Long Branch Public Schools

Energy Savings Plan Revision 2

Project Number: ESG-Project #0201224.18.P00

Long Branch, New Jersey | November 28th, 2018

energy systems group

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SECTION 1. EXECUTIVE SUMMARY

Various energy conservation measures were evaluated in the development of this Energy Savings Plan (ESP). Energy Systems Group has performed field verifications, collected data and taken field measurements to ensure the development of the most cost-effective solutions as well as accurate savings calculations. Various solutions were reviewed with the school district's administration to develop a set of Energy Conservation Measures (ECMs) that allow the school district to address the facility's priority items while reducing the total annual energy spend for the District. This study expands upon the original energy audit conducted by TRC Energy Services (TRC). The original audit information was used for building descriptions as well as an overall indication of the District needs.

Priority items include:

- Upgrade Interior lighting throughout the 10 schools with newer LED technology
- Upgrade the HVAC central plant infrastructure at Morris Avenue & A.W.Clark Elementary Schools
- Eliminate the Steam Boiler at Lenna W Conrow School
- Replace the DDC control system at the Middle School and integrate with the existing district-wide BMS system
- Improve building leakage by upgrading Building Envelope

Energy Savings

Energy saving calculations performed in the development of this ESP was completed using Microsoft Excel worksheets with Bin weather data to accurately model the building systems. Additional spreadsheets were used for measures that are not affected by the weather, such as lighting savings. Energy savings have been provided electronically for ease of review. All of the energy savings calculations that have been performed are in accordance with the New Jersey Clean Energy Program Protocols to Measure Resource Savings.

Benefits

The measures investigated in this Energy Savings Plan could result in an annual utility savings of 3,488,303 kWh's of electricity and save 30,825 therms of natural gas. The total utility cost savings is $10,244,544 over the life of the project (20 years). Additionally, these energy savings will result in a net reduction of greenhouse gases and will reduce the school district's carbon footprint by 1,922 lbs. of CO_2 annually. All these savings are achieved while improving the classroom environment and renewing many items that have been in service beyond useful life expectancy.

SECTION 2. PROJECT DESCRIPTION

This Energy Savings Plan (ESP) addresses the following facilities. Any description in this report-stating "district wide" or similar refers only to the buildings listed below:

Long Branch School	
Long Branch High School	404 Indiana Avenue, Long Branch, NJ 07740
Long Branch Middle School	360 Indiana Avenue, Long Branch, NJ 07740
Audrey W. Clark Elementary School	192 Garfield Avenue, Long Branch, NJ 07740
George L. Catrambone Elementary School	240 Park Ave, Long Branch, NJ 07740
Gregory Elementary School	201 Monmouth Avenue, Long Branch, NJ 07740
Amerigo A. Anastasia School	92 Seventh Avenue, Long Branch, NJ 07740
Morris Avenue Elementary School	318 Morris Ave, Long Branch, NJ 07740
Joseph M. Ferraina ECLC	80 Avenel Boulevard, Long Branch, NJ 07740
Lenna W. Conrow School	335 Long Branch Ave, Long Branch, NJ 07740
Board of Education Office	540 Broadway, Long Branch, NJ 07740

Facility Descriptions

Long Branch High School

Background Information

Long Branch High School is located at 404 Indiana Avenue Long Branch, New Jersey. This 296,000 ft^2 facility was originally built in 2007 and remains in fair condition. Long Branch High School consists of four (4) floors of classroom space, office space, two (2) gymnasiums, an auditorium, library, two (2) cafeterias, a kitchen, locker rooms and a health center.

Building Occupancy

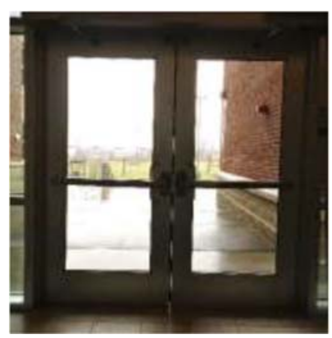
Approximate enrollment is 1500 students with a staff of 130 people, including frequent visitors.

Hours of Operation

- Monday through Friday (Whole Building) 6:00 am to 11:00 pm (students/staff)
- Saturday and Sunday (Gyms, Aud, Health Center and some Classrooms) 7:00 am to 5:00 pm

Envelope

The building is constructed of composite walls with a brick façade. The building has flat roofs and pitched roofs which appear in good condition. The building has double pane operable windows with metal frames and interior shades. The exterior doors are typically metal with glass panes and metal frames. Corridor areas have large double pane fixed windows with metal frames. The curved area of the building where the library/media center is located have visible cracks around the window frames. The sealant around these frames are in poor condition and the windows are a source of air infiltration. The exterior doors have either missing or worn weather-stripping materials which show signs of excessive infiltration. The building envelope has deficiencies and contributes to a significant amount of air infiltration.



Building Envelope

Lighting

The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps. Fixtures throughout the building include pendant mounted continuous rows fixtures, surface mounted wraps, recessed troffer fixtures or industrial fixtures. Some areas have recessed can fixtures and wall sconce fixtures with compact fluorescent plug in lamps. There are also some recessed can fixtures in the lobby area with metal halide lamps.

Long Branch High School Auditorium

The cafeteria areas are lit by recessed can fixtures and pendant mounted fixtures with compact fluorescent lamps. The auditorium is lit by large dimmable incandescent lamp fixtures.

The exterior lighting includes building mounted metal halide lamp and compact fluorescent lamp fixtures. There are also a number of single headed and double headed pole mounted area light fixtures which have either 1000W or 400W lamps.

Lighting Controls: The lighting in individual rooms are manually controlled via wall switches or occupancy based sensors. Typical classrooms are equipped with bi-level switching where 2 or 3 lamps may operate at a time. We recommend only using 2 lamps rather than 3 whenever possible.

Motors

Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and of standard to high efficiency. These systems include self-contained ground source heat pumps, exhaust fan motors, pump motors and supply fan motors. All motors in excess of 5 horsepower either currently utilize a variable frequency drive or were analyzed for retrofit.

Renewable Energy Systems

Long Branch High School has installed a canopy & fix-tilt, roof mounted 965.38 kWDC photovoltaic (solar) energy generation system, operating exclusively as a Net Metering Photovoltaic Solar Electric Facility (SEF). The rooftop Solar Electric Facility is comprised of one hundred and eighty-two (182) strings each with thirteen (13) Motech MTPVp-235-MSC poly-crystalline silicon photovoltaic modules in series with a maximum nominal voltage of 600 VDC. These strings are fed through eight (8) combiner boxes with 200amp, 600 volt integrated DC disconnects and to one (1) PVPowered 260kW, two (2) 100 kW and two (2) 35kW three-phase 480 VAC inverters. The Canopy Solar Electric Facility is comprised of one hundred and thirty-three (133) strings each with thirteen (13) Motech MTPVp-235-MSC poly-crystalline silicon photovoltaic modules in series with a maximum nominal voltage of 600 VDC. These strings are fed through twelve (12) combines boxes with 200 amp, 600 volt integrated DC disconnects and to one (1) PVPowered 260 kW and one (1) 100 kW three-phase 480 VAC inverters.

Mechanical Systems

HVAC Systems

HVAC Systems and Equipment: The building is heated by a ground source heat pump system. This is a highly efficient system as it utilizes the ground's constant temperature as a heat exchanger to provide heating and cooling to the building. This is a renewable source of energy. The heat pumps throughout the building are in good to fair condition. Some components of the major unit serving the gymnasiums, auditorium and cafeterias require frequent maintenance. These units are equipped with heat recovery capabilities as well. The library/media area is heated by perimeter fin tube radiators. For the purposes of this report, the efficiencies were de-rated for the existing equipment.

Refer to Appendix 8 for a detailed list of HVAC equipment at the site.

Hot Water Systems (Heating Hot Water & Domestic Hot Water)

Boiler Plant

The building is supplied hot water by three (3) gas-fired condensing boilers which are in fair to condition.

The sink aerators throughout the building are fit with higher flow devices (2.0 gallon per minute).

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	3	Boiler Room	Entire Building	AERCO	KC-1000 2007	2007	93%	930.00 (MBh)
DHW (Tanks)	2	Boiler Room	Entire Building	-	-	2007	N/A	250 Gal

Building Controls (HVAC Controls)

The building has a DELTA building management system (BMS). All major mechanical equipment are tied into this system. The system is equipped with global temperature set points and are over-ridden in certain areas where complaints are made. Each area of the building (A through G) has a different operating schedule which is tailored to the use of the area and temperature set points are set back for both the heating and cooling seasons. There are temperature sensors throughout the rooms of the buildings which communicate back for each associated heat pump. 68 degrees is the global temperature set point where some were locally overridden to 60 or 70 degrees. There are existing outdoor air temperature sensors and CO2 sensors.

Kitchen Equipment

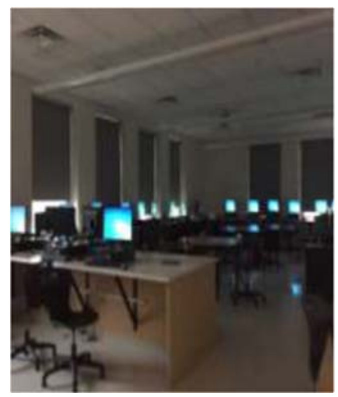
The kitchen utilizes both electric and gas cooking equipment. Various types of refrigeration equipment are present including walk-in coolers and a walk-in freezer.

Plug Load

Office equipment is regularly left in the 'on' state at all times allowing the individual machine to revert to the 'Sleep' mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged in equipment.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Projector	68
Smartboard	0
Projector/Smartboard Combo	0
Amplifier	0
Charging Cart	19
Small Printer	0
Medium Printer	0
Large Printer/Copier (110 only)	0
TV/LCD/Smart TV	0
Snack Vending	0
Soda Vending	0
Lg Coffeemaker (Bunn)	0
H/C Water Dispenser	0
Water Fountain (plug on outside)	0
AC - 220 (not to be more then 20 amps)	0
AC - 110 20 amps	0
AC - 110 15 amps	0
Electric Hot Water Heater	0
Other Device not listed above	0



Building Plug Loads

Plumbing/Water System

There are 80 faucets located in restrooms and locker rooms around the facility. All faucets currently use high flow 2.0 gallon per minute (gpm) or higher and the showerheads are assumed standard and rated for 2.5 gpm or higher aerators that can be replaced with low flow aerators.

Long Branch Middle School

Background Information

Long Branch Middle School is located at 360 Indiana Avenue, Long Branch, New Jersey. This 244,256 ft^2 facility was originally built in 2005 and is in fair condition. Long Branch Middle School consists of three (3) floors of classroom space, office space, two (2) gymnasiums, an auditorium, two (2) cafeterias and a kitchen.

Building Occupancy

Approximate enrollment is 1200 students with a staff of 120 people.

<u>Hours of Operation</u>

- Monday through Friday 6:00 am to 10:00 pm (students/staff)
- Saturday – No use and Sunday 11:00 am to 3:00 pm

Envelope

The building is constructed of composite walls with a brick façade. The building has flat roofs and pitched roofs which appear in good condition. The building has double pane operable windows with metal frames and interior shades. The exterior doors are typically metal with glass panes and metal frames. Corridor areas have large double pane fixed windows with metal frames. The exterior doors have either missing or worn weather-stripping materials which show signs of excessive infiltration. The building envelope has deficiencies and contributes to a significant amount of air infiltration.

Building Envelope

Lighting

Long Branch Middle School Auditorium

The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps. Fixtures throughout the building include pendant mounted continuous rows fixtures, surface mounted wraps, recessed troffer fixtures or industrial fixtures. Some areas have recessed can fixtures and wall sconce fixtures with compact fluorescent plug in lamps. There are also some recessed can fixtures in the lobby area with metal halide lamps.

The cafeteria areas are lit by recessed can fixtures and pendant mounted fixtures with compact fluorescent lamps. The auditorium is lit by large dimmable incandescent lamp fixtures. Both of the gyms are lit by linear fluorescent T8 high bay fixtures and equipped with occupancy sensor controls.

The exterior lighting includes building mounted wall pack fixtures, flood fixtures along the overhang and pole mounted area light fixtures. These contain compact metal halide lamps and some were already converted to LED technology.

Lighting Controls: The lighting in individual rooms are manually controlled via wall switches or occupancy-based sensors. Typical classrooms are equipped with bi-level switching where 2 or 3 lamps may operate at a time.

Motors

Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in good condition and high efficiency. These systems include ground source heat pumps, exhaust fan motors and supply fan motors. All motors in excess of 5 horsepower either currently utilize a variable frequency drive or were analyzed for retrofit.

Renewable Energy Systems

Long Branch Middle School installed a canopy & fix-tilt, roof mounted 772.920 kWDC photovoltaic (solar) energy generation system, operating exclusively as a Net Metering Photovoltaic Solar Electric Facility (SEF). The rooftop Solar Electric Facility is comprised of one hundred and nine (109) strings each with thirteen (13) Motech MTPVp-235-MSC poly-crystalline silicon photovoltaic modules in series with a maximum nominal voltage of 600 VDC. These strings are fed through eleven (11) combiner boxes with 210 amp, 600 volt integrated DC disconnects and to two (2) PVPowered 75kWpme (1) 50 kW and one (1) 100kW PVPowered three-phase 480 VAC inverters. The Canopy Solar Electric Facility is comprised of one hundred and forty-four (144) strings each with thirteen (13) Motech MTPVp-235-MSC poly-crystalline silicon photovoltaic modules in series with a maximum nominal voltage of 600 VDC. These strings are fed through fifteen (15) combiner boxes with 210 amp, 600 volt integrated DC disconnects and to two (2) 35kW and one (1) 75 kW and one 260 kW PVPOwered three-phase 480 VAC inverters.

Mechanical Systems

HVAC Systems and Equipment: The building is heated by a ground source heat pump system. This is a highly efficient system as it utilizes the ground's constant temperature as a heat exchanger to provide heating and cooling to the building. This is a renewable source of energy. The heat pumps throughout the building are in good to fair condition. Some components of the major unit serving the gymnasiums, auditorium and cafeterias require frequent maintenance. These units are equipped with heat recovery capabilities as well. The library/media area is heated by perimeter fin tube radiators. For the purposes of this report, the efficiencies were de-rated for the existing equipment.

Refer to Appendix 8 for a detailed list of HVAC equipment at the site.

Domestic Hot Water Systems

Domestic Hot Water

The building is supplied domestic hot water by three (3) gas-fired condensing boilers which are in fair to poor condition.

The Board of Education recently reported that one of the domestic water heaters is currently not operating and should be included in the proposed project scope of work.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DWH Boiler	3	Boiler Room	All	AERCO	KC100	-	90	330GPH

Building Controls (HVAC Controls)

The building has a Honeywell building management system (BMS). All major mechanical equipment are tied into this system. The Board of Education has confirmed that this system is difficult to maintain and should be considered for replacement. The system is equipped with global temperature set points and are over-ridden in certain areas where complaints are made. Each area of the building (A through G) has a different operating schedule which is tailored to the use of the area and temperature set points are set back for both the heating and cooling seasons. There are temperature sensors throughout the rooms of the buildings which communicate back for each associated heat pump. 68 degrees is the global temperature set point where some were locally overridden to 60 or 70 degrees. There are existing outdoor air temperature sensors and CO2 sensors.

Building Controls

Kitchen Equipment

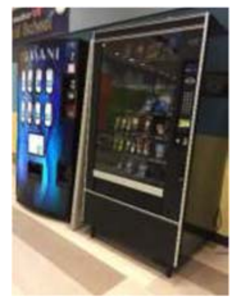
The kitchen utilizes both electric and gas cooking equipment. Various types of refrigeration equipment are present including walk-in coolers and a walk-in freezer. Standard refrigerators and ice machines are also present.

Plug Load

Office equipment is regularly left in the ‘on’ state at all times allowing the individual machine to revert to the ‘Sleep’ mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged-in equipment.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Projector	78
Smartboard	0
Projector/Smartboard Combo	0
Amplifier	0
Charging Cart	31
Small Printer	0
Medium Printer	4
Large Printer/Copier (110 only)	4
TV/LCD/Smart TV	0
Snack Vending	1
Soda Vending	4
Lg Coffeemaker (Bunn)	0
H/C Water Dispenser	0
Water Fountain (plug on outside)	0
AC - 220 (not to be more then 20 amps)	0
AC - 110 20 amps	0
AC - 110 15 amps	0
Electric Hot Water Heater	0
Other Device not listed above	0

Building Plug Load

Plumbing/Water System

There are 101 faucets located in restrooms, maintenance lockers and classrooms around the facility. All faucets currently use high flow 2.0 gallon per minute (gpm) aerators that can be replaced with low flow 0.5 gpm aerators.

Audrey W. Clark Elementary School

Background Information

Audrey W. Clark Elementary School is located at 192 Garfield Avenue, Long Branch, New Jersey. This 46,100 ft^2 facility was originally built in 1964 and is in fair condition. Audrey W. Clark Elementary School consists of two (2) floors of classroom space, office space and an all-purpose room.

Building Occupancy

The average number of occupants in the building on a given day is 110.

Hours of Operation

- Monday through Friday 7:30 am to 6:00 pm (students/staff)
- Saturday and Sunday no use

Envelope

The building is constructed of concrete masonry units with a brick façade. The building has flat roofs which appear in good condition. The building has double pane operable windows with metal frames and interior shades. The exterior doors are typically metal with glass panes and metal frames. Corridor areas have large double pane fixed windows with metal frames. The sealant around these frames is in poor condition and the windows are a main source of air infiltration. The exterior doors have either missing or worn weather-stripping materials which show signs of excessive infiltration. The building envelope has deficiencies and contributes to a significant amount of air infiltration. The unit ventilators, windows and doors are the main contributor to these drafts.

Building Envelope

Lighting

The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps. Fixtures throughout the building include surface mounted wraps, recessed troffer fixtures or industrial fixtures. Some areas have compact fluorescent lamp fixtures.

The all-purpose room and break out room are lit by metal halide recessed fixtures which each contain 400W lamps. The all-purpose room also recessed troffer fixtures with T8 U-lamps. The all-purpose room lighting is a maintenance concern due to the inaccessibility and current inefficient technology.

The exterior lighting includes wall pack fixtures and pole mounted flood light fixtures which contain 100W and 250W metal halide lamps, respectively. The entrances along the exterior of the building above exterior doors include compact fluorescent lamps which are in poor condition and in need of replacement.

Audrey W. Clark Elementary Multi-Purpose Room

Lighting Controls: The lighting throughout majority of the rooms are manually controlled via wall switches. The exterior lighting is controlled by a timeclock which is in poor condition.

Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in poor condition and standard efficiency (for date of installation). These systems include hot water pumps, exhaust fans and the fans within air-handling units (AHUs), unit ventilators (UVs) and cabinet unit heaters (CUHs). The majority of the equipment appears to be in poor condition.

Motors

Renewable Energy Systems

Audrey W. Clark Elementary School installed a roof mounted 100.815 kWDC photovoltaic (solar) energy generation system, operating exclusively as a Net Metering Photovoltaic Solar Electric Facility (SEF). This Solar Electric Facility is comprised of thirty-three (33) strings each with thirteen (13) Motech MTPVp-235-MSC 235 Watt poly-crystalline silicon photovoltaic modules in series with a maximum nominal voltage of 600 VDC. These strings are fed through three (3) combiner boxes each with a 210 amp, 600 volt integrated DC disconnect and to one (1) PVPowered 100 kW three-phase 208 VAC inverter.

Mechanical Systems

Boilers

HVAC Systems and Equipment: The building is heated by a hydronic heating system served by two (2) gas-fired cast iron hot water boilers. The boilers are over 50 years old and past their useful life. They are in poor condition and have mechanical linkage boiler burner controls. Hot water is supplied through the system serving unit ventilators, perimeter radiators and the air handling units that serve the all-purpose room.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler 1 Boiler 2	2	Boiler Room	Entire Building	HB Smith	-	1964	78%	1723 MBh

The unit ventilators in the building are in poor condition and many of the fresh air dampers are broken. The motors need frequent replacement and there are wiring issues. The filters are also in poor condition which negatively affects the equipment performance. There are air-handling units (AHUs) that serve a large all-purpose room are in fair condition.

There are two split AC Systems that are of standard efficiency and fair condition. These serve the server room and an office area.

HVAC Systems

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Cooling Capacity per Unit (Tons)
Window AC	19	Classrooms	Classrooms	Varies	Varies	±2008	-	1.26
Split-System AC	1	Split AC – Server Room	Split AC – Server Room	Varies	Varies	±2008	-	2.00
Window AC	3	Office	Office	Varies	Varies	±2008	-	0.67
Split-System AC	1	Split AC – Office	Split AC – Office	Varies	Varies	±2008	-	2.00

Domestic Hot Water Systems

Domestic Hot Water

The building is supplied domestic hot water by an electric storage tank water heater. This 50-gallon unit is of standard efficiency and fair condition. The sink aerators throughout the building are fit with higher flow devices (2.2 gallon per minute).

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	1	Mechanic Room	Entire Building	AO Smith	ECS-30-200	2001	100%	30 Gal

Building Controls (HVAC Controls)

The building has basic HVAC controls with a limited integration with the building. The old Johnson controls are the original pneumatic control system that is no longer operational.


Building Controls

Kitchen Equipment

The kitchen utilizes both electric and gas cooking equipment. Various types of refrigeration equipment are present including walk-in coolers and a walk-in freezer. Standard refrigerators and ice machines are also present.

Plug Load

Office equipment is regularly left in the ‘on’ state at all times allowing the individual machine to revert to the ‘Sleep’ mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged-in equipment.


Building Plug Load

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Projector	10
Smartboard	0
Projector/Smartboard Combo	0
Amplifier	0
Charging Cart	1
Small Printer	0
Medium Printer	0
Large Printer/Copier (110 only)	0
TV/LCD/Smart TV	0
Snack Vending	0
Soda Vending	0
Lg Coffeemaker (Bunn)	0
H/C Water Dispenser	0
Water Fountain (plug on outside)	0
AC - 220 (not to be more then 20 amps)	0
AC - 110 20 amps	0
AC - 110 15 amps	6
Electric Hot Water Heater	0
Other Device not listed above	0

Plumbing/Water System

There are 16 faucets located in restrooms and classrooms around the facility. All faucets currently use high flow 2.2 gallon per minute (gpm) aerators that can be replaced with low flow 0.5 gpm aerators.

George L. Catrambone Elementary School

Background Information

George L. Catrambone Elementary School is located at 240 Park Ave, Long Branch, New Jersey. This 108,000 ft^2 facility was originally built in 2014 and is in good condition. George L. Catrambone Elementary School consists of classroom space, office areas, a gymnasium, a cafeteria/auditorium, prep kitchen and a media center.

Building Occupancy

Approximate enrollment is 810 students with staff/visitors of 110 people who occupy the building.

Hours of Operation

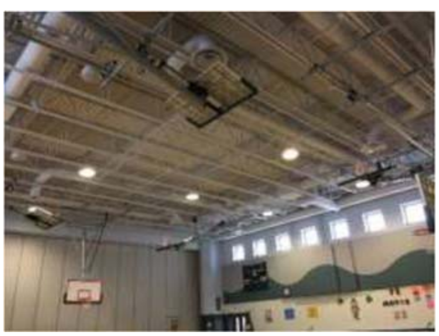
- Monday through Friday 6:00 am to 6:00 pm (students/staff)
- Saturday and Sunday no use

Envelope

The building is constructed of concrete masonry units with a brick façade. The building has flat roofs and is in good condition. The building has double pane operable windows with metal frames and interior shades. The exterior doors are typically metal with glass panes and metal frames. Corridor areas have large double pane fixed windows with metal frames. The sealant around these frames appears to be in good condition. The main entrance doors have worn weather-stripping materials which show signs of excessive infiltration.

Building Envelope

Lighting



GLC Gymnasium

The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps. Majority of fixtures are 2 lamps while some areas have 1 Lamps and 3 Lamps fixtures. Hallways also have recessed can fixtures with compact fluorescent plug in lamps. The gym and cafeteria/auditorium are lit by compact fluorescent high bay fixtures which each contain eight (8) 42W lamps.

The exterior lighting includes wall pack fixtures and area light fixtures which contain 175W high pressure sodium lamps. There are also pole mounted area light fixtures in parking lot areas with 400W high pressure sodium lamps. The main entrance and building mounted fixtures include compact fluorescent lamps.

Lighting Controls: The lighting throughout majority of the rooms are controlled by occupancy-based sensors and controls. There are a few rooms where the existing sensor was noted to be inoperable and a few rooms which are controlled manually via wall switches. The corridor areas are controlled by key switches and some hallways have occupancy sensors. The exterior lighting is controlled by a timeclock

Motors and Variable Frequency Drives (VFDs)

Motors

The HVAC systems that serve the building include fan and pump motors which are generally in good condition and high efficiency. These systems include primary pumps, water supply pumps, cooling tower fans, RTU and MUA unit supply and exhaust fans, general building exhaust fans and the blowers in each heat pump throughout the building. The primary HVAC pumps, condenser water pumps, RTU supply and exhaust fan motors are all driven by VFDs. All equipment appears to be in good condition. However, the triple duty valves at the primary pump motors appear to not be 100% open. Therefore, there may be potential for savings by fully opening them and adjusting the variable frequency drive logic. The cooling tower fan motors are constant speed. Based on the model number of the heat pumps, they operate with the standard motor.

Renewable Energy Systems

George L. Catrambone Elementary School does not currently have any on-site electric generation capacity.

Mechanical Systems

HVAC Systems: The classrooms, offices, and smaller instructional areas and many areas are conditioned by a water source heat pumps. This loop is conditioned with high efficiency gas-fired condensing hot water boilers in the heating season and heat is rejected from the loop by a cooling tower in the cooling season. There are also packaged roof top equipment and make-up air units that are equipped with heat wheels. The roof top appears to be in good condition. The hallways have electric cabinet unit heaters.

HVAC System

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	2	Mechanical Room	Hydronic Heating	RAYPAK	X-Therm	2014	96%	1999 MBh each

Domestic Hot Water Systems

There are storage tank gas-fired domestic hot water heaters. These are in good condition and of standard efficiency. Once they reach the end of their useful life, they should be replaced with high efficiency condensing water heaters.

Domestic Hot Water

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	2	Mechanical Room	DHW	RHEEM	G100	2014	80%	100 Gal

Building Controls (HVAC Controls)

Building Controls

The HVAC systems and equipment are controlled by a Building Management System (BMS). The rooms served by the heat pumps have manual dial thermostat/temperature sensors and humidity sensors. The air handling systems area equipped with CO2 sensors and the amount of outdoor air controlled appropriately.

Kitchen Equipment

The kitchen utilizes both electric and gas cooking equipment. Various types of refrigeration equipment are present including walk-in coolers and a walk-in freezer. Standard refrigerators and ice machines are also present.

Plug Load

Office equipment is regularly left in the 'on' state at all times allowing the individual machine to revert to the 'Sleep' mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged-in equipment.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Projector	40
Smartboard	0
Projector/Smartboard Combo	0
Amplifier	0
Charging Cart	16
Small Printer	0
Medium Printer	0
Large Printer/Copier (110 only)	1
TV/LCD/Smart TV	0
Snack Vending	0
Soda Vending	1
Lg Coffeemaker (Bunn)	0
H/C Water Dispenser	0
Water Fountain (plug on outside)	0
AC - 220 (not to be more then 20 amps)	0
AC - 110 20 amps	0
AC - 110 15 amps	0
Electric Hot Water Heater	0
Other Device not listed above	0


Building Plug Load

Plumbing/Water System

There are large restrooms and private restrooms throughout this facility. The fixtures in all of these restrooms are already low flow and therefore are not recommended for improvement.

Gregory Elementary School

Background Information

Gregory Elementary School is located at 201 Monmouth Avenue, Long Branch, New Jersey. This 94,266 ft^2 facility was originally built in 2007 and is in good condition. Gregory Elementary School consists of three (3) floors of classrooms, office space, a media center, gymnasium, auditorium and a separate mechanical building.

Building Occupancy

Approximate enrollment is 750 students with staff/visitors of 100 people who occupy the building.

Hours of Operation

- Monday through Friday 6:00 am to 9:00 pm (students/staff)
- Saturday and Sunday no use

Envelope

Building Envelope

The building is constructed of concrete masonry units with a brick façade. The building has flat roofs which appear in good condition. The building has double pane operable windows with metal frames. The sealant around these frames appears to be in good condition. The exterior doors are typically metal or metal with glass panes and metal frames. The exterior doors have either missing or worn weather-stripping materials which show signs of excessive infiltration. The building envelope has deficiencies and contributes to a significant amount of air infiltration.

Lighting

The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps. Fixtures throughout the building include pendant mounted continuous rows fixtures, surface mounted wraps, recessed troffer fixtures or industrial fixtures. Some areas have recessed can fixtures with compact fluorescent plug in lamps. There are also recessed fixtures with compact fluorescent biax lamps.

Gregory Elementary School Gymnasium

The gym is lit by metal halide high bay fixtures which each contain 175W lamps. The cafeteria is lit by high bay fixtures which each contains five (5) compact fluorescent biax lamps.

The exterior lighting includes building mounted wall pack fixtures, flood fixtures along the wavy overhang and pole mounted area light fixtures. These contain compact fluorescent lamps, metal halide lamps and some were already converted to LED technology.

Lighting Controls: The lighting in individual rooms are manually controlled via wall switches and there are some occupancy based sensors existing. The classrooms and office areas are equipped with bi-level switching where 2 or 3 lamps may operate at a time. The exterior lighting is controlled by a timeclock.

Motors

Motors

The HVAC systems that serve the building include fan and pump motors which are generally in good condition and of standard to high efficiency. These include hot water pumps, chilled water pumps, condenser water pumps and water supply pumps. These are located in the mechanical building. There are also exhaust fans, supply fans in air-handling units (AHUs), heat recovery units (HRUs), unit ventilators (UVs) and cabinet unit heaters (CUHs) as well as a cooling tower fan motor. Majority of equipment appears to be in good condition, which the exception of the unit ventilators.

Renewable Energy Systems

Gregory Elementary School has installed a roof mounted 62.040 kWDC photovoltaic (solar) energy generation system, operating exclusively as a Net Metering Photovoltaic Solar Electric Facility (SEF). The Solar Electric Facility is comprised of twenty-four (24) strings each with eleven (11) Motech MTPVp-235-M multi-crystalline silicon photovoltaic modules in series with a maximum nominal voltage of 500 VDC. These strings are fed through six (6) Fronius 10kW single-phase inverters.

There are six (6) Fronius Inverter systems. Each inverter system has an integrated AC/DC disconnect, and a Fronius 10 kW inverter. The single-phase AC output from each inverter is fed through a single-phase 277 VAC isolation transformer within the inverter and the output is connected to the line side of an existing customer distribution panel via six (6) 50 amp breakers to a 600 amp main breaker. Power from this new metering system is connected on the Customer side of a JCP&L revenue grade electric meter.

Mechanical Systems

Boilers

HVAC Systems and Equipment: The building is heated by a hydronic heating system served by three (3) gas-fired non-condensing hot water boilers. The boilers are rated for standard efficiency and are in fair condition. Hot water is supplied through the system serving unit ventilators, perimeter radiators and the air handling units heating coils. The building is cooled by a chilled water system served by a high efficiency chiller and cooling tower. This equipment is in good condition.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	3	Mechanical Building	Entire Building	AERCO	Bench Mark 2.0	2007	90%	2000 MBh
Chiller	1	Mechanical Building	Entire Building	Carrier	_	2007	_	300 T

HVAC System

The unit ventilators and cabinet unit heaters in the building are in fair to good condition, however their supply fan motors are in poor condition. The site reported that motors need frequent replacement. All of the air-handling equipment is in good condition.

There are two split AC Systems which serve IT rooms that are of standard efficiency and fair condition. These serve the server rooms and operate year-round. There are also electric unit heaters in the mechanical rooms which are in good condition.

Domestic Hot Water Systems

The building is supplied domestic hot water by a gas-fired storage tank water heater. This 250-gallon unit is of standard efficiency and fair condition. The sink aerators throughout the building are fit with higher flow devices (2.0 gallon per minute).

Domestic Hot Water

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	1	Mechanical Building	DHW	PVI	560P	2007	80%	399 mBH

Building Controls (HVAC Controls)

Building Controls

The building has a building management system (BMS). All major mechanical equipment is tied into this system. The system is equipped with outdoor air temperature reset controls for the boiler system, condenser water temperature controls, outdoor air damper controls and CO_2 sensors in air handling units to provide demand control ventilation, etc.

Some of the hot water convectors also have thermostatic radiator valves. The electric unit heaters in the mechanical rooms are tied to manual dial thermostats that were all set and maintained at a minimum temperature. There are temperature sensors located throughout the building which are tied into the BMS. After ten (10) years, there are components within the mechanical equipment as well as sensors throughout the building which may not be operating as intended.

Kitchen Equipment

The kitchen utilizes both electric and gas cooking equipment. Various types of refrigeration equipment are present including walk-in coolers and a walk-in freezer. Standard refrigerators and ice machines are also present.

Plug Load

Office equipment is regularly left in the 'on' state at all times allowing the individual machine to revert to the 'Sleep' mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged in equipment.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Projector	30
Smartboard	0
Projector/Smartboard Combo	0
Amplifier	0
Charging Cart	15
Small Printer	0
Medium Printer	0
Large Printer/Copier (110 only)	1
TV/LCD/Smart TV	0
Snack Vending	0
Soda Vending	0
Lg Coffeemaker (Bunn)	0
H/C Water Dispenser	0
Water Fountain (plug on outside)	0
Other Device not listed above	0

Building Plug Load

Plumbing/Water System

There are 11 faucets located in restrooms and classrooms around the facility. All faucets currently use high flow 2.0 gallon per minute (gpm) or higher aerators that can be replaced with low flow 0.5 gpm aerators.

Amerigo A. Anastasia School

Background Information

Amerigo A. Anastasia School is located at 92 Seventh Avenue, Long Branch, New Jersey. This 94,266 ft^2 facility was originally built in 2005 and is in good condition. Anastasia Elementary School consists of three (3) floors of classrooms, office space, a media center, gymnasium, auditorium and a separate mechanical building.

Building Occupancy

Approximate enrollment is 750 students with staff/visitors of 100 people who occupy the building.

Hours of Operation

- Monday through Friday 6:00 am to 9:00 pm (students/staff)
- Saturday (Gym) 7:00 am to 4:00 pm
- Sunday (Gym) 6:00 am to 9:00 pm

Envelope

The building is constructed of concrete masonry units with a brick façade. The building has flat roofs which appear in good condition. The building has double pane operable windows with metal frames. The sealant around these frames appears to be in good condition. The exterior doors are typically metal or metal with glass panes and metal frames. The exterior doors have either missing or worn weather-stripping materials which show signs of excessive infiltration. The building envelope has deficiencies and contributes to a significant amount of air infiltration.

Building Envelope

Lighting

Amerigo A. Anastasia Gymnasium

The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps. Fixtures throughout the building include pendant mounted continuous rows fixtures, surface mounted wraps, recessed troffer fixtures or industrial fixtures. Some areas have recessed can fixtures with compact fluorescent plug in lamps. There are also recessed fixtures with compact fluorescent biax lamps. The fixtures are in good condition which provides a great opportunity for energy savings by retrofitting to LED technology.

The gym is lit by compact fluorescent lamp high bay fixtures which each contain eight (8) 42W lamps. The cafeteria is lit by high bay fixtures which each contains five (5) compact fluorescent biax lamps.

The exterior lighting includes building mounted wall pack fixtures with compact fluorescent lamps. Exterior lighting also includes flood fixtures along the wavy overhang and pole mounted area light fixtures. These fixtures contain metal halide lamps.

Lighting Controls: The lighting in individual rooms are manually controlled via wall switches. The classrooms and office areas are equipped with bi-level switching where 2 or 3 lamps may operate at a time. The exterior lighting is controlled by a timeclock.

Motors

Motors

The HVAC systems that serve the building include fan and pump motors which are generally in good condition and of standard to high efficiency. These include hot water pumps, chilled water pumps, condenser water pumps and water supply pumps. These are located in the mechanical building. There are also exhaust fans, supply fans in air-handling units (AHUs), heat recovery units (HRUs), unit ventilators (UVs) and cabinet unit heaters (CUHs) as well as a cooling tower fan motor. Majority of equipment appears to be in good condition, which the exception of the unit ventilators. These are said to be a maintenance concern where many motors need frequent replacement.

It was noted to have triple duty valves that were partially opened.

Renewable Energy Systems

Amerigo A. Anastasia School installed a roof mounted 103.165 kWDC photovoltaic (solar) energy generation system, operating exclusively as a Net Metering Photovoltaic Solar Electric Facility (SEF). The Solar Electric Facility is comprised of twenty-seven (27) strings each with thirteen (13) Motech MTPV p-235-MC poly-crystalline silicon photovoltaic modules and eight (8) strings each with eleven (11) Motech MTPVp-235MC Poly-crystalline silicon photovoltaic modules in series with a maximum nominal voltage of 500 VDC. These strings are fed through six (6) Fronius IG Plus 11.4 kW, 277 VAC split phase inverters and three (3) Fronius IG Plus 10.1 kW, 277 VAC split phase inverters each with a 600 volt integrated DC disconnect.

Mechanical Systems

Boilers

HVAC Systems and Equipment: The building is heated by a hydronic heating system served by three (3) gas-fired non-condensing standard efficiency hot water boilers. The boilers are in fair condition. One of them was not operational at the time of the audit. Hot water is supplied through the system serving unit ventilators, perimeter radiators and the air handling units heating coils. This equipment is in good condition.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	3	Mechanical Building	Entire Building	AERCO	_	2004	93	2000 MBH
Chiller	1	Mechanical Building	Entire Building	TRANE	_	2004	-	300 T

The unit ventilators and cabinet unit heaters in the building are in fair to good condition, however their supply fan motors are in poor condition. The motors need frequent replacement.

There are two split AC Systems which serve IT rooms that are in fair to good condition. These serve the server rooms and operate year-round. There are also electric unit heaters in the mechanical rooms which are in good condition.


HVAC System


Domestic Hot Water

Domestic Hot Water Systems

The building is supplied domestic hot water by a gas-fired storage tank water heater. This 250 gallon unit is of standard efficiency and fair condition. The sink aerators throughout the building are fit with higher flow devices (2.0 gallon per minute).

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	1	Mechanical Building	Entire Building	PVI	_	2004	80	399 MBH

Building Controls (HVAC Controls)


Building Controls

The building has a building management system (BMS). All major mechanical equipment is tied into this system. The system is equipped with outdoor air temperature reset controls for the boiler system, condenser water temperature controls, outdoor air damper controls and CO2 sensors in air handling units to provide demand control ventilation, etc.

Some of the radiators also have thermostatic radiator valves. The electric unit heaters in the mechanical rooms are tied to manual dial thermostats that were all set and maintained at a minimum temperature. There are temperature sensors located throughout the building which are tied into the BMS. After ten (10) years, there are components within the mechanical equipment as well as sensors throughout the building which may not be operating as intended.

Kitchen Equipment

The kitchen utilizes both electric and gas cooking equipment. Various types of refrigeration equipment are present including walk-in coolers and a walk-in freezer. Standard refrigerators and ice machines are also present.

Plug Load

Office equipment is regularly left in the 'on' state at all times allowing the individual machine to revert to the 'Sleep' mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged in equipment.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Projector	35
Smartboard	0
Projector/Smartboard Combo	0
Amplifier	0
Charging Cart	12
Small Printer	0
Medium Printer	5
Large Printer/Copier (110 only)	1
TV/LCD/Smart TV	0
Snack Vending	0
Soda Vending	2
Lg Coffeemaker (Bunn)	0
H/C Water Dispenser	3
Water Fountain (plug on outside)	0
AC - 220 (not to be more then 20 amps)	0
AC - 110 20 amps	0
AC - 110 15 amps	0
Electric Hot Water Heater	0
Other Device not listed above	0

Building Plug Load

Plumbing/Water System

There are 11 faucets located in restrooms around the facility. All faucets currently use high flow 2.0 gallon per minute (gpm) or higher aerators that can be replaced with low flow 0.5 gpm aerators.

Morris Avenue Elementary School

Background Information

Morris Avenue Elementary School is located at 318 Morris Ave, Long Branch, New Jersey. This 41,760 ft^2 facility was originally built in 1979 and is one story high. Morris Avenue Elementary School consists of classroom space, office space, an all-purpose room and a break out room.

Building Occupancy

Approximate enrollment is 330 students with staff of 80 people who occupy the building.

Hours of Operation

- Monday through Friday 6:00 am to 10:00 pm (students/staff)
- Saturday and Sunday no use

Envelope

Building Envelope

The building is constructed of concrete masonry units with a brick façade. The building has flat roofs which appear in good condition. The building has double pane operable windows with metal frames and interior shades. The exterior doors are typically metal with glass panes and metal frames. Corridor areas have large double pane fixed windows with metal frames. The sealant around these frames is in poor condition and the windows are a main source of air infiltration. The exterior doors have either missing or worn weather-stripping materials which show signs of excessive infiltration. The building envelope has deficiencies and contributes to a significant amount of air infiltration. The upper walls, windows and doors are the main contributor to these drafts.

Lighting

The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps. Fixtures throughout the building include surface mounted wraps, recessed troffer fixtures or industrial fixtures. Small restrooms, storage and electric rooms have incandescent lamp fixtures.

The all-purpose room and break out room are lit by metal halide high bay fixtures which each contain 400W lamps. The all-purpose room also has recessed can lighting along the wall with 50W metal halide lamps. The all-purpose room lighting is a maintenance concern due to the inaccessibility and current inefficient technology.

Morris Avenue School Lighting

The exterior lighting includes wall pack fixtures and pole mounted flood light fixtures which contain 175W and 400W metal halide lamps, respectively. The entrances along the exterior of the building overhangs include recessed fixtures with compact fluorescent lamps which are in poor condition and in need of replacement.

Lighting Controls: The lighting throughout majority of the rooms are manually controlled via wall switches. The exterior lighting is controlled by a timeclock.

Motors

Motors

The HVAC systems that serve the building utilize fan and pump motors which are generally in poor condition and of standard efficiency. These systems include primary pumps, exhaust fans and the fans within air-handling units (AHUs), unit ventilators (UVs) and fan coil units (FCUs). Majority of equipment appears to be in poor condition.

Renewable Energy Systems

Morris Avenue School installed a roof mounted 189.410 kWDC photovoltaic (solar) energy generation system, operating exclusively as a Net Metering Photovoltaic Solar Electric Facility (SEF). The rooftop Solar Electric Facility is comprised of sixty-two (62) strings each with thirteen (13) Motech MTPVp-235-MSC235 poly-crystalline silicon photovoltaic modules in series with a maximum nominal voltage of 600 VDC. These strings are fed through six (6) combiner boxes with 210 amp, 600 volt integrated DC disconnects and to two (2) PVPowered 75kW three-phase 208 VAC inverters.

There are two (2) PVPowered inverter systems. Each inverter system consists of an Inverter Control Switch, a DC Disconnect, a PVPowered 75kW inverter, and an AC Disconnect. The three-phase AC output from each inverter is fed through three-phase 208 VAC isolation transformer within the inverter, and the output is connected to the line side of an existing Customer distribution panel via two (2) 300 amp 208 volt AC breakers, one (1) 600 amp AC disconnect fused at 600 amps. Power from this new metering system is connected on the Customer side of a JCP&L revenue grade electric meter.

Mechanical Systems

Chiller

HVAC Systems and Equipment: The building is conditioned by a 2-pipe change over system that is served by a gas-fired hot water boiler and air-cooled chiller.

The boiler is in poor condition, over 20 years old and has mechanical linkage boiler burner controls. The chiller was also reported to be in poor condition. Hot water or chilled water is supplied through the system serving fan coil units and unit ventilators.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	1	Boiler Roon	Entire Building	HB Smith	_	±1979	78%	4295 MBh
Chiller	1	Exterior	Entire Building	Carrier	_	±2004	-	80 T

The unit ventilators in the building are in poor condition and many of the fresh air dampers are broken. The motors need frequent replacement and there are wiring issues. The filters are also in poor condition which negatively affects the equipment performance.

There are air-handling units (AHUs) that serve the large all-purpose room are in poor condition. The bottom of the units are rusted out.

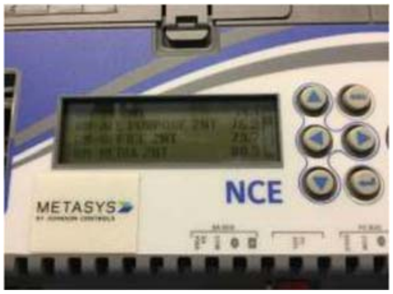
Domestic Hot Water Systems

Domestic Hot Water

The building is supplied domestic hot water by a gas-fired storage tank water heater installed in +/- 2010 . This 74 gallon unit is of standard efficiency and in fair condition. The sink aerators throughout the building are fit with higher flow devices (2.2 gallon per minute).

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	1	Mechanical Room	DHW	AOSMITH	BT80-300	2010	80	50 Gal

Building Controls (HVAC Controls)



Building Controls

The chiller/boiler plant system is controlled by a Building Management System (BMS). The dual-service primary pumps, boiler and chiller are tied into this. The rooms served by the self-contained unit ventilators have manual dial thermostat/temperature sensors. The air handling units that serve the all-purpose room are not currently controlled.

Kitchen Equipment

The kitchen utilizes both electric and gas cooking equipment. Various types of refrigeration equipment are present including walk-in coolers and a walk-in freezer. Standard refrigerators and ice machines are also present.

Plug Load

Office equipment is regularly left in the 'on' state at all times allowing the individual machine to revert to the 'Sleep' mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged in equipment.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Projector	19
Smartboard	0
Projector/Smartboard Combo	0
Amplifier	0
Charging Cart	0
Small Printer	0
Medium Printer	7
Large Printer/Copier (110 only)	0
TV/LCD/Smart TV	0
Snack Vending	0
Soda Vending	1
Lg Coffeemaker (Bunn)	0
H/C Water Dispenser	0
Water Fountain (plug on outside)	0
Other Device not listed above	0

Building Plug Load

Plumbing/Water System

There are 11 faucets located in restrooms around the facility. All faucets currently use high flow 2.2 gallon per minute (gpm) or higher aerators that can be replaced with low flow 0.5 gpm aerators.

Joseph M. Ferraina ECLC

Background Information

Joseph M. Ferraina ECLC is located at 80 Avenel Boulevard, Long Branch, New Jersey. This 42,478 ft^2 facility was originally built in 1997 and is one floor. Joseph M. Ferraina ECLC consists of classroom space, office space, a multi-purpose room and a break out area.

Building Occupancy

Approximate enrollment is 350 staff and students who occupy the building.

Hours of Operation

- Monday through Friday 6:00 am to 6:00 pm (students/staff)
- Saturday and Sunday no use

Envelope

Building Envelope

The building is constructed of concrete masonry units with a brick façade. The building has pitched roofs and is in good condition. The building has double pane operable windows with metal frames and interior shades. The exterior doors are typically metal with glass panes and metal frames. Corridor areas have large double pane fixed windows with metal frames. The sealant around these frames appears to be in good condition. The main entrance doors have worn weather-stripping materials which show signs of excessive infiltration.

Lighting

Joseph M. Ferraina Lighting

The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps. Majority of fixtures are 2 lamps while the kitchen and a restroom have 3L and 4L fixtures, respectively. Corridor areas also have recessed can fixtures with compact fluorescent plug in lamps. The all-purpose room is lit by compact fluorescent high bay fixtures which each contain eight (8) 42W lamps. The exterior lighting includes wall pack fixtures and area light fixtures which contain 250W high pressure sodium lamps. There are also pole mounted area light fixtures in parking lot areas with 400W to 1000W high pressure sodium lamps. The main entrance and building mounted fixtures include compact fluorescent lamps.

Lighting Controls: The lighting throughout majority of the rooms are manually controlled via wall switches. There are a few rooms that currently have occupancy-based sensors and controls. The exterior lighting is controlled by a timeclock.

Motors and Variable Frequency Drives (VFDs)

The HVAC systems that serve the building include fan and pump motors which are generally in good condition and of standard to high efficiency. These include hot water pumps, RTU and unit ventilator supply and return fans. The majority of equipment appears to be in fair condition.

Motors

Renewable Energy Systems

JMF Early Childhood Learning Center does not have any on-site electric generation capacity.

Mechanical Systems

HVAC Systems and Equipment: The classrooms and many areas are conditioned by self-contained unit ventilators equipped with heating and cooling coils. The corridor areas, all purpose room, office and break out room are conditioned by air-handling equipment which are equipped with heating and cooling coils. The building is heated by a hydronic system served by two (2) gas-fired condensing hot water boilers of standard efficiency. In some areas there are hot water baseboard radiators and electric cabinet unit heaters. These appear in good condition.

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler	2	Boiler Roon	–	AERCO	Bench Mark 2.0	1997	90%	300 MBh each

The common area spaces are cooled by the use of outdoor condensing units which are in fair to poor condition. It was also noted that refrigerant piping had worn pipe insulation.

HVAC System

Domestic Hot Water Systems

Domestic Hot Water

The building is supplied domestic hot water by a gas-fired storage tank water heater. This equipment is in good condition and of standard efficiency. The sink aerators throughout the building are already fit with low flow devices (0.5 gallon per minute).

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	1	Boiler Roon	DHW	AO Smith	BTR-120	2011	80	120 Gal

Building Controls (HVAC Controls)

The HVAC systems and equipment are controlled by a Building Management System (BMS). All major mechanical equipment is tied into this. The rooms served by the self-contained unit ventilators have manual dial thermostat/temperature sensors. The air handling systems area equipped with CO2 sensors and the amount of outdoor air controlled appropriately. The boilers operate with outdoor air reset controls.


Building Controls

Kitchen Equipment

The kitchen utilizes both electric and gas cooking equipment. Various types of refrigeration equipment are present including walk-in coolers and a walk-in freezer. Standard refrigerators and ice machines are also present.

Plug Load

Office equipment is regularly left in the ‘on’ state at all times allowing the individual machine to revert to the ‘Sleep’ mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged in equipment.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Projector	19
Smartboard	0
Projector/Smartboard Combo	0
Amplifier	0
Charging Cart	0
Small Printer	0
Medium Printer	0
Large Printer/Copier (110 only)	0
TV/LCD/Smart TV	0
Snack Vending	0
Soda Vending	1
Lg Coffeemaker (Bunn)	0
H/C Water Dispenser	0
Water Fountain (plug on outside)	0
AC - 220 (not to be more then 20 amps)	0
AC - 110 20 amps	0
AC - 110 15 amps	0
Electric Hot Water Heater	0
Other Device not listed above	0

Building Plug Load

Plumbing/Water System

There are large restrooms and private restrooms throughout this facility. The fixtures in all of these restrooms are already low flow and there are no recommendations for improvement.

Lenna W. Conrow School

Background Information

Lenna W. Conrow School is located at 335 Long Branch Ave, Long Branch, New Jersey. This 44,640 ft2 facility was originally built in 1955. Lenna W. Conrow School consists of classrooms, office space and a gym/all-purpose room.

Building Occupancy

Approximate enrollment is 340 students with staff and visitors of 100 people on an average day.

Hours of Operation

- Monday through Friday 6:00 am to 6:00 pm (students/staff)
- Saturday and Sunday no use

Envelope

Building Envelope

The building is constructed of concrete masonry units with a brick façade. The building is broken up into two (2) different sections. One of which has a flat roof and one that has pitched roofs. All roofs appear to be in fair condition.

The building has double pane operable windows with metal frames and interior shades. The exterior doors are typically metal with glass panes and metal frames. Corridor areas have large double pane fixed windows with metal frames. The sealant around these frames appears to be in good condition. The main entrance doors have worn weather-stripping materials which show signs of excessive infiltration.

Lighting

Lenna W. Conrow Lighting

The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps. Majority of fixtures are 2 lamps while some offices have 4 Lamp fixtures and the space was measured to be over lit. Small restrooms, storage and electric rooms have incandescent lamp fixtures. The gym/all purpose room is lit by compact fluorescent high bay fixtures which each contain eight (8) 42W lamps.

The exterior lighting includes wall pack fixtures and area light fixtures which contain 150W or 250W high pressure sodium lamps. There are also building mounted fixtures include compact fluorescent lamps.

Lighting Controls: The lighting throughout majority of the rooms are manually controlled via wall switches. The exterior lighting is controlled by a timeclock.

Motors and Variable Frequency Drives (VFDs)

The HVAC systems that serve the building include fan and pump motors which are generally in good condition and of standard to high efficiency. These include hot water pumps, RTU and unit ventilator supply fans, the steam system condensate return pumps and air compressor for the outdated old pneumatic controls. Majority of equipment appears to be in fair to poor condition.

Renewable Energy Systems

Lenna W. Conrow School installed a 155.805kWDC photovoltaic (solar) energy generation system, operating exclusively as a Net Metering Photovoltaic Solar Electric Facility (SEF). This Solar Electric Facility is comprised of fifty one (51) strings each with thirteen (13) Motech MTPVp-235-MSC 235 Watt poly crystalline silicon photovoltaic modules in series with a maximum nominal voltage of 600 VDC. These strings are fed through four (4) combiner boxes each with a 210 amp, 600 volt integrated DC disconnects and to one (1) PVPowered 100 kW three-phase 208 VAC and one (1) PVPowered 30 kW three-phase 208 VAC inverters.

There are two (2) PVPowered inverter systems. Each inverter system consists of an Inverter Control Switch, a DC Disconnect, a PVPowered 100 kW inverter or a PVPowered 30 kW inverter and an AC Disconnect. The three-phase AC output from each inverter is fed through a three-phase 208 VAC isolation transformer within the inverter, and the output is connected to the line side of two (2) existing Customer distribution panels via one (1) 400 amp, 208 VAC disconnect fused at 350 amps and one (1) 200 amp, 208 VAC disconnect fused at 125 amps. Power from this net metering system is connected on the Customer side of a JCP&L revenue grade electric meter.

Mechanical Systems

HVAC Systems and Equipment: Half of the building is heated by a hot water system. The boiler is in poor condition, over 20 years old and has mechanical linkage boiler burner controls. There are a total of six (6) zones. The boiler provides hot water to perimeter radiators.

Motors

Designation	System Quantity	Location	Floor/ Serves	Manufacturer	Model/ Make	Date	Efficiency	Capacity
Boiler (HW)	1	Boiler Room A	HW	HB Smith	_	±1980	78	3350 MBh
Boiler (STM)	1	Boiler Room B	STM	Well Mclain	MM88	2013	78	839 MBh

HVAC System

The other half of the building is heated by a steam system with a limited amount of controlability. The steam boiler is about 5 years old and is in good condition. The steam system serves unit ventilators throughout this half of the building. Per discussions with facility personnel, the steam system is uncontrolled, and has issues with the distribution piping.

The gym is cooled by roof top equipment and has supplemental heat provided by an electric forced air furnace that is fairly new. This equipment is in good condition.

The classrooms and offices throughout the building are cooled by unitary window AC units that are of standard to high efficiency. There are a few split-system AC systems which serve some offices and server rooms. The outdoor condensing units are located on the roof of the building and are in fair to poor condition and standard efficiency.

The trailer outside is conditioned by an old forced air electric heating and cooling unit. This is in poor condition, low efficiency and in need of replacement. Modifications to the trailers will not be involved in the process.

Domestic Hot Water Systems

The building is supplied domestic hot water by electric storage tank water heaters. There are two (2) 40 gallon and one (1) 50-gallon DHW heater. This equipment is in good condition. The sink aerators throughout the building are fit with higher flow devices (2.0 gallon per minute). It was also noted that the domestic hot water piping was uninsulated.

Domestic Hot Water

Designation	System Quantity	Location	Manufacturer	Model/ Make	Date	Efficiency	Capacity
DHW	2	Boiler Room	-	-	±2016	100	40 Gal
DHW	1	Mechanical Roo	-	-	±2016	100	50 Gal

Building Controls (HVAC Controls)

The HVAC systems and equipment are controlled by a Building Management System (BMS). All major mechanical equipment is tied into this. The rooms served by the self-contained unit ventilators have manual dial thermostat/temperature sensors. The air handling systems area equipped with CO2 sensors and the amount of outdoor air controlled appropriately. The boilers operate with outdoor air reset controls.

The steam system is not controlled. There are temperature sensors in this section of the building that are old, outdated and inoperable at this point in time.

Building Controls

Kitchen Equipment

The kitchen utilizes both electric and gas cooking equipment. Various types of refrigeration equipment are present including walk-in coolers and a walk-in freezer. Standard refrigerators and ice machines are also present.

Plug Load

Office equipment is regularly left in the 'on' state at all times allowing the individual machine to revert to the 'Sleep' mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged-in equipment.

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Projector	20
Smartboard	0
Projector/Smartboard Combo	0
Amplifier	0
Charging Cart	3
Small Printer	0
Medium Printer	14
Large Printer/Copier (110 only)	1
TV/LCD/Smart TV	0
Snack Vending	0
Soda Vending	1
Water Fountain (plug on outside)	0
AC - 110 15 amps	25
Electric Hot Water Heater	0
Other Device not listed above	0

Building Plug Load

Plumbing/Water System

There are 28 faucets located in restrooms around the facility. All faucets currently use high flow 2.0 gallon per minute (gpm) or higher aerators that can be replaced with low flow 0.5 gpm aerators.

Board of Education Office

Background Information

Board of Education Office is located at 540 Broadway, Long Branch, New Jersey. This 40,000 ft^2 facility was originally built in 1890. Board of Education Office consists of two (2) floors of office space, a basement comprised of classrooms and an attic floor.

Building Occupancy

The building has on average 75 to 110 occupants a day.

Hours of Operation

- Monday through Friday 6:00 am to 8:00 pm (students/staff)
- Saturday and Sunday 10:00 am to 5:00 pm

Envelope

Building Envelope

The building is constructed of concrete masonry units with a brick façade. The building has a pitched and a flat roof which appear in fair condition. The building has double pane operable windows with metal frames. The exterior doors are typically metal with glass panes and metal frames. The sealant around these frames appears to be in good condition. The main entrance doors have worn weather-stripping materials which show signs of excessive infiltration.

Lighting

BOE Office Lighting

Lighting & controls: The building is primarily lit by linear fluorescent fixtures which contain 32W T8 lamps. Majority of fixtures are 2 lamp while some areas have 1L and 3L fixtures. In general purpose areas there are screw in compact fluorescent and incandescent lamps. Majority of rooms throughout the building have manual wall switches for lighting controls.

The exterior lighting includes pole mounted flood fixtures with high pressure sodium lamps. These are controlled by a timeclock. The trailers have compact fluorescent lamp wall pack fixtures.

Motors

The HVAC systems that serve the building include fan motors which are generally in fair condition. These standard supply fan motors are located in the furnaces throughout the building. It is recommended that these motors be replaced as part of a furnace retrofit There are also exhaust fan motors located on the roof and are assumed to be in fair condition.

Renewable Energy Systems

Board of Education Office installed a 14.1 kW solar energy project in 2011. The project included a roof mounted photovoltaic (PV) system. There are approximately 62 PV panels in total. The systems is estimated to provide 15% of the electricity required by the facility. Ray Angelini, Inc. had installed the roof mounted 14.1 kWDC photovoltaic (solar) energy generation system, operating exclusively as a Net Metering Photovoltaic Solar Electric Facility (SEF).

Mechanical Systems

HVAC Systems: The building is conditioned by 21 forced air gas-fired furnaces equipped with DX cooling coils and condensing units. Per discussions with facility personnel, portions of this equipment is in poor condition.

Refer to Appendix 8 for a detailed list of HVAC equipment at the site.

Domestic Hot Water Systems

There are several electric storage tank domestic hot water heaters throughout the building. These are in good condition and of standard efficiency. The largest unit which serves the majority of the building is 30 gallons in capacity. The copper domestic hot water piping was noted to be uninsulated.

Domestic Hot Water

Building Controls (HVAC Controls)

The HVAC systems and equipment are controlled by a Building Management System (BMS), which is reported to be in disrepair.

There are manual dial thermostat/temperature sensors in the space that were set between 69 and 75 degrees.

Building Controls

Plug Load

Office equipment is regularly left in the 'on' state at all times allowing the individual machine to revert to the 'Sleep' mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged in equipment.

Building Plug Load

ESG observed to following significant plug load technologies:

Device Type:	Quantity:
Projector	4
Smartboard	0
Projector/Smartboard Combo	0
Amplifier	0
Charging Cart	0
Small Printer	0
Medium Printer	4
Large Printer/Copier (110 only)	2
TV/LCD/Smart TV	0
Snack Vending	0
Soda Vending	1
Lg Coffeemaker (Bunn)	0
H/C Water Dispenser	2
Water Fountain (plug on outside)	0
AC - 220 (not to be more then 20 amps)	0
AC - 110 20 amps	0
AC - 110 15 amps	0
Electric Hot Water Heater	0
Other Device not listed above	0

Plumbing/Water System

There are 16 faucets located in restrooms around the facility. All faucets currently use high flow 2.0 gallon per minute (gpm) or higher.

Utility Baseline Analysis

NOTE: Long Branch Public Schools uses Energy Cap to track utility data. Long Branch Public Schools made Energy Cap access available to ESG and it was used as the primary source of utility data.

Electric

Electrical energy is provided to Long Branch Public Schools from Jersey Central Power & Light (JCP&L). JCP&L, which is the electric transport company and South Jersey Electric Supply, is the commodity supplier. In the event Jersey South is not the supplier then JCP&L is the default supplier. The electric utility measures consumption in kilowatt-hours (kWh). One kWh usage is equivalent to 1000 watts running for one hour.

The primary electric rate used by the buildings at Long Branch Public Schools, is the General Service Secondary (GS).

Natural Gas

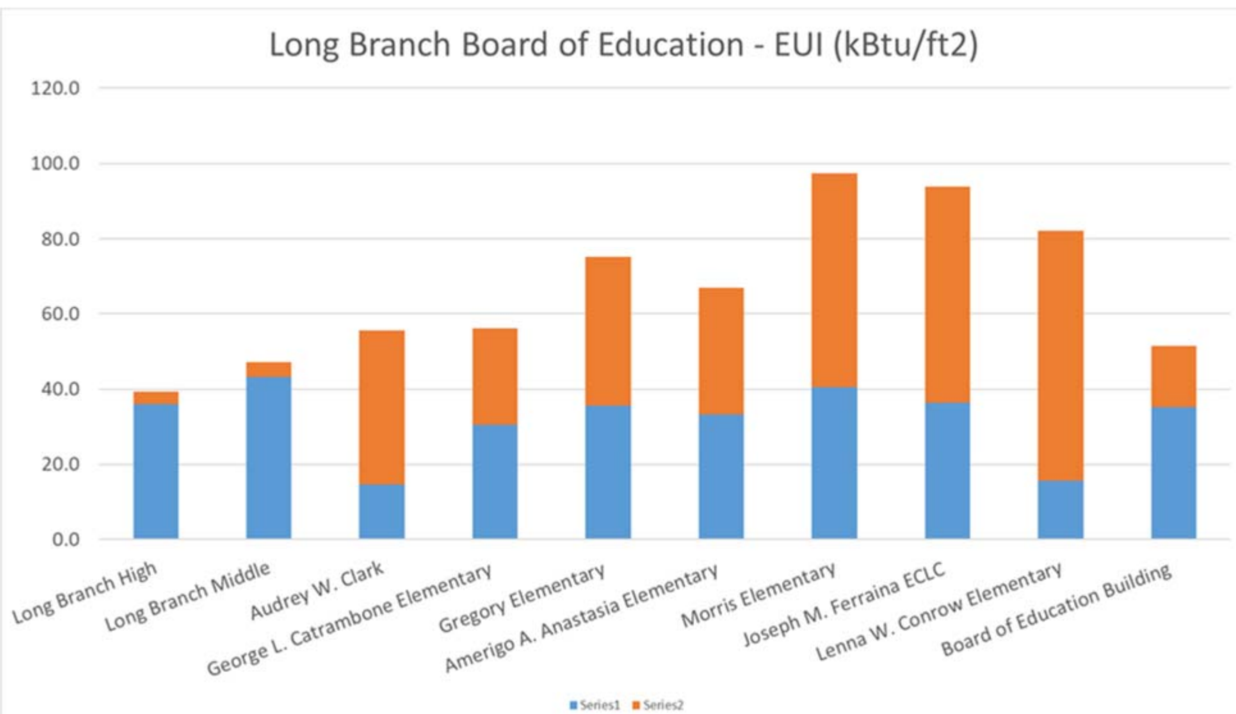
Long Branch Public Schools has natural gas transported and/or delivered by New Jersey Natural Gas. The gas utility measures consumption in cubic feet x 100 (CCF) and converts the quantity into therms of energy. The district buildings fall under the General Service Large (GSL) Rate structure for natural gas.

Energy Usage Summary

Long Branch Public Schools Energy Summary Analysis Table

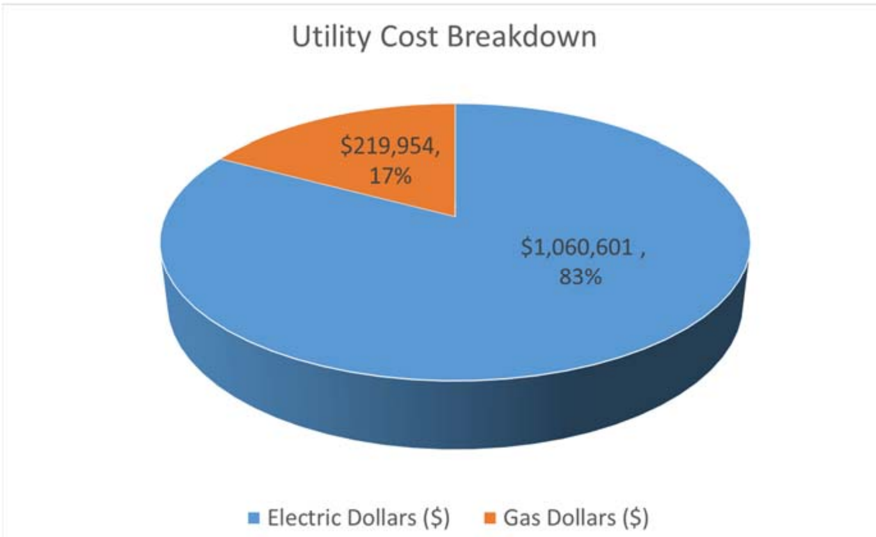
BUILDING	ELECTRIC			NATURAL GAS			TOTAL				Electric	Gas
NAME	Total kWh	Total Electric MMBtus	Total Dollars ($)	Therms	MMBtus	Dollars ($)	MMBtus	Dollars ($)	kBtu/ft²	$/ft²	kBtu/ft2	kBtu/ft²
Long Branch High	3,119,057	10,642	$270,101	9,969	997	$9,485	11,639	$279,586	39.3	$0.94	36.0	3.4
Long Branch Middle	3,101,002	10,581	$302,294	9,151	915	$9,399	11,496	$311,694	47.1	$1.28	43.3	3.7
Audrey W. Clark	199,765	682	15,206	18,829	1,883	$18,863	2,564	$34,069	55.6	$0.74	14.8	40.8
George L. Catrambone Elementary	966,840	3,299	$123,555	27,582	2,758	$28,450	6,057	$152,004	56.1	$1.41	30.5	25.5
Gregory Elementary	984,563	3,359	$113,418	37,307	3,731	$36,320	7,090	$149,738	75.2	$1.59	35.6	39.6
Amerigo A. Anastasia Elementary	920,900	3,142	$93,718	31,650	3,165	$32,046	6,307	$125,763	66.9	$1.33	33.3	33.6
Morris Elementary	495,795	1,692	$33,359	23,789	2,379	$23,760	4,071	$57,119	97.5	$1.37	40.5	57.0
Joseph M. Ferraina ECLC	453,120	1,546	$52,421	24,430	2,443	$24,858	3,989	$77,280	93.9	$1.82	36.4	57.5
Lenna W. Conrow Elementary	205,592	701	10,845	29,646	2,965	$30,032	3,666	$40,878	82.1	$0.92	15.7	66.4
Board of Education Building	413,657	1,411	$45,684	6,452	645	$6,740	2,057	$52,424	51.4	$1.31	35.3	16.1
TOTAL	10,860,291	37,055	$1,060,601	218,804	21,880	$219,954	58,936	$1,280,555	56.0	$1.22		

Note 1: MCF = thousand cubic feet MMBtu = million British thermal units kBtu = thousand British thermal units ft2= square feet
Note 2: Data is for a 12 month period. Energy is site use. Although not shown for simplification, all units are per year.
Note 3: Accounts are combined by facility where multiple accounts/services are present.
Note 4: The electric and total energy usage includes



Long Branch Public Schools Energy Use Index (EUI) Analysis

The pie chart below shows the distribtuion of these two energy source costs relative to the entire District energy consumption. At 70% of the total consumption, electricity comprises a larger share of the energy costs.



Long Branch Public Schools Utility Cost Breakdown

Marginal Rates

For the purposes of determining how energy conservation measures will affect the utility bill, it is important to understand what portions of the cost can be saved. In general, there are costs associated with utility bills that are fixed and independent of usage, such as the monthly meter charge. For example, in the case of a monthly meter charge, this charge often exists even if the energy usage were zero. An energy conservation measure often cannot produce a cost savings on this portion of the bill. The utility rate structure has to, therefore, be analyzed to determine what portion of the bill a cost savings can be produced using a specific energy conservation measure. For the purposes of this report, the blended average utility rate is the total cost divided by the total energy units. The effective rate is the portion of the bill effected by energy saving or the applied energy conservation measure.

The utility rates identified below were used for purposes of calculating the dollar effect of the energy

Electric

Electric Rates	$/kWh	$/kW
GS	$0.09218	$6.423

The effective supply kWh rate is the most recent in the baseline period. The effective transport $/kWh and $/kW demand rates are based on the most recent utility tariff rates as of 10/1/18. The total effective $/kWh rate is the summation of the supply and transport effective rates. A simplified weighted average $/kW demand is used as the effective rate for savings calculations. It was calculated by taking the summation of the annual $/kW demand times 8/12 plus the total summer $/kW demand times 4/12. Summer demand rates are considered June through September.

Building Name	Electric Rate	Meter #	Electric Account #	Effective Rate (Note 2)		EFFECTIVE RATE (Note 2)		Billed Baseline Electric	Solar Baseline Electric	Total Baseline Electric	TOTAL Electric Cost	Blended Avg Unit Cost ($ / Unit) (Note 3)	Base Year (Note 4)	
				Supply	Delivery									
				$/kWh (Note 8)	Annual $/kWh	Effective $/kW	Eff $/kWh	kWh	kWh	kWh	$			
Long Branch High	GS3	L012876647	100-102-688-627	$0.0746	$0.01759	$6.423	$0.09218	2,038,624	1,080,433	3,119,057	$ 270,101	$ 0.132	Mar-17	Mar-18
Long Branch Middle	GS3	L012876626	100-052-214-879	$0.0746	$0.01759	$6.423	$0.09218	2,020,569	1,080,433	3,101,002	$ 302,294	$ 0.150	Apr-17	Apr-18
Audrey W. Clark	GS3	G28281962	100-014-451-213	$0.0746	$0.01759	$6.423	$0.09218	42,480	116,609	159,089	$ 9,843	$ 0.232	Apr-17	Mar-18
Audrey W. Clark (Trailer)	GS1	unknown	100-014-451-130	$0.0746	$0.01759	$6.423	$0.09218	15,934		15,934	$ 2,197	$ 0.138	Mar-17	Mar-18
Audrey W. Clark (Trailer)	GS1	G205623337	100-043-381-217	$0.0746	$0.01759	$6.423	$0.09218	9,071		9,071	$ 1,421	$ 0.157	Mar-17	Mar-18
Audrey W. Clark (Trailer)	GS1	G17849097	100-061-658-439	$0.0746	$0.01759	$6.423	$0.09218	15,671		15,671	$ 1,745	$ 0.111	Apr-17	Mar-18
George L. Catrambone Elementary	GS3	S310219087	100-104-602-816	$0.0746	$0.01759	$6.423	$0.09218	966,840	-	966,840	$ 123,555	$ 0.128	Mar-17	Mar-18
Gregory Elementary	GS3	G28659377	100-057-745-687	$0.0746	$0.01759	$6.423	$0.09218	916,320	68,243	984,563	$ 113,418	$ 0.124	Apr-17	Apr-18
Amerigo A. Anastasia Elementary	GS3	G28153156	100-044-055-042	$0.0746	$0.01759	$6.423	$0.09218	826,751	94,149	920,900	$ 93,718	$ 0.113	Apr-17	Mar-18
Morris Elementary	GS3	G35513675	100-013-832-124	$0.0746	$0.01759	$6.423	$0.09218	286,614	209,181	495,795	$ 33,359	$ 0.116	Mar-17	Mar-18
Joseph M. Ferraina ECLC	GS3	G28118557	100-011-464-649	$0.0746	$0.01759	$6.423	$0.09218	453,120	-	453,120	$ 52,421	$ 0.116	Mar-17	Apr-18
Lenna W. Conrow Elementary	GS3	G28658758	100-015-193-103	$0.0746	$0.01759	$6.423	$0.09218	61,320	-	61,320	$ 5,674	$ 0.093	Mar-17	Apr-18
Lenna W. Conrow Elementary (Note 7)	GS3	G28340345		$0.0746	$0.01759	$6.423	$0.09218	(26,486)	170,758	144,272	$ 5,171	N/A	Mar-17	Apr-18
Board of Education Building (Trailer)	GS1	unknown	100-043-381-225	$0.0746	$0.01759	$6.423	$0.09218	16,012	-	16,012	$ 2,410	$ 0.151	Apr-17	Mar-18
Board of Education Building	GS3	G28460719	100-014-553-356	$0.0746	$0.01759	$6.423	$0.09218	380,720	16,925	397,645	$ 43,273	$ 0.114	Apr-17	Mar-18

Note 1: Utility information provided by the client and was obtained directly from Energy Cap and spread sheets containing additional data including solar production.

Note 2: The effective rate does not include fixed charges and is the portion of energy costs that can be affected by a change in energy or demand. The effective supply kWh rate is the most recent in the baseline period. The effective transport $/kWh and $/kW demand rates are based on the most recent utility tariff rates as of 10/1/18. The total effective $/kWh rate is the summation of the supply and transport effective rates. Summer rate is considered months June through September. A simplified weighed average $/kW demand rate is used as the effective rate for savings calculations. It was calculated by taking the summation of the annual $/kW demand time 8/12 plus the total summer $/kW demand times 4/12.

Note 3: The average blended unit cost is the total 12 month utility costs divided by the total 12 month billed kWhs.

Note 4: The baseline period consists of 2017/2018 April through March.

Note 5: Electric commodity supplier of electricity for the baseline period is South Jersey Energy and the transport company is Jersey Central Power & Light (JCP&L).

Note 6: The High and Middle Schools have two separate solar PV systems, a parking lot and roof system. The parking lot system is subtracted by the utility on the bill while the roof solar is tied into the building electric systems on the building side of the meter.

Note 7: The Lenna W. Conrow account 100-015-193-160 solar production exceeds the baseline total kWh building which is reason for the negative billed baseline and lack of a blended average billed unit cost.

Note 8: South Jersey Energy Website - Effective September 1, 2018, SJE will be implementing a Contract Price adjustment. The rate increase is the result of two factors that are, unfortunately, not in SJE's control. First is the Atlantic City Electric (ACE) transmission rate increase (affects ACE service territory only). Second is a change to the New Jersey Renewable Portfolio Standards (RPS), requiring the percentage of statewide electricity sales derived from solar energy sources to increase from 3.29% to 4.30% by the end of 2019 (affects all of NJ). This requires SJE to use more solar sources for our electricity supply, thereby increasing costs.

Natural Gas

Due to the complex nature and variablity of the gas rates which includes demand and balancing charges in the tarriff rates the blened average unit cost is consided the effective rate for savings calculations. In cases where more than one account/meter serves a school the total average of all combined accouts is used unless the accout is not significant, for instance where the accout exists but delivers no natual gas on a regual basis or uses a very small ammout relative to the other accouts.

Building	$/therm
Long Branch High	$0.951
Long Branch Middle	$1.027
Audrey W. Clark	$1.002
George L. Catrambone Elementary	$1.031
Gregory Elementary	$0.974
Amerigo A. Anastasia Elementary	$1.013
Morris Elementary	$0.999
Joseph M. Ferraina ECLC	$1.018
Lenna W. Conrow Elementary	$1.013
Board of Education Building	$1.045

Building Name	Gas Rate	Meter #	Gas Account #	Total Gas Consumption therms	TOTAL Gas Cost $	Blended Avg Unit Cost ($ / Unit) (Note 3)	Base Year (Note 4)	
Long Branch High	GSL	851084	22-0011-1862-69	9,969	$ 9,485	$ 0.951	Apr-17	Apr-18
Long Branch Middle	GSL	746597	22-0009-8746-36	9,151	$ 9,399	$ 1.027	Apr-17	Apr-18
Audrey W. Clark	GSL	872600	04-3217-1345-13	18,829	$ 18,863	$ 1.002	Apr-17	Apr-18
George L. Catrambone Elementary	GSL	944667	22-0015-2203-05	27,582	$ 28,450	$ 1.031	Apr-17	Apr-18
Gregory Elementary	GSL	7845531	22-0011-1037-26	37,307	$ 36,320	$ 0.974	Apr-17	Apr-18
Amerigo A. Anastasia Elementary	GSL	812012	22-0009-7173-15	31,650	$ 32,046	$ 1.013	Apr-17	Apr-18
Morris Elementary	GSL	872586	19-3292-3410-1Y	23,789	$ 23,760	$ 0.999	Apr-17	Apr-18
Joseph M. Ferraina ECLC	GSL	810445	22-0005-6925-95	24,430	$ 24,858	$ 1.018	Apr-17	Apr-18
Lenna W. Conrow Elementary	GSL	851402	07-3232-4305-13	29,646	$ 30,032	$ 1.013	Apr-17	Apr-18
Board of Education Building	GSL	1010916	20-3298-4370-30	6,452	$ 6,740	$ 1.045	Apr-17	Apr-18

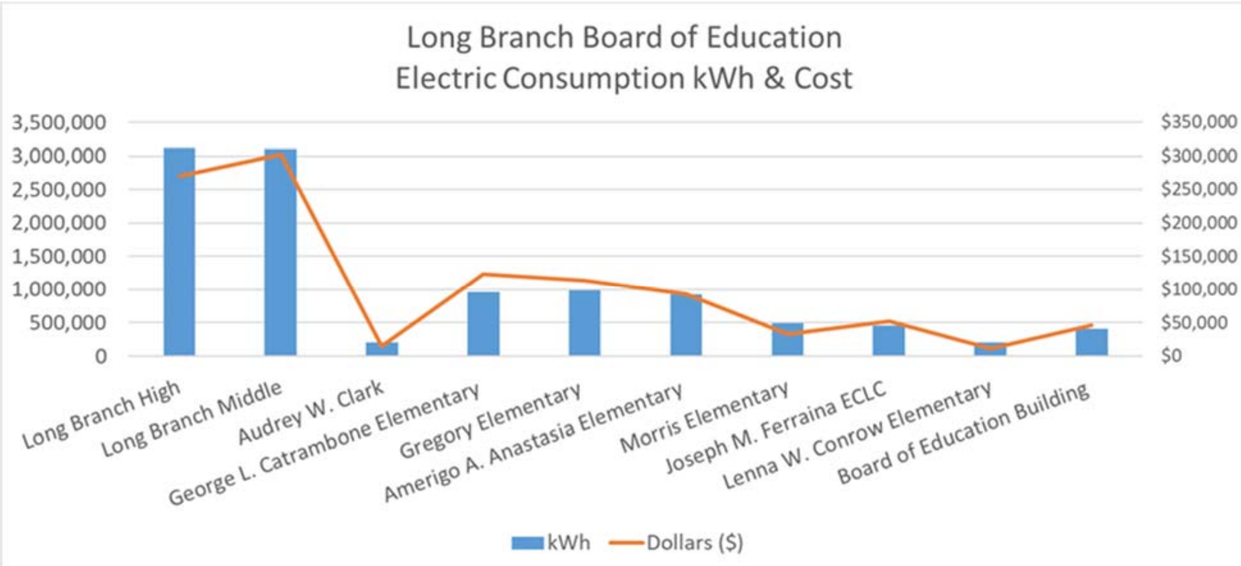
Note 1: Utility information provided by the client and was obtained directly from Energy Cap. Direct copies of bills were not provided for comparison and validation of the data.

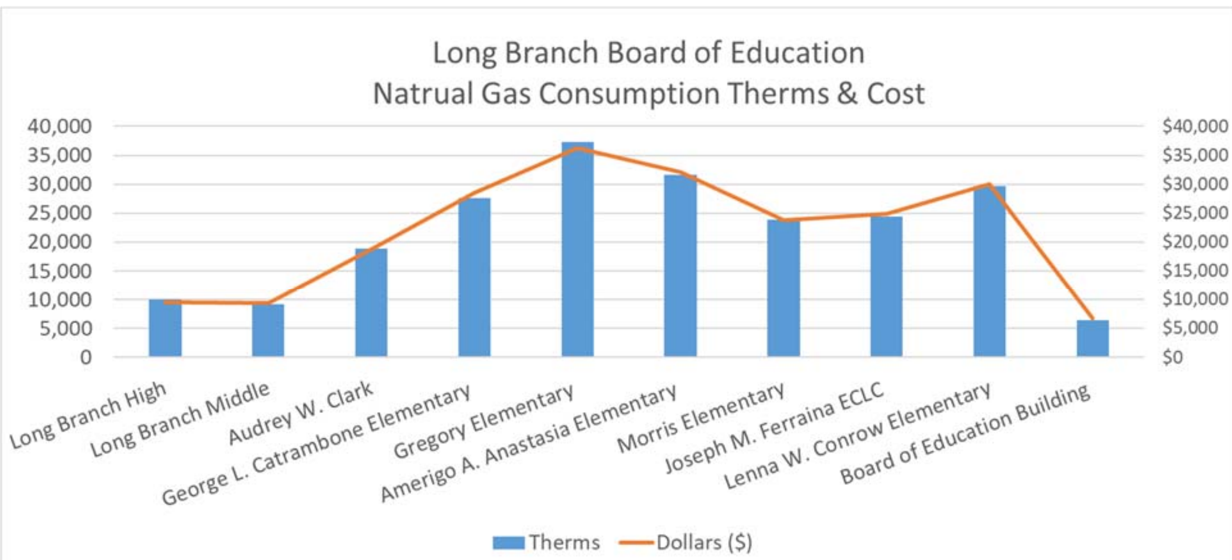
Note 2: Natural Gas commodity suppler of Natural gas for the baseline period is New Jersey Natural Gas and the transport company is New Jersey Natural Gas.

Note 3: The effective rate gas rate is blended average unit costs and is the total annual baseline costs divided by the total baseline consumption.

Note 4: The baseline period consists of 2017/2018 April through March.

Utility Breakdown by Building





Utility Escalation Rates

For purposes of calculating the extended value of the energy savings of this project, the following utility escalation rates have been used.

Name of School	Energy					
	Electric Consumption		Annual Electric Demand		Natural Gas	
	Escalation Rate	Start Year of Escalation	Escalation Rate	Start Year of Escalation	Escalation Rate	Start Year of Escalation
Long Branch High	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Long Branch Middle	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Audrey W. Clark	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
George L. Catrambone Elementary	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Gregory Elementary	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Amerigo A. Anastasia Elementary	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Morris Elementary	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Joseph M. Ferraina ECLC	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Lenna W. Conrow Elementary	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Board of Education Building	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1

SECTION 3. FINANCIAL IMPACT

Energy Savings and Cost Summary

The table below provides a summary of the costs and savings associated with the measures recommended in the Energy Savings Plan. The savings have been calculated based on the savings methodology detailed throughout this report and included in the appendix of this report. Costs for each measure have been estimated based on project implementation experience and industry standards.

ECM #	Energy Conservation Measure	ECM Hard Cost	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
	Long Branch High School					
1	Comprehensive LED Lighting Upgrades (Lighting & Controls) - Long Branch High School	$824,169	$76,195	10.82	Public Bidding	Yes
2	Plug Load Controls - Long Branch High School	$9,397	$626	15.00	Public Bidding	Yes
3	Cogeneration (CHP) - Long Branch High School	$58,225	$3,754	15.51	Public Bidding	Yes
4	Walk-In Cooler Controls - Long Branch High School	$7,729	$1,452	5.32	Public Bidding	Yes
5	Replace W2W Chiller with HE Air Cooled Chiller - Long Branch High School	$397,444	$6,114	65.01	Public Bidding	Yes
6	HVAC Upgrades at HS (WSHP to Gas/Electric) - Café + Media Center - Long Branch High School	$344,400	-$863	-399.05	Public Bidding	Yes
7	HVAC Upgrades at HS (WSHP to Gas/Electric) - Aux Gym - Long Branch High School	$184,500	-$8,752	-21.08	Public Bidding	Yes
8	Enhanced Air Filtration / Ionization Filters - Long Branch High School	$64,380	$5,566	11.57	Public Bidding	Yes
9	Upgrade Building Management System (BMS) - Central Plant - Long Branch High School	$150,060	$7,693	19.51	Public Bidding	Yes
10	Upgrade Building Management System (BMS) - Common Area's LBHS - Long Branch High School	$83,230	$0	N/A	Public Bidding	Yes
11	Building Envelope Weatherization - Long Branch High School	$42,331	$12,166	3.48	Public Bidding	Yes
12	Retro-Commissioning Study & HVAC Improvements - Long Branch High School	$95,735	$8,815	10.86	Public Bidding	Yes
13	Construction Contingency - Long Branch High School	$268,000	$0	N/A	Public Bidding	Yes
	Long Branch Middle School					
14	Comprehensive LED Lighting Upgrades (Lighting & Controls) - Long Branch Middle School	$862,047	$59,786	14.42	Public Bidding	Yes
15	Plug Load Controls - Long Branch Middle School	$13,178	$1,862	7.08	Public Bidding	Yes
16	Install High Efficiency Transformers - Long Branch Middle School	$102,153	$10,275	9.94	Public Bidding	Yes
17	Walk-In Cooler Controls - Long Branch Middle School	$10,213	$1,929	5.29	Public Bidding	Yes
18	Replace DWH with High Efficiency DWH - Long Branch Middle School	$26,906	$1,258	21.39	Public Bidding	Yes

ECM #	Energy Conservation Measure	ECM Hard Cost	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
19	Upgrade Building Management System (BMS) - Central Plant - Long Branch Middle School	$170,560	$2,333	73.11	Public Bidding	Yes
20	Upgrade Building Management System (BMS) - AHU's & RTU's - Long Branch Middle School	$19,988	$0	N/A	Public Bidding	Yes
21	Upgrade Building Management System (BMS) - Terminal Units - Long Branch Middle School	$155,595	$0	N/A	Public Bidding	Yes
22	Building Envelope Weatherization - Long Branch Middle School	$31,111	$9,092	3.42	Public Bidding	Yes
Audrey W. Clark Elementary School						
23	Direct Install Program (Lighting, Controls & HVAC) - Audrey W. Clark Elementary School	$49,218	$10,600	4.64	Public Bidding	Yes
24	Install HVAC-Related Variable Frequency Drives (VFDs) - Audrey W. Clark Elementary School	$12,783	$1,157	11.05	Public Bidding	Yes
25	Plug Load Controls - Audrey W. Clark Elementary School	$1,836	$96	19.12	Public Bidding	Yes
26	Walk-In Cooler Controls - Audrey W. Clark Elementary School	$5,244	$371	14.13	Public Bidding	Yes
27	Replace Boilers with High Efficiency Boilers (Clark) - Audrey W. Clark Elementary School	$199,106	$2,710	73.47	Public Bidding	Yes
28	Replace Unit Ventilator / Fan Coils - Audrey W. Clark Elementary School	$132,784	$420	316.46	Public Bidding	Yes
29	Upgrade Building Management System (BMS) - Central Plant - Audrey W. Clark Elementary School	$66,523	$1,611	41.29	Public Bidding	Yes
30	Upgrade Building Management System (BMS) - AHU's & RTU's - Audrey W. Clark Elementary School	$12,300	$2,131	5.77	Public Bidding	Yes
31	Upgrade Building Management System (BMS) - Terminal Units - Audrey W. Clark Elementary School	$37,413	$922	40.58	Public Bidding	Yes
32	Building Envelope Weatherization - Audrey W. Clark Elementary School	$52,647	$2,539	20.73	Public Bidding	Yes
33	Repair / Install Piping Insulation - Audrey W. Clark Elementary School	$5,339	$802	6.66	Public Bidding	Yes
George L. Catrambone Elementary School						
34	Comprehensive LED Lighting Upgrades (Lighting & Controls) - George L. Catrambone Elementary School	$265,530	$17,975	14.77	Public Bidding	Yes
35	Plug Load Controls - George L. Catrambone Elementary School	$6,265	$731	8.57	Public Bidding	Yes
36	Walk-In Cooler Controls - George L. Catrambone Elementary School	$7,729	$1,272	6.08	Public Bidding	Yes
37	Fuel Use Economizer Controls (Boilers) - George L. Catrambone Elementary School	$6,663	$1,601	4.16	Public Bidding	Yes
38	Building Envelope Weatherization - George L. Catrambone Elementary School	$29,513	$3,230	9.14	Public Bidding	Yes
Gregory Elementary School						
39	Comprehensive LED Lighting Upgrades (Lighting & Controls) - Gregory Elementary School	$255,535	$25,036	10.21	Public Bidding	Yes

ECM #	Energy Conservation Measure	ECM Hard Cost	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
40	Install HVAC-Related Variable Frequency Drives (VFDs) - Gregory Elementary School	$97,765	$9,127	10.71	Public Bidding	Yes
41	Plug Load Controls - Gregory Elementary School	$4,969	$475	10.47	Public Bidding	Yes
42	Walk-In Cooler Controls - Gregory Elementary School	$6,900	$742	9.30	Public Bidding	Yes
43	Fuel Use Economizer Controls (Boilers) - Gregory Elementary School	$19,988	$1,320	15.14	Public Bidding	Yes
44	Building Envelope Weatherization - Gregory Elementary School	$24,401	$2,175	11.22	Public Bidding	Yes
45	Repair / Install Piping Insulation - Gregory Elementary School	$6,695	$1,262	5.30	Public Bidding	Yes
46	Retro-Commissioning Study & HVAC Improvements - Gregory Elementary School	$2,563	$898	2.85	Public Bidding	Yes
Amerigo A. Anastasia School						
47	Comprehensive LED Lighting Upgrades (Lighting & Controls) - Amerigo A. Anastasia School	$263,148	$27,019	9.74	Public Bidding	Yes
48	Install HVAC-Related Variable Frequency Drives (VFDs) - Amerigo A. Anastasia School	$97,765	$9,127	10.71	Public Bidding	Yes
49	Plug Load Controls - Amerigo A. Anastasia School	$6,265	$1,005	6.23	Public Bidding	Yes
50	Walk-In Cooler Controls - Amerigo A. Anastasia School	$7,729	$901	8.58	Public Bidding	Yes
51	Fuel Use Economizer Controls (Boilers) - Amerigo A. Anastasia School	$19,988	$1,373	14.56	Public Bidding	Yes
52	Building Envelope Weatherization - Amerigo A. Anastasia School	$30,487	$3,399	8.97	Public Bidding	Yes
53	Repair / Install Piping Insulation - Amerigo A. Anastasia School	$6,891	$1,078	6.40	Public Bidding	Yes
54	Retro-Commissioning Study & HVAC Improvements - Amerigo A. Anastasia School	$2,563	$787	3.25	Public Bidding	Yes
Morris Avenue Elementary School						
55	Direct Install Program (Lighting, Controls & HVAC) - Morris Avenue Elementary School	$81,185	$13,295	6.11	Public Bidding	Yes
56	Install HVAC-Related Variable Frequency Drives (VFDs) - Morris Avenue Elementary School	$16,370	$1,463	11.19	Public Bidding	Yes
57	Plug Load Controls - Morris Avenue Elementary School	$2,916	$361	8.08	Public Bidding	Yes
58	Walk-In Cooler Controls - Morris Avenue Elementary School	$5,244	$371	14.13	Public Bidding	Yes
59	Replace Air Cooled Chiller with HE Air Cooled Chiller - Morris Avenue Elementary School	$178,658	$4,103	43.55	Public Bidding	Yes
60	Replace Boilers with High Efficiency Boilers (Morris) - Morris Avenue Elementary School	$204,488	$2,954	69.21	Public Bidding	Yes
61	Replace Unit Ventilator / Fan Coils - Morris Avenue Elementary School	$554,269	$832	666.54	Public Bidding	Yes
62	AHU Replacement (Install RTU) - Morris Ave - Morris Avenue Elementary School	$130,989	-$4,921	-26.62	Public Bidding	Yes

ECM #	Energy Conservation Measure	ECM Hard Cost	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
63	Upgrade Building Management System (BMS) - Central Plant - Morris Avenue Elementary School	$120,130	$2,747	43.73	Public Bidding	Yes
64	Upgrade Building Management System (BMS) - Terminal Units - Morris Avenue Elementary School	$164,615	$2,688	61.24	Public Bidding	Yes
65	Building Envelope Weatherization - Morris Avenue Elementary School	$18,971	$2,585	7.34	Public Bidding	Yes
Joseph M. Ferraina ECLC						
66	Direct Install Program (Lighting, Controls & HVAC) - Joseph M. Ferraina ECLC	$99,043	$14,862	6.66	Public Bidding	Yes
67	Install HVAC-Related Variable Frequency Drives (VFDs) - Joseph M. Ferraina ECLC	$76,844	$1,797	42.75	Public Bidding	Yes
68	Plug Load Controls - Joseph M. Ferraina ECLC	$2,160	$278	7.77	Public Bidding	Yes
69	Walk-In Cooler Controls - Joseph M. Ferraina ECLC	$5,244	$604	8.68	Public Bidding	Yes
70	Replace Split AC system with HE Split AC System - Joseph M. Ferraina ECLC	$40,488	$2,474	16.37	Public Bidding	Yes
71	Replace RTUs with High Efficiency RTUs - Joseph M. Ferraina ECLC	$38,950	$392	99.26	Public Bidding	Yes
72	Building Envelope Weatherization - Joseph M. Ferraina ECLC	$3,805	$438	8.68	Public Bidding	Yes
73	Repair / Install Piping Insulation - Joseph M. Ferraina ECLC	$1,803	$316	5.71	Public Bidding	Yes
Lenna W. Conrow School						
74	Direct Install Program (Lighting, Controls & HVAC) - Lenna W. Conrow School	$50,873	$12,014	4.23	Public Bidding	Yes
75	Plug Load Controls - Lenna W. Conrow School	$6,913	$651	10.61	Public Bidding	Yes
76	Walk-In Cooler Controls - Lenna W. Conrow School	$5,244	$318	16.49	Public Bidding	Yes
77	Fuel Use Economizer Controls (Boilers) - Lenna W. Conrow School	$6,663	$607	10.98	Public Bidding	Yes
78	Replace Boilers with High Efficiency Boilers (Conrow) - Lenna W. Conrow School	$204,488	$6,303	32.44	Public Bidding	Yes
79	Replace Unit Ventilator / Fan Coils - Lenna W. Conrow School	$122,693	$584	209.98	Public Bidding	Yes
80	Upgrade Building Management System (BMS) - Central Plant - Lenna W. Conrow School	$22,140	$1,339	16.54	Public Bidding	Yes
81	Upgrade Building Management System (BMS) - Terminal Units - Lenna W. Conrow School	$115,979	$3,180	36.47	Public Bidding	Yes
82	Building Envelope Weatherization - Lenna W. Conrow School	$63,664	$4,567	13.94	Public Bidding	Yes
83	Repair / Install Piping Insulation - Lenna W. Conrow School	$17,759	$1,707	10.41	Public Bidding	Yes
Board of Education Office						
84	Direct Install Program (Lighting, Controls & HVAC) - Board of Education Office	$18,419	$4,407	4.18	Public Bidding	Yes

ECM #	Energy Conservation Measure	ECM Hard Cost	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
85	Plug Load Controls - Board of Education Office	$1,404	$360	3.90	Public Bidding	Yes
86	Upgrade Building Management System (BMS) - Central Plant - Board of Education Office	$42,743	$422	101.29	Public Bidding	Yes
87	Building Envelope Weatherization - Board of Education Office	$33,796	$1,324	25.52	Public Bidding	Yes
Totals		**$8,124,838**	**$418,618**	**19.41**		

Operational Savings Estimates

The lighting retrofits recommended for this project will reduce the amount of lamps that need to be replaced each year due to the longer lasting lamps and new technology fixtures. The LED lighting recommended for the exterior fixtures will last much longer than the current high intensity discharge (HID) lighting and will generate material cost savings.

A brief description of the operational savings estimated for this project is included below. Energy Systems Group has worked with the District to quantify the exact sources of savings by going through past invoices and expenses. The operational savings will not be escalated.

Operational Savings for Financial Model	
ECM Description	**Annual Savings**
LED Lighting Upgrades & Occupancy Sensors – District Wide (10 Schools)	$137,771
HVAC Upgrades / Equipment Replacement	$90,000
Totals	**$227,771**

Potential Revenue Generation Estimates

As part of the Energy Savings Plan for the Long Branch Public Schools, several avenues for obtaining rebates and incentives have been investigated which include:

- NJ Smart Start Equipment Incentives
- Pay for Performance
- Combined Heat and Power Incentive
- Demand Response Energy Efficiency Credit

The estimated incentive amount for each program is listed below. Upon final selection of project scope and award of subcontractor bids, the incentive applications will be filed.

NJ Smart Start Equipment Incentives

The NJ Smart Start Equipment Incentives provide prescriptive rebates for defined retrofits. Incentives are applied on a unit-by-unit basis for making energy efficiency upgrades. The table below summarizes the equipment incentives, which will be applied for at Long Branch BOE:

NJ Smart Start Rebates	
Audrey W. Clark Elementary School - Boiler	$4,400
Morris Avenue Elementary School - Boiler	$4,400
Audrey W. Clark Elementary School - VFD's	$900
Gregory Elementary School - VFD's	$5,200
Amerigo A. Anastasia School - VFD's	$5,200
Morris Avenue Elementary School - VFD's	$900
Joseph M. Ferraina ECLC - VFD's	$2,800
Long Branch High School - Chiller	$18,400
Morris Avenue Elementary School - Chiller	$3,440
Joseph M. Ferraina ECLC - Rooftop Units	$1,030
Long Branch High School - Refrigeration Controls	$100
Long Branch Middle School - Refrigeration Controls	$100
Audrey W. Clark Elementary School - Refrigeration Controls	$100
George L. Catrambone Elementary School - Refrigeration Controls	$100
Gregory Elementary School - Refrigeration Controls	$100
Amerigo A. Anastasia School - Refrigeration Controls	$100
Morris Avenue Elementary School - Refrigeration Controls	$100
Joseph M. Ferraina ECLC - Refrigeration Controls	$100
Lenna W. Conrow School - Refrigeration Controls	$100
Long Branch Middle School - Domestic Water Heater	$350
Long Branch High School - Lighting	$49,422
Long Branch Middle School - Lighting	$46,000
George L. Catrambone Elementary School - Lighting	$16,500
Gregory Elementary School - Lighting	$20,463

NJ Smart Start Rebates	
Amerigo A. Anastasia School - Lighting	$21,900
Totals	$202,205

Pay for Performance Incentives

This project will not utilize P4P because minimum savings criteria will not be met with current scope of work.

Cogeneration Incentives

Incentives are available for Combined Heat and Power (CHP)/ Cogeneration systems with heat recovery and productive use of waste heat that are located on-site. Cogeneration units that are powered by natural gas and under 500kW, as in the case of the system recommended for School 10 and School 24, are eligible for an incentive of $2.00/ watt. There is a minimum of 5,000 EFL Run hours that both schools will meet to qualify for this incentive.

The CHP incentive is paid in three increments as outlined below:

- Thirty percent (30%) of the incentive upon proof of equipment purchase
- Fifty (50%) percent upon project completion and verification of installation
- Remainder twenty percent (20%) upon acceptance and confirmation the project is achieving the required performance thresholds based on twelve (12) months of operating data. proposed and/or minimum efficiency threshold

Building	Estimated Incentive #1	Estimated Incentive #2	Estimated Incentive #3	Estimated Total
Cogeneration – Long Branch High School	$6,000	$10,000	$4,000	$20,000

Demand Response Energy Efficiency Credit

The LED Lighting Upgrades recommended for the District will be eligible for the Energy Efficiency Credit available through PJM. The Energy Efficiency Credit pays consumers based on the permanent load reduction through the installation of energy efficiency measures. The following table summarizes the available Demand Response Incentives available due to the lighting upgrades to be performed in the District.

Demand Response Energy – Emergency Capacity Credit		
PJM Payment Year	Approved Load (kW)	Annual Customer Capacity Benefit
2019/2020	297 kW	$6,510
2020/2021	297 kW	$10,184
2021/2022	297 kW	$5,536
2022/2023	297 kW	$5,536
Totals		**$27,766**

Incentive Breakout for Recommended Project

Year	DR EE Credit	NJ Clean Energy Rebates	Pay for Performance	CHP	Total
1	$6,510	$201,905	$0	$6,000	$214,415
2	$10,184	$0	$0	$10,000	$20,184
3	$5,536	$0	$0	$4,000	$9,536
4	$5,536	$0	$0	$0	$5,536
TOTAL	**$27,766**	**$201,905**	**$0**	**$20,000**	**$249,671**

Business Case for Recommended Project

FORM VI - ENERGY SAVINGS PLAN

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
LONG BRANCH PUBLIC SCHOOLS
ENERGY SAVINGS IMPROVEMENT PROGRAM

ESCO Name: Energy Systems Group

Note: Respondents must use the following assumptions in all financial calculations:

(a) The cost of all types of energy should be assumed to inflate at **2.4% gas, 2.2% electric** per year; and

1. Term of Agreement: 20 years
2. Construction period [2] (months): 12 Months
3. Cash Flow Analysis Format:

Total ESG Project Cost [1]	$	9,989,488
Cost of Financing	$	120,000
CC	$	(1,750,000)
JBA Fee	$	114,000
Financed Amount	$	8,473,488

Interest Rate to be used for Proposal Purposes: 3.80%

	Annual Energy Savings	Annual Operational Savings	Energy Rebates/ Incentives	Total Annual Savings	Annual Project Costs	Board Costs	Annual Service Costs [3]	Net Cash-Flow to client	Cumulative Cash Flow
Installation	$ 214,000	$ 197,078		$ 411,078	$ -	$ -		$ 411,078	$ 411,078
1	$ 523,618	$ 262,771	$ 221,485	$ 1,377,845	$ 1,323,683	$ 1,376,495	$ 52,811	$ 1,350	$ 412,428
2	$ 427,830	$ 262,771	$ 20,184	$ 710,785	$ 709,435	$ 709,435	$ -	$ 1,350	$ 413,778
3	$ 437,245	$ 137,771	$ 9,536	$ 584,552	$ 583,202	$ 583,202	$ -	$ 1,350	$ 415,128
4	$ 446,866	$ 137,771	$ 5,536	$ 590,173	$ 588,823	$ 588,823	$ -	$ 1,350	$ 416,478
5	$ 456,700	$ 137,771	$	$ 594,471	$ 593,121	$ 593,121	$ -	$ 1,350	$ 417,828
6	$ 466,749	$ -	$	$ 466,749	$ 465,399	$ 465,399	$ -	$ 1,350	$ 419,178
7	$ 477,020	$ -	$	$ 477,020	$ 475,670	$ 475,670	$ -	$ 1,350	$ 420,528
8	$ 487,517	$ -	$	$ 487,517	$ 486,167	$ 486,167	$ -	$ 1,350	$ 421,878
9	$ 498,245	$ -	$	$ 498,245	$ 496,895	$ 496,895	$ -	$ 1,350	$ 423,228
10	$ 509,209	$ -	$	$ 509,209	$ 507,859	$ 507,859	$ -	$ 1,350	$ 424,578
11	$ 520,415	$ -	$	$ 520,415	$ 519,065	$ 519,065	$ -	$ 1,350	$ 425,928
12	$ 531,866	$ -	$	$ 531,866	$ 530,516	$ 530,516	$ -	$ 1,350	$ 427,278
13	$ 543,570	$ -	$	$ 543,570	$ 542,220	$ 542,220	$ -	$ 1,350	$ 428,628
14	$ 555,532	$ -	$	$ 555,532	$ 554,182	$ 554,182	$ -	$ 1,350	$ 429,978
15	$ 567,756	$ -	$	$ 567,756	$ 566,406	$ 566,406	$ -	$ 1,350	$ 431,328
16	$ 580,250	$ -	$	$ 580,250	$ 578,900	$ 578,900	$ -	$ 1,350	$ 432,678
17	$ 593,019	$ -	$	$ 593,019	$ 591,669	$ 591,669	$ -	$ 1,350	$ 434,028
18	$ 606,068	$ -	$	$ 606,068	$ 604,718	$ 604,718	$ -	$ 1,350	$ 435,378
19	$ 619,405	$ -	$	$ 619,405	$ 618,055	$ 618,055	$ -	$ 1,350	$ 436,728
20	$ 633,035	$ -	$	$ 633,035	$ 630,302	$ 630,302	$ -	$ 2,733	$ 439,462
Totals	**$ 10,481,916**	**$ 938,855**	**$ 256,741**	**$ 12,047,483**	**$ 11,966,288**	**$ 12,019,099**	**$ 52,811**	**$ 439,462**	**$ 439,462**

NOTES:
(1) Includes: Hard costs and project service fees defined in ESCO's PROPOSED 'FORM V"
(2) No payments are made by the Board during the construction period.
(3) Installation period savings for Energy Savings and Operational Savings are guarenteed. These savings will be used in addition to the first loan payment.

Greenhouse Gas Reductions

The project's reduced emissions would be equivalent to:

CO_2 sequestered by	70,585	tree seedlings grown for 10 years in an urban scenario
CO_2 sequestered by	587	acres of pine or fir forests
CO_2 emissions from	526	passenger vehicles
CO_2 emissions from	6,402	barrels of oil consumed
CO_2 emissions from the *energy* use of	234	homes for one year
CO_2 emissions from burning	14	coal railcars

Source:
All carbon equivalencies extracted directly from the EPA w ebsite.
"Greenhouse Gas Equivalencies Calculator." Clean Energy. U.S. Environmental Protection Agency. <w w w .epa.gov/cleanenergy/energy-resources/refs.html> (Jan. 24,2011).

AVOIDED EMISSIONS	Total Electric Savings	Total Natural Gas Savings	Total Annual Avoided Emissions
Annual Unit Savings	**3,488,303 kWh**	**30,825 Therms**	
NO_X	3,314 lbs	284 lbs	3,597 lbs
SO_2	7,709 lbs	0 lbs	7,709 lbs
CO_2	3,878,260 lbs	360,649 lbs	4,238,909 lbs

Factors Used in Calculations:

CO_2 Electric Emissions:	1,111.79 lbs. per MWh saved
CO_2 Gas Emissions:	11.7 lbs. per therm saved
NO_X Electric Emissions:	0.95 lbs. per MWh saved
NO_X Gas Emissions:	0.0092 lbs. per therm saved
SO_2 Electric Emissions:	2.21 lbs. per MWh saved

SECTION 4. ENERGY CONSERVATION MEASURES

Comprehensive LED Lighting Upgrades

ECM Summary

Long Branch Middle School Light Fixtures

Lighting Retrofit and Replacement: Most of the lighting fixtures throughout the Long Branch School District, utilize older technologies that can be upgraded. Improvements to lighting will reduce electrical consumption and improve lighting levels. The costs of material to maintain the current systems will also be reduced since these renovations replace items (i.e., lamps and ballasts) that are near the end of their life cycle and/or considered environmentally hazardous.

Where appropriate, lighting levels will be adjusted to meet Illumination Engineering Society (IES) standards.

Lighting Levels: Our proposed lighting system improvements will maximize savings while maintaining or improving existing light levels in each area. All installations will comply with IES standards. Post-retrofit light levels are typically increased because of the improved design and installation of newer equipment, but areas that are currently over lit will be adjusted to maintain IES recommended light level. Before and after sample light level reading will be performed to confirm expected results.

Exterior Lighting: In an effort to reduce electricity consumption and provide better security for the Long Branch School District buildings, ESG is proposing to retrofit the existing outside lighting on the buildings with newer, LED technology with photo cells for automatic control. In addition, every effort will be made to standardize the installed components for equipment uniformity and maintenance simplicity. Typical LED lighting system exhibit the following characteristics:

- Extremely Long Life – up to 50,000+ hours
- Highly efficient with very low wattage consumption
- Solid state lighting technology ensures that the fixtures are highly durable

Lighting Controls: Lighting controls are effective in areas where lighting is left on unnecessarily, mainly because it is a common area or due to the inconvenience to manually switch lights off when a room is left or on when a room is first occupied. This is common in rooms that are occupied for only short periods and only a few times per day. Lighting controls come in many forms. Sometimes an additional switch is adequate to provide reduced lighting levels when full light output is not needed.

Occupancy sensors detect motion and will switch the lights on when the room is occupied. Occupancy sensors can either be mounted in place of a current wall switch, or on the ceiling to cover large areas. Lighting controls will be installed in various offices, break rooms, restrooms, and other locations where appropriate. In the next phase, ESG will perform detailed sample measurements to determine coincident lighting room occupancy and overall lighting level information to accurately determine and identify spaces suitable for lighting controls throughout each facility.

Daylight Harvesting: ESG recommends the installation of photocell controls for interior lighting when large amounts of ambient light are present in an area. Turning interior lights off during the day when natural lighting is available has proven to produce a more pleasant environment and increase the productivity of occupants. Turning the lights off based on daylight present and recommended light levels for the area will result in electrical energy savings as well as prolong the life of the lamp due to fewer annual operating hours.

Facilities Recommended for this Measure

- Long Branch High School
- Long Branch Middle School
- Audrey W. Clark Elementary School
- George L. Catarmbone Elementary School
- Gregory Elementary School
- Amerigo A. Anastasia School
- Morris Avenue Elementary School
- Joseph M. Ferraina ECLC
- Lenna W. Conrow School
- Board of Education Office

Scope of Work

- Verify availability of ambient light through detailed light level readings in the spaces
- Safely disconnect the existing lighting fixture from live circuit
- Remove existing Fluorescent Lamps
- Where necessary remove existing receptacles in the fixtures
- Install the retrofit kit and install 10.5 watt LED line voltage tubes
- Reconnect all the wiring
- Test for operation
- Clean-up work area
- Properly dispose of removed material
- Provide training to staff on operation of new lighting system
- Refer to Line by Line inventory included in Appendix #6.

Savings Methodology

In general, savings calculations for lighting retrofits are calculated using the following methodology:

Savings Calculation Method		
Baseline Energy Usage (kWh / yr)	=	Existing Fixture Watts x Operating Hours / yr x 1 kW / 1000 Watts
Estimated Energy Usage (kWh / yr)	=	Proposed Fixture Watts x Op. Hours/yr x 1 kW / 1000 Watts
Energy Savings (kWh / yr)	=	Baseline Energy Usage – Estimated Energy Usage
Baseline Demand (kW)	=	Existing Fixture Watts / 1000 Watts
Retrofit Demand (kW)	=	Proposed Fixture Watts / 1000 Watts
Energy Savings (kW)	=	(Existing Fixture Watts – Proposed Fixture Watts) x 1 kW / 1000 Watts

Sample Calculation for 1st Floor Main Office (BOE Offices)

Current Hours = 3000

Current Total Watts = 506.8

Current kWh = Hours * Watts / 1000 = 1,520kWh

Proposed Hours = 3000

Proposed Total Watts = 189

Proposed kWh = Hours * Watts / 1000 = 567kWh

kWh Savings = Current kWh – Proposed kWh = 1,520kWh – 567kWh = 953kWh

kW Savings = (Current Watts – Proposed Watts)/1000 = (506W-189W)/1000 = 0.32kW

Maintenance

Lighting will need to be routine maintenance to ensure that devices/fixtures a clean and in working condition.

Benefits

- Electrical energy savings
- Improved exterior light quality
- Reduction in maintenance of exterior lighting system
- Improved safety around school perimeter
- Reduced lamp replacement for 5 to 10 years for LEDs

Direct Install Program (Lighting, Controls, HVAC)

ECM Summary

Existing small to mid-sized commercial and industrial facilities with a peak electric demand that did not exceed 200 kW in any of the preceding 12 months are eligible to participate in Direct Install. Applicants will submit the last 12 months of electric utility bills indicating that they are below the demand threshold and have occupied the building during that time. Buildings must be located in New Jersey and served by one of the state's public, regulated electric or natural gas utility companies. Created specifically for existing small to medium-sized facilities, Direct Install is a turnkey solution that makes it easy and affordable to upgrade to high efficiency equipment. The program pays up to 70% of retrofit costs, dramatically improving your payback on the project.

Facilities Available for Direct Install

- Audrey W. Clark Elementary School
- Morris Avenue Elementary School
- Joseph M. Ferraina ECLC
- Lenna W. Conrow School
- Board of Education Office

Scope of Work

- ESG will work closely with one of the program partners to evaluate the Direct Install Program
- The systems and equipment addressed by the program are
    - Lighting
    - Fuel Use Economizers
    - Small HVAC upgrades

Savings Methodology

Please refer to equipment calculations provided for Lighting, Fuel Use Economizer, and HVAC Equipment replacement for savings calculations.

Maintenance

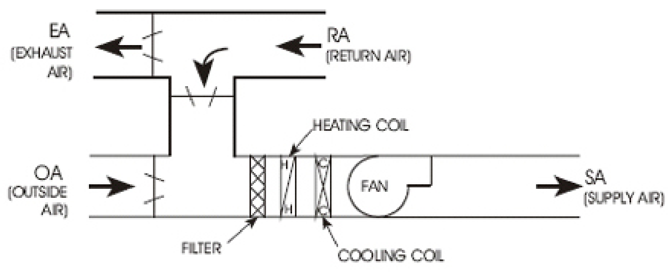
Periodically the equipment should be checked to ensure proper operation.

Benefits

- Reduced installation cost utilizing Direct Install Incentive Program.
- Electrical and Natural Gas energy savings

Install HVAC Related Variable Frequency Drives (VDFs)

ECM Summary



Air Handling Unit Schematic

Typical Cooling Tower Application

We recommend installing VFDs to control fan and pump on all motors in excess of 5HP. A control signal, integrated with the building management system, will cause the VFD to modulate fan speed to maintain the appropriate design parameters. Energy savings results from reducing fan/pump speed (and power) when there is a reduced load required for the zone. The magnitude of energy savings is based on the estimated amount of time that fan motors operate at partial load.

The VFDs will include a bypass to allow the motor to operate at full speed in HAND in the event of VFD failure. The VFD will be supplied complete with an open protocol communications card for integration with existing Building Management System (BMS) or newly installed BMS. The VFD will be controlled by the BMS to maintain the condenser water temperature setpoint.

Facilities Recommended for this Measure

- Audrey W. Clark Elementary School
- Gregory Elementary School
- Amerigo A. Anastasia School
- Morris Avenue Elementary School
- Joseph M. Ferraina ECLC

Scope of Work

- Remove existing fan motor starter, and safely disconnect electrical supply
- Where applicable, replace existing motors with new, inverter duty motors
- Properly dispose of all removed equipment and waste materials
- Furnish and install new VFDs. Each VFD to have the following features
    - Open protocol EMS interface card to connect to existing control system
    - Three Contactor Bypass
    - Fusible or Circuit Breaker Disconnect
- Provide electrical power wiring from the main electrical panel to each new VFD.
- Reuse existing electrical wiring where possible
- Modify electrical power wiring distribution panel as needed
- Extend communication bus to/from each VFD to/from existing Building Management System

- Perform any required programming and graphics modifications
- Start-up and commissioning of VFDs

Savings Methodology

Savings Calculation Method		
Energy Savings (kWh)	=	0.746 * HP * HRS * (ESF/η motor)
Demand Savings (kW)	=	0.746 * HP * (DSF/η motor)

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electric and Natural Gas savings

Plug Load Controls

ECM Summary

Office equipment is regularly left in the 'on' state at all times allowing the individual machine to revert to the 'Sleep' mode based on an internal timer. This measure will plug the office equipment into a networkable device that will allow for scheduling of the plugged in equipment.

Facilities Recommended for this Measure

- Long Branch High School
- Long Branch Middle School
- Audrey W. Clark Elementary School
- George L. Catarmbone Elementary School
- Gregory Elementary School
- Amerigo A. Anastasia School
- Morris Avenue Elementary School
- Joseph M. Ferraina ECLC
- Lenna W. Conrow School
- Board of Education Office

Scope of Work

Energy Systems Group recommends utilizing specialty wall sockets from BERT that have software to track real-time electrical usage of your appliances. The software also allows you to use your web browser to view this usage and automatically turn on/off any and all appliances plugged into these outlets.

Long Branch High School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	68
Smartboard	8760	0
Projector/Smartboard Combo	8760	0
Amplifier	8760	0
Charging Cart	8760	19
Small Printer	8760	0
Medium Printer	8760	0
Large Printer/Copier (110 only)	8760	0
TV/LCD/Smart TV	8760	0
Snack Vending	8760	0
Soda Vending	8760	0
Lg Coffeemaker (Bunn)	8760	0
H/C Water Dispenser	8760	0
Water Fountain (plug on outside)	8760	0
Electric Hot Water Heater	8760	0
Other Device not listed above	8760	0
TOTAL		**87**

Long Branch Middle School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	78
Smartboard	8760	0
Projector/Smartboard Combo	8760	0
Amplifier	8760	0
Charging Cart	8760	31
Small Printer	8760	0
Medium Printer	8760	4
Large Printer/Copier (110 only)	8760	4
TV/LCD/Smart TV	8760	0
Snack Vending	8760	1
Soda Vending	8760	4
Lg Coffeemaker (Bunn)	8760	0
H/C Water Dispenser	8760	0
Water Fountain (plug on outside)	8760	0
AC - 220 (not to be more then 20 amps)	8760	0
AC - 110 20 amps	8760	0
AC - 110 15 amps	8760	0
Electric Hot Water Heater	8760	0
Other Device not listed above	8760	0
TOTAL		**122**

Audrey W. Clark Elementary School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	10
Smartboard	8760	0
Projector/Smartboard Combo	8760	0
Amplifier	8760	0
Charging Cart	8760	1
Small Printer	8760	0
Medium Printer	8760	0
Large Printer/Copier (110 only)	8760	0
TV/LCD/Smart TV	8760	0
Snack Vending	8760	0
Soda Vending	8760	0
Lg Coffeemaker (Bunn)	8760	0
H/C Water Dispenser	8760	0
Water Fountain (plug on outside)	8760	0
AC - 220 (not to be more then 20 amps)	8760	0
AC - 110 20 amps	8760	0
AC - 110 15 amps	8760	6
Electric Hot Water Heater	8760	0
Other Device not listed above	8760	0
TOTAL		**17**

George L. Catrambone Elementary School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	40
Smartboard	8760	0
Projector/Smartboard Combo	8760	0
Amplifier	8760	0
Charging Cart	8760	16
Small Printer	8760	0
Medium Printer	8760	0
Large Printer/Copier (110 only)	8760	1
TV/LCD/Smart TV	8760	0
Snack Vending	8760	0
Soda Vending	8760	1
Lg Coffeemaker (Bunn)	8760	0
H/C Water Dispenser	8760	0
Water Fountain (plug on outside)	8760	0
AC - 220 (not to be more then 20 amps)	8760	0
AC - 110 20 amps	8760	0
AC - 110 15 amps	8760	0
Electric Hot Water Heater	8760	0
Other Device not listed above	8760	0
TOTAL		**58**

Gregory Elementary School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	30
Smartboard	8760	0
Projector/Smartboard Combo	8760	0
Amplifier	8760	0
Charging Cart	8760	15
Small Printer	8760	0
Medium Printer	8760	0
Large Printer/Copier (110 only)	8760	1
TV/LCD/Smart TV	8760	0
Snack Vending	8760	0
Soda Vending	8760	0
Lg Coffeemaker (Bunn)	8760	0
H/C Water Dispenser	8760	0
Water Fountain (plug on outside)	8760	0
AC - 220 (not to be more then 20 amps)	8760	0
AC - 110 20 amps	8760	0
AC - 110 15 amps	8760	0
Electric Hot Water Heater	8760	0
Other Device not listed above	8760	0
TOTAL		**46**

Amerigo A. Anastasia School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	35
Smartboard	8760	0
Projector/Smartboard Combo	8760	0
Amplifier	8760	0
Charging Cart	8760	12
Small Printer	8760	0
Medium Printer	8760	5
Large Printer/Copier (110 only)	8760	1
TV/LCD/Smart TV	8760	0
Snack Vending	8760	0
Soda Vending	8760	2
Lg Coffeemaker (Bunn)	8760	0
H/C Water Dispenser	8760	3
Water Fountain (plug on outside)	8760	0
AC - 220 (not to be more then 20 amps)	8760	0
AC - 110 20 amps	8760	0
AC - 110 15 amps	8760	0
Electric Hot Water Heater	8760	0
Other Device not listed above	8760	0
TOTAL		**58**

Morris Avenue Elementary School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	19
Smartboard	8760	0
Projector/Smartboard Combo	8760	0
Amplifier	8760	0
Charging Cart	8760	0
Small Printer	8760	0
Medium Printer	8760	7
Large Printer/Copier (110 only)	8760	0
TV/LCD/Smart TV	8760	0
Snack Vending	8760	0
Soda Vending	8760	1
Lg Coffeemaker (Bunn)	8760	0
H/C Water Dispenser	8760	0
Water Fountain (plug on outside)	8760	0
AC - 220 (not to be more then 20 amps)	8760	0
AC - 110 20 amps	8760	0
AC - 110 15 amps	8760	0
Electric Hot Water Heater	8760	0
Other Device not listed above	8760	0
TOTAL		**27**

Joseph M. Ferraina ECLC

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	19
Smartboard	8760	0
Projector/Smartboard Combo	8760	0
Amplifier	8760	0
Charging Cart	8760	0
Small Printer	8760	0
Medium Printer	8760	0
Large Printer/Copier (110 only)	8760	0
TV/LCD/Smart TV	8760	0
Snack Vending	8760	0
Soda Vending	8760	1
Lg Coffeemaker (Bunn)	8760	0
H/C Water Dispenser	8760	0
Water Fountain (plug on outside)	8760	0
AC - 220 (not to be more then 20 amps)	8760	0
AC - 110 20 amps	8760	0
AC - 110 15 amps	8760	0
Electric Hot Water Heater	8760	0
Other Device not listed above	8760	0
TOTAL		**20**

Lenna W. Conrow School

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	20
Smartboard	8760	0
Projector/Smartboard Combo	8760	0
Amplifier	8760	0
Charging Cart	8760	3
Small Printer	8760	0
Medium Printer	8760	14
Large Printer/Copier (110 only)	8760	1
TV/LCD/Smart TV	8760	0
Snack Vending	8760	0
Soda Vending	8760	1
Lg Coffeemaker (Bunn)	8760	0
H/C Water Dispenser	8760	0
Water Fountain (plug on outside)	8760	0
AC - 220 (not to be more then 20 amps)	8760	0
AC - 110 20 amps	8760	0
AC - 110 15 amps	8760	25
Electric Hot Water Heater	8760	0
Other Device not listed above	8760	0
TOTAL		**64**

Board of Education Office

Device Type:	Baseline Hours ON:	# of Berts
Projector	8760	4
Smartboard	8760	0
Projector/Smartboard Combo	8760	0
Amplifier	8760	0
Charging Cart	8760	0
Small Printer	8760	0
Medium Printer	8760	4
Large Printer/Copier (110 only)	8760	2
TV/LCD/Smart TV	8760	0
Snack Vending	8760	0
Soda Vending	8760	1
Lg Coffeemaker (Bunn)	8760	0
H/C Water Dispenser	8760	2
Water Fountain (plug on outside)	8760	0
AC - 220 (not to be more then 20 amps)	8760	0
AC - 110 20 amps	8760	0
AC - 110 15 amps	8760	0
Electric Hot Water Heater	8760	0
Other Device not listed above	8760	0
TOTAL		**13**

Savings Methodology

Savings are calculated using the following methodology for all devices plugged in:

Savings Calculation Methodology		
Baseline Energy Usage (kWh / yr)	=	Average kW x Baseline Weekly Hours x 4.348 wks/mo. x Months/yr
Proposed Energy Usage (kWh/ yr)	=	Average kW x Proposed Weekly Hours x 4.348 wks/mo. x Months/yr
Electrical Savings (kWh/ yr)	=	Baseline Energy Usage – Proposed Energy Usage

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

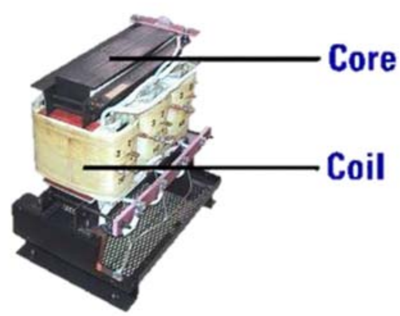
- Electrical energy savings

Install High Efficiency Transformers

ECM Summary

The primary goal of this ECM is increased energy savings through replacement of old, inefficient transformers with new, ultra-high efficient transformers. While facilities can be unique, electrical infrastructure is almost always based on U.S. industry standard transformers. Transformers are typically purchased as part of a total electrical distribution package, installed, and forgotten for 40-50 years. The majority of these transformers are operating at a small fraction of their nameplate capacity, resulting in very low efficiency, and are producing large amounts of excess heat, resulting in energy losses and higher utility costs. In addition, half of all existing transformers, according to the Dept. of Energy, are approaching a mean time to failure of 32 years. Replacing these units prior to a sudden end of life, results in lower risk of facility down time.

For a transformer retrofit to deliver real energy savings, the losses of the new transformer must be measurably lower than those of the existing transformer. This may sound obvious, but losses of existing transformers are not widely understood in relation to actual load conditions and load profiles. Given a real world setting, estimating or "stipulating" savings using factory or industry test data/standards for either the existing or typical replacement unit would be significantly flawed.



Transformers are comprised of two major components: a steel core, and windings made of aluminum or copper.

Because transformers are in operation 24-hours/day, 365-days/year, they produce energy losses around the clock. Core losses, also known as no-load-losses, are constant. The core remains energized at all times, regardless of the % load (so losses are always the same). Coil losses, also known as load losses, vary with the load placed upon them, i.e. as load increases, as do the losses.

Code and all published data are based on performance at a 35% linear load. Therefore, almost all transformers are designed for highest efficiency under that load profile. However, this profile does not typically exist in the real world. Linear loads essentially ceased to exist with the advent of computers and VFD's, and the average load on a transformer in 2016, across almost all verticals, is only about 13%. To reach this extreme percentile, the vast majority must be loaded at lower than 10%! Under this lower load profile, virtually all the losses are found in the core. Through the use of design and manufacturing advances, but more importantly, better materials (i.e. higher grade insulation, copper, aluminum and, most critically, steal in the core), energy efficient transformers lower resistance, producing extremely low no-load-losses and minimized load-losses.

Facilities Recommended for this Measure

- Long Branch Middle School

Scope of Work

The old, inefficient transformers will be removed and replaced with new high-efficient transformers. To the maximum extent practicable, the existing conductors and conduit will be reused. Below is the list of schools and transformer sizes, which are in the scope.

Long Branch Middle School

Location ID	Transformer Size (kVA)	Qty
Electric Closet	30	1
Electric Closet	45	1
Electric Closet	75	1
Electric Closet	150	1
Electric Closet	225	3
TOTAL		7

Savings Methodology

Savings are calculated using the following methodology for all the transformers:

Savings Calculation Methodology		
Baseline Annual losses from Transformers (kWh/yr)	=	(Baseline Transformer kW Losses (Normal Operation) x Equipment Operating hrs/ day x Equipment Operating days/yr) + Baseline Transformer kW Losses (Outside Op. hrs) x (24 x 365 - Equipment Operating hrs/ day x Equipment Operating days/yr)
Powersmith Annual losses from Transformers (kWh/yr)	=	(Powersmiths Transformer kW Losses (Normal Operation) x Equipment Operating hrs/ day x Equipment Operating days/yr) + Powersmiths Transformer kW Losses (Outside Op. hrs) x (24 x 365 - Equipment Operating hrs/ day x Equipment Operating days/yr)
Electrical Savings (kWh/yr)	=	Baseline Annual losses from Transformers – Powersmith Annual losses from Transformers

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

Electrical energy savings

Cogeneration (CHP)

ECM Summary

Energy Systems Group proposes to install one (1) 10 kW cogeneration machine at Long Branch High School to supply electricity and heat to the building, which will offset a portion of the boiler load. The recovered heat will be rejected into the boiler hot water heating system.

Location: There is ample space in the boiler room where the unit will be installed. The radiator, which will reject the excess heat, will be installed in roof or outside the boiler room. The radiator location must be verified and agreed upon with Long Branch School District.

Facilities Recommended for this Measure

- Long Branch High School

Scope of Work

New YANMAR 10 kW system will be located next to existing boilers on concrete pad with module, etc.

New Installation Work:

Furnish & Install (1) Yanmar Model CP10WN (10kW) using natural gas or propane, the high-efficiency generator provides 10kW of electrical power. The engine heat is captured and heats water at a rated temperature of 158°F for immediate use or storage in your facility. Excess electricity production may be sold back onto the grid in certain states, creating a credit on your electric bill.

- Natural gas fired CHP unit with heat rejection system located on outside wall of boiler room mounted in existing combustion air louver converted for radiator and fan. New CHP location will be in basement and set on new concrete housekeeping pad.
- F&I new gas piping to CHP unit from main gas meter bank.
- F&I new insulated hot water piping overhead from Yanmar CHP pump module to heating hot water system piping and heat rejection system.
- F&I new electrical power from Yanmar CHP unit to building electrical main switchgear.
- New exhaust vent piping to go through exterior wall and onto the roof

Savings Methodology

In general, savings calculations for lighting retrofits are calculated using the following methodology:

Savings Calculation Method	
Energy:	10 kW/module x 1 module(s) x 1 net after "parasitic losses"
	= 10 net kW output x $/kWh avg. displaced energy x run hours
Demand :	10 kW/module x 1 module(s) available x 1 net after "parasitic losses"
When Heat Used to Displace Boiler Gas Use:	$\frac{\left(\frac{Th}{hr\ module}\right)\ x}{boiler\ efficiency}\ x\ 1\ modules\ x\ \$/\text{Th boiler gas rate}$

Maintenance

Follow manufacturers' recommendations for preventative maintenance. In order to be eligible for New Jersey Clean Energy incentives, Long Branch Schools must demonstrate that they have contracted for an extended maintenance agreement to service the cogeneration units. This maintenance agreement will be conducted outside of the Energy Savings Improvement Program, as required by law.

Benefits

- The installation of a cogeneration unit will result in significant economic benefits to the overall ESIP program. These benefits include:
    - Up to 20-year financing term.
    - Substantial NJ Clean Energy incentives.
    - Potential demand response revenue generation.
    - Additional funding from FEMA grants and other local, state, and national incentives.

Walk-In Cooler Controls

ECM Summary

The kitchens at the Long Branch Schools contain walk-in freezers, walk-in coolers, reach-in freezers and reach-in coolers. These units are controlled by a dry bulb temperature and as a result run continuously throughout the year. Installing an **eTemp** control retrofit was assessed. The refrigeration systems usually monitor circulating air temperature in order to decide when to switch on and off. The circulating air temperature tends to rise far more quickly than the food temperature, and as result, the refrigeration unit works harder than necessary to maintain stored products at the right temperature. This, in turn, leads to excessive electricity consumption and undue wear and tear on the equipment. With **eTemp**, the thermostat regulates the refrigeration temperature based upon product temperature rather than air temperature, thereby maintaining product at the proper temperature. Savings is a result of reduced frequency of the compressor cycles, which are now based on food temperature rather than volatile air temperature. The equipment present in the middle school are shown in the table below.

Facilities Recommended for this Measure

- Long Branch High School
- Long Branch Middle School
- George L. Catarmbone Elementary School
- Gregory Elementary School
- Amerigo A. Anastasia School
- Joseph M. Ferraina ECLC

Scope of Work

- Furnish and install one (1) eTemp on the following locations.
- Fit eTemp to the thermostat sensor that controls the compressor.
- Provide start up and warranty.
- Provide training for maintenance personnel.

Building	Type	Quantity
All Schools	Walk-In Freezer	3
	Walk-In Cooler	3
	Reach-in Cooler	19
	Reach-in Freezer	8

Savings Methodology

Savings are calculated using the following methodology:

Energy savings will result from reducing the compressor cycling. In general, ESG uses the following approach to determine savings for this specific measure:

Savings Calculation Method		
Pre - kW	=	Compressor (HP) x 0.746 x Pre Cycles/hr
Post - kW	=	Compressor (HP) x 0.746 x Post Cycles/hr
Summer Season Hrs (Hs)	=	Total Hrs/yr x 55%
Winter Season Hrs (Hw)	=	Total Hrs/yr x 45%
Compressor Summer Cycling (% On) (Cs)	=	55%
Compressor Winter Cycling (% On) (Cw)	=	45%
Compressor Summer Operating (Hrs)	=	Hs x Cs
Compressor Winter Operating (Hrs)	=	Hw x Cw
Savings (kW)	=	Pre – Post (KW)
Savings (kWh)	=	(Compressor Summer Operating (Hrs)+ Compressor Winter Operating (Hrs)) x (Pre – Post (KW))

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electrical energy savings

Fuel-Use Economizers (Boilers)

ECM Summary

A heating system must be able to provide acceptable comfort at the lowest anticipated outdoor temperature. Most residential boilers have a heat capacity 1.5 to 2 times larger than needed to maintain space temperature on extreme days. Due to this oversizing of the boiler, the burner will cycle on and off to prevent overheating of the system water during any call for heat.

Intellidyne Heating System Economizers increase system efficiency. Thus, the heating system uses less fuel to generate the same amount of heat. This is done by dynamically changing the aquastat's effective dead-band based on the measured heating load. This causes the average water temperature to be varied (depending on the measured load) and is accomplished by extending the burner's off-time. Extending the off-time also results in longer, more efficient burns and a reduction in burner cycling. Just as computer control has increased the gas mileage of automobiles, Intellidyne Heating System Economizers improve the fuel utilization of heating systems by supplementing the antiquated on/off control action of the aquastat with the analysis and control capabilities of a computer.

Intellidyne Heating System Economizers reduce fuel consumption 10% to 20% and decrease burner cycling by 30% or more.

Facilities Recommended for this Measure

- George L. Catarmbone Elementary School
- Lenna W. Conrow School
- Audrey W. Clark Elementary School
- Morris Avenue Elementary School
- Joseph M. Ferraina ECLC

Scope of Work

- Furnish and install one (1) Hot Water Fuel Use Economizer.
- Provide start up and warranty.
- Provide training for maintenance personnel.

Savings Methodology

Energy savings will result from reducing the compressor cycling. In general, ESG uses the following approach to determine savings for this specific measure:

Savings Calculation Method		
Total Existing Boiler Natural Gas Usage (Therms)	=	Therms
Savings (% of Total)	=	13%*
Factor of Safety	=	50%
Total Natural Gas Savings (Therms)	=	(Existing Usage)*(Savings %)*(Factor of Safety)

- The savings estimate (%) matches the value stipulated by the New Jersey Board of Public Utilities New Jersey Clean Energy Program Protocols to Measure Resource Savings. ESG has alos applied a 50% factor of safety to lower the estimated savings.

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Natural Gas energy savings

Install High Efficiency Air-Cooled Chiller

ECM Summary

The replacement of an older chiller with a new chiller will significantly increase the efficiency of the chilled water plant during all load hours through the use of newer Variable Frequency Drive (VFD) technology and advanced control capabilities of the new chiller system. The VFD's allow for improved performance at part load conditions, in the case of most buildings, this would be the majority of operating hours. The newer chiller will also utilize new, environmentally friendly refrigerant which will help to decrease the carbon footprint of the School as well as minimize the risk exposed by having the discontinued refrigerant on site.

Facilities Recommended for this Measure

- Morris Avenue Elementary School

Scope of Work

- Remove and dispose of existing air-cooled chiller
- Install new, York, or approved equal, air-cooled scroll chiller with integrated VFD
- Provide necessary power and controls wiring to new chiller
- Provide piping modifications and connections for chiller connection to existing chilled water system
- Provide coordination with building automation system including system start-up and commissioning
- Provide customer training on maintenance procedures
- Provide operations and maintenance handbooks and assist in developing scope of work for preventative maintenance activities on new chiller

Savings Methodology

Energy savings will result from reducing the amount of energy the compressor will consume. In general, ESG uses the following approach to determine savings for this specific measure:

Savings Calculation Method		
Energy Savings (kWh)	=	Tons * Equivalent Full Load Hours * (IPLV Baseline – IPLV New Equipment)
Demand Savings (kW)	=	Tons * (Peak Duty Cycle = 67%) * (IPLV Baseline – IPLV New Equipment)

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

Electrical energy savings.

Replace Water to Water Heat Pump with High Efficiency Air-Cooled Chiller

ECM Summary

The replacement of the older Water to Water Heat Pumps with a new air-cooled chiller will significantly increase the effectiveness of the geothermal loop and increase the efficiency of the chiller plant and remaining water-source heat pumps. The integral chiller VFD's allow for improved performance at part load conditions, in the case of most buildings, this would be the majority of operating hours. The newer chiller will be much easier to maintain than the existing system and will also utilize new, environmentally friendly refrigerant which will help to decrease the carbon footprint of the School as well as minimize the risk exposed by having the discontinued refrigerant on site.

Facilities Recommended for this Measure

- Long Branch High School

Scope of Work

- Abandon the existing Water to Water Geothermal Heat Pumps providing chilled water service to the building
- Install new, ±200T, York, or approved equal, air-cooled scroll chiller with integrated VFD. Chiller shall be furnished with an integrate pump package (pumps, VFD, expansion tank, air separator, etc.).
- Provide steel dunnage and related structural improvements as required to support the installation of the chiller on the roof.
- Provide necessary power and controls wiring to new chiller
- Provide piping modifications and connections for the proposed rooftop chiller to/from existing chilled water system
- Provide coordination with building automation system
- Provide system start-up and commissioning
- Provide customer training on maintenance procedures
- Provide operations and maintenance handbooks and assist in developing scope of work for preventative maintenance activities on new chiller

Savings Methodology

Energy savings will result from reducing the amount of energy the compressor will consume. In general, ESG uses the following approach to determine savings for this specific measure:

Savings Calculation Method		
Energy Savings (kWh)	=	Tons * Equivalent Full Load Hours * (IPLV Baseline – IPLV New Equipment)
Demand Savings (kW)	=	Tons * (Peak Duty Cycle = 67%) * (IPLV Baseline – IPLV New Equipment)

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Removes ±200 Tons of cooling load from the existing geothermal well field resulting in cooler condenser water loop temperatures and increased efficiency for remaining WSHP's.
- Ensures proper chilled water temperatures are provided for the existing Auditorium and Gymnasium Air Handling Units to allow for adequate cooling and dehumidification capacity.
- Electrical energy savings.

Install High Efficiency Split Systems

ECM Summary

The District utilizes several split system air handling units each of which utilizes DX cooling. This ECM entails the replacement of existing air handling units and condensing units with high efficiency systems. The proposed system will reduce cooling costs compared to the existing equipment and will include DDC controls that can be easily integrated into the proposed Building Management System. The new systems will also ensure that all equipment operates with a common, environmentally low-impact refrigerant minimizing the plants ozone depletion potential.

Facilities Recommended for this Measure

- Joseph M. Ferraina ECLC

Scope of Work

- Demolition, removal and disposal of (4) condensing units (15T, 15T, 10T,7.5T).
- Provide and install (4) new condensing units to replace the existing equipment.
- Extend / reconnect refrigerant piping and electrical connections to the proposed equipment.
- Provide start up and warranty, and training for maintenance personnel

Savings Methodology

Savings Calculation Method		
Cooling Savings (kWh)	=	Unit-Size (Tons) x Cooling gradient (%) x (Existing Unit kW/Ton – New Unit kW/Ton) x Bin Hours

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electric savings

Replace Boilers with High Efficiency Boilers

ECM Summary

Audrey W. Clark Elementary School

The heating in Audrey W. Clark Elementary School building is provided by hot water generated from two (2) gas-fired cast iron hot water boilers. These boilers each have an input capacity of 1723 MBH (1 MBH = 1,000 BTU/Hr) and are equipped with Power Flame burners. Hot water from the boilers is delivered to convectors, hot water coils of the unit ventilators, and air-handling units in various locations throughout the building.

Location	No.	Manufacturer	Model	Capacity MBH	Utility
Boiler Room	2	AERCO	BMK-1000	1000 Each	Nat-Gas

Morris Avenue Elementary School

The heating in Morris Avenue Elementary School building is provided by hot water generated from a gas-fired hot water boiler. The boiler has an input capacity of 4295 MBH (1 MBH = 1,000 BTU/Hr) and is equipped with a Power Flame burner. Hot water from the boilers is delivered to convectors, hot water coils of the unit ventilators, and air-handling units in various locations throughout the building.

Location	No.	Manufacturer	Model	Capacity MBH	Utility
Boiler Room	2	AERCO	BMK-1000	1000 Each	Nat-Gas

Lenna Conrow Elementary School

The heating in Lenna Conrow Elementary School building is provided by hot water generated from a gas-fired hot water boiler. The boiler has an input capacity of 3350 MBH (1 MBH = 1,000 BTU/Hr) and is equipped with a Power Flame burner. Hot water from the boilers is delivered to perimeter radiators.

Location	No.	Manufacturer	Model	Capacity MBH	Utility
Boiler Room	2	AERCO	BMK-1000	2000 Each	Nat-Gas

Facilities Recommended for this Measure

- Audrey W. Clark Elementary School
- Morris Avenue Elementary School
- Lenna Conrow Elementary School

Scope of Work

Demolition and Removal Work

- Demolish and Remove existing boiler(s). Cut and cap existing piping for future connection during proposed work.
- Disconnect, remove and properly dispose of hot water supply and return piping for boilers to nearest isolation valves or as required for new installation.
- Disconnect, remove and properly dispose of gas flue for boilers as required.
- Disconnect all electric, controls, gas piping, water lines, pressure reliefs and drains.

New Installation Work

- Furnish and Install (F&I) new Aerco BMK-1000 high-efficiency gas boiler with integral burner set on concrete pad.

Details of installation to include the following:

- F&I Qty. (2) new AERCO BMK-1000 condensing hot water boilers.
- F&I new hot water supply and return piping from new boilers to existing piping capped during proposed work.
- F&I new boiler drains, pressure reliefs piped to floor drains, water supply, blow down drains piped over to existing floor drains.
- F&I new 2" fiberglass insulation on all new and existing hot water piping 'that has no insulation', drain lines, piping in boiler room.
- F&I new gas line piping from existing gas line to new burners with new shut off valves.
- F&I new 16 inch diameter AL29-4C single wall stainless steel flue pipe to connect from each new boiler to existing main flue in boiler room.
- F&I proper pipe suspensions for all piping.
- F&I pipe identification and tags for all pipe, valves, etc.
- Reconnect existing line voltage electrical circuits to new boilers.
- Provide factory startup; assist during start up and testing of new boilers.
- Final Boiler sizing will be based on an updated heat loss and gain calculation.

Savings Methodology

In general, savings calculations for boiler replacement are calculated using the following methodology:

Boiler Replacement

$E_E \quad = \sum_{i=1}^{8760} (Q_i \div \eta_E)$

$E_P \quad = \sum_{i=1}^{8760} (Q_i \div \eta_P)$

$E_S \quad = E_E - E_P$

$C_S \quad = E_S \times FUR$

Where,

E_E = Annual energy (fuel) use of existing system

E_P = Annual energy use of proposed system

E_S = Annual energy savings

C_S = Annual cost savings

Q_i = Hourly heating demand, modeled as a linear fit of OA DBT (dry-bulb temperature), with a cut-off temperature above which there is no heating

η = Combustion efficiency of heating system based on field data, manufacturer's rating or snap-

Maintenance

Follow manufacturers' recommendations for preventative maintenance.

Benefits

- Natural Gas savings
- Operational savings through new equipment and preventative maintenance plan

Replace Unit Ventilators with High Efficiency Unit Ventilators

ECM Summary

We recommend replacing the existing unit ventilators with new unit ventilators equipped with high efficiency EC motors. The advantages of replacing existing permanent split capacity (PSC) motors with electronically commutated motors (ECM) is the increase in control ability of the motor. EC Motors may be programmed to vary speed and can reach efficiencies up to 80% above standard PSC motors.

Based on discussions with facility personnel and the inspection of existing unit ventilators throughout the building, there are several units in poor condition and in need of replacement. Although this measure results in a very poor payback period, it is recommended based on the poor condition of the existing units, improved occupant comfort with slight potential energy savings.

Facilities Recommended for this Measure

- Audrey W. Clark Elementary School

Scope of Work

- Demolition, removal and disposal of existing unit ventilators
- Furnish and install the following:
  - High-efficiency Unit Ventilators with EC motors
  - Extend and reconnect piping to/from the existing distribution systems
  - Electrical power and control wiring to new unit(s)
  - Coordinate with new DDC controls
- Provide new unit start-up and commissioning

Savings Methodology

Savings Calculation Method		
Electric Usage Savings (kWh)	=	(# of Unit Ventilators) x (Unit Ventilator Motor HP) x (Run Hours) x (0.746) x (Existing Motor Load Factor – New Motor Load Factor) / (Old Motor Efficiency – New Motor Efficiency)
Electric Demand Savings (kWh)	=	(# of Unit Ventilators) x (Unit Ventilator Motor HP) x (Peak Load Months) x (Demand Load Factor) x (0.746) x (Existing Motor Load Factor – New Motor Load Factor) / (Old Motor Efficiency – New Motor Efficiency)

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electric savings

Replace DHW Heaters

ECM Summary

Typical Domestic Water Heater

The existing domestic water heaters at some Long Branch Schools facilities are nearing the end of their useful life. As existing DHW boiler(s) age, they typically experience a loss in efficiency due to fouling and scaling on the internal heat exchange components, as well as an increase in maintenance costs. This measure will include replacing these units with new high-efficiency domestic water heating systems.

The existing domestic hot water heaters are standard efficiency models that operate at a nameplate value of around 80% thermal efficiency. This measure will include the installation of new hot water heaters to replace these aging, lower efficiency ones. New condensing water heaters are available that operate at efficiencies up to 97%.

Facilities Recommended for this Measure

- Long Branch Middle School

Scope of Work

Demolition and Removal Work

- Drain, disconnect hot water piping, gas piping, electrical and metal flue venting for removing and properly disposing of existing gas fired domestic hot water heater.

New Installation Work

- Furnish and Install (F&I) Qty. (1) AERCO Model #AM399 gas fired domestic hot water heater.
- F&I new copper pipe, fittings, valves and insulation to reconnect existing hot water piping to new water heater.
- Reconnect existing into existing chimney.
- Reconnect existing gas piping to new water heater.
- Reconnect existing electric to new water heater.
- Provide factory-authorized start-up with written combustion report.
- All existing piping, supply pumps and check valve to remain.
- Set new heater on existing concrete housekeeping pad.

Savings Methodology

Savings Calculation Methodology		
Existing DHWH Efficiency	=	Existing Heat Production/ Existing Fuel Input
Proposed DHWH Efficiency	=	Proposed Heat Production/ Proposed Fuel Input
Energy Savings	=	Heating Production (Proposed Efficiency – Existing Efficiency)

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Natural gas savings

Replace RTUs with High Efficiency RTUs

ECM Summary

Rooftop units in the Long Branch schools vary based on age and condition. Replacing aged rooftop HVAC units will reduce the operating and maintenance costs of these systems. Both heating and cooling efficiencies of packaged rooftop equipment have significantly increased in the past 10 years. ESG has identified a number of older units that still utilize R22 refrigerant as the prime candidates for replacement.

Facilities Recommended for this Measure

- Joseph M. Ferraina ECLC

Scope of Work

Joseph M Ferraina ECLC

Demolition and Removal Work:

- Disconnect electrical, controls and gas piping.
- Reclaim refrigerant.
- Crane (2) existing rooftop units off of the roof onto flatbed trailer for disposal.

New Installation Work:

Proposed are the following;

- F&I Qty. (2) new, York packaged gas heating and electric cooling rooftop units, model # ZF060N40D2B5ACA1A1 or approved equal.
- Units to include economizer with single enthalpy control and smoke detector.
- Reconnect line voltage power to new unit disconnects.
- F&I new return air smoke detector.
- F&I new room thermostat controller.
- Provide crane for the removal of RTU's and setting of new units.
- F&I new PVC condensate trap at unit.
- Provide air test and balance of new RTU's only.

Savings Methodology

Savings Calculation Method		
Cooling Savings (kWh)	=	RTU-Size (Tons) x Cooling gradient (%) x (Existing RTU kW/Ton – New RTU kW/Ton) x Bin Hours
Heating Savings (Therm)	=	((RTU-Size (Btu/h)/Existing RTU Eff.) – (RTU-Size (Btu/h)/ New RTU Eff.)) x Heating gradient (%) x Bin Hours/100000

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electric and Natural Gas savings

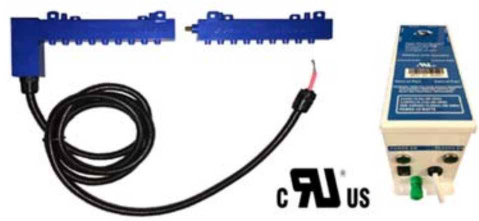
Enhanced Air Filtration / Ionization Filters

ECM Summary

In this measure we examined installing ionization filters for equipment that serves large assembly areas with intermittent occupancy. The ionization filters allow the space to meet the ASHRAE required ventilation air based on a performance method in lieu of diluting the air based on design criteria and or measured occupancy (i.e. CO2 demand control ventilation. The performance-based ventilation strategy will reduce the total amount of outside air required when the space is unoccupied.

An additional benefit of utilizing the ionization filtration equipment is that it reduces the peak cooling demand when the space is fully occupied. This allows new equipment (both central plant and local terminal unit / air handling unit) for the space to be downsized based on revised ventilation load.

This was identified as a benefit at the High School as, in addition to ongoing energy savings, the proposed air-cooled chiller plant equipment can be resized based on the post-retrofit ventilation load.



Modular GPS Ionization Equipment

Facilities Recommended for this Measure

- Long Branch High School

Scope of Work

- Mount and wire the Ionization Filter into (3) Air Handling Units (one AHU's serving the Auditorium and two AHU's serving the Main Gymnasium. Equipment will utilize local 115/1 or 230/1 VAC input from a local circuit.
- Reset the minimum outside air setpoint in accordance with the International Mechanical Code and ASHRAE 62.1 IAQP as per enthe engineered exception found in Section 403.2.
- Coordinate with BMS contractor to reset the minimum and maximum outside air positions.

Savings Methodology

Savings are calculated using the following methodology for all devices:

Savings Calculation Methodology		
Electric Energy Savings (kWh)	=	(Peak Cooling Load Reduction in Tons) x (kW/Ton) x (Hours)
Heating Savings (Therms)	=	(Peak Heating Load Reduction in MMBTU) x (Hours) / System Efficiency

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Natural gas savings

Upgrade Building Management System (BMS)

ECM Summary

This ECM includes modernization of the District's DDC control system for the HVAC equipment. With the communication between the control devices and the new updated digital interface/software, the facility manager will be able to take advantage of scheduling for occupied and unoccupied periods based on the actual occupancy of each space in the facility. The DDC system will also aid in the response time to service / maintenance issues when the facility is not under normal maintenance supervision, i.e. after-hours.

Facilities Recommended for this Measure

- Long Branch High School
- Long Branch Middle School
- Audrey W. Clark Elementary School
- Lenna W. Conrow School
- Board of Education Office

Scope of Work (Long Branch High School)

A. **<u>Building Automation Network Controls (Qty. 1)</u>**

1. Install (1) New Johnson Metasys DDC Building Network Automation Engine (NAE) Panel.

2. Johnson Metasys Graphical User Software Package + Central Web-Server and Operator's Work Station

a) Programmed and Designed Graphical User Interface

1) Site/Building Rendering
2) Graphic Floor Plans showing individual equipment locations
3) Unique Mechanical Equipment graphics depicting monitored/control parameters
4) Alarms and Trending information
5) Alarm Printer

3. Communications wiring.

4. PC Provided by Customer

B. **<u>Rooftop Units Controls (Qty. 3)</u>**

1. The unit manufacturer (UM) shall provide all Internal & external devices including BACnet MS/TP interface devices to meet the specification and sequence of operations.
2. ATC Systems shall provide Labor /materials for wiring &/or mounting (Field installation required) for the following:
   a) BACnet MS/TP interface communications wiring
   b) Space Temperature sensors w/ setpoint adj.
   c) Space Relative Humidity sensors
   d) Space CO2 sensors

C. **Combined Heat and Power (CHP) Controls: (Qty. 1)**
1. The unit manufacturer (UM) shall provide all Internal & external devices including BACnet MS/TP interface devices to meet the specification and sequence of operations.
2. ATC Systems shall provide Labor /materials for wiring &/or mounting (Field installation required) for the following:
   a) BACnet MS/TP interface communications wiring
   b) Supply water temperature sensor.

D. **Existing Water Source Heat Pump Controls (Qty. 10)**
1. ATC Systems shall provide the following controls & material for field installation, mounting &/or wiring
   a) Johnson Metasys Direct Digital Controllers, enclosures, control power transformers
   b) Fan Control
      1) Supply Fan and Exhaust Fan Start/Stop relays (R) & current switches (CS)
   c) Damper Controls
      1) Outside (OAD) & Return (RAD) Damper control
   d) Heating/Cooling Coil Control
      1) Compressor Control
      2) Reversing Valve Control
      3) Condenser Water Isolation valves and actuators
   e) Automatic Temperature Control Sensors
      1) Supply (SAT) & Mixed (MAT) Air Temperature sensors
      2) Space temperature sensors w/ setpoint adj.
   f) Safety & Shutdowns
      1) Low limit temperature switches, associated interlock wiring.

E. **Existing Energy Recovery Units Controls (Qty.2)**
1. ATC Systems shall provide the following controls & material for field installation, mounting &/or wiring
   a) Johnson Metasys Direct Digital Controllers, enclosures, control power transformers
   b) Supply & Exhaust Fan Start/Stop relays (R) & current switches (CS)
   c) Outside (OAD), Return (RAD) & Exhaust (EAD) damper control
   d) Natural Gas (NG) staged and modulation control
   e) Dx Cooling Staged control.
   f) Supply (SAT), Return (RAT), Exhaust Air (EAT) & Mixed (MAT) Air Temperature sensors
   g) Return Air CO2 sensors for Demand Control Ventilation (DCV)

F. **Existing Exhaust Fan Controls (Qty. 5)**
1. ATC Systems shall field install, &/or wiring control wiring to a Johnson Metasys Direct Digital Controller, Fan start/stop control relays and current switch.

Scope of Work (Long Branch Middle School)

A. Building Automation Network Controls (Qty. 1)
  1. Install New Johnson Metasys DDC Building Network Automation Engine (NAE) Panel(s).
  2. Johnson Metasys Graphical User Software Package + Central Web-Server and Operator's Work Station
     a) Programmed and Designed Graphical User Interface
        1) Site/Building Rendering
        2) Graphic Floor Plans showing individual equipment locations
        3) Unique Mechanical Equipment graphics depicting monitored/control parameters
        4) Alarms and Trending information
        5) Alarm Printer
  3. Communications wiring.

B. Existing Condenser Water Pumps: (Qty. 14)
  1. The variable Frequency drives shall be provided by others.
  2. ATC Systems shall provide, field install, mounting &/or wiring the following controls & materials
     a) Condenser Water Pump Start/Stop Relays for Lead/Lag
     b) Condenser Water Pump Current Switch
     c) Condenser Water Pump Speed Control Signal
     d) Condenser Water Pump VFD Fault monitoring

C. Existing Dual Temperature Loop System Sensors
  1. ATC Systems shall provide, field install, mounting &/or wiring the following controls & materials
     a) Loop Supply (LWS) & Return (LWR) Temperature sensors
     b) Loop Water Differential Pressure sensor
     c) Loop Water Differential Pressure Valve control. Reuse existing Valve and Actuator.

D. Domestic Hot Water System Controls: (Qty. 1)
  1. ATC Systems shall field install, &/or wiring control wiring to a Johnson Metasys Direct Digital Controller, Supply Water Temperature sensor and System Fault monitoring.

E. Existing Exhaust Fan Controls (Qty. 28)
  1. ATC Systems shall field install, &/or wiring control wiring to a Johnson Metasys Direct Digital Controller, Fan start/stop control relays and current switch.

F. Water Source Heat Pump Controls (Qty. 46)
  1. ATC Systems shall provide the following controls & material for field installation, mounting &/or wiring
     a) Johnson Metasys Direct Digital Controllers, enclosures, control power transformers
     b) Fan Control
        1) Supply Fan and Exhaust Fan Start/Stop relays (R) & current switches (CS)
     c) Damper Controls
        1) Outside (OAD) & Return (RAD) Damper control
     d) Heating/Cooling Coil Control
        1) Compressor Control
        2) Reversing Valve Control
        3) Condenser Water Isolation valves and actuators
     e) Automatic Temperature Control Sensors
        1) Supply (SAT) & Mixed (MAT) Air Temperature sensors
        2) Space temperature sensors w/ setpoint adj.
     f) Safety & Shutdowns
        1) Low limit temperature switches, associated interlock wiring.

G. Existing Make Up Air Unit Controls (Qty.3)
  1. ATC Systems shall provide the following controls & material for field installation, mounting &/or wiring
     a) Johnson Metasys Direct Digital Controllers, enclosures, control power transformers
     b) Supply & Exhaust Fan Start/Stop relays (R) & current switches (CS)

- **c)** Outside (OAD), Return (RAD) & Exhaust (EAD) damper control
- **d)** Natural Gas (NG) staged and modulation control
- **e)** Supply (SAT), Return (RAT) & Mixed (MAT) Air Temperature sensors
- **f)** Return Air CO_2 sensors for Demand Control Ventilation (DCV)

Scope of Work (Audrey W Clark)

A. <u>Building Automation Network Controls: (Qty. 1)</u>

1. Reuse and add to the existing Johnson Metasys DDC Building Network Automation Engine (NAE) Panel(s).
2. Update existing NAE/NCE firmware to 8.xx level
3. Communications wiring.

B. <u>Rooftop Units (Auditorium and Main Gym) Controls (Qty. 3)</u>

1. The unit manufacturer (UM) shall provide all Internal & external devices including BACnet MS/TP interface devices to meet the specification and sequence of operations.
2. ATC Systems shall provide Labor /materials for wiring &/or mounting (Field installation required) for the following:
   - **a)** BACnet MS/TP interface communications wiring
   - **b)** Space Temperature sensors w/ setpoint adj.
   - **c)** Space Relative Humidity sensors
   - **d)** Space CO_2 sensors

Scope of Work (Lenna W Conrow School)

A. <u>Building Automation Network Controls: (Qty. 1)</u>

1. Reuse and add to the existing Johnson Metasys DDC Building Network Automation Engine (NAE) Panel(s).
2. Update existing NAE/NCE firmware to 8.xx level
3. Communications wiring.

B. <u>Unit Ventilator Controls Hot Water (Qty. 19)</u>

1. ATC Systems shall provide the following controls & material for <u>field installation, mounting &/or wiring</u>
   - **a)** Johnson Metasys Direct Digital Controllers, enclosures, control power transformers
   - **b)** Fan Control
     - 1) Supply Fan Start/Stop relays (R) & current switches (CS)
   - **c)** Damper Controls
     - 1) Outside (OAD) & Return (RAD) Damper control
   - **d)** Heating Coil Control
     - 1) Hot Water Coil Control valve and actuator
     - 2) FTR Control valve and actuator
   - **e)** Automatic Temperature Control Sensors
     - 1) Supply (SAT) & Mixed (MAT) Air Temperature sensors
     - 2) Space temperature sensors w/ setpoint adj.
   - **f)** Safety & Shutdowns
     - 1) Low limit temperature switches, associated interlock wiring.
   - **g)** DX Cooling Coil Control
     - 1) Output and control relay for future remote condensing unit

C. <u>Unit Ventilator Controls Steam (Qty. 12)</u>

1. ATC Systems shall provide the following controls & material for <u>field installation, mounting &/or wiring</u>
   - **a)** Johnson Metasys Direct Digital Controllers, enclosures, control power transformers
   - **b)** Fan Control

1) Supply Fan Start/Stop relays (R) & current switches (CS)
c) Damper Controls
1) Outside (OAD) & Return (RAD) Damper control
d) Heating Coil Control
1) Hot Water Coil Control valve and actuator
2) FTR Control valve and actuator
e) Automatic Temperature Control Sensors
1) Supply (SAT) & Mixed (MAT) Air Temperature sensors
2) Space temperature sensors w/ setpoint adj.
f) Safety & Shutdowns
1) Low limit temperature switches, associated interlock wiring.
g) DX Cooling Coil Control
1) Output and control relay for future remote condensing unit

D. <u>Building Heating System Controls:</u>

1. <u>Hot Water Boilers (Qty. 2)</u>

a) The Boiler manufacturer shall provide the following Internal controls and services
1) Boiler Control Panel (BCP), with control points for external interface
2) Hot Water & Outside Air temperature sensors for wiring to the BCP
3) Low Level, High Temperature and internal control thermostats
4) All other control devices required for stand-alone operation of the boiler

b) ATC Systems shall <u>provide, field install, mounting &/or wiring</u> the following controls & materials
1) Johnson Metasys Direct Digital Controllers, enclosure & control power transformer
2) Communications wiring and system programming
3) Boiler Control Panel Enable Relay and interlock wiring
4) Individual Boiler communications wiring to the BCP
5) Hot Water & Outside Air temperature sensors (BCP manufacturer provided)
6) Outside Air Temperature and Humidity sensors
7) Boiler Status monitoring

Scope of Work (Board of Education Office)

A. <u>Building Automation Network Controls (Qty. 1)</u>

1. Install New Johnson Metasys DDC Building Network Automation Engine (NAE) Panel(s).
2. Johnson Metasys Graphical User Software Package + Central Web-Server and Operator's Work Station
a) Programmed and Designed Graphical User Interface
1) Site/Building Rendering
2) Graphic Floor Plans showing individual equipment locations
3) Unique Mechanical Equipment graphics depicting monitored/control parameters
4) Alarms and Trending information
5) Alarm Printer

3. Communications wiring.

B. <u>AHU/AC Unit Controls (Qty. 21)</u>

1. The unit manufacturer (UM) shall provide all Internal & external devices including BACnet MS/TP interface devices to meet the specification and sequence of operations.
2. ATC Systems shall provide <u>Labor /materials for wiring &/or mounting (Field installation required)</u> for the following:
a) BACnet MS/TP interface communications wiring
b) Space Temperature sensors w/ setpoint adj.

Savings Methodology

See savings calculations provided in Appendix.

Maintenance

The maintenance staff should maintain the newly installed equipment per manufacturers' recommendations. The manufacturer specification sheets will be provided for exact maintenance requirements.

Benefits

- Fuel energy savings

Building Envelope Weatherization

ECM Summary

Infiltration drives energy costs higher by allowing unconditioned outside air to enter the building, thus adding to the building load and causing additional unnecessary heating and cooling loads. All Long Branch School buildings were surveyed in order to identify potential improvements for outside air infiltration reduction. The main observations are listed below:

- Most entrance doors need weather stripping, sweeps or the closure or strike plate adjusted;
- Sealant is recommended around the perimeter of several windows;
- Numerous penetrations were observed that need to be sealed.

These deficiencies mostly reflect the skin of the buildings, which either have existed since original construction of the building, were added during some retrofit periods, or were caused by deterioration.

Facilities Recommended for this Measure

- Long Branch High School
- Long Branch Middle School
- Audrey W. Clark Elementary School
- George L. Catarmbone Elementary School
- Gregory Elementary School
- Amerigo A. Anastasia School
- Morris Avenue Elementary School
- Joseph M. Ferraina ECLC
- Lenna W. Conrow School
- Board of Education Offices

Scope of Work

A building envelope audit was performed for the entire district. The results of the audit were the identification of several areas of envelope deficiency. The deficient areas were tabulated and their savings potential calculated. Building Envelope Scope drawings are listed in the Appendix.

Findings

- Attic Bypass Air Sealing - electrical penetrations entering the attic are not properly sealed at Lenna W. Conrow Elementary School, allowing conditioned air to escape into the vented attic space. Since warm air rises, sealing the attic from the conditioned space is crucial to maintaining an efficient building. The air movement reduces the effectiveness of the existing insulation.
- Attic Flat Insulation – attic insulation is crucial for controlling conductive heat loss in a building. After air gaps are sealed and convective air loss is reduced the biggest remaining form of heat loss becomes conduction. Damaged and inconsistent batt insulation is present in the attic of the Lenna W. Conrow Elementary School, which is not providing the proper insulation value for the climate zone in New Jersey. This will result in excessive energy loss for the building due to the lack of a properly insulated thermal barrier and the size of the area.

- Attic Insulation Baffles – when adding insulation to an attic with active soffit venting attic baffles need to be installed. Often times there will be no baffles in place because the inadequate levels of insulation did not pose a risk of covering the ventilation. The attic baffles makes sure the attic has the same ventilation after insulation is added. This recommendation applies to the vented soffit at Lenna W. Conrow Elementary School.
- Buck Frame Air Sealing – the buck frame is the area above the window frame between the roof-wall intersections that is often left unsealed; this is the case at the High School above the large windows in the stairway on the top floor. There is a one foot gap at this area that allows unwanted air to infiltrate/exfiltrate; since heat rises, the energy loss is amplified since this gap is present on the fifth floor of the building.
- Casement Window Weatherization – existing weather stripping on the windows at the Board of Education office are prone to air leakage due to lack of compression that exists between with the window frame and the operational sash. There is a large amount of windows present in this building, and most of them are directly in occupied offices; not only does the ineffective weather stripping on these windows waste energy, but it also reduces occupancy comfort as cold air infiltrates in the winter and cool air exfiltrates in the summer.
- Door Weather Stripping – deteriorated weather stripping materials, ineffective weather stripping installation and daylight showing at the perimeter of door systems create direct pathways for unwanted infiltration/ exfiltration.
- Double Hung Window Restoration – the double hung windows at Audrey W. Clark Elementary School have broken balances that are preventing the lower sash from staying open. Window hardware often times becomes broken under the load of a heavy sash; installing hardware that can support the weight of the window is crucial for not only proper operation, but also to prevent air leakage from windows that are not aligned properly. The windows at the school shut in a misaligned position due to the broken balances.
- Overhang Air Sealing – overhangs are roofs, floor systems or areas above entryways that extend beyond the plane of the exterior wall system. These areas of construction are often misunderstood by builders and the cavity that extends beyond the plane of the exterior wall system is often incorrectly “connected” to the interior heated spaces of the building. Overhangs that are not properly sealed at the plane of the surface that should separate the conditioned space from the outdoors lead to excessive air leakage and heat loss at these vulnerable areas in the building envelope. This area of weakness is present in the classrooms at both Lenna W. Conrow Elementary School and Morris Avenue Elementary School. There are direct pathways for air leakage from the exterior at both schools. These areas are currently allowing a large volume of unwanted air to pass through the overhang cavities into an occupied, conditioned space. The result is a large amount of energy loss and reduced occupancy comfort in these areas. There are also overhangs at Audrey W. Clark Elementary School that are having the same effect on energy loss.
- Overhead Door Weather Stripping - remove existing weather stripping and replace with new commercial grade weather stripping to create a full air seal around the door. With low grade, none, or deteriorating materials in place overhead and roll-up doors are a major air leakage source in any building with one these systems.
- Penetration Air Sealing – there are skylights present on a first floor section of the Audrey W. Clark Elementary school; there is one skylight in particular that has been sealed with duct tape and a plastic sheet. This is a very ineffective barrier for preventing air in the skylight cavity from penetrating into the classroom below. Since this skylight is approximately 30 square feet, there is a large volume of unwanted air that is able to infiltrate/exfiltrate this particular section of the building.

This is also a weakness that can have a negative effect on the comfort of students and teaching staff in this area of the building.

- Roof-Wall Intersection Air Sealing – the roof-wall intersection is regularly an area that allows unwanted air leakage through the building shell. The unsealed exterior flashing details combine with interior gaps in the framing between the roof and wall assembly to allow infiltration/ exfiltration. This is especially apparent at the High School, where the whole 4th floor (close to 1,750 lineal feet) is not sealed, as well as large sections of the Middle School, Audrey W. Clark Elementary School, George L. Catrambone Elementary School, Amerigo A. Anastasia Elementary School, Gregory Elementary School, Lenna W. Conrow Elementary School, and Morris Avenue Elementary School.

Recommendations

➢ Installation Factsheets, included in the Report for the measures below at the bold round bullets, provide the rationale for a measure and the installation specifications and materials.
➢ For specifications that differ from the Installation Factsheets or where measures do not have Installation Factsheets notes are included at the square bullets below.

- Attic Bypass Air Sealing
- Attic Flat Insulation
    - Reference the Installation Factsheet; site-specific recommendations are included below.
        - Cellulose 8" (Lenna W. Conrow Elementary school) – seal penetrations and install 8 inches of cellulose across the attic flat over existing batt insulation.
- Attic Insulation Baffles
    - There is no Installation Factsheet for this Task.
        - Baffles (Lenna W. Conrow Elementary school) – install material to separate the roof slope from the newly installed cellulose insulation to prevent spillage into the soffit area of the attic.
- Buck Frame Air Sealing

- Casement Window Weatherization
    - Reference the Installation Factsheet; site-specific recommendations are included below.
        - Anderson Casement Windows (Board of Education Office) – remove existing weather stripping on casement style windows and replace with surface mount gasket material to create compression seal.
- Door Weather Stripping
- Double Hung Window Restoration
    - There is no Installation Factsheet for this Task.
        - Double Hung Windows (Audrey W. Clark Elementary School) – remove lower sash of double hung windows, clean out any debris in window frame and lubricate existing hardware, then replace broken window balances, and re-install lower sash.
- Overhang Air Sealing
- Overhead Door Weather Stripping
    - There is no Installation Factsheet for this measure.

        - Weather Strip – install heavy-duty aluminum carrier with oversized vinyl insert gasket at the sides: install heavy-duty aluminum carrier with an oversized bottom U-style gasket at bottom.
- Penetration Air Sealing
    - There is no Installation Factsheet for this Task.
        - Skylight Air Sealing (Audrey W. Clark Elementary School) – remove existing covering from skylight opening and seal with white faced Thermax and sheathing tape.
- Roof-Wall Intersection Air Sealing

Savings Methodology

The energy savings derived from this measure are a result of the heating and cooling systems (DX cooling and boilers) not having to work as hard to achieve the desired environmental conditions. The amount of savings is dependent on the existing building conditions and the amount of air leakage under the current operating conditions.

Energy savings are based on the ASHRAE crack method calculations. If the process reveals any variation in the as-built conditions, then savings will be adjusted accordingly. Determination of air current air leakage rates is based on many factors, including:

- Linear feet of cracks
- Square feet of openings
- Stack coefficient
- Shield class
- Average wind speed
- Heating or cooling set point
- Average seasonal ambient temperatures

Savings due to infiltration reduction:
The following equation is based on the ASHRAE crack method:

Heat loss per hour: $\dot{q}$ = 1.08 x Q x ΔT

Where Q represents the airflow in cubic feet per minute (CFM) and is calculated in the following manner:

$$Q = A_{crack} \times \sqrt{(C_s \Delta T + C_w V^2}$$

In this equation, A_{crack} represents the crack area in square inches to be reduced. The other values in the equation are standard for these buildings and are based on shelter class, height, and local wind speed.

Cw = wind coefficient = 0.0104 average

V = wind speed = 8.8 average mph

Cs = stack coefficient = 0.0299 (two-story typical)

ΔT = temperature difference = Tout – Tin

ΔT is calculated by subtracting the average outdoor air temperature per hour from the indoor temperature, using 24 data points per month to accurately account for weather variances, and subsequently calculating airflow and heat loss for each set of data. Therefore, 288 data points are used, and Δt is the number of hours each data point represents. The total heat loss is calculated as follows:

$$q = \sum_{k=1}^{288} 1.08 \times A_{crack} \times \sqrt{C_s\left(T_{out} - T_{in}\right) + C_w V^2} \times \left(T_{out} - T_{in}\right) \times \Delta t$$

Maintenance

After the building envelopes have been improved, operations and maintenance should be reduced, due to improved space conditions and lower humidity during the cooling season. The maintenance staff should maintain the newly installed equipment per manufacturers' recommendations. The manufacturer specification sheets will be provided for exact maintenance requirements.

Benefits

- Electrical energy savings
- Fuel energy savings
- Increased thermal comfort

Repair Missing Piping Insulation

ECM Summary

The un-insulated pipes (Audrey W. Clark Elementary School)

Non-insulated pipelines and associated valves and fittings carrying thermal fluids because heat loss where not intended and result in excess fuel consumption, as well as discomfort in occupied areas. Valves and fittings without insulation were observed throughout the buildings and installation of new insulation is recommended. Installation of the proper amount of insulation will not only conserve energy but will also improve safety by reducing the chance for burns on hot piping or slipping due to condensate on a pipe.

Facilities Recommended for this Measure

- Audrey W. Clark Elementary School
- Gregory Elementary School
- Amerigo A. Anastasia School
- Joseph M. Ferraina ECLC
- Lenna W. Conrow School

Scope of Work

Findings

- Pipe Insulation – un-insulated pipes in the heating systems are leading to unnecessary distribution losses and wasted energy. The pipes in the geothermal heating and cooling system at the Middle School have a significant section of uninsulated pipes, with large pipe diameters (large surface area). There is also a significant amount of sweating on the pipes at Morris Avenue Elementary School; the sweating, and subsequent energy loss, is so substantial that large barrels are required to collect the dripping water. The heating hot water systems at Audrey W. Clark Elementary School, Amerigo A. Anastasia Elementary School, Gregory Elementary School, Joseph M. Ferraina ECLC, and Lenna W. Conrow Elementary School all have un-insulated, bare pipes that are contributing to wasted distribution. There are also straight pipes present throughout the various mechanical rooms in Long Branch that are presently wrapped, but the insulation is largely ineffective due to damage and wear; this insulation should be removed and replaced with new cellular glass. This condition was found at Morris Avenue Elementary School, where condensation from the sweating pipes has damaged some of the insulation, as well as in the boiler rooms at Audrey W. Clark Elementary School and Lenna W. Conrow Elementary School.
- Valve & Fitting Insulation – valves and fittings are difficult components of a mechanical system to insulate and as a result are frequently left un-insulated. These un-insulated or poorly insulated components have the same temperature fluids passing through them as the pipes that are more likely to be insulated; un-insulated components of the distribution system lead to unnecessary distribution losses and wasted energy. The boiler rooms assessed in Long Branch have many un-insulated gate

valves, control valves, and butterfly valves. In some cases, like at the High School, the valves have a very large surface area, which translates to a larger energy loss. The 90 Degree, 45 Degree, and T-Intersection fittings that connect the straight pipes have also been left un-insulated at all locations with recommendations. While they do not carry as much surface area as the valves, fittings pass the same temperature fluids as both pipes and valves and should be insulated with a pvc jacket.

- Tank Insulation – tanks are difficult components of a mechanical system to insulate and as a result are frequently left un-insulated. Un-insulated tanks have the same temperature fluids passing through them as the pipes that are more likely to be insulated. These fluids lead to energy loss as heat dissipates from the tanks as the fluids pass through from the pipes. This is the case with condensate tank at Lenna W. Conrow Elementary School and the air separator tanks at Gregory Elementary School and Morris Avenue Elementary School.
- Refer to calculations for a detailed inventory of insulation scope of work.

Note: *All insulation thickness shall be confirmed to be in accordance with the New Jersey Energy Conservation Code, ASHRAE 90.1 2013. Contract shall be responsible for verification of these thicknesses.*

Savings Methodology

Mechanical Insulation Savings Calculations

This section describes our methodology for calculating energy savings. We use standard heat transfer methods to compute heat loss from bare and insulated mechanical systems (piping, valves, fittings, tanks and ductwork). The difference in heat loss is the energy savings, as follows:

Energy Savings = [Existing Heat Loss] – [Insulated Heat Loss]

Methodology
We use standard heat transfer methods to compute radiation, convection, and conduction heat loss from

(Alternatively, gain to, for cold systems) bare and insulated systems. Key parameters that affect the heat transfer rate include: temperature of fluid (e.g. steam, hot water, chilled water, etc.); surface temperature of the component (e.g. pipe, fitting, tank, ductwork); temperature of environment; emissivity of surface; average wind speed where applicable; percentage of existing component covered with insulation; and condition of existing insulation, where applicable.

Energy Use
Existing and proposed energy use are computed as follows:

Pipes & Fittings
Heat Loss (Btu/h) = (Heat Loss / lin.ft. bare pipe) * (lin.ft. of pipe) * [1 – (%insulated)] +
(Heat Loss / lin.ft. insulated pipe) * (lin.ft. of pipe) * (%insulated)

Fuel Loss (MMBTU/yr) = (Heat Loss Btu/h) * (heating hrs/year) ÷ (efficiency)
Electric Loss (kWh/yr) = (Heat Loss Btu/h) * (cooling hrs/year) ÷ (12,000 Btu/ton-hr) x (cooling kW/ton)

Tanks, Plates, & Ductwork
Existing and proposed heat loss for tanks, plates, and ductwork are calculated as follows:

Heat Loss (Btu/h) = (Heat Loss / sq.ft.) * (sq.ft. of component) * (qty) * [1 – (%insulated)] +
(Heat Loss / sq.ft. insulated) * (qty) * (sq.ft. of component) * (%insulated)
Fuel Loss (MMBTU/yr) = (Heat Loss Btu/h) * (heating hrs/year) ÷ (efficiency)
Electric Loss (kWh/yr) = (Heat Loss Btu/h) * (cooling hrs/year) ÷ (12,000 Btu/ton-hr) x (cooling kW/ton)

Energy Savings
Energy savings are the difference between existing and proposed heat loss:

Fuel Savings (MMBTU/yr) = (Existing Fuel Loss) – (Proposed Fuel Loss)
Electric Savings (MMBTU/yr) = (Existing Electric Loss) – (Proposed Electric Loss)
Cost Savings ($/yr) = (Fuel Savings MMBTU/yr) * (Fuel Rate $/MMBTU) +
(Electric Savings kWh/yr) * (Electric Rate $/kWh)

Heat Transfer: Bare Systems
Bare systems are subject to convection and radiation heat transfer. We ignore conductive heat transfer through the pipe/fitting material (e.g. steel, copper, PVC etc.) as this is negligible as compared to heat transfer through insulation and air convection.

Pipes & Fittings
This section describes the heat transfer calculations for pipes and fittings for indoor systems subject to natural convection (no wind). The calculations for outdoor systems subject to forced convection (wind) are similar except that the formulas are more complicated. These methods are presented following this section.
Premium eff
For fittings (valves, elbows, strainers, etc.), we estimate heat loss based on equivalent length of straight pipe, which is the ratio of the area of the fitting to the area of 1 linear foot of pipe of the same size (fitting equivalent length = Area of fitting, ft^2 / Area of pipe of equivalent diameter, ft^2).

$$q_{pipe} = \frac{2 * \pi * \Delta T}{\frac{1}{h * \left({D_{outer}}/{2}\right)}}$$

Where:
q_{pipe} = *heat loss per linear foot = Btu/h/lin.ft.*

$h = total\ convective\ heat\ transfer\ factor = h_{convection} + h_{radiation}$

$h_{convection} = 0.213 * \left(\frac{\Delta T}{D}\right)^{\left(\frac{1}{4}\right)}$ [ASHRAE 2005, Ch. 3, Eq. T10.16]

$\square T = T_{surface} - T_{air}$
$\Delta T = T_{surface} - T_{air}$
D = Outer diameter
$h_{radiation} = \varepsilon * \sigma * {\left(T_{surface}^4 - T_{air}^4\right)}/{\left(T_{surface} - T_{air}\right)}$

e = emissivity of surface
s = Stefan-Boltzmann constant = 0.1714 x 10-8 Btu / (hr-ft^2-°R^4)
$T_{surface} = Temperature\ of\ surface$
$T_{air} = Average\ ambient\ air\ temperature$

Heat Transfer: Insulated Systems

Insulated systems are subject to convection, radiation, and conductive heat transfer. We ignore conductive heat transfer through the pipe/fitting material (e.g. steel, copper, PVC etc.) as this is negligible when compared to heat transfer through insulation and air convection.

$$q_{pipe} = \frac{2 * \pi * \Delta T}{\frac{ln\left(D_{outer}/D_{inner}\right)}{k} + \frac{1}{h * \left(D_{outer}/2\right)}}$$

Where:

q_{pipe} = *heat loss per linear foot = Btu/h/lin.ft.*

$$h_{convection} = 0.213 * \left(\frac{\Delta T}{D}\right)^{\left(\frac{1}{4}\right)}$$ [ASHRAE 2005, Ch. 3, Eq. T10.16]

□T = $T_{surface} - T_{air}$

$\Delta T = T_{surface} - T_{air}$

D = Outer diameter

$$h_{radiation} = \varepsilon * \sigma * \left(T_{surface}^4 - T_{air}^4\right) / \left(T_{surface} - T_{air}\right)$$

e = emissivity of surface

s = Stefan-Boltzmann constant = 0.1714 x 10-8 Btu / (hr-ft^2-°R^4)

$T_{surface}$ = *Temperature of surface*

T_{air} = *Average ambient air temperature*

L = Pipe length or fitting equivalent length

Heat Transfer for Outdoor Systems

The methods for computing heat loss for outdoor systems subject to forced convection (wind) are identical to the methods for indoors systems described above except that the formulas to compute the convective heat transfer coefficient h is more complicated. These methods are described below:

Pipes & Fittings: Outdoor Systems

The convection heat transfer coefficient is:

$$h_{convection} = Nu * k / D_{outer}$$

$$Nu = Nussault\ number = 0.3 + \frac{0.62 * Re^{\left(\frac{1}{2}\right)} * Pr^{\left(\frac{1}{3}\right)}}{\left[1 + \left(\frac{0.4}{Pr}\right)^{\left(\frac{2}{3}\right)}\right]^{\left(\frac{1}{4}\right)}} * \left[1 + \left(\frac{Re}{282{,}000}\right)^{\left(\frac{5}{8}\right)}\right]^{\left(\frac{4}{5}\right)}$$

$$Re = Reynolds\ number = \frac{V * D_{outer}}{v}$$

$\mathrm{Pr} = Prandtl\ number = 0.7\ (for\ air)$

$v = kinematic\ viscosity\ of\ air$

$V = wind\ speed$

D_{outer} = *outer pipe diameter*

Plates, Tanks, Ductwork: Outdoor Systems

The convection heat transfer coefficient for flat surfaces is estimated as follows

$$h_{convection} = Nu * k\ /D_{outer}$$

$$Nu = Nussault\ number = \ 0.415 * \ Re^{\left(\frac{1}{2}\right)} * Pr^{\left(\frac{1}{3}\right)}$$

$$Re = Reynolds\ number = \frac{V * L}{v}$$

$$\Pr = Prandtl\ number = 0.7\ (for\ air)$$
$$v = kinematic\ viscosity\ of\ air$$
$$V = wind\ speed$$
$$L = width\ or\ diameter\ of\ component$$

Maintenance

The maintenance staff should maintain the newly installed equipment per manufacturers' recommendations. The manufacturer specification sheets will be provided for exact maintenance requirements.

Benefits

- Fuel energy savings

Retro-commissioning Study & HVAC Improvements

ECM Summary

Due to the complexity of today's HVAC systems and controls, it is likely for systems to be operating incorrectly or not as efficiently as they could be. Retro-commissioning studies reveal hidden deficiencies and highlights operational & maintenance (O&M) issues that could have been avoided as well as exposes hidden control system problems. There are valuable benefits to retro-commissioning in existing buildings. It is a detailed and specialized process that reviews how an HVAC system is controlled and designed to operate. Applying retro-commissioning to existing facilities includes planning, discovering root causes of inefficiencies, development of a cost-effective project delivery and a focus on optimizing value to the building owner. The study includes functional system testing under various modes, such as heating or cooling loads, occupied and unoccupied modes, varying outside air temperature and space temperatures.

This is a systematic process to ensure that the building energy systems perform interactively according to the original design intent and the current operational needs of the facility. Retro-commissioning is a common practice recommended by the American Society of Heating Refrigeration and Energy (ASHRAE) to be revisited every couple of years. We recommend that an engineering firm who specializes in energy control systems and retro-commissioning be contacted for a detailed evaluation and implementation costs. Facility operations personnel would work with the engineers to develop goals and objectives. During on-site testing, the qualified personnel conducting the study would immediately make any no/low cost improvements as identified. Furthermore, any suggested corrective actions which require the purchase of material, a contractor who specializes in that scope of work would be contacted to implement the remaining improvements.

Facilities Recommended for this Measure

- Long Branch High School
- Gregory Elementary School
- Amerigo A. Anastasia School

Scope of Work (High School) – Geothermal System

PROJECT UNDERSTANDING

Energy Systems Group is currently in the process of executing an Energy Savings Improvement Project (ESIP) for the Long Branch School District. Currently, at the Long Branch High School, they are having issues with the Geo-Thermal System and ESG is recommending Retro-Commissioning as an ECM to reduce energy consumption and improve overall HVAC operations.

SCOPE OF SERVICES

The Commissioning Agent (CA) plans to deploy a phased approach to this project;

Documentation Review

To kick off the project, the CA will coordinate a meeting with the necessary parties to understand the concerns present of the current system, coordinate onsite activities and to gather the necessary documentation so a Retro-Commissioning Plan can be developed.

CA will review all available documentation that should include a current set of mechanical and electrical drawings, building equipment list, TAB report, control drawings, points list, maintenance records, and list of recent repairs. These documents will be used to develop the site assessment forms as well as the diagnostic and functional test plans that will be required to verify the equipment performance.

Onsite Investigation Phase

- After gaining a clear understanding of the project goals, the District's operating requirements, and current operating conditions at the facilities, CA will develop a detailed retro-commissioning project plan.
- The RCx Plan shall define (at a minimum) the Commissioning Schedule for the Planning and Investigation Phase, and define the approach moving forward.
- CA shall have an initial walk-through of the facility. The School's operating requirements and building operations plan will be reviewed. CA will walk through the building to gain an understanding of the types of spaces and equipment that will be retro-commissioned.
- CA will interview key maintenance and operations personnel and other relevant parties as needed to define the current needs and issues related to the systems and sub-systems. A list of all parties proposed to be interviewed, including key maintenance and operations personnel will be compiled for review and approval by the District. The interview process is required to understand and define potential issues and problems, uncover potential improvement opportunities, confirm the current facility requirements and to develop consensus on the commissioning process goals to be reviewed and approved by the School. Upon completion of the above, prepare a draft RCx Plan, draft CFR report, completed interview forms/sheets, and a periodic issues database report. After review is completed, CA shall incorporate comments prior to the issuance of final documents.
- CA will perform functional testing of the HVAC System components in efforts to develop a deficiency log so identified repairs can be made by facility staff or outside contractors. In addition to functional issues, CA will document all issues pertaining to maintenance, serviceability and installation deficiencies.
- In addition to the Building Automation System, CA will deploy data loggers within the space in pre-determined locations to validate sensor calibration, trend temperatures and identify inconsistent patterns in the space. The data loggers will be deployed for a period of two weeks at a time which will require data trending on the BAS with the same programmed time intervals. CA will coordinate with Maintenance personnel to setup and document.

Implementation Plan Development and Final Report Phase

- Upon completion of the retro-commissioning efforts, CA will develop a final report documenting all findings and a plan of remediation to be considered for implementation.
- The final report for the project should include the following at a minimum;
    - Executive Summary
    - Data Logger Data and Analysis
    - BAS Review and Analysis
    - Inspection of All Equipment and Analysis
    - Implementation Plan

Scope of Work (Gregory & Anastasia) – Condenser Water System Only

- Review existing Building Automation System (BAS) Sequence of Operations
- Verify BAS is operating properly and overrides have been removed
- Implement additional energy conservation measures throughout BAS
- Work with Board to define operating schedules for each piece of equipment
- Ensure condenser water systems are operating properly and not unecciserily dumping water to the drain (as reported).

Savings Methodology

Savings Calculation Method		
Cooling Savings (kWh)	=	Stipulated Savings % * Total Annual Electrical Usage
Heating Savings (Therm)	=	Stipulated Savings % * Total Annual Natural Gas Usage

Maintenance

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electric and Natural Gas savings

SECTION 5. MEASUREMENT AND VERIFICATION

Measurement & Verification (M&V) Methodologies

This section contains a description of the types of Measurement and Verification (M&V) methodologies that Energy Systems Group will use to guarantee the performance of this project.

They have been developed and defined by two independent authorities:

- International Performance Measurement and Verification Protocol (IPMVP)
- Federal Energy Management Program (FEMP)

There are four guarantee options that may be used to measure and verify the performance of a particular energy conservation measure. Each one is described below.

Option A – Retrofit Isolation: Key Parameter Measurement

Energy savings is determined by field measurement of the key parameters affecting the energy use of the system(s) to which an improvement measure was applied separate from the energy use of the rest of the facility. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter, and the length of the reporting period.

Measurement of key parameters means that those parameters not selected for field measurement will be estimated. Estimates can be based on historical data, manufacturer's specifications, or engineering judgment. Documentation of the source or justification of the estimated parameter will be described in the M&V plan in the contract. Energy savings is determined through engineering calculations of the baseline and post-retrofit energy used based on the combination of measured and estimated parameters, along with any routine adjustments.

Option B – Retrofit Isolation: All Parameter Measurement

Like Option A, energy savings is determined by field measurement of the energy use of the systems to which an improvement measure was applied separate from the energy use of the rest of the facility. However, all of the key parameters affecting energy use are measured; there are no estimated parameters used for Option B. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the savings and the length of the reporting period. Energy savings is determined through engineering calculations of the baseline and post-retrofit energy used based on the measured parameters, along with any routine adjustments.

Option C – Whole Building Metering/Utility Bill Comparisons

Option C involves the use of utility meters or whole building sub-meters to assess the energy performance of a total building. Option C assesses the impact of any type of improvement measure, but not individually if more than one is applied to an energy meter. This option determines the collective savings of all improvement measures applied to the part of the facility monitored by the energy meter. In addition, since whole building meters are used, savings reported under Option C include the impact of any other change made in facility energy use (positive or negative).

Option C may be used in cases where there is a high degree of interaction between installed improvement measures or between improvement measures and the rest of the building or the isolation and measurement of individual improvement measures is difficult or too costly.

This Option is intended for projects where savings are expected to be large enough to be discernable from the random or unexplained energy variations that are normally found at the level of the whole facility meter. The larger the savings, or the smaller the unexplained variations in the baseline, the easier it will be to identify savings. In addition, the longer the period of savings analysis after installing the improvement measure, the less significant is the impact of short-term unexplained variations. Typically, savings should be more than 20% of the baseline energy use if they are to be separated from the noise in the baseline data.

Periodic inspections should be made of all equipment and operations in the facility after the improvement measure installation. These inspections will identify changes from baseline conditions or intended operations. Accounting for changes (other than those caused by the improvement measures) is the major challenge associated with Option C-particularly when savings are to be monitored for long periods.

Savings are calculated through analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis.

Option D – Calibrated Simulation

Option D involves the use of computer simulation software to predict energy use, most often in cases where baseline data does not exist. Such simulation models must be calibrated so that it predicts an energy use and demand pattern that reasonably matches actual utility consumption and demand data from either the base-year or a post-retrofit year.

Option D may be used to assess the performance of all improvement measures in a facility, akin to Option C. However, different from Option C, multiple runs of the simulation in Option D allow estimates of the savings attributable to each improvement measure within a multiple improvement measure project.

Option D may also be used to assess just the performance of individual systems within a facility, akin to Option A and B. In this case, the system's energy use must be isolated from that of the rest of the facility by appropriate meters.

Savings are calculated using energy use simulation models, calibrated with hourly or monthly utility billing data and/or end-use metering.

Selecting M&V Options for a Specific Project

The tailoring of your specific M&V option is based on the level of M&V precision required to obtain the desired accuracy level in the savings determination and is dependent on:

- The complexity of the Energy Conservation Measure
- The potential for changes in performance
- The measured savings value.

The challenge of the M&V plan is to balance three related elements:

- The cost of the M&V Plan
- Savings certainty
- The benefit of the particular conservation measure.

Savings can also be non-measured. If savings are non-measured, these savings are mutually agreed upon as achieved at substantial completion of the respective facility improvement measure and shall not be measured or monitored during the term of the performance contract. Non-measured energy savings are limited to no more than 10-15% of the overall project savings.

Recommended Performance Verification Methods

Energy Systems Group's performance verification methods are designed to provide the facility's administration with the level of M&V necessary to protect them from an under-performing ECM, yet have a minimal impact on the project's financial success.

The selection of the M&V methods to be used is based on the criteria as detailed by IPMVP and Energy Systems Group's experience with hundreds of successful performance contracts in the K-12, state, and local government sectors. Following is a table illustrating how the savings of the major energy conservation measures proposed for this project will be verified.

ECM Description	Measurement and Verification Method – Summary	Detail of M&V Methodology
Comprehensive LED Lighting Upgrades (Includes NJDI)	Option A: One-time pre and post-retrofit kW measurement. Burn hours agreed upon with school district.	Pre M&V: Lighting power readings will be taken on a sample of lighting fixtures. Lighting burn hours were measured through the use of light loggers. Post M&V: Lighting power readings will be taken on a sample of lighting fixtures. Measurements will occur once at the outset of the agreement. "Occupied" hours logged during the baseline data collection will be used as the post-installation burn hours. Energy Savings: Energy savings will be calculated using the actual measured wattage reduction and measured burn-hours.
Building Envelope & Weatherization	Non-Measured: Existing envelope deficiencies will be documented based on collected field data to provide a baseline for evaluating the effectiveness of the air barrier system. Post-retrofit verifications of improvements will be documented.	Pre M&V: The magnitude of the air infiltration caused by cracks and joint deficiencies was determined by field surveys. Post M&V: The areas identified for weatherization improvements will be verified to be complete through visual inspections and as-built documentation. A one-time infrared survey of the buildings, when seasonally appropriate, will be conducted for the M&V agreement. Energy Savings: Energy savings will be based on the ASHRAE crack method calculations. If the commissioning process reveals any variation in the as-built conditions, then savings will be adjusted accordingly.
Pipe Insulation/Blankets	Option A: Savings are from installing pipe insulation and insulation blankets.	Pre M&V: The surface temperature and the size of the space requiring insulation installation were measured during the field audit. Post M&V: Following installation, the size and the surface temperature of the space where the insulation is installed will be verified. Energy Savings: Savings are from a reduction in heat loss through uninsulated pipes and valves.

HVAC Related VFD Upgrades	Option A: Savings are from the reduced operating hours of the plugged in equipment.	Pre M&V: Quantity of motors and horsepower were determined in the field survey. Nameplate data was used to determine the total kW of related equipment. Post M&V: Once the installation is complete, the VFD's will be inspected to ensure proper operation. During the guarantee term, actual operating conditions will be downloaded from the BMS to verify motors (and associated fans/pumps are being operated at part load. Energy Savings: Savings are from the reduced kW load of the equipment at reduced speed.
Boiler Replacement/Steam-HW Conversion	Option A: Baseline energy consumption based on collected field data and combustion efficiency of existing boilers. Post installation energy consumption based on combustion efficiency of new boilers.	Pre M&V: Energy Systems Group will take a combustion efficiency test to verify the efficiency of existing boilers and estimate the fuel consumption of existing boilers based on collected field data and utility bills. Post M&V: Energy Systems Group will take a combustion efficiency test to verify the efficiency of new boilers. Energy Savings: Savings for the new boilers will be determined using the base heating load and the difference in efficiencies between the existing boilers and new boilers.
Walk-In Cooler/Freezer Controls	Non-Measured: Savings are from the reduced electric consumption of freezer and refrigerator.	Pre M&V: Manufacturer's data and operating parameters will be collected on the freezer and refrigerator. Post M&V: Once the installation is completed, the walk-in box control system will be inspected to ensure proper operation. Energy Savings: Savings are from the reduced electric consumption of freezer and refrigerator.
Combined Heat and Power	Option B: Savings are from the electric and heat provided by the cogeneration system.	Pre M&V: The baseline utility bills were analyzed to determine baseline heating and electric loads and the time that the cogeneration system is able to operate per year and the capacity of the cogeneration system. Post M&V: The electric generation output from the cogeneration system will be measured with an electric meter. The heat output from the cogeneration system will be determined by measuring the water inlet/outlet temperature and flow rate. The gas input to the cogeneration system will be measured with a gas meter. Combined, these data points will be used to verify the conversion efficiency of the cogeneration system. Energy Savings: Savings are from the electric and heat provided by the cogeneration system.

Building Automation Controls Upgrades - Central Plant	Option B: Savings are from implementing control strategies.	Pre M&V: Accepted engineering practices / building simulations will be used to calculate energy consumption baselines. Operating parameters of the system will be verified through BAS system. The temperature loggers and motor loggers will be installed to determine the space temperature and motor operation schedule where applicable. The power readings will be taken on a sample of RTUs. Post M&V: Various control points within the building management system will be trended and/or totalized. This data will be used to verify that all control strategies are in place and functioning as intended. Energy Savings: Savings are from implementing control strategies.
Building Automation Controls Upgrades - Primary AHUs	Option B: Savings are from implementing control strategies.	Pre M&V: Accepted engineering practices / building simulations will be used to calculate energy consumption baselines. Operating parameters of the system will be verified through BAS system. The temperature loggers and motor loggers will be installed to determine the space temperature and motor operation schedule where applicable. The power readings will be taken on a sample of RTUs. Post M&V: Various control points within the building management system will be trended and/or totalized. This data will be used to verify that all control strategies are in place and functioning as intended. Energy Savings: Savings are from implementing control strategies.
Building Automation Controls Upgrades - Terminal Units	Option B: Savings are from implementing control strategies.	Pre M&V: Accepted engineering practices / building simulations will be used to calculate energy consumption baselines. Operating parameters of the system will be verified through BAS system. The temperature loggers and motor loggers will be installed to determine the space temperature and motor operation schedule where applicable. The power readings will be taken on a sample of RTUs. Post M&V: Various control points within the building management system will be trended and/or totalized. This data will be used to verify that all control strategies are in place and functioning as intended. Energy Savings: Savings are from implementing control strategies.

Boiler Controllers / Fuel Use Economizers (Includes NJDI)	Non-Measured: Savings are from the optimized on and off cycles of the burner ignition	Pre M&V: Manufacturer's data and existing operating parameters will be collected on the boilers. Post M&V: The boiler controllers will be inspected following installation to verify proper operation Energy Savings: Savings are from the optimized on and off cycles of the burner ignition.
Chiller Replacement	Option B: Savings are from utilizing more efficient chiller equipment.	Pre M&V: The baseline chilled water load was analyzed to determine total cooling ton-hours and system efficiency (kW/ton). Post M&V: The new chiller efficiency will be tracked via the BMS to ensure that the new system maintains increased system efficiency. Energy Savings: Savings are from reduced electrical consumption and peak demand.
Transformer Replacement	Option A: Savings are from installing high efficiency transformers.	Pre M&V: Manufacturer's data and operating parameters will be collected on the existing transformers. The efficiency of the existing transformers will be determined through the test. Post M&V: Once the installation is completed, the new transformers will be inspected to verify if they are working properly. The efficiency of the new transformers will be determined through the test. Energy Savings: Savings are from reduced losses from installing high efficiency transformers.
Domestic Water Heater Replacement	Option A: Savings are from installing high efficiency domestic water heater(s).	Pre M&V: Manufacturer's data and operating parameters will be collected on the existing domestic water heaters (DWH's). The efficiency of the existing DWH's will be determined by a combustion analysis test. Post M&V: Once the installation is completed, the new DWH will be inspected to verify if they are working properly. The efficiency of the new DWH's will be determined through the same test. Energy Savings: Savings are from reduced losses from installing high efficiency DWH's.
GPS Ionization Filters	Non-Measured: Savings are from the reduction of outside air allowed based on operation of GPS Ionization Filters.	Pre M&V: Manufacturer's data and operating parameters (specifically outside air quantities) will be collected on the air handling unit being upgraded with GPS Filters. Post M&V: The new GPS Filters will be inspected following installation to verify proper operation. Energy Savings: Savings are from the reduction in outside air required to meet the ventilation code post installation of ionization filter.
Unit Ventilator Replacement	Non-Measured: Savings are from replacing the	Pre M&V: Manufacturer's data and operating parameters will be collected on the unit

	existing unit ventilators with new unit ventilators.	ventilators requiring replacement. Post M&V: The new unit ventilators will be inspected following installation to verify proper operation. Energy Savings: Savings are from replacing the existing unit ventilators with new unit ventilators.
Replace DX Split Cooling Systems	Option A: Savings are from installing high efficiency condensing units.	Pre M&V: Manufacturer's data and operating parameters will be collected on the existing condensing units (CU). The efficiency of the existing CU's will be determined through the test. Post M&V: Once the installation is completed, the new CU's will be inspected to verify if they are working properly. The efficiency of the new CU's will be determined through the test. Energy Savings: Savings are from increased condensing unit operational efficiency.
Retro-Commissioning	Non-Measured: Savings are retro-commissioning the HVAC equipment to ensure they are working as expected.	Pre M&V: Accepted engineering practices / building simulations will be used to calculate energy consumption baselines. Operating parameters of the system will be verified through BAS system. Post M&V: Various control points within the building management system will be trended and/or totalized. This data will be used to verify that all control strategies are in place and functioning as intended. Energy Savings: Savings are retro-commissioning the HVAC equipment to ensure they are working as expected.
Chiller Replacement(s)	Option B: Savings for the chiller replacement is based on the increased efficiency of the new chillers.	Pre M&V: A chiller modeling program will be used to determine baseline chiller energy consumption. Post M&V: Following the installation, the new chillers will be checked if they are working properly. Chiller data points, including entering and leaving chilled water temperatures, chiller power and chilled water flow rate will be monitored using the building automation system. Energy Savings: Savings are from the increased efficiency of the new chillers.
Plug Load Management	Non-Measured: Savings are from reduced electric consumption by controlling plugged equipment.	Pre M&V: Manufacturer's data of the plug load and the occupancy mode of the affected spaces will be collected during the field audit. Typical plug load is assumed to run 24 hours per day. Post M&V: The occupancy mode is assumed to be same pre and post, so the post retrofit operating hours are determined as the "occupied" hours from the pre- installation. Following the installation, a sample of sensors and correspondent equipment associated with them

		will be inspected to ensure the sensors are in place and operating. Energy Savings: Savings are from reduced electric consumption by controlling plugged equipment.
Demand Response - Energy Efficiency Credit	Non-Measured: Savings are from participating in the Energy Efficiency program of PJM with a permanent reduction in electric energy consumption.	Pre M&V: ESG will determine the energy efficiency value based on the FIM strategies proposed. kW measurement may be taken on a sample of equipment that will be replaced. Post M&V: ESG will verify the equipment are installed and operating properly. kW measurement may be taken on a sample of equipment that are installed. Loggers will be installed to verify the coincident factor Energy Savings: Savings are from participating in the Energy Efficiency program of PJM with a permanent reduction in electric energy consumption.

Measurement and Verification Services

Measurement and Verification Services will be provided in association with the guarantee provided by Energy Systems Group. The guarantee will be in effect for each year that the District elects to participate in the Measurement and Verification Services. The cost of the measurement and verification services is included in the business case in the "Annual Services" column as outlined in the table below:

Year	Annual Amount ($/Yr)
1	$40,710
Total	$40,710

ESG will provide the M&V Services set forth below in connection with the Assured Performance Guarantee.

- During the Installation Period, an ESG Performance Engineer will track Measured Project Benefits. ESG will report the Measured Project Benefits achieved during the Installation Period, as well as any Non-Measured Project Benefits applicable to the Installation Period, to Customer within 60 days of the commencement of the Guarantee Term.
- Within 60 days of each anniversary of the commencement of the Guarantee Term, ESG will provide Customer with an annual report containing:
    - An executive overview of the project's performance and Project Benefits achieved to date;
    - A summary analysis of the Measured Project Benefits accounting; and
    - Depending on the M&V Option, a detailed analysis of the Measured Project Benefits calculations.
- During the Guarantee Term, an ESG Performance Engineer will monitor the on-going performance of the Improvement Measures, as specified in this Agreement, to determine whether anticipated Measured Project Benefits are being achieved. The Performance Engineer will visit Customer regularly and assist Customer on-site or remotely, with respect to the following activities:
    - Review of information furnished by Customer from the facility management system to confirm that control strategies are in place and functioning;
    - Advise Customer's designated personnel of any performance deficiencies based on such information;
    - Coordinate with Customer's designated personnel to address any performance deficiencies that affect the realization of Measured Project Benefits; and
    - Inform Customer of opportunities to further enhance project performance and of opportunities for the implementation of additional Improvement Measures.
    - Track utility bills on a monthly basis to determine current utility rate costs and to identify any billing anomalies.
- For specified Improvement Measures, ESG will:
    - Conduct pre and post installation measurements required under this Agreement;
    - Confirm the building management system employs the control strategies and set points specified in this Agreement; and
    - Analyze actual as-built information and adjust the Baseline and/or Measured Project Benefits to conform to actual installation conditions (e.g., final lighting benefits calculations will be determined from the as-built information to reflect the actual mix of retrofits encountered during installation).
    - Confirm that the appropriate metering and data points required to track the variables associated with the applicable Improvement Measures' benefits calculation formulas are established; and

- Set up appropriate data capture systems (e.g., trend and totalization data on the facility management system) necessary to track and report Measured Project Benefits for the applicable Improvement Measure.

SECTION 6. CUSTOMER SUPPORT

Maintenance Impacts/ On-Going Service

New pieces of equipment that are installed as part of the ESIP project will be provided with the standard manufacturer warranty. Once installation of the equipment is complete, the remaining warranty period will be transferred to Long Branch Board of Education; any warranty issues will be handled directly with the equipment manufacturer rather than with Energy Systems Group.

a) ESG subcontractors will warranty the installation for a period of 12 months, beginning at substantial completion.

b) In addition, ESG will facilitate warranty related issues for a period of 12 months, beginning at substantial completion. Extended manufacture warranties beyond the 12 month installation warranty period will be facilitated by the District.

The installation of the recommended measures will reduce the amount of emergency maintenance required by the district through the installation of new equipment; however, preventative maintenance is still required in order to ensure the correct operation of the equipment for the expected lifetime. A service agreement cannot be included as part of this project per the New Jersey Local Finance Notice 2009-11. Once the scope is finalized and bids are received, Energy Systems Group will assist the District in preparing bids for any preventative service agreement that is felt necessary for the new equipment. The service agreement will cover recommended maintenance per each equipment manufacturer. Training on the proper maintenance and operation of each piece of equipment has also been included as part of the ESIP project which will allow the District to complete the majority of maintenance and repair in-house in order to utilize District resources.

In order to ensure the District is fully capable of achieving the energy savings and fully utilizing the new HVAC and Building Automation Systems, Energy Systems Group has included training for district employees.

Energy Systems Group recommends the District go out to bid for the following 3rd party service contracts in order to achieve the continuous savings throughout the term of the Energy Savings Improvement Program:

- Cogeneration Service Agreement to allow for emergency service and preventative maintenance on the new cogeneration systems. In order to receive the incentives for the cogeneration system, a 10-year maintenance contract must be in place.

Services for Lighting, Boiler Replacements, Combined Heat and Power, Plug Load Management, and walk-in freezer controller upgrades, such as filter changes and on-going maintenance can be completed by District staff.

Design and Compliance Issues

Long Branch Board of Education will work closely with Energy Systems Group and Highland Resource Group (HRG) to oversee and complete all design engineering for the purposes of public bidding of the work as well as completing construction drawings.

As part of the Energy Savings Plan development, Energy Systems Group completed a thorough analysis of the building electrical and mechanical systems including light level readings throughout the spaces. The existing light levels are typically within 10-20% of current Illumination Engineering Society (IES) recommendations, which is reasonable given the varying age of lamps throughout the District. The proposed lighting solution will continue to adhere to current IES and NJ Education Code guidelines for light levels, which in many cases may increase the current light levels to the spaces. At this time, Energy Systems Group did not observe any compliance issues in the development of this Energy Savings Plan.

Customer Risks

Asbestos reports were obtained and reviewed for all schools as part of Energy Systems Group's safety policy. Based on the reports, asbestos materials will have to be abated prior to any work being performed. If any additional asbestos is found during the installation of the measures, Energy Systems Group will stop work and notify the School District. Any work associated with testing or remediation of asbestos containing material will be the responsibility of Long Branch Board of Education. Based on the asbestos reports provided, we feel this is a low risk item.

The NJ SmartStart, Demand Response Energy Efficiency Credit, and Combined Heat and Power Incentives outline the anticipated incentive amounts to Long Branch Board of Education. Energy Systems Group does not guarantee the rebate or state incentive structure. If the programs change or the incentive amounts differ, Long Branch Board of Education will be responsible to make up the difference in received incentives for the financing. The difference could result from over performance of energy conservation measures, other rebates/ incentives that may be available, restructuring the loan payment for years 1 and 2, or capital contributions by the District.

Public Engagement and Community Outreach

Student Engagement in ESIP Development: ESG has involved students at all levels in the energy related fields. At Long Branch, we plan to expand on interests related to energy conservation throughout the district and would welcome and actively encourage student involvement in various phases of the proposed project. Furthermore, in line with our commitment, and with Long Branch's concurrence, we propose to offer presentations to Energy Clubs, including them in the process.

STEM EXPO Sponsorship: ESG has a history of sponsoring STEM programs for many school districts and Universities across the country. If selected, ESG would like to sponsor the Long Branch's Annual STEM EXPO and further complement your Engineering/Technology Science curriculum.

Community Outreach Program: ESG is focused on creating a partnership with Long Branch Public Schools that will extend beyond the scope of this project. Keeping the community informed and involved in the process is key to success. One way this can be achieved is thru a ***Community Scholarship Program.*** At Northern Illinois University (NIU), ESG established The **Energy Systems Group Scholarship Award in Engineering** to underscore our commitment. Established in 2001, ESG and NIU jointly select students for award of this scholarship. To date, we have awarded **$35,000** to NIU engineering students with superior academic excellence. ESG would like to establish a similar program for Long Branch Public Schools.

ESG will seek to develop and build partnerships between The National Education Foundation (NEF) and the Long Branch Public Schools. These partnerships were developed by ESG and the NEF, to bring engineering and engineering technology career opportunities to students through the educational programs offered by the University of Salt Lake City Utah. These programs help students who might not otherwise consider careers in these sciences or further expand the knowledge of the children who are participating in such class. In addition, this affords local colleges and Universities the opportunity to recruit future applicants from the local school boards. Some of these programs are listed below:

Student Engagement in ESIP Development: ESG has involved students at all levels in the energy related fields. At EBPS, we plan to expand on interests related to energy conservation throughout the EBPS campus and would welcome and actively encourage student involvement in various phases of the proposed project. Furthermore, in line with our commitment, and with EBPS's concurrence, we propose to offer presentations to Energy Clubs, including them in the process.

Solar Photovoltaic Systems at Work Grades 9-12: This program includes learning activities for the secondary levels and a supply kit to investigate solar energy and its uses. Additional instructional materials include the Renewable Energy Sources poster, Energist, the Electrical Generation poster and Energist, the Energy Basics CD, and the Eye Chart poster. The program can stand alone or complement Energy Fun, Energy Fundamentals, Energy Action Technology, or Energy Action Patrol.

Career Exploration, grades 11-12: Provides students with career related work experience while obtaining up to 40 hours of academic credit. The program allows students a superb opportunity to integrate classroom theory into the world of work, as well as providing career option exploration, skill development, work environment exposure, and professional contacts.

SECTION 7: IMPLEMENTATION SCHEDULE

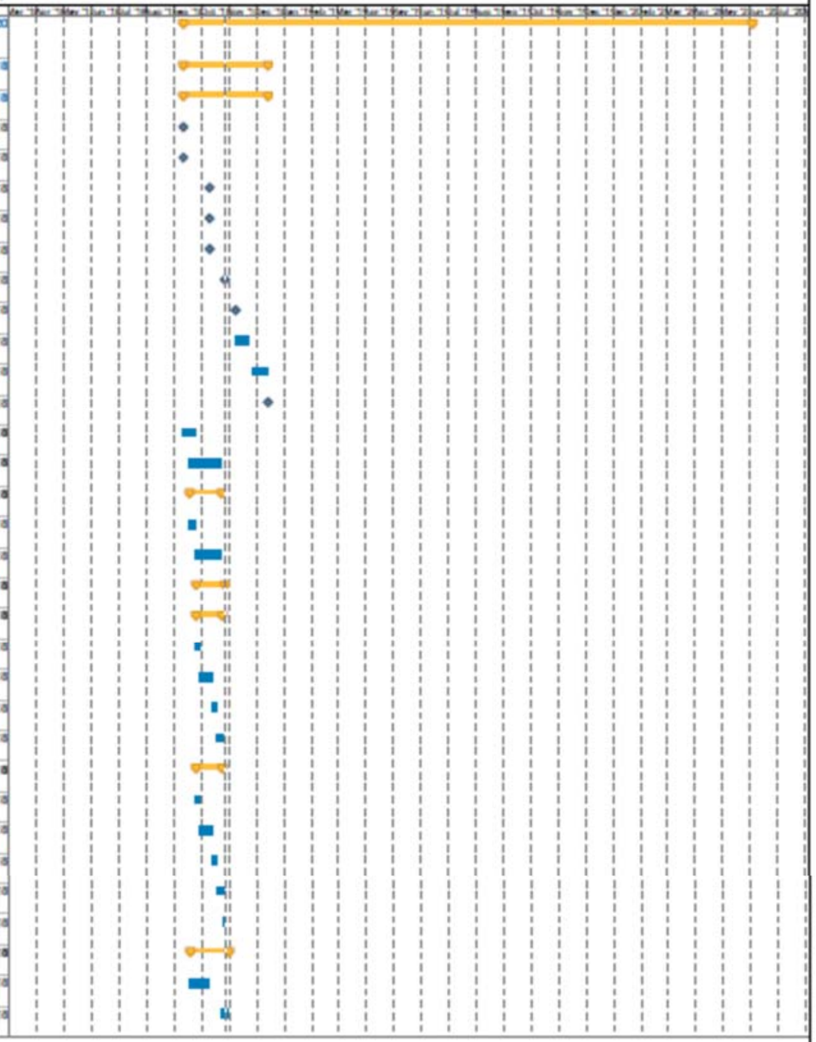
A preliminary installation schedule for the measures implemented as part of the ESP is included below to provide a reasonable expectation for the timeline of construction. Once final bids are received and financing of the project is complete, the installation will be finalized in much greater detail and reviewed with the team from the Long Branch Board of Education to ensure agreement. A high-level review of the next steps in the process is shown below as well as the estimated time frame to complete each step:

- Accept Energy Savings Plan Pending Necessary Reviews – November 7, 2018
- Complete Third Party Engineering Review of Energy Savings Plan – 2 weeks (Nov9 - Nov22)
- Complete Board of Public Utilities Review of Energy Savings Plan – 14 days (Nov26 - Dec13)
- Approval resolution to contract with Energy Systems Group: December 13, 2018
- Financing of project: 21 days (Dec14 - Jan11)
- Complete 100% design drawings and bid specifications – February 8, 2019
- Public bidding for Sub-Contractors – February - March 2019
- Installation – March 2019 - June 2020
- Maintenance: On-going

The project plan on the following page details the Installation Phase schedule.

Long Branch Public Schools
ESP Development & Installation Schedule

ID	Task Name	Duration	Start	Finish
1	Long Branch Public Schools	452 days	Mon 9/10/18	Wed 6/3/20
2	Phase 1: Investment Grade Audit/ Energy Savings Plan	68 days	Mon 9/10/18	Thu 12/13/18
3	Major Milestones	68 days	Mon 9/10/18	Thu 12/13/18
4	Signed Investment Grade Audit Agreement	0 days	Mon 9/10/18	Mon 9/10/18
5	Customer Kick-off Workshop	0 days	Mon 9/10/18	Mon 9/10/18
6	ECM Verification Workshop	0 days	Tue 10/9/18	Tue 10/9/18
7	Baseline Utility Workshop	0 days	Tue 10/9/18	Tue 10/9/18
8	Measurement & Verification Workshop	0 days	Tue 10/9/18	Tue 10/9/18
9	Business Case Workshop	0 days	Fri 10/26/18	Fri 10/26/18
10	IGEA Results Presented to LBPS	0 days	Wed 11/7/18	Wed 11/7/18
11	3rd Party Engineering Review	2 wks	Fri 11/9/18	Thu 11/22/18
12	Submit Energy Savings Plan to BPU for Review	14 days	Mon 11/26/18	Thu 12/13/18
13	LBPS Approval & Acceptance of ESP & ESG Contract	0 days	Thu 12/13/18	Thu 12/13/18
14	Detailed Site Visits	2 wks	Tue 9/11/18	Mon 9/24/18
15	Scope Design & Construction Cost Estimating	5 wks	Tue 9/18/18	Mon 10/22/18
16	Detailed Energy Analysis	25 days	Tue 9/18/18	Mon 10/22/18
17	Update Utility Bills	1 wk	Tue 9/18/18	Mon 9/24/18
18	Energy Saving Calculations	4 wks	Tue 9/25/18	Mon 10/22/18
19	Data Logging	24 days	Tue 9/25/18	Fri 10/26/18
20	Lighting Loggers	21 days	Tue 9/25/18	Tue 10/23/18
21	Deploy Loggers	3 days	Tue 9/25/18	Thu 9/27/18
22	Logging Time	2 wks	Fri 9/28/18	Thu 10/11/18
23	Retrieve Loggers	3 days	Fri 10/12/18	Tue 10/16/18
24	Analyze Data	5 days	Wed 10/17/18	Tue 10/23/18
25	Temperature/ Motor Loggers	21 days	Tue 9/25/18	Tue 10/23/18
26	Deploy Loggers	3 days	Tue 9/25/18	Thu 9/27/18
27	Logging Time	2 wks	Fri 9/28/18	Thu 10/11/18
28	Retrieve Loggers	3 days	Fri 10/12/18	Tue 10/16/18
29	Analyze Data	5 days	Wed 10/17/18	Tue 10/23/18
30	Field Measurements	3 days	Wed 10/24/18	Fri 10/26/18
31	ESP Report Development	31 days	Tue 9/18/18	Tue 10/30/18
32	Detailed Scope Write-up	15 days	Tue 9/18/18	Mon 10/8/18
33	Detailed Energy Savings Analysis	5 days	Tue 10/23/18	Mon 10/29/18



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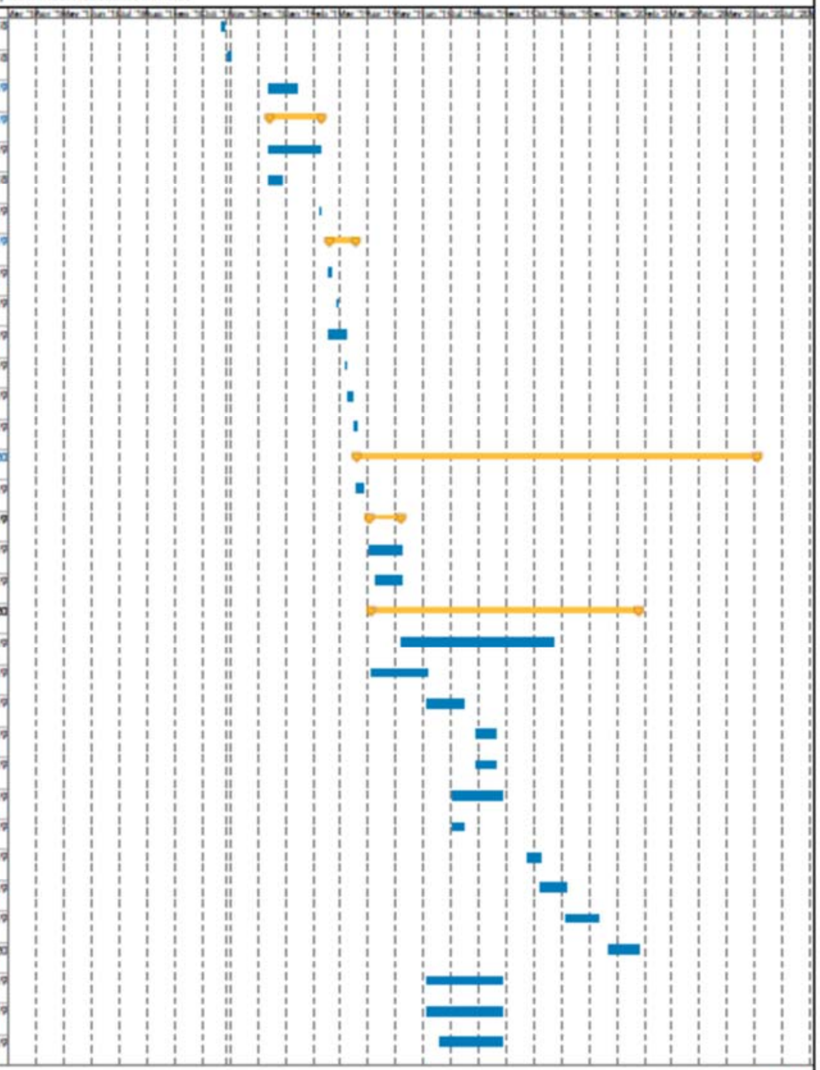
Long Branch Public Schools
ESP Development & Installation Schedule

ID	Task Name	Duration	Start	Finish
34	Develop Business Case	3 days	Tue 10/23/18	Thu 10/25/18
35	Energy Savings Plan Appendix	2 days	Mon 10/29/18	Tue 10/30/18
36	Project Financing	21 days	Fri 12/14/18	Fri 1/11/19
37	Phase 2: Design	41 days	Fri 12/14/18	Fri 2/8/19
38	Final Design Engineering	8 wks	Fri 12/14/18	Thu 2/7/19
39	Bid Specification Development	2 wks	Fri 12/14/18	Thu 12/27/18
40	Final Design Review Workshop	1 day	Fri 2/8/19	Fri 2/8/19
41	Phase 3: Procurement	21 days	Mon 2/18/19	Mon 3/18/19
42	Advertise Bids	1 day	Mon 2/18/19	Mon 2/18/19
43	Pre-Proposal Conference & Site Visits	1 day	Tue 2/26/19	Tue 2/26/19
44	Bid Duration for Subcontractors	3 wks	Mon 2/18/19	Fri 3/8/19
45	Opening of Bids	1 hr	Fri 3/8/19	Fri 3/8/19
46	Evaluation of Bids and Confer on Selection of Sub-Contractors	1 wk	Mon 3/11/19	Fri 3/15/19
47	Subcontractor Selection	1 day	Mon 3/18/19	Mon 3/18/19
48	Phase 4: Construction	316 days	Wed 3/20/19	Wed 6/3/20
49	Issue Subcontracts	1 wk	Wed 3/20/19	Tue 3/26/19
50	**Pre- Construction Activities**	**25 days**	**Wed 4/3/19**	**Tue 5/7/19**
51	Planning / Engineering	25 days	Wed 4/3/19	Tue 5/7/19
52	Shop Drawing Approval	20 days	Wed 4/10/19	Tue 5/7/19
53	**Installation of Recommended ECMs**	**211 days**	**Fri 4/5/19**	**Fri 1/24/20**
54	Comprehensive LED Lighting Upgrades (Lighting & Controls)	120 days	Wed 5/8/19	Tue 10/22/19
55	Direct Install Program (Lighting, Controls & HVAC)	45 days	Fri 4/5/19	Thu 6/6/19
56	Install HVAC-Related Variable Frequency Drives (VFDs)	30 days	Wed 6/5/19	Tue 7/16/19
57	Plug Load Controls	15 days	Tue 7/30/19	Mon 8/19/19
58	Install High Efficiency Transformers	15 days	Tue 7/30/19	Mon 8/19/19
59	Cogeneration (CHP)	40 days	Wed 7/3/19	Tue 8/27/19
60	Walk-In Cooler Controls	10 days	Wed 7/3/19	Tue 7/16/19
61	Fuel Use Economizer Controls (Boilers)	10 days	Wed 9/25/19	Tue 10/8/19
62	Replace Air Cooled Chiller with HE Air Cooled Chiller	21 days	Wed 10/9/19	Wed 11/6/19
63	Replace W2W Chiller with HE Air Cooled Chiller	25 days	Thu 11/7/19	Wed 12/11/19
64	Replace Spilt AC system with HE Spilt AC System	25 days	Mon 12/23/19	Fri 1/24/20
65	Replace Boilers with High Efficiency Boilers (Clark)	60 days	Wed 6/5/19	Tue 8/27/19
66	Replace Boilers with High Efficiency Boilers (Morris)	60 days	Wed 6/5/19	Tue 8/27/19
67	Replace Unit Ventilator / Fan Coils	50 days	Wed 6/19/19	Tue 8/27/19



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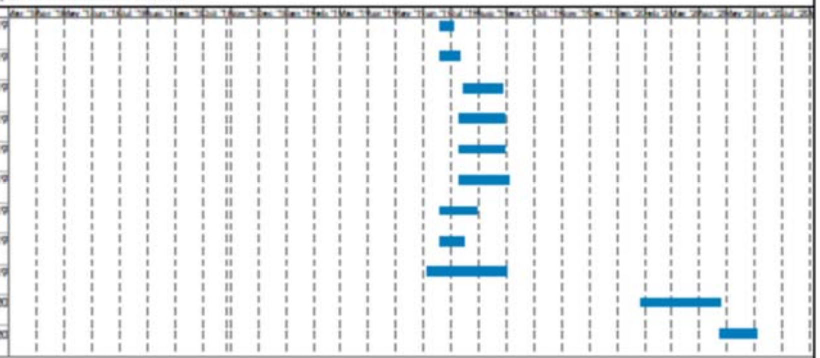
Long Branch Public Schools
ESP Development & Installation Schedule

ID	Task Name	Duration	Start	Finish
68	Replace DWH with High Efficiency DWH	10 days	Wed 6/19/19	Tue 7/2/19
69	Replace RTUs with High Efficiency RTUs	15 days	Wed 6/19/19	Tue 7/9/19
70	Enhanced Air Filtration / Ionization Filters	30 days	Wed 7/17/19	Tue 8/27/19
71	Upgrade Building Management System (BMS) - Central Plant	37 days	Wed 7/10/19	Thu 8/29/19
72	Upgrade Building Management System (BMS) - AHU's & RTU's	37 days	Wed 7/10/19	Thu 8/29/19
73	Upgrade Building Management System (BMS) - Terminal Units	40 days	Wed 7/10/19	Tue 9/3/19
74	Building Envelope Weatherization	30 days	Wed 6/19/19	Tue 7/30/19
75	Repair / Install Piping Insulation	20 days	Wed 6/19/19	Tue 7/16/19
76	Retro-Commissioning Study & HVAC Improvements	63 days	Wed 6/5/19	Fri 8/30/19
77	System Commissioning	63 days	Mon 1/27/20	Wed 4/22/20
78	Project Close Out	30 days	Thu 4/23/20	Wed 6/3/20



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SECTION 8. SAMPLE ENERGY PERFORMANCE CONTRACT

A sample Energy Performance Contract has been provided electronically to the District for review.

APPENDIX 1. ENERGY CONSERVATION MEASURES INVESTIGATED BUT NOT RECOMMENDED AT THIS TIME

ECM: Premium Efficiency Motors (New Exhaust Fans)

ECM Summary

GREENHECK Vari-Green Motor

The District has several exhaust fans that have older low-efficiency motors and have exceeded their useful life. Although this measure results in a poor payback period, it is recommended based on the potential for energy savings, improved occupant comfort and safety concerns.

On small motor applications, Electronically Commutated (EC) Motors have the proven potential to generate significant savings. These motors are typically in sizes up to 1 horsepower, and their efficiencies are high compared to the older fractional horsepower motors. Since these motors are without mechanical brushes and the commuter reduces friction losses, they work much like Direct Current (DC) motors. They are programmable and can be used for a wide range of applications.

Facilities Considered for this Measure

- Audrey W. Clark Elementary School
- Morris Avenue Elementary School

ECM: Install Kitchen Hood Controls

ECM Summary

In this measure we examined optimizing kitchen hood operation through Melink's Intelli-Hood® (or equal) control system. The proposed system is designed for commercial kitchen ventilation systems and can save fan energy by improving the efficiency of the hoods.

With the Melink system installed, when the hood is started, the fans go to a preset minimum speed of 10-50% (typical). The speed control is achieved using a variable frequency drive. When the cooking appliances are turned on, the fan speed increases upon detecting an increase in the exhaust air temperature (detected by a temperature sensor). During the actual cooking the fan reaches 100% of the speed until smoke/vapor, detected by an optical sensor is removed. Each Optic Sensor enclosure has a purge fan that keeps the environment inside the enclosure under a positive air pressure. This prevents contaminated air from entering the sensor unit. If applicable, the makeup-air unit associated with the hood exhaust fan, simply follows the speed (airflow) of the exhaust fan, so proper pressurization is maintained during the entire operation.

Facilities Considered for this Measure

- Long Branch High School
- Long Branch Middle School

ECM: Demand Response Programs

ECM Summary

This measure is a contract that facilitates customer participation in the PJM Energy Efficiency Demand Response Program. PJM Energy Efficiency is defined as a permanent reduction in electric energy consumption in return for payments from the electric power markets. A customer that has recently installed more efficient devices/equipment or implemented more efficient processes or systems, that exceed industry standards at the time of the implementations can participate in the PJM Energy Efficiency program.

PJM Energy Efficient Program payments are independent of the local utilities payments. A customer that implemented energy efficiency retrofits receives benefits from lower demand charges (by lowering their electricity consumption), rebates from local utilities and/or the PJM Energy Efficiency program. Energy Efficiency retrofits that would qualify for the PJM Energy Efficiency Program include implementation of lighting retrofits, appliances, air conditioning installations, building insulation or process improvements, and permanent load shifts that will not be dispatched on the price or other factors.

A customer with a permanent reduction qualifies for up to four consecutive years of revenue for the same energy efficiency measures. The four-year mark starts from the completion year of the project.

Facilities Considered for this Measure

- All Buildings

ECM: Replace Heat Pumps with High Efficiency Heat Pumps

ECM Summary

The District utilizes several heat pump systems that are nearing the end of their useful life. This ECM entails the replacement of the existing heat pump units with high efficiency systems. The proposed systems will reduce heating and cooling costs compared to the existing equipment and will include DDC controls that can be easily integrated into the proposed Building Management System. The new systems will also ensure that all equipment operates with a common, environmentally low-impact refrigerant minimizing the plants ozone depletion potential.

High Efficiency Water Source Heat Pumps

Facilities Considered for this Measure

- Long Branch High School
- Long Branch Middle School

ECM: Refurbish Unit Ventilators

ECM Summary

We investigated refurbishing the existing standard efficiency motors with high efficiency EC motors in the unit ventilators throughout the District. The advantages of replacing existing permanent split capacity (PSC) motors with electronically commutated motors (ECM) is the increase in control ability of the motor. EC Motors may be programmed to vary speed and can reach efficiencies up to 80% above standard PSC motors.

Based on discussions with facility personnel and the inspection of existing unit ventilators throughout the building, they are several units in poor condition and in need of substantial refurbishment or replacement. We recommend replacement with new unit ventilators equipped with EC Motors over refurbishment based on project economics (refurbishment does not provide adequate savings to justify investment).

Facilities Considered for this Measure

- Audrey W. Clark Elementary School
- Morris Avenue Elementary School
- Lenna W. Conrow School

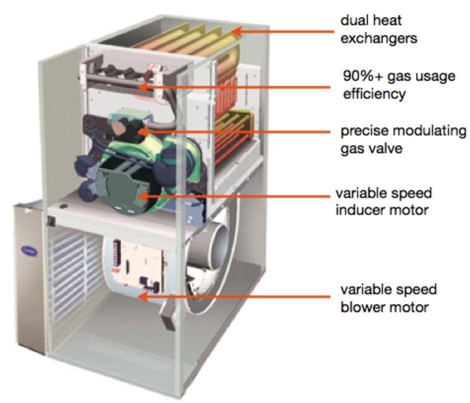
ECM: Replace Furnaces with High Efficiency Furnaces

ECM Summary

We recommend replacing existing standard efficiency furnaces with condensing furnaces. Improved combustion technology and heat exchanger design optimize heat recovery from the combustion gases which can significantly improve furnace efficiency. The proposed systems will reduce heating costs compared to the existing equipment and will include DDC controls that can be easily integrated into the proposed Building Management System.

Facilities Considered for this Measure

- Board of Education Office



High Efficiency Condensing Furnace

ECM: Replace Steam Traps

ECM Summary

Mechanical traps are prone to failure as they age, resulting in large steam losses and requiring substantial maintenance. Steam traps separate the steam system from the condensate system. Traditional steam traps can fail in the open or closed position. When a steam trap fails in the open or leaking-by position, some or all of the energy that was added at the boiler is lost into the condensate return system. The energy contained in steam is only utilized when it condenses in a heat exchanger (radiator, convector, hot water heater, AHU coil, etc.) and releases its latent heat to the process. It is at this point the steam trap should allow this condensate into the condensate return system to return to the boiler. As mentioned above, a leaking trap still allows steam to flow through the heat exchange device it serves and will typically not affect its heating capacity. For this reason, leaking traps are rarely discovered without performing specific tests on the trap. Conversely, a steam trap that fails in the closed position does not allow the condensate to enter the condensate return system. As a result, condensate backs up into the heat exchange device it serves, thereby first reducing, then eliminating, its heating capacity. Plugged traps are often identified through "cold calls" and repaired. Replacing or repairing failed traps will improve the efficiency of the steam distribution system and save energy. The District is planning to eliminate the Steam Boiler and all associated steam piping and traps.

Facilities Considered for this Measure

- Lenna W. Conrow School

ECM: Installation of VRF Systems

ECM Summary

Variable refrigerant flow systems are a multi-split type HVAC system to provide the ability to condition the building and maintain individual zone control in each room, floor and area of the building. This type of system has precise individual controls and technology designed to minimize energy consumption and optimize energy savings above traditional HVAC systems. A modular design of outdoor units with a variety of indoor units allow for specified design and installation. A heat recovery system has a high initial cost, however the potential savings are significant. The system allows for the ability to provide heating and cooling to different spaces at the same time. Heat is essentially transferred to wherever in the system it is needed, without requiring the use of hot water or chilled water to be supplied to the space. Using this type of system requires electric heating and cooling. The coefficient of performance (COP) for heating is greater than 4.0, in comparison to a traditional electric resistance heating COP of 1.0. The integrated energy efficiency rating (IEER) are higher than 24, in comparison to water cooled air conditioners rated at 13.6 IEER as recommended by ASHRAE Standard 90.1-2013.

Per discussions with a representative from the leading manufacturer, the proposed system could utilize ceiling units integrated into the existing drop in ceiling. One of the biggest benefits of installing VRF in a situation like this is that the existing system and infrastructure can remain intact and untouched while VRF is being installed. It can be done where one day the hot water / chilled water is on and the next the VRF is on and the existing is off.

Facilities Recommended for this Measure

- Audrey W. Clark Elementary School
- Morris Avenue Elementary School
- Lenna W. Conrow School

ECM: Install Low Flow Plumbing Fixtures / Devices

ECM Summary

Bathroom fixtures offer good water saving opportunities because many of these fixtures can be retrofit to reduce the amount of water consumed per flush (toilets and urinals) or per minute of use (sinks and showers). Reducing sink and shower water usage also saves the thermal energy used to make hot water.

Facilities Considered for this Measure

- All buldings.

ECM: PC Power Management

ECM Summary

Energy Systems Group will furnish and install a software utility that measures, manages, and minimizes the energy consumed by the network's PC clients through one centralized interface. It provides IT departments with a powerful approach to automate energy-efficient "best practices" throughout their networks, while it adds new control and flexibility to traditional PC power management.

With the help and cooperation of the District, ESG will install and rapidly deploy PC Power Management software on the District's PC network. A one-day deployment plan will address server and client installation, basic administrative configurations, logical power management profile groupings, and energy consumption reporting. Ongoing technical support and product revisions, with an annual energy audit to ensure maximized energy savings are also included for a period of three years.

ECM: Stadium Lighting Upgrade

ECM Summary

Lighting Retrofit and Replacement: The existing Stadium Lighting at the High School utilizes older technologies that can be upgraded. Improvements to the stadium lighting will reduce electrical consumption, improve lighting uniformity and increase foot-candle levels. The system also has flexible dimming capabilities and timer controls for additional security. The cost of materials required to maintain the current fixtures will also be reduced since these renovations replace items that are near the end of their life cycle and/or considered environmentally hazardous.

Facilities Considered for this Measure

- Long Branch High School

ECM: Premium Efficiency Motors (ETR HVAC Equipment)

ECM Summary

We recommend replacing standard efficiency motors with high efficiency EC motors in the unit ventilators throughout the building. The advantages of replacing existing permanent split capacity (PSC) motors with electronically commutated motors (ECM) is the increase in control ability of the motor. EC Motors may be programmed to vary speed and can reach efficiencies up to 80% above standard PSC motors.

The base case motor efficiencies are estimated from nameplate information and our best estimates of motor run hours. Efficiencies of proposed motor upgrades are obtained from the ECM motors in the market today which have capabilities to vary in speed to meet the needs of the space with less energy consumption. Savings are based on the difference between baseline and proposed efficiencies, variable speed impacts and the assumed annual operating hours.

Facilities Considered for this Measure

- All Buildings

ECM: Window Film – Solar/Security Film

ECM Summary

Security window film mitigates hazards from shattered glass during natural disasters. Helps protect people from flying glass shards, one of the most common causes of blast-related injuries and fatalities. Micro-layered and tear-resistant to help increase security and provide added protection against smash and grab burglaries.

Facilities Considered for this Measure

- All Buildings

ECM: Pay for Performance

ECM Summary

This program allows schools district to obtain rebate for energy savings project above and beyond the standard NJ Smart program when energy savings exceeds 15% of the baseline usage for each school. We expect that many of the Long Branch Schools will be eligible for this rebate program

The Pay for Performance for Existing Buildings Program takes a comprehensive, whole-building approach to saving energy in existing facilities through incentives that are directly linked to savings. Pay for Performance program relies on a network of partners who provide technical services under direct contract to you. Acting as your energy expert, your partner will develop an energy reduction plan for each project with a whole-building technical component of a traditional energy audit, a financial plan for funding the energy efficient measures and a construction schedule for installation.

At the same time, ESG feels the knowledge of the Pay for Performance Program allows us to be reasonable in our incentive estimates during the RFP Response and create a realistic expectation for Long Branch Schools.

Facilities Considered for this Measure

- Long Branch High School
- Long Branch Middle School
- George L. Catarmbone Elementary School
- Gregory Elementary School
- Amerigo A. Anastasia School

ECM: Install an Ozone Laundry System

ECM Summary

The energy used to produce hot water for washing machines may be eliminated with the installation of an ozone system. This system uses cold water rather than hot and provides better results. This uses the natural cleaning powers of O3 or Ozone to clean laundry more effectively, safely and efficiently than traditional units. Additionally, this approach will increase the lifespan of the linens washed as it isn't as destructive as soaps and detergents. This technology has been used for years in commercial applications across the U.S. The latest system using this technology is designed to work within existing washers of any make and model. Cold water is directed through the O3 Pure System. An ozone generator converts O2 (regular oxygen) into O3 (ozone) which is mixed and diffused into the water for your washer. The colder the water, the more effective it cleans. The ozone works by breaking the molecular bonds that hold dirt and grime to your clothes while oxidizing most of this material into carbon dioxide and water. Afterward any remaining ozone converts back into regular oxygen. What you are left with are clean clothes and linens free of any smells, dirt and grime or chemicals. This system doesn't require any maintenance, cleaning or additives.

Ozone Laundry System

Facilities Considered for this Measure

- Long Branch High School
- Long Branch Middle School

ECM: Energy Star Refrigerator Replacement

ECM Summary

Energy Star labeled refrigerators are energy efficient refrigerators and should replace existing refrigerators. The replacement of older refrigerators will reduce the energy consumption of the equipment located throughout staff lounges. The refrigerators are a very visible item used by most of the staff throughout the day and will make a positive impact on the teachers by being replaced.

Facilities Considered for this Measure

- All buildings

ECM: Installation of an Energy Management System

ECM Summary

The installation of a new Energy Management System (EMS) increases the efficiency of the building HVAC system operation. Upgrade of controls to optimize the start/stop of all key HVAC equipment, tying in all space temperature controls will minimize the amount of waste energy. Schedules may be put in place to limit system operation when the building is closed. Temperature set back controls may be applied to operate systems only to the point necessary. Ventilation and economizer controls and programming would allow air handling units to operate according to room schedules, occupancy and availability for "free cooling" or "free heating". Some EMS may also tie in lighting control based on occupancy and schedules. This measure is not recommended based on the energy and economic results, however it should be considered as a capital improvement measure for future implementation. Also, if other measures are installed at the same time, with shorter payback periods, this may balance out the longer payback period of this measure. As such, it would be recommended that an HVAC contractor who specializes in energy management systems be contacted for a detailed evaluation and implementation costs. For the purposes of this report, the potential energy savings and measure costs were estimated based on industry standards and previous project experience.

Facilities Considered for this Measure

- All Buildings

ECM: Roof Mounted PV System Installation

ECM Summary

George L. Catrambone Elementary School

TRC Energy Services evaluated the potential for installing on-Site generation for George L. Catrambone Elementary School. Based on the configuration of the site and its loads there is a high potential for installing a photovoltaic (PV) array.

ECM: Install High Efficiency Gas Water Heater

ECM Summary

We evaluated replacing the existing tank water heater with a high efficiency condensing storage tank water heater. Improvements in combustion efficiency and reductions in heat losses have improved the overall efficiency of storage water heaters. Energy savings results from using less gas to heat water, due to higher unit efficiency, and fewer run hours to maintain the tank water temperature.

Facilities Considered for this Measure

- All buildings

APPENDIX 2. ENERGY SAVINGS CALCULATIONS

Energy Savings

Energy savings were calculated using an Excel based bin calculation workbook developed by Energy Systems Group; all savings calculations and field measurements will be provided electronically.

Operational Savings

New LED Fixtures

Annual operational savings are calculated based on the reduced amount of material needed for replacement of the lighting system. This is calculated by comparing the existing lifetime of the T8, HID and halogen lamps to the new lifetime of LED lighting. The calculations are based on replacements of T8 fixtures every three years, T8 ballasts every 5 years, HID lamps every 5 years and halogen lamps being replaced every 2 years. The table below highlights the various lamp types and associated replacement timing as well as total cost with replacement. These savings do not include any costs for labor to replace the bulbs or additional material needed for replacement such as lifts, replacement fixtures, new sockets, etc.

Material Type	Lifetime	Cost/ Unit
Linear fluorescent (T8)	3 years	$5
Electronic Ballast	5 years	$25
HID Lamp	5 years	$25
HID Ballast	5 years	$75
Halogen, PARs, BRs	2 years	$10
Incandescent, CFLs, MRs	2 years	$2

This methodology is used to determine the annual savings through the replacement of all lamp types with new LED lamps and fixtures. The fixture warranty associated with each of these replacements is 10 years. Operational savings have been claimed for a total of 5 years per the BPU regulations.

Mechanical Upgrades (Boiler Replacement & Controls Upgrades)

The annual operating expenses for Long Branch BOE was provided to Energy Systems Group in order to determine the amount of emergency repair maintenance conducted annually at the District. The installation of new equipment along with manufacturers' warranties will effectively eliminate the need for these emergency repair costs. The operational savings for these measures have been claimed for 2 years per the BPU regulations. A complete breakdown of the operational analysis for the District is included on the following pages.

Operational Savings Summary

Energy Systems Group has worked with the District to quantify the exact sources of savings by going through past invoices and expenses. The table below summarizes the cost savings estimated from invoices provided by the District; these invoices are summarized only by the applicable ECMs and any non-recurring charge. Any preventative maintenance or service contracts that will remain were not factored into this analysis. The complete list of invoices is provided electronically. The operational savings will not be escalated.

Operational Savings for Financial Model	
ECM Description	**Annual Savings**
LED Lighting Upgrades & Occupancy Sensors – District Wide (17 Schools)	$137,771
Direct Digital Controls (DDC) Upgrade – District Wide	$90,000
Totals	$227,771

APPENDIX 4. DETAILED SCOPE DESCRIPTIONS

Design Drawings will be available electronically.

APPENDIX 5. RECOMMENDED PROJECT – ESP

ECM #	Energy Conservation Measure	ECM Hard Cost	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
	Long Branch High School					
1	Comprehensive LED Lighting Upgrades (Lighting & Controls) - Long Branch High School	$824,169	$76,195	10.82	Public Bidding	Yes
2	Plug Load Controls - Long Branch High School	$9,397	$626	15.00	Public Bidding	Yes
3	Cogeneration (CHP) - Long Branch High School	$58,225	$3,754	15.51	Public Bidding	Yes
4	Walk-In Cooler Controls - Long Branch High School	$7,729	$1,452	5.32	Public Bidding	Yes
5	Replace W2W Chiller with HE Air Cooled Chiller - Long Branch High School	$397,444	$6,114	65.01	Public Bidding	Yes
6	HVAC Upgrades at HS (WSHP to Gas/Electric) - Café + Media Center - Long Branch High School	$344,400	-$863	-399.05	Public Bidding	Yes
7	HVAC Upgrades at HS (WSHP to Gas/Electric) - Aux Gym - Long Branch High School	$184,500	-$8,752	-21.08	Public Bidding	Yes
8	Enhanced Air Filtration / Ionization Filters - Long Branch High School	$64,380	$5,566	11.57	Public Bidding	Yes
9	Upgrade Building Management System (BMS) - Central Plant - Long Branch High School	$150,060	$7,693	19.51	Public Bidding	Yes
10	Upgrade Building Management System (BMS) - Common Area's LBHS - Long Branch High School	$83,230	$0	N/A	Public Bidding	Yes
11	Building Envelope Weatherization - Long Branch High School	$42,331	$12,166	3.48	Public Bidding	Yes
12	Retro-Commissioning Study & HVAC Improvements - Long Branch High School	$95,735	$8,815	10.86	Public Bidding	Yes
13	Construction Contingency - Long Branch High School	$268,000	$0	N/A	Public Bidding	Yes
	Long Branch Middle School					
14	Comprehensive LED Lighting Upgrades (Lighting & Controls) - Long Branch Middle School	$862,047	$59,786	14.42	Public Bidding	Yes
15	Plug Load Controls - Long Branch Middle School	$13,178	$1,862	7.08	Public Bidding	Yes
16	Install High Efficiency Transformers - Long Branch Middle School	$102,153	$10,275	9.94	Public Bidding	Yes
17	Walk-In Cooler Controls - Long Branch Middle School	$10,213	$1,929	5.29	Public Bidding	Yes
18	Replace DWH with High Efficiency DWH - Long Branch Middle School	$26,906	$1,258	21.39	Public Bidding	Yes
19	Upgrade Building Management System (BMS) - Central Plant - Long Branch Middle School	$170,560	$2,333	73.11	Public Bidding	Yes
20	Upgrade Building Management System (BMS) - AHU's & RTU's - Long Branch Middle School	$19,988	$0	N/A	Public Bidding	Yes
21	Upgrade Building Management System (BMS) - Terminal Units - Long Branch Middle School	$155,595	$0	N/A	Public Bidding	Yes
22	Building Envelope Weatherization - Long Branch Middle School	$31,111	$9,092	3.42	Public Bidding	Yes
	Audrey W. Clark Elementary School					

ECM #	Energy Conservation Measure	ECM Hard Cost	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
23	Direct Install Program (Lighting, Controls & HVAC) - Audrey W. Clark Elementary School	$49,218	$10,600	4.64	Public Bidding	Yes
24	Install HVAC-Related Variable Frequency Drives (VFDs) - Audrey W. Clark Elementary School	$12,783	$1,157	11.05	Public Bidding	Yes
25	Plug Load Controls - Audrey W. Clark Elementary School	$1,836	$96	19.12	Public Bidding	Yes
26	Walk-In Cooler Controls - Audrey W. Clark Elementary School	$5,244	$371	14.13	Public Bidding	Yes
27	Replace Boilers with High Efficiency Boilers (Clark) - Audrey W. Clark Elementary School	$199,106	$2,710	73.47	Public Bidding	Yes
28	Replace Unit Ventilator / Fan Coils - Audrey W. Clark Elementary School	$132,784	$420	316.46	Public Bidding	Yes
29	Upgrade Building Management System (BMS) - Central Plant - Audrey W. Clark Elementary School	$66,523	$1,611	41.29	Public Bidding	Yes
30	Upgrade Building Management System (BMS) - AHU's & RTU's - Audrey W. Clark Elementary School	$12,300	$2,131	5.77	Public Bidding	Yes
31	Upgrade Building Management System (BMS) - Terminal Units - Audrey W. Clark Elementary School	$37,413	$922	40.58	Public Bidding	Yes
32	Building Envelope Weatherization - Audrey W. Clark Elementary School	$52,647	$2,539	20.73	Public Bidding	Yes
33	Repair / Install Piping Insulation - Audrey W. Clark Elementary School	$5,339	$802	6.66	Public Bidding	Yes
George L. Catrambone Elementary School						
34	Comprehensive LED Lighting Upgrades (Lighting & Controls) - George L. Catrambone Elementary School	$265,530	$17,975	14.77	Public Bidding	Yes
35	Plug Load Controls - George L. Catrambone Elementary School	$6,265	$731	8.57	Public Bidding	Yes
36	Walk-In Cooler Controls - George L. Catrambone Elementary School	$7,729	$1,272	6.08	Public Bidding	Yes
37	Fuel Use Economizer Controls (Boilers) - George L. Catrambone Elementary School	$6,663	$1,601	4.16	Public Bidding	Yes
38	Building Envelope Weatherization - George L. Catrambone Elementary School	$29,513	$3,230	9.14	Public Bidding	Yes
Gregory Elementary School						
39	Comprehensive LED Lighting Upgrades (Lighting & Controls) - Gregory Elementary School	$255,535	$25,036	10.21	Public Bidding	Yes
40	Install HVAC-Related Variable Frequency Drives (VFDs) - Gregory Elementary School	$97,765	$9,127	10.71	Public Bidding	Yes
41	Plug Load Controls - Gregory Elementary School	$4,969	$475	10.47	Public Bidding	Yes
42	Walk-In Cooler Controls - Gregory Elementary School	$6,900	$742	9.30	Public Bidding	Yes
43	Fuel Use Economizer Controls (Boilers) - Gregory Elementary School	$19,988	$1,320	15.14	Public Bidding	Yes
44	Building Envelope Weatherization - Gregory Elementary School	$24,401	$2,175	11.22	Public Bidding	Yes

ECM #	Energy Conservation Measure	ECM Hard Cost	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
45	Repair / Install Piping Insulation - Gregory Elementary School	$6,695	$1,262	5.30	Public Bidding	Yes
46	Retro-Commissioning Study & HVAC Improvements - Gregory Elementary School	$2,563	$898	2.85	Public Bidding	Yes
	Amerigo A. Anastasia School					
47	Comprehensive LED Lighting Upgrades (Lighting & Controls) - Amerigo A. Anastasia School	$263,148	$27,019	9.74	Public Bidding	Yes
48	Install HVAC-Related Variable Frequency Drives (VFDs) - Amerigo A. Anastasia School	$97,765	$9,127	10.71	Public Bidding	Yes
49	Plug Load Controls - Amerigo A. Anastasia School	$6,265	$1,005	6.23	Public Bidding	Yes
50	Walk-In Cooler Controls - Amerigo A. Anastasia School	$7,729	$901	8.58	Public Bidding	Yes
51	Fuel Use Economizer Controls (Boilers) - Amerigo A. Anastasia School	$19,988	$1,373	14.56	Public Bidding	Yes
52	Building Envelope Weatherization - Amerigo A. Anastasia School	$30,487	$3,399	8.97	Public Bidding	Yes
53	Repair / Install Piping Insulation - Amerigo A. Anastasia School	$6,891	$1,078	6.40	Public Bidding	Yes
54	Retro-Commissioning Study & HVAC Improvements - Amerigo A. Anastasia School	$2,563	$787	3.25	Public Bidding	Yes
	Morris Avenue Elementary School					
55	Direct Install Program (Lighting, Controls & HVAC) - Morris Avenue Elementary School	$81,185	$13,295	6.11	Public Bidding	Yes
56	Install HVAC-Related Variable Frequency Drives (VFDs) - Morris Avenue Elementary School	$16,370	$1,463	11.19	Public Bidding	Yes
57	Plug Load Controls - Morris Avenue Elementary School	$2,916	$361	8.08	Public Bidding	Yes
58	Walk-In Cooler Controls - Morris Avenue Elementary School	$5,244	$371	14.13	Public Bidding	Yes
59	Replace Air Cooled Chiller with HE Air Cooled Chiller - Morris Avenue Elementary School	$178,658	$4,103	43.55	Public Bidding	Yes
60	Replace Boilers with High Efficiency Boilers (Morris) - Morris Avenue Elementary School	$204,488	$2,954	69.21	Public Bidding	Yes
61	Replace Unit Ventilator / Fan Coils - Morris Avenue Elementary School	$554,269	$832	666.54	Public Bidding	Yes
62	AHU Replacement (Install RTU) - Morris Ave - Morris Avenue Elementary School	$130,989	-$4,921	-26.62	Public Bidding	Yes
63	Upgrade Building Management System (BMS) - Central Plant - Morris Avenue Elementary School	$120,130	$2,747	43.73	Public Bidding	Yes
64	Upgrade Building Management System (BMS) - Terminal Units - Morris Avenue Elementary School	$164,615	$2,688	61.24	Public Bidding	Yes
65	Building Envelope Weatherization - Morris Avenue Elementary School	$18,971	$2,585	7.34	Public Bidding	Yes
	Joseph M. Ferraina ECLC					
66	Direct Install Program (Lighting, Controls & HVAC) - Joseph M. Ferraina ECLC	$99,043	$14,862	6.66	Public Bidding	Yes

ECM #	Energy Conservation Measure	ECM Hard Cost	Total Savings, $/yr	Simple Payback	Installation Plan	Recommend for Installation
67	Install HVAC-Related Variable Frequency Drives (VFDs) - Joseph M. Ferraina ECLC	$76,844	$1,797	42.75	Public Bidding	Yes
68	Plug Load Controls - Joseph M. Ferraina ECLC	$2,160	$278	7.77	Public Bidding	Yes
69	Walk-In Cooler Controls - Joseph M. Ferraina ECLC	$5,244	$604	8.68	Public Bidding	Yes
70	Replace Split AC system with HE Split AC System - Joseph M. Ferraina ECLC	$40,488	$2,474	16.37	Public Bidding	Yes
71	Replace RTUs with High Efficiency RTUs - Joseph M. Ferraina ECLC	$38,950	$392	99.26	Public Bidding	Yes
72	Building Envelope Weatherization - Joseph M. Ferraina ECLC	$3,805	$438	8.68	Public Bidding	Yes
73	Repair / Install Piping Insulation - Joseph M. Ferraina ECLC	$1,803	$316	5.71	Public Bidding	Yes
Lenna W. Conrow School						
74	Direct Install Program (Lighting, Controls & HVAC) - Lenna W. Conrow School	$50,873	$12,014	4.23	Public Bidding	Yes
75	Plug Load Controls - Lenna W. Conrow School	$6,913	$651	10.61	Public Bidding	Yes
76	Walk-In Cooler Controls - Lenna W. Conrow School	$5,244	$318	16.49	Public Bidding	Yes
77	Fuel Use Economizer Controls (Boilers) - Lenna W. Conrow School	$6,663	$607	10.98	Public Bidding	Yes
78	Replace Boilers with High Efficiency Boilers (Conrow) - Lenna W. Conrow School	$204,488	$6,303	32.44	Public Bidding	Yes
79	Replace Unit Ventilator / Fan Coils - Lenna W. Conrow School	$122,693	$584	209.98	Public Bidding	Yes
80	Upgrade Building Management System (BMS) - Central Plant - Lenna W. Conrow School	$22,140	$1,339	16.54	Public Bidding	Yes
81	Upgrade Building Management System (BMS) - Terminal Units - Lenna W. Conrow School	$115,979	$3,180	36.47	Public Bidding	Yes
82	Building Envelope Weatherization - Lenna W. Conrow School	$63,664	$4,567	13.94	Public Bidding	Yes
83	Repair / Install Piping Insulation - Lenna W. Conrow School	$17,759	$1,707	10.41	Public Bidding	Yes
Board of Education Office						
84	Direct Install Program (Lighting, Controls & HVAC) - Board of Education Office	$18,419	$4,407	4.18	Public Bidding	Yes
85	Plug Load Controls - Board of Education Office	$1,404	$360	3.90	Public Bidding	Yes
86	Upgrade Building Management System (BMS) - Central Plant - Board of Education Office	$42,743	$422	101.29	Public Bidding	Yes
87	Building Envelope Weatherization - Board of Education Office	$33,796	$1,324	25.52	Public Bidding	Yes
Totals		**$8,124,838**	**$418,618**	**19.41**		

Operational Savings for Financial Model	
ECM Description	**Annual Savings**
LED Lighting Upgrades & Occupancy Sensors – District Wide (10 Schools)	$137,771
HVAC Upgrades / Equipment Replacement	$90,000
Totals	$227,771

NJ Smart Start Rebates	
Audrey W. Clark Elementary School - Boiler	$4,400
Morris Avenue Elementary School - Boiler	$4,400
Audrey W. Clark Elementary School - VFD's	$900
Gregory Elementary School - VFD's	$5,200
Amerigo A. Anastasia School - VFD's	$5,200
Morris Avenue Elementary School - VFD's	$900
Joseph M. Ferraina ECLC - VFD's	$2,800
Long Branch High School - Chiller	$18,400
Morris Avenue Elementary School - Chiller	$3,440
Joseph M. Ferraina ECLC - Rooftop Units	$1,030
Long Branch High School - Refrigeration Controls	$100
Long Branch Middle School - Refrigeration Controls	$100
Audrey W. Clark Elementary School - Refrigeration Controls	$100
George L. Catrambone Elementary School - Refrigeration Controls	$100
Gregory Elementary School - Refrigeration Controls	$100
Amerigo A. Anastasia School - Refrigeration Controls	$100
Morris Avenue Elementary School - Refrigeration Controls	$100
Joseph M. Ferraina ECLC - Refrigeration Controls	$100
Lenna W. Conrow School - Refrigeration Controls	$100
Long Branch Middle School - Domestic Water Heater	$350
Long Branch High School - Lighting	$49,422
Long Branch Middle School - Lighting	$46,000
George L. Catrambone Elementary School - Lighting	$16,500
Gregory Elementary School - Lighting	$20,463
Amerigo A. Anastasia School - Lighting	$21,900
Totals	$202,205

Building	Estimated Incentive #1	Estimated Incentive #2	Estimated Incentive #3	Estimated Total
Cogeneration – Long Branch Board of Education	$6,000	$10,000	$4,000	$20,000

Demand Response Energy – Emergency Capacity Credit		
PJM Payment Year	**Approved Load (kW)**	**Annual Customer Capacity Benefit**
2019/2020	297 kW	$6,510
2020/2021	297 kW	$10,184
2021/2022	297 kW	$5,536
2022/2023	297 kW	$5,536
Totals		**$27,766**

Incentive Breakout for Recommended Project

Year	DR EE Credit	NJ Clean Energy Rebates	Pay for Performance	CHP	Total
1	$6,510	$201,905	$0	$6,000	$214,415
2	$10,184	$0	$0	$10,000	$20,184
3	$5,536	$0	$0	$4,000	$9,536
4	$5,536	$0	$0	$0	$5,536
TOTAL	**$27,766**	**$201,905**	**$0**	**$20,000**	**$249,671**

Energy Conservation Measure	Electric Consumption		Annual Electric Demand		Natural Gas		Total Annual Utility Dollars
	kWh	$	kW	$	therms	$	
Comprehensive LED Lighting Upgrades (Lighting & Controls) - Long Branch High School	664,435	$61,248	2,327	$14,947	0	$0	$76,195
Plug Load Controls - Long Branch High School	6,796	$626	0	$0	0	$0	$626
Cogeneration (CHP) - Long Branch High School	54,132	$4,990	110	$709	(2,045)	-$1,945	$3,754
Walk-In Cooler Controls - Long Branch High School	15,755	$1,452	0	$0	0	$0	$1,452
Replace W2W Chiller with HE Air Cooled Chiller - Long Branch High School	47,095	$4,341	276	$1,773	0	$0	$6,114
Enhanced Air Filtration / Ionization Filters - Long Branch High School	59,488	$5,484	0	$0	86	$82	$5,566
Upgrade Building Management System (BMS) - Common Area's LBHS - Long Branch High School	0	$0	0	$0	0	$0	$12,166
Building Envelope Weatherization - Long Branch High School	131,980	$12,166	0	$0	0	$0	$8,815
Retro-Commissioning Study & HVAC Improvements - Long Branch High School	93,572	$8,625	0	$0	199	$190	$0
Construction Contingency - Long Branch High School	0	$0	0	$0	0	$0	$0
Comprehensive LED Lighting Upgrades (Lighting & Controls) - Long Branch Middle School	521,680	$48,088	1,821	$11,698	0	$0	$1,862
Plug Load Controls - Long Branch Middle School	20,202	$1,862	0	$0	0	$0	$10,275
Install High Efficiency Transformers - Long Branch Middle School	101,713	$9,376	140	$899	0	$0	$1,929
Walk-In Cooler Controls - Long Branch Middle School	20,930	$1,929	0	$0	0	$0	$1,258
Replace DWH with High Efficiency DWH - Long Branch Middle School	0	$0	0	$0	1,225	$1,258	$2,333
Upgrade Building Management System (BMS) - Central Plant - Long Branch Middle School	23,240	$2,142	0	$0	186	$191	$0
Upgrade Building Management System (BMS) - AHU's & RTU's - Long Branch Middle School	0	$0	0	$0	0	$0	$0
Upgrade Building Management System (BMS) - Terminal Units - Long Branch Middle School	0	$0	0	$0	0	$0	$9,092
Building Envelope Weatherization - Long Branch Middle School	98,637	$9,092	0	$0	0	$0	$10,885
Direct Install Program (Lighting, Controls & HVAC) - Audrey W. Clark Elementary School	97,844	$9,019	337	$2,167	(584)	-$586	$1,157

Energy Conservation Measure	Electric Consumption		Annual Electric Demand		Natural Gas		Total Annual Utility Dollars
	kWh	$	kW	$	therms	$	
Install HVAC-Related Variable Frequency Drives (VFDs) - Audrey W. Clark Elementary School	11,847	$1,092	10	$64	0	$0	$2,710
Plug Load Controls - Audrey W. Clark Elementary School	1,042	$96	0	$0	0	$0	$420
Walk-In Cooler Controls - Audrey W. Clark Elementary School	4,025	$371	0	$0	0	$0	$2,131
Replace Boilers with High Efficiency Boilers (Clark) - Audrey W. Clark Elementary School	0	$0	0	$0	2,705	$2,710	$802
Replace Unit Ventilator / Fan Coils - Audrey W. Clark Elementary School	1,737	$160	40	$259	0	$0	$18,471
Upgrade Building Management System (BMS) - AHU's & RTU's - Audrey W. Clark Elementary School	6,607	$609	0	$0	1,519	$1,522	$731
Building Envelope Weatherization - Audrey W. Clark Elementary School	5,268	$486	0	$0	2,050	$2,054	$1,272
Repair / Install Piping Insulation - Audrey W. Clark Elementary School	0	$0	0	$0	801	$802	$1,601
Comprehensive LED Lighting Upgrades (Lighting & Controls) - George L. Catrambone Elementary School	165,850	$15,288	577	$3,709	(991)	-$1,021	$1,478
Plug Load Controls - George L. Catrambone Elementary School	7,930	$731	0	$0	0	$0	$3,230
Walk-In Cooler Controls - George L. Catrambone Elementary School	13,800	$1,272	0	$0	0	$0	$25,687
Fuel Use Economizer Controls (Boilers) - George L. Catrambone Elementary School	0	$0	0	$0	1,553	$1,601	$9,127
Upgrade Building Management System (BMS) - Central Plant - George L. Catrambone Elementary School	10,021	$924	0	$0	537	$554	$475
Building Envelope Weatherization - George L. Catrambone Elementary School	6,548	$604	0	$0	2,548	$2,627	$742
Comprehensive LED Lighting Upgrades (Lighting & Controls) - Gregory Elementary School	229,795	$21,183	808	$5,191	(1,373)	-$1,337	$2,175
Install HVAC-Related Variable Frequency Drives (VFDs) - Gregory Elementary School	90,611	$8,353	121	$775	0	$0	$1,262
Plug Load Controls - Gregory Elementary School	5,148	$475	0	$0	0	$0	$898
Walk-In Cooler Controls - Gregory Elementary School	8,050	$742	0	$0	0	$0	$27,751
Fuel Use Economizer Controls (Boilers) - Gregory Elementary School	0	$0	0	$0	1,355	$1,320	$9,127
Building Envelope Weatherization - Gregory Elementary School	4,615	$425	0	$0	1,796	$1,749	$1,005
Repair / Install Piping Insulation - Gregory Elementary School	0	$0	0	$0	1,296	$1,262	$901
Retro-Commissioning Study & HVAC Improvements - Gregory Elementary School	9,747	$898	0	$0	0	$0	$3,399
Comprehensive LED Lighting Upgrades (Lighting & Controls) - Amerigo A. Anastasia School	249,157	$22,967	866	$5,559	(1,488)	-$1,507	$1,078

Energy Conservation Measure	Electric Consumption		Annual Electric Demand		Natural Gas		Total Annual Utility Dollars
	kWh	$	kW	$	therms	$	
Install HVAC-Related Variable Frequency Drives (VFDs) - Amerigo A. Anastasia School	90,611	$8,353	121	$775	0	$0	$787
Plug Load Controls - Amerigo A. Anastasia School	10,903	$1,005	0	$0	0	$0	$13,656
Walk-In Cooler Controls - Amerigo A. Anastasia School	9,775	$901	0	$0	0	$0	$1,463
Fuel Use Economizer Controls (Boilers) - Amerigo A. Anastasia School	0	$0	0	$0	1,355	$1,373	$361
Building Envelope Weatherization - Amerigo A. Anastasia School	6,990	$644	0	$0	2,720	$2,755	$4,103
Repair / Install Piping Insulation - Amerigo A. Anastasia School	0	$0	0	$0	1,064	$1,078	$2,954
Retro-Commissioning Study & HVAC Improvements - Amerigo A. Anastasia School	8,541	$787	0	$0	0	$0	$2,585
Direct Install Program (Lighting, Controls & HVAC) - Morris Avenue Elementary School	124,803	$11,504	395	$2,535	(745)	-$745	$15,271
Install HVAC-Related Variable Frequency Drives (VFDs) - Morris Avenue Elementary School	15,172	$1,399	10	$64	0	$0	$1,797
Plug Load Controls - Morris Avenue Elementary School	3,914	$361	0	$0	0	$0	$278
Walk-In Cooler Controls - Morris Avenue Elementary School	4,025	$371	0	$0	0	$0	$604
Replace Air Cooled Chiller with HE Air Cooled Chiller - Morris Avenue Elementary School	31,430	$2,897	188	$1,205	0	$0	$2,474
Replace Boilers with High Efficiency Boilers (Morris) - Morris Avenue Elementary School	0	$0	0	$0	2,957	$2,954	$392
Replace Unit Ventilator / Fan Coils - Morris Avenue Elementary School	3,475	$320	80	$511	0	$0	$438
Building Envelope Weatherization - Morris Avenue Elementary School	5,376	$496	0	$0	2,092	$2,090	$316
Direct Install Program (Lighting, Controls & HVAC) - Joseph M. Ferraina ECLC	138,801	$12,795	453	$2,911	(829)	-$844	$12,340
Install HVAC-Related Variable Frequency Drives (VFDs) - Joseph M. Ferraina ECLC	16,408	$1,513	44	$285	0	$0	$651
Plug Load Controls - Joseph M. Ferraina ECLC	3,018	$278	0	$0	0	$0	$607
Walk-In Cooler Controls - Joseph M. Ferraina ECLC	6,555	$604	0	$0	0	$0	$1,339
Replace Split AC system with HE Split AC System - Joseph M. Ferraina ECLC	24,496	$2,258	34	$216	0	$0	$4,567
Replace RTUs with High Efficiency RTUs - Joseph M. Ferraina ECLC	3,260	$301	4	$29	62	$63	$1,707
Building Envelope Weatherization - Joseph M. Ferraina ECLC	898	$83	0	$0	349	$356	$4,532
Repair / Install Piping Insulation - Joseph M. Ferraina ECLC	0	$0	0	$0	310	$316	$360
Direct Install Program (Lighting, Controls & HVAC) - Lenna W. Conrow School	111,304	$10,260	378	$2,426	(663)	-$672	$422
Plug Load Controls - Lenna W. Conrow School	7,066	$651	0	$0	0	$0	$651

Energy Conservation Measure	Electric Consumption		Annual Electric Demand		Natural Gas		Total Annual Utility Dollars
	kWh	$	kW	$	therms	$	
Walk-In Cooler Controls - Lenna W. Conrow School	3,450	$318	0	$0	0	$0	$318
Fuel Use Economizer Controls (Boilers) - Lenna W. Conrow School	0	$0	0	$0	599	$607	$607
Replace Unit Ventilator / Fan Coils - Lenna W. Conrow School	2,448	$226	56	$359	0	$0	$584
Replace Boilers with High Efficiency Boilers (Conrow) - Lenna W. Conrow School	0	$0	0	$0	6,223	$6,303	$6,303
Upgrade Building Management System (BMS) - Central Plant - Lenna W. Conrow School	2,674	$246	0	$0	1,078	$1,092	$1,339
Upgrade Building Management System (BMS) - Terminal Units - Lenna W. Conrow School	3,399	$313	0	$0	2,830	$2,867	$3,180
Building Envelope Weatherization - Lenna W. Conrow School	10,558	$973	0	$0	3,547	$3,593	$4,567
Repair / Install Piping Insulation - Lenna W. Conrow School	0	$0	0	$0	1,685	$1,707	$1,707
Direct Install Program (Lighting, Controls & HVAC) - Board of Education Office	41,387	$3,815	132	$850	(247)	-$258	$4,407
Plug Load Controls - Board of Education Office	3,906	$360	0	$0	0	$0	$360
Upgrade Building Management System (BMS) - Central Plant - Board of Education Office	1,706	$157	0	$0	253	$265	$422
Building Envelope Weatherization - Board of Education Office	2,655	$245	0	$0	1,033	$1,079	$1,324

Business Case for Recommended Project

FORM VI - ENERGY SAVINGS PLAN

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
LONG BRANCH PUBLIC SCHOOLS
ENERGY SAVINGS IMPROVEMENT PROGRAM

ESCO Name: Energy Systems Group

Note: Respondents must use the following assumptions in all financial calculations:

(a) The cost of all types of energy should be assumed to inflate at **2.4% gas, 2.2% electric** per year; and

1. Term of Agreement: 20 years
2. Construction period [2] (months): 12 Months
3. Cash Flow Analysis Format:

Total ESG Project Cost [1]	**$**	**9,989,488**
Cost of Financing	$	120,000
CC	$	(1,750,000)
JBA Fee	$	114,000
Financed Amount	**$**	**8,473,488**

Interest Rate to be used for Proposal Purposes: 3.80%

	Annual Energy Savings	Annual Operational Savings	Energy Rebates/ Incentives	Total Annual Savings	Annual Project Costs	Board Costs	Annual Service Costs [3]	Net Cash-Flow to client	Cumulative Cash Flow
Installation	$ 214,000	$ 197,078		$ 411,078	$ -	$ -		$ 411,078	$ 411,078
1	$ 523,618	$ 262,771	$ 221,485	$ 1,377,845	$ 1,323,683	$ 1,376,495	$ 52,811	$ 1,350	$ 412,428
2	$ 427,830	$ 262,771	$ 20,184	$ 710,785	$ 709,435	$ 709,435	$ -	$ 1,350	$ 413,778
3	$ 437,245	$ 137,771	$ 9,536	$ 584,552	$ 583,202	$ 583,202	$ -	$ 1,350	$ 415,128
4	$ 446,866	$ 137,771	$ 5,536	$ 590,173	$ 588,823	$ 588,823	$ -	$ 1,350	$ 416,478
5	$ 456,700	$ 137,771	$	$ 594,471	$ 593,121	$ 593,121	$ -	$ 1,350	$ 417,828
6	$ 466,749	$ -	$	$ 466,749	$ 465,399	$ 465,399	$ -	$ 1,350	$ 419,178
7	$ 477,020	$ -	$	$ 477,020	$ 475,670	$ 475,670	$ -	$ 1,350	$ 420,528
8	$ 487,517	$ -	$	$ 487,517	$ 486,167	$ 486,167	$ -	$ 1,350	$ 421,878
9	$ 498,245	$ -	$	$ 498,245	$ 496,895	$ 496,895	$ -	$ 1,350	$ 423,228
10	$ 509,209	$ -	$	$ 509,209	$ 507,859	$ 507,859	$ -	$ 1,350	$ 424,578
11	$ 520,415	$ -	$	$ 520,415	$ 519,065	$ 519,065	$ -	$ 1,350	$ 425,928
12	$ 531,866	$ -	$	$ 531,866	$ 530,516	$ 530,516	$ -	$ 1,350	$ 427,278
13	$ 543,570	$ -	$	$ 543,570	$ 542,220	$ 542,220	$ -	$ 1,350	$ 428,628
14	$ 555,532	$ -	$	$ 555,532	$ 554,182	$ 554,182	$ -	$ 1,350	$ 429,978
15	$ 567,756	$ -	$	$ 567,756	$ 566,406	$ 566,406	$ -	$ 1,350	$ 431,328
16	$ 580,250	$ -	$	$ 580,250	$ 578,900	$ 578,900	$ -	$ 1,350	$ 432,678
17	$ 593,019	$ -	$	$ 593,019	$ 591,669	$ 591,669	$ -	$ 1,350	$ 434,028
18	$ 606,068	$ -	$	$ 606,068	$ 604,718	$ 604,718	$ -	$ 1,350	$ 435,378
19	$ 619,405	$ -	$	$ 619,405	$ 618,055	$ 618,055	$ -	$ 1,350	$ 436,728
20	$ 633,035	$ -	$	$ 633,035	$ 630,302	$ 630,302	$ -	$ 2,733	$ 439,462
Totals	**$ 10,481,916**	**$ 938,855**	**$ 256,741**	**$ 12,047,483**	**$ 11,966,288**	**$ 12,019,099**	**$ 52,811**	**$ 439,462**	**$ 439,462**

NOTES:

(1) Includes: Hard costs and project service fees defined in ESCO's PROPOSED 'FORM V"

(2) No payments are made by the Board during the construction period.

(3) Installation period savings for Energy Savings and Operational Savings are guarenteed. These savings will be used in addition to the first loan payment.

APPENDIX 6. LIGHTING UPGRADES

Long Branch High School

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
29	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	58	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
6	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	6	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 30W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
75	*3' FIXTURE, 2-F25/T8/LAMPS, ELECTRONIC BALLAST	150	G4 SP 3 Foot 12W 4000K 120LPW Nano Lens SEP LED Tube
26	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	26	14W 4ft G2 All-Plastic Ballast-Ready Frosted 4000K Tube - DLC Listed
65	***4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST**	**65**	**Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed**
2711	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	5422	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
555	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	1665	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
49	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	196	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	91	1 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	2814	2 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	555	3 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	49	4 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	6	4FT 2 LAMP INDUSTRIAL HOOD
0	0 - N/A	19	Ceiling Sensor
0	0 - N/A	24	Cree 16" Clear Prismatic Conical Lens for Prismatic & Acrylic Reflectors
0	0 - N/A	80	Cree 16" Matte Spun Aluminium Reflector / Single Pkg
0	0 - N/A	24	Cree 16" Matte Spun Clear Acrylic Reflector / Single Pkg
0	0 - N/A	80	Cree 16" Wire Guard for Prismatic & Acrylic Reflectors
0	0 - N/A	26	GE DIMMABLE BALLAST 0-10V, 120-277V FOR RVLT TUBES
0	0 - N/A	169	Multi-Technology Wall Switch Sensor - MDW
0	0 - N/A	4681	Non-Shunted Socket, 600v, 660w
0	0 - N/A	19	Super Duty Power Pack Line
0	0 - N/A	400	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	2899	Wall wrap socket non shunted
1	1 - 18 WATT CFL	1	PL Stab-In 4 Pin, 2G11, Ballast Compatible, 14.5W, 3500K
20	1 - 32 WATT QUAD-PIN CFL	20	"PL V G24q/G24d 10W PL EDGE Series BYPass 4000K 120-277V"
141	1 - 32 WATT QUAD-PIN CFL	141	6" Retrofit 8.5/14.5/21W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
32	1 - 32 WATT QUAD-PIN CFL	32	PL H G24q/G24d 15.5W PL EDGE Series BYPass 120-277V 4000K
3	1 - 32 WATT QUAD-PIN CFL	3	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
24	1- 250 Watt Quartz Lamp	24	8" Architectural Cylinder LED Downlight- Maxlume
20	1- 250 Watt Quartz Lamp	20	Elite Cylinder Down/Up Light - Pendant Mount (48") - White - 55W - 4000lm - 3000
13	2 - 18 WATT QUAD-PIN CFL	23	PLS 2GX7 5.5W 3500K PL EDGE Series BYPass 120-277V
1	2 - 32 WATT QUAD-PIN CFL	1	VANDALPROOF CANOPY 20W 4000K NEUTRAL LED 120-277V W/ DROP LENS BZ
327	2 - 32 WATT QUAD-PIN CFL	327	6" Retrofit 8.5/14.5/21W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
3	2 - 32 WATT QUAD-PIN CFL	3	8" Retrofit 12/19/27W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
5	2 - 32 WATT QUAD-PIN CFL	5	LED A19 8.5 Watt, Fully Omni E26 Base, 120V, 4000K, Dimmable - Energy Star
52	2 - 32 WATT QUAD-PIN CFL	102	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
74	2 - 40 WATT CFL Fixture	74	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 30W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
20	3' FIXTURE, 2-F30/T12/EE LAMPS, ENERGY SAVING MAGNETIC BALLAST	40	G4 SP 3 Foot 12W 4000K 120LPW Nano Lens SEP LED Tube
32	3-32 WATT CFL in Fixture	32	9.5" Retrofit 23.5/32/45W Innofit Series 4000K 120-277V Non-Dimmable
18	35 WATT MR 16 INCANDESCENT 12V - TRACK LIGHTING	18	MR16, GU5.3 Base 8.5 Watt, 12V, 35°, 3000K, Dimmable - Energy Star
16	4-36 WATT BIAX	64	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
79	6-42 WATT, 4 PIN STADB IN CFL, HIGH BAY, 252 WATTS TOTAL	79	KBL Highbay, 29,100 Lumens, Universal Mount, 4000K, 120-277V, 0-10V Dim
58	A LAMP 60 WATT INCANDESCENT	58	LED A19 8.5 Watt, Fully Omni E26 Base, 120V, 4000K, Dimmable - Energy Star
18	A LAMP 60 WATT INCANDESCENT	18	LED A19 9 Watt, Fully Omni, E26 Base, 120V, 4000K, Dimmable (Energy Star)
32	BR 40 75 WATT DIMMABLE INCANDESCENT	32	BR40, E26 Base, 14 Watt, 120V, 2700K, Dimmable - Energy Star

Long Branch High School

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
5	METAL HALIDE, 1-100 WATT LAMP	5	PAR38, E26 Base, 17 Watt, High CRI, 120V 40°, 4000K, Dimmable - Energy Star
5	METAL HALIDE, 1-150 WATT LAMP	5	HID LED EX39 25W High Output 277V Non-Dimmable, 4000k, mogul base
55	METAL HALIDE, 1-250 WATT LAMP	55	ALED78 TYPE IV WITH 8 POLE MOUNTING ARM NEUTRAL LED BNZ - DLC Listed
24	METAL HALIDE, 1-250 WATT LAMP	24	KBL Highbay, 22,100 Lumens, Universal Mount, 4000K, 120-277V, 0-10V Dim
1	METAL HALIDE, 1-400 WATT LAMP - OVER 15'	1	KBL Highbay, 29,100 Lumens, Universal Mount, 4000K, 120-277V, 0-10V Dim
1	METAL HALIDE, 1-70 WATT LAMP	1	6" Retrofit 8.5/14.5/21W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
72	PAR 38 FLOOD 75 WATT	72	PAR38, E26 Base, 17 Watt, High CRI, 120V 40°, 4000K, Dimmable - Energy Star

Long Branch Middle School

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
93	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	93	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 20W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
1	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	1	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 20W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
25	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	25	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 30W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
2	*2' FIXTURE, 3-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	6	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
2	*3' FIXTURE, 1-F25/T8/ LAMPS, ELECTRONIC BALLAST	2	G4 SP 3 Foot 12W 4000K 120LPW Nano Lens SEP LED Tube
920	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	920	TUBE LIGHT, T8, 4FT, 10W, 4000K, G1 ECO-FIT, BALLAST-READY, FROSTED NANO LENS - DLC Listed
301	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	311	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
2142	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	4284	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
293	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	879	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
61	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	244	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	1650	1 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	2040	2 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	200	3 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	1	4 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	286	4FT 2 LAMP INDUSTRIAL HOOD
0	0 - N/A	2	8FT 2 LAMP TANDEM INDUSTRIAL HOOD
0	0 - N/A	990	GE DIMMABLE BALLAST 0-10V, 120-277V FOR RVLT TUBES
0	0 - N/A	24	GX24 4 PIN MALE TO E27 FEMALE CONVERTER
0	0 - N/A	3020	Non-Shunted Socket, 600v, 660w
0	0 - N/A	24	PHILIPS IZT BALLAST DIMMABLE FOR PLL HIGH BAY LIGHT
0	0 - N/A	50	TUBE LIGHT, T8, 4FT, 10W, 4000K, G1 ECO-FIT, BALLAST-READY, FROSTED NANO LENS - DLC Listed
0	0 - N/A	300	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	2350	U Tube Socket non shunted
19	1 - 40 Watt CFL Quad Pin	19	PL Stab-In 4 Pin, 2G11, Ballast Compatible, 14.5W, 3500K
25	1 - 42 Watt Stab-In	25	8" Retrofit 12/19/27W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
24	1 - 42 Watt Stab-In	24	HID LED E26 25W High Output 277V Non-Dimmable, 4000k, med base
6	2 - 26 WATT CFL QUAD - PIN FIXTURE	12	"PL H G24q 9.5W PL EDGE Series DIRect Ballast Compatible"
537	2 - 26 WATT CFL QUAD - PIN FIXTURE	537	8" Retrofit 12/19/27W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
2	2 - 40 WATT CFL Fixture	4	PL Stab-In 4 Pin, 2G11, Ballast Compatible, 14.5W, 3500K
13	3' FIXTURE, 1-F30/T12/STD LAMPS, STANDARD MAGNETIC BALLAST	13	G4 SP 3 Foot 12W 4000K 120LPW Nano Lens SEP LED Tube
15	4' FIXTURE, 1-F34/T12 LAMP, ENERGY SAVING MAGNETIC BALLAST	15	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
5	4' FIXTURE, 1-F34/T12 LAMP, STANDARD MAGNETIC BALLAST	5	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
46	4' FIXTURE, 4-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	46	2 x 2, HIGH BAY, ECO LINEAR, 167W, 4000K, 120-277VAC, DIMMABLE, MEDIUM OPTIC - DLC Listed
8	4-40 WATT BIAX	8	PL Stab-In 4 Pin, 2G11, Ballast Compatible, 17W, 3000K
65	8' FIXTURE, 4-F32/T8 LAMPS, INSTANT START ELECT BALLAST BF: .85-.95	260	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
7	A LAMP 60 WATT INCANDESCENT	7	LED A19 9 Watt, Fully Omni, E26 Base, 120-277V, 4000K, Non-Dimmable (Energy Star)
10	BR 30 65 WATT DIMMABLE INCANDESCENT	10	LED BR30 8 WATT CLOUD DESIGN, E26 BASE, 120V, 4000K, DIMMABLE (ENERGY STAR)
1	METAL HALIDE, 1-100 WATT LAMP	1	FUTURE FLOOD 39W NEUTRAL LED 120V TO 277V BRONZE - DLC Listed
6	METAL HALIDE, 1-100 WATT LAMP	6	8" Retrofit 12/19/27W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
24	METAL HALIDE, 1-100 WATT LAMP	24	HID LED E26 25W High Output 277V Non-Dimmable, 4000k, med base
6	METAL HALIDE, 1-175 WATT LAMP	6	HID LED EX39 54W 120-277V Non-Dimmable
27	METAL HALIDE, 1-175 WATT LAMP	27	WALLPACK 55W NUETRAL LED BRONZE - DLC Listed
11	METAL HALIDE, 1-250 WATT LAMP	11	ALED78 TYPE IV WITH 8 POLE MOUNTING ARM NEUTRAL LED WHITE - DLC Listed

Audrey W. Clark Elementary School

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
4	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	8	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
4	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	4	2 X 4, HIGH BAY, ECO LINEAR, 160W, 4000K, 120-277VAC, DIMMABLE, MEDIUM OPTIC - DLC Listed
1	*2' FIXTURE, 3-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	3	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
12	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	12	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
649	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	1298	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
9	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	36	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	10	**** ALREADY LED ****
0	0 - N/A	12	1 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	649	2 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	9	4 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	2	4FT 2 LAMP INDUSTRIAL HOOD
0	0 - N/A	1346	Non-Shunted Socket, 600v, 660w
0	0 - N/A	70	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
1	1 - 26 Watt CFL screw-in	1	LED A19 8.5 Watt, Fully Omni E26 Base, 120V, 4000K, Dimmable - Energy Star
3	150 Watt MH wall pack	3	SLIM 26W NEUTRAL LED 120V TO 277V WALLMOUNT BRONZE - DLC Listed
1	1-70 Watt MH	1	BRISK WALLPACK 12W NEUTRAL LED 120-277V PC BZ
1	1-70 Watt MH	1	FUTURE FLOOD 39W NEUTRAL LED + 277V PC BRONZE - DLC Listed
1	1-70 Watt MH	1	FUTURE FLOOD 39W NEUTRAL LED 120V TO 277V BRONZE - DLC Listed
5	1-70 Watt MH	5	WALLPACK 24W NEUTRAL LED 120V PC W/ GLASS LENS BZ
3	1-70 Watt MH	3	WALLPACK 30W NEUTRAL LED 277V PCS W/ POLYCARB LENS BZ - DLC Listed
2	1-70 Watt MH	2	WALLPACK 24W NUETRAL LED BRONZE - DLC Listed
2	2 - 26 WATT CFL QUAD - PIN FIXTURE	2	Metalux AP Series-Round Flush Mount-11" 13.5W 4000K 1100 LUMEN
1	2 - 26 WATT CFL QUAD - PIN FIXTURE	1	Metalux AP Series-Round Flush Mount-15"-21.3W 4000K 1700 LUMEN
3	2 - 32 WATT QUAD-PIN CFL	3	Brisk Low Profile Wall Pack, 12 Watt, 4000K, Bronze - DLC Listed
4	2 - 32 WATT QUAD-PIN CFL	4	Metalux AP Series-Round Flush Mount-15"-21.3W 4000K 1700 LUMEN
1	2 - 32 WATT QUAD-PIN CFL	1	Metalux AP Series-Round Flush Mount-19" 30.5W- 4000K-2450 LUMEN
1	2 - 60W A Lamp	1	Metalux AP Series-Round Flush Mount-11" 13.5W 4000K 1100 LUMEN
4	A LAMP 34 WATT INCANDESCENT	4	LED A19 8.5 Watt, Fully Omni E26 Base, 120V, 4000K, Dimmable - Energy Star
6	A LAMP 60 WATT INCANDESCENT	6	BR40, E26 Base, 14 Watt, 120V, 3000K, Dimmable - Energy Star
14	A LAMP 60 WATT INCANDESCENT	14	LED A19 8.5 Watt, Fully Omni E26 Base, 120V, 4000K, Dimmable - Energy Star
1	A LAMP 75 WATT INCANDESCENT	1	LED A19 12 Watt, Fully Omni E26 Base, 120V, 4000K, Dimmable - Energy Star
20	METAL HALIDE, 1-250 WATT LAMP	16	2 x 2, HIGH BAY, ECO LINEAR, 167W, 4000K, 120-277VAC, DIMMABLE, MEDIUM OPTIC - DLC Listed
1	PAR 38 FLOOD 75 WATT	1	PAR38, E26 Base, 17 Watt, 120-277V 40°, 4000K, High CRI, Non-Dimmable

George L. Catarmbone Elementary School

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
34	*3' FIXTURE, 1-F25/T8/ LAMPS, ELECTRONIC BALLAST	34	G4 SP 3 Foot 12W 4000K 120LPW Nano Lens SEP LED Tube
107	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	107	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
337	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	674	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
101	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	303	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	1	**** ALREADY LED ****
0	0 - N/A	141	1 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	337	2 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	167	3 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	8	4 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	6	4FT 2 LAMP INDUSTRIAL HOOD
0	0 - N/A	36	Cree 16" Matte Spun Aluminium Reflector / Single Pkg
0	0 - N/A	36	Cree 16" Wire Guard for Aluminum Reflectors
0	0 - N/A	1130	Non-Shunted Socket, 600v, 660w
0	0 - N/A	700	PHILIPS ADVANCE T5 HE BALLAST MARK 10 POWERLINE
0	0 - N/A	50	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	198	U Tube Socket non shunted
0	0 - N/A	50	Uni-Fit T5 HE 4' Ballast Ready LED Tube 14 Watt Frosted 4000K - DLC Listed
1	1 - 26 WATT CFL QUAD - PIN FIXTURE	1	"PL H G24q 9.5W PL EDGE Series DIRect Ballast Compatible"
57	1 - 26 WATT CFL QUAD - PIN FIXTURE	57	6" Retrofit 8.5/14.5/21W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
26	1 - 26 WATT CFL QUAD - PIN FIXTURE	26	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
23	1 - 32 WATT QUAD-PIN CFL	23	"PL H G24q 9.5W PL EDGE Series DIRect Ballast Compatible"
15	1 - 32 WATT QUAD-PIN CFL	15	6" Retrofit 8.5/14.5/21W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
16	1 - 32 WATT QUAD-PIN CFL	16	8" Retrofit 12/19/27W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
1	1 - 42 Watt Stab-In	1	PL V G24q/G24d 10W 2700K PL EDGE Series BYPass 120-277V
10	2 - 13 WATT CFL DUAL - PIN FIXTURE	10	GX23 (2 Pin CFL) Hybrid 3.5 Watt 3500K Magnetic Ballast Compatible
14	2 - 32 WATT QUAD-PIN CFL	14	9.5" Retrofit 23.5/32/45W Innofit Series 2700K 120-277V Non-Dimmable
4	2' FIXTURE, 2-F14/T5/ELECTRONIC BALLAST	8	2 ft. T5 Tube 9.5W 4000K BYPASS SEP 120-277V
706	4' FIXTURE, 2-F28/T5 ELECTRONIC BALLAST	1412	Uni-Fit T5 HE 4' Ballast Ready LED Tube 14 Watt Frosted 4000K - DLC Listed
3	4-26 WATT CFL	12	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
4	8' FIXTURE, 2-F32/T8 LAMPS, ELECTRONIC BALLAST	8	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 3000K, High Efficacy - DLC Listed
12	8' FIXTURE, 4-32/T8, ELECTRONIC BALLAST	48	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
36	8-42 Watt CFL Highbay	36	KBL Highbay, 29,100 Lumens, Universal Mount, 4000K, 120-277V, 0-10V Dim
35	HIGH PRESSURE SODIUM, 1-70 WATT LAMP	35	HID LED EX39 25W 3000K High Output 120-277V Non-Dimmable

Gregory Elementary School

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
1	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	2	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
33	*2' FIXTURE, 3-F32/T8/U3 LAMPS, ELECTRONIC BALLAST	132	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
8	*2' FIXTURE, 3-F32/T8/U3 LAMPS, ELECTRONIC BALLAST	8	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 30W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
3	*3' FIXTURE, 1-F25/T8/ LAMPS, ELECTRONIC BALLAST	3	G4 SP 3 Foot 12W 4000K 120LPW Nano Lens SEP LED Tube
36	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	60	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
359	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	718	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
775	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2355	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
6	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	839	1 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	1160	2 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	10	3 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	6	4 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	36	4FT 2 LAMP INDUSTRIAL HOOD
0	0 - N/A	40	Cree 16" Matte Spun Aluminium Reflector / Single Pkg
0	0 - N/A	40	Cree 16" Wire Guard for Aluminum Reflectors
0	0 - N/A	3295	Non-Shunted Socket, 600v, 660w
0	0 - N/A	33	Retrofit Kit for 2' U-Tube (Includes (4) Sockets)
0	0 - N/A	160	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
3	1 - 32 WATT QUAD-PIN CFL	3	PL H G24Q/G24D 15.5W PL EDGE SERIES BYPASS, 4000k, 120-277V HORIZONTAL
23	1 - 32 WATT QUAD-PIN CFL	23	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
13	1-70 WATT CFL LAMP	13	HID LED E26 25W High Output 277V Non-Dimmable, 4000k, med base
55	2 - 32 WATT QUAD-PIN CFL	55	8" Retrofit 12/19/27W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
52	2 - 32 WATT QUAD-PIN CFL	104	PL H G24Q/G24D 15.5W PL EDGE SERIES BYPASS, 4000k, 120-277V HORIZONTAL
2	2 - 32 WATT QUAD-PIN CFL	4	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
47	2' FIXTURE, 2-F32/T8, U3, ELECTRONIC BALLAST	47	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 30W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
16	4' FIXTURE, 2-F54/T5/HO/LAMPS, ELECTRONIC BALLAST	32	Uni-Fit T5 HO 4' Ballast Ready LED Tube 27 Watt Frosted 4000K - DLC Listed
8	4-26 WATT CFL	32	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
16	8-40 WATT PL HIGH BAY-320 WATTS	16	KBL Highbay, 29,100 Lumens, Universal Mount, 4000K, 120-277V, 0-10V Dim
24	8-42 Watt CFL Highbay	24	KBL Highbay, 29,100 Lumens, Universal Mount, 4000K, 120-277V, 0-10V Dim
3	A LAMP 60 WATT INCANDESCENT	3	LED A19 9 Watt, Fully Omni, E26 Base, 120V, 4000K, Dimmable (Energy Star)

Amerigo A. Anastasia School

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
4	*2' FIXTURE, 1-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	4	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
1	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	2	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
5	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	5	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 30W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
40	*2' FIXTURE, 3-F32/T8/U3 LAMPS, ELECTRONIC BALLAST	160	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
35	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	59	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
356	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	712	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
764	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	2292	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
6	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	24	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	795	1 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	1115	2 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	50	3 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	10	4 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	38	4FT 2 LAMP INDUSTRIAL HOOD
0	0 - N/A	16	Ballast, 2 Lamp, T5 HO, Sylvania for RVLT
0	0 - N/A	40	Cree 16" Matte Spun Aluminium Reflector / Single Pkg
0	0 - N/A	40	Cree 16" Wire Guard for Aluminum Reflectors
0	0 - N/A	3255	Non-Shunted Socket, 600v, 660w
0	0 - N/A	40	Retrofit Kit for 2' U-Tube (Includes (4) Sockets)
0	0 - N/A	160	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
12	1-70 Watt MH	12	HID LED E26 25W High Output 277V Non-Dimmable, 4000k, med base
55	1-70 Watt MH	55	PL H G24q/G24d 15.5W PL EDGE Series BYPass 120-277V 4000K
63	2 - 32 Watt CFL (Round)	63	8" Retrofit 12/19/27W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
24	2 - 32 Watt CFL (Round)	48	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
42	2' FIXTURE, 2-F32/T8, U3, ELECTRONIC BALLAST	42	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 30W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
16	4' FIXTURE, 2-F54/T5/HO/LAMPS, ELECTRONIC BALLAST, 117w	32	Uni-Fit T5 HO 4' Ballast Ready LED Tube 27 Watt Frosted 4000K - DLC Listed
10	4-26 WATT CFL	40	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
40	8-42 Watt CFL Highbay	40	KBL Highbay, 29,100 Lumens, Universal Mount, 4000K, 120-277V, 0-10V Dim
1	METAL HALIDE, 1-150 WATT LAMP	1	FUTURE FLOOD 52W 4000K LED NEUTRAL ARM ON-OFF 7X6 BRONZE
20	METAL HALIDE, 1-150 WATT LAMP	20	HID LED EX39 54W 120-277V Non-Dimmable

Morris Avenue Elementary School

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
10	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	20	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
45	*2' FIXTURE, 3-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	135	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
11	*2' FIXTURE, 3-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	10	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 20W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
4	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	4	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X2, 20W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
242	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	103	INTERIOR LUMINAIRES, G2 THIN PANEL, 2X4, 36W, 4000K, 120-277VAC, DIMMABLE - DLC LISTED
1	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	1	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
123	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	246	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
140	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	420	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
3	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	12	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	15	**** ALREADY LED ****
0	0 - N/A	1	1 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	133	2 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	1	2ft Wall Wrap Around 2 lamp
0	0 - N/A	195	3 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	3	4 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	23	4FT 2 LAMP INDUSTRIAL HOOD
0	0 - N/A	20	Cree 16" Matte Spun Aluminium Reflector / Single Pkg
0	0 - N/A	20	Cree 16" Wire Guard for Aluminum Reflectors
0	0 - N/A	834	Non-Shunted Socket, 600v, 660w
0	0 - N/A	3	Retrofit Kit for 2' U-Tube (Includes (3) Sockets)
0	0 - N/A	40	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
12	1-F13/T5 (21")	12	2 ft. T5 Tube 9.5W 4000K BYPASS SEP 120-277V
3	2' FIXTURE, 2-F32/T8/U6 LAMPS, INSTANT START ELECTRONIC BALLAST	9	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
25	2-26 WATT QUAD CFL	25	8" Retrofit 12/19/27W Innoft Series 4000K 120-277V Non-Dimmable - Energy Star
19	2-26 WATT QUAD CFL	38	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
35	A LAMP 60 WATT INCANDESCENT	35	LED A19 9 Watt, Fully Omni, E26 Base, 120-277V, 4000K, Non-Dimmable (Energy Star)
3	METAL HALIDE, 1-150 WATT LAMP	3	WALLPACK 30W 4000K NEUTRAL LED 120-277V W/ POLYCARB LENS BZ - DLC Listed
24	METAL HALIDE, 1-400 WATT LAMP - OVER 15'	24	2 x 2, HIGH BAY, ECO LINEAR, 167W, 4000K, 120-277VAC, DIMMABLE, PRISMATIC OPTIC - DLC Listed
20	METAL HALIDE, 1-400 WATT LAMP - OVER 15'	20	KBL Highbay, 29,100 Lumens, Universal Mount, 4000K, 120-277V, 0-10V Dim
7	PAR 56 FLOOD 240 WATT	7	PAR38, E26 Base, 17 Watt, High CRI, 120V 40°, 4000K, Dimmable - Energy Star

Joseph M. Ferraina ECLC

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
62	*2' FIXTURE, 2-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	124	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
731	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	1462	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
43	*4' FIXTURE, 3-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	129	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
17	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	68	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	793	2 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	43	3 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	17	4 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	647	Non-Shunted Socket, 600v, 660w
0	0 - N/A	100	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	1136	U Tube Socket non shunted
15	1 - 23 WATT CFL	15	LED A19 12 Watt, Fully Omni E26 Base, 120V, 4000K, Dimmable - Energy Star
11	1 - 40 Watt CFL Quad Pin	11	PL Stab-In 4 Pin, 2G11, Ballast Compatible, 14.5W, 3500K
3	1- 32 Watt 4 PIN/PL-T-32W/41/4P	3	8" Retrofit 12/19/27W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
27	150 Watt MH wall pack	27	WALLPACK 30W 4000K NEUTRAL LED 120-277V W/ POLYCARB LENS BZ - DLC Listed
2	1-70 Watt MH	2	8" Retrofit 12/19/27W Innofit Series 4000K 120-277V Non-Dimmable - Energy Star
2	2 - 18 WATT DUAL-PIN CFL	2	Metalux AP Series-Round Flush Mount-11" 13.5W 4000K 1100 LUMEN
3	2 - 32 WATT QUAD-PIN CFL	3	PL H G24q/G24d 9.5W PL EDGE Series ByPass 120-277V Horizontal
6	35 WATT MR 16 INCANDESCENT 12V - TRACK LIGHTING	6	MR16, GU5.3 Base 8.5 Watt, 12V, 35°, 3000K, Dimmable - Energy Star
21	8-42 Watt CFL Highbay	21	KBL Highbay, 29,100 Lumens, Universal Mount, 4000K, 120-277V, 0-10V Dim
1	A LAMP 60 WATT INCANDESCENT	1	LED A19 8.5 Watt, Fully Omni E26 Base, 120V, 4000K, Dimmable - Energy Star
1	METAL HALIDE, 1-100 WATT LAMP	1	FUTURE FLOOD 39W NEUTRAL LED 120V TO 277V BRONZE - DLC Listed
8	METAL HALIDE, 1-100 WATT LAMP	8	HID LED E26 27W, 4000K, 120-277V Non-Dimmable
1	METAL HALIDE, 1-100 WATT LAMP	1	WALLPACK 24W NUETRAL LED BRONZE - DLC Listed
3	METAL HALIDE, 1-150 WATT LAMP	3	AREA LIGHT 52W NEUTRAL LED BRONZE - DLC Listed
6	PAR 30 FLOOD 65 WATT	6	PAR30, E26 Base, 11 Watt, 120V 40°, 4000K, High CRI, Dimmable - Energy Star

Lenna W. Conrow School

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
1	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	1	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
596	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	1192	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
16	*4' FIXTURE, 4-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	64	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	1	**** ALREADY LED ****
0	0 - N/A	1	1 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	596	2 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	16	4 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	12	Cree 16" Matte Spun Aluminium Reflector / Single Pkg
0	0 - N/A	12	Cree 16" Wire Guard for Aluminum Reflectors
0	0 - N/A	1257	Non-Shunted Socket, 600v, 660w
0	0 - N/A	70	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
15	1 - 26 Watt CFL screw-in	15	LED A19 9 Watt, Fully Omni, E26 Base, 120-277V, 4000K, Non-Dimmable (Energy Star)
2	2 - 18 WATT DUAL-PIN CFL	2	Metalux AP Series-Round Flush Mount-11" 13.5W 4000K 1100 LUMEN
1	2 - 26 WATT CFL QUAD - PIN FIXTURE	1	Metalux AP Series-Round Flush Mount-15"-21.3W 4000K 1700 LUMEN
12	8-42 Watt CFL Highbay	12	KBL Highbay, 29,100 Lumens, Universal Mount, 4000K, 120-277V, 0-10V Dim
6	A LAMP 150 WATT INCANDESCENT	6	16.5 WATT, A21, 4000K, 277 V, A LAMP
2	A LAMP 150 WATT INCANDESCENT	2	WALLPACK 30W 4000K NEUTRAL LED 120-277V W/ POLYCARB LENS BZ - DLC Listed
12	A LAMP 60 WATT INCANDESCENT	12	LED A19 8.5 Watt, Fully Omni E26 Base, 120V, 4000K, Dimmable - Energy Star
2	A LAMP 60 WATT INCANDESCENT	2	LED A19 9 Watt, Fully Omni, E26 Base, 120-277V, 4000K, Non-Dimmable (Energy Star)
9	METAL HALIDE, 1-100 WATT LAMP	9	WALLPACK 30W 4000K NEUTRAL LED 120-277V W/ POLYCARB LENS BZ - DLC Listed
2	METAL HALIDE, 1-1000 WATT LAMP	2	FLEXFLOOD 300W NEUTRAL LED TRUNNION BRONZE - DLC Listed
4	METAL HALIDE, 1-175 WATT LAMP	4	FUTURE FLOOD 52W NEUTRAL LED, SLIPFITTER MOUNT 120V TO 277V BRONZE - DLC Listed
1	METAL HALIDE, 1-400 WATT LAMP - OVER 15'	1	FLEXFLOOD 150W NEUTRAL LED TRUNNION BRONZE - DLC Listed
1	METAL HALIDE, 1-400 WATT LAMP - OVER 15'	1	AREA LIGHT 78 WATT SQUARE 0-10V DIM 4000K DLC Listed
1	METAL HALIDE, 1-70 WATT LAMP	1	WALLPACK 24W NEUTRAL LED 120V PC W/ GLASS LENS BZ
14	METAL HALIDE, 1-70 WATT LAMP	14	WALLPACK 24W NUETRAL LED BRONZE - DLC Listed
3	METAL HALIDE, 2-250 WATT LAMP	3	ALED78 TYPE IV WITH 8 POLE MOUNTING ARM NEUTRAL LED WHITE - DLC Listed
4	PAR 30 FLOOD 75 WATT	4	LED PAR30, 13 Watt, 120V, Dimmable, 4000K, 40°, 1100 Lumen, High CRI

Board of Education Office

Ex Fixt Qty	Existing Fixture or Lamp Description	New Fixture or Lamp Qty	Replacement Fixture or Lamp Description
2	*2' FIXTURE, 2-F32/T8/U6 LAMPS, ELECTRONIC BALLAST	6	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
67	*2' FIXTURE, 3-F17/T8/STD LAMPS, (.88) ELECTRONIC BALLAST	201	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
2	*4' FIXTURE, 1-F32/T8 LAMP, (.88) ELECTRONIC BALLAST	2	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
267	*4' FIXTURE, 2-F32/T8 LAMPS, (.88) ELECTRONIC BALLAST	534	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
0	0 - N/A	43	**** ALREADY LED ****
0	0 - N/A	3	1 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	269	2 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	67	3 Lamp Universal Tombstone Kit with Ballast Disconnect
0	0 - N/A	25	G4 SP 2 Foot 8W 4000K 140LPW Nano Lens SEP LED Tube - DLC Listed
0	0 - N/A	742	Non-Shunted Socket, 600v, 660w
0	0 - N/A	2	Retrofit Kit for 2' U-Tube (Includes (3) Sockets)
0	0 - N/A	25	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
3	1 - 26 WATT CFL QUAD - PIN FIXTURE	3	Brisk Low Profile Wall Pack, 12 Watt, 4000K, Bronze - DLC Listed
2	1-70 Watt MH	2	FUTURE FLOOD 39W NEUTRAL LED 120V TO 277V BRONZE - DLC Listed
1	4' FIXTURE, 1-F34/T12 LAMP, STANDARD MAGNETIC BALLAST	1	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
2	4' FIXTURE, 2-F34/T12 LAMPS, STANDARD MAGNETIC BALLAST	4	Tube Light, T8, G4, 10.5W, 4Ft, SEP, Nano, 4000K, High Efficacy - DLC Listed
9	A LAMP 60 WATT INCANDESCENT	9	LED A19 8.5 Watt, Fully Omni E26 Base, 120V, 4000K, Dimmable - Energy Star
1	A LAMP 60 WATT INCANDESCENT	1	Metalux AP Series-Round Flush Mount-11" 13.5W 4000K 1100 LUMEN
356		1939	

APPENDIX 7. DIRECT INSTALL SCOPE OF WORK

APPENDIX 8. HVAC EQUIPMENT SCHEDULES

APPENDIX 9. 3RD PARTY REVIEW CORRESPONDANCE (DLB ASSOCIATES)

4.1 Energy Savings Calculations Review

4.1.1 Methodology of Submitted Calculations

The Energy Savings Improvement Plan included calculations that utilized BPU-acceptable equations and spreadsheet analyses.

- The twenty (20) ECMs analyzed and accepted in the base project include:
  - Comprehensive LED Lighting Upgrades
  - Direct Install Program (Lighting, Controls, HVAC)
  - Install HVAC Related Variable Frequency Drives (VDFs)
  - Plug Load Controls Installation
  - High Efficiency Transformers Installation
  - Combined Heat and Power (CHP)
  - Walk-in Cooler Control Installation
  - Fuel-Use Economizers (Boilers)
  - High Efficiency Air-Cooled Chiller Installation
  - Replacement of Water to Water Heat Pump with High Efficiency Air-Cooled Chiller
  - High Efficiency Split Systems Installation
  - Replacement of Existing Boilers with High Efficiency Boilers
  - Replacement of Existing Unit Ventilators with High Efficiency Unit Ventilators
  - Replacement of DHW Heaters
  - Replacement of Existing RTUs with High Efficiency RTUs
  - Enhanced Air Filtration / Ionization Filters Installation
  - Building Management System (BMS) Upgrade
  - Building Envelope Weatherization
  - Missing Piping Insulation Repair
  - Retro-commissioning Study & HVAC Improvements

4.1.2 General Calculation Quality

The quality of the energy savings calculations is satisfactory and representative sample sets were checked for accuracy. Spreadsheet analyses were provided by Energy Systems Group as separate appendix files and have been spot-checked by DLB.

The approach and equations used were summarized broadly in the body of the report with no results given in the ECM description sections. References for equations were listed for some ECMs in the report body. The report body could be expanded to include more details on methodology and results.

DLB notes the following comments for the overall report:

1. Any ECMs which propose to modify temperature setpoints or operation schedules of any equipment, including, but not limited to, HVAC equipment, equipment connected to plug load control devices, walk-in freezers or coolers, or computing equipment, should be confirmed with the district to ensure there will be no detrimental operations impacts.
    - ESG has confirmed that the proposed schedules and temperature setpoints are acceptable to Long Branch Public Schools.
2. Section 2, tables on pages 50 and 51 use blended utility rates for calculations.
    - Blended utility rates were not utilized, calculations are using \$/kWh, \$/kW and \$/therm rates from the utility baseline.
3. Table on pages 164 – 167 lists electric consumption and demand for each ECM after implementation but no comparison to the existing values which greatly diminishes its usefulness. Please revise to show the difference before and after.
    - Depending on the application, the demand savings for individual ECM's varies from month to month (i.e. cooling measures only apply during summer months) and are shown on an annualized basis. Rather than show an average value the individual demand reduction for each ECM been included in the ESP.
4. ESP would greatly benefit from the sequential numbering of the proposed ECMs for easier reference search. Currently, no numbers provided.
    - The intent was to update the numbering once the ESP has been approved so that if scope/ECM's changed, the numbering wouldn't have to be updated multiple times. This will be completed in final ESP document.
5. It is customary to provide a sample calculation for each ECM (where applicable) within Savings Methodology section, after the formulas. Those are currently missing. Please add.
    - Sample savings calculations have been included as noted in this review document.

4.1.3 Mechanical and Electrical Energy Conservation Measures

ECMs were evaluated using spreadsheet analyses. The ECMs submitted agree with standard industry practice and BPU protocol requirements.

Some ECMs presented in the Energy Systems Group report are not included in the recommended baseline financial analysis. These ECMs only were spot-checked with the protocol for consistency.

DLB notes the following possible issues with the ECM analysis:

1. ECM 2, 12, 22, 30, 37, 45, 53, 61, 68, 77 - Plug Load Controls (10 Facilities):

a) The baseline running hours for all equipment is 8,760. This baseline assumption seems high for a school district and should be reviewed.
   - All equipment that is intended to be integrated into the Plug Load Control ECM is currently plugged in and has power available to it on a continuous basis. Long Branch Public Schools has confirmed that the equipment is not currently de-energized / un-plugged.

2. ECM 3 – Combined Heat and Power (CHP) (1 Facility):

a) The supporting calculations show 2,223 therms of savings a year. Using the rate provided on page 51, it comes to $2,114 in dollar savings. But table on page 55 lists this value at $3,754. Please review and confirm the values.
   - The CHP system also contributes electrical savings. The differential in cost savings dollars is attributed to the consumption (kWh) and demand (kW) of the proposed system.

b) Table on page 55 shows the system payback as 15.5 years. The updated New Jersey's Clean Energy Program - CHP Program Guide for year 2019 requires that CPH systems must not exceed a payback period of 10 years. Please review and revise values as needed.
   - The Simple Payback shown on page 55 does not account for any utility incentives. The CHP system will have a payback period of less than 10 years in complains with the program guidelines.

c) Greenhouse gas emission calculations should be included with the combined heat and power system analysis using the factors presented in the BPU guidelines.
   - The current greenhouse gas reduction statement (on page 63) are inclusive of the proposed operation of the CHP system and are in accordance with BPU guidelines.

d) The thermal load factor is shown as 90% for all year including the summer months. These values are typically lower during this period. Potential Runtime hours should also be revised accordingly. Please review and update.

- The CHP system was sized to allow for maximum possible utilization (of potential run hours) and is only 10kW. The thermal load factor caps the potential utilization of the CHP at 90% of the historical usage. The system is actually operating between 45-60% of total available hours based on current projections. Also, please note that the system is being tied into multiple, existing hot water storage tanks that will allow the equipment to discharge and store heat over extended periods of time to match the existing domestic hot water usage.

3. ECM 4, 14, 23, 31, 38, 46, 54, 62, 69 – Walk-in Cooler Controls (7 Facilities):

a) In Savings Methodology section on page 80, Winter Season Hrs calculations use 45% for winter cycling, while the same parameter is shown as 35% two lines lower. Please check and revise.

- The document has been revised such that both read “45%”.

b) Supporting calculations show $0.1475 as current effective kWh rate. On page 49 this rate is shown as
$0.09218. Please check for consistency.

- The energy calculations have been revised to remove the reference to cost.

c) It would be beneficial for the additional details on the walk-in equipment to be provided. For example, the supporting calculations show values for kWh / unit type, but no equipment size, volume, or other nameplate data is provided.

- The existing equipment sizing has been added to the calculations.

4. ECM 5 – Replace Water to Water Heat Pump with High Efficiency Air-Cooled Chiller (1 Facility):

a) Supporting calculations table calls for 180-ton chiller, but the provided cut sheet shows the chiller with the maximum capacity of 150-ton. Please provide the cut sheet for the chiller with the appropriate capacity.

- An Updated equipment cutsheet has been provided for the air-cooled chiller.

b) Table on page 55 shows year 1 energy savings from the new chiller installation as $6,114. But the number of kWh from the supporting calculations table (51,190 kWh) multiplied by the electric rate ($0.09218 / kWh) comes to $4,718. Please check the calculations and revise as needed.

- The proposed Chiller installation will provide demand savings in addition to consumption savings. The differential in cost savings dollars is attributed the demand (kW) reduction of the proposed system.

c) The payback period for the new chiller is listed as 65 years. This value is too high considering that the average useful life of the air-cooled chillers is 15 – 20 years. Please provide more reasons to include this ECM into the ESP.

- The proposed Chiller installation is a priority item for Long Branch Public Schools and will provide multiple benefits through implementation including: reduced energy consumption, better control of chilled water temperature setpoint (resulting in improved moisture removal), and lower loop temperatures for the remaining water-cooled equipment.

5. ECM 6– Enhanced Air Filtration / Ionization Filters (1 Facility):

a) Please provide type, count and locations of the ionization filters/systems proposed to be installed.

- The basis of design for the Ionization Filters is Global Plasma Solutions ("GPS"). The equipment will be installed in three existing air handling units (two AHU's in the Main Gym and one AHU serving the Auditorium). The scope of work on page 96 was updated for additional clarity and a cut sheet of the proposed equipment has been added to the ECM folder.

6. ECM 7, 16, 17, 18, 26, 33, 72, 73, 78 – Upgrade Building Management System (3 Facilities):

a) The ECM description includes a scope of work section, which recommends this upgrade at all the schools, but it appears there is no ECM listing for Joseph M Ferraina ECLC. Lost and ECM list should be coordinated.

- The list of buildings and scope of work description in the ECM Summary for "Upgrade Building Management System" (page 97) has been updated to remove the reference to the JMF ECLC.

b) A number of the BMS ECMs have no or a very high payback, would be good to confirm these are Capital Improvement Projects.

- These improvements are high priority items for Long Branch Public Schools and were requested as necessary scope items.

c) The majority of savings appear to be derived from reduced occupied operating. The proposed hour reductions should be confirmed with the school district.

- ESG has confirmed that the proposed schedules and temperature setpoints are acceptable to Long Branch Public Schools.

7. ECM 8, 19, 27, 34, 40, 48, 58, 65, 74, 79 – Building Envelope Weatherization (10 Facilities):

a) Scope of work lists 8 facilities eligible for this ECM. But Appendix 3 shows the scope drawings for 10 facilities. Please check for consistency.

- The scope of work has been updated to list all (10) facilities as indicated in the ECM List.

b) The supporting ECM documentation includes only the floor plans scope drawings. Please provide detailed investment and savings summaries along with data for calculations for each facility.

- Updated savings calculations have been provided in the ECM folder. Additional clarifications regarding the scope of work was added to the ECM Summary.

8. ECM 9, 42, 50 – Retro-commissioning (3 Facilities):

a) In the supporting calculations table, the savings are shown as certain percentage reduction of electric and gas usages. It is unclear how these values were calculated.

- The savings calculation for this measure was estimated as a percentage of the total utility consumption based on the total consumption of electricity and natural gas at the site. The site has ongoing maintenance and performance issues with the geothermal system (high condenser water temperatures, excessive requirements for auxiliary heat, insufficient capacity to complete warm-up / cool-down cycles, etc.) that have increased the total energy consumption of the building. The stipulated savings of 2.5% of electric and 1% of natural gas is based on the assumption that following a proper calibration / retro-commissioning effort the High School geothermal system performance will more closely resemble the Middle School (located adjacent to site, also utilizing ground-source heat pumps).

b) Please provide Retro-commissioning implementation plan for review if available.

- The Scope of Work in the ECM Summary outlines the requirements of the proposed Commissioning effort.

9. ECM 13 – High Efficiency Transformers (1 Facility):

a) It may be worthwhile to note what Baseline was used for the exiting transformer efficiency, if Incentives are included for the Transformer ECM they will need to meet the Smart Start or P4P TRC requirements.

- The baseline (and retrofit) performance of all transformers is provided on the "Losses Reference" tab in the calculation spreadsheet.

10. ECM 15 – DHW Heaters Replacement (1 Facility):

a) The manufacturer and model in the cut sheet doesn't match the one proposed in the ESP. Please review
for consistency.

- The ECM Summary Scope of Work and Calculation spreadsheet have been updated to reflect an AERCO Model #AM399.

b) The supporting calculations spreadsheet doesn't look complete for this particular facility. Please complete.

- The calculation for Domestic Hot Water savings has been updated.

11. ECM 20, 51, 59, 67, 76 – Direct Install Program (Lighting, Controls, HVAC) (5 Facilities):

a) Please list peak electric demand and other required data confirming the eligibility of these 5 facilities for the Direct Install Program.

- The peak demand for all proposed buildings was confirmed to be below 200kW.

b) Confirm that this ECM falls under the current Direct Install Program, this program has been significantly changing each year.

- The Direct Install project scope was vetted with the program provider (Tri State Light & Energy). TSLE reviewed and confirmed the project scope, incentive level, and cost. This included verification of the site's peak demand to confirm site eligibility.

12. ECM 21, 36, 52, 60 – Install HVAC Related Variable Frequency Drives (4 Facilities):

a) It is unclear from the description if this would need to be installed with the BMS Upgrade ECMs, it may be worthily to confirm that they would need to be installed together.

- The integration of the VFD's with the BMS is included in the scope (& cost) of the installation. The scope of work description indicates the following (with regards to BMS integration): Extend communication bus to/from each VFD to/from existing Building Management System; perform any required programming and graphics modifications.

b) In the supporting calculations table it appears that VFDs are being installed on HW Pumps, CHW Pumps. Cooling tower fans, FC Fans and wanted to confirm that the equipment/ system being retrofit will work with Variable Frequency Drives.

- Yes, the proposed installations are appropriate for VFD integration. The scope includes controls to ensure the equipment/systems operates properly post-retrofit.

13. ECM 24, 56 – Boiler Replacement (2 Facilities):

a) The total capacities of the proposed new boilers (1000 MBH each) do not match the capacities of the existing boilers that are being replaced at both facilities. Please indicate if the existing boilers are oversized or revise the new boiler selections.

- The existing boilers are oversized for the building. The proposed boilers will be sized based on the actual heat load of the building (including reasonable / approved redundancy).

b) Please provide more information about the existing boilers to justify the replacement. Currently only the type and capacity are stated.

- The existing boilers that were selected for replacement are all non-condensing type, 30+ years old, and have reached the end of their useful service life.

c) The calculations spreadsheets provide Retrofit Fuel Rate values in the hourly table. Please provide an example of how those values were calculated.

- The retrofit fuel rate is calculated by multiplying the required Heat Load (in BTU/H) and dividing by the efficiency of the Boiler.

  Heat Load / Efficiency = Fuel Rate
  Month 1, Hour 1
  (341,140)/(0.93) = 366,817

d) The supporting calculations utilize an hourly analysis with outdoor dry bulb temperature and building heat load. Additional information on how the building heat load was determined should be included in the report.

- The Building Heat Load was determined by normalizing the calculated existing therm usage with the actual existing annual therm usage after accounting for the equipment efficiency and building size. The calculation shows the estimated boiler loading to be low (<50%), further validating that the equipment is oversized as discussed in the previous comment.

e) The supporting calculations do not show the utility rate which will determine the dollar amount of the energy savings. Please finalize the calculations with the dollar amounts. The total for a year should match the value shown in Section 3 financial impact table, page 55.

- The calculation of all energy savings is included in the financial impact section and has been excluded from the Energy Calculations (typical for all measures).

14. ECM 25, 57, 71 – Unit Ventilators Replacement (3 Facilities):

a) Note: The payback period and energy savings resulting from the replacement are not enough for this ECM to be counted as an energy conservation measure. This can be considered a capital improvement project instead.

- These improvements are high priority items for Long Branch Public Schools and were requested as necessary scope items.

15. ECM 28, 41, 49, 66, 75 – Piping Insulation (5 Facilities):

a) No Scope of Work provided in the ESP for this ECM. Please include. The scope of work should preferably contain locations, system types, pipe sizes / linear feet, insulation type / thickness and fluid temperature.

- The ECM Summary Scope of Work has been updated to provide additional clarity.

b) Additional supporting data should be provided for this ECM, including information on the baseline pipe heat loss coefficient, the fluid and ambient temperature assumptions, and the hours per year of runtime for these piping systems.

- Updated savings calculations have been provided in the ECM folder.

16. ECM 32, 39, 47, 70 – Fuel-Use Economizers (Boilers) (4 Facilities):

a) Supporting calculations show existing boiler efficiencies as 95% (initial combustion) and 101.5% (final combustion). These values look too high. Please check and revise as needed.

- The utilization of Fuel Use Economizers has been accepted by the BPU as a stipulated savings applied to the total consumption and do not reflect a steady-state efficiency. The calculation uses the nameplate efficiency of the boiler (which is condensing at 95%) to ensure the boiler loading is appropriate relative to the actual consumption. The additional savings (stipulated at 6.5%) brings the theoretical system efficiency above 100% to account for the other system losses.

17. ECM 55 – High Efficiency Air-Cooled Chiller (1 Facility):

a) Table on page 57 shows year 1 energy savings from the new chiller installation as $4,103. But the number of kWh from the supporting calculations table (34,163 kWh) multiplied by the electric rate ($0.09218 / kWh) gives $3,149. Please check the calculations and revise as needed.

- The proposed Chiller installation will provide demand savings in addition to consumption savings. The differential in cost savings dollars is attributed the demand (kW) reduction of the proposed system.

b) The payback period for the new chiller is listed as 43.5 years. This value is too high considering that the average useful life of the air-cooled chillers is 15 – 20 years. Please provide more reasons to include this ECM into the ESP.

- These improvements are high priority items for Long Branch Public Schools and were requested as necessary scope items.

18. ECM 63 – High Efficiency Split System Installation (1 Facility):

a) Please provide cut sheets for the proposed replacement equipment.

- A cutsheet for a Trane Condensing Unit has been added to the ECM folder.

b) Please provide the exact number of units to be replaced and new units to be installed within the Scope of Work section on page 86.

- The Scope of Work was clarified to indicate (4) total units (including their respective tonnage) to be replaced.

c) The spot-check of the results provided in the supporting calculations, table "Cooling Savings", last column, does not match the kWh's shown. Please provide a sample calculation for Cooling Savings using the described method in Saving Methodology section on page 86.

- The discrepancy may have been the result of the tonnage value being shown in the summary table already reflects the cooling gradient. The kWh's and formulas were confirmed to be accurate.

- Value Checks for OAT=58, Bin Hours=812, Cooling Gradient = 30%
  (2x15Ton Units)= 30T*30%*(1.24kW/ton-0.98kW/ton)*812 = 1,900kWh
  (10Ton Unit)= 10T*30%*(1.19kW/ton-1.07kW/ton)*812 = 290kWh
  (7.5Ton Units)= 7.5T*30%*(1.19kW/ton-1.07kW/ton)*812 = 218kWh

Total = 2,408kWh, Table shows 2,353kWh (discrepancy in check value is due to rounding of kW/ton values up to 3 significant figures).

19. ECM 64 – Replace RTUs with High Efficiency RTUs (1 Facility):

a) Supporting calculations indicate (2) 5-ton units as existing to be replaced. The Scope of Work on page 93 says that those are (2) 20-ton units. Please check for consistency.

- The scope of work was clarified to reflect both as 5-ton RTU's.

b) Note: The high payback period of 99.3 years indicates that this ECM should probably be considered a part of the capital improvement project, not an ECM.

- These improvements are high priority items for Long Branch Public Schools and were requested as necessary scope items.

4.1.4 Lighting Energy Conservation Measures

Lighting improvement savings calculations were performed in a satisfactory manner using a spreadsheet analysis and reviewed in a spot-check fashion.

DLB notes the following potential issues with the lighting ECM analysis:

1. ECM 1,11,29,35,43 - Comprehensive LED Lighting Upgrades (10 Facilities):

a) The energy savings calculations do not appear to utilize the interactive factor (IF) used on page 63 of the BPU protocols. The calculation approach given in the BPU protocols should be reviewed and utilized as necessary to reflect the energy savings.

- The calculations assume an Interactive Factor of 0.0. This is a conservative estimate that reduces the projected savings by 15% on average.

b) Fixture / Lamp replacement spreadsheet for Lenna W. Conrow School on page 183 looks identical to Board of Education Office spreadsheet on page 184. Please replace with the appropriate spreadsheet.

- The scope of work for the BOE Offices was updated on page 184.

c) The actual calculations of energy savings from lighting upgrades are not provided to support dollar values shown in the table on pages 167 – 172. Please provide at least a sample calculation on page 66 below savings methodology formulas.

- Revised page 66 as requested.
  Sample Calculation for 1st Floor Main Office
  Current Hours = 3000
  Current Total Watts = 506.8
  Current kWh = Hours * Watts / 1000 = 1,520kWh
  Proposed Hours = 3000
  Proposed Total Watts = 189
  Proposed kWh = Hours * Watts / 1000 = 567kWh
  kWh Savings = Current kWh – Proposed kWh = 1,520kWh – 567kWh = 953kWh
  kW Savings = (Current Watts – Proposed Watts)/1000 = (506W-189W)/1000 = 0.32kW

d) There are 10 facilities recommended for the Comprehensive LED Lighting Upgrades ECM listed on page 65. But the table Recommended Project – ESP on pages 161 – 164 lists only 5 facilities. Please revise table to match the ECM summary.

- Lighting upgrades will be provided at all 10 schools. We included (5) schools as a traditional "Comprehensive LED Upgrade" ECM and (5) schools as part of the Direct Install program.

e) In general, Recommended Project - ESP table on pages 161 – 164 would benefit from re-formatting to match similar table created for The Board of Education of the Borough of Butler ESP, dated October 24, 2016, which clearly groups all ECMs by facility. Current table is difficult to follow and check.

- The table in Section 3 as well as Appendix 5 have been updated to reflect the re-formatting.

4.1.5 Financial Calculations

The financial calculations included within the ESP incorporate a 3.6% interest rate for the loan and the BPU- required 2.2% electric and 2.4% natural gas utility escalation.

The baseline option includes twenty (20) ECMs and is analyzed over a 20-year financing term.
DLB notes the following potential issues with the financial calculations:

a) Section 3, Table on page 61 shows Demand Response Annual Customer Capacity Benefits for 4 years, however, the ESIP Program BPU Rules state that Demand Response revenues claimed by ESCOs can only be projected for a maximum period of 3 years. The credits should be reviewed and revised.

- According to the BPU Rules, the 3 years is for RFP proposals only. The actual credit does get paid out over 4 years and we did model it for the full 4 years.

b) Section 3, table on page 61 lists incentive breakdown available for the project. The table is missing the NJ Smart Start incentive detailed earlier in this section. Also, the NJ Clean Energy rebate listed in this table is not detailed anywhere in this section. Please revise as needed.

- Details have been provided in Section 3 and Appendix 5.

c) Section 3, "Business Case for Recommended Project" table on page 62 counts operational savings from HVAC equipment installation 2 years in a row (as part of the total amount). Please provide explanation for this or revise the amount for year 2.

- The BPU allows for 2 years of operational savings on mechanical & controls equipment with provided back-up documentation identifying the district's current spend. The current maintenance spend has been provided in the appendix. The installation period savings are shown for illustration purposes only and have no impact on the proforma.

d) Section 3, Energy Savings and Cost Summary table – it would be helpful to provide total amounts for Year 1 Savings and ECM Hard Cost columns.

Totals have been added for Year 1 savings and ECM Hard Cost Columns.