Revised Draft Energy Audit Report

Newark Board of Education
July 15, 2013

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July 15, 2013

Mr. Rodney L. Williams
Facility Manager
Newark Public Schools
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Subject: Newark Board of Education
Energy Audit
Draft Report

Dear Mr. Williams:

Please find attached an electronic PDF copy of our revised draft energy audit report for the Newark Public Schools.

An electronic copy of this report has also been provided to TRC for their comment and review.

Should you have any questions or comment, kindly give me a call.

Very truly yours,

Matthew T. G

Matthew T. Goss, P.E., C.E.M., C.E.A., LEED® AP
Senior Project Manager
CDM Smith Inc.

cc: Christopher Korzenko – CDM Smith

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Executive Summary

Newark Board of Education (BOE) has secured the services of CDM Smith to perform an energy audit for six (6) facilities. This audit is part of an initiative to reduce energy cost and consumption of facilities owned and operated by the Board. The recommendations from this audit will be used to develop comprehensive Energy Conservation and Retrofit Measures (ECRMs).

CDM Smith's energy audit team visited the facilities on March 25th-27th, 2013. This site visit and an evaluation of historical energy usage of the facilities were useful in identifying opportunities for energy savings measures.

CDM Smith also evaluated the potential for renewable energy technologies to be implemented at the Newark BOE's facilities. To offset the electrical energy usage solar electric photovoltaic panels and ground source heat pumps were investigated. Additionally, there is potential for the Newark BOE to offset capital by participation in a Demand Response Program, as discussed in Section 5.2.

Not all ECRMs identified as a result of the energy audit are recommended. ECRMs must be economically feasible to be recommended to the Newark BOE for implementation. The feasibility of each ECRM was measured through a simple payback analysis. The simple payback period was determined using Engineer's Opinion of Probable Construction Cost estimates, and Operation and Maintenance (O&M) cost estimates to develop capital costs. Projected annual energy savings, and the potential value of New Jersey Clean Energy rebates, or applicable Renewable Energy Credits were used to determine savings. ECRMs with a payback period of 20 years or less can be recommended.

Historical Energy Usage

The following table, Table ES-1, summarizes the historical energy usage at each of the Newark BOE's facilities as presented in Section 3. The data in Table ES-1 has been taken from the facility data forms, provided by the Newark BOE. These values can serve as a bench-marking tool. Building profiles have been established through the EPA's Portfolio Manager Program. The Profiles quantify the reduction in electrical energy and natural gas usage following the implementation of the recommended ECRMs.

Table ES-1
Summary of Annual Energy Usage & Cost

Facility	Electrical Energy Use (kWh)	Fuel Use for Entire Building (therms)	Cost for Electric Service	Cost for Fuel
Arts High School	1,225,084	135,962	$183,763	$122,366
Barringer High School	1,389,847	109,838	$194,579	$95,559
George Washington Carver	1,032,000	122,524	$102,200	$117,623
Malcolm X Shabazz	2,182,647	145,068	$327,397	$134,913

Table ES-1 (Continued)
Summary of Annual Energy Usage & Cost

Facility	Electrical Energy Use (kWh)	Fuel Use for Entire Building (therms)	Cost for Electric Service	Cost for Fuel
Technology High School	1,084,800	92,173	$119,328	$86,260
Weequahic High School	837,408	184,083	$133,985	$173,038

Recommended ECRMs

The following Table ES-2 presents the ranking of recommended ECRMs identified for the building lighting and HVAC systems based on the simple payback analysis.

Additional ECRMs associated with the building envelope and other miscellaneous appliances were identified and evaluated, as discussed in Sections 2 and 4. However these ECRMs were not recommended due to longer payback periods. This table includes the Engineer's Opinion of Probable Construction Cost as the total 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[1]
Ranking of Recommended Energy Savings Measures Summary

Overall Ranking (Based on Simple Payback)	Facility Measure	Total Cost	Energy Savings	Annual Maintenance Savings	Annual Fiscal Savings2	Simple Payback (Years)
1	**All Schools** **VendingMiser**	$2,091	-300 therms 17,552 kWh	$0	$2,090	1.0
2	Arts High School **Condensing DHW**	$36,067	-5,654 therms 149,100 kWh	0	$17,321	2.1
3	Arts High School **Premium Efficiency Motors**	$5,960	0 therms 11,692 kWh	0	$1,765	3.2
4	Barringer High School **Premium Efficiency Motors**	$5,355	0 therms 9,277 kWh	0	$1,299	3.8
5	Malcolm X Shabazz High School **Lighting Upgrades**	$128,139	0 kWh 173,856 kWh	$3,903	$25,539	4.4
6	Weequahic High School **Lighting Upgrades**	$60,883	0 kWh 53,332 kWh	$1,021	$8,661	6.3
7	Arts High School **DDC Contols**	$172,163	20,775 therms 45,405 kWh	0	$25,903	6.6
8	Arts High School **Lighting Upgrades**	$104,685	0 kWh 96,417 kWh	$1,098	$14,553	6.7

Table ES-2[1] (Continued)

Ranking of Recommended Energy Savings Measures Summary

Overall Ranking (Based on Simple Payback)	Facility Measure	Total Cost	Energy Savings	Annual Maintenance Savings	Annual Fiscal Savings2	Simple Payback (Years)
9	Arts High School **Condensing Boiler**	$264,428	34,700 therms 0 kWh	$4,500	$31,818	8.1
10	Malcom X Shabazz **Premium Efficiency Motors**	$5,505	0 therms 4,069 kWh	0	$610	8.3
11	Weequahic High School **DDC Contols**	$220,995	24,450 therms 24,285 kWh	0	$25,987	8.5
12	Technology High School **Lighting Upgrades**	$44,206	0 kWh 34,283 kWh	$146	$4,946	8.7
13	Barringer High School **Lighting Upgrades**	$89,169	0 kWh 67,389 kWh	$752	$9,217	8.9
14	Malcom X Shabazz **Condensing Boiler**	$196,571	20,700 therms 0 kWh	3000	$19,199	10.0
15	George Washington Carver **Lighting Upgrades**	$63,861	0 kWh 40,970 kWh	$188	$5,933	10.4
16	Arts High School **Steam Boiler**	$293,631	28,500 therms 0 kWh	0	$26,133	10.9
17	Technology High School **DDC Contols**	$172,163	9,465 therms 47,340 kWh	0	$15,776	10.9
18	Malcom X Shabazz **DDC Contols**	$316,828	14,700 therms 58,935 kWh	0	$22,291	14.2
19	Barringer High School **DDC Contols**	$296,708	19,710 therms 34,680 kWh	0	$19,669	15.1
20	George Washington Carver **Condensing Boiler**	$258,958	17,389 therms 0 kWh	$4,500	$16,623	15.2
21	Weequahic High School **Steam Boiler**	$293,631	19,400 therms 0 kWh	0	$17,490	16.3
22	Technology High School **Condensing Boiler**	$258,958	15,252 therms 0 kWh	$4,500	$14,415	17.5
23	Barringer High School **Condensing Boiler**	$275,836	18,000 therms 0 kWh	$4,500	$13,631	19.8
24	George Washington Carver **DDC Contols**	$210,384	5,325 therms 28,845 kWh	0	$9,267	22.7

Table ES-2[1] (Continued)
Ranking of Recommended Energy Savings Measures Summary

Overall Ranking (Based on Simple Payback)	Facility Measure	Total Cost	Energy Savings	Annual Maintenance Savings	Annual Fiscal Savings2	Simple Payback (Years)
25	Technology High School **Premium Efficiency Motors**	$1,715	0 therms 608 kWh	0	$67	23.6
26	Weequahic High School **Condensing DHW**	$20,000	710 therms 0 kWh	0	$640	31.2
27	George Washington Carver **Condensing DHW**	$34,960	823 therms 0 kWh	0	$787	44.4
28	Barringer High School **Condensing DHW**	$34,960	920 therms 0 kWh	0	$697	50.2
29	Malcom X Shabazz **Condensing DHW**	$58,105	970 therms 0 kWh	0	$900	64.6
30	Technology High School **Condensing DHW**	$34,960	314 therms 0 kWh	0	$297	117.8

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

Renewable Energy Technologies

Solar Energy

Section 4 of the report provides for an economic evaluation of a solar energy system recommended to be installed at several of the Board's facilities. The evaluation covered the economic feasibility of the Board installing a solar energy system under a typical construction contract and to assume full responsibility of the operation of such a system.

Based on a simple payback model, summarized in Table ES-3, it would not benefit the Board to further investigate the installation of a solar energy system at five buildings. This is primarily based on the initial upfront capital investment required for a solar energy system installation and the 36 year payback period. Other options such as Power Purchase Agreements are potentially available as well to help finance the project.

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. For the payback model, conservative estimates of the SREC's market value over the preceding six months, as discussed in Section 4.

Table ES-3 includes a simple payback analysis for the installation of a solar energy system at the identified Board buildings.

Table ES-3
Simple Payback Analysis for Solar Energy Systems

Solar Energy Systems Summary	
Estimated Budgetary Project Cost	$19,679,800
1st Year Production	1,842,811 kWh
Annual Electric Savings	$183,615
Annual Estimated SREC Revenue	$368,562
Maintenance Costs	($36,856)
Project Simple Payback	**36 Years**

Power Generation Technologies

Combined Heat and Power

Section 4 of the report provides for an economic evaluation of a combined heat and power system such as a micro turbine. Below is a screening of combined heat and power with the most current utility pricing for each school. Further investigation is recommended to resolve installation and control issues.

Facility Measure	Total Cost	Energy Savings	Incentive	Annual Fiscal Savings[2]	Simple Payback (Years)
Arts High School	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$14,820	**6.8**
Barringer High School	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$16,650	**6.0**
Malcom X Shabazz	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$11,681	**8.6**
George Washington Carver	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$13,302	**7.5**
Technology High School	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$11,924	**8.4**
Weequahic High School	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$18,595	**5.4**

Recommended ECRMs

Table ES-4 summarizes the Total Engineer's Opinion of Probable Construction Cost, annual energy savings, projected annual energy and O&M cost savings and the payback period based on the implementation of all of the above recommended ECRMs.

Table ES-4

Recommended ECRM's[1]

Total Engineer's Opinion of Probable Construction Cost	Projected Annual Energy Savings	Projected Annual Fiscal Savings	Simple Payback Period (years)
$4,819,875	27,950 Therms 2,582,834 kWh*	$28,108 Maint $440,195 Energy	10.9

1. *Does not include energy savings associated with Solar Energy System or Wind Power Generation.

Section 1

Introduction

1.1 General

As part of an initiative to reduce energy cost and consumption, Newark BOE has secured the services of CDM Smith to perform an energy audit. This audit includes 6 facilities in an effort to develop comprehensive energy conservation initiatives.

The performance of an Energy Audit requires a coordinated phased approach. This approach identifies, evaluates and recommends 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 and evaluate renewable/distributed energy measures;
- Develop the energy audit report.

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

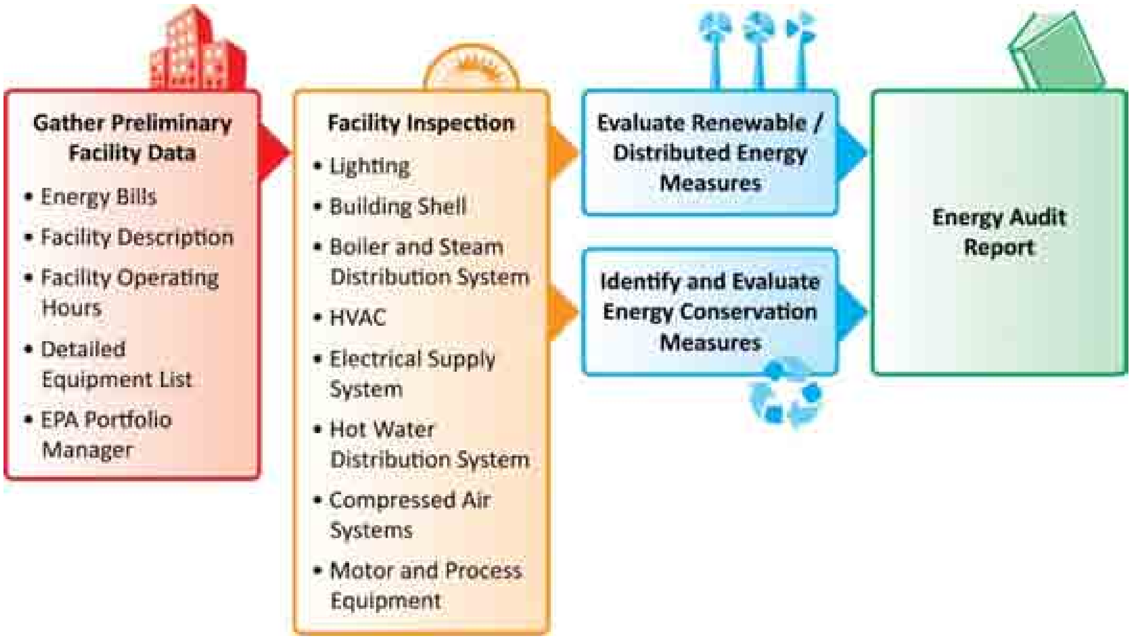


Figure 1-1: Energy Audit Phases

1.2 Background

The facilities that were included in the energy audit for the Newark BOE were Arts High School, Barringer High School, George Washington Carver, Malcolm X Shabazz, Technology High School, and Weequahic High School.

The Arts High School was constructed in the 1931/1996. The floor area is approximately 172,163 square feet. It is normally occupied during from from 7am to 11pm by 638 occupants.

The Barringer High School was constructed in 1962. Floor area is approximately 296,708 square feet. It is normally occupied during from 7am to 11pm by 1498 occupants.

The George Washington Carver was constructed in 1972. Floor area is approximately 210,384 square feet. It is normally occupied during from 7am to 4 pm by 509 occupants.

The Malcolm X Shabazz was constructed in 1913/1976. Floor area is approximately 316,828 square feet. It is normally occupied from 7am to 11pm by 831 students.

The Technology High School was constructed around 1912/1974. Floor area is approximately 172,163 square feet. It is normally occupied during 7am to 5pm by 534 occupants.

The Weequahic High School was constructed in 1935/1958/2010. Floor area is approximately 220,995 square feet. It is normally occupied from 7am to 11pm by 695 occupants.

1.3 Purpose and Scope

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

Significant energy savings may be available with retrofits to the heating and cooling systems and lighting systems. The magnitude of energy savings available is not only dependent on the type of heating, lighting or insulation systems in use. Available energy savings also depend on the age and condition of the equipment and the capital available for major changes. Due to the rising cost of power and the desire to minimize dependence on foreign oil supplies, energy consumption is taking a higher priority,nationally. Feasible alternatives for reducing energy consumption and operating costs must be evaluated on a case-by-case basis.

The purpose of this energy audit is to identify the various critical building comfort systems that are major consumers of electrical and thermal energy. These systems are clear candidates for energy savings measures. Potential energy producing systems such as solar electric and wind energy systems were also evaluated. Energy reclaim and reuse systems such as ground source heat pumps were evaluated. A discussion on these technologies is included in Section 4 Energy Conservation and Retrofit Measures (ECRM).

In addition to identifying ECRMs, the potential for on-site energy generation was evaluated. There is potential for further energy cost savings through the use of a third party energy supplier and participation in a Demand Response Program. This is discussed further in Section 5.

Section 2

Facility Description

2.1 Arts High School

2.1.1 Description of Building Envelope

The energy audit includes an evaluation of the building's envelope (exterior shell) to determine the components' effective thermal resistance, or R-values; These values are 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, windows, foundation and roof. The construction, material, age and general condition of these components, including exterior windows and doors, impact the building's energy use.

The building has 2 distinctive constructions. The original building is solid brick. The roof type is flat a with built up roofing membrane. Some of the interior surfaces are plaster on wire mesh. Walls and roof are presumed to have no insulation.

The addition has a steel structure. The exterior wall covering is stucco and brick. The roof construction type is a sloped standing seam metal portions surrounding flat roof with bitumen membrane surface.

2.1.2 Description of Building HVAC

The building heating system is supplied by 2 steam boilers. The boilers are Cleaver Brooks, CB657-500, are rated at 20,922 MBH input from 1971. The original building heats the space with steam radiators and unit ventilators. The new building is heated by hot water unit ventilators and air handlers with hot water coils. The hot water is generated by a steam to hot water heat exchanger located in the mechanical room. The hot water system had symptoms of air in the system. The original building is cooled by window air conditioners. The new building is cooled by two air cooled chillers which circulate chilled water through air handlers.

The building is controlled by local thermostats for the unit heaters. The window air conditioners are unit mounted-controls. The building has pneumatic controls with DDC monitoring. Steam radiators have had actuators removed. The unit controls do not appear to be capable of temperature set back . The controls do not appear to close the unit ventilator outdoor air dampers during the unoccupied hours.

Domestic hot water for the original building is generated by an AO Smith, electric, storage water heater with 500 gallons of storage and 480 kW input capacity. The addition has a 350 gallon of storage capacity and 330 kW input capacity. The units are 1992 models and in good condition.

Kitchen has commercial refrigeration with heat rejection to the space. The kitchen cooking equipment is mostly gas fired.

2.1.3 Description of Building Lighting

This facility's existing interior lighting system consists of 1X4 (1, 2 lamp), 2X4 (2, and 4 lamp) T8 linear fluorescent fixtures with electronic ballasts, and compact fluorescent fixtures. The building has no occupancy sensing controls. Refer to Section 4 for a more detailed description.

2.2 Barringer High School

2.2.1 Description of Building Envelope

The building is concrete and steel framed with masonry infill and brick exterior finish. The building roof flat with bitumen roll surface. The roof has a large solar array. The windows are single and double pane with aluminum frames. The windows are operable. The building is presumed to be insulated at R-19 for the roof.

2.2.2 Description of Building HVAC

The building is heated by a central boiler plant. The plant is comprised of 4 natural gas-fired, hot water boilers. Each boiler is a Pacific P242A-7 rated at 8860 MBH input each. The boilers appear to be converted from steam. One remaining steam boiler is a Pacific P103A-5 rated at 3770 MBH input. The steam boiler was not connected to a fuel at the time of the site visit and is assumed to be abandoned in place.

The heating hot water is circulated through unit ventilators in the classrooms and hot water coils in air handlers. At least one zone of the hot water system had excessive water velocity. The hot water zoning and pumping should be reviewed. The unit ventilators are controlled by local pneumatic thermostats.

The building is cooled by window air conditioners, and a few split systems. The largest split system is a Trane M Series for cooling the cafeteria kitchen which is at least 10 tons of cooling capacity. The remaining air conditioning systems are packaged units and split systems with less than 5 tons of cooling capacity.

The building spaces are controlled by pneumatic controls. The large air handlers in the building have some pneumatic to electric converters. The classrooms have pneumatic thermostats. The classrooms and perimeter radiators do not apperar to have a space temperature set back or unoccupied outdoor air reduction. The controls are fed by a Furnas 80 gallon storage. The building has at 2 natural gas fired water heaters. These units are AO Smith BTR365A118, with 365 MBH input capacity and 85 gallons of storage.

The building has commercial refrigeration equipment in the in the kitchen and cafeteria. These units reject heat to their respective spaces. Kitchen cooking equipment is mostly gas fired.

2.2.3 Description of Building Lighting

This facility's existing interior lighting system consists of 1X4 (1, 2 lamp), 2X2 (2 lamp), 2X4 (2, and 4 lamp) T8 linear fluorescent fixtures with electronic ballasts, and compact fluorescent fixtures. The building has no occupancy sensing controls. Refer to Section 4 for a more detailed description.

2.3 George Washington Carver

2.3.1 Description of Building Envelope

The building has a steel structure with concrete block walls. The exterior wall surfaces are brick. The interior surface is painted block. The roof is flat with a bitumen roll surface and light stone ballast. The exterior walls are presumed to be insulated to R-11 and the roof is presumed to be insulated to R-19.

2.3.3 Description of Building HVAC

The building is heated by a central boiler plant. The plant is comprised of 2 natural gas fired, hot water boilers. Each boiler is a Cleaver Brooks CB-600-400 rated at 16,738 MBH input each. The boilers appear to be converted from steam.

The heating hot water is circulated through unit ventilators in the classrooms and hot water coils in air handlers. The building has pneumatic controls. The unit ventilators and air handlers are controlled by local thermostats. The pneumatic control panel has set back capability installed. The pneumatic panel did not appear to be operational at the time of the site visit. Newer air handlers and air conditioners have electronic controls.

The building is cooled by window air conditioners, and a few split systems. These air conditioning systems are packaged units or split systems with less than 5 tons of cooling capacity. There are packaged rooftop units for the auditorium that were not operational at the time of the site visit. The cafeteria has 2 air handlers with direct expansion (dx) cooling coils with roof top air cooled condensers.

The building has at 2 natural gas fired water heaters. Each of these units are AO Smith BTR365A118, with 365 MBH input capacity and 85 gallons of storage.

The building has commercial refrigeration equipment in the in the kitchen and cafeteria. These units reject heat to their respective space. Kitchen cooking equipment is all electric.

2.3.3 Description of Building Lighting

This facility's existing interior lighting system consists of 1X4 (1, 2 lamp), 2X2 (2 lamp), 2X4 (2, and 4 lamp) T8 linear fluorescent fixtures with electronic ballasts, T5 (4 lamp) linear fluorescent fixtures with electronic ballasts, incandescent, and compact fluorescent fixtures. The building has no occupancy sensing controls. Refer to Section 4 for a more detailed description.

2.4 Malcolm X Shabazz

2.4.1 Description of Building Envelope

The building has 2 distinctive constructions. The original building is brick exterior with plaster interior finish. The addition has concrete block walls with brick façade. The walls are assumed to have R-8 insulation. The building has a flat roof. The roof is assumed to have R-19 insulation.

The building has double pane, aluminum frame windows. The new building has single pane windows in the hallways and courtyards. The building doors are typically full glass, double pane, aluminum frame.

2.4.2 Description of Building HVAC

The building heating system is supplied by 3 natural gas fired steam boilers. The boiler are Superior 7531 fire tube boilers rated at 12,000 lbs per hour from 1974. The original building heats the space with steam radiators and a few unit ventilators. The new building is heated by hot water unit ventilators and air handlers with hot water coils. The hot water is generated by a steam to hot water heat exchanger located in the mechanical room. The building is cooled by window air conditioners. The addition also has rooftop units to cool the gymnasium. The new building has propriatary electronic controls for the unit ventilators and air handlers. The classrooms also have a thermostatic radiator valve for passive convectors.

The original building is controlled by thermostatic radiator valves. The addition has local thermostats for the unit ventilators. The window air conditioners have unit mounted-controls. The building has pneumatic controls with DDC monitoring.

Domestic hot water is generated by a pair of Raypak, H3-2500, gas fired, domestic water boiler rated at 2,499 MBH input capacity. These units are serving the entire building. At the time of the site visit the entire of building was served by one boiler. There is also a 40 gallon storage water heater with a 3.5 kW input.

Kitchen has commercial refrigeration with heat rejection to the space. The kitchen cooking equipment has electric heat.

2.4.3 Description of Building Lighting

This facility's existing interior lighting system consists of 1X4 (1, 2 lamp), 2X2 (2 lamp), 2X4 (2, and 4 lamp) T8 linear fluorescent fixtures with electronic ballasts, 1X4 (2 lamp) T12 linear fluorescent fixtures with magnetic ballasts, high bay metal halide, incandescent, and compact fluorescent fixtures. The building has no occupancy sensing controls. Refer to Section 4 for a more detailed description.

2.5 Technology High School

2.5.1 Description of Building Envelope

The building is brick façade with plaster interior. The building has an addition. The addition has structural steel with drywall interior and exterior brick façade. The walls of the addition are assumed to be insulated to R-11. The roof is a flat roof with bitumen rolls on the addition. The original building has a flat roof construction with built up membrane.

The original building has double pane windows with aluminum frames. The addition has a mix of single pane and double pane aluminum frame units.

2.5.2 Description of Building HVAC

The building heating system is supplied by three natural gas fired hot water boilers. Each boiler is a Cleaver Brooks CBI-200 200 015 rated at 8,165 MBH input each. The hot water boilers circulate hot water through cast iron radiators in the original building. The radiators are controlled by either pneumatic thermostats or self-powered thermostatic radiator valves. The addition is heated and cooled by rooftop units with packaged direct expansion, or dx, cooling and hot water heating coils. The local zones have thermostats that control local zone reheats. The third floor of the addition was under construction during the site visit.

The original building is cooled by window units. The addition is cooled by air cooled rooftop units. The majority of the addition is cooled. About half of the original building classrooms have window air conditioners.

The building has 3 gas-fired, domestic water heaters. Two of the units are AO Smith, HW670 932, water heaters and each rated at 660 MBH input capacity. The remaining unit is an AO Smith BTR 199 118 with 81 gallons of storage and 199 MBH input capacity. The kitchen equipment is gas heated.

2.5.3 Description of Building Lighting

This facility's existing interior lighting system consists of 1X4 (1, 2 lamp), 2X2 (2 lamp), 2X4 (2, 3, and 4 lamp) T8 linear fluorescent fixtures with electronic ballasts, T5 (4 lamp) linear fluorescent fixtures with electronic ballasts, incandescent, and compact fluorescent fixtures. The building has no occupancy sensing controls. Refer to Section 4 for a more detailed description.

2.6 Weequahic High School

2.6.1 Description of Building Envelope

The building is brick façade with plaster and painted brick interior finish. The building also has steel and concrete structural system. The building roof is flat with bitumen roll surface. The building does not appear to have any insulation.

The building has an addition which consists of a gymnasium and associated spaces. The building has a steel structure with block walls. The roof is flat with bitumen roll surface. The roof and walls are assumed to have insulation. The roof is assume to be insulated to R-19 and the walls insulated to R-11. The windows are aluminum framed double pane windows.

2.6.2 Description of Building HVAC

The original building is heated by two natural gas fired steam boilers. Each boiler is a Eastman EAP225 rated at 7,538 MBH input each. The boilers supply heat to cast iron radiators in the original building. The radiators are controlled by either pneumatic thermostats or self-powered thermostatic radiator valves. There is a multizone with a dx split system cooling that serves the music room.

The addition is heated and cooled by rooftop units with packaged direct expansion, or dx, cooling and natural gas fired heating. The local zones have thermostats that control local electric reheat coils.

The original building is cooled by window units. The addition is cooled by air cooled rooftop units. The majority of the addition is cooled. About half of the original building classrooms have window air conditioners.

The building has a gas-fired, domestic water heater in the boiler room. The unit is AO Smith, BTR 365 118 with 120 gallons of storage and 365 MBH input capacity. The trainer room also has a Rheem 61V40D, storage water heater, with 40 gallons of storage and 4.5 kW input capacity. The kitchen equipment is electric heated.

2.6.3 Description of Building Lighting

This facility's existing interior lighting system consists of 1X4 (1, 2 lamp), 2X2 (2 lamp), 2X4 (2, 3, and 4 lamp) T8 linear fluorescent fixtures with electronic ballasts, T5 (4 lamp) linear fluorescent fixtures with electronic ballasts, incandescent, and compact fluorescent fixtures. The building has existing occupancy sensing in controls in several rooms in the school. Refer to Section 4 for a more detailed description.

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 facility's current and historical energy usage and associated utility costs. It is important to establish existing patterns of electricity and gas usage in order to be able to identify areas in which energy consumption can be reduced.

For this study, the monthly gas and electric bills for each facility were analyzed and unit costs of energy were obtained. The unit cost of energy, as determined from the information provided by the Board. These unit costs were utilized to determine the feasibility of switching from one energy source to another. The unit costs were also used to determine the feasibility of demand reduction of a particular source of energy. The unit costs were used to determine annual cost savings for the Board.

3.1.1 Electric Charges

It is 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. This equipment may include kitchen appliances, computers, printers and projectors. 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 and the monthly consumption appears on the utility bill as kWh consumed per month with a cost figure associated with it. The electrical consumption is billed on a flat rate or time of day rates per kWh, based on total usage per billing period. A monthly service charge is usually included for the utility connection. This rate is often based on the ownership of the substation transformation.

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. Fortunately, this penalty charge does not impact the Board.

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.

Public Service Electric & Gas is the current supplier and distributor of electric energy for Arts, Barringer, George Washington Carver, Malcom X Shabazz, Technology and Weequahic High School. The electrical supplier for Arts High School is South Jersey Energy for a portion of the billing submitted.

3.1.2 Natural Gas Charges

PSE&G is the current supplier is the current supplier and distributor of natural gas for Arts, Barringer, George Washington Carver, Malcolm X Shabazz, Technology, and Weequahic High School.

3.2 Facility Results

3.2.1 Arts High School

Electric power for Arts High School is supplied and delivered from one General Service Secondary three phase line from PSE&G. Figure 3.2-1 illustrates the average monthly total energy consumption from January, 2011 through December, 2012. For example, for the month of February, the bar graph represents average energy consumption for February 2011 and 2012. This same graphical 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 above referenced time period to portray a more encompassing monthly usage trend.

From this graph, it can be determined that the baseline electrical consumption for Arts High School is approximately 106,273 kWh/month.

Table 3.2-1 illustrates the monthly electrical usage loads for the Arts High School from January, 2011 through December, 2012. The information presented is only as recent as the most recent bill received.

Figure 3.2-1: Arts High School Electricity Usage

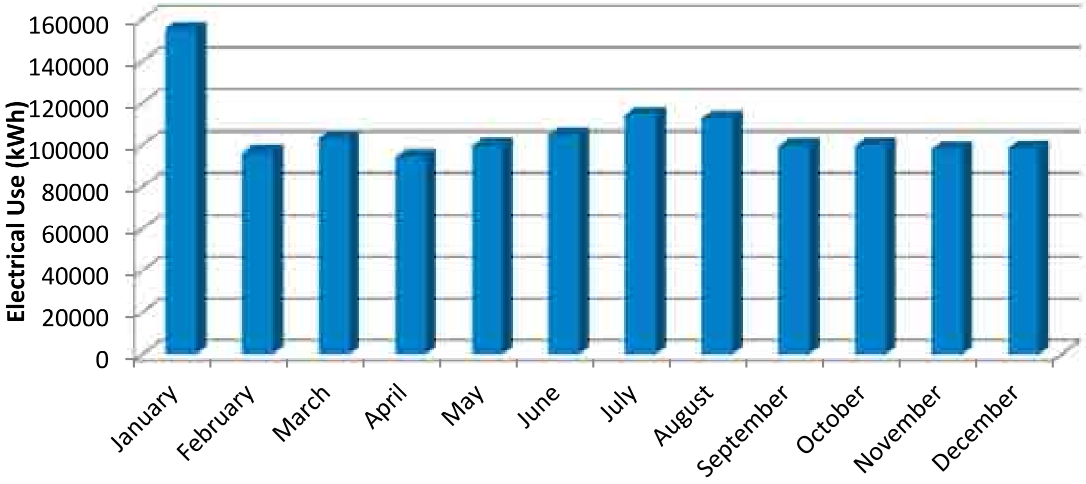
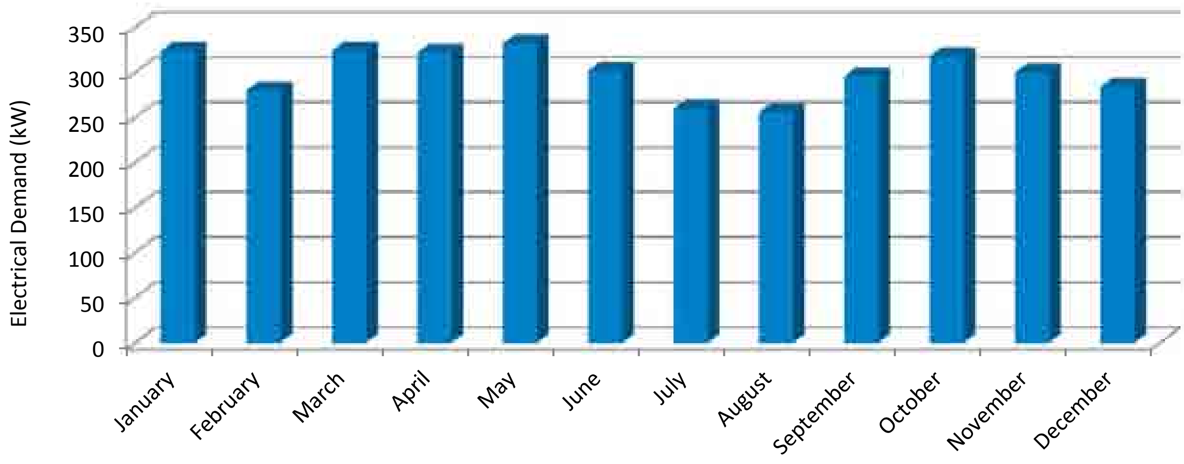


Table 3.2-2 illustrates the monthly electrical demand for the Arts High School from January, 2011 through December, 2012. The information presented is only as recent as the most recent bill received.



The tariff rates for March 2012 for the electrical service at Arts High School, from PSE&G are as follows:

	Acct #: 42 011 034 00
Delivery Service Charges:	kWh Charges: $0.0.59576/kWh
Supply Service Charges:	kWh Charges: $0.094903/kWh

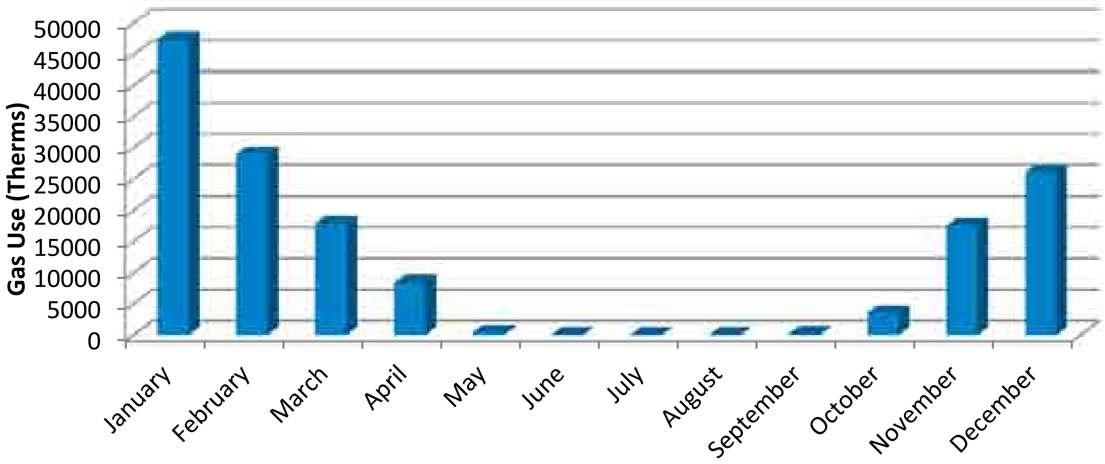
Table 3.2-1: Arts High School Seasonal Peak Demands

Season	Peak Demand (kW)
Summer	236
Winter	200

Refer to Table 3.3-1, in Section 3.3 for the average electrical aggregate cost and Table 3.3-2 for the average natural gas cost. Refer to Appendix A for a complete Historical Energy Data Analysis.

Figure 3.2 -2 illustrates the monthly average natural gas consumption at Arts High School from January, 2010 through December, 2012.

Figure 3.2-2: Arts High School Natural Gas Usage



For more building energy use information on Arts High School gas usage, refer to Section 4.2.

3.2.2 Barringer High School

Electric power and natural gas for Barringer High School is supplied by PSE&G. Electricity is supplied under a GLP and an LPLS rate. Figure 3.2-3 illustrates the average monthly total electrical energy consumption from January, 2011 through December, 2012. For example, for the month of February, the bar graph represents average electrical energy consumption for February 2011, and 2012. This same graphical 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 above referenced time period to portray a more encompassing monthly usage trend.

From this graph, it can be determined that the baseline electrical consumption for Barringer High School is approximately 115,821 kWh/month.

Figure 3.2-3: Barringer High School Electricity Usage

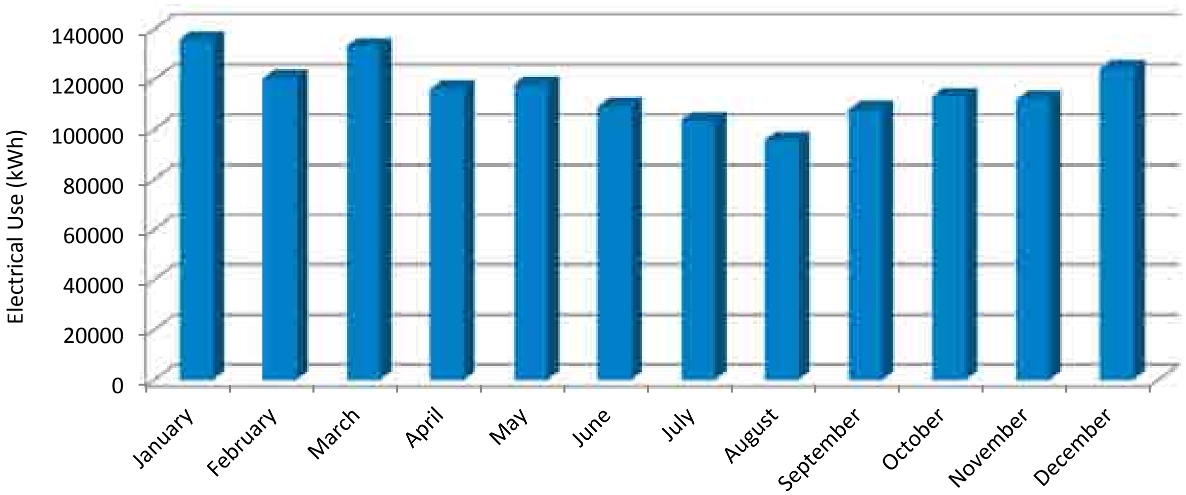
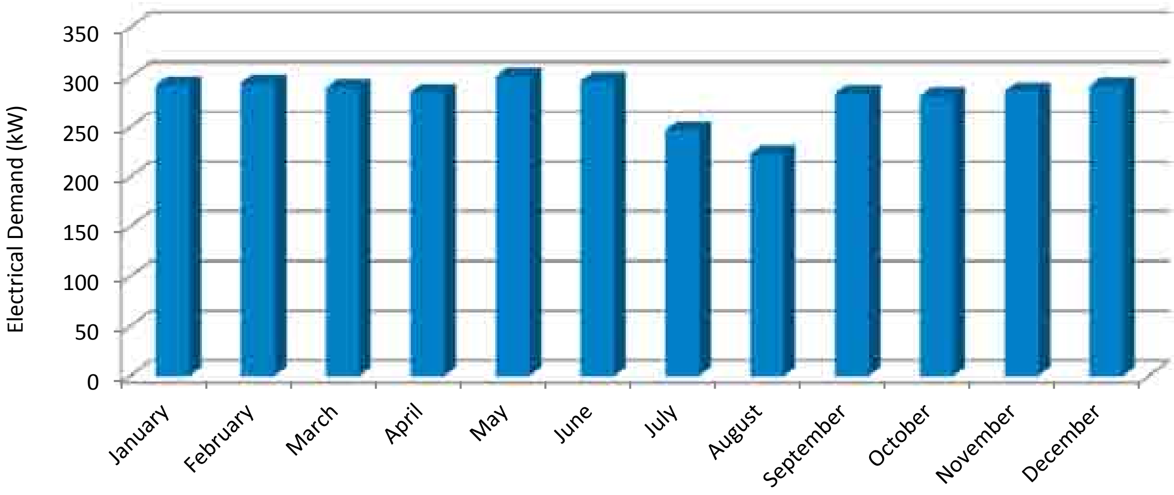


Table 3.2-2 illustrates the monthly electrical demand for the Barringer High School from January, 2011 through December, 2012. The information presented is only as recent as the most recent bill received.



The tariff rates for June 2012 for the electrical service at Barringer High School, from PSE&G are as follows:

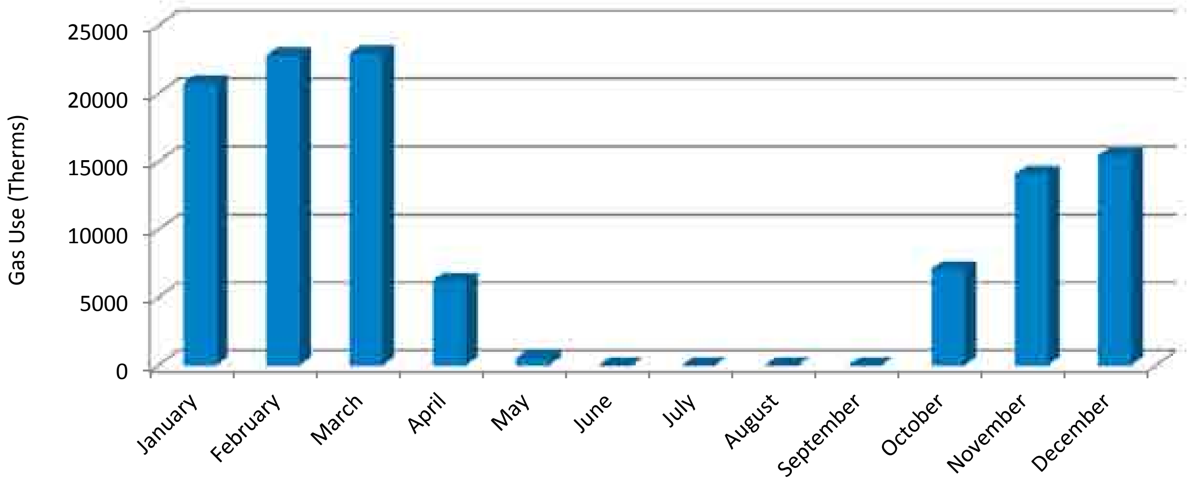
RATE: GLP	**Acct #: 66 047 832 00**
Delivery	Service Charges: $ 13.14
Distribution Charges	
Annual Demand:	78 kW @9.885128205 = $ 771.04
Summer Demand:	78 kW @18.346282051 = $1431.01
kWh charges:	1600 kWh @ $0.018656250 = $ 29.85
Next:	39200 kWh @ $0.02019639 = $ 791.72
Next:	19400 kWh @ $0.020258763 = $ 393.02
Societal Benefits:	60200 kWh @ $0.009247010 = $ 556.67
Securitization Transition:	60200 kWh @ $0.0010608969 = $ 638.66
BGS Capacity	
Generation	20.21 kW @ $18.031172687 = $ 364.41
Transmission	18.89 kW @ $ 8.050291159 = $ 152.07
BGS Energy	
kWh charges:	20800 kWh @ $0.072436058 = $ 1506.67
Next:	20000 kWh @ $0.075751000 = $ 1515.02
Next:	19400 kWh @ $0.072947938 = $ 1415.19

Table 3.2-2: Barringer High School Seasonal Peak Demands

Season	Peak Demand (kW)
Summer	218
Winter	210

Natural gas is provided by PSE&G. Figure 3.2 -4 illustrates the monthly average natural gas consumption at Barringer High School from June, 2011 through May, 2013. Refer to Appendix A for a complete Historical Data Analysis.

Figure 3.2-4: Barringer High School Natural Gas Usage



For more building energy usage data on Barringer High School natural gas usage, refer to Section 4.2.

3.2.3 George Washington Carver

Electric power and natural gas for Barringer High School is supplied by PSE&G. Electricity is being supplied under an LPLS rate. Figure 3.2-5 illustrates the average monthly total energy consumption from February, 2011 through December, 2012. For example, for the month of September, the bar graph represents average electrical energy consumption for September 2011 and 2012. This same graphical 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 above referenced time period to portray a more encompassing monthly usage trend.

From this graph, it can be determined that the baseline electrical consumption for George Washington Carver is approximately 86,000 kWh/month.

Figure 3.2-5: George Washington Carver Electricity Usage

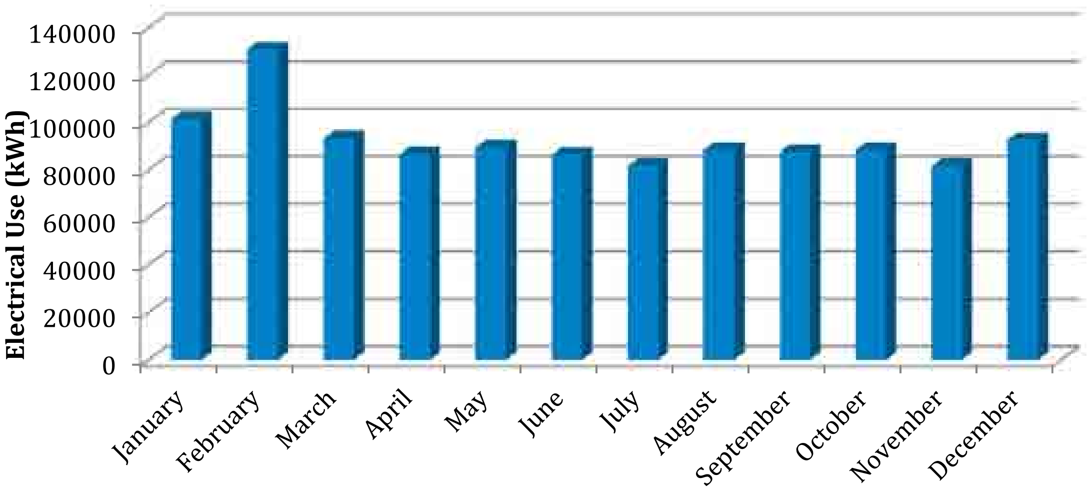
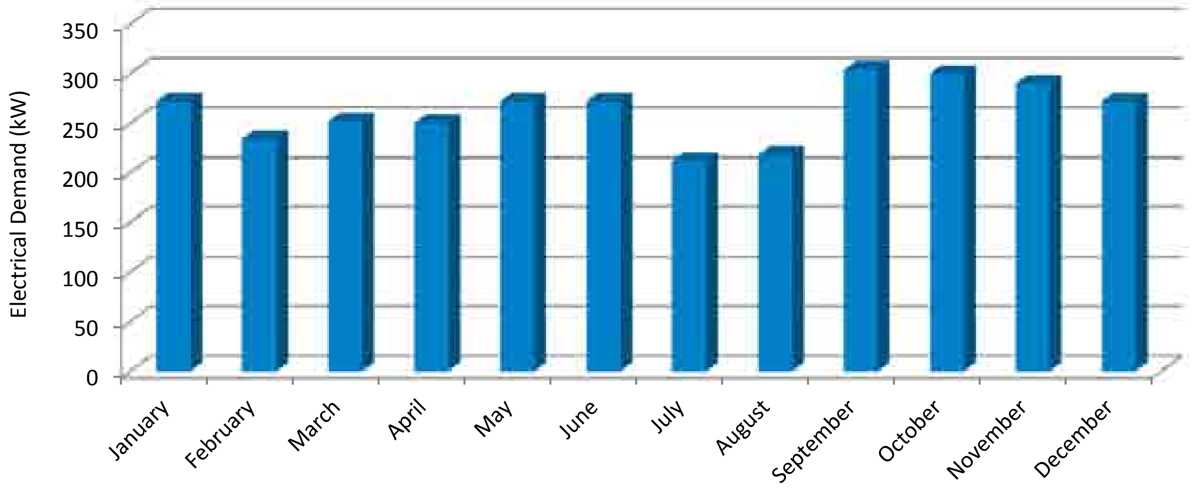


Table 3.2-2 illustrates the monthly electrical demand for the George Washington Carver from January, 2012 through December, 2012. The information presented is only as recent as the most recent bill received.



The tariff rates for September 2012 for the electrical service at George Washington Carver, from PSE&G are as follows:

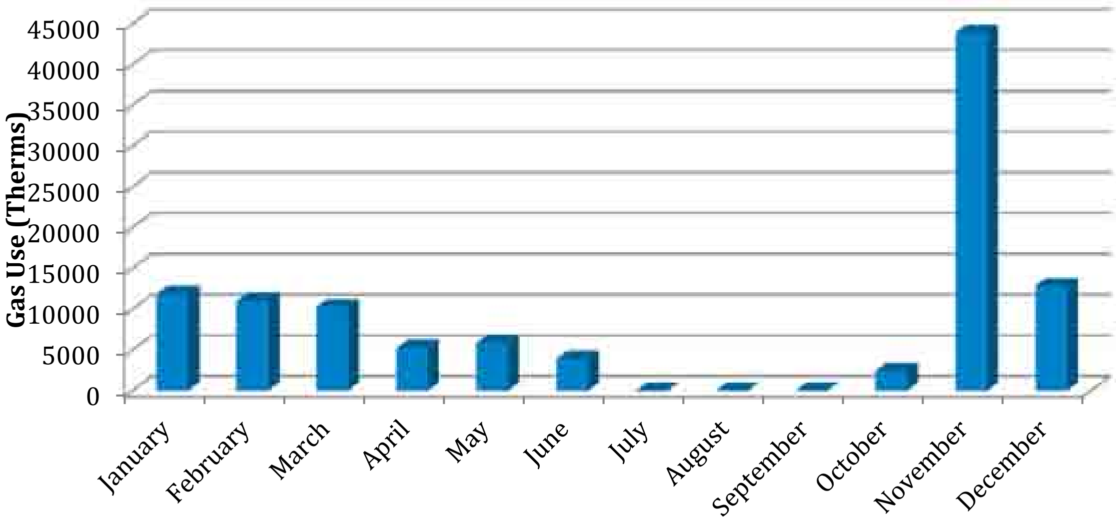
RATE: LPLS	**Acct #: 42 004 393 01**
Delivery	Service Charges: $ 384.62
Distribution Charges	
Annual Demand:	196 kW @3.486581633 = $ 683.37
Summer Demand:	196 kW @8.294795918 = $1,625.78
kWh – On-peak:	39600 kWh @ $0.009819949 = $ 791.72
kWh – Off-peak:	36000 kWh @ $0.009820000 = $ 393.02
Societal Benefits:	75600 kWh @ $0.009246958 = $ 556.67
Securitization Transition:	75600 kWh @ $0.0010608995 = $ 638.66
BGS Capacity	
Generation	301.50 kW @ $ 6.010746269 = $ 1,812.24
Transmission	276.68 kW @ $ 2.683786321 = $ 742.55
BGS Energy	
kWh – On-peak:	39600 kWh @ $0.089752020 = $ 3,554.18
kWh – Off-peak:	36000 kWh @ $0.050783056 = $ 1,828.19

Table 3.2-3: George Washington Carver Seasonal Peak Demands

Season	Peak Demand (kW)
Summer	328
Winter	296

Figure 3.2 -6 illustrates the monthly average natural gas consumption at George Washington Carver from July, 2010 through December, 2012. Monthly usages are an average of Refer to Appendix A for a complete Historical Data Analysis.

Figure 3.2-6: George Washington Carver Natural Gas Usage



The spike in November appears to be related to preceeding estimated billing in 2012. For more building energy data on George Washington Carver natural gas usage refer to Section 4.2.

3.2.4 Malcolm X Shabazz

Electricity and natural gas for Malcolm X Shabazz is supplied by PSE&G. The electricity is provided under the GLP and LPLS rates. Figure 3.2-8 illustrates the average monthly total energy consumption from January, 2011 through December, 2012. For example, for the month of February, the bar graph

Represents average electrical energy consumption for February 2011, and 2012. This same graphical 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 above referenced time period to portray a more encompassing monthly usage trend.

From this graph, it can be determined that the baseline electrical consumption for Malcolm X Shabazz is approximately 181,887 kWh/month.

Figure 3.2-7: Malcolm X Shabazz Electricity Usage

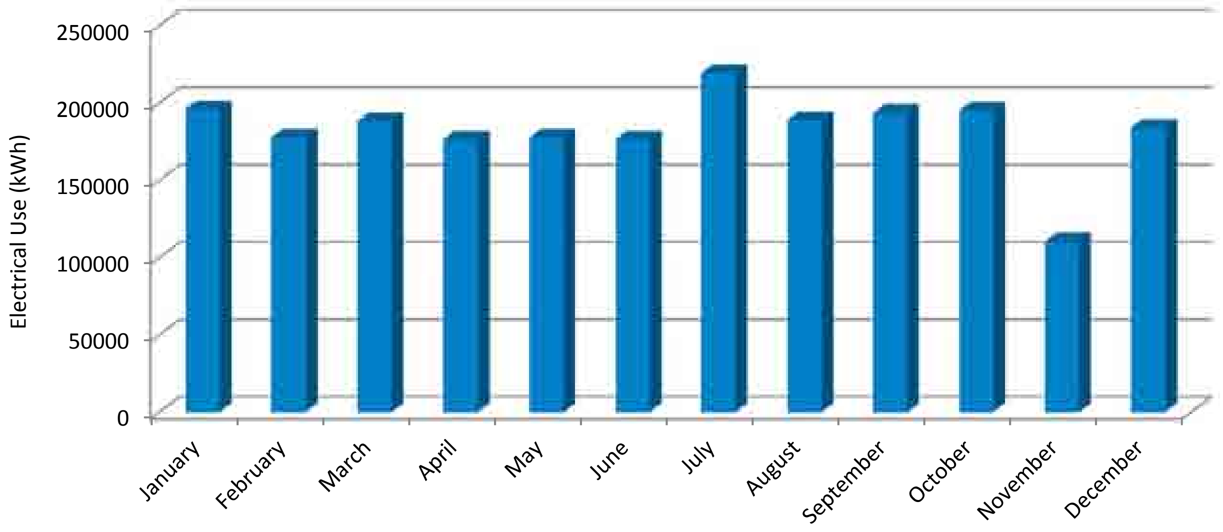
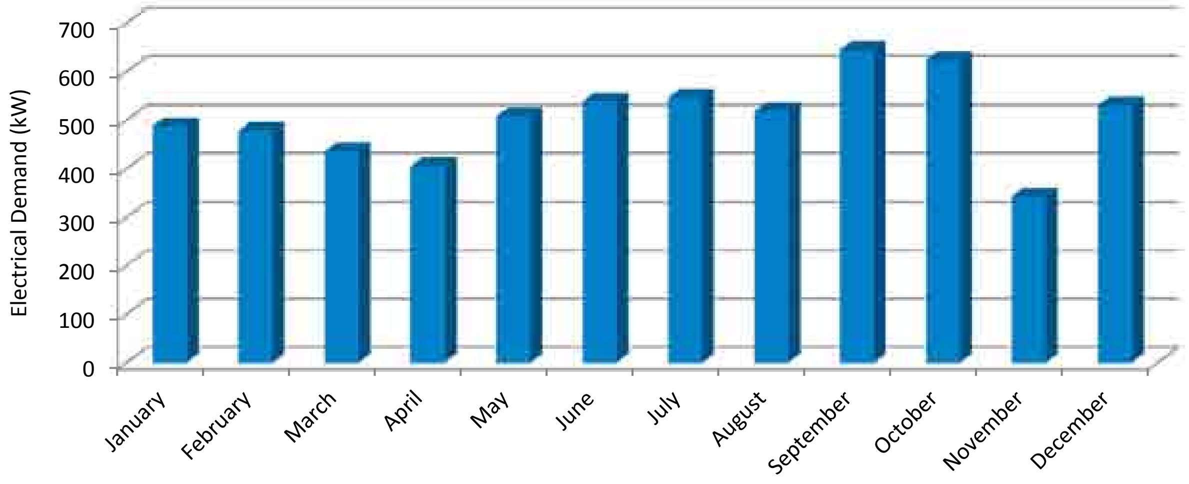


Table 3.2-9 illustrates the monthly electrical demand for the Malcolm X Shabazz from January, 2012 through December, 2012. The information presented is only as recent as the most recent bill received.



The tariff rates for September 2012 for the electrical service at Malcolm X Shabazz, from PSE&G are as follows:

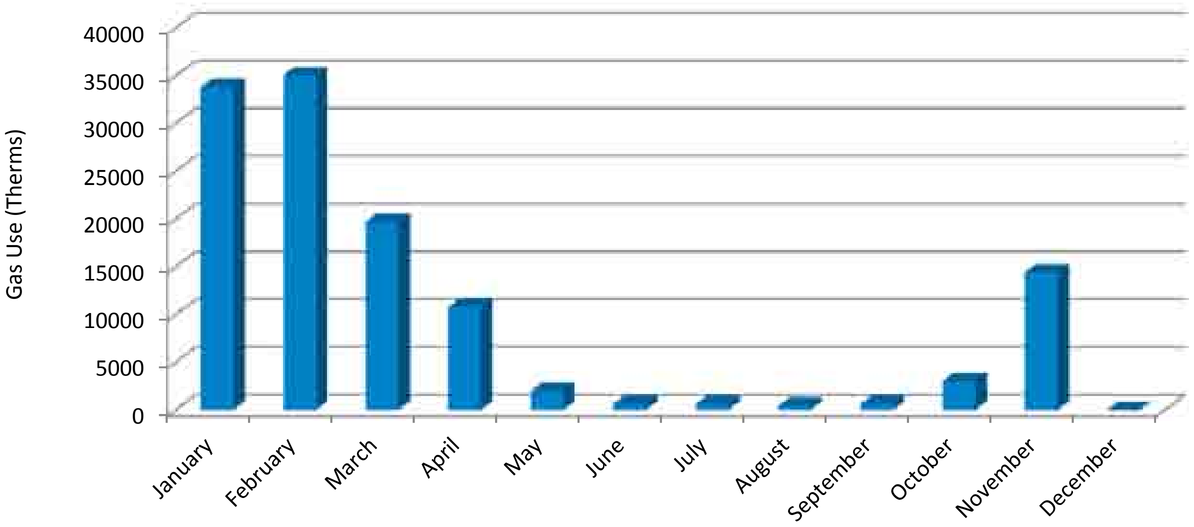
RATE: LPLS	**Acct #: 42 008 049 05**
Delivery	Service Charges: $ 384.62
Distribution Charges	
Annual Demand:	368 kW @3.486603261 = $ 1,283.07
Summer Demand:	368 kW @8.294709783 = $ 3,052.49
kWh – On-peak:	80800 kWh @ $0.009820050 = $ 793.46
kWh – Off-peak:	94400 kWh @ $0.009820021 = $ 927.01
Societal Benefits:	175200 kWh @ $0.009246975 = $ 1,620.07
Securitization Transition:	175200 kWh @ $0.0010609018 = $ 1,858.70
BGS Capacity	
Generation	437.62 kW @ $ 6.010625657 = $ 2,630.37
Transmission	401.58 kW @ $ 2.683823896 = $ 1,077.77
BGS Energy	
kWh – On-peak:	80,800 kWh @ $0.089751980 = $ 3,554.18
kWh – Off-peak:	94,400 kWh @ $0.050783051 = $ 4,793.92

Table 3.2-4: Malcolm X Shabazz Seasonal Peak Demands

Season	Peak Demand (kW)
Summer	346
Winter	645

Figure 3.2 -10 illustrates the monthly average natural gas consumption at Malcolm X Shabazz from January, 2011 through December, 2012. Refer to Appendix A for a complete Historical Data Analysis.

Figure 3.2-8: Malcolm X Shabazz Natural Gas Usage



For more on Malcolm X Shabazz natural gas usage, refer to Section 4.2.

3.2.5 Technology High School

Electric power and natural gas is provided by PSE&G. Electrical power is provided under the LPLS rate. Figure 3.2-11 illustrates the average monthly total energy consumption from August, 2010 through December, 2012. For example, for the month of February, the bar graph represents average electrical energy consumption for February 2011 and 2012. This same graphical 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 above referenced time period to portray a more encompassing monthly usage trend.

From this graph, it can be determined that the baseline electrical consumption for Technology High School is approximately 90,400 kWh/month.

Figure 3.2-9: Technology High School Electricity Usage

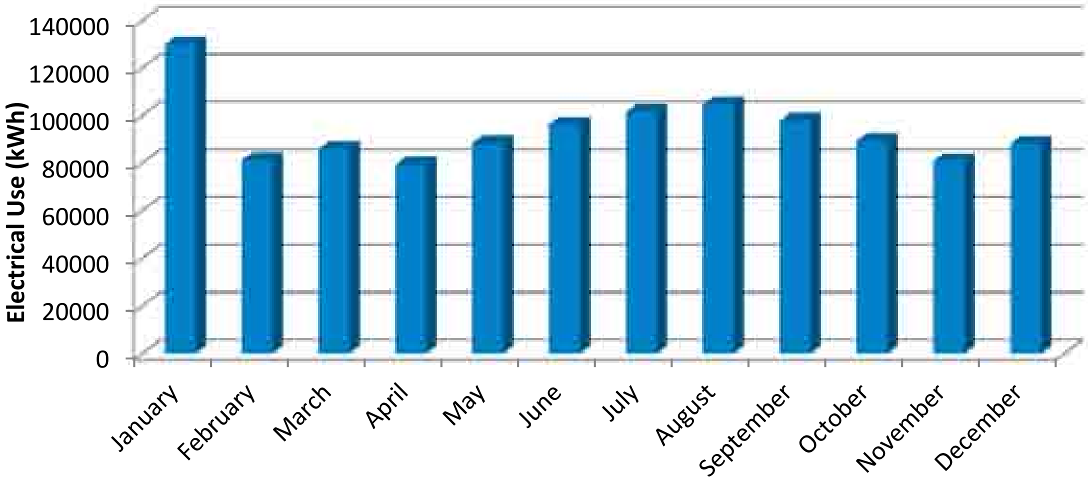
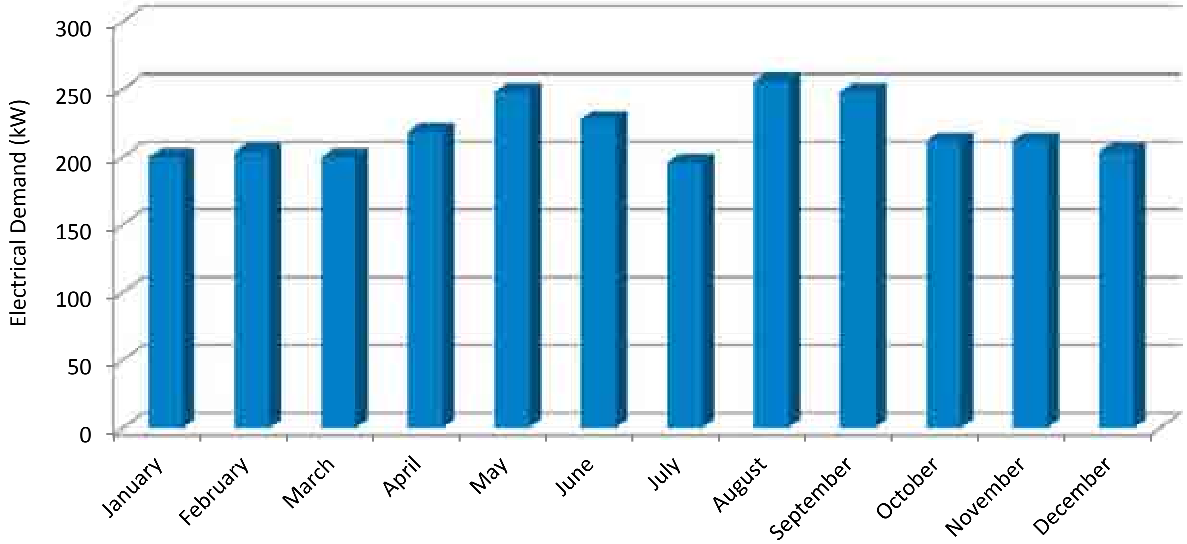


Table 3.2-9 illustrates the monthly electrical demand for the Technology High School from January, 2012 through December, 2012. The information presented is only as recent as the most recent bill received.



The tariff rates for September 2012 for the electrical service at Technology High School, from PSE&G are as follows:

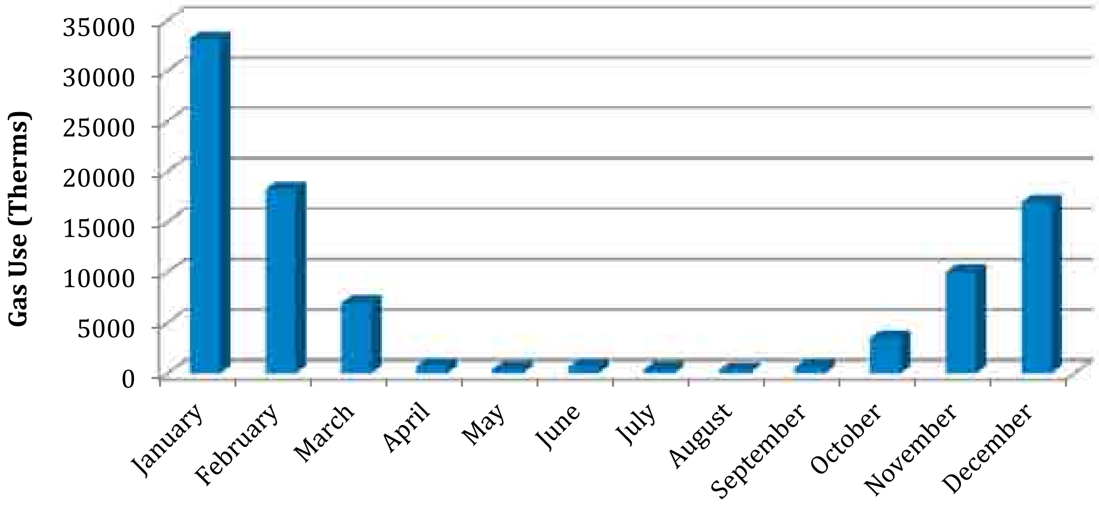
RATE: LPLS	Acct #: 42 010 146 06
Delivery	Service Charges: $ 384.62
Distribution Charges	
Annual Demand:	224 kW @3.486603261 = $ 781.00
Summer Demand:	224 kW @8.294709783 = $ 1,858.04
kWh – On-peak:	40800 kWh @ $0.009820050 = $ 400.66
kWh – Off-peak:	38400 kWh @ $0.009820021 = $ 377.09
Societal Benefits:	79200 kWh @ $0.009246975 = $ 732.36
Securitization Transition:	79200 kWh @ $0.0010609018 = $ 840.23
Area Development Credit	$ -645.12
BGS Capacity	
Generation	324.37 kW @ $ 6.010625657 = $ 1,949.68
Transmission	297.66 kW @ $ 2.683823896 = $ 2,418.84
BGS Energy	
kWh – On-peak:	13,600 kWh @ $0.069752205 = $ 1,220.63
	27,200 kWh @ $0.088927941 = $ 2,418.84
kWh – Off-peak:	12,000 kWh @ $0.050783051 = $ 609.40
	26,400 kWh @ $0.049959091 = $ 1,318.92

Table 3.2-5: Technology High School Seasonal Peak Demands

Season	Peak Demand (kW)
Summer	224
Winter	208

Figure 3.2 -12 illustrates the monthly average natural gas consumption at Technology High School from August, 2011 through August, 2012. Refer to Appendix A for a complete Historical Data Analysis.

Figure 3.2-10: Technology High School Natural Gas Usage



For more on Technology High School natural gas usage, refer to Section 4.2.

3.2.6 Weequahic High School

Electric power for Weequahic High School is supplied by PSE&G. The connection is under the LPLS rate. Figure 3.2-14 illustrates the monthly total energy consumption from January, 2012 through December, 2012.

From this graph, it can be determined that the baseline electrical consumption for Weequahic High School is approximately 137,984 kWh/month.

Table 3.2-2 illustrates the monthly electrical usage loads for the Weequahic High School from January, 2012 through December, 2012. The information presented is only as recent as the most recent bill received.

Figure 3.2-11: Weequahic High School Electricity Usage

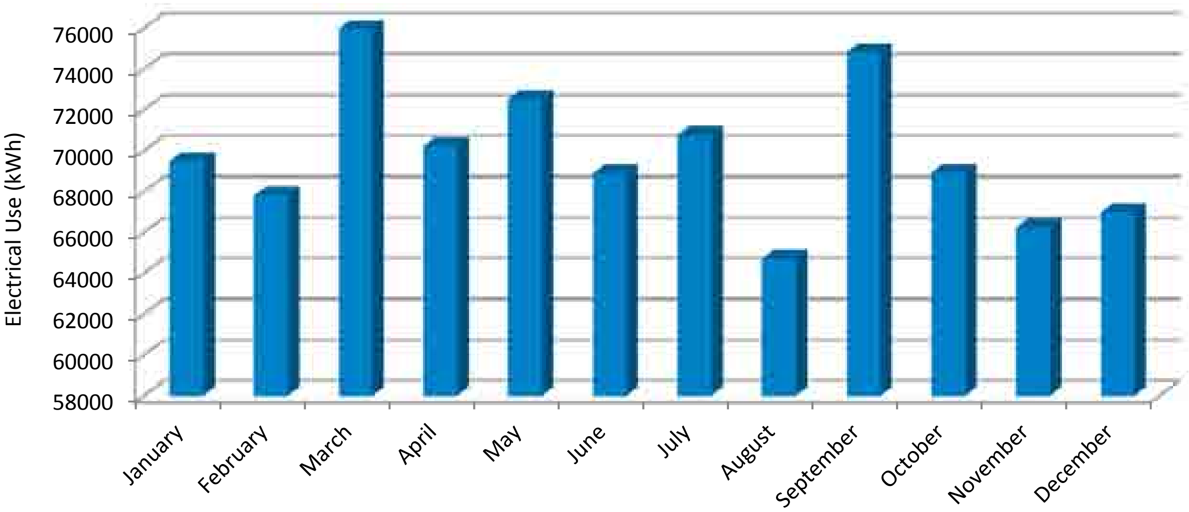


Table 3.2-9 illustrates the monthly electrical demand for the Weequahic High School from January, 2012 through December, 2012. The information presented is only as recent as the most recent bill received.

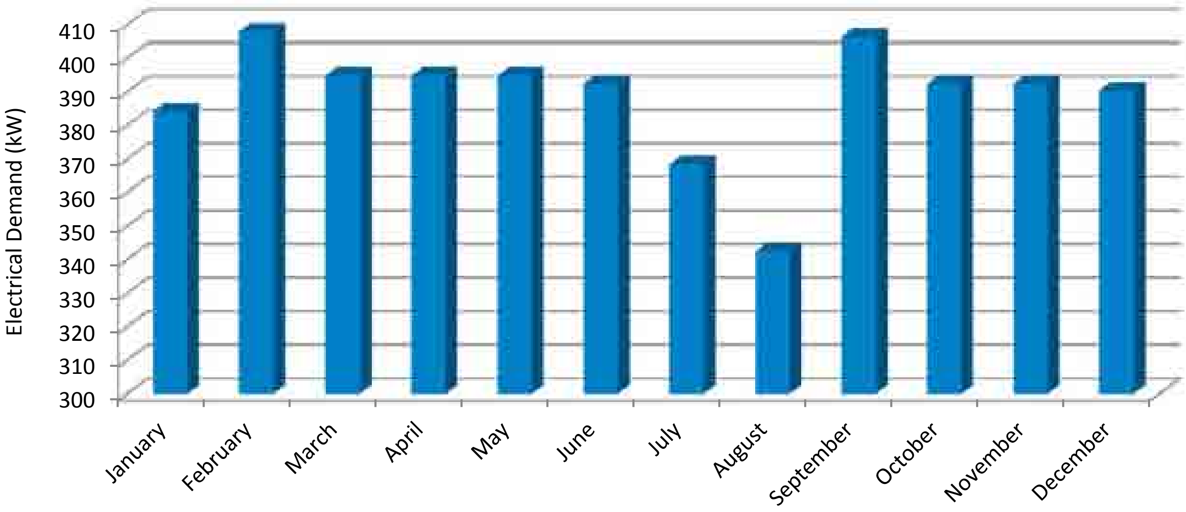
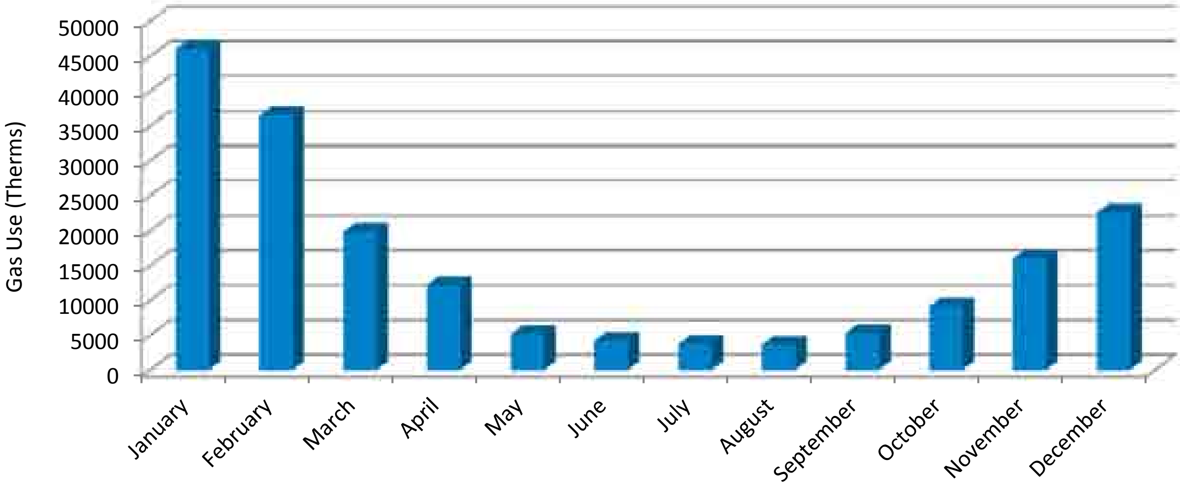


Figure 3.2 -12 illustrates the monthly average natural gas consumption at Weequahic High School from August, 2011 through August, 2012. Refer to Appendix A for a complete Historical Data Analysis.

Figure 3.2-12: Weequahic High School Natural Gas Usage



The most recent tariff rates available at the time of this audit for the electrical service at Weequahic High School, from PSE&G are as follows:

RATE: LPLS	Acct #: 42 010 230 01
Delivery	Service Charges: $ 384.62
Distribution Charges	
Annual Demand:	152 kW @3.486603261 = $ 529.96
Summer Demand:	152 kW @8.294709783 = $ 1,260.81
kWh – On-peak:	27600 kWh @ $0.009820050 = $ 271.03
kWh – Off-peak:	31600 kWh @ $0.009820021 = $ 310.31
Societal Benefits:	59200 kWh @ $0.009246975 = $ 547.42
Securitization Transition:	59200 kWh @ $0.0010609018 = $ 628.05
BGS Capacity	
Generation	243.49 kW @ $ 6.010625657 = $ 1,463.54

Transmission	223.44 kW @ $ 2.683823896 = $ 599.67
BGS Energy	
kWh – On-peak:	27,600 kWh @ $0.089752174 = $ 2,477.16
kWh – Off-peak:	31,600 kWh @ $0.050782911 = $ 1,604.74

Table 3.2-7: Weequahic High School Seasonal Peak Demands

Season	Peak Demand (kW)
Summer	406
Winter	408

Refer to Table 3.3-1, in Section 3.3 for the average electrical aggregate cost. Refer to Appendix A for a complete Historical Data Analysis.

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 fuel, in terms of cost/kWh and cost/therm, were determined for each service location 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
Arts High School	$0.15
Barringer High School	$0.14
George Washington Carver School	$0.10
Malcolm X Shabazz High School	$0.15
Technology High School	$0.11
Weequahic High School	$0.16

Table 3.3-2: Natural Gas Aggregate Unit Costs

Service Location	Aggregate $ / therm
Arts High School	$0.90
Barringer High School	$0.87
George Washington Carver School	$0.96
Malcolm X Shabazz High School	$0.93
Technology High School	$0.97
Weequahic High School	$0.94

3.4 Portfolio Manager

3.4.1 Portfolio Manager Overview

Portfolio Manager is an interactive energy management tool that allows the Board to track and assess energy consumption at the facilities in a secure online environment. Portfolio Manager can help the Board 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.

3.4.3 Portfolio Manager Account Information

A Portfolio Manager account has been established for the Board, which includes a profile for the six (6) buildings. Information entered into this Portfolio Manager Facility profile, including electrical energy consumption and natural gas consumption has been used to establish a performance baseline.

It is recommended that the information be updated to track the buildings' energy usage. Results are a reflection of the information supplied, if more recent information is entered into the Portfolio Manager account, there is a possibility for better results.

Table 3.4-1: Portfolio Manager Ratings

Service Location	Building Rating
Arts High School	49
Barringer High School	92*
George Washington Carver School	56
Malcolm X Shabazz High School	75
Technology High School	63
Weequahic High School	45

*Portfolio manager is being serviced 6/27 to 7/16 and scores need to be updated for most current usage. The current billing produces a rating is in the 60's.

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 Board:

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

USERNAME: Newark_BOE

PASSWORD: Energystar1

Section 4

Energy Conservation and Retrofit Measures (ECRM)

The following is a summary of how Annual Return on Investment (AROI), Internal Rate of Return (IRR), and Net Present Value (NPV) will be broken down in the cost analysis for all ECRMs recommended in this report.

Included in the simplified payback analysis summary table is the ‘Annual Return on Investment’ (AROI) values. This value is a performance measure used to evaluate the efficiency of an investment and is calculated using the following equation:

$$AROI = \frac{AECS + OCS}{NET\ ECM\ Cost} - \frac{1}{Lifetime}$$

Where OCS = Operating Cost Savings, and AECS = Annual Energy Cost Savings.

Also included in the table are net present values for each option. The NPV calculates the present value of an investment’s future cash flows based on the time value of money, which is accounted for by a discount rate (DR) (assume bond rate of 3%). NPV is calculated using the following equation:

$$NPV = \sum_{n=0}^{N} \frac{C_n}{(1 + DR)^n}$$

Where C_n=Annual cash flow, and N = number of years.

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

$$IRR \rightarrow 0 = \sum_{n=0}^{N} \frac{C_n}{(1 + IRR)^n}$$

Where C_n=Annual cash flow, and N = number of years.

The lifetime energy savings represents the cumulative energy savings over the assumed life of the 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. This thermal component is due to the fact that the more energy efficient bulbs give off less heat.

Three options are offered for all of the facilities included in this audit. The first option will be for upgrading existing interior lighting, and the second option will be for upgrading existing exterior lighting. The final option is a total cost for upgrading both interior and exterior at the same. Retrofitting of existing fluorescent fixtures includes upgrading both ballasts and lamps for the fixture. Refer to Appendix D for more information.

Please note that the Engineer's Estimate of 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.

It is recommended that the existing lighting systems at the facilities listed in Section 1 be upgraded to high efficiency standards to create lighting uniformity throughout the portfolio of properties. The recommended lighting upgrades, as presented in Appendix D, involve the replacement of existing T12 fluorescent, and incandescent fixtures. For the exterior lighting replacement ECMs, high efficiency wall and pole mounted CREE LED fixtures have been used as a basis for cost and energy use. The exterior LED fixtures meet the requirements of the NJ Clean Energy Program, and are eligible for incentives. Occupancy sensing controls have been proposed for most applicable locations in all six of the school facilities, and this is where the Board will see the largest energy savings component, in relation to lighting ECMs.

The following table, Table 4.1-1, summarizes a simple payback analysis assuming the implementation of all lighting system improvements at all of the Newark BOE facilities.

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 Philadelphia, PA was used for analyses. From this, the model may be calibrated, using historical utility bills, to predict the impact of theoretical energy savings measures.

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.

Table 4.1-1

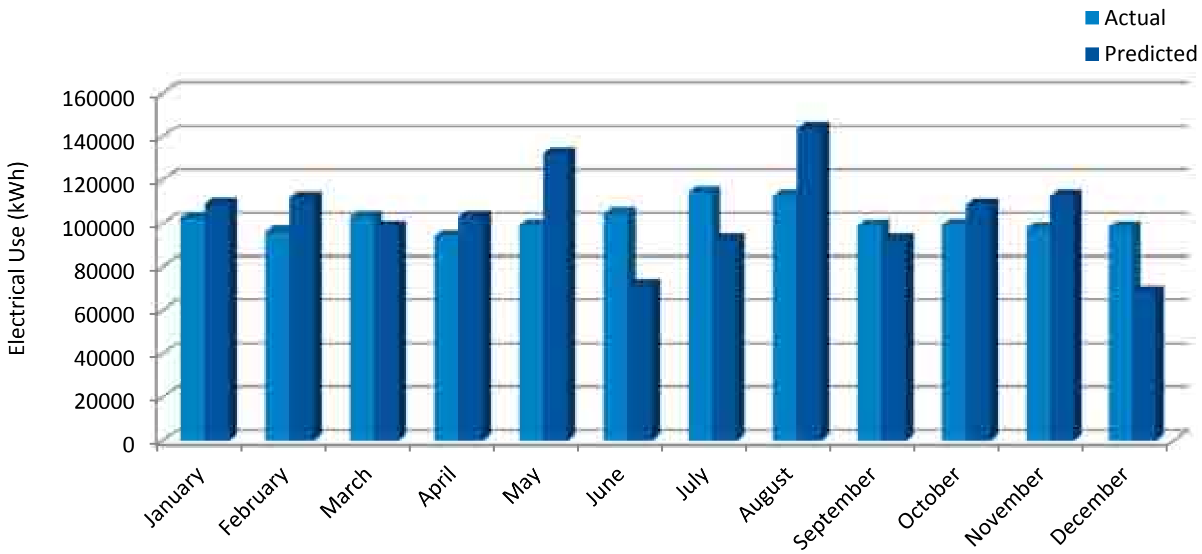
Newark Board of Education Lighting Upgrades

Location	Engineers Opinion of Probable Cost	Incentives	Total Cost	Energy Savings	Energy Savings+NMCS	Simple Payback (Years)	KW Save	KWH Save	Net Maintenance Cost Savings (NMCS)	Annual Return on Investment (AROI)	Internal Rate of Return (IRR)	Net Present Value (NPV)	Lifetime Savings (15 Years)
Malcom X Shabazz High School - Interior	$98,885.3	$5,635.0	$93,250.3	$20,958.0	$24,051.0	3.9	22.6	149,700.3	$3,092.99	19.1%	27.8%	$257,007.6	$447,323.2
Malcom X Shabazz High School - Exterior	$40,863.8	$5,975.0	$34,888.8	$3,381.8	$4,191.8	8.3	5.5	24,155.7	$810.0	5.3%	11.2%	$26,156.4	$77,962.3
Malcom X Shabazz High School - Total	$139,749.1	$11,610.0	$128,139.1	$24,339.8	$28,242.8	4.5	28.1	173,856.0	$3,903.0	15.4%	23.6%	$283,163.9	$525,285.5
Technology High School - Interior	$40,192.9	$5,635.0	$34,557.9	$2,188.3	$2,209.6	15.6	0.1	31,261.1	$21.3	(0.3%)	2.1%	($2,379.2)	$41,096.2
Technology High School - Exterior	$11,147.8	$1,500.0	$9,647.8	$211.6	$336.5	28.7	0.7	3,022.2	$125.0	(3.2%)	(4.7%)	($4,747.3)	$6,258.6
Technology High School - Total	$51,340.7	$7,135.0	$44,205.7	$2,399.8	$2,546.1	17.4	0.7	34,283.3	$146.3	(0.9%)	0.8%	($2,379.2)	$47,354.9
Weequahic High School - Interior	$56,064.7	$4,830.0	$51,234.7	$4,527.8	$5,423.7	9.4	2.2	50,309.3	$895.9	3.9%	9.2%	$27,751.2	$100,874.9
Weequahic High School - Exterior	$11,147.8	$1,500.0	$9,647.8	$272.0	$396.9	24.3	0.7	3,022.2	$125.0	(2.6%)	(3.0%)	($3,867.0)	$7,382.8
Weequahic High School - Total	$67,212.5	$6,330.0	$60,882.5	$4,799.8	$5,820.6	10.5	2.8	53,331.5	$1,020.8	2.9%	7.6%	$23,884.2	$108,257.7
Arts High School - Interior	$88,274.0	$9,960.0	$78,314.0	$13,049.4	$13,724.6	5.7	10.3	86,995.7	$675.3	10.9%	18.3%	$121,559.4	$255,263.4
Arts High School - Exterior	$30,470.7	$4,100.0	$26,370.7	$1,413.2	$1,836.4	14.4	2.2	9,421.4	$423.2	0.3%	3.2%	$373.5	$34,155.7
Arts High School - Total	$118,744.7	$14,060.0	$104,684.7	$14,462.6	$15,561.1	6.7	12.5	96,417.1	$1,098.5	8.2%	15.0%	$121,933.0	$289,419.2
Barringer High School - Interior	$84,665.9	$6,790.0	$77,875.9	$4,199.1	$4,554.6	17.1	1.8	52,488.5	$355.5	(0.8%)	1.0%	($11,547.1)	$84,710.2
Barringer High School - Exterior	$12,517.8	$1,225.0	$11,292.8	$1,192.1	$1,588.7	7.1	3.4	14,900.8	$396.6	7.4%	14.0%	$11,843.4	$29,547.7
Barringer High School - Total	$97,183.6	$8,015.0	$89,168.6	$5,391.1	$6,143.3	14.5	5.2	67,389.2	$752.1	0.2%	3.0%	$296.3	$114,257.9
George Washington Carver - Interior	$55,862.3	$4,865.0	$50,997.3	$2,955.2	$2,976.5	17.1	0.1	36,939.9	$21.3	0.1%	2.7%	($858.3)	$55,360.1
George Washington Carver - Exterior	$14,863.8	$2,000.0	$12,863.8	$322.4	$489.0	26.3	0.9	4,029.6	$166.6	(2.9%)	(3.8%)	($5,742.9)	$9,094.3
George Washington Carver - Total	$70,726.1	$6,865.0	$63,861.1	$3,277.6	$3,465.5	18.4	1.0	40,969.5	$187.9	(1.2%)	0.1%	($13,392.8)	$64,454.4

4.2.1 Arts High School

A model of Arts High School was created in eQuest to predict heating and cooling loads for the building. To calibrate this model, CDM Smith used electricity bills and natural gas bills from January 2011 through December 2012. Figure 4.2-1 below compares actual monthly electricity usages, with those predicted by the eQuest model. Historical monthly usages were averaged for each month observed over multiple years. For example, usage during the month of June was averaged for the three years, to yield an approximate average usage during the month of June.

Figure 4.2-1: Arts High School Electricity Usage



Once the eQuest model was calibrated, it could be used to predict approximate major usage categories, such as lighting, plug loads (miscellaneous), ventilation, and cooling. It should be noted that these are only estimated usages based on information gathered during CDM Smith's field audit. Figure 4.2-2 presents this information to help the Board visualize where CDM Smith anticipates the electricity is ultimately being used.

Figure 4.2-2: Arts High School Electricity Usage Breakdown

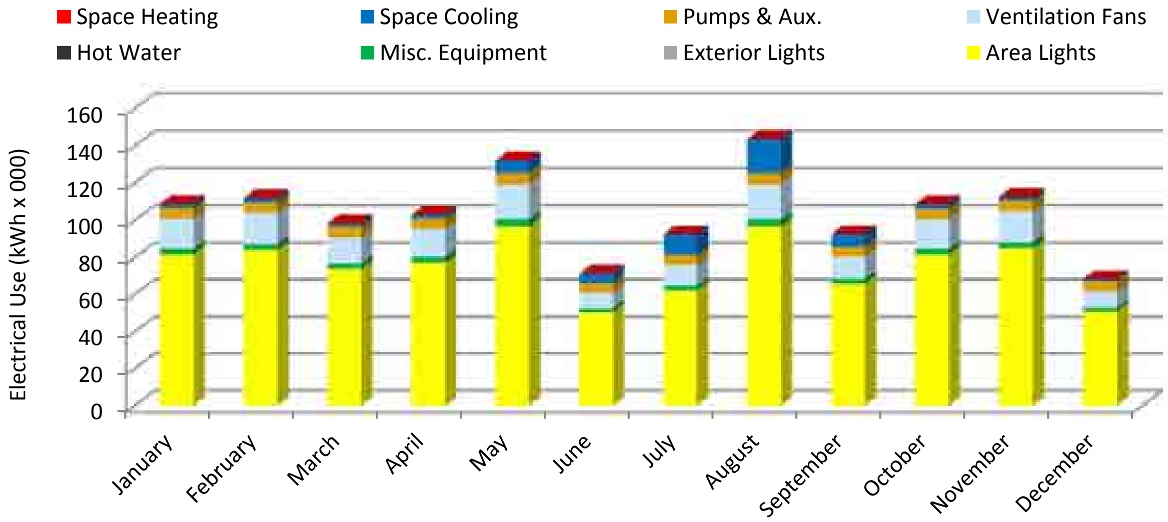
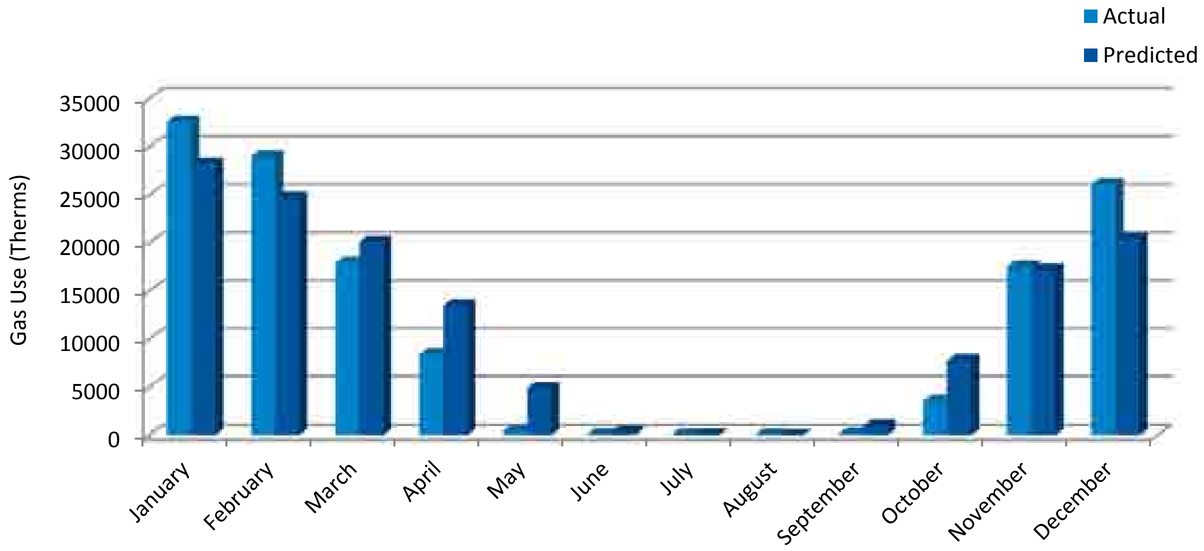


Figure 4.2-3 below compares actual natural gas usage to model-predicted natural gas use.

Figure 4.2-4: Arts High School Natural Gas Usage

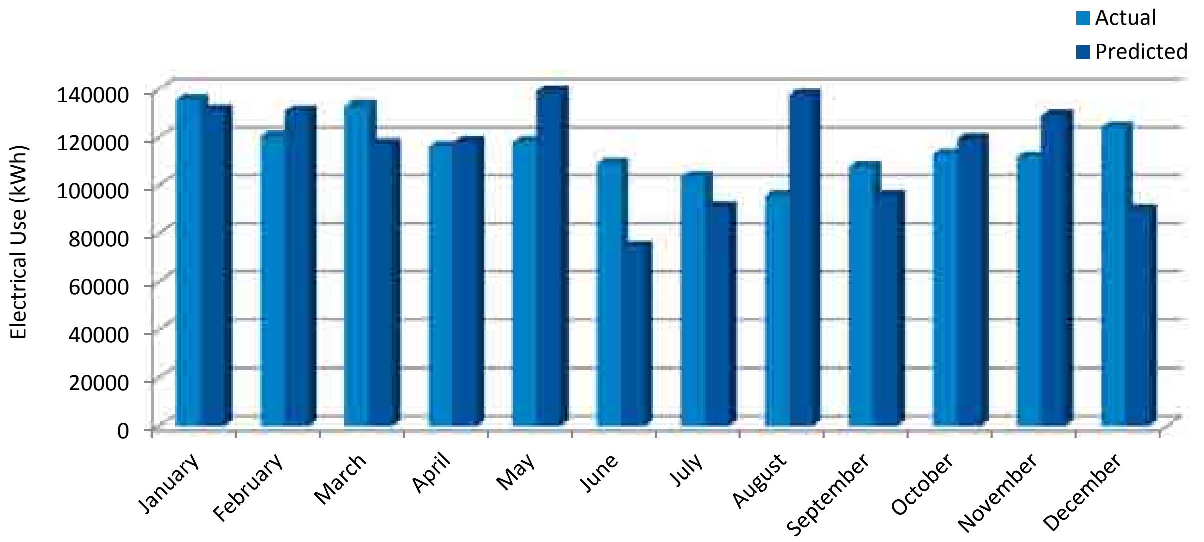


All major equipment noted during CDM Smith's on site audit is listed in Appendix I. See Appendix for additional equipment information.

4.2.2 Barringer High School

A model of Barringer High School was created in eQuest to predict heating and cooling loads for the building. To calibrate this model, CDM Smith used electricity bills and natural gas bills from January 2010 through December 2012. Figure 4.2-5 below compares actual monthly electricity usages, with those predicted by the eQuest model. Historical monthly usages were averaged for each month observed over multiple years. For example, usage during the month of June was averaged for the three years, to yield an approximate average usage during the month of June.

Figure 4.2-5: Barringer High School Electricity Usage



Once the eQuest model was calibrated, it could be used to predict approximate major usage categories, such as lighting, plug loads (miscellaneous), ventilation, and cooling. It should be noted that these are only estimated usages based on information gathered during CDM Smith's field audit. Figure 4.2-6 presents this information to help the Board visualize where CDM Smith anticipates the electricity is ultimately being used.

Figure 4.2-6: Barringer High School Electricity Usage Breakdown

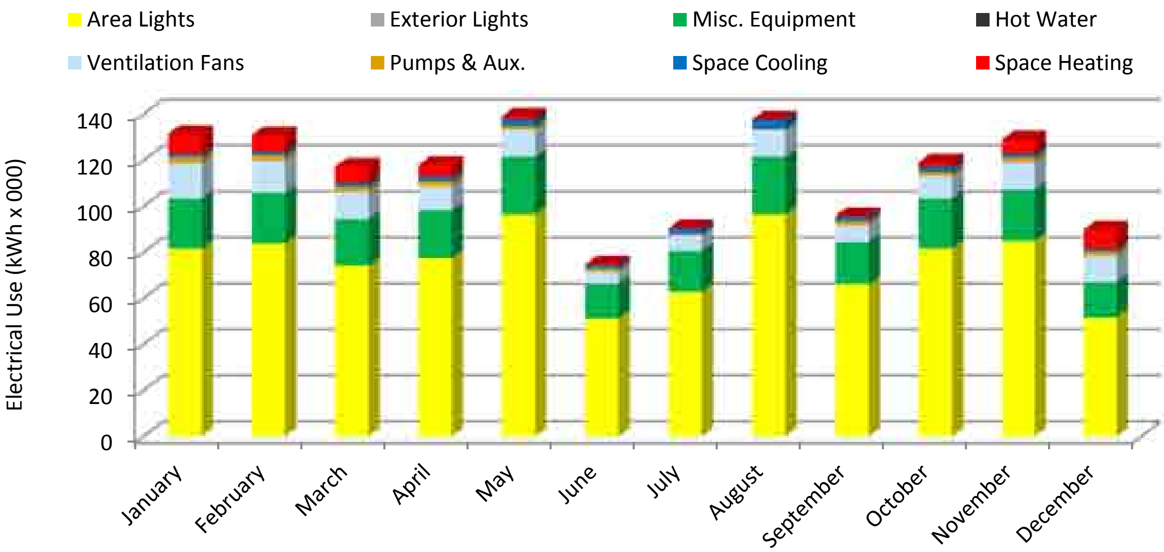
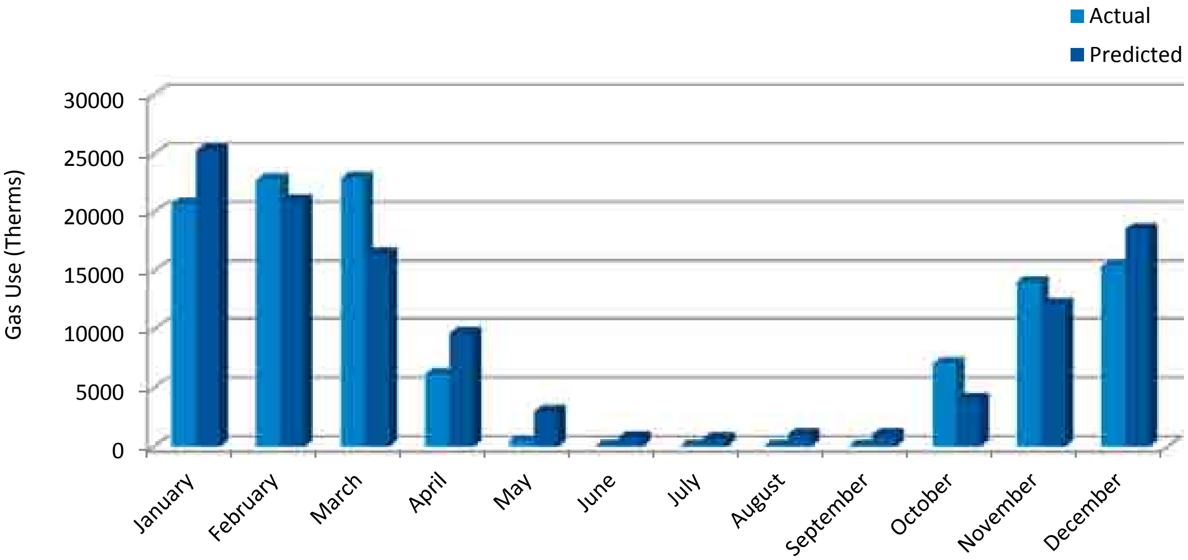


Figure 4.2-7 below compares actual natural gas usage to model-predicted natural gas use.

Figure 4.2-7: Barringer High School Natural Gas Usage

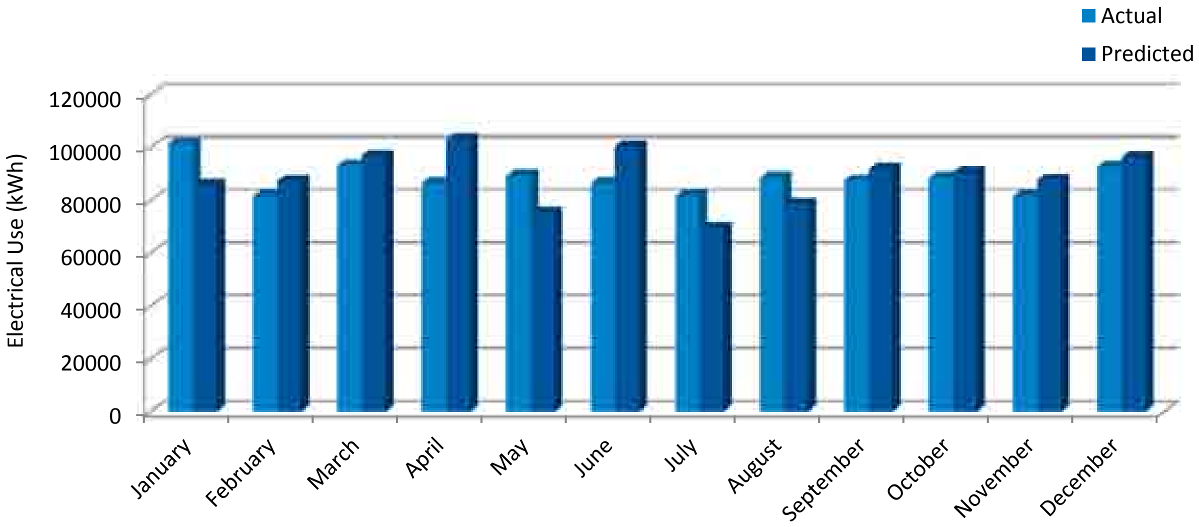


All major equipment noted during CDM Smith's on site audit is listed in Appendix I. See Appendix for additional equipment information.

4.2.3 George Washington Carver

A model of George Washington Carver was created in eQuest to predict heating and cooling loads for the building. To calibrate this model, CDM Smith used electricity bills from May 2011 to December 2012 and steam and chilled water bills from July 2010 through December 2012. Figure 4.2-8 below compares actual monthly electricity usages, with those predicted by the eQuest model. Historical monthly usages were averaged for each month observed over multiple years. For example, usage during the month of June was averaged for the three years, to yield an approximate average usage during the month of June.

Figure 4.2-8: George Washington Carver Electricity Usage



Once the eQuest model was calibrated, it could be used to predict approximate major usage categories, such as lighting, plug loads (miscellaneous), ventilation, and cooling. It should be noted that these are only estimated usages based on information gathered during CDM Smith's field audit. Figure 4.2-9 presents this information to help the Board visualize where CDM Smith anticipates the electricity is ultimately being used.

Figure 4.2-9: George Washington Carver Electricity Usage Breakdown

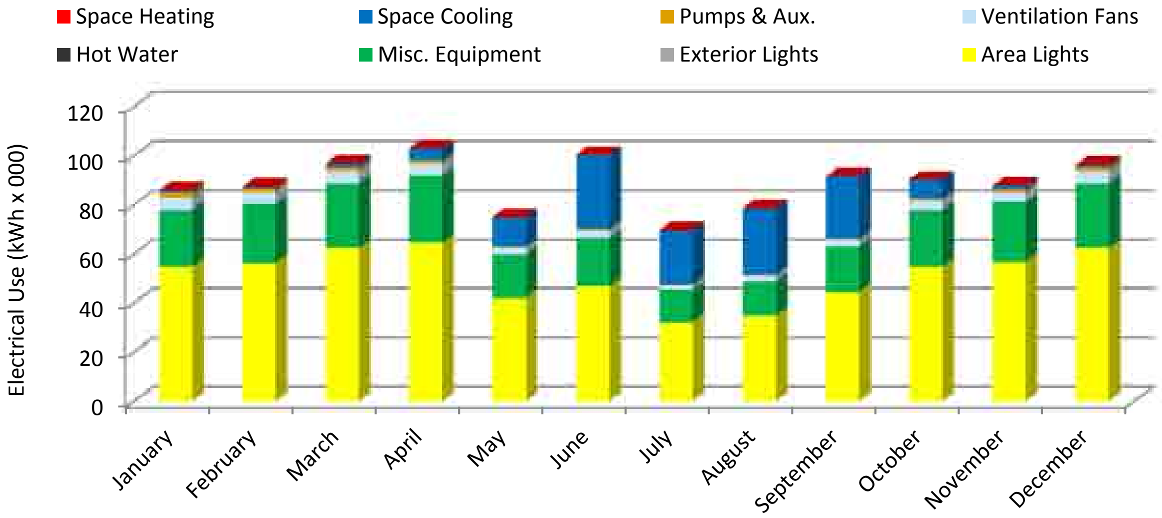
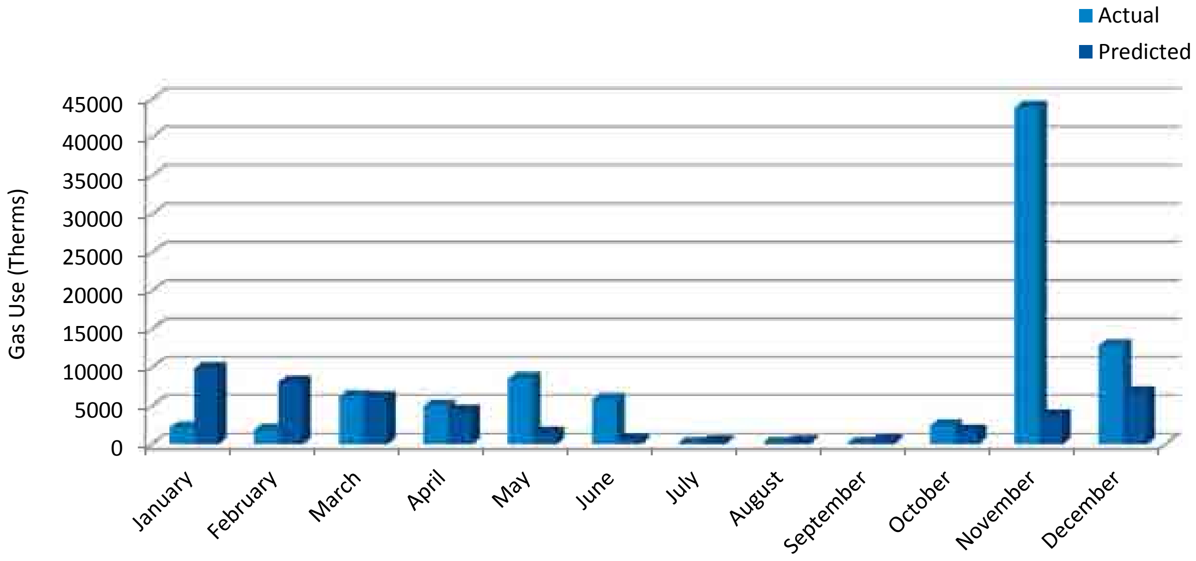


Figure 4.2-10 below compares actual natural gas usage to model-predicted natural gas use.

Figure 4.2-10: George Washington Carver Natural Gas Usage

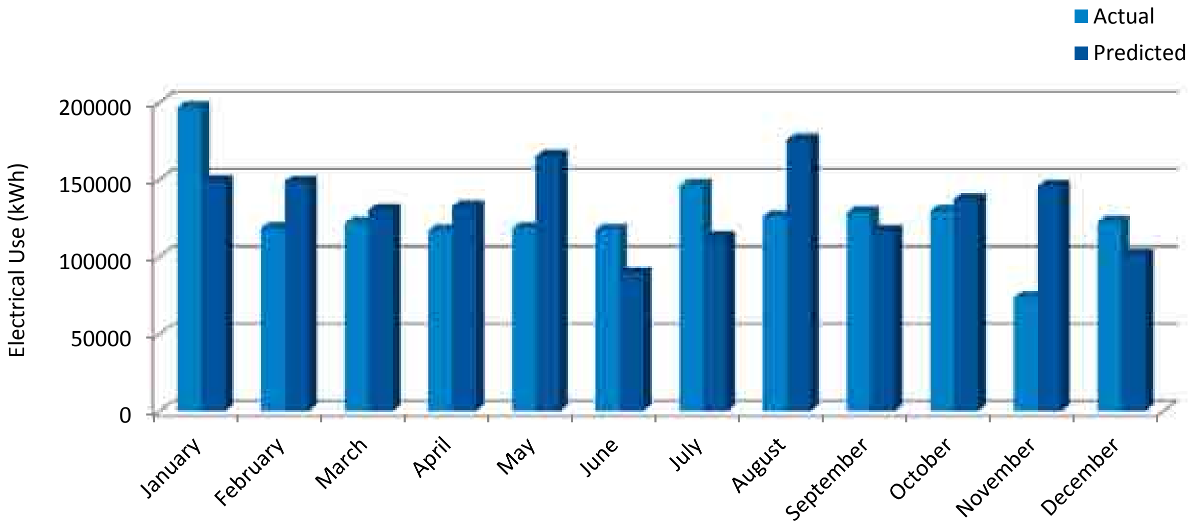


All major equipment noted during CDM Smith's on site audit is listed in Appendix I. See Appendix for additional equipment information.

4.2.4 Malcolm X Shabazz

A model of Malcolm X Shabazz was created in eQuest to predict heating and cooling loads for the building. To calibrate this model, CDM Smith used electricity bills from January 2010 to December 2012 and steam and chilled water bills from July 2010 through December 2012. Figure 4.2-11 below compares actual monthly electricity usages, with those predicted by the eQuest model. Historical monthly usages were averaged for each month observed over multiple years. For example, usage during the month of June was averaged for the three years, to yield an approximate average usage during the month of June.

Figure 4.2-11: Malcolm X Shabazz Electricity Usage



Once the eQuest model was calibrated, it could be used to predict approximate major usage categories, such as lighting, plug loads (miscellaneous), ventilation, and cooling. It should be noted that these are only estimated usages based on information gathered during CDM Smith's field audit. Figure 4.2-12 presents this information to help the Board visualize where CDM Smith anticipates the electricity is ultimately being used.

Figure 4.2-12: Malcolm X Shabazz Electricity Usage Breakdown

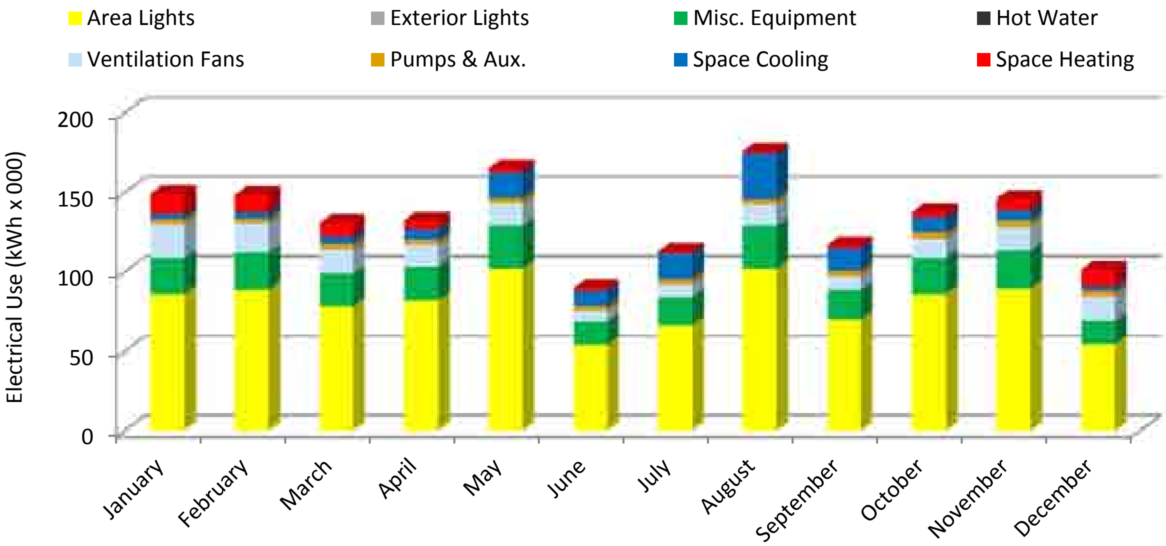
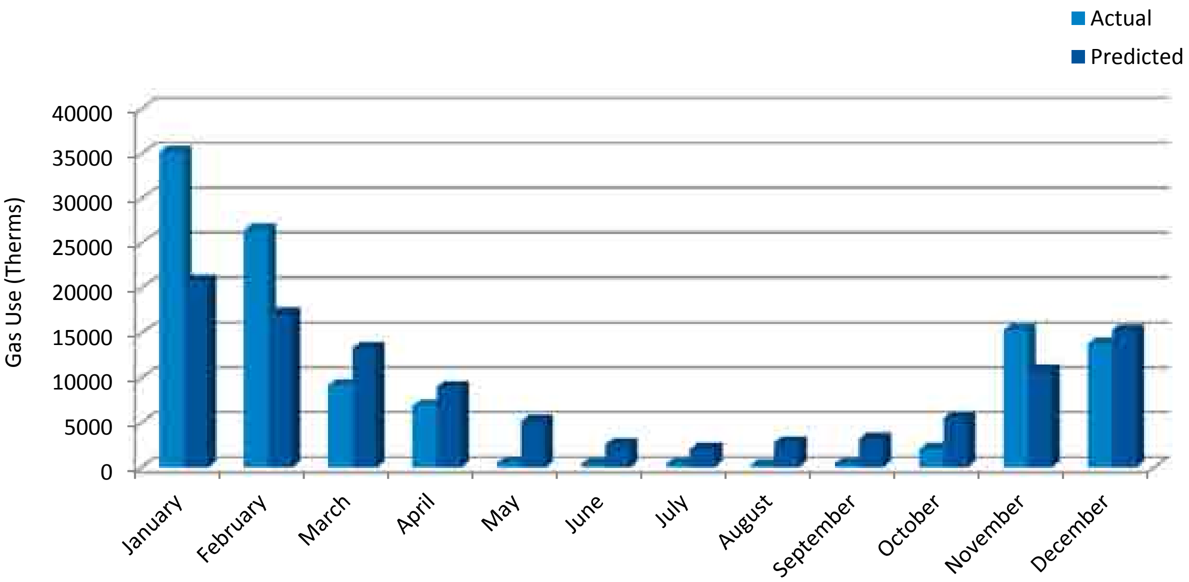


Figure 4.2-13 below compares actual natural gas usage to model-predicted natural gas use.

Figure 4.2-13: Malcolm X Shabazz Natural Gas Usage

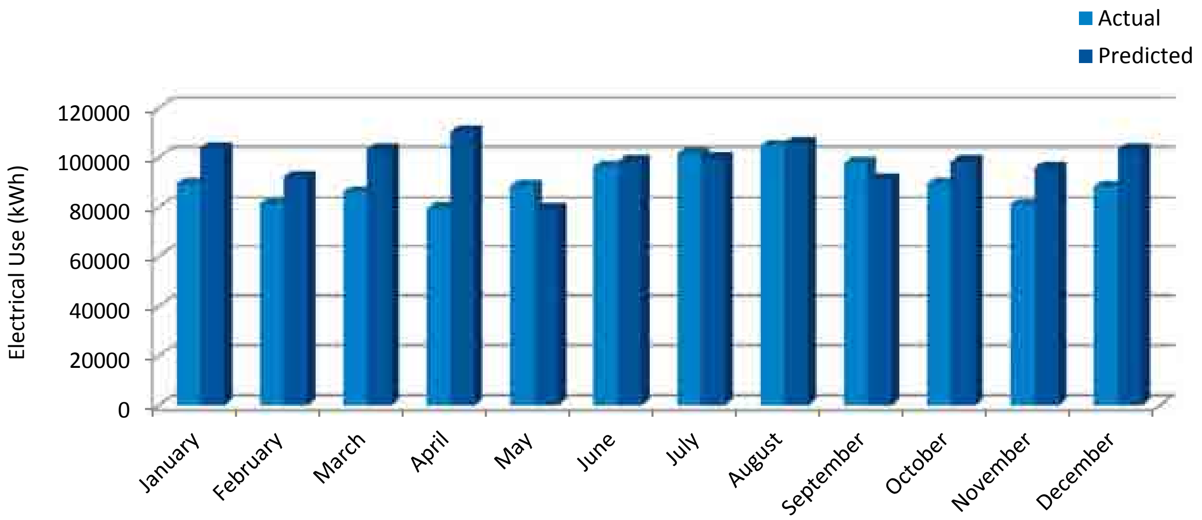


All major equipment noted during CDM Smith's on site audit is listed in Appendix I. See Appendix for additional equipment information.

4.2.5 Technology High School

A model of Technology High School was created in eQuest to predict heating and cooling loads for the building. To calibrate this model, CDM Smith used electricity, steam and chilled water bills from July 2010 through December 2012. Figure 4.2-14 below compares actual monthly electricity usages, with those predicted by the eQuest model. Historical monthly usages were averaged for each month observed over multiple years. For example, usage during the month of June was averaged for the three years, to yield an approximate average usage during the month of June.

Figure 4.2-14: Technology High School Electricity Usage



Once the eQuest model was calibrated, it could be used to predict approximate major usage categories, such as lighting, plug loads (miscellaneous), ventilation, and cooling. It should be noted that these are only estimated usages based on information gathered during CDM Smith's field audit. Figure 4.2-15 presents this information to help the Board visualize where CDM Smith anticipates the electricity is ultimately being used.

Figure 4.2-15: Technology High School Electricity Usage Breakdown

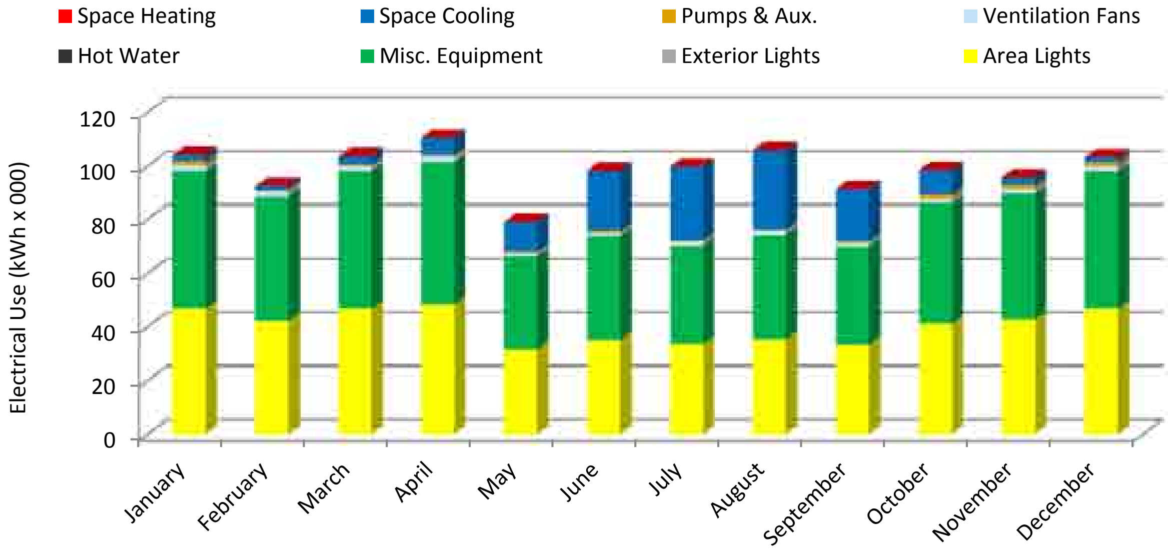
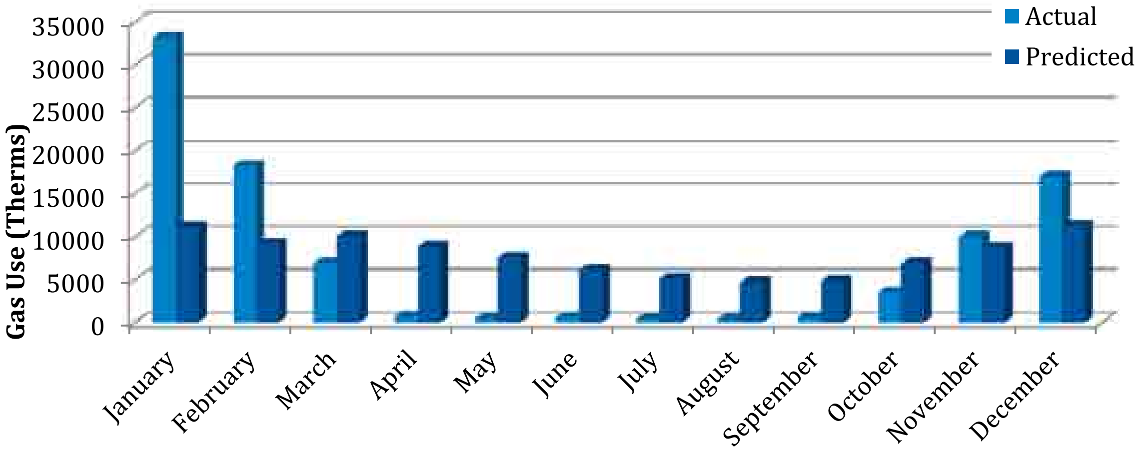


Figure 4.2-16 below compares actual natural usage to model-predicted natural gas use.

Figure 4.2-16: Technology High School Natural Gas Usage

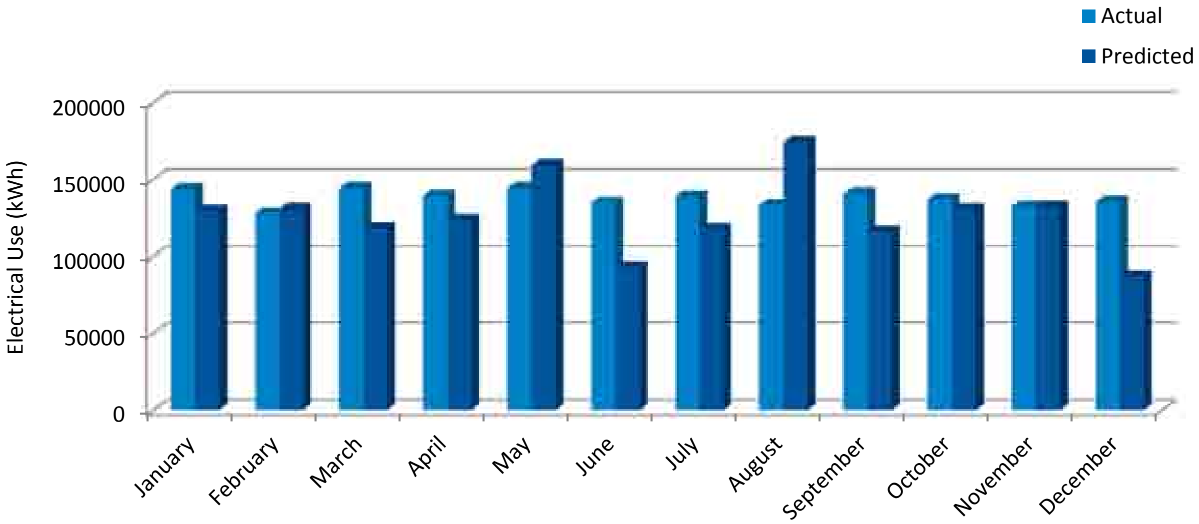


All major equipment noted during CDM Smith's on site audit is listed in Appendix I. See Appendix for additional equipment information.

4.2.6 Weequahic High School

A model of Weequahic High School was created in eQuest to predict heating and cooling loads for the building. To calibrate this model, CDM Smith used electricity bills and natural gas bills from January 2012 through December 2012. Figure 4.2-17 below compares actual monthly electricity usages, with those predicted by the eQuest model. Historical monthly usages were averaged for each month observed over multiple years. For example, usage during the month of June was averaged for the three years, to yield an approximate average usage during the month of June.

Figure 4.2-17: Weequahic High School Electricity Usage



Once the eQuest model was calibrated, it could be used to predict approximate major usage categories, such as lighting, plug loads (miscellaneous), ventilation, and cooling. It should be noted that these are only estimated usages based on information gathered during CDM Smith's field audit. Figure 4.2-18 presents this information to help the Board visualize where CDM Smith anticipates the electricity is ultimately being used.

Figure 4.2-18: Weequahic High School Electricity Usage Breakdown

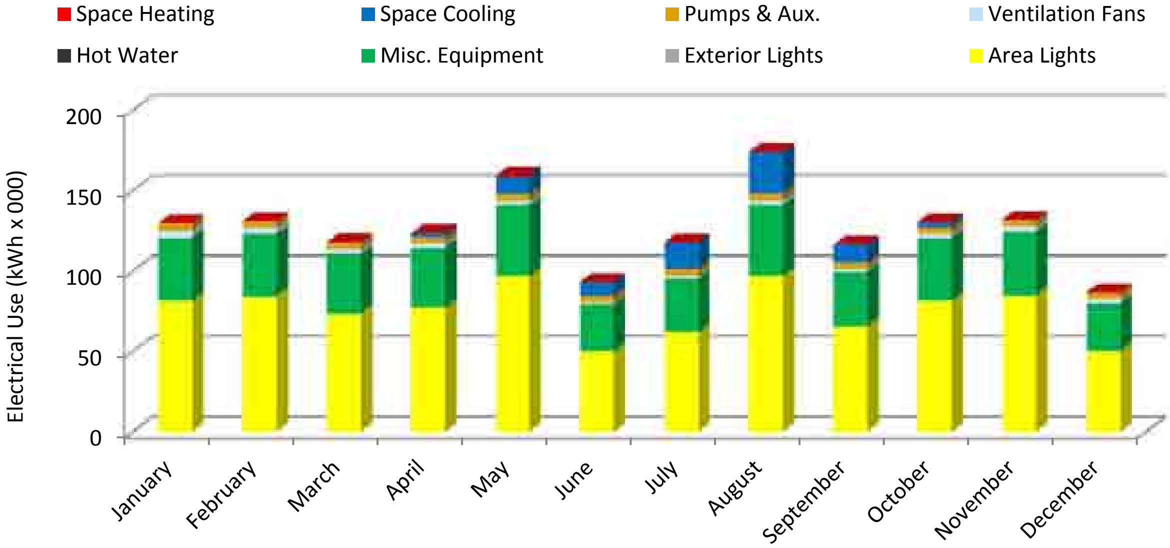
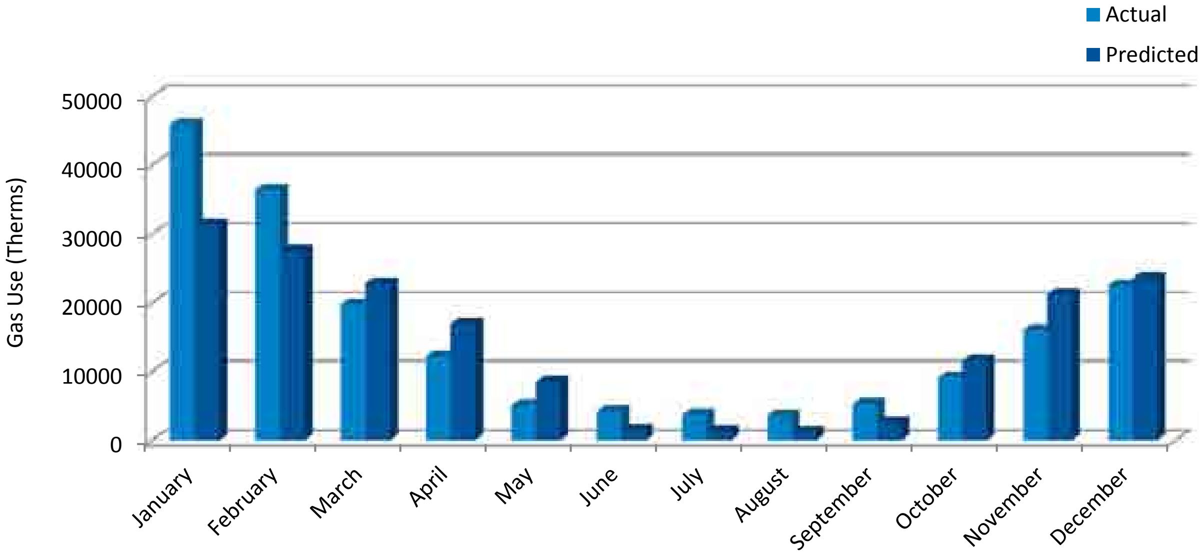


Figure 4.2-19 below compares actual natural usage to model-predicted natural gas use.

Figure 4.2-19: Weequahic High School Natural Gas Usage



All major equipment noted during CDM Smith's on site audit is listed in Appendix I. See Appendix for additional equipment information.

4.2.7 Energy Conservation and Reduction Measures

4.2.7.1 Condensing Boiler Installation

The existing boilers are all fire tube boilers. Three schools have hot water boilers. Two other schools have a heat exchanger that make space heating hot water using steam from the boilers. These boilers are aging any many are due for replacement.

Condensing boilers have lower exhaust temperatures. This lower temperature keeps more energy in the boiler. The lower temperature exhaust is generated with lower temperature heating water. The condensing boiler has greater efficiencies as the water temperature decreases. The savings can be increased by changing the water temperature based upon the outdoor air temperature.

This measure involves installing new boilers, breeching, and wiring and outdoor reset controls. This does not change the zone pumping, piping and controls. In buildings with steam boilers, the condensing boilers will be installed in place of the steam wot water heat exchangers. The condensing boilers will only be connected to the space heating hot water loop.

Fiscal savings from such an upgrade are then identified in Table 4.2-1 below. Lifetime savings calculations for all ECRM's may be found in Appendix I. Please note that these are estimates based on building models, and further investigation is warranted before pursuing boiler replacements.

Due to the improved automation and control within modern condensing boilers, their operation and maintenance costs tend to be less than those of typical cast iron boilers. CDM estimates a cast iron / fire-tube boiler system will typically cost around $3,500 per year for regular preventative maintenance, whereas a condensing boiler system would cost around $2,000 per year. Therefore, replacing the existing boiler with a condensing boiler should result in an operation and maintenance cost savings of $1,500 per year.

Table 4.2-1
Condensing Boiler Installation Payback

Facility	Total Cost	Energy Savings	Annual Maintenance Savings	Incentive	Annual Fiscal Savings[2]	IRR	NPV	Lifetime Savings	Simple Payback (Years)
Arts High School	$217,265	34,700 therms	$4,500	$6,000	$ 31,818	13.08%	$388,067	$ 939,074	**8.1**
Barringer High School	$217,265	18,000 therms	$4,500	$6,000	$ 13,631	-5.83%	($145,534)	$ 277,768	**19.8**
George Washington Carver	$217,265	17,389 therms	$4,500	$6,000	$ 16,623	-2.17%	($87,920)	$ 209,645	**15.2**
Malcolm X Shabazz	$154,876	20,700 therms	$3,000	$4,000	$ 19,199	10.24%	$196,395	$ 400,855	**10.0**
Technology High School	$217,265	15,255 therms	$4,500	$6,000	$ 14,415	4.01%	$30,236	$ 409,637	**17.5**

*Assumes 2% yearly inflation on natural gas costs
**Incentives, per New Jersey Clean Energy Program, are $1.00 per MBH

4.2.7.2 VFD Space Heating Hot Water Pumping Control

The heating hot water system has multiple large pumps to circulate the water through the heating units. The pumps are on whenever the building needs heating. The building does not require the full flow when the outdoor air temperature is moderate.

The heating water temperature drops less when there is less demand for space heating. A variable frequency drive, or VFD, can be installed to reduce the flow when it is not needed. The VFD can be controlled to maintain the heating hot water return temperature. This measure involves installing a VFD, sensors and controls for each main heating circulation pumps.

Table 4.2-2
Barringer High School Pump VFD Payback

Predicted Annual Savings (Therms)	-4,000
Predicted Annual Savings (kWh)	43,500
Total Annual Savings	$2,610
Initial Capital Cost of Upgrade	$89,500
Incentives**	$ 0
Cost of Upgrade	$89,500
Annual Maintenance Cost Savings (AMCS)	$ 0
Simple Payback	34.3
Lifetime Energy Savings (15 years)*	$53,086
Annual Return on Investment (AROI)	-2.08%
Internal Rate of Return (IRR)	-5.48%
Net Present Value (NPV)	$-48,187

*Assumes 2% yearly inflation on natural gas costs, 3% inflation on electricity costs
**Incentives, per New Jersey Clean Energy Program

4.2.7.3 George Washington Carver Auditorium RTU Replacement

The two roof top units serving the auditorium were not operational at the time of the site visit. Building staff reported that the units were not properly functioning. The units are responsible for cooling the Auditorium.

Replacing these roof top units will increase the system efficiency and add economizer controls. Replacing the units will allow the proper cooling of the space. The analysis of this measure shows that a properly functioning unit will increase the building heating and cooling usage.

4.2.7.4 Condensing Domestic Water Heater

The domestic water heaters at the school district are typically atmospheric, gas fired, storage type. The water heaters are of various age and capacity.

Installing condensing domestic water heaters increases the efficiency of the production. Condensing water heaters can increase efficiency from 80% to 90% or higher.

This measure involves installing condensing domestic water heaters to replace the existing domestic water heaters. Table 4.2-8 demonstrates the potential payback from such an implementation.

Table 4.2-3
Condensing Domestic Water Heater Payback

Facility	Total Cost	Energy Savings	Incentive**	Annual Fiscal Savings[2]	IRR	NPV	Lifetime Savings	Simple Payback (Years)
Arts High School	$35,000	-5,654 therms 149,100 kWh	$1,000	$17,321	48.24%	$161,345	$245,818	**2.1**
Barringer High School	$35,000	920 therms 0 kWh	$1,000	$697	-10.48%	-$24,476	$12,048	**50.2**
George Washington Carver	$35,000	823 therms 0 kWh	$1,000	$787	-9.37%	-$23,204	$13,663	**44.4**
Malcolm X Shabazz	$58,105	970 therms 0 kWh	$2,000	$900	-12.54%	-$43,824	$15,600	**64.6**
Technology High School	$35,000	314 therms 0 kWh	$1,000	$297	-17.25%	-$29,920	$5,132	**117.8**
Weequahic High School	$20,000	710 therms 0 kWh	$500	$640	-6.13%	-$10,786	$11,070	**31.2**

*Assumes 2% yearly inflation on natural gas costs, 3% inflation on electricity costs

**Incentive of $500 per unit installed

4.2.7.5 DDC Control System

The existing control systems are a mix of local pneumatic controls, proprietary electronic controls and thermostatic radiator valves. This measure involves installing DDC controls on the HVAC systems of the schools. This system shall be able to schedule the space temperature, outdoor air, and unit functionality.

This measure involves installing DDC thermostats, terminal unit controllers, electric actuators on valves and dampers, and boiler controls. The savings of this system is approximated to be 10% of the annual heating, cooling, pumping and ventilation usage. Installing a new DDC system will have a cost of $1/sqft of building.

Table 4.2-4
DDC Control System Payback

Facility	Total Cost	HVAC Energy	Energy Savings	Annual Fiscal Savings[2]	IRR	NPV	Lifetime Savings	Simple Payback (Years)
Arts High School	$172,163	138,500 therms 302,700 kWh	20,775 therms 45,405 kWh	$25,903	14.58%	$186,986	$456,904	**6.6**
Barringer High School	$296,708	131,400 therms 231,200 kWh	19,710 therms 34,680 kWh	$19,669	1.89%	-$24,439	$346,331	**15.1**

Table 4.2-4 (Continued)
DDC Control System Payback

Facility	Total Cost	HVAC Energy	Energy Savings	Annual Fiscal Savings[2]	IRR	NPV	Lifetime Savings	Simple Payback (Years)
George Washington Carver	$210,384	35,497 therms 192,300 kWh	5,325 therms 28,845 kWh	$9,267	-2.70%	-$80,259	$165,712	**22.7**
Malcolm X Shabazz	$316,828	98,000 therms 392,900 kWh	14,700 therms 58,935 kWh	$22,291	2.79%	-$5,138	$396,797	**14.2**
Technology High School	$172,163	4,532 therms 172,400 kWh	9,465 therms 47,340 kWh	$15,776	6.46%	$49,090	$281,735	**10.9**
Weequahic High School	$220,995	163,000 therms 161,900 kWh	24,450 therms 24,285 kWh	$25,987	10.08%	$136,526	$454,546	**8.5**

*Assumes 2% yearly inflation on natural gas costs
**No Incentives, per New Jersey Clean Energy Program,

4.2.7.6 Combined Heat and Power

When using thermal energy and electrical energy coincidentally, it can be cost effective to produce both on site instead of purchasing them from the grid. Commonly the grid power producers use similar technologies to produce electricity but nominally waste the thermal energy produced. Sites with continuous need for electrical and thermal energy can produce a base load of both energies.

This measure involves installing a device that will consume natural gas and produce electrical and thermal energy. These yields are typical for 65 kW devices such as a micro turbine or engine generator. The savings of this system is approximated by the following screening. Buildings with average demands of at least twice the unit rated capacity are presumed to have a majority of hours. The detailed calculations are included in Appendix C.

School	Electric			Gas		
	kWh	kW (avg)	$	Therms	MBH (avg)	$
Arts High School	1,225,084	140	$183,763	135,962	1,552	$122,366
Barringer High School	1,389,847	159	$194,579	109,838	1,254	$95,559
George Washington Carver	1,032,000	118	$103,200	122,524	1,399	$117,623
Malcolm X Shabazz	2,182,647	249	$327,397	145,068	1,656	$134,913
Technology High School	1,084,800	124	$119,328	21,236	242	$20,599
Weequahic High School	837,408	96	$133,985	184,083	2,101	$173,038
			Schools that appear to be CHP candidates			

Table 4.2-5
Combined Heat and Power Payback

Facility	Total Cost	Energy Savings	Incentive	Annual Fiscal Savings[2]	Simple Payback (Years)
Arts High School	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$14,820	**6.8**
Barringer High School	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$16,650	**6.0**
Malcolm X Shabazz	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$11,681	**8.6**
George Washington Carver	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$13,302	**7.5**
Technology High School	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$11,924	**8.4**
Weequahic High School	$143,000	-36,374 therms 594,000 kbtuh 280,800 kWh	$42,900	$18,595	**5.4**

These facilities require further analysis before pursuing further installation. Cost does not include any changes the electrical system, gas service, building or hot water system.

4.2.7.7 Building Insulation Upgrade

The existing buildings have minimal exterior insulation. The buildings are primarily masonry construction for exterior walls. The interior surface of the walls are often obstructed by mechanical equipment. These conditions all make exterior insulation a more logical means of insulating the building.

Exterior Insulation Finishing System, or EIFS, is comprised of a rigid insulation with an exterior coating, typically stucco. This method of insulating the building provides a continuous layer of insulation over the exterior of the building. This continuous layer helps eliminate thermal bridging through interior walls and floors, which is common with installing insulation along the interior face of the walls.

This measure involves installing 2 inches of polystyrene insulation and a light stucco finish to the above grade exterior walls of the buildings. This measure is not recommended due to the long paybacks.

Table 4.2-6
Building Insulation Payback

Facility	Total Cost	Energy Savings	Incentive**	Annual Fiscal Savings[2]	Simple Payback (Years)
Arts High School	$1,644,364	3,800 therms 400 kWh	$1,000	$3,420	**472.5**
Barringer High School	$1,232,334	20,800 therms 19,400 kWh	$1,000	$18,096	**59.2**
George Washington Carver	$1,064,849	2,270 therms 19,400 kWh	$1,000	$2,179	**258.5**
Malcom X Shabazz	$1,568,817	15,400 therms 25,700 kWh	$2,000	$14,322	**86.3**
Technology High School	$708,831	4,200 therms 7,800 kWh	$1,000	$4,074	**143.7**
Weequahic High School	$1,016,966	2,000 therms 600 kWh	$500	$1,880	**514.7**

4.2.7.8 Window Upgrade

The existing building windows are typically replacements and almost exclusively double pane windows. The windows are in fair condition. The existing windows are presumed to have a u-value of 0.6.

New windows with insulated glass, thermal break in frame, and low-e coatings help to reduce the heating and cooling loads of the space. The evaluated replacement windows have a u-value of 0.35.

This measure involves replacing windows with aluminum frame, double pane, argon filled, and low-e glazing with a u-value of 0.35 or less. This measure is not recommended due to the long paybacks.

Table 4.2-7
Window Upgrade Payback

Facility	Total Cost	Energy Savings	Incentive**	Annual Fiscal Savings[2]	Simple Payback (Years)
Arts High School	$346,393	3,400 therms 1,000 kWh	0	$3,060	**107.9**
Barringer High School	$571,860	4,200 therms 2,100 kWh	$0	$3,654	**144.8**
George Washington Carver	$604,111	4,886 therms -900 kWh	$0	$4,691	**131.3**
Malcom X Shabazz	$715,740	5,100 therms 16,600 kWh	$0	$4,743	**99.0**

Facility	Total Cost	Energy Savings	Incentive**	Annual Fiscal Savings[2]	Simple Payback (Years)
Technology High School	$313,320	-300 therms 1,700 kWh	$0	($291)	**-3012.7**
Weequahic High School	$653,437	5,000 therms 2,600 kWh	$0	$4,700	**127.7**

4.2.7.9 Steam Boiler Replacement

The existing boilers are all fire tube boilers. Weequahic has 2 large boilers that are nearing the end of their expected life. Arts High School has 2 large boilers that are also near the end of their life.

High efficiency steam boilers will have higher thermal efficiency, allowing for the boilers to use less fuel to produce the same amount of heat. The boilers size should also be re-evaluated to verify that boiler capacity is matching the building requirements. CDM's building model shows the building heating requirement is much less than the boiler capacity installed.

This measure involves installing new boilers, breeching, and wiring and outdoor reset controls. This does not change the pumping, piping and controls. Boilers in steam building shall be sized by installed radiation capacity. This measure is based upon installing two high efficiency, dual fuel, cast iron, boilers, rated at 4000 MBH at each high school.

Fiscal savings from such an upgrade are then identified in Table 4.2-8 below. Lifetime savings calculations for all ECRM's may be found in Appendix I. Please note that these are estimates based on building models, and further investigation is warranted before pursuing boiler replacements.

Table 4.2-8
Steam Boiler Installation Payback

Facility	Total Cost	Energy Savings	Annual Maintenance Savings	Incentive	Annual Fiscal Savings[2]	IRR	NPV	Lifetime Savings	Simple Payback (Years)
Arts High School	$293,631	28,500 therms	$0	$8,000	$ 26,133	8.48%	$177,624	$ 634,968	**10.9**
Weequahic High School	$293,631	19,400 therms	$0	$8,000	$ 17,490	5.22%	$79,486	$ 532,084	**16.3**

*Assumes 2% yearly inflation on natural gas costs
**Incentives, per New Jersey Clean Energy Program, are $1.00 per MBH

4.2.7.10 Vending Miser

The schools have vending machines. These machines are in an assortment of locations. Schools have various levels of usage of these machines. These machines are always on even though the building is occupied less than half of the week.

Adding controls to the vending machines reduces the electrical usage. If the building's schedule is very consistent the vending machines can be turned on and off by an electrical timer. Another means of controlling the vending machine operation is an occupancy based controller like a VendingMiser. The VendingMiser uses an occupancy sensor to control the operation of the vending machines.

This measure is based upon facilities being occupied 75 hours a week and half the electrical savings would have to be replaced with heating. The savings is created by the VendingMiser energy analysis tool.

Table 4.2-9
VendingMiser Payback

Facility	Total Cost	Energy Savings	Incentive**	Annual Fiscal Savings[2]	Simple Payback (Years)
Barringer High School	$678	-68 therms 3,998 kWh	$0	$500	**1.4**
George Washington Carver	$179	-32 therms 1,872 kWh	$0	$157	**1.1**
Malcom X Shabazz	$358	-64 therms 3,744 kWh	$0	$502	**0.7**
Technology High School	$518	-72 therms 4,194 kWh	$0	$392	**1.3**
Weequahic High School	$358	-64 therms 3,744 kWh	$0	$539	**0.7**

*Assumes 2% yearly inflation on natural gas costs, 3% inflation on electricity costs
**No incentives offered for this measure

4.2.7.11 Premium Efficiency Motors

Installing premium efficiency motors in place of older or standard efficiency motors reduces the electricity required to perform the same work.

This measure is based upon replacement of the following motors. Motors are presumed to be ODP style and 1800 RPM. The efficiencies of non-NEMA rated motors have been estimated.

Facility	Total Cost	Energy Savings	Incentive**	Annual Fiscal Savings[2]	IRR	NPV	Lifetime Savings	Simple Payback (Years)
Arts High School	$5,960	11,692 kWh	$342	$ 1,765	32.8%	$18,408	$ 30,520	**3.2**
Barringer High School	$5,355	9,277 kWh	$369	$ 1,299	27.0%	$12,695	$ 22,460	**3.8**
Malcom X Shabazz	$5,505	4,069 kWh	$428	$ 610	10.3%	$3,231	$ 10,554	**8.3**
Technology High School	$1,715	608 kWh	$135	$ 67	-3.5%	($670)	$ 1,156	**23.6**

Table 4.2-10
Premium Efficiency Motor Installation Payback

Building Premium Efficiency Motors														
		Existing				Proposed				Annual Savings		Cost	Incentive	Payback
Location	Motor Use	HP	Efficiency	Hours	Usage	HP	Efficiency	Hours	Usage	(kWh)	($)	($)	($)	(Years)
ARTS	HEATING P-1	25	85.5%	3000	65,439	25	93.6%	3000	59,776	5,663	$849.44	$2,275	$ 117	2.54
ARTS	HEATING P-2	25	85.5%	3000	65,439	25	93.6%	3000	59,776	5,663	$849.44	$2,275	$ 117	2.54
ARTS	AIR COMPRESSOR 1	3	80.5%	1000	2,780	3	89.5%	1000	2,501	280	$41.93	$ 705	$ 54	15.52
ARTS	AIR COMPRESSOR 2	3	86.5%	1000	2,587	3	89.5%	1000	2,501	87	$13.01	$ 705	$ 54	50.04
BARRINGER	HEATING P-SPARE	5	80.0%	3000	13,988	5	89.5%	3000	12,503	1,485	$207.86	$ 805	$ 54	3.61
BARRINGER	HEATING P-1	5	80.0%	3000	13,988	5	89.5%	3000	12,503	1,485	$207.86	$ 805	$ 54	3.61
BARRINGER	HEATING P-2	5	80.0%	3000	13,988	5	89.5%	3000	12,503	1,485	$207.86	$ 805	$ 54	3.61
BARRINGER	HEATING P-3	1	78.0%	3000	2,869	1	89.5%	3000	2,501	369	$51.61	$ 525	$ 45	9.30
BARRINGER	HEATING P-4	5	80.0%	3000	13,988	5	89.5%	3000	12,503	1,485	$207.86	$ 805	$ 54	3.61
BARRINGER	HEATING P-5	5	80.0%	3000	13,988	5	89.5%	3000	12,503	1,485	$207.86	$ 805	$ 54	3.61
BARRINGER	HEATING P-6	5	80.0%	3000	13,988	5	89.5%	3000	12,503	1,485	$207.86	$ 805	$ 54	3.61
SHABAZZ	HEATING P-1	5	87.5%	3000	12,789	5	89.5%	3000	12,503	286	$42.87	$ 805	$ 54	17.52
SHABAZZ	HEATING P-2	15	89.5%	3000	37,508	15	93.0%	3000	36,097	1,412	$211.74	$1,475	$ 104	6.47
SHABAZZ	HEATING P-3	10	87.5%	3000	25,577	10	91.7%	3000	24,406	1,171	$175.72	$1,075	$ 90	5.61
SHABAZZ	HEATING P-4	10	89.5%	3000	25,006	10	91.7%	3000	24,406	600	$89.99	$1,075	$ 90	10.95
SHABAZZ	HEATING P-5	10	89.5%	3000	25,006	10	91.7%	3000	24,406	600	$89.99	$1,075	$ 90	10.95
TECHNOLOGY	AIR COMPRESSOR 1	5	87.5%	1000	4,263	5	89.5%	1000	4,168	95	$10	$ 805	$ 54	71.67
TECHNOLOGY	AIR COMPRESSOR 2	8	84.0%	1000	6,661	8	91.0%	1000	6,148	512	$56	$ 910	$ 81	14.71

4.3 Alternative Energy Sources

4.3.1 Photovoltaic Solar Energy System Overview

Photovoltaic (PV) cells convert energy from 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.

Fixed Tilt System

Based on the estimated cumulative total available roof area, calculations determine that the installation of five (5) systems with a total rating of approximately 1,694 kW (dc) will be appropriate for the five (5) buildings listed below.

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

- Site visit by CDM Smith engineers;
- Satellite Image Analysis and Conceptual design and layout of the photovoltaic system;
- Design and construction cost estimates;
- Determine a preliminary design for the size and energy production of the solar system.

The total unobstructed available area of each section of roof having a southern exposure for the existing buildings were evaluated. It is important to note that the structural integrity of the roofs was not confirmed during CDM Smith's site visit, therefore, buildings may require some degree of roof reinforcing work prior to the implementation of a roof mounted solar system.

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 (180 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.

Blended electric rates were used based on actual utility bills and were applied for the buildings.

The following is a preliminary study on the feasibility of installing PV solar systems at five (5) buildings to generate a portion of each building's electricity requirements. Each 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 buildings was performed on March 25th-27th, 2013.

Also, as part of the assessment, CDM Smith 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.

Table 4.3-1 provides a summary of all proposed roof mounted PV systems for the Board. The Project Team conducted facility walkthroughs and utilized satellite image analysis and to determine the estimated total available area, then calculated the potential capacity of a solar array system for each location. It should be noted that the interconnection point for the PV system will require a modification or replacement of the existing service entrance equipment wherein the PV system feeder connections will have to be made after the main circuit breaker, and protective relaying will also have to be implemented. Any connection points would have to meet NEC and local utility requirements. Further investigation and verification of existing electrical equipment at each location would be required prior to implementation of a PV system. See section 2 for a detailed description of each building's roof type.

Table 4.3-1: Proposed Solar System Summary

Location	Roof Type	Proposed PV Array Size (kW DC)
Arts High School	Flat	134
Malcolm X Shabazz High School	Flat	400
Technology High School	Flat	350
Weequahic High School	Flat	340
George Washington Carver	Flat	470

4.3.1.1 Basis for Design and Calculations

The proposed Photovoltaic (PV) Power systems outlined in Table 4.3-1 for each facility 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.

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 NJ should be 25-35 degrees with an azimuth as close as possible to 180 (south); however, 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.

4.3.1.2 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. Results of this calculation are summarized in Table 4.3-2. The PV systems were designed to provide maximum kWh production based on available roof space.

Table 4.3-2: Summary of Solar (PV) Systems

Building	Simple Payback	Size (kW DC)	kWh Production	Energy Savings	SREC*	AROI	IRR	NPV	Lifetime Savings (25 Years)
Arts High School	33.9	**134**	145,531	$21,830	$29,106	(1.05%)	(3.07%)	($842,188.69)	$795,892
Malcolm X Shabazz High School	33.2	**400**	435,200	$60,928	$87,040	(0.99%)	(3.05%)	($2,369,232.64)	$2,221,390
Technology High School	42.7	**350**	380,800	$26,656	$76,160	(1.66%)	(6.39%)	($2,698,322.43)	$971,858
Weequahic High School	39.5	**340**	369,920	$33,293	$73,984	(1.47%)	(5.26%)	($2,455,598.59)	$1,213,831
George Washington Carver	40.7	**470**	511,360	$40,909	$102,272	(1.54%)	(5.74%)	($3,463,657.11)	$1,491,505

*An SREC factor of 0.200/kWh was used in this calculation, based on SREC trading values over the past six months.

4.3.2 On-Site Wind Power Generation

Due to the lack of available space within the city limits of Newark, the required clearances for a wind turbine are not available, therefore on-sire wind power generation is not a viable option for the Newark BOE at this time.

4.3.3 Additional Measures

It may be possible to reduce the plug load of the facilities even further with the implementation of smart strips and energy star appliances. Smart Strips save energy by electronically unplugging all of the devices that are plugged into the “Automatically Switched outlets” when the device plugged into the control outlet is turned off. It is important to note that CDM Smith is not suggesting that computers be plugged into the automatically switched off outlets, as there would be potential for the computers to be shut off mid-operation. There are a vast amount of computer peripherals that are typically left on after a computer is shut off, including monitors, scanners, printers and DSL/Cable modems. These peripherals can be plugged into the automatic outlets.

A standard Smart Strip has one ‘control’ outlet, six (6) outlets that are automatically switched off when the control device is and three (3) outlets that are always hot. An example of how the University can implement the use of Smart Strips office or library settings is to plug a computer into the control outlet, five (5) monitors and a personal printer (8 W in standby mode) into the automatic outlets and three (3) computers into the always hot outlets. An LCD monitor can use up to 34W; in standby mode

the monitor utilizes 1 – 2W. A CRT monitor typically utilizes around 75W. The following table 4.3-3 summarizes the payback of a Smart Strip, assuming 5 LCD monitors and 1 printer are automatically powered down that would otherwise been left on 8 hours/day and in standby mode 16 hours/day, 5 days/week for 9 months.

Table 4.3-3: Simple Payback

Smart Strip Application Example	
Predicted Annual Savings – 5 LCD monitors, 1 printer (kWh)	308
*Total Annual Savings	$31
Initial Capital Cost	$40
Simple Payback (years)	1.2
Lifetime Energy Savings (15 years)	$465

*Aggregate Cost of $0.10/kWh

The following Table 4.3-4 summarizes other applications for the Smart Strip that may be applicable throughout the buildings:

Table 4.3-4 Applications for Smart Strips

Control Outlet	Switched Outlets
Computer	Monitors, printers, scanners, lamps
TV	VCR, DVD player, cable box
Lamp	Stereo, space heater

The Board should continue to implement Energy Star appliances. This is recommended on an ‘as-needed’ basis.

In addition to replacing old appliances with Energy Star appliances, the following two maintenance procedures can work to save the energy consumed by the refrigerators. One is cleaning dirty condenser coils, twice a year. A refrigerator’s condenser coils and cooling fins are located either under the unit behind a grille in the front or on the back of the appliance. The coils can be cleaned with a brush or vacuum cleaner hose. The second source of wasted energy associated with a refrigerator is the door seal. Realigning the door or replacing a no longer airtight door seal will work to improve energy efficiency.

Section 5

Evaluation of Energy Purchasing and Procurement Services

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.

CDM Smith obtained a third party energy supplier quote for the District, and unfortunately, the rates offered by the third party energy supplier were not competitive with the Public Services Enterprise Group (PSE&G) utility rates that the District is currently paying. The breakeven cost for the District was $0.08/kWh, but the quotes provided by the third party energy supplier exceeded this amount. Therefore, CDM Smith does not recommend that the District switch to a third party energy supplier at this time.

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

5.2 Demand Response Program

Demand Response is a program through which a business may save money by reducing their electricity use when wholesale electricity prices are high. Demand cost savings may be accrued when heavy demand causes instability on the electric grid, which can result in voltage fluctuations or grid failure. Demand Response is an energy management program that compensates the participant for reducing their energy consumption at critical times. Demand Response is a highly efficient and cost effective means of reducing the potential for electrical grid failure and price volatility. It is one of the best solutions to the Mid-Atlantic region’s current energy challenges.

The program provides at least 2 hours advance notice before curtailment is required. There is typically 1 event a year that lasts about 3 hours in the summer months, during periods of highest electrical demand.

Participation in Demand Response is generally done through companies known as Curtailment Service Providers, or CSPs. These companies who are members of PJM Interconnection. There is no cost to enroll in the program and participation is voluntary. You can choose when you want to participate. In most cases, there is no penalty for declining to reduce your electricity use when you’re asked to do so. The event is managed remotely by notifying your staff of the curtailment request. Then enacting curtailment through your Building Management System. CSPs will share in a percentage of your savings. These savings may differ among various CSPs, since there may be costs associated with the hardware and /or software required for participation. It is recommended that a number of CSPs be contacted to review their offers.

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 in 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 complex, 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

6.1.1 Lighting Systems

Table 6.1-1 includes the recommended ECRMs to provide energy savings for all building lighting systems, which include the installation of 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

Complex	Retrofit Cost	Incentives	Total Cost	Annual Fiscal Savings	Simple Payback (Years)
Malcom X Shabazz High School	$139,749.1	$11,610.0	$128,139.1	$28,242.8	**4.5**

Arts High School	$118,744.7	$14,060.0	$104,684.7	$15,561.1	**6.7**
Weequahic High School	$67,212.5	$6,330.0	$60,882.5	$5,820.6	**10.5**
Barringer High School	$97,183.6	$8,015.0	$89,168.6	$6,143.3	**14.5**
Technology High School	$51,340.7	$7,135.0	$44,205.7	$2,546.1	**17.4**
George Washington Carver	$70,726.1	$6,865.0	$63,861.1	$3,465.5	**18.4**

6.1.2 HVAC Systems

Table 6.1-2 includes the recommended ECRM 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 Upgrade

Facility Measure	Retrofit Cost	Incentive	Total Cost	Annual Fiscal Savings	Simple Payback (Years)
All Schools **VendingMiser**	$2,091	$0	$2,091	$2,090	1.0
Arts High School **Condensing DHW**	$36,067	$1,000	$35,067	$18,321	2.1
Arts High School **Premium Efficiency Motors**	$5,960	$342	$5,618	$2,107	3.2
Barringer High School **Premium Efficiency Motors**	$5,355	$369	$4,986	$1,668	3.8
Weequahic High School **Combined Heat and Power**	$143,000	$42,900	$100,100	$61,495	5.4
Barringer High School **Combined Heat and Power**	$143,000	$42,900	$100,100	$59,550	6.0
Arts High School **DDC Contols**	$172,163	$0	$172,163	$25,903	6.6
Arts High School **Combined Heat and Power**	$143,000	$42,900	$100,100	$57,720	6.8
George Washington Carver **Combined Heat and Power**	$143,000	$42,900	$100,100	$56,202	7.5
Arts High School **Condensing Boiler**	$264,428	$6,000	$258,428	$37,818	8.1
Malcom X Shabazz **Premium Efficiency Motors**	$5,505	$428	$5,077	$1,038	8.3

Table 6.1-2 (cont)
Ranking of Energy Savings Measures Summary – HVAC System Upgrade

Facility Measure	Retrofit Cost	Incentive	Total Cost	Annual Fiscal Savings	Simple Payback (Years)
Technology High School **Combined Heat and Power**	$143,000	$42,900	$100,100	$54,824	8.4
Weequahic High School **DDC Contols**	$220,995	$0	$220,995	$25,987	8.5
Malcom X Shabazz **Combined Heat and Power**	$143,000	$42,900	$100,100	$54,581	8.6
Malcom X Shabazz **Condensing Boiler**	$196,571	$4,000	$192,571	$23,199	10.0
Arts High School **Steam Boiler**	$293,631	$8,000	$285,631	$34,133	10.9
Technology High School **DDC Contols**	$172,163	$0	$172,163	$15,776	10.9
Malcom X Shabazz **DDC Contols**	$316,828	$0	$316,828	$22,291	14.2
Barringer High School **DDC Contols**	$296,708	$0	$296,708	$19,669	15.1
George Washington Carver **Condensing Boiler**	$258,958	$6,000	$252,958	$22,623	15.2
Weequahic High School **Steam Boiler**	$293,631	$8,000	$285,631	$25,490	16.3
Technology High School **Condensing Boiler**	$258,958	$6,000	$252,958	$20,415	17.5
Barringer High School **Condensing Boiler**	$275,836	$6,000	$269,836	$19,631	19.8

6.1.3 Solar Energy

Implementation of new solar energy systems has been evaluated to determine the economic feasibility for furnishing and installing such systems. Based on the simple payback modeling performed, it would not benefit the Board to further investigate installing the solar energy systems. This is primarily based on the initial upfront capital investment required for a solar energy system installation and a payback period greater than 20 years. Table 6.1-3, includes a ranking of the solar energy ECRMs evaluated for the Board.

Table 6.1-3
Ranking of Energy Savings Measures Summary – Solar Energy Systems

Building	Retrofit Cost	Annual SREC Credit	Annual Fiscal Savings	Simple Payback (Years)
Malcom X Shabazz High School	$4,625,000	$87,040.0	$60,928.0	33.2
Arts High School	$1,629,800	$29,106.2	$21,829.6	33.9
Weequahic High School	$3,950,000	$73,984.0	$33,292.8	39.5
George Washington Carver	$5,412,500	$102,272.0	$40,908.8	40.7
Technology High School	$4,062,500	$76,160.0	$26,656.0	42.7

Section 7

Grants, Incentives and Funding Sources

7.1 Renewable Energy

7.1.1 Renewable Energy Certificates (NJ BPU)

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 renewable energy. Electric suppliers fulfill this obligation by purchasing renewable energy certificates (RECs) from the owners of solar generating systems. One REC is created for every 1,000 kWh (1 MWh) of renewable electricity generated. Although solar systems generate electricity and Solar Renewable Energy Credits, or SRECs, in tandem, the two are independent commodities and sold separately. The RPS, and creation of RECs, is intended to provide additional revenue flow and financial support for renewable energy projects in New Jersey. Class I RECs, which include electricity generated from wind, wave, tidal, geothermal and sustainable biomass, typically trade at around $25/MWh. RECs generated from solar electricity, or SRECs, trade at $550/MWh due to supplemental funding from NJ PBU. The supplemental funding will decrease over time to $350/MWh.

7.1.2 Clean Energy Solutions Capital Investment Loan/Grant (NJ EDA)

NJ EDA, in cooperation with NJ DEP, is offering interest-free loans and grants for energy efficiency, combined heat and power (CHP), and renewable energy projects with total project capital equipment costs of at least $1 million. The interest-free loans are available for up to $5 million, a portion of which may be issued as a grant. For additional information, contact CESCI@njeda.com or call 866-534-7789.

7.1.3 Renewable Energy Incentive Program (NJ BPU)

The Renewable Energy Incentive Program (REIP) is currently on hold. For more information on REIP, please see www.njcleanenergy.com.

7.1.4 Grid Connected Renewables Program (NJ BPU)

The New Jersey Grid Connected Renewables Program offers competitive incentives for wind and sustainable biomass electricity generation projects larger than 1 Megawatt (MW). Most of the incentives offered under this program will take the form of a payment for energy production ($/MWh) once the project is operating. Incentives range up to $58.49/MWh for publicly-owned wastewater biogas projects. Up to 10% of the incentive may be requested in the form of a lump grant to cover up-front costs such as financing fees, interconnection fees, project design, permitting, and construction costs. For more information on the Grid Connected Renewable Program, please see www.njcleanenergy.com.

7.1.5 Utility Financing Programs

All four Electric Distribution Companies (EDCs) in New Jersey have developed long term contracting or financing programs for the development of solar energy systems. In all of the programs, Solar Renewable Energy Credits (SRECs) generated by the solar energy systems will be sold at auction to energy suppliers who are required to purchase a certain quantity of SRECs to meet their Renewable Portfolio Standard requirements.

7.1.6 Renewable Energy Manufacturing Incentive (NJ BPU)

New Jersey's Renewable Energy Manufacturing Incentive (REMI) program provides rebates to purchase and install solar panels, inverters, and racking systems manufactured in New Jersey. Rebates for panels start at $0.25 per watt and rebates for tracking systems and inverters start at $0.15 per watt for solar projects up to 500 kW in capacity. To be eligible for REMI, applicants must apply to either the Renewable Energy Incentive Program (REIP) or the SREC Registration Program (SRP).

7.1.7 Clean Renewable Energy Bonds (IRS)

The IRS is currently not accepting application for CREBs. For more information, please refer to http://www.irs.gov/pub/irs-drop/a-10-54.pdf.

7.1.8 Qualified Energy Conservation Bonds (IRS)

These IRS 0% interest bonds are very similar to CREBs except they are allocated based on state and county population. New Jersey was allocated $90 million as part of the ARRA stimulus fund. QECBs are typically distributed through municipal bond banks or state economic development agencies.

7.1.9 Global Climate Change Mitigation Incentive Fund (US EDA)

The Economic Development Agency (part of the U.S. Department of Commerce) administers the GCCMIF to public works projects that reduce greenhouse gas emissions and creates new jobs. In FY 2012, $16.5 million was allocated to the fund, and additional funding is expected to be allocated in FY 2013. Applications are due on a rolling basis. The program does not have a maximum grant amount but does limit the grant to 50 percent of the project cost.

7.1.10 Private Tax-Exempt Financing

Similar to traditional municipal bond financing, there are many private financial service companies that offer a myriad of options for tax-exempt financing of municipal projects. The providers of these services suggest that this capital can be offered at competitive rates in an expedited timeframe. Fewer complications arise when compared to traditional municipal financing methods. These factors will need to be compared on a case-by-case basis. The one distinct advantage to private financing, on the current project, would likely be flexibility to structure payments. This structure will meet budget needs with consideration given to the terms and conditions of existing loan and/or bond agreements. For example, this mechanism could be used to limit the initial debt payments when the current bond debt is the greatest. The operations savings of the project has yet to be fully realized. In many cases, the construction and long term financing can be rolled into a single private financing agreement. Equipment manufacturers have the ability to offer competitive financing terms (e.g. Siemens Financial Services Corporation). Financing from these sources is generally contingent upon a substantial portion of the project cost (~20% to 30%) being furnished with their respective equipment.

7.1.11 Performance Based Contracts (ESCOs)

A second financing alternative for a project of this nature would be to enter into a Performance Based Contract with an Energy Services Company (ESCO). The premise of this type of contract is that it requires no initial municipal capital contributions in order to implement the project. Instead they rely on future operations cost savings and/or energy production. These revinue streams fund the annual payments. Prior to entering into an agreement for the funding of the project, an ESCO would perform an energy audit. This audit or conceptual study will confirm future energy cost savings or energy production inherent with the projects implementation and operation. The contract would then be formulated based on some measurable parameter(s) (energy production, etc.). These parameters would be verified by measurement throughout the contract duration. The energy savings or production would then be used to pay back the capital investment of the project. The contract time period is typically on the order of 10-years or less. The ESCO would guarantee the agreed upon energy savings or energy production. If the project does not meet energy savings or production commitments, the ESCO pays the owner the equivalent difference.

With this funding alternative, the ownership and operation of the facility would be maintained by the original owner. A performance contract may also include ESCO operation and maintenance of the energy-related facilities. Significant ESCO's with experience in this area include Siemens Building Technologies, Chevron and Johnson Controls. CDM Smith has functioned in several roles on performance based contracts including being the owner's representative and, on different contracts, providing design-build services (as a subcontractor to the ESCO). CDM Smith can provide additional experience-based information upon request.

7.1.12 Power Purchase Agreements (SPC)

A Power Purchase Agreement (PPA) also delivers a project with no initial capital contribution by the original owner. In this model, a Special Purpose Company (SPC) created by a developer, would own the energy production facilities. Within the framework of a PPA, a SPC will typically lease property from the owners for construction and operation of the new facilities. The funding and construction of the new facilities would be performed by the SPC. The SPC would then own and operate the facilities for the duration of the contract (typically 20 to 30 years). Throughout that period of time, the original owner would purchase power from the SPC at a pre-negotiated rate. This rate would take into account the initial capital cost, operation and maintenance of the constructed facility. Ancillary benefits of the project and investor returns on investment are also included in the rate. For renewable energy, financial incentives may enable this financing approach to compete favorably with utility power tariffs. Incentives include state and local tax credits, renewable energy credits, and Federal energy production tax credits or energy investment tax credits. It is expected that a number of experienced companies and developers may be interested in a PPA for New Jersey municipal renewable energy projects.

7.2 Energy Efficiency

7.2.1 Introduction

New Jersey's Clean Energy Program (NJ CEP) 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 Buildings Program (NJ BPU)

The New Jersey Smart Start Buildings Program offers rebate incentives for several qualified equipment items 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 F.

7.2.3 Pay for Performance Program (NJ BPU)

Another program offered through the New Jersey Smart Start Program, is the Pay for Performance Program. Commercial, industrial and institutional buildings are eligible for participation if not already receiving Energy Efficiency and Conservation Block Grants.

Incentives are available for buildings that are able to present an Energy Reduction Plans that reduce the building's current energy consumption by 15% or more. These savings are in addition to incentives for installing the recommended measures and energy savings in a post-construction benchmarking report. No more than 50% of the total energy savings may be derived from lighting retrofits. In addition, the total energy savings of 15% may not come from the implementation of one energy savings measure. The incentive structure is provided in Appendix F.

The table below gives relevant details of the building details and energy usage and outlines the estimated Pay for Performance incetives. Incentives can vary bases upon the 15% savings distribution between the electric and fuel.

Facility	Square Footage	Electrical Energy Use (kWh)	Fuel Use for Entire Building (therms)	Incentive #1	Incentive #2	Incentive #3	Estimated Total Incentives
Arts High School	203,284	1,225,084	135,962	$10,164	$34,894	$34,894	$79,951
Barringer High School	296,708	1,389,847	109,838	$14,835	$33,591	$33,591	$82,018
George Washington Carver	210,384	1,032,000	122,524	$10,519	$30,473	$30,473	$71,465
Malcolm X Shabazz	316,828	2,182,647	145,068	$15,841	$49,050	$49,050	$113,941
Technology High School	172,163	1,084,800	92,173	$8,608	$27,088	$27,088	$62,784
Weequahic High School	220,995	837,408	184,083	$11,050	$36,156	$36,156	$83,362

The recommended ECRM's presented in this report are expected to warrant participation in this program.

7.2.4 Direct Install (NJ BPU)

Owners of existing small to mid-size commercial and industrial facilities may be eligible to participate in direct install. Facilities with a peak electric demand that did not exceed 150 kW in any of the preceding 12 months are eligible. Buildings must be located in New Jersey and served by one of the state's public, regulated electric or natural gas utility companies.

This program will cover up to 70% of the retro-fitting costs associated with the use of new energy efficient equipment. Lighting, HVAC, refrigeration, motors, natural gas systems, and variable frequency drives are covered under the Direct Install program.

The requirement of a peak demand of 150 kW in the preceding year and the information provided by the Disctrict precludes qualification of facilities included in this audit. The Direct Install Program is designed to fast-track project implementation. Energy savings can be realized sooner rather than later. Steps for participation are to contact the contractor assigned and trained to provide Direct Install services in your County. Then schedule an Energy Assessment with this contractor. The contractor will assist in completing the Program Application and Participation Agreement.

The Energy Assessment with the participating contractor will work to determine which conservation measures qualify and the resulting project cost. Following this assessment, a scope of work will be finalized and installation will be arranged. Following completion of the installation a 'project completion form' must be submitted to the program representative assigned to the project.

The contractor for Essex County is:

Lime Energy
Tony McCoy
Phone: 732-791-5380
Email: tmccoy@lime-energy.com

Any additional information on the Direct Install Program can be obtained by calling 866-NJSMART or by e-mail to DirectInstall@trcsolutions.com.