CDM

The Somerset Hills School District

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Somerset Hills School District

JUNE 2009

Final Energy Audit Report

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Executive Summary

As part of an initiative to reduce energy cost and consumption, the Somerset Hills School District has secured the services of Camp Dresser and McKee (CDM) to perform an energy audit for buildings owned and operated by the District in an effort to develop comprehensive Energy Conservation and Retrofit Measures (ECRMs).

CDM's energy audit team visited the facilities on April 15th and 16th, 2009. As a result of the site visits and evaluation of the historical energy usage of the facilities, CDM was successful in identifying opportunities for energy savings measures.

CDM has also evaluated the potential for renewable energy technologies to be implemented at the District's facilities to offset the District's electrical energy usage. Specifically, the use of solar electric photovoltaic panels was investigated.

In addition, CDM solicited proposals from third party electric energy suppliers to investigate any additional energy cost savings that may be available for the District.

Not all ECRMs identified as a result of the energy audit are recommended. ECRMs must be economically feasible to be recommended to the District for implementation. The feasibility of each ECRM was measured through a simple payback analysis. The simple payback period was determined after establishing Engineer's Opinion of Probable Construction Cost estimates, O&M estimates, projected annual energy savings estimates, and the potential value of New Jersey Clean Energy rebates, or Renewable Energy Credits, if applicable. ECRMs with a payback period of 20 years or less can be recommended.

Recommended ECRMs

The following table, Table ES-1, presents the ranking of recommended ECRMs identified for the building lighting and HVAC systems. Additional ECRMs were identified and evaluated, as discussed in Section 4; however, were not recommended due to longer payback periods. This table includes the Engineer's Opinion of Probable Construction Cost, projected annual energy cost savings, projected annual energy usage savings, and total simple payback period for each recommended ECRM. The ECRMs are ranked based on payback period.

Table ES-2 summarizes the Total Engineer's Opinion of Construction Cost, annual energy savings, projected annual energy and O&M cost savings and the payback period based on the implementation of all recommended ECRMs.

Table ES-1: Ranking of Recommended ECRM's					
Overall Ranking (Based on Simple Payback)	**ECRM**	**Engineer's Opinion of Probable Construction Cost[1]**	**Projected Annual Energy Savings (kWH or therms)**	**Projected Annual Energy & O&M Cost Savings**	**Simple Payback Period (years)**
1	**Olcott Building – Lighting System Retrofits**	$20,206	44,660 kWh	$7,921	**2.5**
2	**Bernardsville Middle School– Lighting System Retrofits**	$48,000	109,019 kWh	$18,185	**2.6**
3	**Bernards High School – Lighting System Retrofits**	$64,580	146,254 kWh	$24,664	**2.6**
4	**Bedwell Elementary School- Lighting System Retrofits**	$36,262	77,881 kWh	$11,467	**3.2**
5	**Olcott Building – Reflective Insulation Board**	$7,965	987 therms	$1,421	**5.6**
6	**Bernards High School – H&V Units Control Change**	$2,094	2,080 kWh	$322	**6.5**
7	**Bedwell Elementary – Boiler Upgrade**	$221,000	16,515 therms	$21,304	**10.4**
8	**Olcott Building – Zone Restructure**	$17,965	850 therms	$1,224	**14.7**
9	**Bernardsville Middle School – Boiler Upgrade**	$165,422	7,344 therms	$10,428	**15.9**

1. Engineers Probable Construction takes into account any applicable rebates.

Table ES-2: Recommended ECRM's[1]			
Total Engineer's Opinion of Probable Construction Cost	**Projected Annual Energy Savings (kWH or therms)**	**Projected Annual Energy & O&M Cost Savings**	**Simple Payback Period (years)**
$583,494	436,694 kWh 25,696 therms	$105,751	5.5

1. Does not include energy savings associated with Solar Energy System.

Renewable Energy Technologies

Solar Energy

Section 4.3.5 of the report provides for an economic evaluation of a solar energy system recommended to be installed at the Bedwell Elementary School and Bernardsville High School. The evaluation covered the economic feasibility of the District furnishing and installing a solar energy system under a typical construction contract and to assume full responsibility of the operation of such a system.

Based on the payback modeling performed, as shown in Appendix E and summarized in Table ES-3, it would benefit the District to further investigate the solar energy system at both the Bedwell Elementary School and Bernards High School. This is primarily based on the initial upfront capital investment required for a solar energy system installation and the 15 year payback period. This payback period justifies installing the solar energy system. Other options such as Power Purchase Agreements are potentially available as well to help finance the project. Solar technology is constantly changing and will most likely continue to lower in price.

Two major factors influencing the project financial evaluation is the variance of the prevailing energy market conditions and Solar Renewable Energy Credit (SREC) rates, with the largest impact to the payback model being the SREC credit pricing. SREC pricing for the last half of 2008 ranged from $308/MWh to a high of $419.5/MWh. For the payback model, a value of $390/MWh was used.

Table ES-3 includes the Payback Period Analysis of the solar energy ECRM for the Bedwell Elementary School and Bernards High School.

Table ES-3: Simple Payback Analysis for Solar Energy System

Parameter	Solar
Estimated Budgetary Project Cost	$2,023,800
1st Year Production	277,491 kWh
1st Year Electric Savings @ $0.1362/kWH and $0.1552/kWH	$41,228
1st Year SREC Revenue @ $0.39/kWh	$110,996
Project Simple Payback	15 Years
Total Revenue based on 25 Year Project	$3,027,166

Section 1
Introduction

1.1 General

As part of an initiative to reduce energy cost and consumption, the Somerset Hills School District has secured the services of Camp Dresser and McKee (CDM) to perform an energy audit on the District's elementary school, middle school, high school and administration building (Olcott Building) in an effort to develop comprehensive energy conservation initiatives.

The performance of an Energy Audit requires a coordinated phased approach to identify, evaluate and recommend energy conservation and retrofit measures (ECRM). The various phases conducted under this Energy Audit included the following:

- Gather preliminary data on all facilities;
- Facility inspection;
- Identify and evaluate potential ECRMs;
- Develop the energy audit report.

Figure 1-1 is a schematic representation of the phases utilized by CDM to prepare the Energy Audit Report.

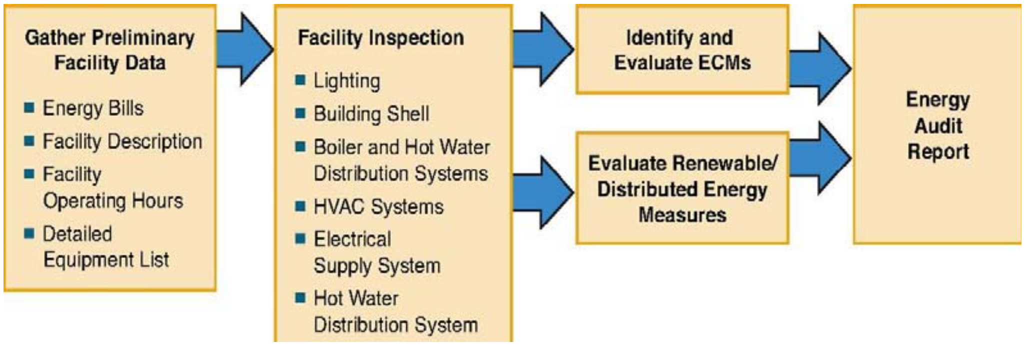


Figure 1-1: Energy Audit Phases

1.2 Background

The Somerset Hills School District consists of four buildings; the Bedwell Elementary School, the Bernardsville Middle School, the Bernards High School and the Olcott Building.

The Bedwell Elementary School is a 83,183 ft^2 building that was originally built in 1958. Extensions to provide additional classroom space were built in 1987, 1998 and

2005, as illustrated in Figures 1-1 and 1-2. The school is utilized for grades Pre-K through 4th, for a total of 730 students, in addition to teachers, administration, maintenance and cafeteria staff. The elementary school is occupied from 7 am to approximately 6 pm.

The Bernardsville Middle School is a 81,746 ft^2 building that was originally built in 1968, with subsequent additions in 1987, 1995 and 2005, as shown in Figure 1-3. The middle school is utilized for grades 5 through 8, for a total of 560 students, in addition to teachers, administration, maintenance and cafeteria staff. The middle school is occupied from 7 am to approximately 6 pm.

The Bernards High School is a 252,715 ft^2 building that was originally built in 1929, with subsequent additions in 1964, 1991, 2005 and 2008, as shown in Figure 1-4. The high school is utilized for grades 9 through 12, for a total of 810 students, in addition to the teaching, administration, maintenance and the cafeteria staff. The high school is occupied between 7 am to as late as 10 pm. The high school is utilized during the summer for sports camps, theater productions, summer school, etc.

The Olcott Building was the original school for this area, built in 1901. Floor plans for the Olcott Building are shown in Figures 1-5 and 1-6. Extensions have not been made to this building, as it is an historical building and is no longer used for classrooms, but serves as an administration, meeting and training building. There are 20 employees that regularly occupy the Olcott Building between 7 am to as late as 10 pm.

In previous summers, June – August, the middle school and high schools were both open on Saturdays. However, this summer all schools will be shut Saturdays and Sundays.

1.3 Purpose and Scope

The objective of the energy audit is to identify energy conservation and retrofit measures to reduce energy usage and to develop an economic basis to financially validate the planning and implementation of identified energy conservation and retrofit measures.

The buildings that comprise the Somerset Hills School District were originally designed to comfortably house school children and staff with limited consideration for energy consumption. Currently, due to the rising costs of power and the desire to minimize dependence on foreign oil supplies, energy consumption is taking a higher priority across the nation. Significant energy savings may be available with retrofits to the buildings' envelopes, heating and cooling systems and lighting systems. It should be noted that the magnitude of energy savings available is not only dependent on the type of heating, lighting or insulation systems that are in use, but also on the age and condition of the equipment and the capital available to implement major changes.

The purpose of this energy audit is to identify the various critical building comfort systems within the four buildings that are major consumers of electrical energy and are clear candidates for energy savings measures. In addition, the potential for solar electric systems to be installed at each building was evaluated and presented herein.

The scope of the electrical portion of this audit includes: building lighting systems retrofits, solar feasibility analyses, occupancy sensor installations, and evaluation of existing electrical systems. These systems have been identified in an effort to provide ECRMs. A list of the current electrical equipment in each facility has been provided. In addition potential incentives and rebates have been identified based on the New Jersey BPU's SmartStart Buildings Program or the Clean Energy Program to be discussed further in Section 7.

In addition to identifying ECRMs and the potential for on-site energy generation, alternate third party suppliers were contacted in an effort to identify further cost savings available for the Authority, by switching service providers. This is discussed further in Section 5.

Section 2
Facility Description

2.1 Bedwell Elementary School

2.1.1 Description of Building Envelope

The energy audit included an evaluation of the building envelope to determine the component's effective R-values to be utilized in the building model and to locate and fix any thermal weaknesses that may be present. The components of a building envelope include the exterior walls, foundation and roof. The construction and material, age and general condition, of these components, including exterior windows and doors, impact the buildings energy use.

The Bedwell Elementary School's exterior walls range from 8" – 14" thick concrete masonry unit (CMU) block with brick facade, batt insulation at ceilings, cavity wall insulation and vapor barriers at grade elevation. The original single pane windows were recently replaced with insulating double pane windows and portions of the flat roof of the Bedwell Elementary school were recently coated with a white thermal barrier coating. This coating works to reduce the surface temperature of the roof by reflecting the UV rays, and provides insulation for the interior of the building reducing the heating and cooling loads. The Somerset Hills Board of Education has indicated future plans to apply the white thermal barrier to the remainder of the roof.

It was determined that the building envelope is in good condition and is currently providing a high level of insulation. In conclusion, any modifications to the insulation system would not be cost effective.

2.1.2 Description of Building HVAC

Heating for the Bedwell Elementary School is provided primarily by a hot water system, fed by two gas-fired Cleaver Brooks 80 horsepower steam boilers. The steam created by the boilers is passed through a heat exchanger to heat the water utilized in the buildings hot water system. This hot water system then serves a number of roof top air handling units, fin tube radiators, unit ventilators, and the gymnasium heating and ventilating units. Additional heating is provided to some classrooms by rooftop gas-fired air handling units. All cooling is provided by air handler or unit ventilator direct expansion coils.

2.1.3 Description of Building Lighting

The existing lighting system consists of 2X2 (2-lamp), 1X4 (2-lamp), 2X4 (2, 3, and 4-lamp), 2-foot (2-lamp), 3-foot (2-lamp), 4-foot (1, 2, 3, and 4-lamp) linear fluorescent fixtures, as well as compact fluorescent, metal halide, quartz, and incandescent fixtures. Some of the fluorescent fixtures are T-12 fixtures that should be replaced with a more efficient system using retrofit kits, electronic ballasts, and reflectors. The incandescent fixtures are inefficient and should be replaced. There are currently no controlling devices turning lights on and off based upon occupancy.

2.1.4 Miscellaneous Equipment

On average, each 800 ft^2 elementary school classroom contains 4 computers, 1 printer, 1 smart board and a sink. The school also has a media center which contains 19 computers, 2 televisions, a radio and smart board. The elementary school also has two faculty rooms that contain copiers, microwaves, refrigerators, laminators, vending machines, soda machines and coffee makers.

CDM was advised by operations staff that the computers are currently left on over night to allow for system updates to occur outside of classroom hours. It is recommended that the District consider implementing the standardized use of Smart Strips, as the need arises. Computer peripherals, such as monitors, printers or scanners, continue to use energy even after they are shut off, which adds up over time. The Smart Strip power strips offer surge protection and the ability to monitor the current on a single 'control' outlet. When the computer that is plugged into that single outlet is shut down and Smart Strip shuts off all of the other peripherals on the power strip.

The elementary school also has a hydraulic elevator, which travels from the basement to the first floor on average one to two times per day for handicapped students.

The Bedwell Elementary School's kitchen has a number of appliances including a walk-in freezer, refrigerators, warming cabinets and electric warming tables, microwaves, steamers and convection ovens.

2.2 Bernardsville Middle School

2.2.1 Description of Building Envelope

The Bernardsville Middle School's exterior walls are 12" thick CMU block wall with brick facade, cavity wall insulation and vapor barriers at grade elevation. As illustrated in Figure 1-3, the original construction was in 1968 with two additions later built in 1989 and 2001. The original and 1989 sections of the building have single pane windows. The 2001 addition has double paned insulating windows. The Bernardsville Middle School also has a flat roof in good condition, portions of which have been coated with a white thermal barrier coating.

The building roof and exterior walls and insulation systems are in good condition and providing a high level of thermal resistance. As such, there are no recommended energy efficiency improvements. Although the replacement of single pane windows was thought to be effective, further modeling and analysis found this improvement not to be investment worthy due to an extended payback period.

2.2.2 Description of Building HVAC

The Bernardsville Middle School is heated by a hot water system, fed by several boilers. There are two gas-fired Cleaver Brooks boilers which have a total capacity of 4,000 MBH; one Donlee boiler with a capacity of 837 MBH; and 4 Caravan slant fin boilers with a total capacity of 1,216 MBH. This hot water system then feeds a number of roof top air handling units, fin tube radiators and unit ventilators. Cooling for the school is provided by direct expansion coils within individual air handlers.

2.2.3 Description of Building Lighting

The existing lighting system consists of 2X2 (2, 3, and 4-lamp), 1X4 (2-lamp), 2X4 (2, 3, and 4-lamp), 2-foot (2-lamp), 3-foot (2-lamp), 4-foot (1, 2, and 4-lamp) linear fluorescent, compact fluorescent, metal halide, and incandescent fixtures. The existing T-12 fixtures should be replaced or upgraded with a more efficient system using retrofit kits, electronic ballasts, and reflectors. The existing incandescent fixtures are inefficient and should be replaced as well. There are currently no controlling devices turning lights on and off based upon occupancy.

2.2.4 Miscellaneous Equipment

Each middle school classroom contains 6 computers, 1 printer and 1 smart board. The classrooms from the original 1968 construction contain sinks. The media center has 22 computers, 2 televisions and 2 window air conditioning units. There are two tech rooms, one with 25 computers, the second with 28

computers. The faculty rooms in the middle school contain copiers, microwaves, refrigerators, and coffee makers.

The middle school also has a hydraulic elevator to accommodate handicapped students and faculty.

The Bernardsville Middle School's kitchen has a number of appliances including a walk-in refrigerator and freezer, electric warming tables, microwaves, a pressure cooker, convection ovens and a dishwasher.

2.3 Bernards High School

2.3.1 Description of Building Envelope

The Bernards High School has undergone a number of additions, as described in Section 1 and ultimately consists of seven buildings. The exterior walls of which are 12" thick CMU block with brick facade, cavity wall insulation and vapor barriers at grade elevation. The windows throughout the High School have been replaced with double pane insulating windows. The Bernards High School flat roof is in good condition. The areas of the roof with bubbling have been marked out for repair. There are no recommendations for improving the high school's building envelope.

2.3.2 Description of Building HVAC

The Bernardsville High School also employs a central hot water system to provide heating for the building. Hot water is delivered by 10 Aerco boilers, with a total system capacity of 20,000 MBH. This hot water system then serves air handlers, unit ventilators, fin tube radiators, and fin tube convectors throughout the school. Cooling for the school is primarily provided by a chilled water system, fed by two 230-ton McQuay chillers. Additionally, the school employs an ice storage system allowing the chillers to run during the night to create ice. This ice is then utilized to provide cooling during school hours. This helps keep the electrical demand of the building lower, as the chillers are not running at the same time as lighting, ventilation, and miscellaneous equipment required during school hours.

2.3.3 Description of Building Lighting

The existing lighting system consists of 2X2 (2 and 3 lamp), 1X4 (1 and 2 lamp), 2X4 (2, 3, and 4 lamp), 8-foot (4-lamp), 4-foot (1, 2, and 3 lamp), 2-foot (2-lamp) linear fluorescent fixtures, along with compact fluorescent, metal halide, quartz, and incandescent fixtures. Although a large number of the fluorescent fixtures already have T-8 lamps, a substantial number of T-12 fluorescent fixtures remain that should be upgraded to more energy efficient T8 technology to fully maximize the efficiency of the system and to reduce maintenance costs. The existing incandescent fixtures are inefficient and should be replaced. A survey of the facility identified that there is currently a large number of motion sensors that are controlling existing areas of the school based upon occupancy, although we recommend the installation of additional sensors in select locations.

2.3.4 Miscellaneous Equipment

Similarly to the elementary and middle schools, the high school classrooms contain computers, printers, smart boards. In addition, the high school also has a music wing with electric keyboards, an auditorium, a movie production studio and laboratories with fume hoods, gas lines for Bunsen burners, and microscopes. The faculty rooms in the high school contain copiers, microwaves, refrigerators, and coffee makers.

The Bernards High School's kitchen has a number of appliances including electric warming tables, microwaves, convection ovens, a dishwasher, an ice maker, fryer, refrigerators and freezers.

2.4 Olcott Building

2.4.1 Description of Building Envelope

As discussed in Section 1, the Olcott Building was built in 1901; the exterior walls are thick granite providing a high level of insulation. The windows in the Olcott Building were recently replaced and the roof is a sloped clay and in good condition. There is evidence of ACM in the Olcott Building, so disturbing this to apply additional insulation does not appear to be a cost effective recommendation.

2.4.2 Description of Building HVAC

The Olcott building is heated with a steam system which employs an HB Smith boiler with a net output steam heating capacity of 1,746 MBH. The entire building system operates as one zone, with one point of temperature control. There is no central cooling system for the building; however tenants have installed window air conditioning units in several offices to provide minimal cooling.

2.4.3 Description of Building Lighting

The existing lighting system consists of 2X2 (2 and 3-lamp), 1X4 (1-lamp), 2X4 (4-lamp), 8-foot (2- lamp), 4-foot (2 and 4-lamp) linear fluorescent fixtures, as well as compact fluorescent, metal halide and incandescent fixtures. The majority of the fluorescent fixtures have T-12 lamps. These should be upgraded to a more efficient system. The incandescent fixtures are inefficient and should be replaced. There are currently no controlling devices turning lights on and off based upon occupancy.

2.4.4 Miscellaneous Equipment

The Olcott Building contains a number of offices for the 23 employees, which have computers, printers, copiers, refrigerators, water fountains and coffee machines.

Section 3
Baseline Energy Use

3.1 Utility Data Analysis

The first step in the energy audit process is the compilation and quantification of the facilities current and historical energy usage and associated utility costs. It is important to establish the existing patterns of electric, gas and fuel oil usage in order to be able to identify areas in which energy consumption can be reduced.

For this study, monthly utility bills were analyzed and unit costs of energy obtained. The unit cost of energy, as determined from the monthly utility bills, was utilized in determining the feasibility of switching from one energy source to another or reducing the demand on that particular source of energy to create annual cost savings for the Somerset Hills School District.

3.1.1 Electric Charges

It was also important to understand how the utilities charge for the service. The majority of the energy consumed is electric, as a result of both indoor and outdoor lighting and appliances, such as kitchen appliances, computers, printers and smart boards. Electricity is charged by three basic components: electrical consumption (kWH), electrical demand (kW) and power factor (kVAR) (reactive power). The cost for electrical consumption is similar to the cost for fuel oil, the monthly consumption appears on the utility bill as kWH consumed per month with a cost figure associated with it. The School District's service connections are billed with a flat rate for consumption, as explained in Section 3.2.1.

Electrical demand can be as much as 50 percent or more of the electric bill. The maximum demand (kW value) during the billing period is multiplied by the demand cost factor and the result is added to the electric bill. It is often possible to decrease the electric bill by 15 – 25 percent by reducing the demand, while still using the same amount of energy.

The power factor (reactive power) is the power required to energize electric and magnetic fields that result in the production of real power. Power factor is important because transmission and distribution systems must be designed and built to manage the need for real power as well as the reactive power component (the total power). If the power factor is low, then the total power required can be greater than 50 percent or more than the real power alone. The power factor charge is a penalty for having a low power factor. This penalty charge does not impact the School District.

The other parts of the electric bill are the supply charges, delivery charges, system benefits, transmission revenue adjustments, state and municipality tariff surcharges and sales taxes, which cannot be avoided.

3.1.2 Natural Gas Charges

PSE&G is the current distributor and Hess Corporation is the third party supplier of natural gas for the District. Delivery charges, service charges, distribution charges, demand charges, balancing charges and societal benefits charges comprise a monthly gas bill. Delivery charges are the sum of the service charge, distribution charge and balancing charge. The service charge is the fixed monthly charge that covers the cost to maintain the account and includes metering and billing charges. The distribution charge is the charge for using PSE&G's gas distribution services. This cost also includes the cost of government-mandated programs and certain net revenue credits. The balancing charge is the charge for using PSE&G's storage system to adjust for the differences between the amount of gas delivered to a customer daily and the amount of gas used by the customer daily. This charge is applied from November through March.

3.1.3 Water Charges

New Jersey American Water currently supplies treated water to the Somerset Hills School District buildings. Water usage is metered similarly to electric and natural gas usage and the District is billed monthly per service location. In addition to the water service and water volume charges, the District is subject to a 'Purchased Water Adjustment Clause (PWAC) 1,000 gallon non-exempt' charge each billing cycle. The PWAC is a charge placed on the District for water that NJ American Water purchases from other water purveyors across the state.

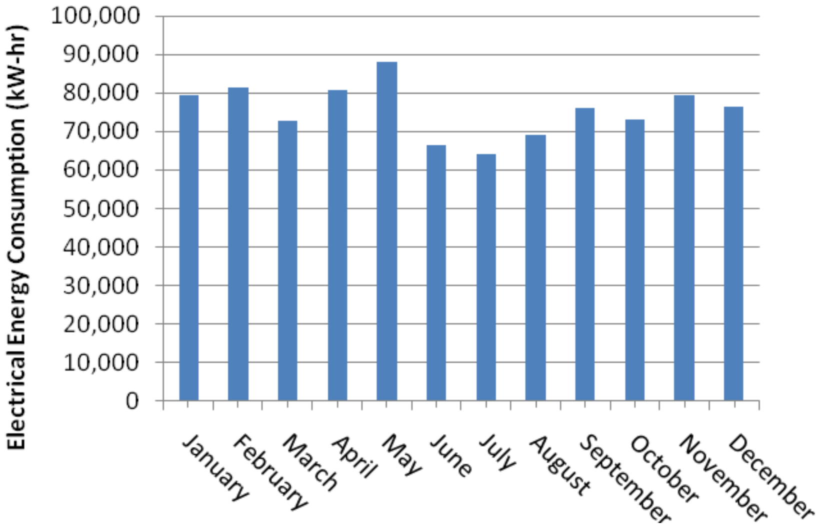
3.2 Facility Results

3.2.1 Bedwell Elementary School

Electric power for the Bedwell Elementary Building is fed from a General Secondary Service line from the Jersey Central Power and Light Company (JCP&L). Figure 3.2.1-1 illustrates the average monthly total energy consumption from July 2006 through October 2008. For example, for the month of January, the bar graph represents average energy consumption for January 2006 and January 2007. The same graph representation approach has been carried through for all months and is typical for all graphs presented in this Section. Electrical usage has been averaged by month for the two and a half year time period to portray a more encompassing monthly usage trend. From this graph, it can be determined that the electrical baseline consumption for the Bedwell Elementary School averages around 65,000 kWH / month.

This building is billed using a flat rate kWH charge based on JCP&L's current tariff rates. Demand charges are calculated using the highest measured load, sustained over a 15 minute period, per month. Figure 3.2.1-2 illustrates the average monthly demand load from July 2006 through October 2008.

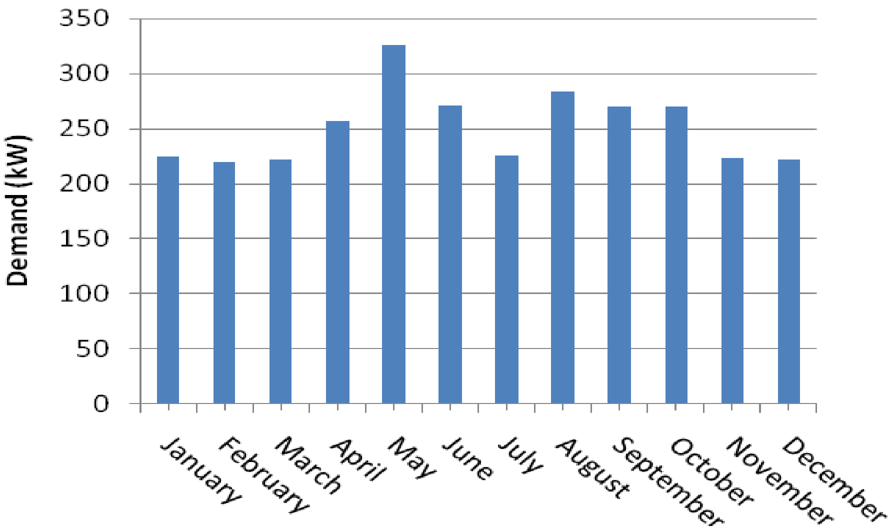
Figure 3.2.1-1: Bedwell Elementary School Building Electrical Usage



The most recent tariff rates available at the time of this audit for General Secondary Service from JCP&L are as follows:

Basic Generation Service: $0.080099/KWH
Non-Utility Generation Charges: $0.016960/KWH
Societal Benefits Charges: $0.002529/KWH
Delivery Service Charges: $0.008620/KWH
System Control Charge: $0.000079/KWH
Demand Charges: $6.1832/kW over 10 kW

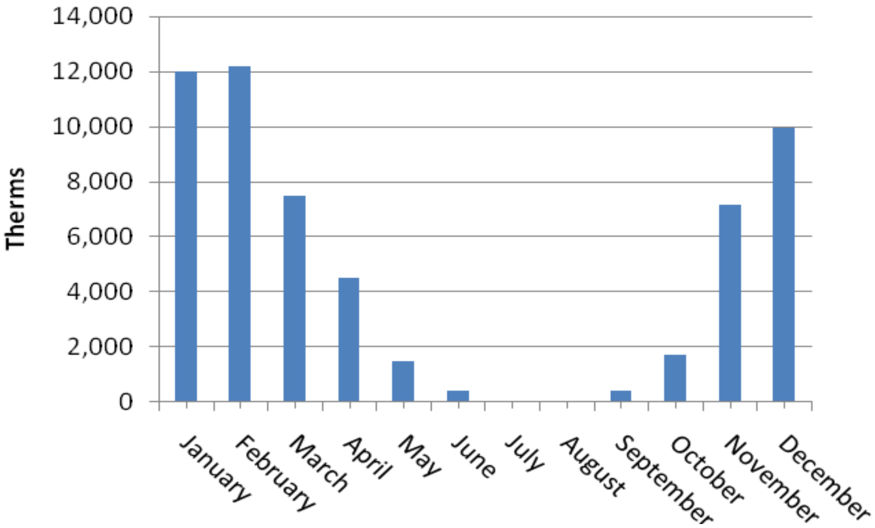
Figure 3.2.1-2: Bedwell Elementary School Maximum Monthly Demand



Refer to Table 3.3-1, in Section 3.3, for average electrical aggregate cost. These tariffs are subject to change quite frequently. For the most up to date tariffs, refer to JCP&L's website. Refer to Appendix A for complete Historical Data Analysis.

The boilers in the Bedwell Elementary School are run on natural gas. Figure 3.2.1-3 illustrates the building's average monthly natural gas consumption from January 2006 through December 2008. Similar to electric usage, gas usages have been averaged by month for the three year time period to portray a more encompassing monthly usage trend.

Figure 3.2.1-3: Bedwell Elementary School Gas Usage



The current tariff rates for natural gas from PSE&G are as follows:

Service Charge: $91.89 / month
Distribution Charges: First 100,000 therms @ $0.0668400
Remaining therms @ $0.0440400
Demand Charges: $3.50/therm
Balancing Charge: $0.09595710/therm
Societal Benefits Charge: $0.04385750/therm (total therms)

For more on the building gas usage, refer to Section 4.2.

The Bedwell Elementary School utilizes anywhere from 3,000 to 34,000 gallons of water per month, as shown in Appendix A. The aggregate cost per gallon is $0.0104.

3.2.2 Bernardsville Middle School

Electric power for the Bernardsville Middle School is fed from two General Secondary Service lines from JCP&L. Figures 3.2.2-1 and 3.2.2-2 illustrate the Middle School's average monthly consumption from July 2006 through October 2008, from meter L86728288 and meter G28168482 respectively. In this case, the combined baseline energy consumption 48,000 kWH per month. The consumption increases between September and May, during the school year, as a result of lighting all classrooms and the use of window air conditioning units on the first floor.

This building is billed using a flat rate KWH charge based on JCP&L's current tariff rates. Demand charges are calculated using the highest measured load, sustained over a 15 minute period, for the month. Figures 3.2.2-3 and 3.2.2-4 illustrate the average monthly demand load from July 2006 through October 2008.

Figure 3.2.2-1: Bernardsville Middle School Electrical Usage (Meter L86728288)

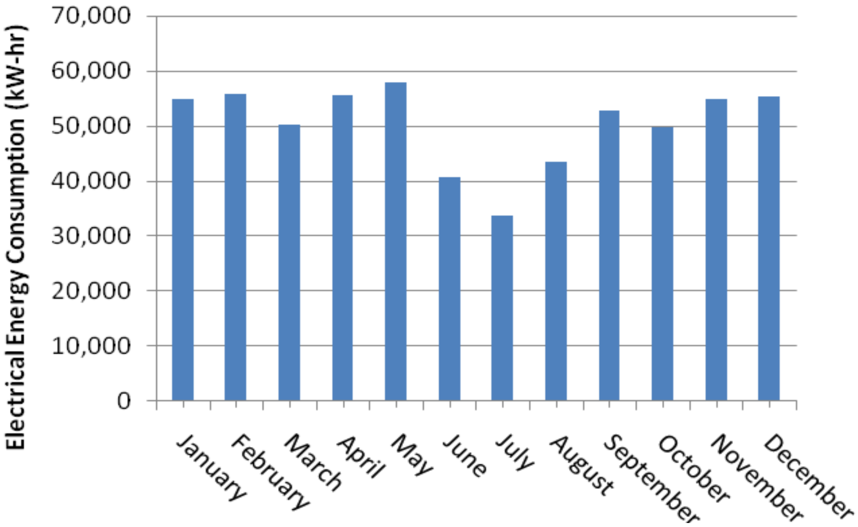
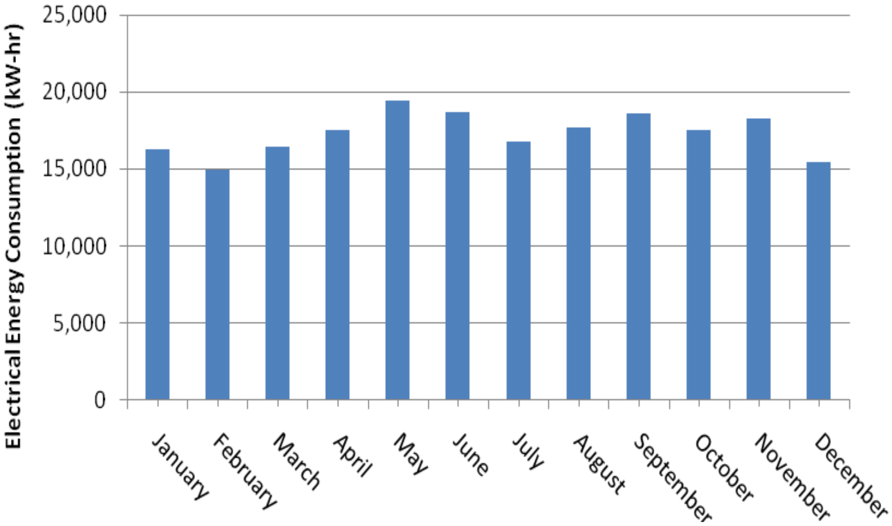


Figure 3.2.2-2: Bernardsville Middle School Electrical Usage (Meter G28168482)



The current tariff rates for General Secondary Service from JCP&L are as follows:

Basic Generation, Transmission and Reconciliation Charges: $0.113862/KWH
Delivery Charges: First 1,000 KWH, $0.057366/KWH
Remaining KWH, $0.004958
Non-Utility Generation Charges: $0.016960/KWH
Societal Benefits Charges: $0.006444/KWH
Transitional Assessment Charges: $0.002928/KWH
System Control Charge: $0.000079/KWH
Demand Charges: $6.94/kW over 10kW

Figure 3.2.2-3: Bernardsville Middle School Maximum Monthly Demand (Meter L86728288)

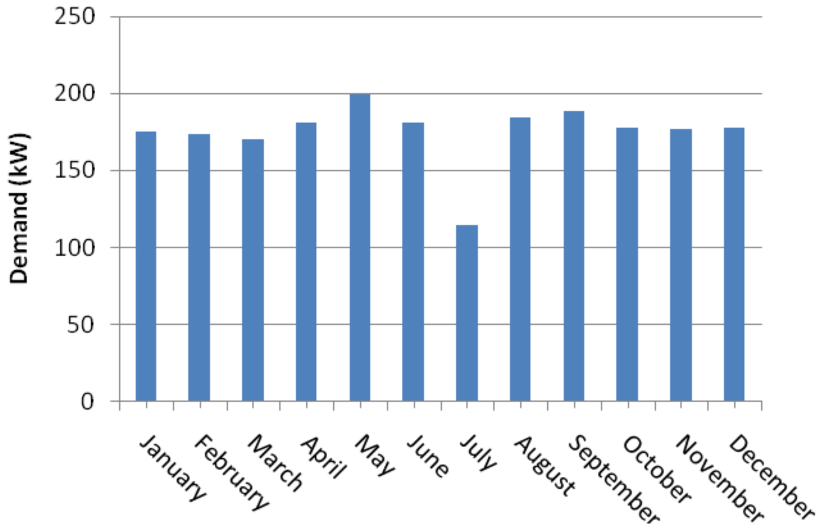
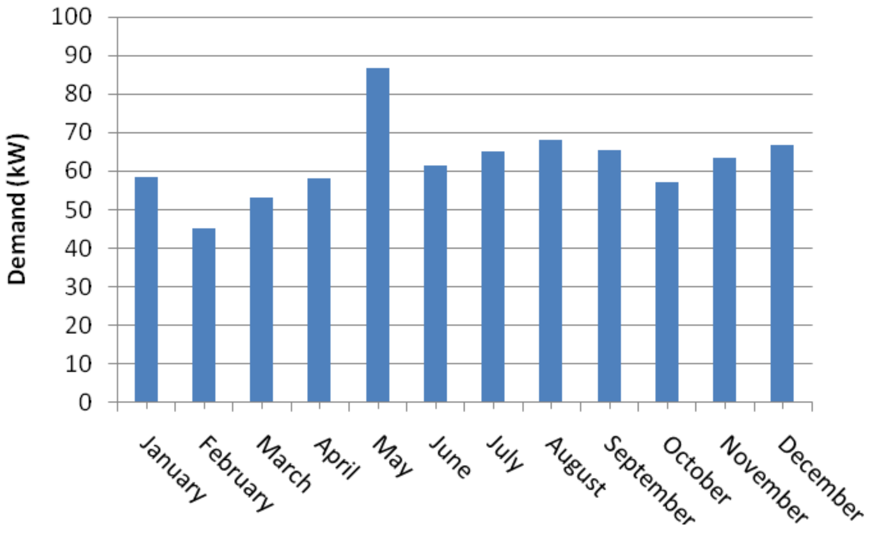


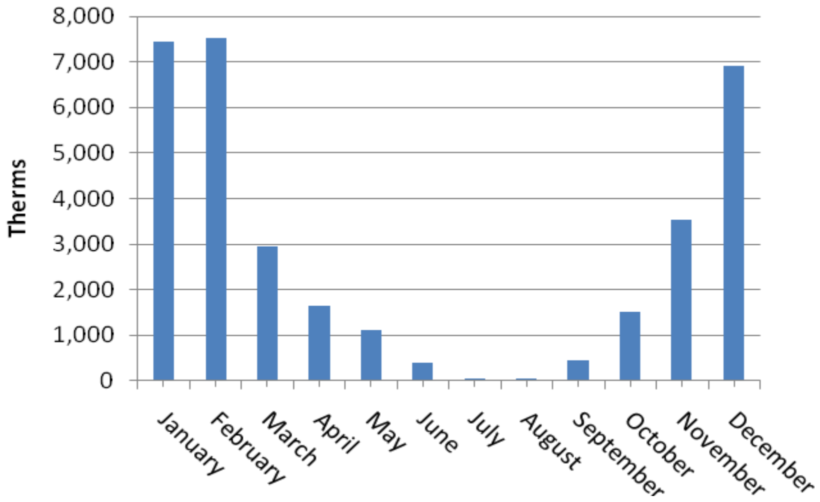
Figure 3.2.2-4: Bernardsville Middle School Maximum Monthly Demand (Meter G28168482)



Refer to Table 3-1, in Section 3.3, for average electrical aggregate cost. These tariffs are subject to change quite frequently. For the most up to date tariffs, refer to JCP&L's website. Refer to Appendix A for complete Historical Data Analysis.

The building heating system is run on natural gas. Figure 3.2.2-5 illustrates the building average monthly natural gas consumption from July 2006 through October 2008.

Figure 3.2.2-5: Bernardsville Middle School Gas Usage



The current tariff rates for natural gas from PSE&G are as follows:

Service Charge: $91.89 / month
Distribution Charges: First 100,000 therms @ $0.0668400
Remaining therms @ $0.0440400
Demand Charges: $3.50/therm
Balancing Charge: $0.09595720/therm
Societal Benefits Charge: $0.04385790/therm (total therms)

For more on the building gas usage, refer to Section 4.2.

Water usage at the Bernardsville Middle School is metered at three (3) locations and ranges from 30,000 to 123,000 gallons per month. The aggregate cost per gallon is $0.0095.

3.2.3 Bernards High School

Electric power for the Bernards High School is fed from two General Secondary Service lines from JCP&L. Figures 3.2.3-1 and 3.2.3-2 illustrate the High School's average monthly consumption from July 2006 through October 2008, from meter

G21163225 and meter G28408112 respectively. In this case, the combined baseline energy consumption 138,000 kWH per month.

This building is billed using a flat rate KWH charge based on JCP&L's current tariff rates. Demand charges are calculated using the highest measured load, sustained over a 15 minute period, for the month. Figures 3.2.3-3 and 3.2.3-4 illustrate the average monthly demand load from July 2006 through October 2008.

Figure 3.2.3-1: Bernards High School Electrical Usage (Meter G21163225)

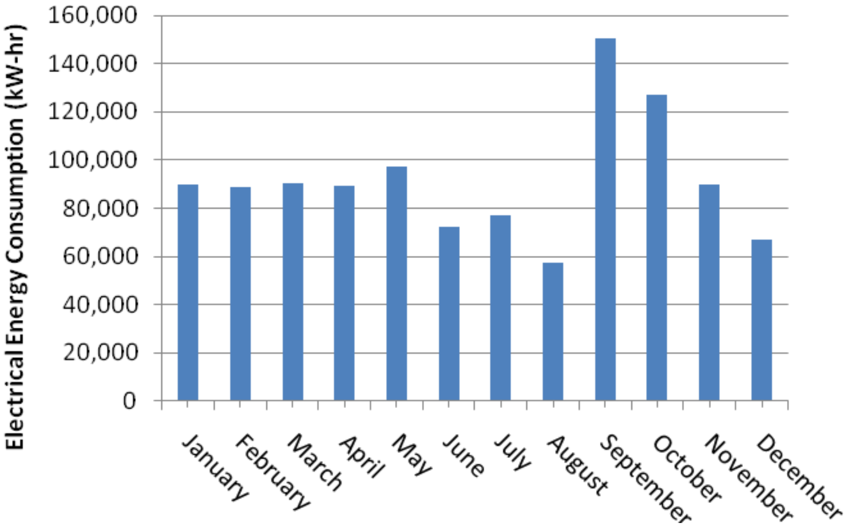
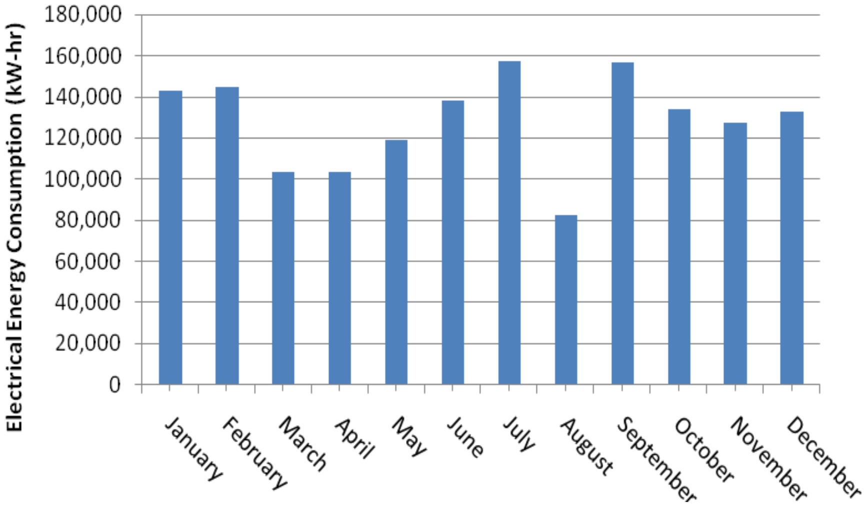


Figure 3.2.3-2: Bernards High School Electrical Usage (Meter G28408112)



The current tariff rates for General Secondary Service from JCP&L are as follows:

Basic Generation, Transmission and Reconciliation Charges: $0.113862/KWH
Delivery Charges: First 1,000 KWH, $0.057366/KWH

Remaining KWH, $0.004958
Non-Utility Generation Charges: $0.016960/KWH
Societal Benefits Charges: $0.006444/KWH
Transitional Assessment Charges: $0.002928/KWH
System Control Charge: $0.000079/KWH
Demand Charge: $6.94/kW over 10 kW

Refer to Table 3.3-1, in Section 3.3, for average electrical aggregate cost. These tariffs are subject to change quite frequently. For the most up to date tariffs, refer to JCP&L's website. Refer to Appendix A for complete Historical Data Analysis.

Figure 3.2.3-3: Bernards High School Maximum Monthly Demand (Meter G21163225)

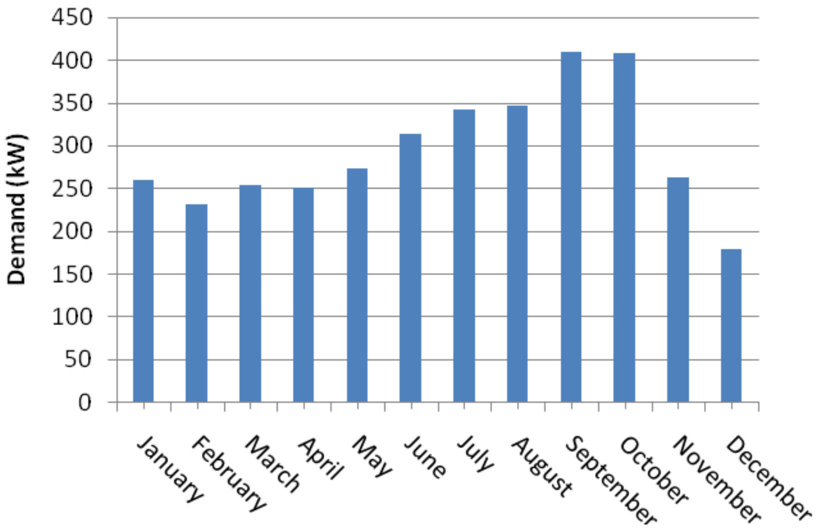
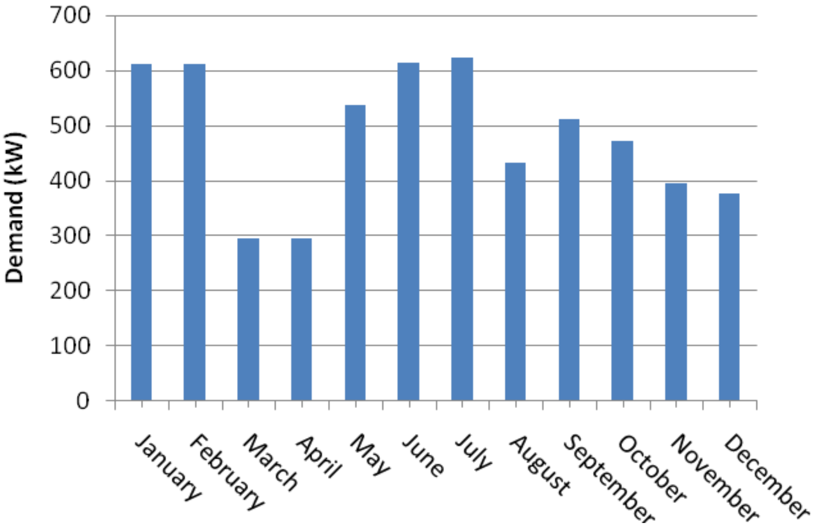
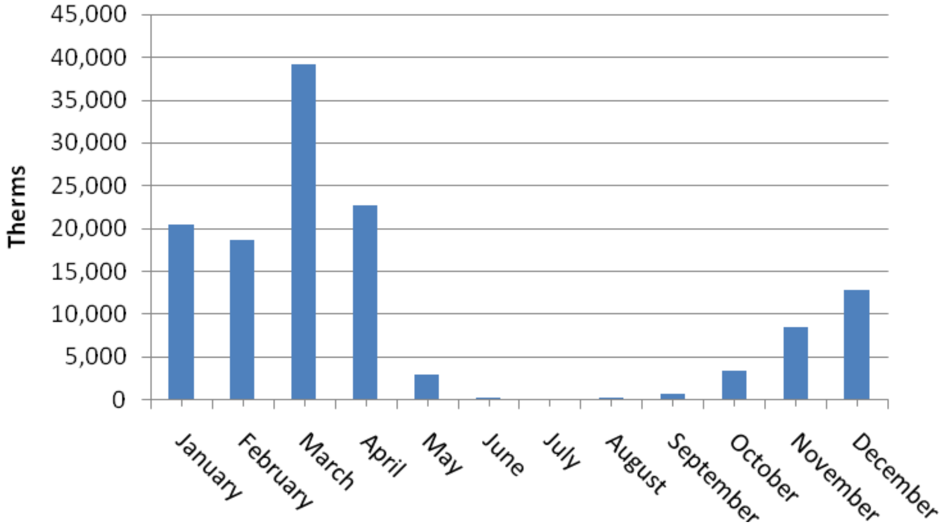


Figure 3.2.3-4: Bernards High School Maximum Monthly Demand (Meter G28408112)



The building's heating system is run on natural gas. Figure 3.2.3-5 illustrates the building average monthly natural gas consumption from July 2006 through October 2008.

Figure 3.2.3-5: Bernards High School Gas Usage



The current tariff rates for natural gas from PSE&G are as follows:

Service Charge: $91.89 / month
Distribution Charges: First 100,000 therms @ $0.0668400
Remaining therms @ $0.0440400
Demand Charges: $3.50/therm
Balancing Charge: $0.09595720/therm
Societal Benefits Charge: $0.04385790/therm (total therms)

For more on the building gas usage, refer to Section 4.2.

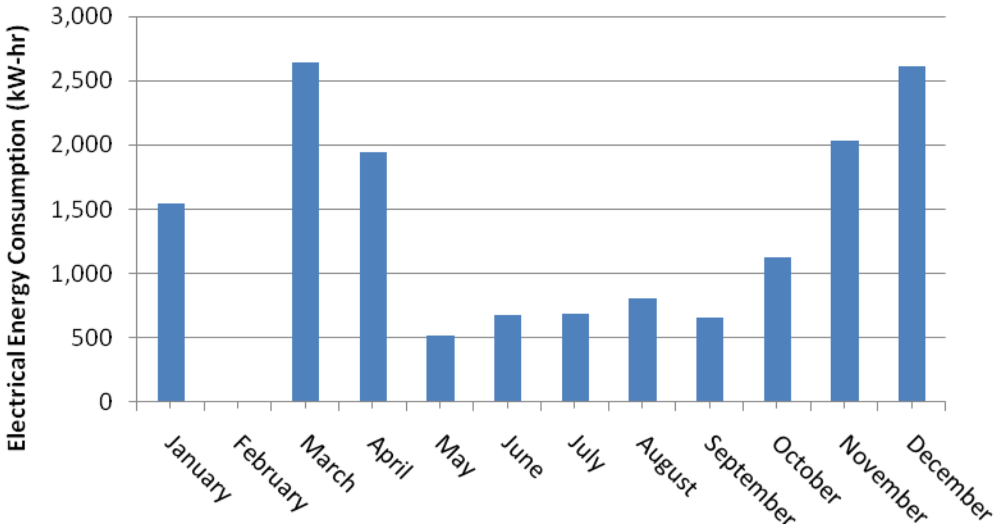
Water usage at the Bernardsville High School ranges from 71,000 to 129,000 gallons per month. The aggregate cost per gallon is $0.0065.

3.2.4 Olcott Building

Electric power for the Olcott Building is fed from one General Secondary Service line from JCP&L. Figure 3.2.4-1 illustrates the Olcott Building's average monthly consumption from July 2006 through October 2008. The baseline electric energy consumption 500 kWH per month.

This building is billed using a flat rate KWH charge based on JCP&L's current tariff rates.

Figure 3.2.4-1: Olcott Building Electrical Usage



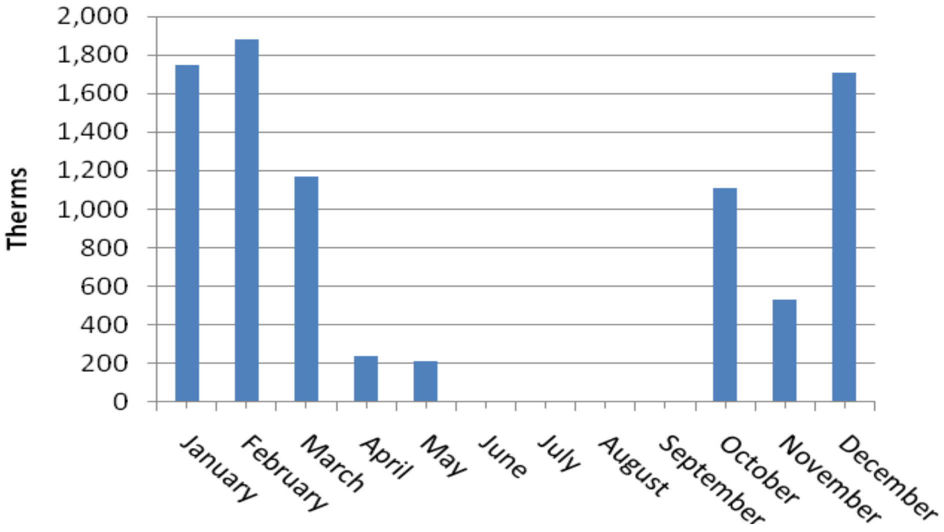
The current tariff rates for General Secondary Service from JCP&L are as follows:

Basic Generation, Transmission and Reconciliation Charges: $0.103052/KWH
Delivery Charges: $0.057366/KWH
Non-Utility Generation Charges: $0.016960/KWH
Societal Benefits Charges: $0.005707/KWH
Transitional Assessment Charges: $0.002928/KWH
System Control Charge: $0.000079/KWH

Refer to Table 3-1, in Section 3.3, for average electrical aggregate cost. These tariffs are subject to change quite frequently. For the most up to date tariffs, refer to JCP&L's website. Refer to Appendix A for complete Historical Data Analysis.

The Olcott Building's heating system is fueled by natural gas. Figure 3.2.4-2 illustrates the building's average monthly natural gas consumption from July 2006 through October 2008.

Figure 3.2.4-2: Olcott Building Gas Usage



Water usage at the Olcott Building ranges from 7,000 to 11,000 gallons per month. The aggregate cost per gallon is $0.0142.

3.3 Aggregate Costs

For the purposes of computing energy savings for all identified energy conservation and retrofit measures, aggregate unit costs for electrical energy and natural gas, in terms of cost/kWH and cost/therm, were determined for each building and utilized in the simple payback analyses discussed in subsequent sections. The aggregate unit cost accounts for all distribution and supply charges for each location. Table 3.3-1 and Table 3.3-2 summarize the aggregate costs for electrical energy consumption and therms utilized, respectively.

Table 3.3-1: Electrical Aggregate Unit Costs

Service Location	Aggregate $ / kW-hr
Bedwell Elementary School	$0.1362
Bernardsville Middle School	$0.1551
Bernards High School	$0.1552
Olcott Building	$0.1646

Table 3.3-2: Natural Gas Aggregate Unit Costs

Service Location	Aggregate $ / therm
Bedwell Elementary School	$1.29
Bernardsville Middle School	$1.42
Olcott Building	$1.44

3.4 Portfolio Manager

3.4.1 Portfolio Manager Overview

Portfolio Manager is an interactive energy management tool that allows the Board of Education to track and assess energy consumption across the School District's buildings in a secure online environment. Portfolio Manager can help the Board of Education set investment priorities, verify efficiency improvements, and receive EPA recognition for superior energy performance.

3.4.2 Energy Performance Rating

For many facilities, you can rate their energy performance on a scale of 1–100 relative to similar facilities nationwide. Your facility is *not* compared to the other facilities entered into Portfolio Manager to determine your ENERGY STAR rating. Instead, statistically representative models are used to compare your facility against similar facilities from a national survey conducted by the Department of Energy's Energy Information Administration. This national survey, known as the Commercial Building Energy Consumption Survey (CBECS), is conducted every four years, and gathers data on building characteristics and energy use from thousands of facilities across the United States. Your facility's peer group of comparison is those facilities in the CBECS survey that have similar facility and operating characteristics. A rating of 50 indicates that the facility, from an energy consumption standpoint, performs better than 50% of all similar facilities nationwide, while a rating of 75 indicates that the facility performs better than 75% of all similar facilities nationwide.

K through 12 grade school buildings are eligible to receive a rating.

3.4.3 Portfolio Manager Account Information

A Portfolio Manager account has been established for the District, which includes profiles for the Bedwell Elementary School, the Bernardsville Middle School and the Bernards High School. Information entered into these three (3) Portfolio Manager building profiles, including electrical energy consumption, natural gas consumption and water usage may be used to apply for an Energy Star rating with the USEPA.

At the time of this report, with the utility data more than 120 days old the school buildings received the following ratings:

> Bedwell Elementary School – 6
> Bernardsville Middle School – 51
> Bernards High School – 25

A Statement of Energy Performance report for each building was generated through Portfolio Manager and included in Appendix B, along with a Portfolio Manager reference sheet.

In order to qualify for an energy star rating, utility data must be current. Therefore, as the District takes possession of this account, it is important to keep it updated with the latest utility bill data. Also, as a result of the District's commitment to implementing energy efficiency improvements, the building ratings may improve to be 75 or more, warranting an Energy Star label.

The following website link, username and password shall be used to access the Portfolio Manager account and building profiles that has been established for the District:

https://www.energystar.gov/istar/pmpam/

USERNAME: SomersetBOE

PASSWORD: energystar

Section 4
Energy Conservation and Retrofit Measures (ECRM)

4.1 Building Lighting Systems

The goal of this section is to present any lighting energy conservation measures that may also be cost beneficial. It should be noted that replacing current bulbs with more energy-efficient equivalents will have a small effect on the building heating and cooling loads. The building cooling load will see a small decrease from an upgrade to more efficient bulbs and the heating load will see a small increase, as the more energy efficient bulbs give off less heat.

Please note that the probable construction costs presented herein are estimates based on historic data compiled from similar installations and engineering opinions. Additional engineering will be required for each measure identified in this report and final scope of work and budget cost estimates will need to be confirmed prior to the coordination of project financing or the issuance of a Request for Proposal.

4.1.1 Bedwell Elementary School

It is recommended that the existing lighting system at the Bedwell Elementary School, which consists of T-12 fixtures and incandescent lighting, as discussed in Section 2.1.2, be upgraded to high efficiency standards to create lighting uniformity throughout the buildings. In general, the recommended lighting upgrade project, as presented in Appendix D, involves installing energy-efficient lighting retrofit kits, electronic ballasts, reflectors, and new energy-efficient luminaires to the existing lighting systems. The strategies included in this section focus on maximizing energy savings and maintaining or exceeding existing lighting levels, while also maintaining the existing look of each fixture; therefore, proposed lamp styles remain consistent with existing lamp styles. In addition, it is recommended to install occupancy sensors in specified areas of the facility. Please refer to Appendix D: Lighting Retrofit Spreadsheets for a line-by-line proposed detailed lighting upgrades.

The annual energy savings are estimated to be 22.7 kW, 77,881 kWh and $10,607. In addition, the project will generate annual maintenance savings of $860 from avoided costs related to changing lamps and ballasts. The following table, Table 4.1.1-1, summarizes a simple payback analysis assuming the implementation of all recommended lighting system improvements at the Bedwell Elementary School. Included in this simplified payback analysis summary table is a 'Return on Investment' (ROI) values. This value is a performance measure used to evaluate the efficiency of an investment and is calculated by dividing the 'return' or savings associated with an investment by the total investment cost. ROI ratings can be utilized to prioritize the implementation of energy savings measures.

Table 4.1.1-1 **Bedwell Elementary School Lighting System Improvements**	
Retrofit Cost (Material and Labor)	$44,577
New Jersey SmartStart Rebate	-$8,315
Total Cost	$36,262
Annual Energy Savings	$10,607
Annual Maintenance Savings	$860
Simple Payback	**3.2 years**
Return on Investment (ROI)	**31%**

It should be noted that the Lighting Annual Savings assume the annual hours per year of operation as outlined under the column entitled "Hours Code" in Appendix D and the O&M savings for the first three years are calculated by assuming the avoidance of total existing lamp and ballast maintenance costs by installing newer technologies. Years four and five are calculated using just the avoided existing material costs because the five-year warranty on the ballasts and the three-year warranty on the lamps have now expired. Years six through ten are calculated by using the difference between the cost to maintain the existing system and the cost to maintain the proposed system.

4.1.2 Bernardsville Middle School

It is recommended that the existing lighting system at the Bernardsville Middle School, which consists of T-12 fixtures and incandescent lighting, as discussed in Section 2.2.3, be upgraded to high efficiency standards to create lighting uniformity throughout the buildings. In general the energy efficient lighting upgrade project involves installing energy-efficient lighting retrofit kits, electronic ballasts, reflectors, and new energy-efficient luminaires to the existing lighting systems. The strategies included in this section focused on maximizing energy savings and maintaining or exceeding light levels, while maintaining the existing look of each fixture; therefore, proposed lamp styles remain consistent with existing lamp styles. In addition, it is also recommended to install occupancy sensors in specified areas of the facility. Please refer to Appendix D: Lighting Retrofit Spreadsheets for a line-by-line proposal spreadsheet for detailed strategies and sensor locations.

The annual energy savings are estimated to be 33.51 kW, 109,019 kWh and $16,909. In addition the project will generate estimated annual maintenance savings of $1,276 from avoided costs related to changing lamps and ballasts. The following table, Table 4.1.2-1, summarizes a simple payback analysis assuming the implementation of all recommended lighting system improvements at the Bernardsville Middle School:

Table 4.1.2-1
Bernardsville Middle School Lighting System Improvements

Retrofit Cost (Material and Labor)	$60,850
New Jersey SmartStart Rebate	-$12,850
Total Cost	$48,000
Annual Energy Savings	$16,909
Annual Maintenance Savings	$1,276
Simple Payback	**2.6 years**
ROI	**38%**

It should be noted that the Lighting Annual Savings assume the annual hours per year of operation as outlined under the column entitled "Hours Code" in Appendix D and the O&M savings for the first three years are calculated by assuming the total avoidance of existing lamp and ballast maintenance costs by installing newer technologies. Years four and five are calculated using just the avoided existing material costs because the five-year warranty on the ballasts and the three-year warranty on the lamps have now expired. Years six through ten are calculated by using the difference between the cost to maintain the existing system and the cost to maintain the proposed system.

4.1.3 Bernards High School

It is recommended that the existing lighting system at the Bernards High School, which consists of T-12 fixtures and incandescent lighting, as discussed in Section 2.3.3, be upgraded to high efficiency standards to create lighting uniformity throughout the buildings. In general, the energy efficient lighting upgrade involves installing energy-efficient lighting retrofit kits, electronic ballasts, reflectors, and/or new energy-efficient luminaires to the existing lighting systems. The strategies included in this section focused on maximizing energy savings and maintaining or exceeding light levels, while maintaining the existing look of each fixture, therefore, proposed lamp styles remain consistent with existing lamp styles. These lighting system recommendations will also reduce the number of different lamp and ballast types needed for maintenance. In addition, it is also recommended to install occupancy sensors in specified areas of the facility. Please refer to Appendix D: Lighting Retrofit

Spreadsheets for a line-by-line proposal spreadsheet for detailed strategies and sensor locations.

The annual energy savings are estimated to be 55.03 kW, 146,254 kWh and $22,699. In addition the project will generate annual maintenance savings, estimated at $1,965 from avoided costs related to changing lamps and ballasts. The following table, Table 4.1.3-1, summarizes a simple payback analysis assuming the implementation of all recommended lighting system improvements at the Bernardsville High School:

Table 4.1.3-1 **Bernards High School Lighting System Improvements**	
Retrofit Cost (Material and Labor)	$80,125
New Jersey SmartStart Rebate	-$15,545
Total Cost	$64,580
Annual Energy Savings	$22,699
Annual Maintenance Savings	$1,965
Simple Payback	**2.6 years**
ROI	**38%**

It should be noted that the Lighting Annual Savings assume the annual hours per year of operation as outlined under the column entitled “Hours Code” in Appendix D and the Operational and Maintenance (O&M) savings for the first three years are calculated by assuming the total avoidance of existing lamp and ballast maintenance costs by installing newer technologies. Years four (4) and five (5) are calculated using just the avoided existing ballasts costs based on the fact that the five-year warranty on the ballasts and the three-year warranty on the lamps has now expired. Years six (6) through ten (10) are calculated by using the difference between the cost to maintain the existing system and the cost to maintain the proposed system.

4.1.4 Olcott Building

It is recommended that the existing lighting system at the Olcott Building, which consists of T-12 fixtures and incandescent lighting, as discussed in Section 2.4.3, be upgraded to high efficiency standards to create lighting uniformity throughout the buildings. In general lighting upgrade project involves installing energy-efficient lighting retrofit kits, electronic ballasts, reflectors, and new energy-efficient luminaires to the existing lighting systems. The strategies included in this section focused on maximizing energy savings and maintaining or exceeding light levels, while maintaining the existing look of each fixture, therefore, proposed lamp styles remain consistent with existing lamp styles. In addition, it is also recommended to install occupancy sensors in specified areas of the facility. Please refer to Appendix D: Lighting Retrofit Spreadsheets for a line-by-line proposal spreadsheet for detailed strategies and sensor locations.

The annual energy savings are estimated to be 17.27 kW, 44,660 kWh and $7,351. In addition the project will generate annual maintenance savings of $570 from avoided costs related to changing lamps and ballasts. The following table, Table 4.1.4-1, summarizes a simple payback analysis assuming the implementation of all recommended lighting system improvements at the Olcott Building:

Table 4.1.4-1
Olcott Building Lighting System Improvements

Retrofit Cost (Material and Labor)	$25,156
New Jersey SmartStart Rebate	-$4,950
Total Cost	$20,206
Annual Energy Savings	$7,351
Annual Maintenance Savings	$570
Simple Payback	**2.5 years**
ROI	**39%**

It should be noted that the Lighting Annual Savings assume the annual hours per year of operation as outlined under the column entitled “Hours Code” in Appendix D and the O&M savings for the first three years are calculated by assuming the avoidance of total existing lamp and ballast maintenance costs by installing newer technologies. Years four and five are calculated using just the avoided existing material costs because the five-year warranty on the ballasts and the three-year warranty on the lamps have now expired. Years six through ten are calculated by using the difference between the cost to maintain the existing system and the cost to maintain the proposed system.

4.2 HVAC Systems

The goal of this section is to present any heating and cooling energy reduction and cost saving measures that may also be cost beneficial. Where possible, measures will be presented with a life-cycle cost analysis. This analysis displays a payback period based on weighing the capital cost of the measure against predicted annual fiscal savings. To do this, the buildings have been modeled as accurately as possible to predict energy usage for space heating and cooling, as well as domestic hot water use.

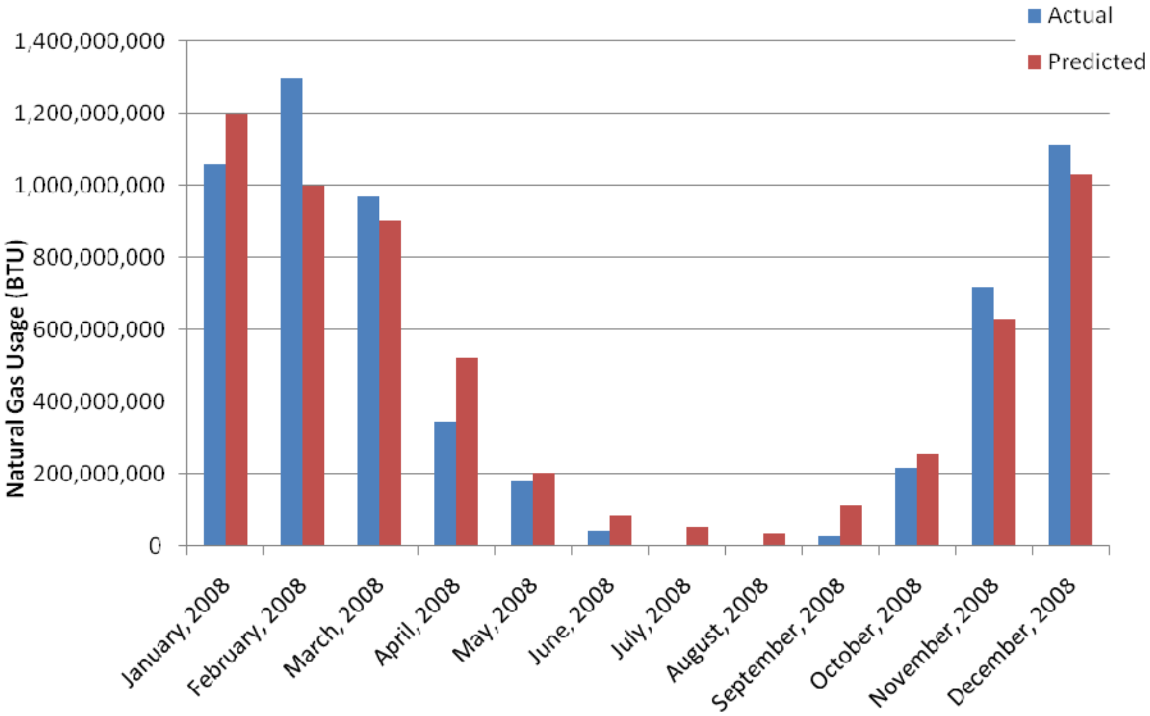
Each building is modeled using software called eQuest, a Department of Energy-sponsored energy modeling program, to establish a baseline space heating and cooling energy usage. Climate data from Newark, NJ was used for analysis. From this, the model may be calibrated, using historical utility bills, to predict the impact of theoretical energy savings measures. Refer to Appendix C for model run summaries.

Once annual energy savings from a particular measure have been predicted and the initial capital cost has been estimated, payback periods may be approximated. Equipment cost estimate calculations are provided in Appendix H.

4.2.1 Bedwell Elementary School

A model of the Bedwell Elementary School was created in eQuest to predict heating and cooling loads for the building. The model was calibrated using natural gas bills from 2008 and electrical bills from 2006 – 2008. Figure 4.2.1-1 compares the model-predicted natural gas usage with actual natural gas usage during 2008.

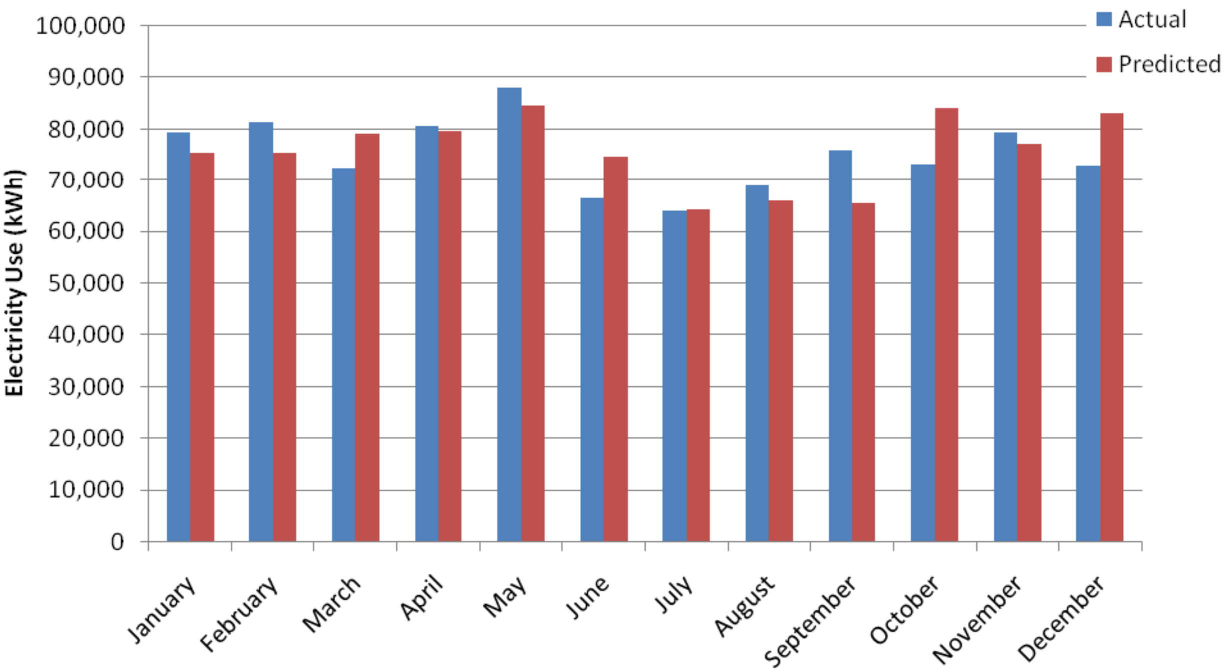
Figure 4.2.1-1: Bedwell Elementary School Natural Gas Usage



It may be seen in Figure 4.2.1-1 that the natural gas usage of the building followed a fairly predictable pattern, with peak heating in December – February, and minimal heating in June – August. It should be noted that the model predictions are based on average local climate data compiled over several years, while the actual usage represents just that of 2008. For example, February, 2008 may have been colder than average, necessitating additional heating, as is evident by the relative spike in actual gas usage during that month.

Figure 4.2.1-2 compares the model-predicted electricity usage with actual electricity usage, averaged over the previous three years.

Figure 4.2.1-2: Bedwell Elementary School Electricity Usage



In Figure 4.2.1-3, the electricity usage has been broken into major categories such as lighting and space cooling. From here, the portion of electricity that is specifically devoted to space cooling may be predicted in Figure 4.2.1-4.

Figure 4.2.1-3: Bedwell Elementary School Predicted Electricity Usage Breakdown

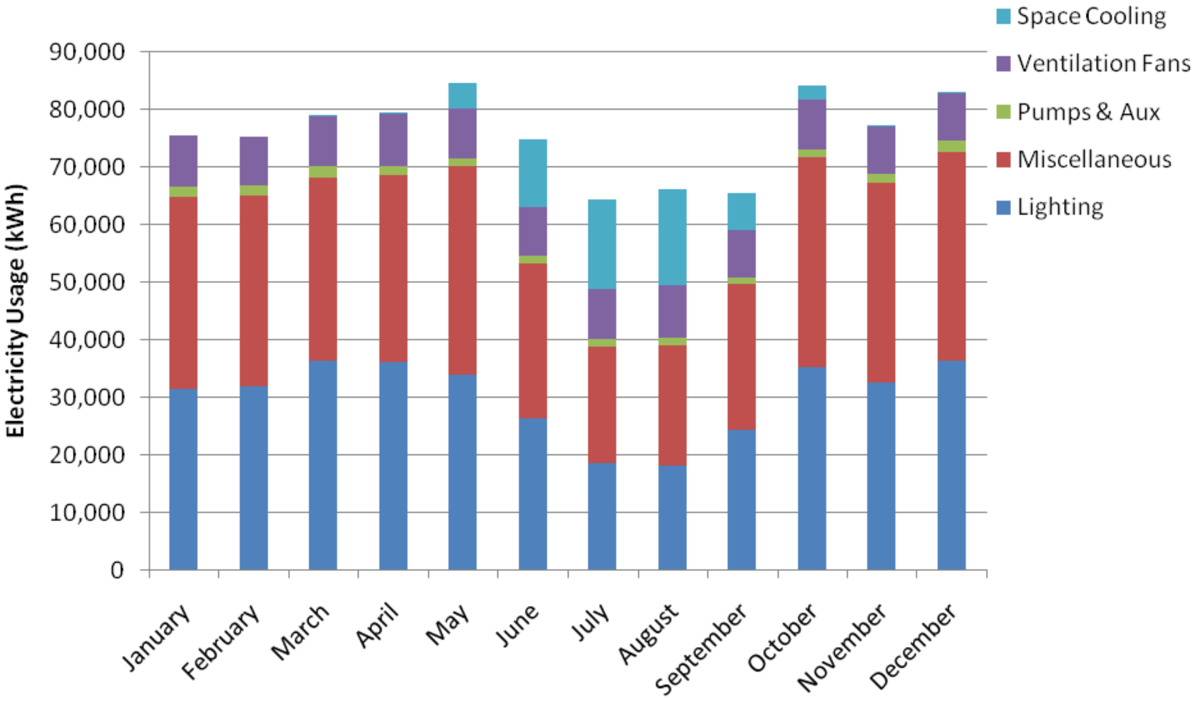
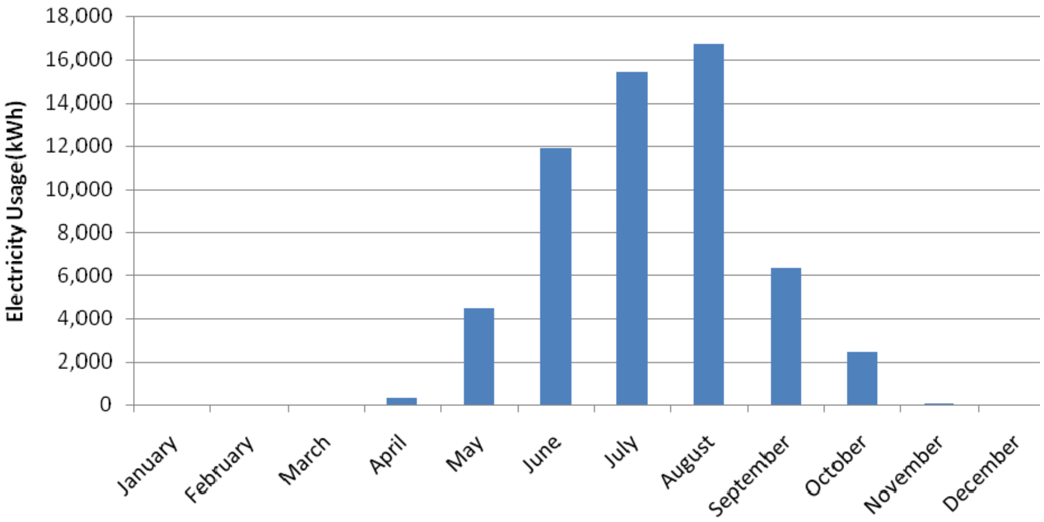


Figure 4.2.1-4: Bedwell Elementary School Predicted Cooling Electricity Usage

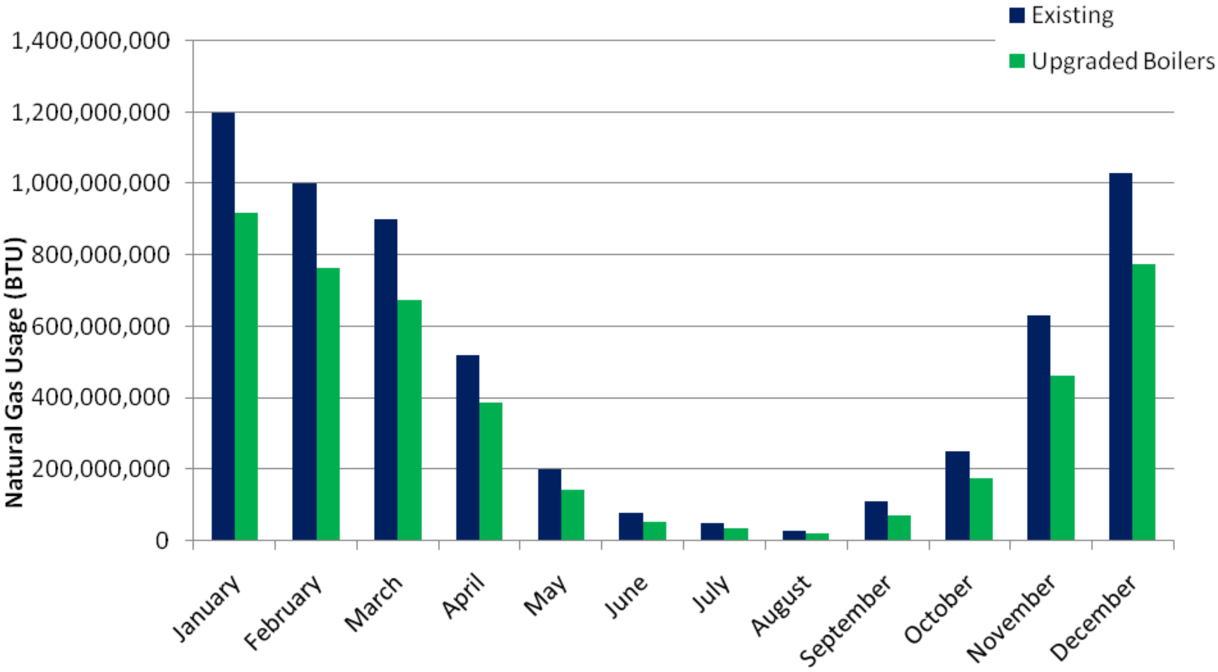


Data presented in Figures 4.2.1-3 and 4.2.1-4 are primarily for information purposes. The largest cooling demand occurs during the summer months, during which the schools are relatively unoccupied. Building cooling is provided by a combination of air handling units and unit ventilators, all of which are fairly efficient. Upgrading these units would provide minimal savings, and would not prove cost-effective.

The school's heating system may provide an opportunity to realize significant savings. Currently, the school is primarily heated with a hot water system, using two steam boilers and a steam to water heat exchanger. CDM estimates these boilers to have a maximum efficiency of 80%. However, the actual realized energy efficiency of these boilers is likely less, due to their age, and losses from steam generation and steam to water heat conversion.

An upgrade to high efficiency, condensing boilers in the elementary school would likely provide the District with considerable monetary and energy savings. Energy savings from an upgrade to a condensing, high efficiency hot water boiler system are predicted in Figure 4.2.1-5.

Figure 4.2.1-5: Boiler Upgrade Predicted Gas Usage



It should be noted that system efficiency also increases with a reduction in hot water loop temperature. With condensing boilers, the system may operate at a much lower water temperature than the current steam to hot water system. For purposes of this model, the hot water temperature was reduced from the assumed current 180 degrees F to 100 degrees F. This reduced hot water temperature and the increased boiler efficiencies were factored into the model to predict new monthly gas usages. These are presented as the "Upgraded Boilers" usages in Figure 4.2.1-5.

Additionally, because the current system generates steam, it requires a continuous supply of makeup water to regenerate steam that has condensed. This makeup steam supply will not be required by the new system. Therefore, an additional savings may be calculated from the elimination of this need. CDM assumes that 5% of the generated steam is required as makeup. Assuming this water must be heated from a supply temperature of 55 degrees F to its boiling point, and then vaporized into steam, this 5% makeup requires 155,680 Btuh (british thermal units per hour) for every hour that the boilers are operating. Based on the calculated yearly heating demand of 60,000 therms, and the total existing boiler capacity of 6,720 MBH (thousands of british thermal units per hour), CDM estimates the boilers run for approximately 892 full load hours per year. A 155,680 Btuh demand for 892 hours results in a usage of approximately 139,000,000 BTU. Table 4.2.1-1 demonstrates the potential payback period estimate for such an upgrade.

Table 4.2.1-1: Elementary School – Boiler Upgrade Payback	
Predicted Annual Savings (Therms)	15,125
Additional Annual Savings – From elimination of steam system (Therms)	1,390
Total Annual Energy Savings (Therms)	16,515
Total Annual Savings	$21,304
Initial Capital Cost of Upgrade	$229,000
Incentives	$8,000
Cost of Upgrade	$221,000
Simple Payback	**10.4 Years**
ROI	**9.6%**

Based on the projected simple payback period of 10.4 years, CDM recommends an upgrade to gas-fired condensing, high efficiency boilers.

Over several decades, ASHRAE has compiled data pertaining to service lives of most HVAC related equipment. From this, ASHRAE indicates a median service life (life until replacement) for HVAC related equipment that may be used as an estimate for the useful life of HVAC equipment currently in service. For example, ASHRAE indicates a window air conditioning unit has a median service life of 10 years. Therefore, if a window unit has been in service for more than 10 years, the owner may want to consider replacement. Not only will a replacement ensure minimal downtime between units (the unit is replaced before it ceases to function), but it will also maintain rated system efficiency, as efficiency tends to decrease with age.

All major equipment noted during CDM's on site audit is listed in Table 4.2.1-2 below, along with estimated current ages and ASHRAE-expected service lives. It should be noted that only equipment that was observed at the time of the audit is included.

Table 4.2.1-2
Bedwell Elementary School HVAC Equipment Service Lives

Description	Tag	Manufacturer	Model	Heating Capacity (MBH)	Cooling Capacity (MBH)	Estimated Age (Years)	ASHRAE Expected Life (Years)
Rooftop Unit	RTU 1	Lennox	LCC180H2BN1Y	--	180	<10	15
Rooftop Unit	RTU 2	Lennox	LCA102H2BN3Y	--	100	<10	15
Rooftop Unit	RTU 3	Lennox	LGA048H2BS3Y	62.4	48	<10	15
Rooftop Unit	RTU 4	Lennox	LGA048H2BS3Y	62.4	48	<10	15
Rooftop Unit	RTU 5	Lennox	LGA048H2BS3Y	62.4	48	<10	15

Table 4.2.1-2
Bedwell Elementary School HVAC Equipment Service Lives

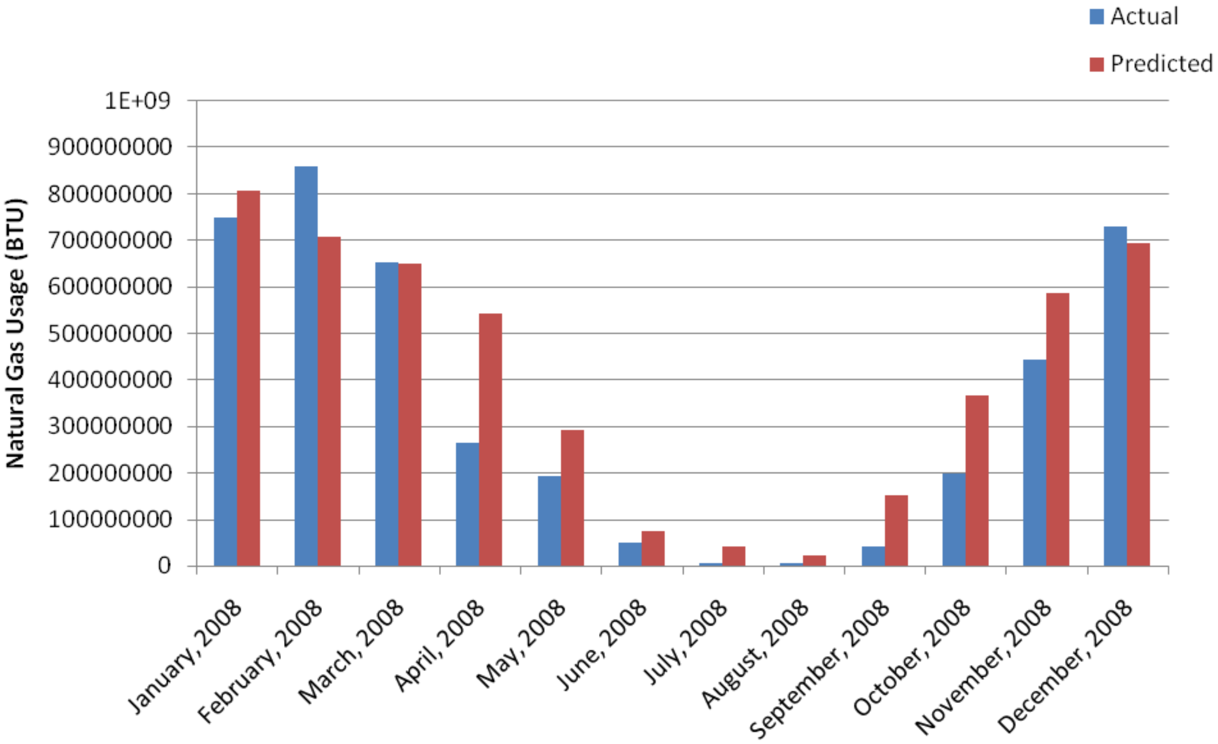
Rooftop Unit	RTU 6	Lennox	LGA048H2BS3Y	62.4	48	<10	15
Rooftop Unit	RTU 7	Lennox	LGA048H2BS3Y	62.4	48	<10	15
Rooftop Unit	RTU 8	Lennox	LGA048H2BS3Y	62.4	48	<10	15
Rooftop Unit	RTU 9	Lennox	LGA060H2BT2Y	100	60	<10	15
Rooftop Unit	RTU 10	Lennox	LGA060H2BT2Y	100	60	<10	15
Rooftop Unit	RTU 11	Lennox	LGA042H2BS2Y	62.4	42	<10	15
Rooftop Unit	RTU 12	Lennox	LGA042H2BS2Y	62.4	42	<10	15
Rooftop Unit	RTU 2	Trane	TCD103C30AAB	--	103	9	15
Rooftop Unit	RTU 3	Trane	TCD181C30CAA	--	180	9	15
Rooftop Unit	RTU 4	Trane	YCD074C3LCBE	97	72	9	15
Rooftop Unit	AC 1	Lennox	GCS16-048-75-2Y	60	48	<10	15
Rooftop Unit	AC 2	Lennox	GCS16-036-90-2Y	72	36	<10	15
Rooftop Unit	AC 3	Lennox	GCS16-036-90-2Y	72	36	<10	15
Rooftop Unit	AC 4	Lennox	GCS16-48-75-2Y	60	48	<10	15
Rooftop Unit	AC 5	Lennox	GCS16-060-75-1Y	60	60	<10	15
Rooftop Unit	AC 6	Lennox	GCS16-060-75-1Y	60	60	<10	15
Rooftop Unit	AC 7	Lennox	GCS16-036-90-2Y	72	36	<10	15
Rooftop Unit	AC 8	Lennox	GCS16-036-90-2Y	72	36	<10	15
Rooftop Unit	AC 9	Lennox	GCS16-036-90-2Y	72	36	<10	15
Rooftop Unit	AC 10	Lennox	GCS16-036-90-2Y	72	36	<10	15
Rooftop Unit	AC 11	Lennox	GCS16-036-90-2Y	72	36	<10	15
Outdoor AHU		Lennox	LGA120SH1Y	188	120	10	15
Outdoor AHU		Lennox	LGA120SH1Y	188	120	10	15
Boiler		Cleaver Brooks	CB134-80	1,344	--	**49**	35
Boiler		Cleaver Brooks	CB134-80	1,344	--	**49**	35

4.2.2 Bernardsville Middle School

Similarly to the elementary school, a model of the Bernardsville Middle School was created in eQuest.

Figure 4.2.2-1 compares the model-predicted natural gas usage with actual natural gas usage during 2008.

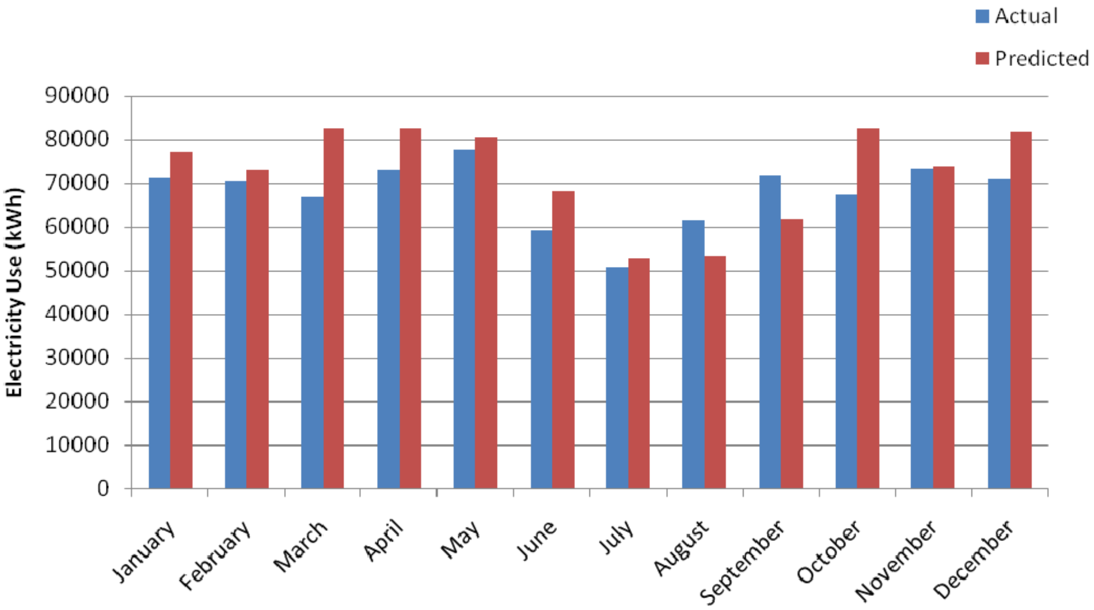
Figure 4.2.2-1: Bernardsville Middle School Natural Gas Usage



Again it may be seen that gas usage was high during the month of February, 2008, further substantiating the assumption that this month was particularly cold. Additionally, it can be seen in Figure 4.2.2-1 that CDM was not able to accurately predict gas usages for all months. So the model was instead calibrated for the coldest months (December – March). This resulted in high gas usage predictions for some of the remaining months. This discrepancy has been addressed in savings calculations.

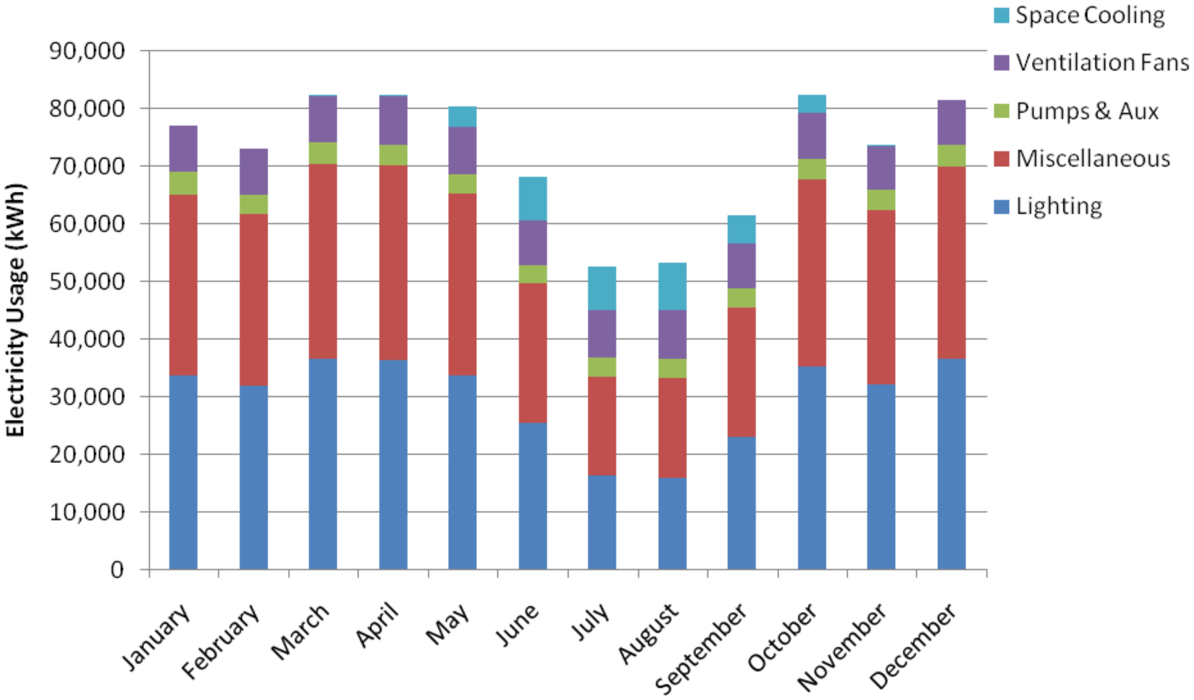
Figure 4.2.2-2 compares the model-predicted electricity usage with actual electricity usage, averaged over the previous three years.

Figure 4.2.2-2: Bernardsville Middle School Electricity Usage



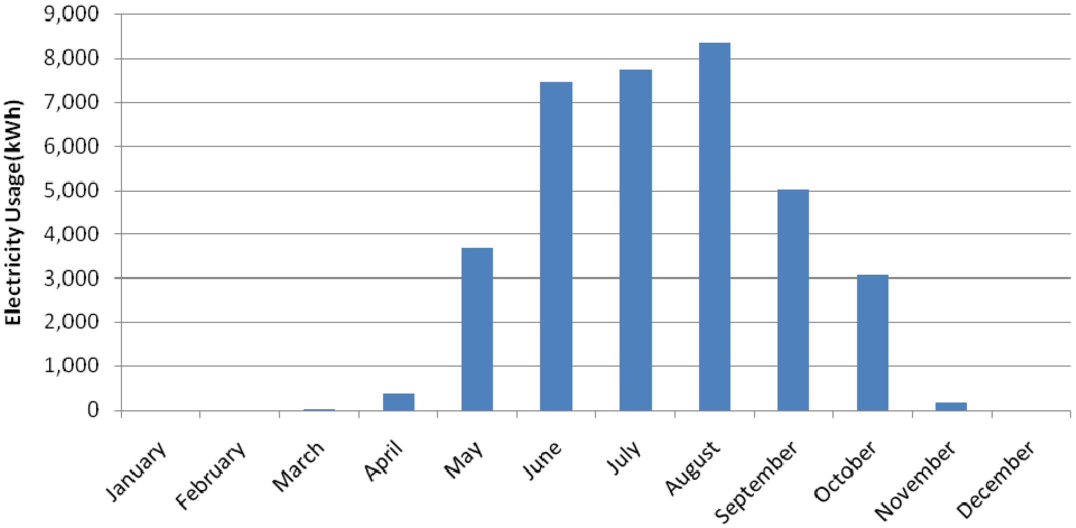
This predicted electrical usage may now be broken into major usage categories in Figure 4.2.2-3.

Figure 4.2.2-3: Bernardsville Middle School Predicted Electricity Usage Breakdown



Finally, the electricity usage for space cooling may be extracted and is displayed in Figure 4.2.2-4.

Figure 4.2.2-4: Bernardsville Middle School Predicted Cooling Electricity Usage



Similarly to the cooling systems in the Bedwell Elementary School, the cooling units in the Middle School would not realize significant savings from upgrades. Therefore, no cooling equipment upgrades are recommended.

The primary heating system in the Middle School is a hot water system fed by several boilers. CDM estimates these boilers to have a maximum gross efficiency of 80%. Based on this estimate, a savings from a hypothetical upgrade to high efficiency, condensing boilers may be estimated. If condensing boilers are used, the hot water loop temperature can be reduced to 100 degrees F. Figure 4.2.2-5 demonstrates a predicted savings from a boiler upgrade and loop temperature reduction.

As previously stated, the model-predicted gas usage was a bit higher than the actual gas usage for the building, so the savings for this upgrade were calculated a bit differently. The model-predicted savings were represented as a percentage saved, then that percentage was applied to the actual 2008 gas usage to predict savings in therms. It is CDM's assertion that this is a more accurate prediction of gas savings for this particular building. Table 4.2.2-1 summarizes the potential calculated savings and payback period of such a renovation.

Figure 4.2.2-5: Boiler Upgrade Natural Gas Usage

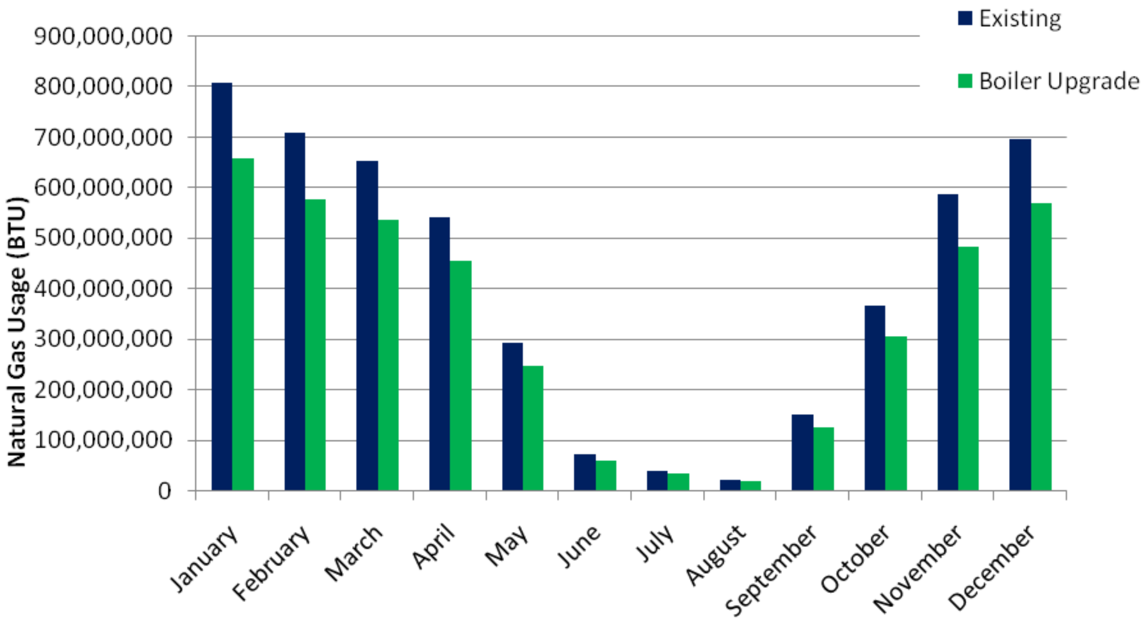


Table 4.2.2-1 Middle School – Boiler Upgrade Payback	
Predicted Annual Savings (Therms)	7,344
Total Annual Savings	$10,428
Initial Capital Cost of Upgrade	$171,422
Incentives	$6,000
Cost of Upgrade	$165,422
Simple Payback	**15.9 Years**
ROI	**6.3%**

All existing boilers in the Middle School have a combined input rated-capacity of 6,053 MBH. Because the condensing boiler efficiency would be significantly higher, CDM asserts that three 2,000 MBH condensing boilers will be required to adequately replace the existing boiler system in the school. So, while the total input-rated capacity of 6,000 MBH would be ~1% lower than the existing 6,053 MBH, the system efficiency would be 10%-15% higher, likely resulting in more available heat.

Based on the simple payback period of 15.9 years, CDM recommends an upgrade to high-efficiency, condensing boilers.

Additionally, CDM noted a number of classrooms in the Middle School have single pane windows. Approximate window sizes and locations are factored into the eQuest model of the school. Therefore, CDM is able to roughly predict energy savings from replacing these windows with more efficient double-paned windows.

Model predictions estimate an annual natural gas usage savings of 1,500 therms or approximately 3% of the total gas usage. This could result in an annual savings of $2,130. However, because this is a rough estimate based on approximate window sizes, CDM cannot provide an accurate upgrade cost, and a simple payback has not been provided. Estimated savings have been provided simply for informational purposes should the District consider replacing these windows in the future.

Again, all major equipment noted during CDM's on site audit is listed in Table 4.2.2-2 below, along with estimated current ages and ASHRAE-expected service lives. It should be noted that only equipment that was observed at the time of the audit is included.

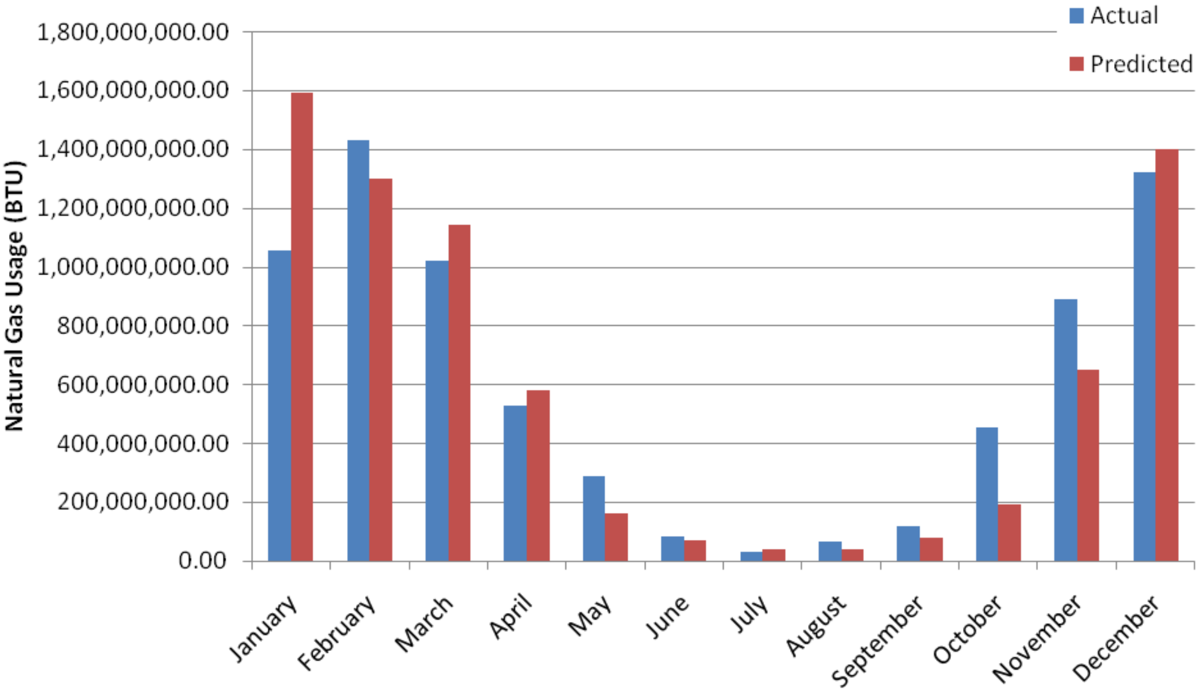
Table 4.2.2-2: Bernardsville Middle School HVAC Equipment Service Lives

Description	Tag	Manufacturer	Model	Heating Capacity (MBH)	Cooling Capacity (MBH)	Estimated Age (Years)	ASHRAE Expected Life (Years)
Rooftop Unit	RTU 1	Lennox	LCA102H2BN3G	--	101	12	15
Rooftop Unit	RTU 2	Lennox	LGA120H2BM3G	144	120	12	15
Rooftop Unit	RTU 3	Trane	GRAA60GDJB0L3JQ105C0FJNPQ	480	--	12	15
Rooftop Unit	RTU 4	Trane	GRAA60GDJB0L3JQ105C0FJNPQ	480	--	12	15
Rooftop Unit		Lennox	LCA060HN1Y	--	61	<10	15
Rooftop Unit		Lennox	LCA048HN1Y	--	49	<10	15
Rooftop Unit		Lennox	LCA060HN1Y	--	49	<10	15
Condenser		Lennox	HS26-030-4P	--	30	<10	20
Condenser		Lennox	HS26-048-4Y	--	48	<10	20
Condenser		Lennox	HS26-048-4Y	--	48	<10	20
Condenser		Lennox	HS26-024-5P	--	24	<10	20
Condenser		XE 1000	TTR042C100A2	--	42	13	20
Condenser			2AC13B24P	--	24	<10	20
Condenser		EMI	SCB09DA0200BA0A	--		10-15	20
Boiler		Cleaver Brooks	CB810-100	2,000	--	**40**	35
Boiler		Cleaver Brooks	CB810-100	2,000	--	**40**	35
Boiler		Caravan	GG-375 HEC	1,216	--	3	35
Boiler		Donlee	5PW-25-N	837	--	12	25

4.2.3 Bernards High School

The Bernards High School was modeled in eQuest to predict heating and cooling loads for the building. The model was calibrated using natural gas bills from 2008 and electrical bills from 2006 – 2008. Figure 4.2.3-1 compares the model-predicted natural gas usage with actual natural gas usage during 2008.

Figure 4.2.3-1: Bernards High School Natural Gas Usage



Again, for information purposes, model-predicted electricity usage and corresponding usage breakdown at the high school have been presented in Figures 4.2.3-2 and 4.2.3-3, respectively.

Figure 4.2.3-2: Bernards High School Electricity Usage

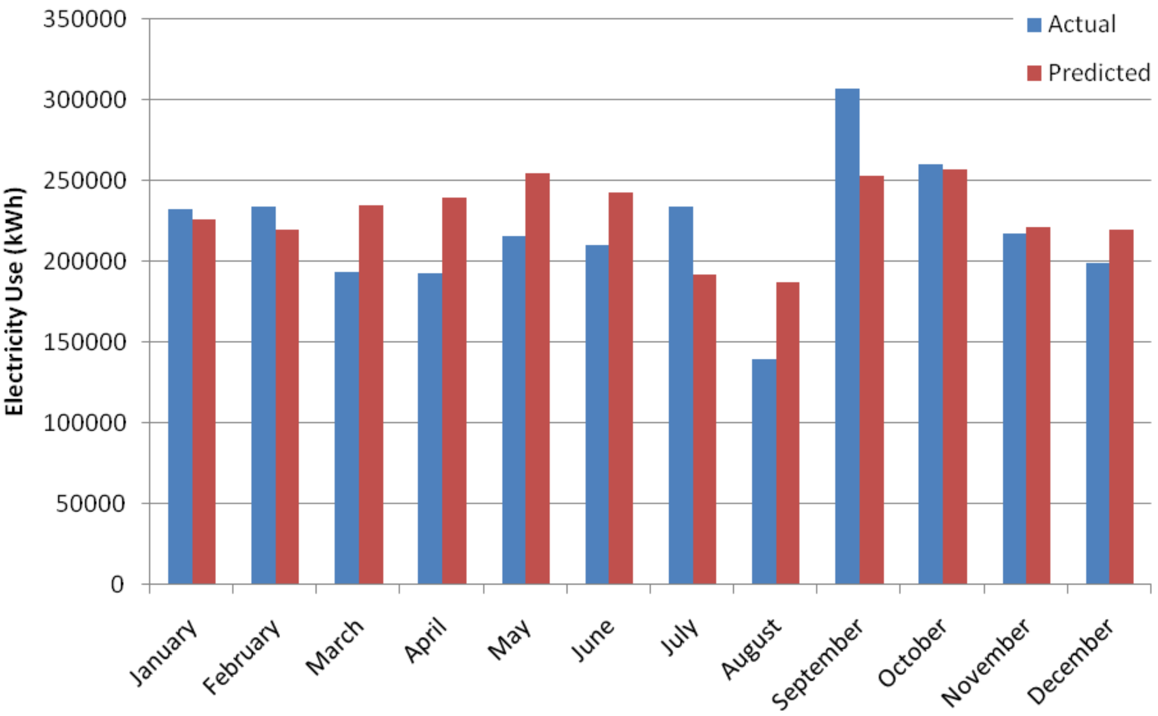
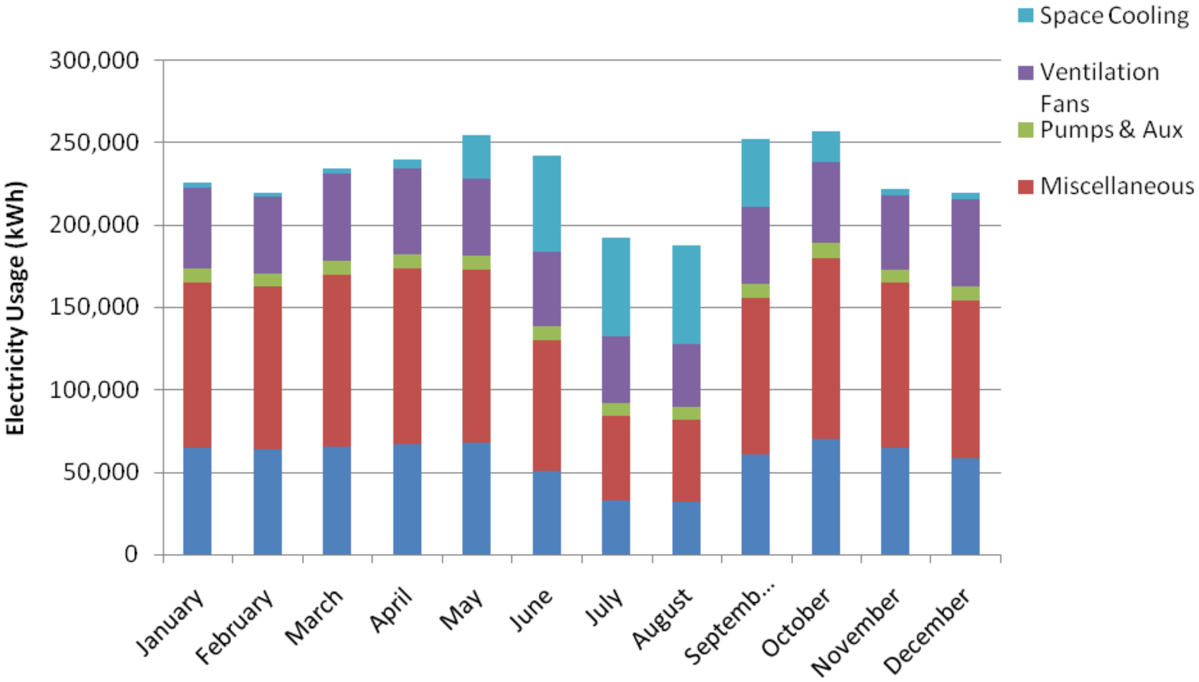


Figure 4.2.3-3: Bernards High School Electricity Usage Breakdown



There are several HVAC systems that condition the various buildings or wings that comprise the high school. As many of these systems have been replaced or upgraded within the last several years, CDM does not find replacing any of these systems to be cost effective.

However, CDM was able to locate a potential energy savings measure in the gymnasium in the A wing. The gymnasium has four overhead indoor air handling units that are used in the winter to heat the space, and in the summer to provide adequate air circulation. Each unit is a McQuay LAH010AHH, with a maximum air flow capacity of approximately 8,500 CFM.

CDM estimates the gym to be approximately 6,500 square feet and the corresponding maximum capacity to be around 195 people (based on a 30 person per 1,000 square foot assumption). Typical outdoor air ventilation rates for gymnasiums are around 25 CFM per person. The system therefore must at least have the capacity to provide 4,875 CFM of outdoor air at any given time. A requirement of 1 CFM per square foot would not only provide adequate comfort and air circulation, but also allow for at least 4,875 CFM of outdoor air when fully occupied.

During the field visit, CDM learned that all four units operate simultaneously and provide more than enough air flow to heat the space and keep a steady air circulation pattern within the room. The units are also very loud when operating. CDM finds that operating these units at a lower capacity would not only save energy, but also reduce unwanted equipment noise levels when the gym is occupied.

CDM was not able to obtain any information detailing how the units were balanced, but, based on conversations with facility personnel, finds it reasonable to assume they are at least operating at half capacity (~4,000 CFM). These units could be reduced to operate at 2,000 CFM without sacrificing comfort or adequate air circulation. If all four units are rebalanced to operate at 2,000 CFM, this would provide approximately 1.2 CFM per square foot.

At 4,000 CFM, CDM estimates the pressure drop through the HVAC system (from the outdoor weather hood to the ceiling diffuser) to be around 1.87 in. water. If this air flow were then reduced to 2,000 CFM, the pressure drop over the same system would be reduced by 75%, or to around .47" in. water. Fan laws dictate that for a system static pressure differential reduction of 50%, the corresponding fan horsepower reduction is 87.5% (or one-eighth of the original horsepower).

CDM assumes that there are 1 horsepower motors operating the fans in these units. Based on this assumption CDM anticipates that a reduction to half the flow (2,000 CFM) would result in a total systems savings of approximately 1 kW. Assuming the units operate roughly 40 hours per week, this equates to an energy savings of approximately 2,080 kWh per year. It is important to note that if the existing flow is higher than 4,000 CFM, or the motor is larger than 1 horsepower, the savings resulting from a decrease to half the current airflow will increase.

This will save on fan motor electricity usage, as well as natural gas. An expected savings has been calculated in Table 4.2.3-1.

Table 4.2.3-1 **High School – H&V Unit Control Change Payback**	
Predicted Annual Savings (kWh)	2,080
Total Annual Savings	$322
Initial Capital Cost of Upgrade	$2,094
Simple Payback	**6.5 Years**
ROI	**15.3%**

Not only will a reduction in airflow save energy, it will also make the units less noisy. Therefore, based on the calculated simple payback of 6.5 years, CDM recommends rebalancing the units to provide half the current air flow.

Boilers and chillers noted during CDM's on site audit are listed in Table 4.2.3-2 below, along with estimated current ages and ASHRAE-expected service lives. Complete information for other major equipment was not obtained and is therefore not included.

Table 4.2.3-3
Bernards HighSchool HVAC Equipment Service Lives

Description	Tag	Manufacturer	Model	Heating Capacity (MBH)	Cooling Capacity (MBH)	Estimated Age (Years)	ASHRAE Expected Life (Years)
Chiller		McQuay	AGS230B27-FR10	--	2,760	4	23
Chiller		McQuay	AGS230B27-FR10	--	2,760	4	23
Boiler		Aerco		2,000	--	3	35
Boiler		Aerco		2,000	--	3	35
Boiler		Aerco		2,000	--	3	35
Boiler		Aerco		2,000	--	3	35
Boiler		Aerco		2,000	--	3	35
Boiler		Aerco		2,000	--	3	35
Boiler		Aerco		2,000	--	3	35
Boiler		Aerco		2,000	--	3	35
Boiler		Aerco		2,000	--	3	35
Boiler		Aerco		2,000	--	3	35

While rooftop air handling units are not included in this table, typical service life for these units is 15 years. The District may assess the current age of any rooftop air handling units at the High School. Units that have been in service for more than 15 years should be considered for replacement.

4.2.4 Olcott Building

Due to the relative simplicity of the Olcott Building, a different modeling approach was taken. The building structure was modeled in eQuest to calculate the peak heating load, which was found to be approximately 660,000 Btuh, assuming a 72° F indoor temperature.

The Olcott Building has a steam heating system, with radiators throughout the building. CDM finds that providing reflective insulation behind these radiators would provide significant energy savings.

CDM counted 47 radiators within the Olcott Building. Based on the calculated peak heat load of 660 MBH, each radiator dissipates approximately 14 MBH to the surrounding space. CDM assumes 75% of the dissipation is convective, and the remaining 25% is radiation. Therefore, each radiator is actually radiating approximately 3.5 MBH to the space. CDM calculates the outside surface of each radiator to account for approximately 35% of the total surface area. The resulting radiated heat from the outside surface of each radiator is 1,225 Btuh, or 57,575 Btuh from the entire system (47 radiators). This is approximately 8% of the peak heat load being radiated to exterior walls.

The Olcott Building used approximately 12,339 therms of natural gas in 2008. CDM has therefore estimated that providing reflective insulation board behind the radiators will save 987 therms, or 8% of the energy usage. Table 4.2.4-1 below indicates a predicted payback from providing reflective insulation board behind the radiators.

Table 4.2.4-1
Olcott Building – Reflective Insulation Board

Predicted Annual Savings (Therms)	987
Total Annual Savings	$1,421
Initial Capital Cost of Upgrade	$7,965
Simple Payback	**5.6 Years**
ROI	**17.8%**

The system currently operates as one zone, with only one thermostat dictating temperature for the entire building. Consequently, several of the rooms within the building often are either chilly or over heated. This can be a major cause of wasted energy.

Therefore, CDM's recommendation is to break the building up into several zones, with individual thermostats controlling steam delivery to each zone. During the daytime, each zone would be controlled by a thermostat located at the radiator, and system control would be pressure-driven, to ensure every radiator has an adequate steam supply. During the night, the system would switch to thermostatic control, with a night setback temperature of approximately 55° F. This ensures that the system thermostat will override individual zone (radiator) thermostats, and no zone will be heated past 55° F at night.

Table 4.2.4-2 shows an estimated savings and payback calculation of such a measure.

Table 4.2.4-2
Olcott Building – Zone Restructure Savings

Predicted Annual Savings (Therms)	850
Total Annual Savings	$1,224
Initial Capital Cost of Upgrade	$17,965
Simple Payback	**14.7 Years**
ROI	**6.8%**

The only major HVAC related equipment in the Olcott Building is the boiler. Table 4.2.4-3 below indicates the current age and expected service life for this boiler.

Table 4.2.4-3
Olcott Building HVAC Equipment Service Lives

Description	Tag	Manufacturer	Model	Heating Capacity (MBH)	Cooling Capacity (MBH)	Estimated Age (Years)	ASHRAE Expected Life (Years)
Boiler		HB Smith	28HE-S-9	2,718	--	2	35

4.3 Photovoltaic Solar Energy System

4.3.1 Overview

Photovoltaic (PV) cells convert energy in sunlight directly into electrical energy through the use of silicon semi conductors, diodes and collection grids. Several PV cells are then linked together in a single frame of module to become a solar panel. PV cells are able to convert the energy from the sun into electricity. The angle of inclination of the PV cells, the amount of sunlight available, the orientation of the panels, the amount of physical space available and the efficiency of the individual panels are all factors that affect the amount of electricity that is generated.

Based on the estimated cumulative total available roof area, calculations determine that the installation of a system rated at approximately 239.23 kW (dc) will be appropriate for two of the schools. The total for both the buildings would generate an annual production of approximately 271,491 kWh (ac).

As part of this energy audit, a preliminary engineering feasibility study of the sites outlined above to support solar generation facilities was completed consisting of the following tasks:

a. Site Visit by our engineers.

b. Satellite Image Analysis and Conceptual design and layout of the photovoltaic system

c. Design and construction cost estimates

d. Determine a preliminary design for the size and energy production of the solar system.

The total unobstructed available area of each section of the roof with southern exposure was evaluated. It is important to note the following:

1. The structural integrity of the roofs was not confirmed during our site visit. The schools may require some degree of roofing work prior to the implementation of a solar system.

2. Our site visits did identify schools with potential issues related to the existing electric service and the need for certain modifications to accommodate a PV system.

3. In the case of the flat areas, the PV system sizing and kWh production was calculated assuming the installation of a crystalline module facing south direction (220 Degree Azimuth) and tilted approximately 20 degrees to allow better rain water shedding and snow melting. Please note that the kWh production as well as system size may differ significantly based on final panel tilt selected during the RFP and design phase.

4. Blended electric rates were used based on actual utility bills and were applied for each facility.

The following is a preliminary study on the feasibility of installing a PV solar system at the Somerset Hills School District buildings to generate a portion of the facility's electricity requirements. The system is designed to offset the electric purchased from the local utility and not as a backup or emergency source of power.

In order to determine the best location for the installation of the PV solar system, a satellite image analysis and site walkthrough of the school district buildings was performed on April 15-17. As per the Scope of Work, only the building roofs were considered for PV installation.

Also, as part of our assessment we investigated possible locations for electrical equipment that need to be installed such as combiner boxes, disconnect switches and DC to AC inverters. Consideration was also given to locations of interconnection between the solar system and building's electrical grid.

4.3.2 Bedwell Elementary School

The roof of this building has a flat roof with a number of obstructions such as exhaust fans, rooftop HVAC units, and electrical and gas piping. There is a minimal amount of shading on the roof from adjacent foliage that would need to be addressed during the design phase of the project. The older sections of the roof appear to be built-up while newer sections are of the membrane type. School personnel were unable to state if there are any existing warranties. The structural integrity of the roof was not confirmed although a visual inspection revealed no leaks or major defects. The structural integrity of the roof and the existence of a warranty shall be confirmed prior to the implementation of a PV system.

Bedwell Roofs

The Project Team conducted both a facility walkthrough and a satellite image analysis and based on the estimated total available area we calculated the installation of a system rated at approximately 83.78 kW (dc).

Electrical Service

This school is served by a 1,600 ampere, three-phase four-wire 120/208 volt service located in the basement boiler room. There are no available spaces for a load-side interconnection of the arrays. The interconnection point for the solar arrays will require a modification of the service entrance equipment wherein connections will have to be made between the main circuit breaker and the CT section of the switch board. There is no available space for the

inverter to be installed within the boiler room. The inverter would be installed outside on a concrete pad. The inverter would be housed in a NEMA 3R enclosure. The AC wiring would run from the inverters into the connection point(s) at the switchboard. Any connection points would have to meet NEC and local utility requirements.

4.3.3 Bernards High School

The High School is comprised of seven buildings that have been added over the years because of student population increase. The total roof area is approximately 252,715 square feet. The roofs of the buildings are flat. Areas have been identified that would be suitable for a solar panel installation taking into consideration the number of rooftop units and the amount of gas and electrical piping in these areas. There appeared to be little to no shading from adjacent foliage in those areas deemed suitable for a solar installation.

The roofs of all buildings appear to be in good condition. Although there was considerable water pooling on the roofs, they appeared sound. There was one area marked out for apparent repairs (EPDM surface) and this appeared to have “bubbled.” This section is located near the access ladder to the roof hatch. The structural integrity of each roof section, the age of the roofs and the existence of a warranty should be confirmed prior to the implementation of a PV system, as solar panels have the same useful life as a standard roof, the solar panels should be installed following any necessary roof repairs or roof replacement.

Flat Area of High School Roof

A facility walkthrough and a satellite image analysis of the estimated total available roof area was conducted. Based on our surveys, we calculated the installation of a system rated at approximately 155.46 kW (dc). There are two potential interconnection points for the solar installation at the High School.

Electric Service

The building has two separate electrical services. The old section of the High School has a 3000 ampere three-phase four-wire 120/208 volt service located in the basement. The metering for this service is located in the electrical equipment room. The main distribution board currently has one 225-ampere space and one 100-ampere space available for use. Based on National Electrical Code (NEC)

4000amp 480 volt service

requirements, approximately 60 kW may be connected at this service. The other potential additional interconnection point is at the new service feeding several of the newer buildings on the campus. This service is rated at 4000 amperes three-phase four-wire 480/277 volt (pictured to right). Because NEC requirements mandate ground-fault protection on this service, the PV system would have to be connected to the line side of the main. This would involve modification of the service to some extent in order to accommodate the interconnection point.

Space limitations in both electrical equipment rooms dictate that the inverters for these arrays would have to be located outside the High School on concrete pads. The inverters would be housed in NEMA 3R enclosures, and the AC wiring would run from the inverters into the connection point(s) at the switchboards. Any connection points would have to meet NEC and local utility requirements.

The proposed Photovoltaic (PV) Power systems outlined above for each school are comprised of the PV arrays, inverter(s), combiner boxes, disconnect switches, and all of the necessary wiring and interconnection equipment. The solar panels will be mounted onto the roof. The array outputs will feed power into the DC to AC inverters. AC outputs will then be connected at each building's electrical service as outlined above. Pending further engineering analysis of the roofs, it is yet to be determined if the solar arrays will be installed using a self-ballasting system, or roof penetration system, or a combination of both.

4.3.4 Middle School and Olcott Building

The Bernardsville Middle School was not included for solar because our survey indicated that the existence of too many roof obstructions as well as major shading issues would not make this building a viable candidate for solar power. The Olcott building has been excluded because the roof is composed of Spanish clay tiles (red roof pictured to right) and solar installation would be impractical.

Middle School surrounded by Trees

Olcott Building in Rear with Red Roof

4.3.5 Basis for Design and Calculations

Fixed Tilt System

The most common roof mounted system is referred to as a ("fixed tilt") system typically mounted to a metal rack that can be fixed at a specific angle. There are also ("tracking systems") or movable along one or two axes to follow the position of the sun during the day. For a roof-mounted PV system, tracking systems are very rarely installed and are usually used for ground-mounted systems only, as they require more complex racks and higher maintenance costs. For the "fixed" system, the tilt is determined based on the following factors: geographical location, total targeted kWh production, seasonal electricity requirements and weather conditions such as wind. Ideally, the module tilt for Northern New Jersey should be 25-35 degrees with an azimuth as close as possible to 180 (south); however, our experience has shown that PV systems are typically installed at a tilt of 20 degrees or lower in order to avoid any issues with wind and to maximize total system size

The type of PV panels and equipment used to mount the system shall be determined based on the wind conditions and structural integrity of the roof determined during the design phase of the project. In general, penetration/tie-down systems, non-penetrating ballasted type systems, or a combination of the two should be considered.

PV System Sizing

The installation of a south facing, non-tracking, fixed tilt system was investigated. The total size is estimated at approximately 239.24 kW dc. The calculations were based on a poly-crystalline panel such as Sharp ND-224U (rated at 224 watts dc) utilizing a 20-degree panel tilt. The azimuth was estimated at 220 degrees.

Calculation of PV System Yield

An industry accepted software package, PV Watts, was used to calculate projected annual electrical production of the crystalline silicon PV system in its first year , as summarized in Table 4.3.5-1. The assumptions we used in the calculations were as follows: solar array tilt angle of 10°, array azimuth of 170° and a de-rate factor of 0.8. The energy savings generated by the installation of approximately 239.24 kW dc of photovoltaic power is estimated to be 277,491 kWh ac.

Table 4.3.5-1 System Summary

Site	Number of Solar Panels	Est. Area (ft2)	kWh Production	kW dc	Annual Energy Savings	Est. Annual SREC
Bernardsville HS	694	22,623	180,713	155.46	$28,047	$72,285
Bedwell ES	374	12,886	96,778	83.78	$13,181	$38,711
Totals	1,068	35,509	277,491	239.24	$41,228	$110,996

Total Costs

It should be noted that construction costs are only estimates based on historic data compiled from similar installations, and engineering opinion. Additional engineering and analysis is required to confirm the condition of the roofs, structural integrity of the roofs, the system type, sizing, costs and savings. Budget costs assume existing roofs are structurally sound, do not need to be replaced, and can accommodate a solar system. For illustration purposes, a draft financial analysis pro forma is attached outlining all project costs and revenues.

Table 4.3.5-2 Budget Installation Cost

Budget Installation Cost	**$2,023,800**

As stated above the estimated installation costs are based on significant experience with the pricing of solar installations in New Jersey, and are intended to provide SHSD with a realistic budget cost. A typical solar installation can vary in cost from $7.00 - $10.00 per watt depending on size, complexity of the system, labor rates, etc. Approximately 60-70% of that number is material costs while the balance is labor, engineering, etc. Like any installation, certain conditions can affect a price upward or downward. For purposes of this analysis the estimated installation cost does not include any roofing or structural work which may be required to maintain warranties or for additional structural support. We have included a budget of $8/watt for the solar system installation with an additional estimated budget of $110,000 for potential electric service work.

Electric Generation

The most obvious direct benefit of solar systems is that they generate electricity on site and result in reduced utility purchases. We have assumed a blended retail electric rate of:

Bedwell Elementary School: $0.1362/kWH

Bernardsville High School: $0.1552/kWH

In addition, the current design of solar panels can result in gradual decline of output efficiency. Although many systems show negligible decline after years of operation, this financial analysis assumes a 0.5% annual degradation in electric output.

Refer to Section 7 for discussion on Solar Renewable Energy Certificates and other financing options for solar projects. The financial model in Appendix E provides an annual forecast illustration of project revenues and costs for 15 years.

Section 5
Evaluation of Energy Purchasing and Procurement Strategies

5.1 Energy Deregulation

In 1999, New Jersey State Legislature passed the Electric Discount & Energy Competition Act (EDECA) to restructure the electric power industry in New Jersey. This law, the deregulation of the market, allowed all consumers to shop for their electric supplier. The intent was to create a competitive market for electrical energy supply. As a result, utilities were allowed to charge Cost of Service and customers were given the ability to choose a third party supplier. Energy deregulation in New Jersey increased the energy buyers' options by separating the function of electricity distribution from that of electricity supply.

Jersey Central Power and Lighting (JCP&L) is currently the generator and supplier of energy for the Somerset Hills School District. JCP&L is one of seven subsidiaries of First Energy Corp., an energy company headquartered in Akron, Ohio. Energy deregulation creates the opportunity to choose your electric generation supplier. The benefit of this is the ability to choose a supplier based on what is important to you, for example, lowest rate or how the electric generation supply is produced.

To sell electric generation service in New Jersey, electric power suppliers must be licensed by the New Jersey Board of Public Utilities (NJ BPU). They must also be registered with the local public utility (JCP&L) to sell electric service in that utility's service areas. The following suppliers are licensed with the NJ BPU and are registered to sell electric service in the JCP&L service territory:

- Amerada Hess Corp
- BOC Energy Services
- Con Edison Solutions, Inc.
- Constellation New Energy, Inc.
- Direct Energy, LLC.
- First Energy Solutions Corp.
- Glacial Energy
- Integrys Energy Service
- Liberty Power
- Pepco Energy Services, Inc.

- PP&L Energy Plus, LLC.
- Reliant Energy Solutions East, LLC.
- Sempra Energy Solutions
- South Jersey Energy
- Strategic Energy LLC
- Suez Energy Resources NA, Inc
- UGI Energy Services

5.1.1 Alternate Third Party Electrical Energy Supplier

In evaluating the potential for an alternative third party supplier, CDM contacted and requested quotes for electric service from First Energy Solutions Corp, Constellation Energy and Glacial Energy. The objective of which was to get an overall idea of whether or not switching electric energy suppliers is an avenue that the School District should pursue further to obtain electrical energy cost savings.

The School District has already pursued this avenue with natural gas, as PSE&G is the overall distributor for the area and Hess Corporation is the third party supplier.

CDM received a proposal from Glacial Energy for six of the seven electric service connections, one (1) for the elementary school, two (2) for the middle school and two (2) for the high school. This proposal is included in Appendix F. Glacial Energy did not include the electrical service for the Olcott Building, as the addition of their transmission charges would result in unattractive aggregate costs per kWH. In general, third party electrical energy suppliers have indicated that cost effectiveness exists on the services providing more than 150,000 kWHs per year.

The following five (5) services fall within this ‘cost effective’ range:

Bedwell Elementary School

- Account #080147194300000591005

Bernardsville Middle School

- Account # 080147194300000591001
- Account #0801471943000006348250

Bernards High School

- Account #080147194300000006977

- Account #080147194300006356092

Glacial Energy has proposed a retail rate of $0.08925/kWH for a 12 month period, as opposed to the estimated average rate from JCP&L for the next 12 months of $0.11797. Both the proposed rate from Glacial Energy and the retail rate used in this analysis from JCP&L include electric generation charges and sales and use tax. These rates represent the baseline generation rates from the two suppliers and do not include any applicable demand charges, societal benefits charges, transmission charges, energy charges, reconciliation charges, transitional assessment charges or system control charges that were included in the aggregate rates presented in Section 3. These baseline generation rates, are used for comparison purposes to identify any potential cost savings, as all other applicable charges cannot be avoided by switching suppliers.

The following table, Table 5.1.1-1, summarizes the cost savings available over the 12 month period based on historical energy consumption rates.

Table 5.1.1-1: Potential Energy Cost Savings with an Alternate Third Party Supplier – Glacial Energy

Combination of Six Services	Historical Monthly Average Consumption (kWH)	Cost with JCP&L ($0.11797/kWH)	Proposed Cost with Glacial Energy ($0.08925/kWH)	Potential Savings
January	398,030	$46,955	$35,524	$11,431
February	400,800	$47,282	$35,771	$11,511
March	349,050	$41,177	$31,152	$10,025
April	363,240	$42,851	$32,419	$10,432
May	394,830	$46,578	$35,238	$11,340
June	349,320	$41,209	$31,176	$10,033
July	365,200	$43,082	$32,594	$10,488
August	280,260	$33,062	$25,013	$8,049
September	463,500	$54,679	$41,367	$13,312
October	410,500	$48,427	$36,637	$11,790

Combination of Six Services	Historical Monthly Average Consumption (kWH)	Cost with JCP&L ($0.11797/kWH)	Proposed Cost with Glacial Energy ($0.08925/kWH)	Potential Savings
November	384,000	$45,300	$34,272	$11,028
December	358,000	$42,233	$34,361	$7,872
			Total Potential Annual Savings:	**$127,311**

As energy cost savings are available by switching to a third party supplier, such as Glacial Energy, for the six electrical services at the elementary school, middle school and high school, this is a recommended energy cost savings measure. The estimated annual cost savings available, provided by Glacial Energy is $133,067 (Appendix F), which was based on 2008 energy consumption. This value has been confirmed utilizing the average total energy consumption over the past year years, as shown in Table 5.1.1-1, with a total potential energy savings of $127,311. CDM recommends that the Somerset Board of Education investigate this opportunity further and compare proposals from alternate third party suppliers to obtain the lowest electrical energy rates available.

Section 6
Ranking of Energy Conservation and Retrofit Measures (ECRM)

6.1 ECRMs

The main objective of this energy audit is to identify potential Energy Conservation and Retrofit Measures and to determine whether or not the identified ECRM's are economically feasible to warrant the cost for planning and implementation of each measure. Economic feasibility of each identified measure was evaluated through a simple payback analysis. The simple payback analysis consists of establishing the Engineer's Opinion of Probable Construction Cost estimates, O&M cost savings estimates, projected annual energy savings estimates and the potential value of New Jersey Clean Energy rebates or Renewable Energy Credits, if applicable. The simple payback period is then determined as the amount of time (years) until the energy savings associated with each measure amounts to the capital investment cost.

As discussed is Section 3, aggregate unit costs for electrical energy delivery and usage and natural gas delivery and usage, which accounts for all demand and tariff charges at each facility, was determined and utilized in the simple payback analyses.

In general, ECRMs having a payback period of 20 years or less have been recommended and only those recommended ECRMs within Section 4 of the report have been ranked for possible implementation. The most attractive rankings are those with the lowest simple payback period.

Ranking of ECRMs has been broken down into the following categories:

- Lighting Systems
- HVAC Systems
- Solar Energy

6.1.1 Lighting Systems

Table 6.1-1 includes rankings of all recommended ECRMs to provide energy savings for all building lighting systems, which include the installation of energy-efficient lighting retrofit kits, electronic ballasts, reflectors, energy-efficient luminaires and occupancy sensors. A detailed discussion on building lighting systems is presented in Section 4.1.

Table 6.1-1
Ranking of Energy Savings Measures Summary – Lighting System Retrofits

Site	Retrofit Cost	Incentives	Total Cost	Annual Fiscal Savings	Simple Payback (Years)
Olcott Building	$25,156	$4,950	$20,206	$7,921	**2.5**
Bernardsville Middle School	$60,850	$12,850	$48,000	$18,185	**2.6**
Bernards High School	$80,125	$15,545	$64,580	$24,664	**2.6**
Bedwell Elementary School	$44,577	$8,315	$36,262	$11,467	**3.2**
Equipment and Labor Totals	**$210,708**	**-$41,660**		**$62,237**	
		PROJECT TOTAL	***$169,048***		

6.1.2 HVAC Systems

Table 6.1-2 includes rankings of all recommended ECRMs to provide energy savings for building HVAC systems, which provide a simple payback of less than 20 years. A detailed discussion on building HVAC systems is presented in Section 4.2.

Table 6.1-2
Ranking of Energy Savings Measures Summary – HVAC System Upgrades

Building & Measure	Retrofit Cost	Incentives	Total Cost	Annual Fiscal Savings	Simple Payback (Years)
Olcott Building – Reflective Insulation Board	$7,965	-	$7,965	$1,421	**5.6**
Bernards High School – H&V Unit Control Change	$2,094	-	$2,094	$322	**6.5**
Bedwell Elementary – Boiler Upgrade	$229,000	$8,000	$221,000	$21,304	**10.4**
Olcott Building – Zone Restructure	$17,965	-	$17,965	$1,224	**14.7**
Bernardsville Middle – Boiler Upgrade	$171,422	$6,000	$165,422	$10,428	**15.9**
Equipment and Labor Totals	**$428,446**	**-$14,000**		**$34,699**	
		PROJECT TOTAL	***$414,446***		

6.1.3 Solar Energy

Implementation of a new solar energy system has been evaluated to determine the economic feasibility for furnishing and installing such systems for the Somerset Hills School District buildings. Based on the simple payback modeling performed, it would benefit the District to further investigate installing the solar energy systems at the Bedwell Elementary School and the Bernards High School. This is primarily based on the initial upfront capital investment required for a solar energy system installation and an acceptable payback period.

Two major factors influencing the project financial evaluation is the variance of the prevailing energy market conditions and Solar Renewable Energy Credit (SREC) rates, with the largest impact to the simple payback model being the SREC credit pricing.

Table 6.1-3, includes a ranking of the solar energy ECRMs for the elementary and high schools.

Table 6.1-3

Ranking of Energy Savings Measures – Solar Energy

Building	Installation Cost	Annual SREC Credit	Annual Fiscal Savings	Payback Period (Years)
Bedwell Elementary School	$702,000	$72,285	$28,047	**7**
Bernards High School	$1,321,800	$38,711	$13,181	**25**
Equipment and Labor Totals	**$2,023,800**	**$110,996**	**$41,228**	

It should be noted that Federal and other tax incentives were not included in this simple payback model. Refer to Appendix D for more detailed solar energy models.

Section 7
Available Grants, Incentives and Funding Sources

7.1 Solar Energy Incentives and Financial Options

7.1.1 Solar Renewable Energy Certificates

As part of New Jersey's Renewable Portfolio Standards (RPS), electric suppliers are required to have an annually-increasing percentage of their retail sales generated by solar energy. Electric suppliers fulfill this obligation by purchasing SRECs from the owners of solar generating systems. One SREC is created for every 1,000 kWh (1 MWh) of solar electricity generated. Although solar systems generate electricity and SRECs in tandem, the two are independent commodities and sold separately. The RPS, and creation of SRECs, is intended to provide additional revenue flow and financial support for solar projects in New Jersey.

We have assumed what we believe to be a conservative estimate of the market value of SRECs over a 15 year period. Over the first 5 years, we have assumed that the SREC value would be at 80% of the NJBPU market forecast. For years 6 through 9, we have assumed that the SREC value would be at 75% of the NJBPU market forecast. Finally, for the balance of the term, we have assumed that the SREC value would be at a floor of $350 per SREC. We believe these values to be conservative compared to recent market transactions. We know of recent transactions in excess of $650 for 1 year, $550 for 4 years and $375 for 12 years. Should the winning developer have contracts in place, or a view of the market that SRECs will exceed our assumptions; the economics of the project will improve.

In addition, State law now requires that the utility must interconnect and net meter your photovoltaic system provided your system passes the local electrical inspection (National Electric Code) and meets the utility safety requirements as outlined in the law. Net metering is the term given which allows your utility meter to literally "spin backward" when the solar panels are producing more electricity than the building is using. However, given the high electrical demand of the facility at most times, this scenario is unlikely to happen.

7.1.2 Financing Options for Solar Projects

1. Direct Purchase by SHSD – under this model, SHSD would fund the project directly, and receive all of the financial benefits of a PV system directly.

2. Power Purchase Agreement (PPA) – under this model, a private, third party would invest all of the capital necessary to build, own, operate, and maintain the PV system. The third party would claim all of the financial benefits of the project, including federal tax incentives and accelerated depreciation benefits that public sector entities are not entitled to. SHSD would enter into a 15 or 20 year agreement to purchase power from the PV system at a rate guaranteed to be less

than the cost of power from the utility. It should be noted that most PPAs require a minimum system size of approximately 300 kW on one building, so SHSD may not qualify for a PPA unless the system size can be increased.

Additional Potential Financial Incentives:

Debt Service Aid - Based on the Education Facilities Construction and Financing Act signed into law in 2000, New Jersey Boards of Education are eligible for 40% debt service aid for eligible improvements to school facilities. It is anticipated that the installation of solar photovoltaic panels will be considered eligible improvements. Under this scenario the SHSD would be required to go to referendum for voter approval to gain access to debt service aid.

Clean Renewable Energy Bonds – The federal government made available $750 Million in federal income tax credit allotments in 2007-08 for local governments to support the installation of green energy generation systems including solar photovoltaic. Such allotments may provide for an interest- free loan for the issuer. The recent energy bill for 2008-09 did not include any provisions for this energy bond. However, industry experts expect some allotments will be included prior to execution of the final plan. Although there is no guarantee that SHSD will be awarded such allotments, we have included the calculation for illustration purposes. If the program is approved for 2008-09 an application will be submitted on behalf of the Somerset Hills Board of Education

7.2 New Jersey Clean Energy Program

7.2.1 Introduction

New Jersey's Clean Energy Program (N JCEP) promotes increased energy efficiency and the use of clean, renewable sources of energy including solar, wind, geothermal, and sustainable biomass. The results for New Jersey are a stronger economy, less pollution, lower costs, and reduced demand for electricity. NJCEP offers financial incentives, programs, and services for residential, commercial, and municipal customers.

NJCEP reduces the need to generate electricity and burn natural gas which eliminates the pollution that would have been caused by such electric generation or natural gas usage. The benefits of these programs continue for the life of the measures installed, which on average is about 15 years. Thus, the public receives substantial environmental and public health benefits from programs that also lower energy bills and benefit the economy.

7.2.2 New Jersey Smart Start Program

The New Jersey Smart Start Program offers rebate incentives for several qualifying equipment such as high efficient premium motors and lighting, and lighting controls.

Incentive information and incentive calculation worksheets are provided for the various new equipment installation identified in this report and are included in Appendix G.