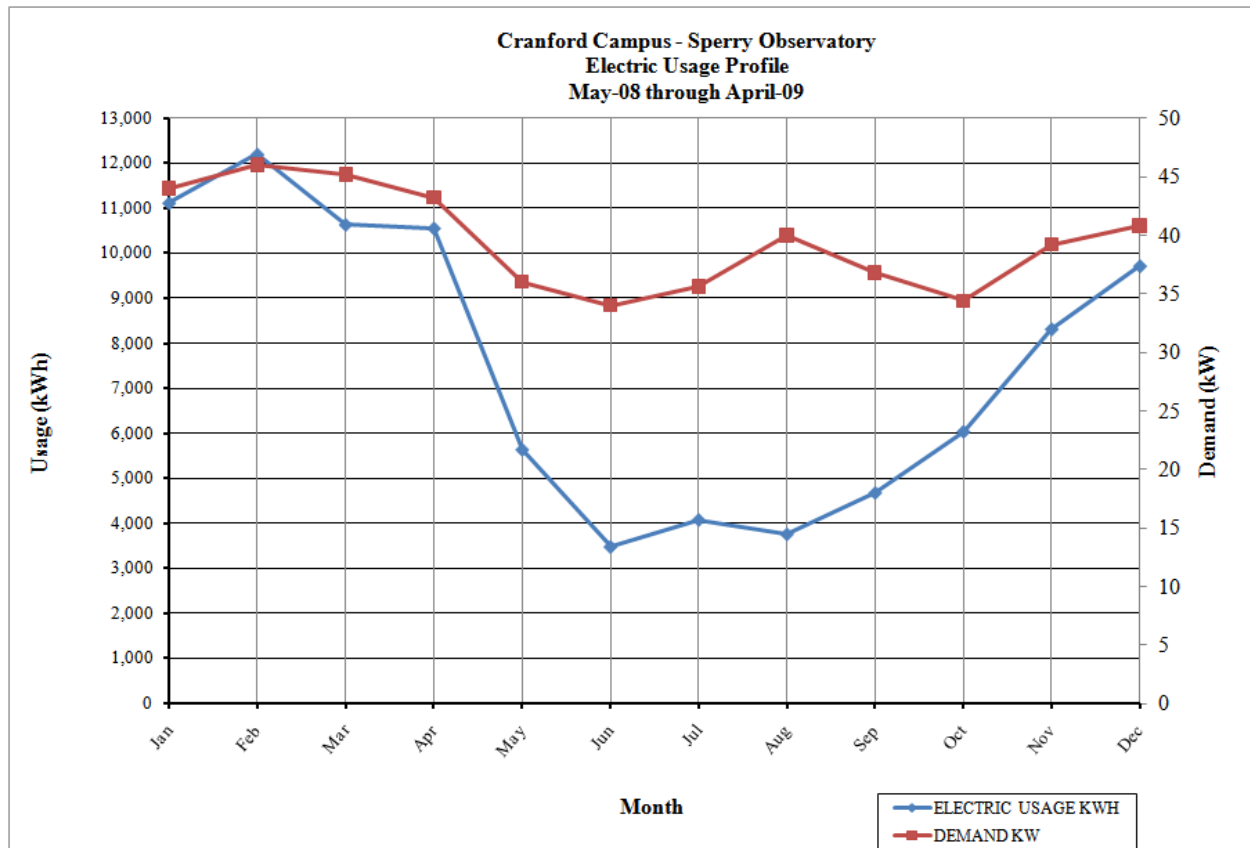
There is not a natural gas service at this building.

<u>Description</u>	<u>Average</u>
Electricity	17.9¢ / kWh

**Table 3
Electricity Billing Data**

ELECTRIC USAGE SUMMARY			
Utility Provider: PSE & G			
Rate: Rate - GLP			
Account No: 778016313			
Customer ID No: PE000011715101968482			
Third Party Utility Provider: N/A			
TPS Meter / Acct No: N/A			
MONTH OF USE	CONSUMPTION KWH	DEMAND	TOTAL BILL
Jan-09	11,120	44.0	\$1,629
Feb-09	12,200	46.0	\$1,819
Mar-09	10,640	45.2	\$1,649
Apr-09	10,560	43.2	\$1,599
May-08	5,640	36.0	\$824
Jun-08	3,480	34.0	\$1,004
Jul-08	4,080	35.6	\$1,166
Aug-08	3,760	40.0	\$1,191
Sep-08	4,680	36.8	\$1,271
Oct-08	6,040	34.4	\$1,046
Nov-08	8,320	39.2	\$1,283
Dec-08	9,720	40.8	\$1,635
Totals	90,240	46.0 Max	\$16,118
AVERAGE DEMAND		39.6 KW average	
AVERAGE RATE		\$0.179 \$/kWh	

Figure 1
Electricity 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:

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

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

Table 4
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	90240.0			308,079	3.340	1,028,985
NATURAL GAS		0.0		0	1.047	0
FUEL OIL			0.0	0	1.010	0
PROPANE			0.0	0	1.010	0
TOTAL				308,079		1,028,985
*Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued Dec 2007.						
BUILDING AREA	2,834 SQUARE FEET					
BUILDING SITE EUI	108.71 kBtu/SF/YR					
BUILDING SOURCE EUI	363.09 kBtu/SF/YR					

As a comparison, data has been gathered by the US Department of Energy (DOE) for various facilities cataloguing the standard site and source energy utilization. This data has been published in the 2003 Commercial Building Energy Consumption Survey and is noted as follows for facilities of this type:

- Education – College/University (Campus Level):
120 kBtu/SF Site Energy, 280 kBtu/SF Source Energy.

Based on the information compiled for the studied campus, as compared to the national average the energy usage is approximately 9.5% lower in Site Energy usage than the baseline data. However, because the usage is all electric, the Source Energy required by the Sperry Observatory is approximately 30% higher than the baseline data.

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.

In accordance with the Local Government Energy Audit Program, CEG has created an ENERGY STAR account for the municipality to access and monitoring the facility's yearly energy usage as it compares to facilities of similar type. 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: unioncountycollege
 Password: lgeaceg2009
 Security Question: What city were you born in?
 Security Answer: "cranford"

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 5
ENERGY STAR Performance Rating

ENERGY STAR PERFORMANCE RATING		
FACILITY DESCRIPTION	ENERGY PERFORMANCE RATING	NATIONAL AVERAGE
Sperry Observatory	N/A	N/A

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

An Energy Performance Rating cannot be established for the Sperry Observatory. The Energy Star program does not have enough data available to establish an Energy Performance Rating for a college campus at this time.

V. FACILITY DESCRIPTION

The 2,834 SF Sperry Observatory building is a single story facility comprised of a classrooms, telescope areas, optical room, photography area, and enclosed offices. Also, included in the audit of the observatory was the adjacent parking lot lighting. The building was constructed in 1965 for use by Union County College. The typical hours of operation for this facility vary from day-to-day based on classes and use of the telescopes. Exterior walls for the facility are constructed typically of block with brick face. The roof construction consists of built-up roof with stone cover and has an area of roof that opens to the sky for telescope use. There are no windows within the facility.

HVAC Systems

The HVAC systems for the facility vary in type and zoning. A summary of the equipment is as follows:

- *Classroom:* General heating and cooling is provided by an indoor air-handling unit (Carrier M/N 38R5), located in the Shop Area, containing a supply fan and DX cooling coil with remote air-cooled condensing unit (Carrier M/N 38BA005) located on the roof. There is a duct-mounted, electric heater (13kW at 208V) that provides the main heating to the Classroom. The air-handling unit and condensing unit appear to be approximately 35 years of age and are passed their useful service life. At the time of our survey, the air-cooled condensing unit's casing was noted as starting to rust out.

In addition to the main heating system, there are also supplemental heaters (baseboard and ceiling-mounted, cabinet heaters) that provide trim heating to the classroom space. It is estimated that approximately 13.5 kW of electric heat is currently installed.

- *Shop Area:* The Shop Area is provided heating only. An electric, wall-hung heater with missing nameplate heats this area. Based on size of the heater, an estimated 3 kW output is being utilized for reference.
- *Server Room:* The Server Room is provided heating via an electric unit heater manufactured by TPI (M/N 30WB). Cooling is provided to the Server Room via a ductless, split-system unit as manufactured by Samsung. The unit can provide approximately 2-tons of cooling with an estimated energy efficiency of 15.5 SEER. The unit was manufactured in 2004 and has an estimated 10 years remaining useful life as outlined in 2007 ASHRAE Applications Handbook.
- *Office:* The Office is heated via a 10'-0" section of electric baseboard with an output of approximately 1.25 kW. The cooling for the Office is provided by a thru-the-wall air-conditioner manufactured by Carrier. The unit appears very old and does not contain nameplate data. Based on physical size of the air-conditioner it is estimated to provide approximately 7,500 Btu/h of cooling.

- *Toilet Rooms and Corridor:* The Toilet Rooms and Corridor are both heated via section of electric baseboard. Each Toilet Room contains a 4'-0" section of electric baseboard with an output of approximately 1.4 kW. The Corridor contains a 2'-0" section of electric baseboard with an estimated output of approximately 0.7 kW.

Exhaust System

Air is exhausted from the facility via two (2) Jenn-Air exhaust fans. The exhaust fans are operated by time clock.

HVAC System Controls

The HVAC systems within the facility are controlled via standard non-programmable thermostats. The air-handling unit serving the Classroom is controlled via separate occupied and unoccupied thermostats wired to a time clock with relays. A direct digital control system is not present at this facility.

Domestic Hot Water

Domestic hot water for the Toilet Rooms and Kitchenette is provided by a small electric hot water heater. The hot water heater appears to be in decent condition and is used seldom based on the minimum occupancy in the Sperry Observatory. Replacement would only be recommended if the unit was malfunctioning.

Lighting

Typical lighting throughout the building is fluorescent tube fixtures with T-8 lamps and electronic ballasts. There are also areas lit with a mixture of incandescent lamps and compact fluorescent lamps.

The parking lot is lit with "shoebox" type light poles containing 250W HID lamps. These lights are controlled by astronomical timers located in the Observatory electrical room.

VI. MAJOR EQUIPMENT LIST

The equipment list is considered major energy consuming equipment and through 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: Lighting Upgrade

Description:

The existing lighting within the Observatory consists of efficient fluorescent fixtures containing T8 lamps and electronic ballasts. There are various fixture sizes and lamp configurations utilized within the building. There are a minimal amount of incandescent lamps still used within the Observatory and these lamps should be replaced.

This ECM includes the replacement of all incandescent fixtures to compact fluorescent fixtures. The energy usage of an incandescent compared to a compact fluorescent is 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:

Refer to the **Investment Grade Lighting Audit Appendix** that outlines the proposed replacements, costs, savings, and payback periods. Due to the fact that the incandescent lamps in this facility operate for minimal hours per year, maintenance savings were not included in the final savings calculation for this ECM. Currently, a lighting incentive is not available for the installation of CFL lamps with the Smart Start[®] program.

Energy Savings Summary:

ECM #1 - ENERGY SAVINGS SUMMARY	
Installation Cost (\$):	\$137
NJ Smart Start Equipment Incentive (\$):	\$0
Net Installation Cost (\$):	\$137
Maintenance Savings (\$/Yr):	\$0
Energy Savings (\$/Yr):	\$103
Total Yearly Savings (\$/Yr):	\$103
Estimated ECM Lifetime (Yr):	15
Simple Payback	1.3
Simple Lifetime ROI	1031.2%
Simple Lifetime Maintenance Savings	\$0
Simple Lifetime Savings	\$1,547
Internal Rate of Return (IRR)	75%
Net Present Value (NPV)	\$1,094.41

ECM #2: AHU Replacement – Air to Air Heat Pump

Description:

General heating and cooling for the Classroom is provided by an indoor air-handling unit (Carrier M/N 38R5), located in the Shop Area, containing a supply fan and DX cooling coil with remote air-cooled condensing unit (Carrier M/N 38BA005) located on the roof. There is a duct-mounted, electric heater (13kW at 208V) that provides the main heating to the Classroom. The air-handling unit and condensing unit appear to be approximately 35 years of age and are passed their useful service life. This equipment is antiquated and is in need of replacement. It is estimated that the existing air-cooled condensing unit is operating at an efficiency of 7 EER.

Due to the lack of a natural gas service at the Observatory, CEG recommends utilizing heat pump technology for heating and cooling the building. This energy conservation measure would replace the split system air-handling unit serving the Classroom with a split system air-to-air heat pump. The new unit will provide heating and cooling capacities typical to that of the existing equipment. The NJ State Energy Code (ASHRAE 90.1-2004) mandates a minimum energy efficiency of 12.0 SEER for units of this type and this baseline will be utilized in selecting the new equipment. The new air-to-air heat pump shall be a Carrier M/N25HPA548 air-cooled, heat pump condensing unit with matching Carrier 58-Series air-handling unit or equivalent. The unit will be provided with low-ambient controls to -20°F operation in heating mode and an automatic change-over, programmable thermostat. The unit will provide approximately 48 MBH cooling capacity at an efficiency of 12 EER (14.5 SEER) during cooling mode and approximately 29.6 MBH at a 2.6 COP heating efficiency.

Energy Savings Calculations:

Given Information

Room Square Footage:	±1,350 SF
Estimated Cooling Load:	Nominal 4 Tons, 47.3 MBH
Full-Load Cooling Hours:	440 hours per year (June through September)
Estimated Heating Load:	44.4 MBH (13 kW)
Full-Load Heating Hours:	1,200 hours per year (November through March)
Total Full-Load Hours:	1,640 hours per year
Cost of Electricity:	\$0.179 / kWh

Existing Equipment

Cooling Efficiency:	7.0 EER (Estimate based on age.)
Heating Efficiency:	1.0 COP (Electric Heat)

New Equipment

Cooling Efficiency:	12.0 EER
Heating Efficiency:	2.6 COP

Cooling Energy Savings Calculations

$$\text{Energy Savings} = \frac{[\text{Cooling Tons} \times 12,000 \text{ Btu / ton}]}{[1000 \text{ W / kW}]} \times \left(\frac{1}{\text{EER}_{\text{OLD}}} - \frac{1}{\text{EER}_{\text{NEW}}} \right) \times \text{Hrs. of Cooling}$$

$$\text{Energy Savings} = \frac{[4 \text{ Tons} \times 12,000 \text{ Btu / ton}]}{[1000 \text{ W / kW}]} \times \left(\frac{1}{7} - \frac{1}{12} \right) \times 440 = \underline{1,257 \text{ kWh per year}}$$

Heating Energy Savings Calculations

$$\text{Base Heating Use} = \text{Heating Load} \times \text{Heating Hours} = 13 \text{ kW} \times 1,200 = \underline{15,600 \text{ kWh per year}}$$

$$\text{Energy Savings} = \text{Base Heating Use} \times \left(\frac{1}{\text{COP}_{\text{OLD}}} - \frac{1}{\text{COP}_{\text{NEW}}} \right) = \underline{9,600 \text{ kWh per year}}$$

$$\begin{aligned} \text{Total Energy Savings} &= \text{Cooling Energy Savings} + \text{Heating Energy Savings} \\ &= 1,257 + 9,600 \text{ kWh} = \underline{10,857 \text{ kWh per year}} \end{aligned}$$

$$\text{Energy Cost Savings} = 10,857 \text{ kWh} \times \$0.179 / \text{kWh} = \underline{\$1,943 \text{ per year}}$$

$$\text{Estimated Demand Savings} = \text{kWh Saved} / \text{Hrs at Load} = 10,857 \text{ kWh} / 1640 \text{ hrs} = \underline{6.6 \text{ kW}}$$

$$\text{Estimated Installation Cost} = \text{Material} + \text{Labor} = \$5,675 + \$2,140 = \underline{\$7,815}$$

NJ Smart Start[®] Program Incentives are calculated as follows:

From the **New Jersey Smart Start[®] Program Incentives Appendix**, the replacement of an air-to-air heat pump system totaling less than 5.4 cooling tons with efficiency greater than 14 SEER, warrants an incentive of \$92 per cooling ton.

$$\text{Smart Start[®] Equipment Incentive} = (4 \text{ Tons} \times \$92 \text{ per ton}) = \underline{\$368}$$

Maintenance savings could not be calculated due to the fact that there is not adequate data to baseline the existing expenditures.

Energy Savings Summary:

ECM #2 - ENERGY SAVINGS SUMMARY	
Installation Cost (\$):	\$7,815
NJ Smart Start Equipment Incentive (\$):	\$368
Net Installation Cost (\$):	\$7,447
Maintenance Savings (\$/Yr):	\$0
Energy Savings (\$/Yr):	\$1,943
Total Yearly Savings (\$/Yr):	\$1,943
Estimated ECM Lifetime (Yr):	20
Simple Payback	3.8
Simple Lifetime ROI	421.8%
Simple Lifetime Maintenance Savings	\$0
Simple Lifetime Savings	\$38,860
Internal Rate of Return (IRR)	26%
Net Present Value (NPV)	\$21,459.93

ECM #3: AHU Replacement – Geothermal Heat Pump

Description:

General heating and cooling for the Classroom is provided by an indoor air-handling unit (Carrier M/N 38R5), located in the Shop Area, containing a supply fan and DX cooling coil with remote air-cooled condensing unit (Carrier M/N 38BA005) located on the roof. There is a duct-mounted, electric heater (13kW at 208V) that provides the main heating to the Classroom. The air-handling unit and condensing unit appear to be approximately 35 years of age and are passed their useful service life. This equipment is antiquated and is in need of replacement. It is estimated that the existing air-cooled condensing unit is operating at an efficiency of 7 EER.

Due to the lack of a natural gas service at the Observatory, CEG recommends utilizing heat pump technology for heating and cooling the building. This energy conservation measure would replace the split system air-handling unit serving the Classroom with a geothermal heat pump system. The new unit will provide heating and cooling capacities typical to that of the existing equipment. The NJ State Energy Code (ASHRAE 90.1-2004) mandates a minimum energy efficiency of 13.4 EER and 3.1 COP for units of this type and this baseline will be utilized in selecting the new equipment. The new geothermal heat pump shall be a Climate Master M/N TS048 geothermal heat pump unit or equivalent. The unit will be provided with a flow controller (inline pump package), DDC controller with programmable thermostat. The unit will provide approximately 50.1 MBH cooling capacity at an efficiency of 18.5 EER during cooling mode and approximately 38.4 MBH at a 3.8 COP heating efficiency. CEG estimates this installation will require approximately two (2) 400'-0" vertical bores to make-up the geothermal heat exchanger. The vertical bores shall be installed next to the building as close as possible to the Shop Area.

Energy Savings Calculations:

Given Information

Room Square Footage:	±1,350 SF
Estimated Cooling Load:	Nominal 4 Tons, 47.3 MBH
Full-Load Cooling Hours:	440 hours per year (June through September)
Estimated Heating Load:	44.4 MBH (13 kW)
Full-Load Heating Hours:	1,200 hours per year (November through March)
Total Full-Load Hours:	1,640 hours per year
Cost of Electricity:	\$0.179 / kWh

Existing Equipment

Cooling Efficiency:	7.0 EER (Estimate based on age.)
Heating Efficiency:	1.0 COP (Electric Heat)

New Equipment

Cooling Efficiency: 18.5 EER
 Heating Efficiency: 3.8 COP
 Flow Controller: 3/4 HP Inline Pump

Cooling Energy Savings Calculations

$$\text{Energy Savings} = \frac{[\text{Cooling Tons} \times 12,000 \text{ Btu / ton}]}{[1000 \text{ W / kW}]} \times \left(\frac{1}{\text{EER}_{\text{OLD}}} - \frac{1}{\text{EER}_{\text{NEW}}} \right) \times \text{Hrs. of Cooling}$$

$$\text{Energy Savings} = \frac{[4 \text{ Tons} \times 12,000 \text{ Btu / ton}]}{[1000 \text{ W / kW}]} \times \left(\frac{1}{7} - \frac{1}{18.5} \right) \times 440 = \underline{1,875 \text{ kWh per year}}$$

Heating Energy Savings Calculations

$$\text{Base Heating Use} = \text{Heating Load} \times \text{Heating Hours} = 13 \text{ kW} \times 1,200 = \underline{15,600 \text{ kWh per year}}$$

$$\text{Energy Savings} = \text{Base Heating Use} \times \left(\frac{1}{\text{COP}_{\text{OLD}}} - \frac{1}{\text{COP}_{\text{NEW}}} \right) = \underline{11,495 \text{ kWh per year}}$$

Pump Energy Calculations

Annual Hours: 2,200 hours per year (Total Building Operation)
 Motor Horsepower: 3/4 HP
 Motor Efficiency: 81%
 Load Factor (LF): 0.75

$$\text{Annual Pump Energy} = \frac{\text{Annual Hrs} \times \text{Motor HP} \times \text{LF} \times 0.746 \frac{\text{W}}{\text{HP}}}{\text{Motor Efficiency}} = \underline{1,140 \text{ kWh per year}}$$

$$\text{Total Energy Savings} = \text{Cooling Energy Savings} + \text{Heating Energy Savings} - \text{Pumping Energy} \\ = 1,875 + 11,495 - 1,140 \text{ kWh} = \underline{12,230 \text{ kWh per year}}$$

$$\text{Energy Cost Savings} = 12,230 \text{ kWh} \times \$0.179 / \text{kWh} = \underline{\$2,190 \text{ per year}}$$

$$\text{Estimated Demand Savings} = \text{kWh Saved} / \text{Hrs at Load} = 12,230 \text{ kWh} / 1640 \text{ hrs} = \underline{7.5 \text{ kW}}$$

$$\text{Estimated Installation Cost} = \text{Material} + \text{Labor} = \$11,232 + \$7,488 = \underline{\$18,720}$$

NJ Smart Start[®] Program Incentives are calculated as follows:

From the **New Jersey Smart Start[®] Program Incentives Appendix**, the installation of a geothermal heat pump system with efficiency ≥ 16 EER warrants an incentive of \$370 per cooling ton.

Smart Start[®] Equipment Incentive = (4 Tons x \$370 per ton) = \$1,480

Maintenance savings could not be calculated due to the fact that there is not adequate data to baseline the existing expenditures.

Energy Savings Summary:

ECM #3 - ENERGY SAVINGS SUMMARY	
Installation Cost (\$):	\$18,720
NJ Smart Start Equipment Incentive (\$):	\$1,480
Net Installation Cost (\$):	\$17,240
Maintenance Savings (\$/Yr):	\$0
Energy Savings (\$/Yr):	\$2,190
Total Yearly Savings (\$/Yr):	\$2,190
Estimated ECM Lifetime (Yr):	20
Simple Payback	7.9
Simple Lifetime ROI	154.1%
Simple Lifetime Maintenance Savings	\$0
Simple Lifetime Savings	\$43,800
Internal Rate of Return (IRR)	11%
Net Present Value (NPV)	\$15,341.67

ECM #4: Thru-the-Wall A/C Unit Replacement

Description:

Air-conditioning is provided within the Office via a residential-style window air-conditioning unit. The existing window air-conditioning unit is inefficient with an estimated seasonal energy efficiency ratio (SEER) of 8.0. The NJ State Energy Code (ASHRAE 90.1-2004) mandates a minimum energy efficiency of 10.6 SEER for units of this type. The existing window air-conditioning unit appears to be approximately 20-plus years of age and is past its service life as outlined in Chapter 36 of the 2007 ASHRAE Applications Handbook. The estimated service life for a window air-conditioning unit is 10 years.

This energy conservation measure would replace the window-air conditioning unit serving the Office. The existing unit will be replaced with a high energy efficient, window air-conditioning unit with cooling capacities typical of the existing unit; approximately 9,000 Btu/h. The average EER of the new equipment will be upwards of 10.5 EER (12.6 SEER est.). Basis of Design: Friedrich Model WS10 or equivalent.

Energy Savings Calculations:

$$EnergySavings = \frac{[CoolingTons \times 12,000 Btu / ton]}{[1000W / kW]} \times \left(\frac{1}{SEER_{OLD}} - \frac{1}{SEER_{NEW}} \right) \times Avg.LoadFactor \times Hrs.ofCooling$$

Existing Air Conditioning Units

Rated Capacity = $\frac{3}{4}$ Cooling Tons

Condenser Unit Efficiency = 8.0 SEER

Cooling Season Hrs. of Operation = 1,800 hrs/yr.

Average Cost of Electricity - \$0.179 / kWh

Proposed High-Efficiency Air Conditioning Unit

Rated Capacity = $\frac{3}{4}$ Cooling Tons

New Condenser Unit Efficiency = 12.6 SEER

$$EnergySavings = \frac{[3/4 tons \times 12,000 Btu / ton]}{[1000W / kW]} \times \left(\frac{1}{8.0} - \frac{1}{12.6} \right) \times 0.80 \times 1800 hrs = 591 kWh / yr$$

Energy Cost Savings = 591 kWh * \$0.179 / kWh = \$106 per year

Estimated Demand Savings = kWh Saved / Hrs of Operation = 591 kWh / 1440 hrs = 0.4 kW

Estimated Installation Cost = Material + Labor = \$540 + \$270 = \$810

There are currently no applicable equipment incentives for equipment of this capacity. Furthermore, maintenance savings could not be calculated due to the fact that there is not adequate data to baseline the existing expenditures.

Energy Savings Summary:

ECM #4 - ENERGY SAVINGS SUMMARY	
Installation Cost (\$):	\$810
NJ Smart Start Equipment Incentive (\$):	\$0
Net Installation Cost (\$):	\$810
Maintenance Savings (\$/Yr):	\$0
Energy Savings (\$/Yr):	\$106
Total Yearly Savings (\$/Yr):	\$106
Estimated ECM Lifetime (Yr):	15
Simple Payback	7.6
Simple Lifetime ROI	96.3%
Simple Lifetime Maintenance Savings	\$0
Simple Lifetime Savings	\$1,590
Internal Rate of Return (IRR)	10%
Net Present Value (NPV)	\$455.42

ECM #5: Parking Lot Fixture Upgrade - LED

Description:

The parking lot (Lot #5A) directly outside of the Sperry Observatory contains approximately fifteen (15) shoe-box type lighting fixtures mounted atop 20'-0" high steel poles and tagged consecutively 501 through 515. These fixtures contain one (1) 175W HID lamp per fixture. Based on our survey, it was noted that six (6) of the fixtures are single fixtures and nine (9) are dual fixtures. This results in a total of fifteen (15) 175W HID lamps at 215W input being utilized in the parking lot. The parking lot lights are controlled by astronomical timers located in the Observatory Electrical Room. Based on the average hours of dusk until 11:30 PM, these fixtures operate 6 hours per day, 365 days per year; totaling approximately 2,190 hours per year.

This ECM recommends replacing the existing 175W HID fixtures with comparable LED fixtures with photo-cell control as manufactured by Beta LED M/N BLDARE or equivalent. The fifteen (15) fixtures are to be replaced with fifteen (15) 3-Bar LED light fixtures producing 5,100 lumens at 162W input and light distribution typical to that of the existing fixtures. For the recommended fixture, CEG has calculated an estimated 0.25 foot candle boundary of 35 feet.

Energy Savings Calculations:

Existing Annual Energy Usage = Existing Lamp Input Watts x Hours of Operation
 = (215W input x 15 fixtures) x 2,190 hours = 7,063 kWh

New Annual Energy Usage = New Lamp Input Watts x Hours of Operation
 = (162W input x 15 fixtures) x 2,190 hours = 5,322 kWh

Total Energy Savings = Existing Annual Energy Usage – New Annual Energy Usage
 = 7,063 - 5,322 = 1,741 kWh per year

Energy Cost Savings = 1,741 kWh x \$0.179 / kWh = \$312 per year

Estimated Demand Savings = kWh Saved / Hrs at Load = 1,741 kWh / 2190 hrs = 0.8 kW

Estimated Installation Cost = Material + Labor = \$17,925 + \$1,425 = \$19,350

NJ Smart Start[®] Program Incentives are calculated as follows:

From the **New Jersey Smart Start[®] Program Incentives Appendix**, the installation of a low-bay LED parking lot light warrants an incentive of \$43 per fixture.

Smart Start[®] Incentive = (15 Fixtures x \$43 per Fixture) = \$645

Energy Savings Summary:

ECM #5 - ENERGY SAVINGS SUMMARY	
Installation Cost (\$):	\$19,350
NJ Smart Start Equipment Incentive (\$):	\$645
Net Installation Cost (\$):	\$18,705
Maintenance Savings (\$/Yr):	\$0
Energy Savings (\$/Yr):	\$312
Total Yearly Savings (\$/Yr):	\$312
Estimated ECM Lifetime (Yr):	15
Simple Payback	60.0
Simple Lifetime ROI	-75.0%
Simple Lifetime Maintenance Savings	\$0
Simple Lifetime Savings	\$4,680
Internal Rate of Return (IRR)	-14%
Net Present Value (NPV)	(\$14,980.36)

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 municipality 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 energy produces clean energy and reduces a building's carbon footprint. This is accomplished via photovoltaic panels which will be 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). 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 of the building being audited for the purposes of determining a potential for a roof mounted photovoltaic system. It was determined that due to lack of roof area, a ground mount system would be recommended. A ground area of 2,000 S.F. can be utilized for a PV system. A depiction of the area utilized is shown in **Renewable / Distributed Energy Measures Calculation Appendix**. Using this square footage it was determined that a system size of 28.3 kilowatts could be installed. A system of this size has an estimated kilowatt hour production of 32,690 kWh annually, reducing the overall utility bill by approximately 36% percent. 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. This 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 ground space on the existing facility. 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 college 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 6
Financial Summary – Photovoltaic System**

FINANCIAL SUMMARY - PHOTOVOLTAIC SYSTEM				
PAYMENT TYPE	SIMPLE PAYBACK	SIMPLE ROI	NET PRESENT VALUE	INTERNAL RATE OF RETURN
Direct Purchase	14.7 Years	6.8%	\$221,677	5.3%

*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 College to invest in a solar system through a Direct Purchase, CEG does not recommend the College pursue this route. It would be more advantageous for the college 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 College at a reduced rate compared to their existing electric rate.

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 is not adequate, and the kilowatt demand for the building is below the threshold (200 kW) 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:

Sperry Observatory is an all electric facility meaning lighting, heating and cooling are all done using electric. The Observatory contains a Classroom, Shop, Server Room, Office, and Toilet Rooms.

The Electric Usage Profile for this facility is a typical profile for an all electric building. The winter load (September – April), is elevated and typical for electric heat. All of the major rooms utilize some form of electric resistance heat to provide the required heat capacity for the space. As noted in the facility description, there are electric cabinet heaters, baseboard, and a single duct heater that are all part of the heating system. Cooling during the summer months (June-August) is much reduced but steady in its usage. Cooling in this facility is provided by a split system air-handling unit with roof-mounted condensing unit for the Classroom. The Server Room has a ductless split system and the Office has a thru-the-wall AC unit.

Tariffs:

Electricity:

This facility receives electrical service through the utility Public Service Electric and Gas Company (PSE&G) on a GLP (General Lighting and Power Service) rate schedule. The Delivery Service and Commodity Service's are provided by PSE&G. The GLP Delivery Service is for general purposes at secondary distribution voltages. Customers may either purchase electric supply from a Third Party Supplier (TPS) or from PSE&G's Basic Generation Service default service as detailed in the rate schedule. Delivery Charges include: Service Charge, Distribution Charges, Societal Benefits Charge, Non-utility Generation Charge, Securitization and Transition Charges. System Control Charge, Customer Account Services Charge, CIEP Standby Fee, Base-rate Adjustment Charge, Solar Pilot Recovery Charge, RGGI Recovery Charge and Capital Adjustment Charge. Currently the Sperry facility utilizes full electric service from PSE&G.

Recommendations:

CEG recommends a global approach that will be consistent with all Union County College facilities. Potential savings can be seen in the electric costs. The average price per kWh

(kilowatt hour) for commodity to this facility, based on a historical 1-year weighted average fixed price from PSE&G (based on information provided), is \$.151 / kWh (this is the “price to compare” when shopping for energy procurement alternatives).

The “price to compare” is the netted cost of the energy (including other costs), that the customer will use to compare to Third Party Supply sources when shopping for alternative suppliers. For electricity this cost would not include the utility transmission and distribution charges. For natural gas (if it were applicable to this facility) the cost would not include the utility distribution charges and is said to be delivered to the utility’s city-gate.

Energy commodities are among the most volatile of all commodities, however at this point and time, energy is extremely competitive. This facility could see improvement in its energy costs if it were to take advantage of these current market prices quickly, before energy prices increase. Based on electric supply from PSE&G and utilizing the historical consumption data provided (May 2008 through April 2009) and current electric rates, this facility could see an improvement in its electric costs of up to 28 % or over \$4,000 annually. (Note: Savings were calculated using Average Annual Consumption and a variance to a Fixed Average One-Year commodity contract). CEG recommends aggregating the entire campus electric load to gain the most optimal energy costs. CEG recommends advisory services to review these energy costs.

CEG recommends the College receive further advisement on TPS prices through an energy advisor. They should also consider having an energy advisor write an RFP (Request for Proposal) for energy procurement now, while energy costs are deflated.

CEG also recommends scheduling a meeting with the current utility provider to review their utility charges and current tariff structures for electricity. This meeting would provide insight regarding alternative procurement options that are currently available. Through its meeting with the Local Distribution Company (LDC), the College can learn more about the competitive supply process. The College can acquire a list of approved Third Party Suppliers from the New Jersey Board of Public Utilities website at www.nj.gov/bpu. They should also consider using a billing-auditing service to further analyze the utility invoices, manage the data and use the information for ongoing demand-side management projects. Furthermore, special attention should be given to credit mechanisms, imbalances, balancing charges and commodity charges when meeting with the utility representative. The College should ask the utility representative about alternative billing options, such as consolidated billing when utilizing the service of a Third Party Supplier. Finally, if the supplier for energy (electric) is changed, closely monitor balancing, particularly when the contract is close to termination. This could be performed with the aid of an “energy advisor.”

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 pay 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.

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 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.

ECM COST & SAVINGS BREAKDOWN
CONCORD ENGINEERING GROUP

Union County College - Sperry Observatory

ECM ENERGY AND FINANCIAL COSTS AND SAVINGS SUMMARY

ECM NO.	DESCRIPTION	INSTALLATION COST			YEARLY SAVINGS			ECM LIFETIME (Yr)	LIFETIME ENERGY SAVINGS (Yearly Saving * ECM Lifetime) (\$)	LIFETIME MAINTENANCE SAVINGS (Yearly Maint Saving * ECM Lifetime) (\$)	LIFETIME ROI (Lifetime Savings - Net Cost) / (Net Cost) (%)	SIMPLE PAYBACK (Net cost / Yearly Savings) (Yr)	INTERNAL RATE OF RETURN $\sum_{t=0}^N \frac{C_t}{(1+r)^t}$ (%)	NET PRESENT VALUE (NPV) (\$)
		MATERIAL (\$)	LABOR (\$)	REBATES INCENTIVES (\$)	NET INSTALLATION COST (\$)	ENERGY (\$/Yr)	MAINT. / SECC (\$/Yr)							
ECM #1	Lighting Upgrade	\$47	\$90	\$0	\$137	\$103	\$0	\$103	\$1,547	\$0	103.2%	1.3	\$1,094.41	
ECM #2	AHU Replacement - Air to Air HP	\$5,675	\$2,140	\$3,688	\$7,447	\$1,943	\$0	\$1,943	\$38,860	\$0	421.8%	3.8	\$21,459.93	
ECM #3	AHU Replacement - Geothermal	\$11,232	\$7,488	\$1,480	\$17,240	\$2,190	\$0	\$2,190	\$43,800	\$0	154.1%	7.9	\$15,341.67	
ECM #4	Through-Wall AC Unit Replacement	\$540	\$270	\$0	\$810	\$106	\$0	\$106	\$1,590	\$0	96.3%	7.6	\$455.42	
ECM #5	Pushing Low Voltage Upgrade - LED	\$17,925	\$1,425	\$645	\$18,795	\$312	\$0	\$312	\$4,680	\$0	-75.0%	60.0	(\$14,680.50)	
REMAINING ENERGY AND FINANCIAL COSTS AND SAVINGS SUMMARY														
REM #1	28.3 kW PV System	\$254,610	\$0	\$0	\$254,610	\$5,852	\$11,442	\$17,294	\$432,350	\$386,050	69.8%	14.7	\$46,532.98	

Notes: 1) The variable C_n 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 C_n 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 January, 2009:

Electric Chillers

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

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

Ground Source Heat Pumps

Closed Loop & Open Loop	\$370 per ton
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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

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

Premium Motors

Three-Phase Motors	\$45 - \$700 per motor
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Prescriptive Lighting

T-5 and T-8 Lamps w/Electronic Ballast in Existing Facilities	\$10 - \$30 per fixture, (depending on quantity)
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

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

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



STATEMENT OF ENERGY PERFORMANCE

Sperry Observatory

Building ID: 1906941
For 12-month Period Ending: April 30, 2009¹
Date SEP becomes ineligible: N/A

Date SEP Generated: October 22, 2009

Facility
 Sperry Observatory
 1033 Springfield Avenue
 Cranford, NJ 07016

Facility Owner
 Union County College
 232 East Second Street
 Plainfield, NJ 07060

Primary Contact for this Facility
 John Hone
 232 East Second Street
 Plainfield, NJ 07060

Year Built: 1965
Gross Floor Area (ft²): 2,834

Energy Performance Rating² (1-100) N/A

Site Energy Use Summary³

Electricity - Grid Purchase(kBtu)	307,899
Natural Gas - (kBtu) ⁴	0
Total Energy (kBtu)	307,899

Energy Intensity⁵

Site (kBtu/ft ² /yr)	109
Source (kBtu/ft ² /yr)	363

Emissions (based on site energy use)

Greenhouse Gas Emissions (MtCO ₂ e/year)	47
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Electric Distribution Utility

PSE&G - Public Service Elec & Gas Co

National Average Comparison

National Average Site EUI	120
National Average Source EUI	280
% Difference from National Average Source EUI	30%
Building Type	College/University (Campus-Level)

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.

Meets Industry Standards⁶ for Indoor Environmental Conditions:

Ventilation for Acceptable Indoor Air Quality	N/A
Acceptable Thermal Environmental Conditions	N/A
Adequate Illumination	N/A

Certifying Professional

Raymond Johnson
 520 South Burnt Mill Rd.
 Voorhees, NJ 08043

Notes:

- 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.
- 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.
- Values represent energy consumption, annualized to a 12-month period.
- Natural Gas values in units of volume (e.g. cubic feet) are converted to kBtu with adjustments made for elevation based on Facility zip code.
- Values represent energy intensity, annualized to a 12-month period.
- 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.

ENERGY STAR® Data Checklist for Commercial Buildings

In order for a building to qualify for the ENERGY STAR, a Professional Engineer (PE) must validate the accuracy of the data underlying the building's energy performance rating. This checklist is designed to provide an at-a-glance summary of a property's physical and operating characteristics, as well as its total energy consumption, to assist the PE in double-checking the information that the building owner or operator has entered into Portfolio Manager.

Please complete and sign this checklist and include it with the stamped, signed Statement of Energy Performance.

NOTE: You must check each box to indicate that each value is correct, OR include a note.

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	<input checked="" type="checkbox"/>
Building Name	Sperry Observatory	Is this the official building name to be displayed in the ENERGY STAR Registry of Labeled Buildings?		<input type="checkbox"/>
Type	College/University (Campus-Level)	Is this an accurate description of the space in question?		<input type="checkbox"/>
Location	1033 Springfield Avenue, Cranford, NJ 07016	Is this address accurate and complete? Correct weather normalization requires an accurate zip code.		<input type="checkbox"/>
Single Structure	Single Facility	Does this SEP represent a single structure? SEPs cannot be submitted for multiple-building campuses (with the exception of acute care or children's hospitals) nor can they be submitted as representing only a portion of a building		<input type="checkbox"/>
Sperry Observatory (Other)				
CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	<input checked="" type="checkbox"/>
Gross Floor Area	2,834 Sq. Ft.	Does this square footage include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc. Also note that existing atriums should only include the base floor area that it occupies. Interstitial (plenum) space between floors should not be included in the total. Finally gross floor area is not the same as leasable space. Leasable space is a subset of gross floor area.		<input type="checkbox"/>
Number of PCs	N/A(Optional)	Is this the number of personal computers in the space?		<input type="checkbox"/>
Weekly operating hours	N/A(Optional)	Is this the total number of hours per week that the space is 75% occupied? This number should exclude hours when the facility is occupied only by maintenance, security, or other support personnel. For facilities with a schedule that varies during the year, "operating hours/week" refers to the total weekly hours for the schedule most often followed.		<input type="checkbox"/>
Workers on Main Shift	N/A(Optional)	Is this the number of employees present during the main shift? Note this is not the total number of employees or visitors who are in a building during an entire 24 hour period. For example, if there are two daily 8 hour shifts of 100 workers each, the Workers on Main Shift value is 100.		<input type="checkbox"/>

ENERGY STAR® Data Checklist for Commercial Buildings

Energy Consumption

Power Generation Plant or Distribution Utility: PSE&G - Public Service Elec & Gas Co

Fuel Type: Electricity		
Meter: Electric Meter (kWh (thousand Watt-hours)) Space(s): Entire Facility Generation Method: Grid Purchase		
Start Date	End Date	Energy Use (kWh (thousand Watt-hours))
04/01/2009	04/30/2009	10,560.00
03/01/2009	03/31/2009	10,640.00
02/01/2009	02/28/2009	12,200.00
01/01/2009	01/31/2009	11,120.00
12/01/2008	12/31/2008	9,720.00
11/01/2008	11/30/2008	8,320.00
10/01/2008	10/31/2008	6,040.00
09/01/2008	09/30/2008	4,680.00
08/01/2008	08/31/2008	3,760.00
07/01/2008	07/31/2008	4,080.00
06/01/2008	06/30/2008	3,480.00
05/01/2008	05/31/2008	5,640.00
Electric Meter Consumption (kWh (thousand Watt-hours))		90,240.00
Electric Meter Consumption (kBtu (thousand Btu))		307,898.88
Total Electricity (Grid Purchase) Consumption (kBtu (thousand Btu))		307,898.88
Is this the total Electricity (Grid Purchase) consumption at this building including all Electricity meters?		<input type="checkbox"/>

Additional Fuels	
Do the fuel consumption totals shown above represent the total energy use of this building? Please confirm there are no additional fuels (district energy, generator fuel oil) used in this facility.	<input type="checkbox"/>

On-Site Solar and Wind Energy	
Do the fuel consumption totals shown above include all on-site solar and/or wind power located at your facility? Please confirm that no on-site solar or wind installations have been omitted from this list. All on-site systems must be reported.	<input type="checkbox"/>

Certifying Professional

(When applying for the ENERGY STAR, the Certifying Professional must be the same as the PE that signed and stamped the SEP.)

Name: _____ Date: _____

Signature: _____

Signature is required when applying for the ENERGY STAR.

FOR YOUR RECORDS ONLY. DO NOT SUBMIT TO EPA.

Please keep this Facility Summary for your own records; do not submit it to EPA. Only the Statement of Energy Performance (SEP), Data Checklist and Letter of Agreement need to be submitted to EPA when applying for the ENERGY STAR.

Facility
Sperry Observatory
1033 Springfield Avenue
Cranford, NJ 07016

Facility Owner
Union County College
232 East Second Street
Plainfield, NJ 07060

Primary Contact for this Facility
John Hone
232 East Second Street
Plainfield, NJ 07060

General Information

Sperry Observatory	
Gross Floor Area Excluding Parking: (ft ²)	2,834
Year Built	1965
For 12-month Evaluation Period Ending Date:	April 30, 2009

Facility Space Use Summary

Sperry Observatory	
Space Type	Other - College/University (Campus-Level)
Gross Floor Area(ft ²)	2,834
Number of PCs ^o	N/A
Weekly operating hours ^o	N/A
Workers on Main Shift ^o	N/A

Energy Performance Comparison

Performance Metrics	Evaluation Periods		Comparisons		
	Current (Ending Date 04/30/2009)	Baseline (Ending Date 04/30/2009)	Rating of 75	Target	National Average
Energy Performance Rating	N/A	N/A	75	N/A	N/A
Energy Intensity					
Site (kBtu/ft ²)	109	109	0	N/A	120
Source (kBtu/ft ²)	363	363	0	N/A	280
Energy Cost					
\$/year	\$ 16,116.00	\$ 16,116.00	N/A	N/A	\$ 17,801.18
\$/ft ² /year	\$ 5.69	\$ 5.69	N/A	N/A	\$ 6.28
Greenhouse Gas Emissions					
MtCO ₂ e/year	47	47	0	N/A	52
kgCO ₂ e/ft ² /year	17	17	0	N/A	19

More than 50% of your building is defined as College/University (Campus-Level). This building is currently ineligible for a rating. Please note the National Average column represents the CBECS national average data for College/University (Campus-Level). This building uses X% less energy per square foot than the CBECS national average for College/University (Campus-Level).

Notes:

- o - This attribute is optional.
- d - A default value has been supplied by Portfolio Manager.

MAJOR EQUIPMENT LIST
Concord Engineering Group
"Sperry Observatory"

Air Handling Units										
EQUIP TAG	LOCATION	AREA SERVED	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	VPWRZ	FLA	MCA	MOP	REMARKS
AM11	Shop Area	Chaoson	Carrier	3082-5-53	621814	208V/3	-	-	20	Refrigerant of R22, Manufacturer: Carrier

Computer Room Air Conditioning Units																		
EQUIP TAG	LOCATION	AREA SERVED	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	ELECTRICAL DATA			COMPLIANCE DATA			COMPONENTS			SERVICE LIFE		REMARKS	
						VPWRZ	FLA	MCA	REFRIGERANT	CAPACITY (TONS)	HP	HP	HP	QTY	QTY	QTY		APPROX AGE
CU1	Roof	Chaoson	Carrier	30100500	542071	208V/3	-	23.1	20	R-502	4	3844	1	1	1	15	15	
CU2	Roof	Server Room	Starnig	122428C	A119235028P	208V/3	-	-	25	R-410A	2	1543ER	1	1	1	5	20	15

- Notes**
- Equipment tags are utilized solely for identification purposes. Actual equipment in field was averaged.
 - CU2 Unit is a three pump that provides approximately 2700 Btu/h @ 7.5 HSP. Minimal peak data was available for this unit even with being installed in 2014.

Using Carrier Tag no Error Room, Sperry M/N
30100500, 122428C, 1543ER, 1543ER

CEG Job #: 9C08144
 Project: UCC Cranford - Observatory
 Address: 1033 Springfield Ave.
 Cranford, NJ
 Building SF: 2,834

"Cranford Observatory"

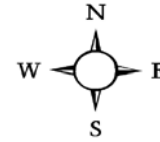
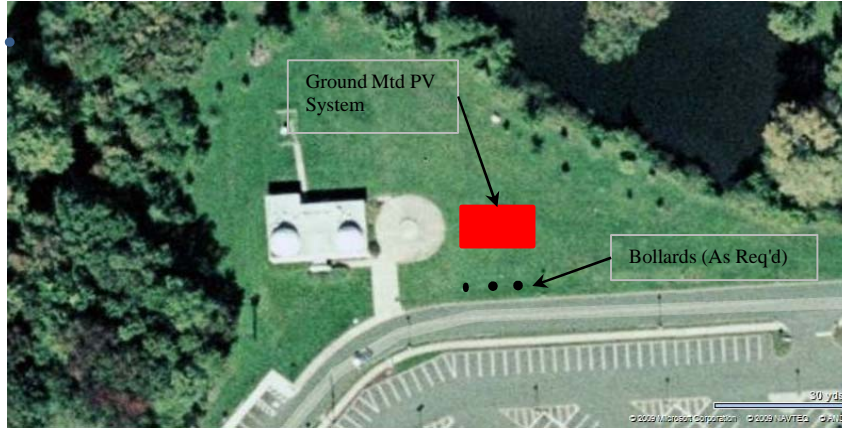
KWH COST: \$61.79

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	kWh Savings	kw Savings	kWh/Yr Savings	Yearly \$ Savings	Yearly Simple Payback	
1	Classroom	2080	16	2	1x4 2 Lamp 32w T8 Elect. Ballast, Surface	57	0.91	1,897.0	\$339.56	16	2	No Change	57	0.91	1896.96	\$339.56	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
1	Optical Shop	2080	6	2	1x4 2 Lamp 32w T8 Elect. Ballast, Surface	57	0.34	711.4	\$127.33	6	2	No Change	57	0.34	711.36	\$127.33	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
	10" Refractor	2080	3	1	Wall Mnt. 40w A19 Red Lamp, No Globe	40	0.12	249.6	\$44.68	3	1	10W CFL Replacement (Red)	10	0.03	62.4	\$11.17	\$14.75	\$44.25	0.09	187.2	0.09	\$33.51	1.32	
	24" Reflector	2080	4	1	Wall Mnt. 40w A19 Red Lamp, No Globe	40	0.16	332.8	\$59.57	4	1	10W CFL Replacement (Red)	10	0.04	83.2	\$14.89	\$14.75	\$59.00	0.12	249.6	0.12	\$44.68	1.32	
	Women's Restroom	2080	1	1	Vanity Light, 17w T8, White Globe	20	0.02	41.6	\$7.45	1	1	No Change	20	0.02	41.6	\$7.45	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
26		2080	1	2	2x2 2 Lamp 32w T8 Tube, Elect. Ballast,	57	0.06	118.6	\$21.22	1	2	No Change	57	0.06	118.56	\$21.22	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
8	Kitchen	2080	1	2	12" Round Surface Mnt., 2 14w CFL	30	0.03	62.4	\$11.17	1	2	No Change	30	0.03	62.4	\$11.17	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
	Men's Restroom	2080	1	1	Vanity Light, 17w T8, White Globe	20	0.02	41.6	\$7.45	1	1	No Change	20	0.02	41.6	\$0.00	\$0.00	\$0.00	0.00	0	0	\$7.45	0.00	
26		2080	1	2	2x2 2 Lamp 32w T8 Tube, Elect. Ballast,	57	0.06	118.6	\$21.22	1	2	No Change	57	0.06	118.56	\$21.22	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
26	Hall	2080	2	2	2x2 2 Lamp 32w T8 Tube, Elect. Ballast,	57	0.11	237.1	\$42.44	2	2	No Change	57	0.11	237.12	\$42.44	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
1	Computer Room	2080	2	2	1x4 2 Lamp 32w T8 Elect. Ballast, Surface	57	0.11	237.1	\$42.44	2	2	No Change	57	0.11	237.12	\$42.44	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
3.22	Server Room	2080	1	3	2x4 3 Lamp 32w T8 Elect. Ballast, Recessed,	93	0.09	193.4	\$34.63	1	3	No Change	93	0.09	193.44	\$34.63	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
	Exterior	4380	6	1	Wall Mnt., 9w CFL, Fresnel Lens	11	0.07	289.1	\$51.75	6	1	No Change	11	0.07	289.08	\$51.75	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
	Electrical Room	4380	1	1	Flood, 500w Quartz	500	0.50	2,190.0	\$392.01	1	1	No Change	500	0.50	2190	\$392.01	\$0.00	\$0.00	0.00	0	0	\$0.00	0.00	
		1040	2	1	Porcelain Socket, 60w A19 Lamp	60	0.12	124.8	\$22.34	2	1	13W CFL Lamp Replacement	13	0.03	27.04	\$4.84	\$16.75	\$33.50	0.09	97.76	0.09	\$17.50	1.91	
	Totals		48	24			2.73	6,845	\$1,225.26	48	24			2.42	6,310	\$1,122.12		\$136.75	0.30	535	\$103.13	1.33		

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 replacement calculations

Building	Ground Area (sq ft)	Panel	Qty	Panel Sq Ft	Panel Total Sq Ft	Total KW _{DC}	Total Annual kWh	Panel Weight (33 lbs)	W/SQFT
Observatory	2000	Sunpower SPR230	123	14.7	1,809	28.29	32,690	4,059	15.64



Station Identification	
City:	Newark
State:	New_Jersey
Latitude:	40.70° N
Longitude:	74.17° W
Elevation:	9 m
PV System Specifications	
DC Rating:	28.3 kW
DC to AC Derate Factor:	0.810
AC Rating:	22.9 kW
Array Type:	Fixed Tilt
Array Tilt:	10.0°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	0.2 ¢/kWh

Results			
Month	Solar Radiation (kWh/m ² /day)	AC Energy (kWh)	Energy Value (\$)
1	2.39	1697	3.04
2	3.17	2058	3.68
3	4.07	2880	5.16
4	4.83	3191	5.71
5	5.70	3796	6.79
6	5.94	3709	6.64
7	5.77	3681	6.59
8	5.38	3409	6.10
9	4.65	2933	5.25
10	3.61	2414	4.32
11	2.35	1540	2.76
12	2.01	1382	2.47
Year	4.16	32690	58.52

Notes:

= Proposed PV Layout

1. Estimated kWh based on the National Renewable Energy Laboratory PVWatts Version 1 Calculator Program.

Project Name: LGEA Solar PV Project - Sperry Observatory							
Location: Cranford, NJ							
Description: Photovoltaic System - Direct Purchase							
Simple Payback Analysis							
	Photovoltaic System - Direct Purchase						
Total Construction Cost	\$254,610						
Annual kWh Production	32,690						
Annual Energy Cost Reduction	\$5,852						
Annual SREC Revenue	\$11,442						
First Cost Premium	\$254,610						
Simple Payback:	14.72						Years
Life Cycle Cost Analysis							
Analysis Period (years):	25			Financing %:	0%		
Financing Term (mths):	0			Maintenance Escalation Rate:	3.0%		
Average Energy Cost (\$/kWh)	\$0.179			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	\$254,610	0	0	0	\$0	(254,610)	0
1	\$0	32,690	\$5,852	\$0	\$11,442	\$17,293	(\$237,317)
2	\$0	32,527	\$6,027	\$0	\$11,384	\$17,411	(\$219,906)
3	\$0	32,364	\$6,208	\$0	\$11,327	\$17,535	(\$202,370)
4	\$0	32,202	\$6,394	\$0	\$11,271	\$17,665	(\$184,706)
5	\$0	32,041	\$6,586	\$330	\$11,214	\$17,470	(\$167,235)
6	\$0	31,881	\$6,784	\$328	\$11,158	\$17,613	(\$149,622)
7	\$0	31,721	\$6,987	\$327	\$11,103	\$17,763	(\$131,859)
8	\$0	31,563	\$7,197	\$325	\$11,047	\$17,919	(\$113,941)
9	\$0	31,405	\$7,413	\$323	\$10,992	\$18,081	(\$95,860)
10	\$0	31,248	\$7,635	\$322	\$10,937	\$18,250	(\$77,610)
11	\$0	31,092	\$7,864	\$320	\$10,882	\$18,426	(\$59,184)
12	\$0	30,936	\$8,100	\$319	\$10,828	\$18,609	(\$40,575)
13	\$0	30,782	\$8,343	\$317	\$10,774	\$18,799	(\$21,776)
14	\$0	30,628	\$8,593	\$315	\$10,720	\$18,997	(\$2,778)
15	\$0	30,475	\$8,851	\$314	\$10,666	\$19,203	\$16,425
16	\$0	30,322	\$9,116	\$312	\$10,613	\$19,417	\$35,842
17	\$0	30,171	\$9,390	\$311	\$10,560	\$19,639	\$55,481
18	\$0	30,020	\$9,672	\$309	\$10,507	\$19,869	\$75,350
19	\$0	29,870	\$9,962	\$308	\$10,454	\$20,109	\$95,459
20	\$0	29,720	\$10,261	\$306	\$10,402	\$20,357	\$115,815
21	\$1	29,572	\$10,568	\$305	\$10,350	\$20,614	\$136,429
22	\$2	29,424	\$10,886	\$303	\$10,298	\$20,881	\$157,310
23	\$3	29,277	\$11,212	\$302	\$10,247	\$21,157	\$178,467
24	\$4	29,130	\$11,548	\$300	\$10,196	\$21,444	\$199,911
25	\$5	28,985	\$11,895	\$299	\$10,145	\$21,741	\$221,652
Totals:		623,657	\$157,232	\$5,087	\$218,280	\$476,262	\$370,425
Net Present Value (NPV)						\$221,677	
Internal Rate of Return (IRR)						5.3%	