Energy Savings Improvement Plan (ESIP)

Monroe Township School District

75 E Academy St, Williamstown, NJ 08094

May 1st, 2020

MONROE TOWNSHIP PUBLIC SCHOOLS

Johnson Controls

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Section 1. Executive Summary

Johnson Controls has evaluated various Energy Conservation Measures (ECMs) during the development phase of this Energy Savings Improvement Plan (ESIP) program. We have 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 Monroe Township Public Schools (MTPS) administration to develop a set of ECMs that allow the District to address the facility's priority items while reducing the total annual energy spend. This study expands upon the original energy audit conducted by TRC. The original audit was used for building descriptions as well as an overall indication of the District needs.

Priority items include:

- Upgrade Interior and Exterior Lighting with LED Retrofits
- Pendent Fixture replacement in class rooms
- Lighting Occupancy Controls
- Building Envelope Improvements – Weatherization
- HVAC System Replacement at Holly Glen Elementary School
- Cooling addition to High School and Middle School Gymnasiums
- Roof Top Units Replacement at Oak Knoll Elementary School
- Boiler Replacements at the High School and Radix Elementary School
- Boiler Plant Reconfiguration and Domestic Hot Water System Decoupling at the Middle School
- Boiler Replacement and Domestic Hot Water System Decoupling at Whitehall Elementary School
- Air Cooled Chiller Replacement (#2) Replacement at the High School
- Napps Chiller Reconfiguration at the Middle School
- Pumps and Pump Motors Replacement
- Variable Speed Drives on Pump Motors
- Roof Upgrades at High School and Middle School for Solar PV System Install
- Micro Cogeneration at Whitehall Elementary School
- Kitchen Hood Controls at High School and Middle School
- Transformer Replacement

Energy saving calculations performed in the development of this ESIP (Energy Calculation Workbook) were 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. Energy savings have been provided in the Appendix for ease of review.

Benefits

The measures investigated in this ESP would result in an annual utility savings of **3,876,924 kWh** of electricity with a **7,035 kW** reduction and the facility will save a total of **94,383 therms** of natural gas. The natural gas savings include the purchase of approximately **2,104 therms** of natural gas due to the micro CHP usage. The total net utility cost savings are **$16,625,486** over the life of the project (19 years) plus **$566,584** in operational savings and **$1,265,882** in project incentives. Additionally, the project also leverages $**10,541,032** in solar PPA savings and **$2,804,715** in water and sewer rate change savings with approval from Board of Public Utilities. These energy savings will result in a net reduction of greenhouse gases and will reduce the Monroe Schools' carbon footprint by **6,113,235 lbs.** of CO_2 annually. These savings are achieved while improving the classroom environment and replacing many items that have been in service beyond their useful life expectancy.

Section 2. Project Description

This ESIP addresses the following facilities:

Building	Address	Square Feet
Williamstown High School	700 N Tuckahoe Rd, Williamstown, NJ 08094	338,067
Williamstown Middle School	561 Clayton Rd, Williamstown, NJ 08094	313,512
Holly Glen Elementary School	900 N Main St, Williamstown, NJ 08094	79,055
Oak Knoll Elementary School	23 Bodine Ave, Williamstown, NJ 08094	80,528
Radix Elementary School	363 Radix Rd, Williamstown, NJ 08094	88,777
Whitehall Elementary School	161 Whitehall Rd, Williamstown, NJ 08094	57,017

Facility Description

Williamstown High School

Williamstown High School is a 338,067 square foot facility comprised of various space types within a single building. The building is a mix of single and two (2) story sections that includes classrooms, offices, gymnasium, auditorium, library, theater, cafeteria and kitchen. The building was constructed in 1997. There have been several renovations and additions since then.

Building Occupancy

The school is open Monday through Friday and has weekend usage for sports and other activities. The typical schedule is presented in the table below. School is in session from early September through the end of June and also used for summer school and other programs. There are one-week breaks at the end of December and in the spring. During a typical day, the facility is occupied by approximately 188 staff and 1,840 students.

Occupants	Number	Hours
Students, Staff	1,840 & 188	7 am to 6 pm (Monday – Friday)

The building control system is set to occupied mode more than necessary to reduce any humidity issues within the space.

Building Envelope

The building is constructed of concrete and structural steel with a brick facade. The building has a mix of pitched and flat roofs. There are a mix of single and dual pane windows.

Lighting System

Lighting at the High School is provided mostly by 4-foot, linear fluorescent fixtures with T8 lamps although there are a few fixtures with light emitting diode (LED) lamps. Approximately three-quarters of the 4-foot fluorescent fixtures have three lamps and the remaining fixtures have one (1), two (2), or four (4) lamps. Exit signs have been modified to use light emitting diodes (LEDs).

Nearly all of the interior light fixtures are controlled by wall switches. Occupancy sensor controls are currently used in some restrooms and locker rooms.

Exterior lighting is provided primarily by fixtures with high pressure sodium lamps but there are also fixtures that use LED and metal halide lamps. Exterior fixtures are controlled by either photocells or timers.

Please see Appendix A: Equipment Inventory & Recommendations for an inventory of the facility's lighting equipment.

Chilled Water or Condenser Water System

The High School has three (3) Trane air-cooled scroll chillers. There is one (1), 155-ton chiller located on the roof and two (2), 339-ton chillers located on the ground near the tennis courts. The chillers operate throughout the entire year to provide chilled water to the fan coils and air handlers located throughout the building. Chilled water is circulated by four pumps located in the mechanical room. There are three (3) 40 hp constant speed pumps and one (1) 15 hp variable speed pump. The variable flow pump serves the new addition. At least one (1) chilled water pump is always on.

Hot Water Heating System

The hot water system consists of three (3) Cleaver Brooks boilers rated at 5,250,000 btu/hr. There are two (2) 25 hp constant speed pumps and one (1) 20 hp variable speed pump. The variable speed pump serves the new addition. Hot water is distributed to the air handlers and fan coils throughout the building. Based on the high natural gas use in the summer, the heating boilers appear to operate all year.

Ventilation System

Conditioning is provided to most of the campus by 285 four-pipe fan coils. The fan coils have fans that range from 1/6 hp to 1/2 hp. There are 19 air handlers that supply outside air to the fan coils. The supply fans for the air handlers range from 2 to 15 hp. Only the cafeteria, stage, and auditorium air handlers have return fans. Air handlers seven (7), eight (8), nine (9) and ten (10) serving the library and offices are variable air volume. All of the air handlers have heating and cooling coils to precondition the outside air being delivered to the fan coils. The supply air temperature from the air handlers is reset based on the outside air temperature. The supply air temperature reset varies for different air handlers but ranges from 50°F to 70°F at 30°F outside air and 50°F to 60°F at 67°F outside air. There are 12 heating and ventilating units that serve the gymnasium and associated areas. The heating and ventilating units have supply fans that range from 1.5 to 10 hp and return fans that range from 1 to 7.5 hp. There are also approximately 40 unit heaters throughout the building. The air handlers are on from 6:00 AM to 11:00 PM. It was assumed that all of the HVAC fans operate 365 days per year in order to balance the calculated electricity use with the historical utility bills and to be consistent with the historical energy use profile.

Because of the configuration of air handlers supplying outside ventilation air to the fan coils, there are times that the fan coils operate as reheat units.

Direct Expansion Air Conditioning System (DX)

There are two (2) split system air conditioners rated at 1 ton and 2 tons that condition locker rooms. There are also two (2) 3.5 ton split system heat pumps that condition the weight room.

Building Management System (BMS)

The campus has a Tracer Summit building management system (BMS) that monitors and controls the chilled water, heating water, and ventilation systems.

Domestic Hot Water Heating System

There are four (4) 199,000 Btu/hr tankless natural gas fired water heaters that provide domestic hot water for the campus.

Williamstown Middle School

Williamstown Middle School is a 313,512 square foot facility comprised of various space types within a single building. The building is a mix of single and two story sections that includes classrooms, offices, gymnasium, auditorium, library, media center and kitchen.

The original building was constructed in 1958. There have been several renovations and additions since then. The facility has replaced most of its T12 fluorescent fixtures with T8 fluorescent fixtures.

Building Occupancy

The school is open Monday through Friday and has very minimal weekend activity. The typical schedule is presented in the table below. School is in session from early September through the end of June and also used for summer school and other programs. There are one (1) week breaks at the end of December and in the spring. During a typical day, the facility is occupied by approximately 220 staff and 1,970 students.

Occupants	Number	Hours
Students, Staff	1,970 & 220	8 am to 3 pm (Monday – Friday)

The building control system is set to occupied mode more than necessary to reduce any humidity issues within the space.

Building Envelope

The building is constructed of concrete and structural steel with a brick facade. The building has a mix of pitched and flat roofs.

Lighting System

Lighting at the facility is provided mostly by 4-foot, linear fluorescent fixtures with T8 lamps although there are a few fixtures with T5 and T12 lamps. There is a fairly even mixture of fixtures with two (2), three (3) and four (4) lamps and a few fixtures with one (1) or six (6) lamps. Exit signs have all been modified to use light emitting diodes (LEDs).

Approximately 75% of the interior light fixtures are controlled by wall switches and approximately 25% of the fixtures have occupancy sensor controls. Occupancy sensor controls are currently used in offices, classrooms, and hallways.

Exterior lighting is provided primarily by fixtures with high pressure sodium lamps but there are also fixtures that use compact fluorescent and metal halide lamps. The exterior fixtures are controlled by either photocells or timers.

Please see Appendix A: Equipment Inventory & Recommendations for an inventory of the facility's lighting equipment.

Chilled Water and Condenser Water System

The facility is served by two (2) sets of chillers that supply a common chilled water distribution loop. While there are three (3) 50 ton Napps variable speed, water cooled scroll chillers in the mechanical room only one (1) is connected and operated as part of the chilled water system.. There is also a 400 ton Trane constant speed, air cooled chiller on the roof. All of the chillers are less than five (5) years old. The chillers are configured in a primary distribution loop with three 50 hp constant speed pumps in the mechanical room and two 40 hp variable speed pumps mounted on the Trane chiller skid. Two (2) of the 50 hp chilled water pumps operate continuously – the pumps are operated during winter months for freeze protection.

The cooling season is typically from mid-April through mid-October. The chillers supply water to the fan coils located throughout the building and to the air handlers on the roof. The Trane chiller has a chilled water setpoint of 41°F.

The Trane chiller has twenty-four 1.25 hp and four (4) 1.5 hp condenser fans. A two (2) cell BAC cooling tower with two (2) variable speed 20 hp fans serves the Napps chillers. There are two (2) constant speed 50 hp condenser water pumps. The setpoint of the condenser water supply temperature to the chillers is 75°F.

Hot Water Heating System

The hot water system consists of two (2) Hydrotherm 3,000 MBH condensing boilers with a nominal combustion efficiency of 92.7%. The boilers are configured in a constant flow primary distribution loop with three (3) 25 hp pumps. The typical heating season is mid-October through mid-April. During that time one (1) heating water pump operates continuously. Hot water is supplied at 180°F when the outside air temperature is below 40°F and the setpoint is reset to 110°F when the outside air is above 60°F. The boilers provide hot water to the fan coils located throughout the building and to the air handlers on the roof. The boilers are about three (3) years old.

Direct Expansion Air Conditioning System (DX)

There are two (2) 20 ton and one (1) 10 ton Trane package units on the roof. The package units have direct expansion cooling coils and natural gas fired furnaces.

Ventilation System

Ventilation is provided by a mix of equipment. There are four (4) heating only air handlers on the roof for the gymnasium. There are also three (3) McQuay air handlers and three (3) Trane package units on the roof that condition various areas in the building. Most of the building is conditioned by 44 fan coil units located in the ceiling space and 41 unit ventilators located in rooms throughout the building. The fan coils and unit ventilators provide both heating and cooling. The supply air temperature of the fan coils and air handlers is reset based on outside air temperature. Nearly continuous fan operation was assumed in order to balance the calculated electricity use with the historical utility bills and to be consistent with the historical energy use profile.

Building Management System (BMS)

Most of the HVAC equipment is controlled by a CM3 building management system (BMS). The BMS controls occupied and unoccupied settings for the air handlers and conditioned spaces, controls the chillers and boilers, and provides current status of most of the operating parameters of the HVAC equipment.

Domestic Hot Water Heating System

Most of the domestic hot water for the campus is supplied by a heat exchanger that uses hot water from the boilers to produce domestic hot water. There is also a 67 gallon electric water heater in the mechanical room.

Holly Glen Elementary School

Holly Glen Elementary School is a 79,055 square foot facility comprised of various space types within a single building. The building is single story and includes classrooms, offices, gym, cafeteria, and kitchen.

The building was constructed in 1967. There have been numerous renovations and additions since then with the most recent project completed in 2010. The facility has replaced all of its existing T12 fluorescent fixtures with T8 fluorescent fixtures.

Building Occupancy

The school is open Monday through Friday and has very minimal weekend activity. The typical schedule is presented in the table below. School is in session from early September through the end of June. There are one (1) week breaks at the end of December and in the spring. During a typical day, the facility is occupied by approximately 83 staff and 560 students.

Occupants	Number	Hours
Students, Staff	560 & 83	8:30 am to 2 pm (Monday – Friday)

Building Envelope

The building is constructed of concrete block, and structural steel with a brick and stone facades. The building has mostly flat roofs. The windows are double pane.

Lighting System

Lighting at the facility is provided mostly by 4-foot, linear fluorescent fixtures with T8 lamps. Most of the fixtures have two (2) or four (4) lamps. Exit signs have all been modified to use LEDs.

Wall switches provide lighting control in most spaces. A few areas, primarily restrooms, have occupancy sensor controls.

Exterior lighting is provided by fixtures with LED, compact fluorescent, and high-pressure sodium lamps. The exterior fixtures are controlled by either photocells or timers.

Please see Appendix A: Equipment Inventory & Recommendations for an inventory of the facility's lighting equipment.

Chilled Water and Heating Water System

The campus has a single hybrid, natural gas-fired, 165-ton absorption chiller. The unit provides either heating water or chilled water for unit ventilators located throughout the campus. The system generally operates in heating mode from mid-October through mid-April and in cooling mode the rest of the year. Supply water is circulated by one (1) of two (2) 7.5 hp constant flow pumps. Heating water is supplied at 160°F and chilled water is supplied at 40°F. A cooling tower with a 15 hp fan and 15 hp circulation pump serves the chiller.

Ventilation Systems

The classrooms are conditioned by unit ventilators with constant speed supply fans and outside air dampers. The administration offices are conditioned by four pipe fan coils located above the ceiling. The gym and kitchen are conditioned by package units located on the roof. The package units have direct expansion cooling. The gym unit has a direct fired furnace and the kitchen unit has a hot water coil. The only ventilation systems that have variable flow supply fans are the kitchen package unit and the gym exhaust fans.

All of the ventilation equipment is controlled by the campus building management system.

Domestic Hot Water Heating System

Domestic hot water is supplied primarily by the hybrid absorption chiller and a heat exchanger. There is also a 100 gallon, natural gas-fired storage water heater that services the kitchen.

Oak Knoll Elementary School

Oak Knoll Elementary School is an 80,528 square foot facility comprised of various space types within a single building. The school building is two (2) stories and includes classrooms, offices, gymnasium, auditorium, cafeteria, kitchen, and basement storage space.
The building was originally constructed in 1927. There have been numerous renovations and additions since then with the most recent completed in 2010. The facility has replaced all of its existing T12 fluorescent fixtures with T8 fluorescent fixtures. A significant portion of the heating, ventilating, and air conditioning equipment has been replaced within the past ten years.

Building Occupancy

The school is open Monday through Friday and has very minimal weekend activity. The typical schedule is presented in the table below. School is in session from early September through the end of June. There are one (1) week breaks at the end of December and in the spring. During a typical day, the facility is occupied by approximately 77 staff and 560 students.

Occupants	Number	Hours
Students, Staff	560 & 77	8:30 am to 3:30 pm (Monday – Friday)

Lighting System

Lighting in this facility is provided primarily by fluorescent fixtures with 32-Watt fluorescent T8 lamps. Most of the fixtures are 4-foot long, surface mounted or recessed, and have two, three or four lamps. The building had a comprehensive T8 retrofit. The gymnasium has 4-foot fixtures with six (6) T5 lamps per fixture.

Wall switches provides lighting control in most spaces. Occupancy sensors control approximately 20% of the interior fixtures in the newer parts of the building.

Fixtures with high pressure sodium (HPS) or metal halide (MH) lamps, controlled by a combination of timeclocks and photocells, primarily provides the building's exterior lighting.

Please see Appendix A: Equipment Inventory & Recommendations for an inventory of the facility's lighting equipment.

Hot Water Heating System

The school has two (2) Patterson Kelly 987 kBtu/hr condensing boilers rated at 94% efficiency, which supplies hot water to air handlers in the gymnasium, auditorium, cafeteria, library, and a few fan coils in various locations. The boilers only operate during cold weather. The boilers are approximately eight (8) years old and in good condition.

Direct Expansion Air Conditioning System (DX)

The school has a mix of air source heat pumps and packaged air conditioners combined with electric resistance heaters. The heat pumps are used primarily to condition administrative and office spaces and range in capacity from 2.5 to 12 tons. There are over 40 combination package air conditioners and electric heaters serving primarily classrooms. The air conditioners are typically 4 tons and the electric heaters are either 11 or 18.35 kW.

Individual thermostats control the units.

Domestic Hot Water Heating System

Two (2) Bradford White 50 gallon, 9 kW electric water heaters provide domestic hot water for most of the campus. A Rheem 72 gallon, 75,100 Btu/hr gas water heater supplies hot water for the kitchen. Hot water is circulated from the water heaters using 1/12 hp pumps.

Radix Elementary School

Radix Elementary School is an 88,777 square foot facility comprised of various space types within a single building. The building is two (2) story and includes classrooms, offices, gymnasium, library, multipurpose room and kitchen.

The building was constructed in 1981. There have been renovations and additions since then. The facility has replaced all of its T12 fluorescent fixtures with T8 fluorescent fixtures.

Building Occupancy

The school is open Monday through Friday and has very minimal weekend activity. The typical schedule is presented in the table below. School is in session from early September through the end of June. There are one (1) week breaks at the end of December and in the spring. During a typical day, the facility is occupied by approximately 72 staff and 670 students.

Occupants	Number	Hours
Students, Staff	670 & 72	8:30 am to 3:30 pm (Monday – Friday)

Building Envelope

The building is constructed of concrete and structural steel with a brick facade. The building has a mix of pitched and flat roofs. Approximately 30% of the windows are double pane and the remainder are the original single pane.

Lighting System

Lighting is provided mostly by 4-foot, linear fluorescent fixtures with T8 lamps. Most of the fixtures have two (2) lamps. Exit signs have all been modified to use light emitting diodes (LEDs).

Lighting control in most spaces is provided by wall switches. Less than 10% of the fixtures are controlled by occupancy sensors.

Exterior lighting is provided by fixtures with compact fluorescent, LED, or metal halide lamps. The exterior fixtures are controlled by either photocells or timers.

Heating, Ventilating, and Air Conditioning System

There are 64 water-source heat pump units (WSHPs) located throughout the building that provide heating, cooling, and ventilation to most of the building. The WSHP range in capacity from 0.75 to 10 tons with most of the units in the 4 to 5 ton range. As needed, heat is added to the water loop by a 2,800,000 Btu/hr natural gas fired boiler or removed by a cooling tower with a 5 hp fan. The WSHPs are constant air volume units with supply fans from 0.5 to 2 hp. The WSHP have outside air dampers. There is a 7.5 hp variable speed pump that circulates water from the cooling tower to a flat plate heat exchanger. There are two (2) 5 hp constant speed pumps that circulate water from the heat exchanger to the WSHPs. There are also two (2) 7.5 hp constant speed hot water circulation pumps the supply water to preheat coils in the WSHP.

The gymnasium is conditioned by a 20 ton split system rooftop unit with a gas furnace. The kitchen is conditioned by a gas fired furnace. There are approximately 40 electrical resistance duct heaters to supplement the WSHP. The duct heaters are rated at 8 or 13 kW. There are also approximately 40 electric resistance heaters throughout the building ranging from 1.5 to 4.8 kW.

Most rooms have their own thermostat with a limited range of temperature settings. All of the HVAC equipment is controlled by a building management system (BMS). The BMS provides setback control from 11:00 PM to 5:00 AM.

Domestic Hot Water Heating System

The domestic hot water heating system for the facility consists of one (1) natural gas and four (4) electric water heaters. The natural gas heater is 97 gallons and the electric heaters 20 to 50 gallons.

Whitehall Elementary School

Whitehall Elementary School is a 57,017 square foot facility comprised of various space types within a single building. The building is single story and includes classrooms, offices, gym, library, and kitchen. The building was constructed in 1967. There have been renovations and additions since then with the most recent in 2007. The facility has replaced all of its T12 fluorescent fixtures with T8 fluorescent fixtures.

Building Occupancy

The school is open Monday through Friday and has very minimal weekend activity. The typical schedule is presented in the table below. School is in session from early September through the end of June. There are one (1) week breaks at the end of December and in the spring. During a typical day, the facility is occupied by approximately 49 staff and 400 students.

Occupants	Number	Hours
Students, Staff	400 & 49	8:30 am to 3:30 pm (Monday – Friday)

Building Envelope

The building is constructed of concrete block, and structural steel with a brick facade. The building has a mix of pitched and flat roofs.

Lighting System

Lighting at the facility is provided mostly by 4-foot, linear fluorescent fixtures with T8 lamps. Most of the fixtures have two lamps. Exit signs have all been modified to use light emitting diodes (LEDs).

Lighting in most spaces is manually controlled via wall switches. Approximately 10% of the fixtures are controlled by occupancy sensors. Occupancy sensors have mostly been installed in restrooms, some storage areas, and halls.

Exterior lighting is provided by fixtures with compact fluorescent or metal halide lamps. The exterior fixtures are controlled by either photocells or timers.

Please see Appendix A: Equipment Inventory & Recommendations for an inventory of the facility's lighting equipment.

Hot Water Heating System

The school has two (2) Smith 2,636 kBtu/hr boilers that supply hot water to the classroom unit ventilators and the stage air handlers.

Direct Expansion Air Conditioning System (DX)

The campus has a mix of split system air conditioners, window mounted air conditioners, and air source heat pumps. The window units generally have cooling capacities less than one ton and the remaining equipment ranges in capacity from 3 to 20 tons. Most of the units are used to condition the classrooms. The gymnasium, library, TV room, and several offices also have air conditioning.

Most of the units have stand-alone thermostat controls. The newest wing has a building management system (BMS) that controls the air conditioning units in that wing

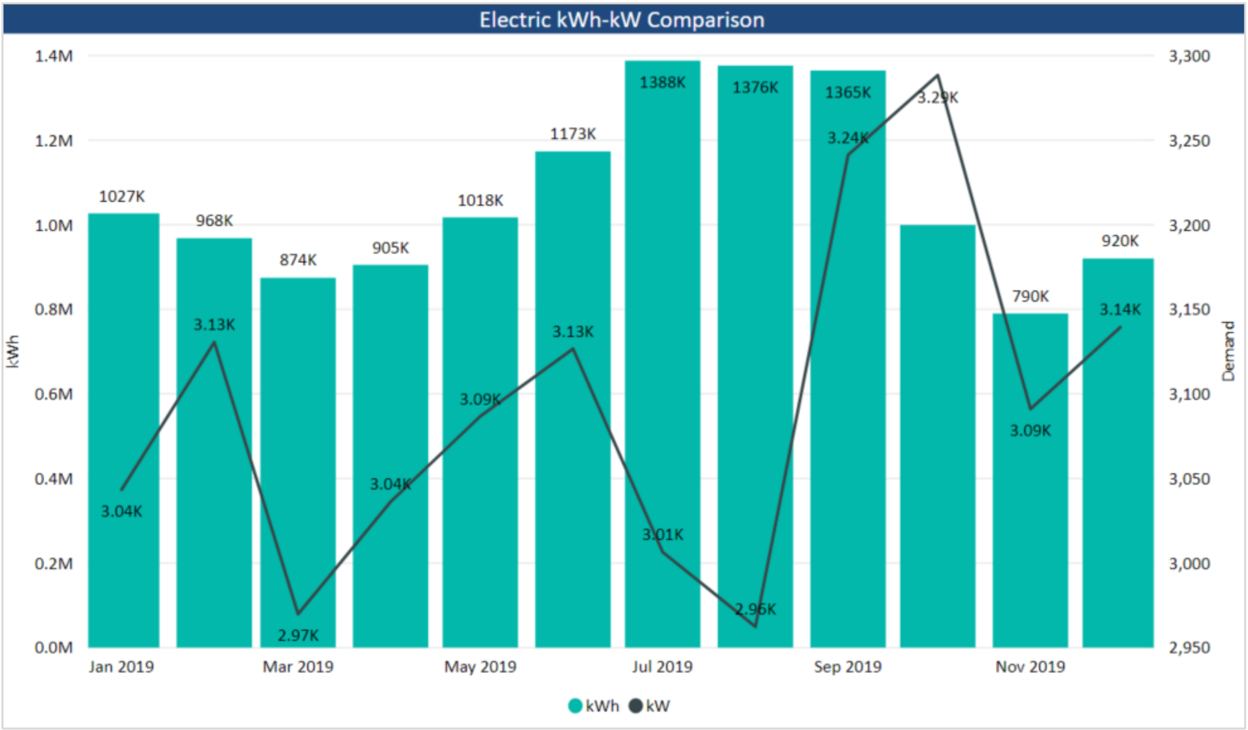
Domestic Hot Water Heating System

Domestic hot water for the school is provided by heat exchangers in the top of the Smith sectional heating hot water boilers and one (1) 40 gallon electric water heater located in a custodial closet.

Utility Baseline Analysis

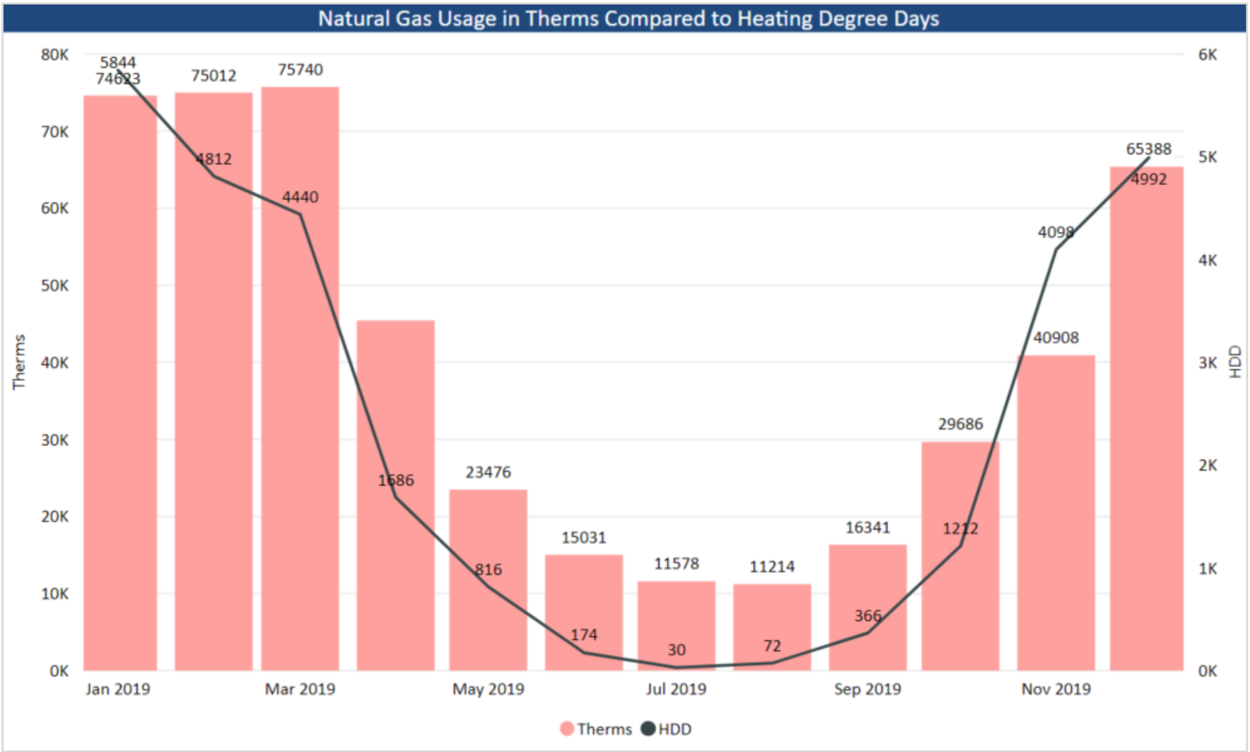
Electric Utility

Electrical energy is delivered to Monroe Township School District through Atlantic City Electric. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1000 watts running for one hour. One kW of electric demand is equivalent to 1000 watts running at any given time. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges. The Baseline period for Electric utility is January to December of 2019.



Natural Gas

Monroe Township School District acquires Natural Gas from South Jersey Gas and supplied by UGI Energy. The natural gas utility company measures consumption in CCF and converts the quantity into Therms, using the factor of 1.0370. The Baseline period for Natural Gas utility is January 2019 to December 2019.

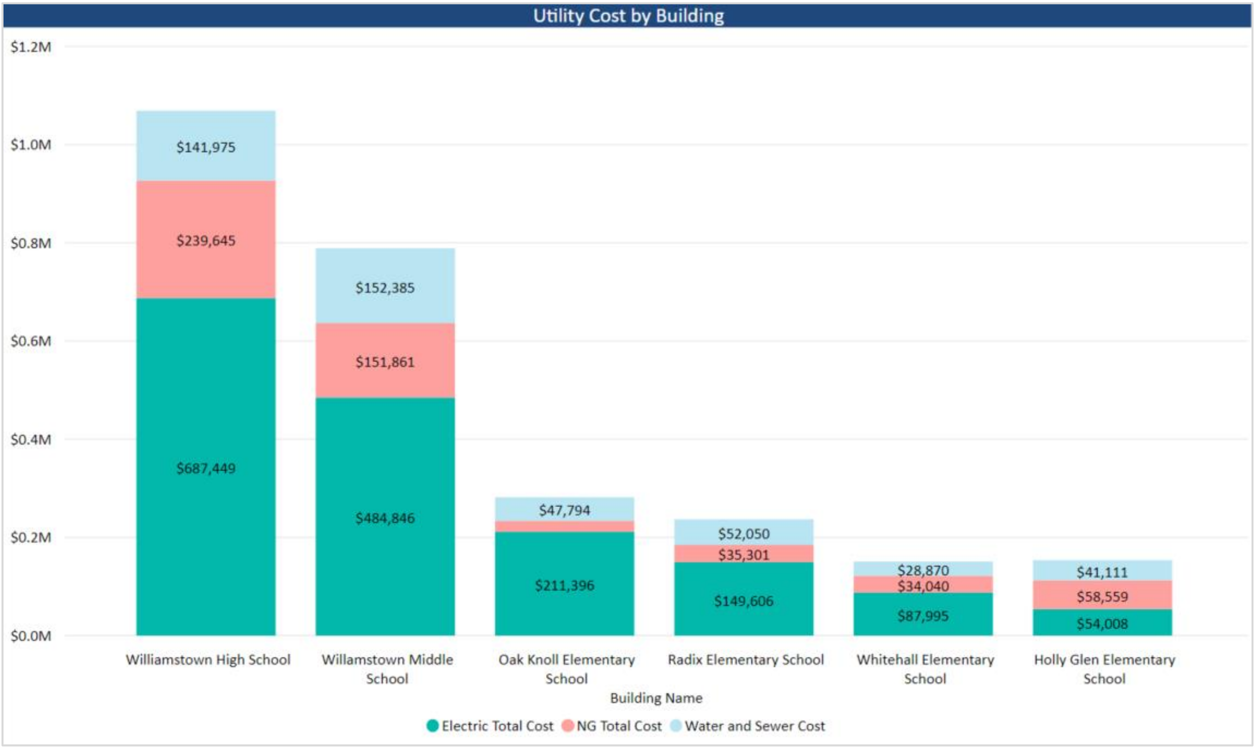


The following table shows the Schools' building names, addresses and utility account numbers considered for the baseline of this ESIP.

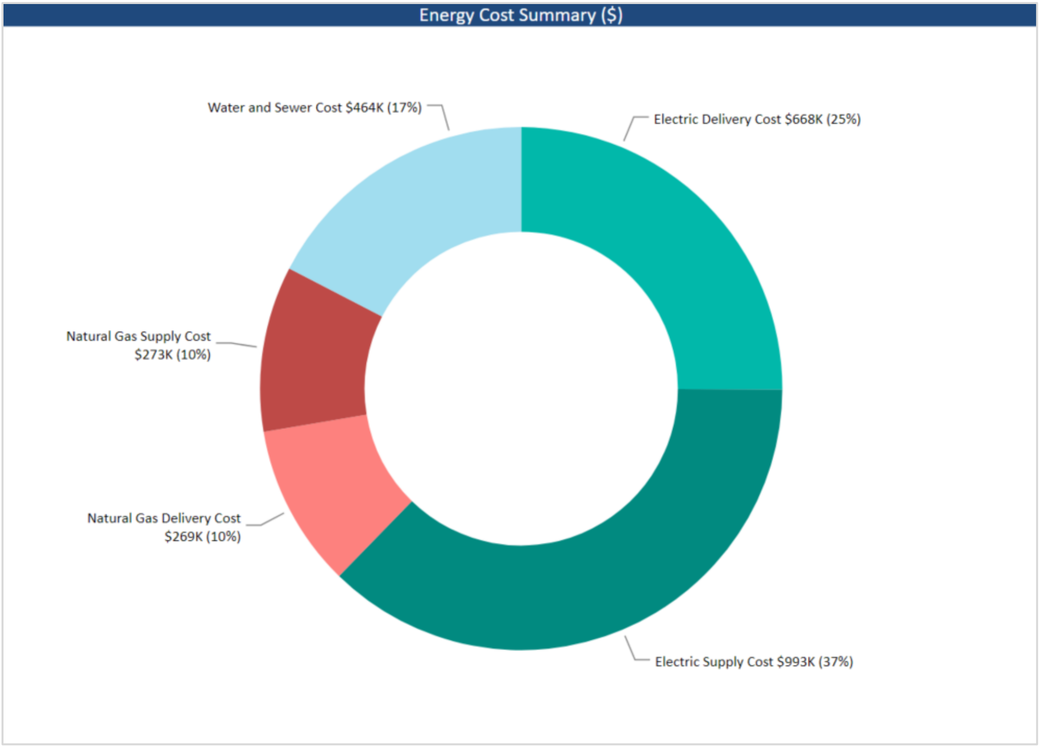
Building	ACE Electric Account No.	SJG Natural Gas Account No.	MUA Water & Sewer Account No.
Williamstown High School	5501105914	6625920000	217580
Williamstown Middle School	55003051533	1088820000	210710A
Williamstown MS Stadium Lighting	55001647613	6719820000	
Holly Glen Elementary School	55009968524	429720000	211600
Oak Knoll Elementary School	55012020917	8788820000	210750
Radix Elementary School	55000739916	428720000	211860
Whitehall Elementary School	55000106850	9198920000	217251

Energy Usage Summary

Based on JCI's utility analysis MTPS has a total spend of $2.68 million towards electric, natural gas and water and sewer utilities. The energy and utility spend breakdown is provided below.



Building Name	Electric Cost	Natural Gas Cost	Water and Sewer Cost
Williamstown High School	$687,449	$239,645	$141,975
Williamstown Middle School	$484,846	$151,861	$152,385
Williamstown MS Stadium Lighting	$95,247	$4,155	
Oak Knoll Elementary School	$211,396	$22,645	$47,794
Radix Elementary School	$149,606	$35,301	$52,050
Whitehall Elementary School	$87,995	$34,040	$28,870
Holly Glen Elementary School	$54,008	$58,559	$41,111
Total	$1,675,300	$542,051	$464,185



The Combined EUI for Electric and Thermal is shown below for each school. The EUI per school is higher compared to the national benchmark of 48.6 for the K-12 schools.

Combined EUI	EUI (KBTU/SQ-FT)
Williamstown High School	118.7
Williamstown Middle School	87.9
Holly Glen Elementary School	73.4
Oak Knoll Elementary School	92.6
Radix Elementary School	75.0
Whitehall Elementary School	79.2

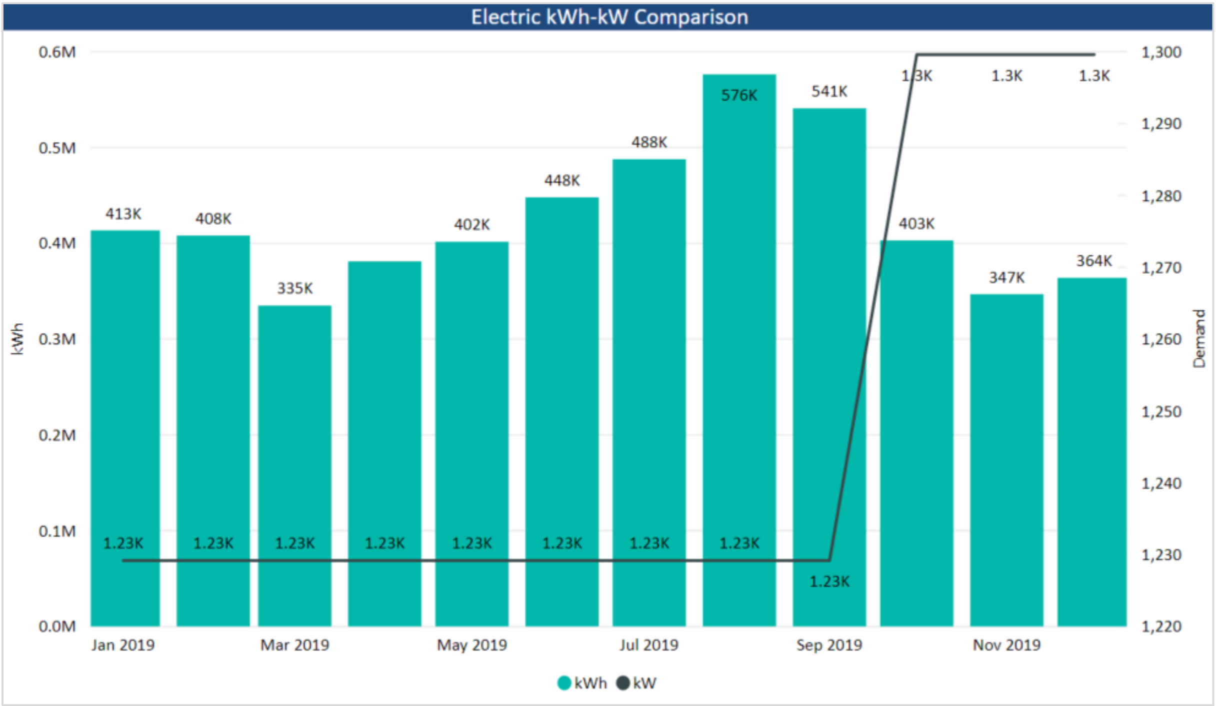
Marginal Rates

The utility rates identified below were used for purposes of calculating the dollar effect of the energy savings for the schools. These rates were determined based on data from tariff data and utility data.

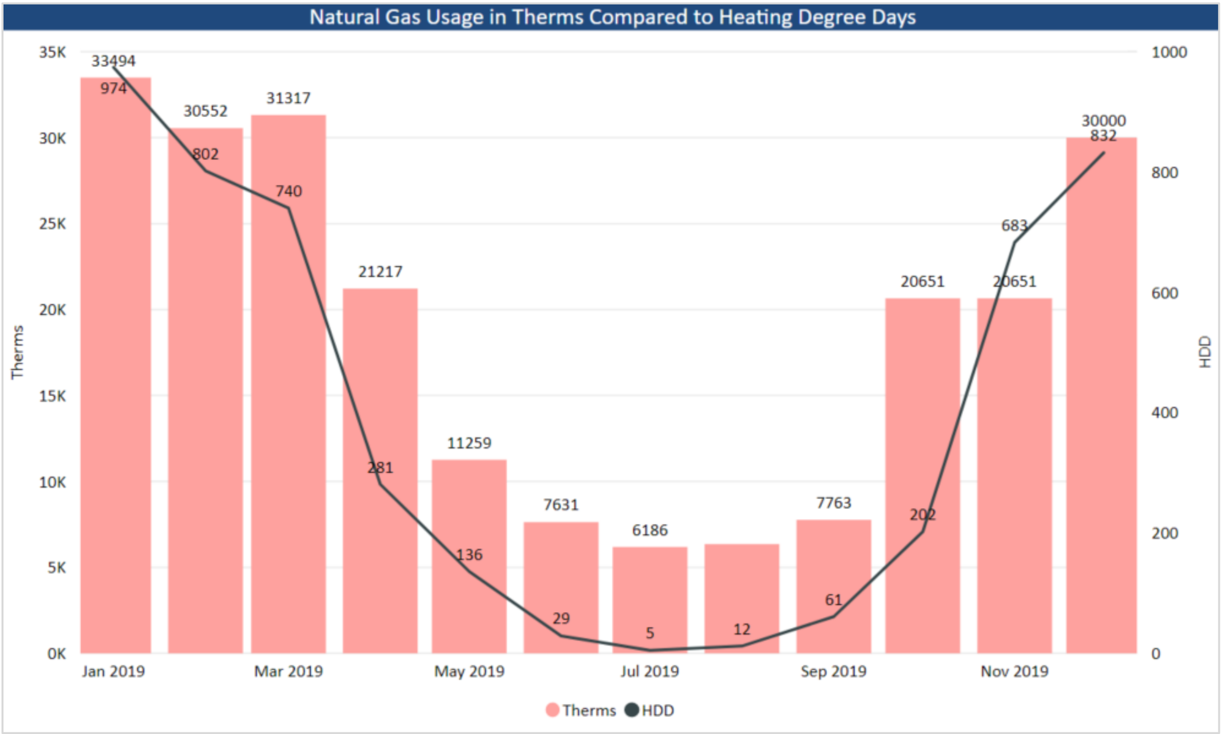
BUILDING	Utility Electric Rates		Natural Gas
	$/kWh	**$/kW**	**$/ THERM**
Williamstown High School	**$0.0987**	**$12.26**	**$1.05**
Williamstown Middle School	**$0.0984**	**$10.64**	**$1.04**
Holly Glen Elementary School	**$0.1033**	**$10.64**	**$1.32**
Oak Knoll Elementary School	**$0.0986**	**$10.47**	**$1.18**
Radix Elementary School	**$0.0988**	**$10.63**	**$1.31**
Whitehall Elementary School	**$0.1010**	**$10.66**	**$1.33**

Utility Breakdown by Building

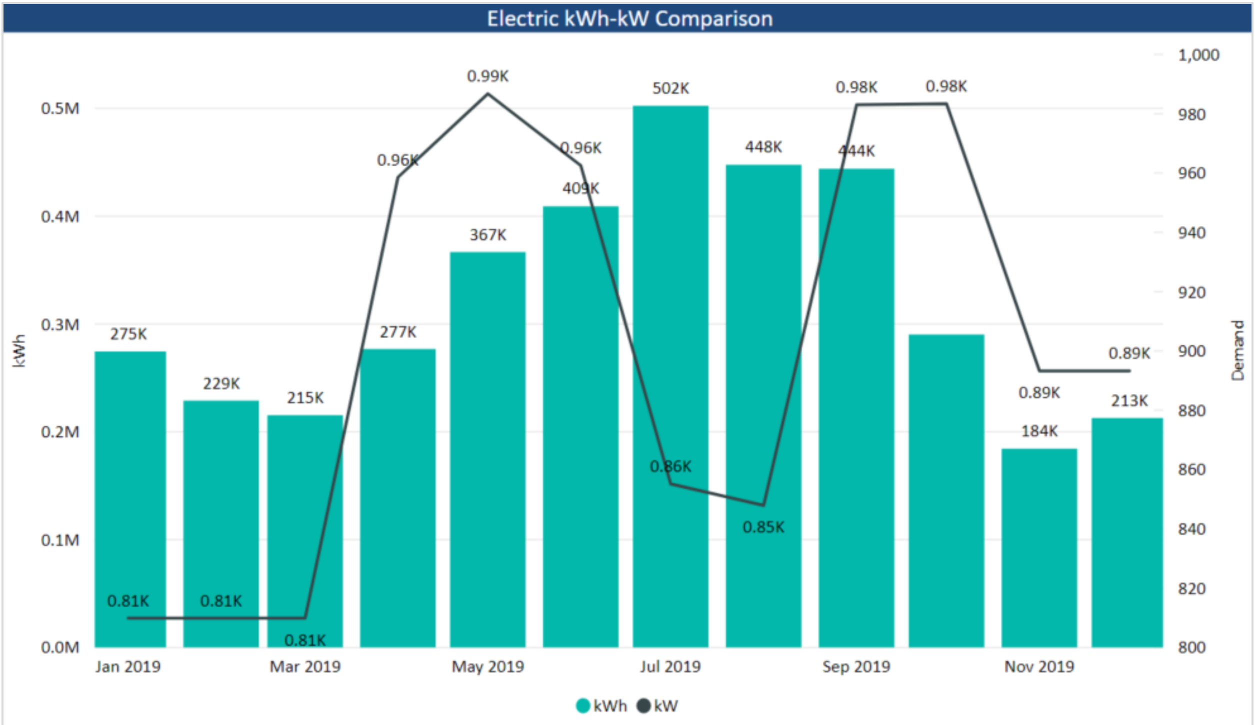
Williamstown High School

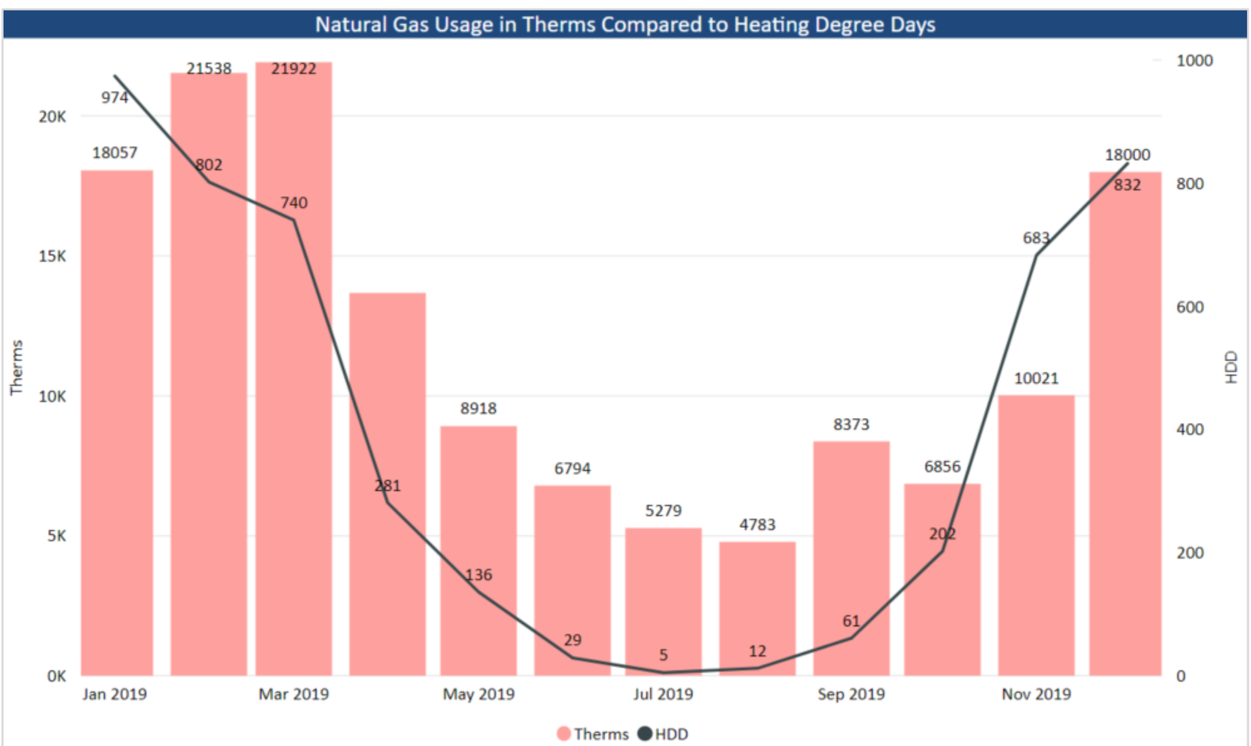


The above chart indicated billed kW usage for the year 2019.

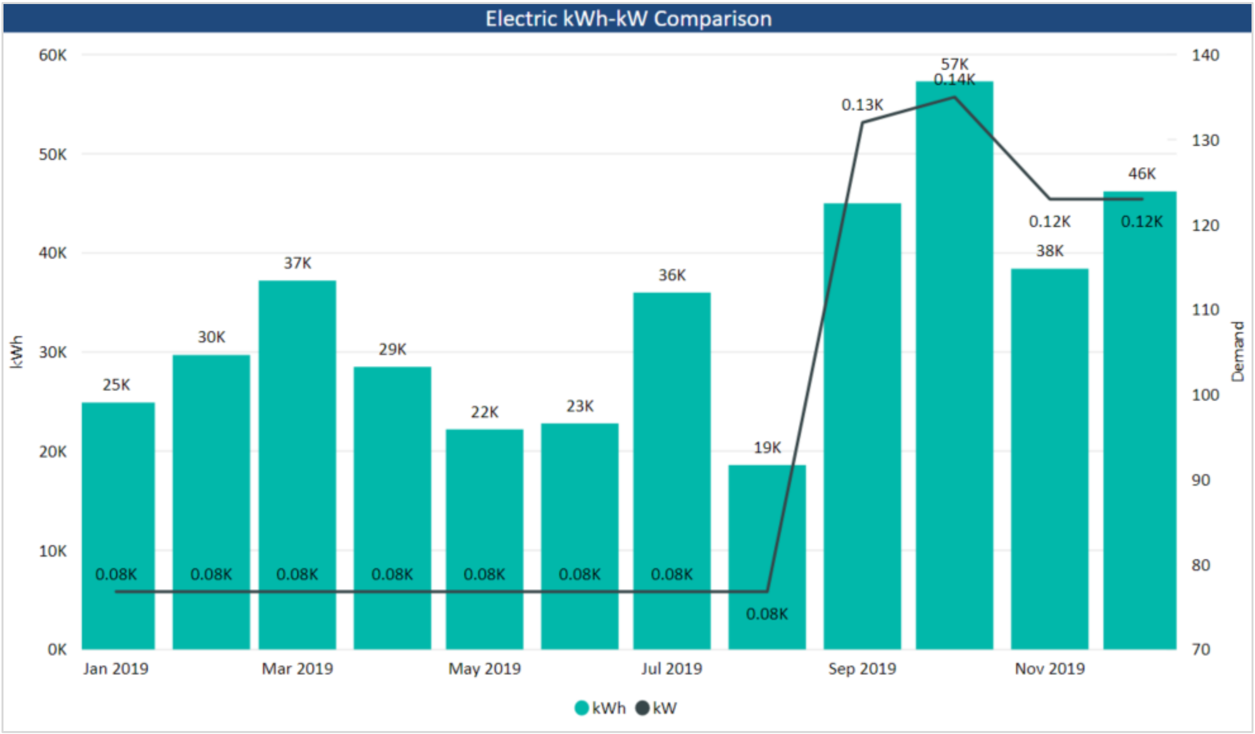


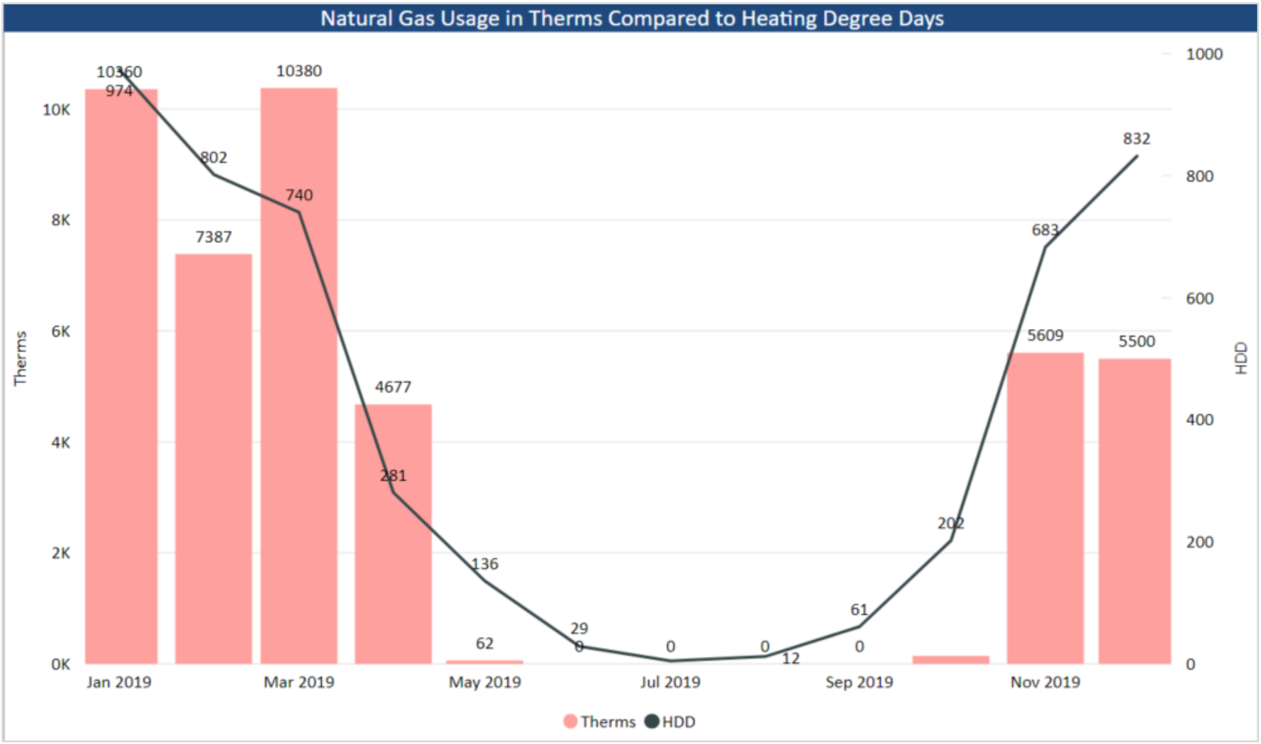
Williamstown Middle School



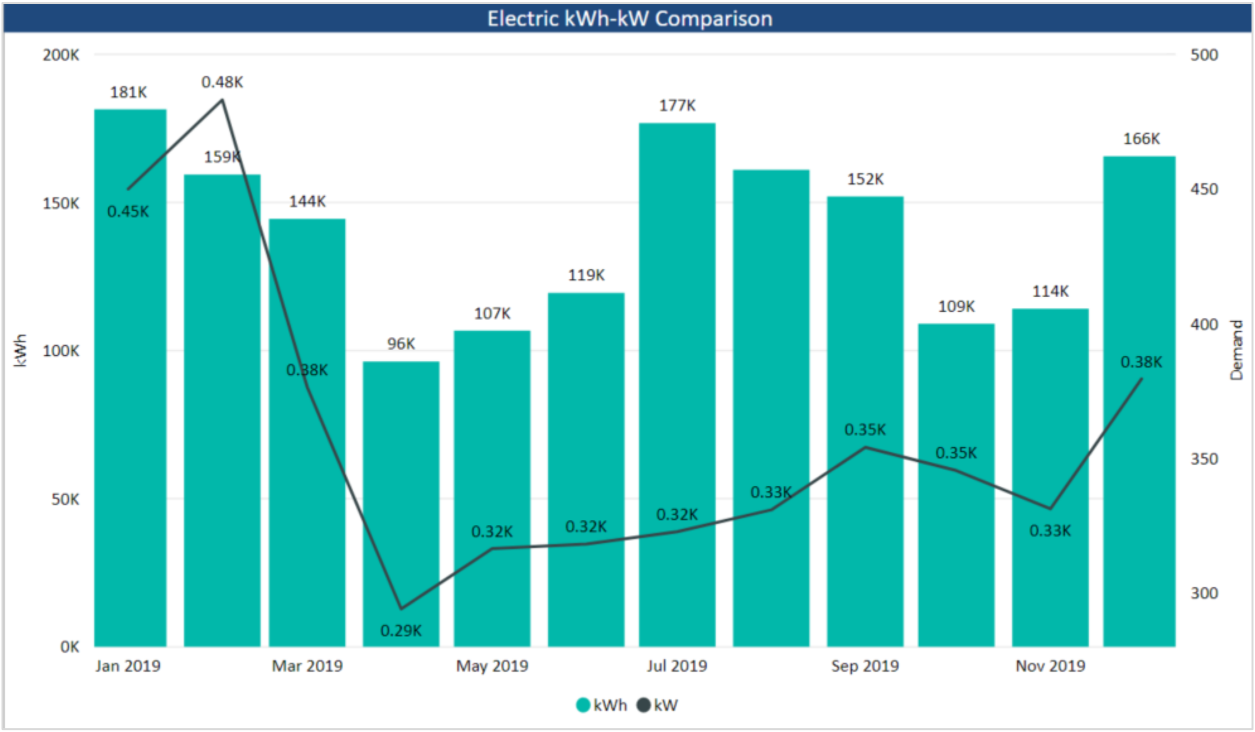


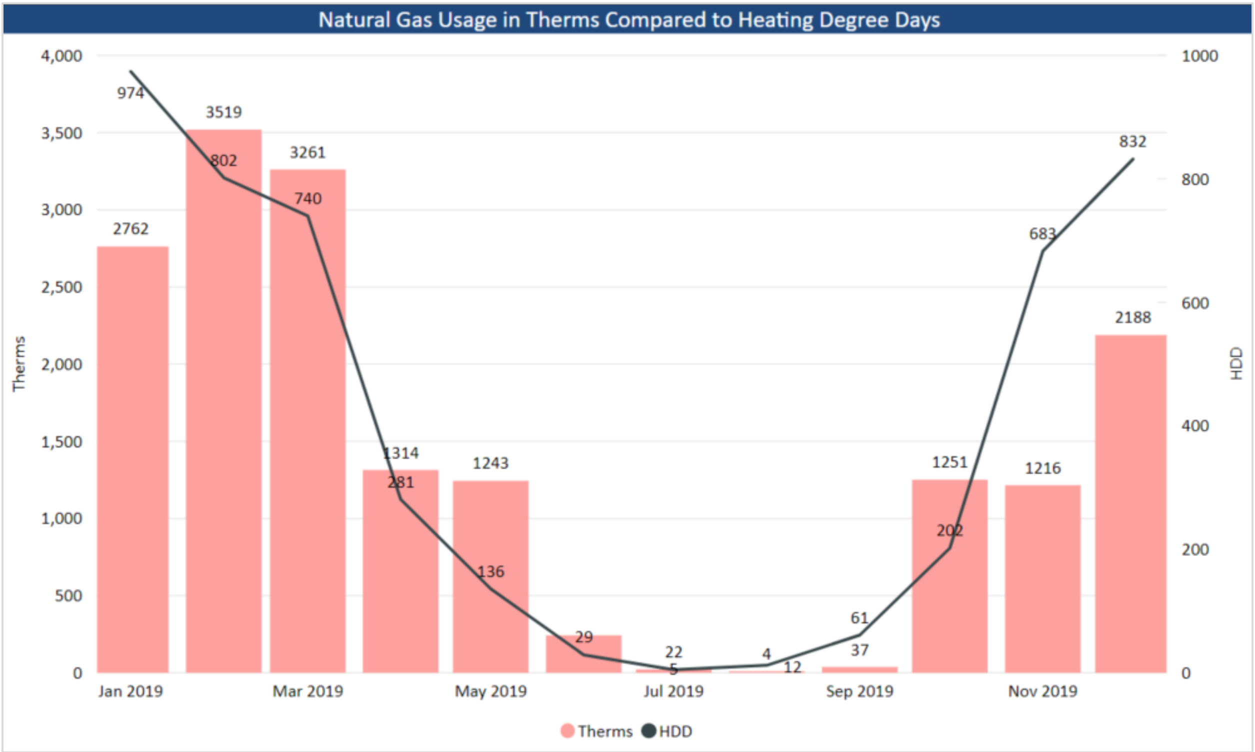
Holly Glen Elementary School



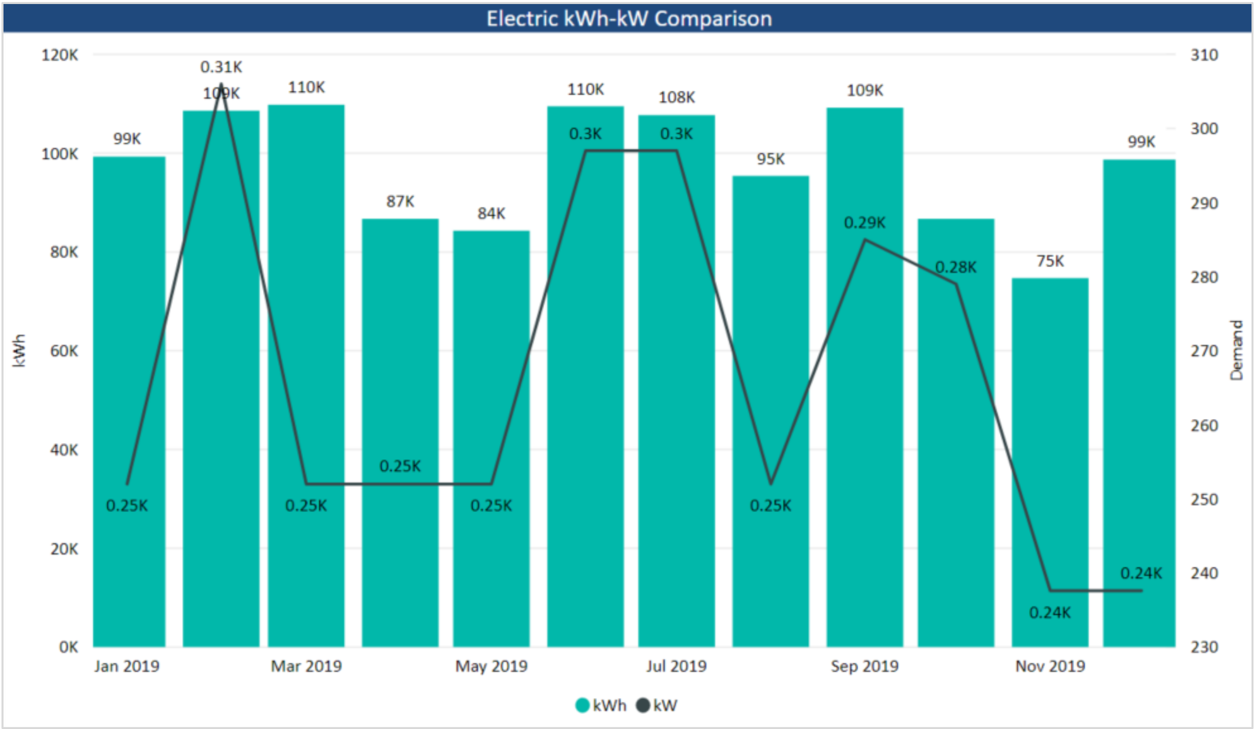


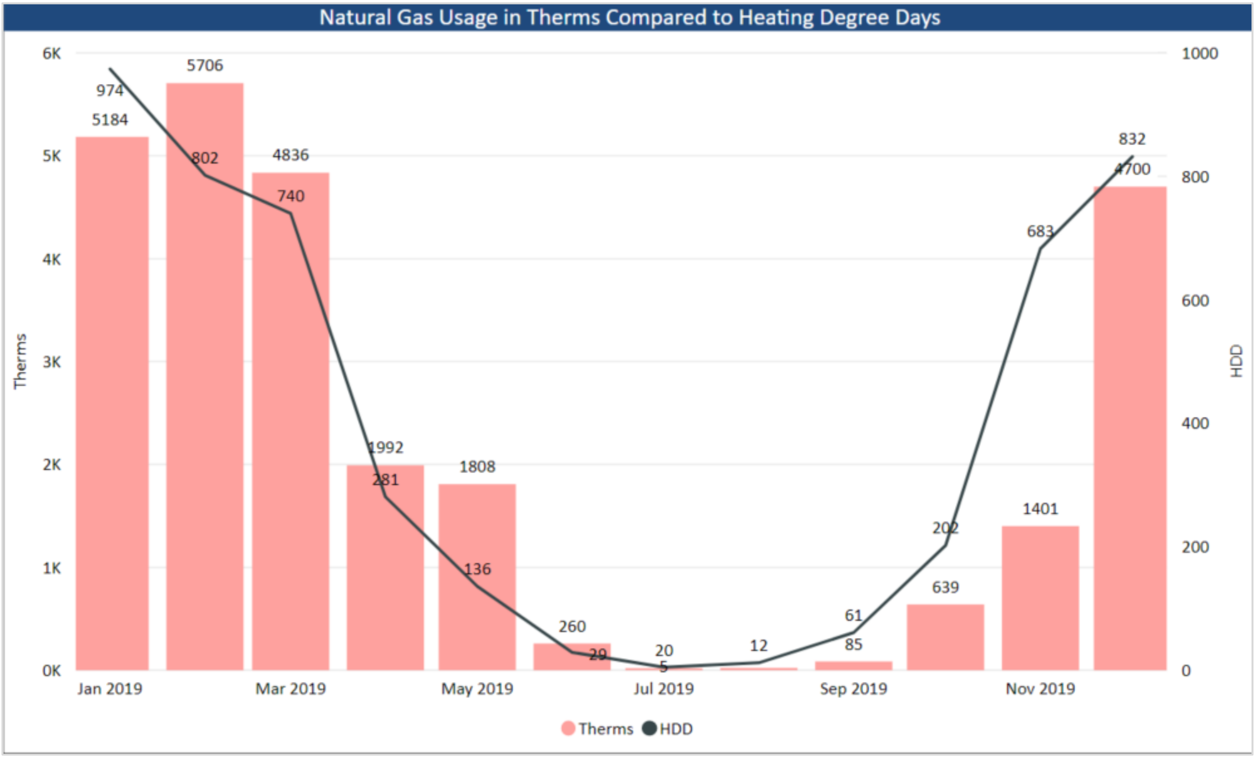
Oak Knoll Elementary School



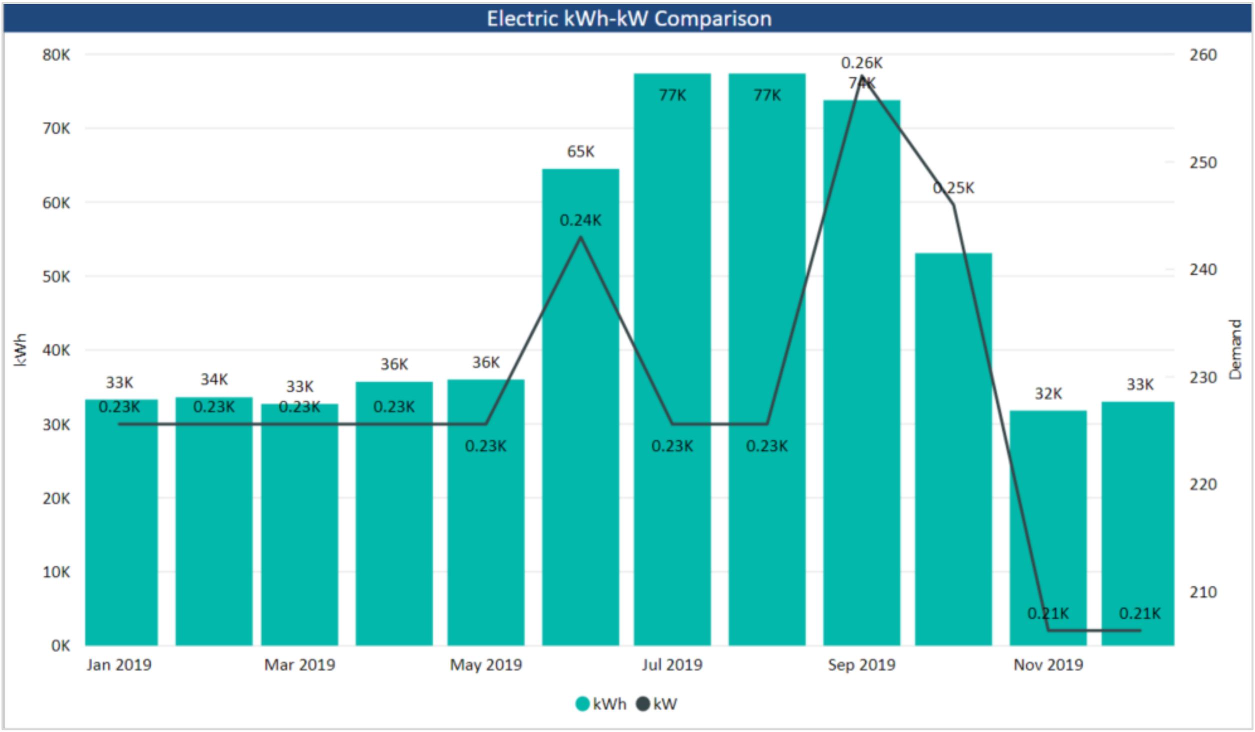


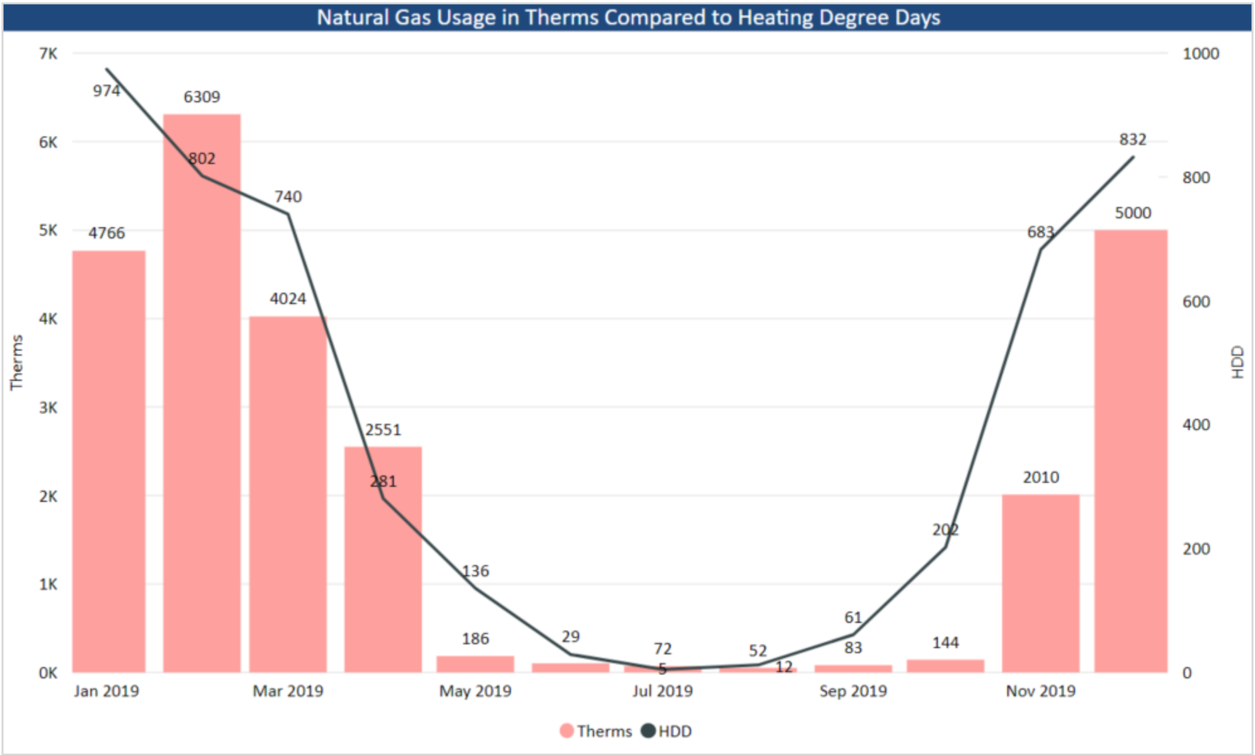
Radix Elementary School





Whitehall Elementary School





Johnson Controls

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.

Electric Consumption		Annual Electric Demand		Natural Gas		Water	
Escalation Rate	Start Year of Escalation	Escalation Rate	Start Year of Escalation	Escalation Rate	Start Year of Escalation	Escalation Rate	Start Year of Escalation
2.2%	Year 1	2.2%	Year 1	2.4%	Year 1	2.2%	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 ESP. 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.

ID #	Energy Conservation Measure	ECM Hard Cost	Year 1 Utility Savings*	Simple Payback
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - High School	$1,751,069	$114,964	15
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - Middle School	$1,212,756	$96,334	13
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior- DI - Holy Glen ES	$-	$22,786	
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior- W/Controls - Oak Knoll ES	$345,128	$22,022	16
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - Radix ES	$323,367	$27,146	12
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls- Whitehall ES	$188,706	$18,248	10
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - HS Auditorium	$146,699	$11,043	13
1 & 2	Lighting Redesign to Replace Pendant Fixtures at ES Classrooms	$455,000	$-	
3	Weather Stripping & Air Sealing - High School	$31,304	$4,874	6
3	Weather Stripping & Air Sealing - Middle School	$38,795	$5,973	6
3	Weather Stripping & Air Sealing - Oak Knoll ES	$12,429	$2,251	6
3	Weather Stripping & Air Sealing - Radix ES	$23,317	$4,655	5
3	Weather Stripping & Air Sealing - Whitehall ES	$11,376	$1,835	6
4	Building Controls Upgrade - High School	$1,563,500	$91,722	17
4	Building Controls Upgrade - Middle School	$1,356,500	$19,568	69
4	Building Controls Upgrade - Holy Glen ES	$367,737	$10,543	35
4	Building Controls Upgrade - Oak Knoll ES	$398,800	$9,931	40
4	Building Controls Upgrade - Radix ES	$380,812	$11,117	34
4	Building Controls Upgrade - Whitehall ES	$388,487	$12,067	32
5	HVAC System Replacement at Holly Glen Elementary School	$4,750,255	$2,866	1657
5	Demo Existing Absorption Chiller and Cooling Tower at Holly Glen ES	$64,000	$-	
6	Replace Existing H&V Units and Add Cooling to High School Gymnasium	$943,750	$(12,397)	
6	Replace Existing AHU Units and Add Cooling to Middle School Gymnasium	$482,500	$(4,380)	
7	Air Handling Unit Replacement at Oak Knoll Elementary School	$72,782	$179	407

ID #	Energy Conservation Measure	ECM Hard Cost	Year 1 Utility Savings*	Simple Payback
8	Ceramics and Welding Labs Ventilation Upgrades –High School	$213,000	$(1,784)	
9	Boiler Relocation and Domestic Hot Water Decoupling at Middle School	$276,624	$6,062	46
10	Boiler Replacement and Domestic Hot Water Decoupling at Whitehall Elementary School	$516,659	$5,789	89
11	Boiler Replacement at High School	$913,332	$25,977	35
11	Boiler Replacement at Radix Elementary School	$97,147	$4,590	21
12	Premium Efficiency Motors on HVAC Equipment - High School	$118,375	$3,401	35
12	Premium Efficiency Motors on HVAC Equipment- Middle School	$6,005	$142	42
12	Premium Efficiency Motors on HVAC Equipment - Radix ES	$17,495	$154	113
12	Premium Efficiency Motors on HVAC Equipment- Whitehall ES	$17,668	$175	101
13	Variable Speed Drives on Hot Water Pumps - High School	$65,129	$6,799	10
13	Variable Speed Drives on Hot Water Pumps - Middle School	$70,425	$5,825	12
14	Chiller Replacement at High School	$456,169	$15,471	29
15	Chiller Re-Configuration at Middle School	$504,294	$10,271	49
16	Variable Speed Drives on Chilled Water Pumps - High School	$90,188	$5,741	16
16	Variable Speed Drives on Chilled Water Pumps - Middle School	$100,982	$7,165	14
17	Domestic Water VFD Booster Skid at High School	$57,853	$1,594	36
18	Domestic Hot Water System Installation at Holly Glen ES	$52,725	$1,993	26
19	Roof Upgrades and Repairs at High School	$627,325	$253	2480
19	Roof Upgrades and Repairs at Middle School	$836,275	$269	3109
20	Solar PV- Power Purchase Agreement Savings	$-	$614,141	
21	Micro CHP - Whitehall ES	$80,000	$1,370	58
22	Kitchen Hood Controls - High School	$32,000	$1,666	19
22	Kitchen Hood Controls - Middle School	$31,000	$2,295	14
23	Transformer Replacement - High School	$175,297	$11,516	15
23	Transformer Replacement - Middle School	$99,752	$5,573	18
23	Transformer Replacement - Radix ES	$32,981	$1,630	20
24	P4P Rebate Modeling - High School	$22,000	$-	
24	P4P Rebate Modeling - Middle School	$22,000	$-	
25	Score Board Electrical Service	$45,000	$-	
26	Water and Sewer Rate Change	$-	$120,503	
	Total	**$ 20,886,770**	**$ 1,331,928**	**16**

***Year 1 Utility Savings in the above table include a 2.2% escalation on Electric, 2.4% escalation on Natural Gas and 2.2% escalation on Water and Sewer for guaranteed savings.**

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 lighting and will generate material cost savings.

A brief description of the operational savings estimated for this project is included below. Johnson Controls has worked with the School 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	Years to Carry
Retrofit LED Lighting Operational Savings	$44,310	5
Building Automation Controls Upgrade	$50,031	2
Boiler Replacement and DHW System Modification - Whitehall ES	$6,414	2
Boiler Replacement - Williamstown HS	$10,624	2
Chiller Replacement - Williamstown HS	$60,583	2
Chiller Re Configuration - Williamstown MS	$31,920	2
Premium Efficiency Motors Replacement	$1,862	2
Domestic Hot Water System Modification - Williamstown MS	$11,084	2
Total	**$216,828**	

Potential Revenue Generation Estimates

Rebates

As part of the ESP for the Monroe Township School District, several avenues for obtaining rebates and incentives have been investigated which include:

P4P Rebates

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 building with a whole-building technical component of a traditional energy audit, an energy model, a financial plan for funding the energy efficient measures, and a construction schedule for installation.

School	First Incentive	Second Incentive	Third Incentive
High School	$25,000	$435,190	$217,595
Middle School	$23,513	$263,693	$131,847

JCI is taking a conservative approach to the P4P rebates and carrying only 50% of third P4P rebate estimate in the financial model of this project.

SmartStart Incentives

New Jersey SmartStart Buildings is a statewide energy efficiency program available to qualified K-12 customers planning to construct, expand, renovate, or remodel a facility, or to replace electric or gas equipment. Incentives are available for prescriptive measures or for custom measures that are selected and incorporated into the project to help offset the added cost to purchase qualifying energy-efficient equipment.

Inventive Type	Estimated Amount
Retrofit LED Lighting Rebates*	$ 106,594
HVAC Upgrades at Holly Glenn ES	$16,130
Boiler Replacement at Whitehall ES	$8,510
Boiler Replacement at Radix ES	$3,750
Total	**$ 134,984**

* Holly Glen ES is not included

Demand Response Energy Efficiency Credit

The LED Lighting and facility upgrades will qualify the school will be eligible for the Energy Efficiency Credit and the Energy Efficiency Credit pays consumers based on the permanent load reduction through the installation of energy efficiency measures. The following Energy Efficiency Credits are estimated for the demand reduction from lighting upgrades.

Year	Estimated Amount
Year 1	$11,800
Year 2	$8,670
Year 3	$8,670
Year 4	$8,670
Total	**$ 37,810**

Johnson Controls does not guaranteed any rebates carried in this project.

Greenhouse Gas Reductions

Avoided Emissions	Total Electric Savings	Total Natural Savings	Total Annual Avoided Emissions
Annual Unit Savings	3876.9 MWh	94,383 Therms	
NOX, , lbs	3,218	868	4,086
SO2 , lbs	2,598		2,598
CO2 , lbs	5,008,954	1,104,281	6,113,235

Factors Used In Calculations:

- 1,292 lbs. CO_2 per MWh saved
- 0.83 lbs. NOx per MWh saved
- 0.67 lbs. SO_2 per MWh saved
- 11.7 lbs. CO_2 per therm saved

0.0092 lbs. NOx per therm saved

Baseline Utility Savings

ID#	Energy Conservation Measure	Electric Consumption		Annual Electric Demand		Natural Gas		Water and Sewer		Total Annual Utility
		Dollars	kWh	Dollars	kW	Dollars	Therms	Dollars	Units	Dollars
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - Williamstown HS	$84,783	840,375	$30,264	2,415	-$83	(819)			$114,964
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - Williamstown MS	$71,425	710,252	$24,973	2,297	-$64	(639)			$96,334
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior- DI - Holy Glen ES	$17,762	162,903	$5,038	463	-$14	(136)			$22,786
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior- W/Controls - Oak Knoll ES	$16,089	159,588	$5,948	556	-$15	(153)			$22,022
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - Radix ES	$21,533	213,359	$5,629	518	-$16	(158)			$27,146
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls- Whitehall ES	$13,625	132,018	$4,636	426	-$13	(126)			$18,248
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - HS Auditorium	$6,539	64,811	$4,512	360	-$8	(84)			$11,043
3	Weather Stripping & Air Sealing - Williamstown HS	$361	3,572			$4,513	4,200			$4,874
3	Weather Stripping & Air Sealing - Williamstown MS	$445	4,419			$5,529	5,190			$5,973
3	Weather Stripping & Air Sealing - Oak Knoll ES	$149	1,418			$2,102	1,740			$2,251
3	Weather Stripping & Air Sealing - Radix ES	$280	2,776			$4,375	3,260			$4,655
3	Weather Stripping & Air Sealing - Whitehall ES	$115	1,123			$1,719	1,260			$1,835
3	Water Conservation Rate Change Savings							$120,503		$120,503
4	Building Controls Upgrade - Williamstown HS	$62,045	615,000			$29,676	2,768			$91,722

ID#	Energy Conservation Measure	Electric Consumption		Annual Electric Demand		Natural Gas		Water and Sewer		Total Annual Utility
		Dollars	kWh	Dollars	kW	Dollars	Therms	Dollars	Units	Dollars
4	Building Controls Upgrade - Williamstown MS	$6,960	69,211			$12,609	11,840			$19,568
4	Building Controls Upgrade - Holy Glen ES	$7,581	71,820			$2,962	2,190			$10,543
4	Building Controls Upgrade - Oak Knoll ES	$7,198	71,394			$2,733	2,263			$9,931
4	Building Controls Upgrade - Radix ES	$6,412	63,539			$4,705	3,505			$11,117
4	Building Controls Upgrade - Whitehall ES	$7,450	72,184			$4,617	3,386			$12,067
5	HVAC System Replacement at Holly Glen Elementary School	-$15,839	(150,059)			$18,705	13,850			$2,866
6	Replace Existing H&V Units and Add Cooling to High School Gymnasium	-$12,397	(122,877)							-$12,397
6	Replace Existing AHU Units and Add Cooling to Middle School Gymnasium	-$4,380	(43,558)							-$4,380
7	Air Handling Unit Replacement at Oak Knoll Elementary School	$179	1,774							$179
8	Ceramics and Welding Labs Ventilation Upgrades - Middle School	-$162	1,604			-$1,622	(1,343)			-$1,784
9	Boiler Relocation and Domestic Hot Water Decoupling at Middle School					$6,062	5,690			$6,062
10	Boiler Replacement and Domestic Hot Water Decoupling at Whitehall Elementary School					$5,789	4,247			$5,789
11	Boiler Replacement at High School					$25,977	24,235			$25,977
11	Boiler Replacement at Radix Elementary School					$4,590	3,420			$4,590
12	Premium Efficiency Motors on HVAC Equipment - High School	$3,401	33,714							$3,401
12	Premium Efficiency Motors on HVAC Equipment- Middle School	$142	1,408							$142
12	Premium Efficiency Motors on HVAC Equipment - Radix ES	$154	1,524							$154

ID#	Energy Conservation Measure	Electric Consumption		Annual Electric Demand		Natural Gas		Water and Sewer		Total Annual Utility
		Dollars	kWh	Dollars	kW	Dollars	Therms	Dollars	Units	Dollars
12	Premium Efficiency Motors on HVAC Equipment- Whitehall ES	$175	1,694							$175
13	Variable Speed Drives on Hot Water Pumps - High School	$6,799	67,391							$6,799
13	Variable Speed Drives on Hot Water Pumps - Middle School	$5,825	57,931							$5,825
14	Chiller Replacement at High School	$15,471	153,355							$15,471
15	Chiller Re-Configuration at Middle School	$10,271	102,128							$10,271
16	Variable Speed Drives on Chilled Water Pumps - High School	$5,741	56,904							$5,741
16	Variable Speed Drives on Chilled Water Pumps - Middle School	$7,165	71,249							$7,165
17	Domestic Water VFD Booster Skid at High School	$1,594	15,804							$1,594
18	Domestic Hot Water System Installation at Holly Glen ES					$1,993	1,480			$1,993
19	Roof Upgrades and Repairs at High School	$7	72			$246	229			$253
19	Roof Upgrades and Repairs at Middle School	$7	66			$262	25			$269
20	Solar PV- Power Purchase Agreement Savings	$614,141								$614,141
21	Micro CHP - Whitehall ES	$4,235	41,040			-$2,865	(2,104)			$1,370
22	Kitchen Hood Controls - High School	$910	9,020			$756	705			$1,666
22	Kitchen Hood Controls - Middle School	$1,608	15,989			$687	645			$2,295
23	Transformer Replacement - High School	$11,516	114,169							$11,516
23	Transformer Replacement - Middle School	$5,573	55,421							$5,573
23	Transformer Replacement - Radix ES	$1,630	16,146							$1,630
Total		**$994,507**	**3,761,532**	**$81,001**	**7,035**	**$135,396**	**90,311**	**$120,503**		**$1,331,928**

Business Case for Recommended Project

FORM VI

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
MONROE TOWNSHIP BOARD OF EDUCATION
ENERGY SAVINGS IMPROVEMENT PROGRAM

ESCO NAME: **Johnson Controls**

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, 2.2% water and sewer per year**; and

1. Term of Agreement: **19 years (228 Months)**
2. Construction Period [2] (months): **18 months**
3. Cash Flow Analysis Format:

Project Cost [1]:	**$25,554,963**
Other Fee :	**$75,000**
Capital Contribution:	**$78,000**
Project Finance Amount:	**$25,551,963**

Interest Rate to Be Used for Proposal Purposes: 2.25%

Year	ESIP Utility Savings	Solar PPA Savings	Annual Energy Savings	Annual Operational Savings	Energy Rebates/ Incentives	Total Annual Savings	Annual Project Costs	Board Costs	Annual Service Costs [3]	ESIP Cash Flow	Cumulative Cash Flow
Installation	$433,343		$433,343	$0	$48,513	$481,857	$0	$0	$0	$0	$542,108
1	$731,007	$600,921	$1,331,928	$216,827	$841,917	$2,390,672	$2,870,221	$2,930,381	$60,160	$2,400	$2,400
2	$761,185	$614,497	$1,375,682	$216,827	$8,670	$1,601,180	$1,538,620	$1,598,780	$60,160	$2,400	$4,800
3	$792,659	$628,285	$1,420,944	$44,310	$366,782	$1,832,035	$1,769,475	$1,829,635	$60,160	$2,400	$7,200
4	$825,478	$642,289	$1,467,767	$44,310	$0	$1,512,077	$1,509,677	$1,509,677	$0	$2,400	$9,600
5	$859,696	$656,513	$1,516,209	$44,310	$0	$1,560,518	$1,558,118	$1,558,118	$0	$2,400	$12,000
6	$895,366	$670,960	$1,566,326	$0	$0	$1,566,326	$1,563,926	$1,563,926	$0	$2,400	$14,400
7	$932,546	$685,634	$1,618,180	$0	$0	$1,618,180	$1,615,780	$1,615,780	$0	$2,400	$16,800
8	$971,294	$700,539	$1,671,833	$0	$0	$1,671,833	$1,669,433	$1,669,433	$0	$2,400	$19,200
9	$1,011,671	$715,680	$1,727,350	$0	$0	$1,727,350	$1,724,950	$1,724,950	$0	$2,400	$21,600
10	$1,053,740	$731,059	$1,784,799	$0	$0	$1,784,799	$1,782,399	$1,782,399	$0	$2,400	$24,000
11	$1,097,567	$746,682	$1,844,250	$0	$0	$1,844,250	$1,841,850	$1,841,850	$0	$2,400	$26,400
12	$1,143,221	$762,553	$1,905,774	$0	$0	$1,905,774	$1,903,374	$1,903,374	$0	$2,400	$28,800
13	$1,190,773	$778,675	$1,969,447	$0	$0	$1,969,447	$1,967,047	$1,967,047	$0	$2,400	$31,200
14	$1,240,295	$795,053	$2,035,348	$0	$0	$2,035,348	$2,032,948	$2,032,948	$0	$2,400	$33,600
15	$1,291,865	$811,692	$2,103,557	$0	$0	$2,103,557	$2,101,157	$2,101,157	$0	$2,400	$36,000
16	$1,000,459		$1,000,459	$0	$0	$1,000,459	$998,059	$998,059	$0	$2,400	$38,400
17	$1,022,857		$1,022,857	$0	$0	$1,022,857	$1,020,457	$1,020,457	$0	$2,400	$40,800
18	$1,045,757		$1,045,757	$0	$0	$1,045,757	$1,043,357	$1,043,357	$0	$2,400	$43,200
19	$1,069,170		$1,069,170	$0	$0	$1,069,170	$1,048,784	$1,048,784	$0	$20,386	$63,586
Totals	**$19,369,949**	**$10,541,032**	**$29,971,233**	**$566,584**	**$1,265,882**	**$31,803,698**	**$31,559,632**	**$31,740,112**	**$180,480**	**$63,586**	

NOTES:

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

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

(3) This figure should equal the value indicated on the ESCOs PROPOSED "FORM V". DO NOT include in the Financed Project Costs

Section 4. Energy Conservation Measures

- Upgrade Interior and Exterior Lighting LED Retrofits with Pendent Fixture replacement in class rooms
- Lighting Occupancy Controls
- Building Envelope Improvements – Weatherization
- Building Automation System Upgrades
- HVAC System Replacement at Holly Glen Elementary School
- Replace Existing H&V/AHU Units and Add Cooling to High School and Middle School Gymnasiums
- Roof Top Units Replacement at Oak Knoll Elementary School
- Ceramic and Welding Lab Ventilation Upgrades
- Boiler Relocation and Domestic Hot Water Decoupling at Middle School
- Boiler Replacement and Domestic Hot Water Decoupling at Whitehall Elementary School
- Boiler Plant Reconfiguration and Domestic Hot Water System Decoupling at the Middle School
- Boiler Replacement at High School and Radix Elementary School
- Installation of Premium Efficiency Motors and Pumps
- Variable Speed Drives on Hot Water Pumps
- Chiller Replacements at High School
- Chiller Re-Configuration at Middle School
- Variable Speed Drives on Chilled Water Pumps
- Domestic Water VFD Booster Skid
- Domestic Water Heater System Holly Glenn Elementary School
- Capital Improvement Projects – Roof Replacement at High School and Middle School
- Micro Combined Heat and Power (CHP) at Whitehall Elementary School
- Kitchen Hood Controls at High School and Middle School
- Transformer Replacement
- Score Board Electrical

ECM #1: Upgrade Interior and Exterior Lighting LED Retrofits with Pendent Fixture Replacement in Elementary School Class Rooms
&
ECM #2: Lighting Occupancy Controls

ECM Summary

Since the advent of energy efficient T8 lighting (with electronic ballast), there have been several generations of improvements to interior lighting. Today, a 10.5-watt LED lamp offers an opportunity to lower energy consumption in areas lit by the standard 32 or 28-watt T8 lamp.

The large majority of lighting fixtures throughout Monroe Township Public Schools utilize 32-watt T8 lamps operating on electronic ballasts.

Light levels vary from school to school, and in some instances from classroom to classroom within a school. In general, light levels are typically within 10-15% of current IES and Department of Education recommendations and this is likely due the variation of fixture types, as well as the lamps that are at different stages of their life cycles. During the lighting survey, most of the lamps were found towards the lower end of the depreciation curve. There are also a small number of failed lamps in each building.

For exterior lighting, existing 70-watt and 100-watt wall-pack and 250 watt metal halide exterior fixtures installed in various locations in the School will be replaced with newer technology LED type fixtures. The newer technology fixtures have a much longer life and improved light quality throughout the entire life of the lamp than the existing lamps. This will provide energy savings as well as provide a safe environment around the exterior of the buildings. Any of the pole-mounted fixtures used by the School but owned and maintained by the electric utility company are not included in the project. A detailed room-by-room description of the existing and proposed fixture type, fixture count and lamp wattage are presented in the Appendix.

The standardization to LED lighting in most areas of the School will allow for reduced lighting operational expenses.

Lighting Controls

The majority of the project would consist of an RF point to point network lighting control system that uses a hub to link the fixtures together. This gives the ability to utilize three key components of the system to conserve energy and reduce costs. The occupancy sensor would shut the lights off in unoccupied areas and can be adjusted for time. The daylight harvesting part would take into account any natural light in the room and adjust the lights accordingly. The third component of the system and where the biggest energy savings opportunity exists would be in the ability to trim the system down based on exact light levels needed in that particular space. It would also allow you to adjust the light levels in each space to address special requirements or the wishes of the current occupant. This could be achieved in a few different ways from new fixtures to retrofit door kits to straight retrofitting of existing T8 tubes to LED tubes.

Scope of Work

Williamstown High School

Interior

- All two 2' biax lamps, two 2' T5's and two 4' T8 u-tubes as listed, will be replaced with new 2x2 18-watt volumetric retrofit kits with integrated controls.
- All two, three and four 4' F32 T8 lamps with normal powered electronic ballast, as listed, will replaced with new 2x4 30-watt volumetric retrofit kits with integrated controls.
- All 2x4 two and three lamp T5's, as listed, will be replaced with new 2x4 30-watt volumetric retrofit kits with integrated controls.
- All two 2' biax lamps, as listed, will be replaced with new lx4 one lamp T8 prism fixtures.
- All 250 and 400-watt metal halide high bays, as listed, will be replaced with new 100- watt LED UFO high bays.
- All 13-watt compact fluorescent screw-ins, as listed will be re-lamped with new 9-watt LED A-lamp screw-ins.
- All one 2' F17 T8 lamps with normal powered electronic ballast, as listed will be retrofitted with new one 2' LED self-ballasted tubes.
- All one 3' F25 T8 lamps with normal powered electronic ballast, as listed, will be retrofitted with new one 3' Led self-ballasted tubes.
- All one and two 4' T8 lamps with normal powered electronic ballast, as listed, will be retrofitted with new one and two 4' LED self-ballasted tubes.
- All (2)13-watt compact fluorescent hardwired fixtures, as listed, will be retrofitted with new 12-watt LED high hats.
- All 250-watt metal halide wall packs, as listed, will be replaced with new 55-watt LED wall packs.
- As listed, sensors will be added for additional savings.
- As listed, emergency ballast throughout the building.

Exterior

- All 100-watt metal halide wall packs, as listed, will be replaced with new 19-watt LED wall packs.
- All 17S-watt high pressure sodium cobra heads, as listed, will be replaced with new 80- watt LED cobra heads.
- All 400-watt metal halide floods, as listed, will be replaced with new 100-watt LED floods with adjustable arms.
- All 400-watt metal halide shoebox fixtures, as listed, will be replaced with new 140- watt LED shoebox fixtures with arms.

High School Auditorium

- All 70- and 100-watt metal halide wall packs, as listed, will be replaced with new 19- watt LED wall packs.
- All 500-watt incandescent quartz, as listed, will be retrofitted with new 49-watt LED high-hats.
- All two 4' F32 T8 lamps with normal powered electronic ballast, as listed, will be retrofitted with new two 4' LED self-ballasted tubes.

- All two and three 4' F32 T8 lamps with normal powered electronic ballast, as listed, will replaced with new 2x4 30-watt volumetric retrofit kits with integrated controls.

Williamstown Middle School

Interior

- All two and three 2' biax lamps, as listed, will be replace with new 2x2 volumetric retrofit kits.
- All 2SO-watt metal halide high bays, as listed, will be replaced with new 2x2 LED 69-watt high output troffers.
- All 13-watt compact fluorescent screw-ins and 60-watt incandescent bulbs, as listed, will be re-lamped with new 9-watt A-lamp LED screw-ins.
- All 2SO-watt metal halide deco fixtures, as listed, will be re-lamped with new SO- watt LED com style screw-ins.
- All two and three 2' biax lamps and two 4' T8 u-tubes as listed, will be replaced with new 2x2 18-watt volumetric retrofit kits with integrated controls.
- All two, three and four 4' F32 T8 lamps with normal powered electronic ballast, as listed, will replaced with new 2x4 30-watt volumetric retrofit kits with integrated controls.
- All 2x4 two lamp T5's, as listed, will be replaced with new 2x4 30-watt volumetric retrofit kits with integrated controls.
- All one 3' F30 T12 lamps with standard magnetic ballast, as listed, will be retrofitted with new one 3' LED self-ballasted tubes.
- All one, two, four and six 4' F32 T8 lamps with normal powered electronic ballast, as listed, will be retrofitted with new one, two, four and six 4' LED self - ballasted tubes.
- All 2x4 two and six lamp TS's, as listed, will be retrofitted with new two and six 4' TS high output LED self-ballasted tubes.
- All (2) 13-watt compact fluorescent hard-wired fixtures, as listed, will be retrofitted with new 12-watt LED high hats.
- All two 8' F96 T12 lamps with energy efficient standard magnetic ballast, as listed will be retrofitted with new four 4' LED strip kits.
- As listed, sensors will be added for additional savings.
- As listed, emergency ballast throughout the building.

Exterior

- All 70 and 100-watt metal halide and high-pressure sodium wall packs, as listed, will be replaced with new 19-watt LED wall packs.
- All 400-watt metal halide floods, as listed, will be replaced with new 100-watt LED floods with adjustable arms.
- All 50-watt metal halide canopy fixtures, as listed, will be replaced with new 21-watt LED canopies.

Whitehall Elementary School

Interior

- All (2) 20-watt incandescent exit signs, as listed, will be replaced with new 2-watt LED battery backup exit signs.
- All 13-watt compact fluorescent screw-ins, as listed, will be re-lamped with new 9- watt A-lamp LED screw-ins.
- All two 2' F17 T8 lamps and two 4' F32 T8 u-tubes with normal powered electronic ballast, as listed, replaced with new 2x2 18-watt volumetric retrofit kits with integrated controls.
- All one, two, three and four 4' F32 T8 lamps with normal powered electronic ballast, as listed, will replaced with new 2x4 30-watt volumetric retrofit kits with integrated controls.
- All 2x4 six lamp TS's, as listed, will be replaced with new 2x4 30-watt volumetric retrofit kits with integrated controls.
- All two 3' T8 lamps with normal powered electronic ballast, as listed, will be retrofitted with new two 3' LED self-ballasted tubes.
- All one, two and four 4' F32 T8 lamps with normal powered electronic ballast, as listed, will be replaced with new one, two and four 4' LED self-ballasted tubes.
- All 2x4 two and six lamp T5's, as listed, will be retrofitted with new two and six 4' T5 high output LED self-ballasted tubes.

Exterior

- All 50-watt metal halide high hats, as listed, will be retrofitted with new 12-watt LED high hats.
- All (2) 23-watt compact fluorescent hard wired wall packs and 100-watt metal halide wall packs, as listed, will be replaced with new 19-watt LED wall packs.
- All 400-watt metal halide floods, as listed, will be replaced with new 100-watt LED floods with adjustable arms.
- All 400-watt metal halide shoebox fixtures, as listed, will be replaced with new 140-watt LED shoebox fixtures with arms.

Radix Elementary School

Interior

- All 13-watt compact fluorescent screw-ins and 60-watt incandescent bulbs, as listed, will be re-lamped with new 9-watt A-lamp LED screw-ins.
- All 75-watt incandescent floods and 300-watt incandescent screw-ins, as listed, will be re-lamped with new 9-watt A-lamp LED screw-ins.
- All two 2' F17 T8 lamps and two 4' F32 T8 u-tubes with normal powered electronic ballast, as listed, replaced with new 2x2 18-watt volumetric retrofit kits with integrated controls.
- All one, two, three and four 4' F32 T8 lamps with normal powered electronic ballast, as listed, will replaced with new 2x4 30-watt volumetric retrofit kits with integrated controls.
- All 2x4 two and six lamp T5's, as listed, will be retrofitted with new two and six 4' T5 high output LED self-ballasted tubes.
- All two 2' F17 T8 lamps with normal powered electronic ballast, as listed, will be retrofitted with new two 2' LED self-ballasted tubes.

- All one, two, and four 4' F32 T8 lamps with normal powered electronic ballast, as listed, will be retrofitted with new one, two, and four 4' LED self-ballasted tubes.
- All (2) 13-watt compact fluorescent hard-wired fixtures, as listed, will be retrofitted with new 12-watt LED high hats.
- As listed, sensors will be added for additional savings.

Exterior

- All 50-watt metal halide canopies, as listed, will be replaced with new 21-watt LED canopies.
- All 100-watt and 250-watt metal halide wall packs, as listed, will be replaced with new 19-watt LED wall packs.

Oak Knoll Elementary School

Interior

- All two 2' F17 T8 lamps and two 4' F32 T8 u-tubes with normal powered electronic ballast, as listed, replaced with new 2x2 18-watt volumetric retrofit kits with integrated controls.
- All two, three and four 4' F32 T8 lamps with normal powered electronic ballast, as listed, will replaced with new 2x4 30-watt volumetric retrofit kits with integrated controls.
- All 2x4 three T5 lamps, as listed, will be replaced with new 2x4 30-watt volumetric retrofit kits with integrated controls.
- All 13-watt compact fluorescent screw-ins, as listed, will be re-lamped with new 9- watt A-lamp LED screw-ins.
- All 200-watt incandescent lamps, as listed, will be re-lamped with new 50-watt LED com style screw-ins.
- All two and four 2' F17 T8 lamps with normal powered electronic ballast, as listed, will be retrofitted with new two and four 2' LED self-ballasted tubes.
- All two 4' F32 T8 u-tubes with normal powered electronic ballast, as listed, will be retrofitted with new two lamp self-ballasted LED u-tubes.
- All two 3' F25 T8 lamps with normal powered electronic ballast, as listed, will be retrofitted with new two 3' LED self-ballasted tubes.
- All one and two 4' F32 TS lamps with normal powered electronic ballast, as listed, will be retrofitted with new one and two 4' LED self-ballasted tubes.
- All 2x4 two and six lamp T5's, as listed, will be retrofitted with new two and six 4' T5 high output LED self-ballasted tubes.
- As listed, sensors will be added for additional savings.

Exterior

- All 50-watt metal halide high hats, as listed, will be retrofitted with new 12-watt LED high hats.
- All 100-watt high pressure sodium and metal halide wall packs, as listed, will be replaced with new 19-watt LED wall packs.
- All 250-watt metal halide floods, as listed, will be replaced with new 100-watt LED floods with adjustable arms.
- All 400-watt high pressure sodium shoebox fixtures, as listed, will be replaced with new 140-watt LED shoebox fixtures with arms.

Proposed LED lamps

Proposed Exterior Fixtures

Proposed LED High Bays

Proposed Troffers & LED Kits

Proposed ULB – TLED (direct wire)

Savings Methodology

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

Demand (kW)

$$Connected\ kW\ Savings = \sum_u [\ (kW/Fixture_{baseline} \times Quantity_{baseline} - kW/Fixture_{post} \times Quantity_{post})]_{t,u}$$

where:

$kW/fixture_{baseline}$ = lighting baseline demand per fixture for usage group *u*

$kW/fixture_{post}$ = lighting demand per fixture during post-installation period for usage group

$Quantity_{baseline}$ = quantity of affected fixtures before the lighting retrofit for usage group *u*

$Quantity_{post}$ = quantity of affected fixtures after the lighting retrofit for usage group *u*

Energy (kWh)

$$kWh\ Savings_{Lighting} = \sum_u [\ Connected\ kW\ Savings_u \times Hours\ of\ Operation]_{t,u}$$

$$kWh\ Savings_{Lighting\ controls} = \sum_u [kW/Fixture_{post} \times Quantity_{post} \times (Hours\ of\ Operation_{pre} - House\ of\ Operation_{post}]_{t,u}$$

where:

Connected kW Savings= total connected fixture demand reduction for usage group *u*

Hours of Operation = number of operating hours during the time period *t* for the usage group *u*

Hours of operation and watt readings of existing lamp/ballast combinations will be taken before and after installation.

Benefits

- Electrical energy savings
- Improved exterior light quality
- Reduction in maintenance of exterior lighting system
- Improved safety around school perimeter
- 10 year warranty by lamp manufacturer
- Reduced lamp replacement for 10 to 15 years for LEDs

ECM #3: 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. A detailed building envelope survey was conducted throughout the Schools as part of the Comprehensive Maintenance Plan (CMP). The main observations are listed below among other recommend modifications:

- Most entrance doors need weather stripping, sweeps or the closure or strike plate adjusted;
- 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.

Findings and Observations:

- Caulking – there are gaps between the door frame and the door jamb. These gaps allow direct infiltration/ exfiltration; clear daylight is showing at select joints of both buildings which is a clear indicator of air leakage.
- 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 of the buildings throughout the schools.
- 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 throughout the schools lead to excessive air leakage and heat loss at these vulnerable areas in the building envelope.
- Roof-Wall Intersection Air Sealing – the roof-wall intersection is regularly an area that allows unwanted air leakage through the building shell. The roof-wall intersection is the largest area of unwanted air losses throughout the schools. Exterior flashing and finish details at this area are not constructed to stop air leakage (exterior flashings are for water control, not air control); unsealed exterior flashing details combine with interior gaps in the framing between the roof and wall assembly to allow infiltration/ exfiltration.
- Wall Air Sealing/ Insulation – a wall assembly that does not have an effective air barrier in place allows unnecessary air leakage losses. Areas of poorly insulated and sealed wall assemblies create bypasses for air leakage and heat loss that force the heating and cooling systems to work harder than necessary.

Scope of Work

The results of the CMP audit were used to identify several areas of envelope deficiency. The estimated deficient areas were tabulated and their savings potential calculated. A final verification audit will be conducted before proceeding to implementation of this measure.

Williamstown High School

Quantity	***Envelope Improvements***
0.05	Sq/ft - Penetrations sealed with polyurethane sealant
100	LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant
69	Sets of weather-strip DF
69	Door sweeps
33	Astragals (weather-strip for center of double door)

Williamstown Middle School

Quantity	***Envelope Improvements***
0.05	Sq/ft - Penetrations sealed with polyurethane sealant
100	LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant
86	Sets of weather-strip DF
86	Door sweeps
42	Astragals (weather-strip for center of double door)

Whitehall Elementary School

Quantity	***Envelope Improvements***
0.05	Sq/ft - Penetrations sealed with polyurethane sealant
100	LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant
25	Sets of weather-strip DF
25	Door sweeps
8	Astragals (weather-strip for center of double door)

Radix Elementary School

Quantity	***Envelope Improvements***
0.05	Sq/ft - Penetrations sealed with polyurethane sealant
100	LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant
53	Sets of weather-strip DF
53	Door sweeps
20	Astragals (weather-strip for center of double door)

Oak Knoll Elementary School

Quantity	Envelope Improvements
0.05	Sq/ft - Penetrations sealed with polyurethane sealant
100	LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant
27	Sets of weather-strip DF
27	Door sweeps
11	Astragals (weather-strip for center of double door)

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 setpoint
- Average seasonal ambient temperatures

Savings due to infiltration reduction:

The following equation is based on the ASHRAE crack method:

CFM = (Area (sq.in.) x ((Stack Coeff. x Avg. Temp. Diff) + (Wind Coeff. x Wind Speed^2))$^{1/2}$)x Correction Factor
Average Temperature differential is calculated by taking the average of the occupied and unoccupied setpoints
Sensible Heat Gain
Heating: Q (Btu/hr): Qsens = 1.08 x CFM x delta T x Bin Hours x 1/Boiler Eff
Cooling: Q (Btu/hr): Qsens = 1.08 x CFM x delta T x Bin Hours x 1 ton/12,000 Btu/hr x Cooling Efficiency kW/ton x % of Space Cooled
Proposed:
85% Reduction in CFM
Savings:
(Existing - Proposed) x Correction Factor
Correction Factor is used to provide a conservative approach to savings estimation. Based on previous experience on similar projects

Maintenance

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

Benefits

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

ECM #4: Building Automation System Upgrades

ECM Summary

Monroe Township Public Schools currently utilize a combination of different direct digital control systems to run the buildings cooling and heating components. These include various measures to control unit run time and space temperature set points. This energy conservation opportunity includes the proposal to upgrade the existing control infrastructure / capabilities / settings to optimize performance and enable additional energy savings to be captured.

Existing System

The buildings surveyed had a variety of controls systems from the latest Direct Digital Controls (DDC) to some pneumatic controls with BAS scheduling. Facilities with DDC systems had electronically controlled field devices with a front end, for monitoring of the HVAC systems in the facilities. The operators have limited scheduling, monitoring and override capabilities with the older systems.

Older pneumatic controls systems often have issues because they are maintenance intensive. Building personnel must ensure the pressurized air stays clean and dry, calibrate the controls and gauges regularly, and ensure that controls strategies are being implemented correctly.

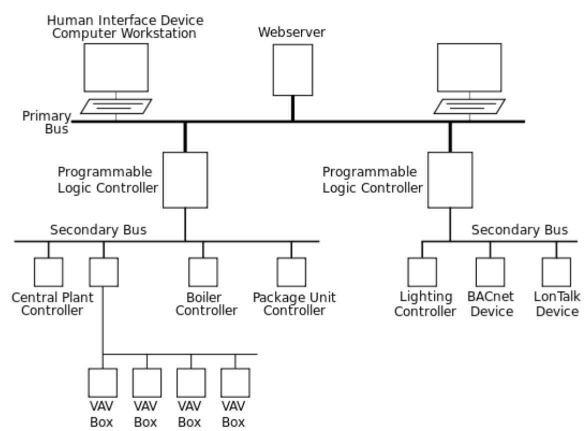
As a whole, it helps the system realize its full potential by implementing a re-commissioning and enhanced-programming strategies to ensure that potential energy conservation measures are being used. The constant change in technology is reason to periodically revisit any existing building controls systems to fully take advantage of their inherent energy conservation capabilities.

These energy conservation opportunities includes the proposal to modify the existing control infrastructure/ capabilities/settings to optimize performance and enable additional energy savings to be captured.

Scope of Work

Johnson Controls proposes an open protocol system architecture controls upgrade to a full DDC system to enable the District facilities to have superior scheduling, monitoring and controls capabilities. An upgraded DDC system will be provided to integrate the mechanical system to a Metasys front end.

All the buildings in the project will be upgraded to the latest controls technology, moving away from the legacy systems. This enables a consistent mechanical systems mapping to the single front-end, allowing the facility management team to schedule, monitor and control from a single dashboard with remote capabilities. Graphics will be provided for the new systems included in the building automation and mechanical equipment to be controlled by the system.



As part of an effort to realize the existing system and the proposed upgrades to the fullest potential Johnson Controls proposes to review the existing Building Automation System (BAS) Sequence of Operations and its proper operation. This measure may be combined with a Condition Assessment of mechanical equipment. A Condition Assessment will verify dampers, valves, actuators, etc. are in proper working order. The district will define operating schedules for each space and piece of equipment. In addition, multiple sensor points will be checked for proper function and that the BAS is reading the correct value at the computer workstation.

The following are some the strategies that can be implemented using a DDC system:

Hot Water Temperature Reset

The hot water system currently resets the hot water temperature from 180°F to 140°F as the outside air temperature rises from 28°F to 60°F.

Johnson Controls will provide services to modify the existing DDC system to reset the hot water supply temperature based on building load as indicated by the hot water valve positions.

Demand Controlled Ventilation

Johnson Controls will provide services to modify the existing DDC system to allow reduced ventilation during periods when the measured building air quality exceeds ASHRAE recommended levels. Provide a return air CO_2 sensor.

CHW Differential Pressure Reset

The pump package is currently maintaining a constant pressure setpoint. Johnson Controls will provide services to modify the existing system to reset the differential pressure setpoint based on building load as indicated by the valve positions.

HW System Optimization

Johnson Controls will provide the labor to de-couple the boilers, pumps, and associated equipment from the third party sequencing panel currently in place. The existing equipment will then be integrated into the DDC system where the chillers and pumps can be staged by real-time feedback from the building field controllers.

HW Differential Pressure Reset

The pump package is currently maintaining a constant pressure setpoint. Johnson Controls will provide services to modify the existing DDC system to reset the differential pressure setpoint based on building load as indicated by the valve positions.

CHW Valve conversion to 2-way, Pressure Independent with Return Water Sensor

Johnson Controls will provide the labor and materials to convert the existing pneumatic 2- and 3-way valves to 2-way pressure independent electronic valves. In addition, Johnson Controls will add a return water temperature sensor to retard the action on the valve until the water temperature differential across the coil exceeds a minimum setpoint.

HW Valve Conversion to 2-way, Pressure Independent

Johnson Controls will provide the labor and materials to convert the existing pneumatic 2- and 3-way valves to 2-way pressure independent electronic valves.

Optimal Start

The optimal start control strategy monitors the outdoor temperature and the building indoor temperature. Adjustments are made to determine the exact time the HVAC system needs to start cooling or heating the building to the occupied temperature setpoints to attain the desired space conditions, by the scheduled time.

Enterprise Management System

Johnson Controls proposes to install an Enterprise Management System containing a comprehensive, analytical and optimization tool that proactively analyzes building energy and equipment data to identify opportunities for improved performance and operational savings. Powerful analytics root out energy and equipment-related problems 24x7. These analytics run in the background and find energy and equipment anomalies. Energy Management software automatically collects, analyzes, and displays information for the configured physical meters and virtual meters located in a facilities operation. The information for energy demand and consumption can be aggregated and displayed using various out of the box dashboards.

Savings Methodology

Savings were calculated from the Excel-based bin temperature calculations. Savings result from implementing night setback temperatures, adjusting occupied heating and cooling setpoints.

Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance. It is recommended that the School continue with the planned service agreement for an additional year in order to keep the BMS in proper working order.

Benefits

- Fuel energy savings.
- Improved occupant comfort
- Capital improvement of the BAS

ECM #5: HVAC System Replacement at Holly Glen Elementary School

ECM Summary

During the preliminary and detailed site audit, Holly Glenn Elementary School's issues with humidity and ventilation have been brought to JCI's attention. Monroe Township Public Schools has engaged F&A Architects and Moore Engineer to redesign the existing HVAC system in the building and address the extreme humidity issues.

The current system consists of a single hybrid, natural gas fired 165 ton absorption chiller which provides either heating water or chilled water to unit ventilators located throughout the campus. Supply water is circulated by two constant flow water pumps. Though this type system can provide an efficient operation of the building, it limits the overall ability to simultaneously heat and cool to reduce humidity in the supply air. The classrooms are provided with unit ventilators with constant speed supply fans and outside air dampers, which tend to bring outside air into the space aggravating the humidity issues in the building.

To address the ongoing issues with the building, a full redesign of the HVAC system was laid out by the district and provided to JCI during the RFP phase.

Scope of Work

The new HVAC system being proposed at Holly Glenn ES will be a combination of upgrades with dedicated roof top outside air units (DOAS) with DX cooling, hot gas reheat and energy recovery ventilation (ERV) capabilities along with new duct work, piping and direct gas supply to the units. This part of the system is intended to provide dry dehumidified ventilation to the space. Along with the DOAS system a Variable Refrigerant Flow (VRF) system with heat pumps will be installed to meet the heating and cooling needs of the individual spaces.

The proposed system will be capable of dehumidification operation during peak humid summer months using the hot gas reheat when the compressor is running while having dedicated reheat via gas fired system to provide during winter.

Johnson Controls does not guarantee the operational performance of dehumidification of the proposed units and specific relative humidity conditions of the space. The following are the suggested specification for the DOAS units.

UNIT TAG #	NOM. TONS	EER	SUPPLY FAN DATA		EXHAUST FAN DATA		DX COOLING COIL DATA		GAS HEATING CAPACITIES	
			CFM	HP	CFM	HP	NET TOTAL (MBH)	NET SENSIBLE (MBH)	INPUT (MBH)	OUTPUT (MBH)
RTU- 1	15	20	3,130	3	1950	1.5	196.4	110.5	200	160
RTU- 2	15	20.0	3,755	5	2,750	3	203.0	119.2	250	200
RTU- 3	10	16.0	2,200	2	2,090	2	123.6	71.7	150	120
RTU- 4	15	20.0	3,500	5	3,330	5	199.2	116.0	250	200
RTU- 5	10	16.0	2,635	3	3,020	3	127.4	78.2	150	120
RTU- 6	15	20.0	3,385	3	2,510	3	199.6	114.3	250	200
RTU- 7	10	16.0	2,405	2	2,280	2	125.9	75.3	150	120

Dedicated Outside Air System (DOAS)

- Demolition of existing exhaust fans, exhaust ductwork and brick vents as shown on Moore Consulting Engineers drawings dated 4/26/2019.
- Furnish/install structural steel for DOAS rooftop unit supports and joist struts.
- Required roof penetrations, roof flashing, and roofing repairs.
- Furnish/install seven (7) DOAS units (six on the roof and one pad-mounted). Concrete pad and chain link fence for the pad-mounted unit.
- Furnish/install seven (7) plenum curbs.
- Remove unit ventilator outside air grilles and install thermal panels provided by others.
- Furnish/install new supply air and return air ductwork and ductwork supports as shown on Moore Consulting Engineers drawings dated 4/26/2019.
- Furnish/install new exhaust fan for the art classroom.
- Make necessary tie-ins to existing ductwork as shown on Moore Consulting Engineers drawings dated 4/26/2019.
- Install required new gas piping as shown on Moore Consulting Engineers drawings dated 4/26/2019. Co-ordinate all work with the local gas utility company.
- Furnish/install seven (7) smoke detectors.
- Engage school district's fire alarm service company for wiring, programming and testing on existing fire alarm system.
- Engage a certified air balancer to insure a positive building pressure.
- Factory start-up and commissioning of entire DOAS

Variable Refrigerant Flow

- Furnish/install fan coil suspended ceiling-mounted cassettes along with required controls as shown on Moore Consulting Engineers drawings.
- Furnish and install refrigerant piping and manifolds. Insulate and support as shown on Moore Consulting Engineers drawings.
- Furnish and install roof-mounted air-cooled condensing units and structural steel reinforcement of the roofs as shown on Moore Consulting Engineers drawings.
- Electrical work, power wiring and controls wiring to cassettes and condensing units as shown on Moore Consulting Engineers drawings.
- Thermostats/ temperature sensors as shall be indicated on Moore Consulting Engineers drawings.
- Factory start-up and commissioning of the entire VRF system.

Savings Methodology

Energy savings were estimated using existing conditions and proposed conditions. Energy savings are estimated using FIMCalcs, a Johnson Controls proprietary Excel based calculation tool. The tool uses local weather data to perform an hourly simulation of facility energy use, as well as occupancy and operating schedules.

Data collected for baseline models include on-site audit observations and equipment nameplate data, collected during site audits. Data sources also include inspection of building mechanical drawings and schedules, and inspection of the existing BAS set points, strategies and operating schedules.

Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance.

Benefits

- Reduced annual energy cost.
- Improved temperature control, consistency.
- Reduced annual operational and maintenance costs.

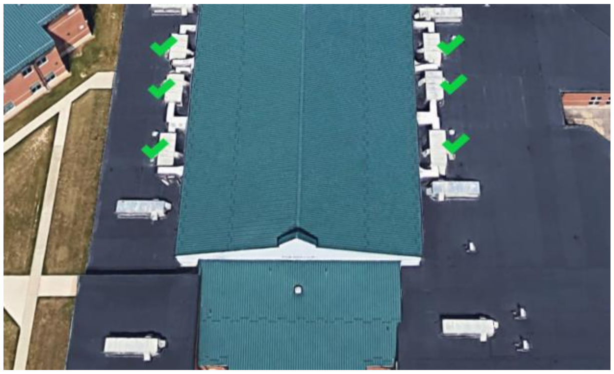
ECM #6: Replace Existing H&V/AHU Units and Add Cooling to High School and Middle School Gymnasiums

ECM Summary

JCI proposes to replace the existing HVAC units and add cooling capabilities to the High School and Middle School gymnasiums as part this measure.

Existing System

Majority of the High School and Middle School are heated and cooled by roof top units and other equipment except for Gymnasiums at both locations. The gyms at both schools are extensively used by the students and the community for various sports and other extracurricular activities. The gym at High School is served by six (six) Heating and Ventilation (H&V) units and the gym at Middle school is served four (4) by Roof Top Units without cooling capabilities.



The following table lists the units that are proposed to be replaced:

Location	Area	Unit	CFM
Williamstown HS	Gym	HV 1&2	2600
Williamstown HS	Gym	HV 3&4	3200
Williamstown HS	GYM	HV 11&12	6190
Williamstown MS	GYM	RTU 3	2,800
Williamstown MS	GYM	RTU 4	2,800
Williamstown MS	GYM	RTU 5	2,800
Williamstown MS	GYM	RTU 6	2,800

Proposed System

This ECM will furnish and install new high efficiency air conditioning equipment and associated equipment at High School and Middle School.

Johnson Controls proposes to install new high efficiency air handling units with cooling equipment. The new air conditioning systems will provide excellent cooling capabilities with temperature and air quality control. In addition, the system shall be efficient and easy to maintain.

Scope of Work

New Equipment to Install

- Install new RTUs with hot water heating and DX cooling

Structural

- Install reinforcing steel at each new curb opening as necessary.

Electrical

- Furnish and install new electrical feeds, electrical gear and starters for RTUs
- Provide and install new electrical disconnects for the new RTUs
- Provide and install electrical conduit, wiring, hangers, and miscellaneous materials required for complete installation.

Mechanical

- Install new RTUs, per manufacturer's recommendations. New RTUs to be located at existing unit locations with new curbs sized for new openings.
- Provide and install new ductwork from new AHUs to existing supply, return and/or outdoor air ductwork. Make all modifications required for transitions. Include sheet metal transitions from the new ductwork to existing ductwork. Match existing duct size (or equivalent SF).
- New ductwork and transitions to be insulated per code.
- Provide and install fire/smoke dampers for supply air and return air fire rated wall penetration.
- Provide and install smoke detectors and connect to existing fire alarm system. Fire alarm company shall program/test new smoke detectors.
- Provide and install condensate drain piping.
- Mechanical Subcontractor to supply miscellaneous material (ductwork, piping, insulation, hangers, flex hoses, circuit setters, etc).
- Include cranes and rigging, including traffic control and coordination (as required)
- Obtain licenses, permits and required inspections.
- Submit Operations and Maintenance (O&M) documentation in Adobe Acrobat format.
- Provide landscape repair from any damage
- Provide air-side balance. Report to be turned over to JCI Solutions Project Manager.
- Installation to be performed in accordance with mechanical, electrical, fire, local, state and national installation and operational codes and to be performed in a neat and workman like manner.
- Start up, testing, commissioning will be performed by certified technician and report will be provided.

Controls

- Install new factory installed BACnet DDC controls for the RTUs.
- Implement control sequence of operation to include energy savings strategies including:
- Night time setback
- Scheduling of the building
- Optimal Start/Stop
- Demand Control Ventilation (DCV) strategy

Energy Savings Methodology

In general, consumption is calculated using Excel-based Bincalc and effective full load hours. There will be negative energy savings for running the unit in cooling mode as extra cooling load is added to the building.

Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance.

Benefits

- Reduced annual energy cost.
- Improved temperature control, consistency.
- Reduced annual operational and maintenance costs.

ECM #7: Air Handling Unit Replacement at Oak Knoll Elementary School

Existing Conditions

The air handling units (AHU) serving Oak Knoll ES cafeteria space are at the end of their useful life and of low efficiency.

Scope of Work

This ECM will replace and upgrade existing AHU and associated equipment with new high efficiency equipment. The new air distribution systems will provide excellent heating and cooling capabilities with temperature and air quality control. In addition, the system is efficient and easy to maintain.

- Disconnect, remove and properly dispose of existing air handling unit; including electrical, mechanical and control connections.
- Reclaim and properly dispose of refrigerant per local codes.
- Insulate new and disturbed ductwork, valves and fittings.
- Reconnect units to existing electrical system.
- Reconnect equipment to new BAS.

Savings Methodology

Savings were calculated from the Excel-based bin temperature calculations.

Benefits

Ventilation and space conditioning equipment is a large component in building HVAC systems. Replacing this equipment with new high efficiency equipment can save a considerable amount of electricity and fossil fuel. Long term maintenance costs will also be lower due to less service requirements of the new equipment.

ECM #8: Ceramic and Welding Lab Ventilation Upgrades

ECM Summary

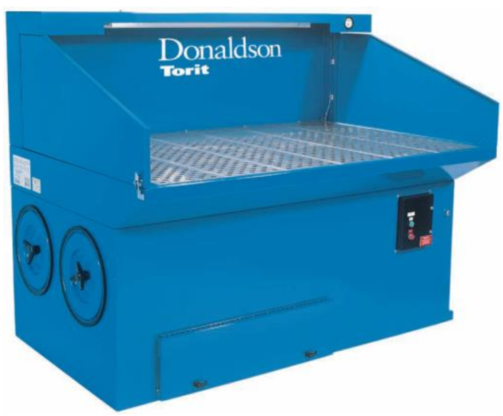
During the site audits, it was brought to JCI's attention regarding the ventilation issues at High School Ceramics and Welding labs. This ECM attempts to alleviate the Ventilation Air issues in these spaces by installing down flow dust collectors and make up air units for the two locations.

Existing System

The existing system in the ceramics and welding shop are not designed to handle the fine dust and particulate from the student workshops. This poses a critical necessity to upgrade the ventilation and exhaust system to eliminate the particulate matter.

Proposed System Upgrades

JCI proposes to install a dust/fume collection systems for the welding and ceramics labs along with gas fired make up air unit with interior duct work and controls. This helps mitigate the ventilation and exhaust issues at the two locations.



Scope of Work

- JCI shall furnish and install one downdraft bench and ultra-fine filter cartridge at the Ceramics lab
- JCI shall furnish and install Downflow Dust Collector with up to 7 ports for seven welding booths
- New piping runs to each welding booth, installation of dust collector outdoors, and run piping to outdoor unit.
- JCI shall furnish and install a direct gas-fired Make-Up Air unit for the ceramic lab including interior duct work.
- Run new electrical to new indoor and new outdoor units.
- Provide controls for the new units.

Savings Methodology

No savings associated with this ECM.

Benefits

Ventilation and exhaust to labs

ECM #9: Boiler Relocation and Domestic Hot Water Decoupling at Middle School

ECM Summary

This ECM relocates the existing high efficiency KN boilers and creates separate boiler plants to reduce operating costs by eliminating black seal operator requirements. The existing boilers are 2014 high-efficiency condensing boilers and are not being replaced.

Proposed System Upgrades

Relocate existing boilers along with installing an appropriately sized domestic water heater. The domestic water heater is sized for the existing domestic hot water requirements. The installation intent is to separate the DHW system from the heating hot water boiler system.

Scope of Work

Gas-Fired Absorption Unit/ Existing Cooling Tower Demolition

- Safe off the heating hot water, cooling tower water, and make-up water to the gas-fired absorption unit coming into the mechanical room.
- Safe off the natural gas line to the gas-fired absorption unit.
- Drain/disconnect the cooling tower water above/below the roof line.
- Disconnect/discard cooling tower make up water (leave above roof for the new tower).
- Safe off and disconnect (water-power) and remove (2) tower water pumps and piping.
- Disconnect/discard the 275 gallon tank used for the absorption unit vent.
- Disconnect/discard heating hot water piping from the absorption unit back to the mains.
- Disconnect/discard the exhaust flue vent piping and cap the roof opening.
- Test the gas-fired absorption unit bromide for chromemates and recover the bromide in 55-gallon barrels. Discard of properly per EPA regulations.
- Circulate neutralizer through the absorption unit prior to demolition.
- Disconnect/demolish the absorber and rig from mechanical room, and discard from site (keep the concrete pad).
- Disconnect and discard the floor-mounted expansion tank.

Domestic Hot Water Decoupling/New Condensing Domestic Hot Water Unit

- Safe off and disconnect the existing DHW heat exchanger.
- Furnish and install new high-efficiency DHW heater.
- Install a new exhaust flue for the new DHW heater (reuse absorber opening).
- Fabricate/install DHW piping/valves/fittings to connect DHW unit to the existing system.
- Fabricate/install new natural gas line from the new DHW heater to the existing gas main.
- Furnish and install one (1) new DHW circulation pump.
- Provide and install the condensate drain piping and neutralization units for the DHW.
- Provide factory start-up for the new condensing DHW unit.

Heating Hot Water Boiler Relocation

- Safe off and disconnect the (1) KN HHW boiler from HHW & natural gas systems.
- Disconnect the exhaust-intake flue lines from the boiler and stack (reserve for re-use).
- Relocate the one (1) KN boiler and provide separate manifold and exhaust flue.
- Furnish and install separate HHW pump/motor set.
- Fabricate/install the new natural gas line from the existing over to the KN boiler.
- Fabricate/install new HHW piping to connect the boiler to existing HHW system.
- Re-install the existing condensate drain and neutralization unit for the relocated KN boiler.
- Fill/test the HHW piping. Provide factory start-up of the KN boiler. Set flows through the two (2) KN boilers.

Facilities Recommended for This Measure

- Williamstown Middle School

Building Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Heating Efficiency = Existing Heat Production / Existing Fuel Input
Proposed Heating Efficiency = Proposed Heat Production / Proposed Fuel Input
Energy Savings $ = Heating Production (Proposed Efficiency – Existing Efficiency)

Equipment Information

Manufacturer and Type	Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections.
Equipment Identification	As part of the measure design and approval process, specific product selection will be provided for the customer's review and approval.

Environmental Issues

Resource Use	Energy savings will result from greater plant efficiency, and reduced maintenance costs.
Waste Production	This measure will produce waste by products. Existing boilers will be removed and demolished according to proper guidelines by contractor.
Environmental Regulations	Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements.

ECM #10: Boiler Replacement and Domestic Hot Water Decoupling at Whitehall Elementary School

ECM Summary

This ECM replaces boilers that operate at low efficiencies. The new boilers will help the District achieve future energy savings and lower the amount of maintenance cost during the contract period.

Existing System

The gas-fired heating hot water boilers at Whitehall ES use older technology burners and controls. Replacing these inefficient boilers with new energy efficient equipment and state-of-the-art controls would result in significant energy and maintenance cost savings along with improved performance. The current Hot Water Boilers also serve the domestic hot water needs of the building via a heat exchanger. This system results in the operating of the existing boilers throughout the year, including summer. The proposed project would upgrade the hot water boilers listed below with gas-fired, modular, condensing boilers with efficiencies in the range of 90% to 95% and decouple the domestic hot water system, eliminating summer operation of the hot water boilers.

Proposed System Upgrades

Install two (2) 3,000 MBH gas-fired, modular, condensing boilers to replace the two (2) 2,636 MBH non condensing hot water boilers along with three (3) instantaneous domestic water heaters. The boiler replacements are based on the output capacity of the existing boilers. The installation intent is to separate the DHW system from the heating boiler system.

Scope of Work

Heating Hot water Boilers:

- JCI shall safe off the (2) Existing boilers
- Demo and remove the two existing boilers from the below grade boiler room
- JCI shall provide and install two (2) new High Eff Boilers boiler's (PK-Mach, KN, Aerco boiler or equal) rated @2.5 MBH operating on natural gas
- Safe off the power and control wiring from each boiler set aside for re-use
- JCI shall provide and install the required new schedule 40 black steel hot water supply and return pipe, valves and fittings to produce two independent boiler plants with separate pumps, manifolds, exhaust flues, etc.
- Provide and install the required new natural gas piping to connect the new boilers to the existing gas piping
- JCI shall provide and install (2) primary flow circulation pumps (1) for each boiler
- JCI shall provide and install (2) Heating Hot water secondary circulation pump (1) for each boiler total system flow
- Provide the required new roof closure materials and methods to seal the roof around the new exhaust pipes.
- JCI shall provide and install the required new Shut off valves, drain & vent valves to complete the installation
- JCI shall provide and install the required pipe insulation for the new and disturbed hot water piping.
- JCI shall provide and install the required new power wiring

- JCI shall provide and install the required control wiring and interface to allow connection between the new boilers and the existing building BAS
- Fill and test the new boilers
- Factory Start up the boiler/burner operation

Domestic Hot Water Replacement:

- Demo and remove the two existing, abandoned DHW (tank type heaters) from the boiler room and discard
- Safe off and demo the DHW hot water piping system back to the tank heater area. (Reserve for re-use)
- Provide and install (3) Navien (or equal) on demand Domestic hot water tankless heaters.
- Safe off the power and control wiring from each boiler set aside for re-use
- The installation intent is to separate the DHW system from the heating hot water boiler system.
- Provide and install the required new natural gas pipe, valves & fittings to connect the existing gas piping to the new installed gas manifold
- Provide and install (1) primary return flow circulation pumps
- Provide and install Fiberglass pipe insulation on the new and disturbed hot/cold water piping from the heater to the interior boiler room wall.
- Install PVC exhaust/intake vent system.
- Factory startup of the new heaters.

Facilities Recommended for This Measure

- Whitehall Elementary School

Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Heating Efficiency = Existing Heat Production / Existing Fuel Input
Proposed Heating Efficiency = Proposed Heat Production / Proposed Fuel Input
Energy Savings $ = Heating Production (Proposed Efficiency – Existing Efficiency)

Equipment Information

Manufacturer and Type	Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections.
Equipment Identification	As part of the measure design and approval process, specific product selection will be provided for the customer's review and approval.

Environmental Issues

Resource Use	Energy savings will result from greater plant efficiency, and reduced maintenance costs.
Waste Production	This measure will produce waste by products. Existing boilers will be removed and demolished according to proper guidelines by contractor.
Environmental Regulations	Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements.

ECM #11: Boiler Replacement at High School and Radix Elementary School

ECM Summary

This ECM replaces boilers that operate at low efficiencies and are at the end of their life. The new boilers will help the District achieve future energy savings and lower the amount of maintenance cost during the contract period.

Existing System

The gas-fired heating hot water boilers at High School and Radix ES use older technology burners and controls. Replacing these inefficient boilers with new energy efficient equipment and state-of-the-art controls would result in significant energy and maintenance cost savings along with improved performance. This proposed project would upgrade the hot water boilers at each of the buildings listed below with gas-fired, modular, condensing boilers with efficiencies in the range of 90% to 95%.

Proposed System Upgrades

JCI proposes to install six (6) 2,500 MBH input capacity gas-fired, modular, condensing boilers to replace three (3) 5,250 MBH non-condensing hot water boilers at the High School.

At Radix ES, JCI proposes to install one (1) 2,500 MBH gas-fired, modular, condensing boilers to replace one (1) 2,324 MBH non-condensing hot water boiler.

The boiler replacements are based on the output capacity of the existing boilers.

Scope of Work

- JCI shall safe off the existing boilers
- Demo and remove the existing boilers
- JCI shall provide and install new High Efficiency Condensing Boilers (PK-Mach, KN, Aerco boiler or equal) operating on natural gas
- Safe off the power and control wiring from each boiler set aside for re-use
- JCI shall provide and install the required new hot water supply and return pipe, valves and fittings to connect the new boilers to the existing piping system
- Provide and install the required new natural gas piping to connect the new boilers to the existing gas piping
- JCI shall provide and install primary flow circulation pumps for each of the boilers
- JCI shall provide and install the required new pressure/temperature gauges (Supply/return or inlet –outlet of the boiler)
- JCI shall provide and install the required new shut off valves, drain & vent valves to complete the installation
- JCI shall provide and install the required pipe insulation for the new and disturbed hot water piping.
- JCI shall provide and install the required new power wiring
- JCI shall provide and install the required control wiring and interface to allow connection between the new boilers and the existing building BAS
- Fill and test the new boilers

- Factory Start up the boiler/burner operation

Facilities Recommended for This Measure

- Williamstown High School
- Radix Elementary School

Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Heating Efficiency = Existing Heat Production / Existing Fuel Input
Proposed Heating Efficiency = Proposed Heat Production / Proposed Fuel Input
Energy Savings $ = Heating Production (Proposed Efficiency – Existing Efficiency)

Equipment Information

Manufacturer and Type	Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections.
Equipment Identification	As part of the measure design and approval process, specific product selection will be provided for the customer's review and approval.

Environmental Issues

Resource Use	Energy savings will result from greater plant efficiency, and reduced maintenance costs.
Waste Production	This measure will produce waste by products. Existing boilers will be removed and demolished according to proper guidelines by contractor.
Environmental Regulations	Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements.

ECM #12: Installation of Premium Efficiency Motors and Pumps

ECM Summary

Energy savings can be achieved by replacing the standard efficiency motors that are installed throughout the facility with premium efficiency motors. Johnson Controls has identified motors in the below school as candidates for replacement with premium efficiency equivalents.

Facilities Recommended for this Measure

- Williamstown High School
- Williamstown Middle School
- Radix Elementary School
- Whitehall Elementary School

Scope of Work

Johnson Controls proposes to replace all motors listed in the table below with new premium efficiency units.

- Installation to include leveling and alignment
- Install coupling
- Reconnect motor to existing electrical power wiring, reusing motor starter
- Verify new motor rotation
- Perform Start-up and Testing to manufacturer supplied specifications
- Provide conduit, fittings, gauges, insulation, etc.

Building	Location	System Served	Equipment Type	Horsepower
Williamstown HS	Roof	Main Gym	Supply Air Fan	10
Williamstown HS	Roof	Main Gym	Supply Air Fan	10
Williamstown HS	Roof	Main Gym	Supply Air Fan	7.5
Williamstown HS	Roof	Main Gym	Supply Air Fan	7.5
Williamstown HS	Roof	Aux Gym	Supply Air Fan	7.5
Williamstown HS	Roof	Aux Gym	Supply Air Fan	7.5
Williamstown HS	Roof	Aux Gym	Return Air Fan	7.5
Williamstown HS	Roof	Aux Gym	Return Air Fan	7.5
Williamstown HS	Various	Offices	Supply Air Fan	7.5
Williamstown HS	Various	Offices	Supply Air Fan	7.5
Williamstown HS	Various	Offices	Supply Air Fan	7.5
Williamstown HS	Various	Offices	Supply Air Fan	7.5
Williamstown HS	Roof	Cafeteria	Supply Air Fan	7.5
Williamstown HS	Roof	Cafeteria	Supply Air Fan	7.5
Williamstown HS	Roof	Library	Supply Air Fan	10
Williamstown HS	Roof	Library	Return Air Fan	7.5
Williamstown HS	Stage	Auditorium	Supply Air Fan	15

Building	Location	System Served	Equipment Type	Horsepower
Williamstown HS	Stage	Auditorium	Supply Air Fan	15
Williamstown HS	Stage	Auditorium	Return Air Fan	7.5
Williamstown HS	Stage	Auditorium	Return Air Fan	7.5
Williamstown MS	N/A	N/A	Supply Fan	10
Radix ES	Mech. Room	Entire School	WSHP Circ. Pump	7.5
Radix ES	Mech. Room	Entire School	HHW Pump	7.5
Radix ES	Mech. Room	Entire School	HHW Pump	7.5
Whitehall ES	Stage	N/A	Supply Air Fan	7.5
Whitehall ES	Stage	N/A	Supply Air Fan	7.5
Whitehall ES	Roof	Gym	Supply Air Fan	10

Savings Methodology

In general, savings are calculated using Excel-based Bincalc. The equation presented below is used along with bin temperatures to equate building load and calculate pump savings. :

Motor Savings,kWh	kWh reduced = [(Motor kW/Proposed efficiency – Pump kW/existing efficiency) x EFLH Where EFLH = Effective Full Load Hours

Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance.

Benefits

- Electrical energy savings

ECM #13: Variable Speed Drives on Hot Water Pumps

Facilities Recommended for This Measure

- Williamstown High School
- Williamstown Middle School

Existing Conditions

The heating hot water circulating pumps in the above mentioned schools are constant volume pumps without any flow control. The result is unnecessary excess pumping power especially when there is a decreased building heating load.

Scope of Work

Johnson Controls will provide the labor and materials to install Variable Frequency Drive (VFD) with applicable controls necessary for each of these pumps. 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 BACnet communications card for integration with the BAS. Johnson Controls will provide the controls necessary to operate the pumps in a lead/lag mode using a “sawtooth” staging configuration, (i.e. modulate one pump until the total flow is greater than the minimum setting of both pumps, stage on the lag pump, and modulate both in unison).

- Provide and install thermal wells and pressure ports for remote differential pressure transmitter.
- Provide and install variable speed drives for each motor
- Provide and install replacement inverter duty rated high efficiency motors for these pumps.

Building	Location	Equipment Type	GPM	Horsepower
Williamstown HS	Mechanical Room	Heating Hot Water Pump	815	25
Williamstown HS	Mechanical Room	Heating Hot Water Pump	815	25
Williamstown MS	Mechanical Room	Heating Hot Water Pump	400	25
Williamstown MS	Mechanical Room	Heating Hot Water Pump	400	25
Williamstown MS	Mechanical Room	Heating Hot Water Pump	400	25

Savings Methodology

Energy Savings (kWh) = 0.746 * *HP * *HRS * (ESF/ηmotor)
Demand Savings (kW) = 0.746 * *HP * (DSF/ηmotor)

HP = nameplate motor horsepower or manufacturer spec. sheet per application

ηmotor = Motor efficiency at the peak load. Motor efficiency varies with load. At low loads relative to the rated hp (usually below 50%) efficiency often drops dramatically.

ESF = Energy Savings Factor. The energy savings factor is calculated by determining the ratio of the power requirement for baseline and VFD control at peak conditions.

DSF = Demand Savings Factor. The demand savings factor is calculated by determining the ratio of the power requirement for baseline and VFD control at peak conditions

HRS = annual operating hours

Benefits

- Fuel savings generated through an increased efficiency

- Lower utility expenditures
- Reduced operation and maintenance cost, new unit will be under warranty
- Improved system reliability

Equipment Information

Manufacturer and Type	Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections.
Equipment Identification	Product cut sheets and specifications for generally used product will be included in the comprehensive audit. As part of the measure design and approval process, specific product selection will be provided for your review and approval.

Customer Support and Coordination with Utilities

Coordination of the electrical lock out and tag out will be required. All interruptions (if necessary) will be coordinated and scheduled with the staff in advance.

Environmental Issues

Resource Use	Energy savings will result from reducing electrical usage by load following. The equipment uses no other resources.
Waste Production	This measure may produce waste by products. Old motors will be removed and disposed of according to all guidelines by the contractor.
Environmental Regulations	No environmental impact is expected.

ECM #14: Chiller Replacement at High School

Existing Conditions

The chillers in the Williamstown High School are less efficient than the new generation of air-cooled chillers. Estimated efficiency of the existing chillers is 1.22 kW/Ton at full load capacity (FLV) while the FLV of new, high-efficiency is 1.04 kW/Ton.

Scope of Work

We propose replacing the existing nominal efficiency Chiller #2 with one (1) 340-ton high-efficiency unit. The district has already procured a replacement for Chiller #1 and in the process of installation. Chiller #2 will match the specifications of Chiller #1. The proposed chiller improves part-load performance and uses environmentally friendly R-134A refrigerant. Replacing the old chiller(s) will avoid future chiller repair and replacement expenditures. The latest generation of air-cooled chillers also have variable frequency drive compressors, improved DDC and operating sequences to improve efficiency, reliability and turndown capacity.

- Furnish/install new air-cooled chiller rated @ 340 nominal tons with propylene glycol @ 25% mixture.
- Disconnect, remove and properly dispose of existing chiller; including electrical, mechanical and control connection.
- Reclaim and properly dispose of refrigerant and oil per local codes.
- Provide and install chillers.
- Reconnect new chiller to existing chilled water piping.
- Furnish/install two (2) new CHW isolation valves located @ the chiller inlet/outlet.
- Furnish/install two (2) rubber or braided pipe isolation devices at new air-cooled chiller inlet/outlet.
- Insulate new and disturbed chilled water pipe, valves and fittings. Paint new piping to match existing.
- Reconnect chiller to existing electrical system. New starter will have a VFD.
- Furnish/install required new power circuit for the heat trace. Connect the new power circuit from the existing heat trace circuit.
- Furnish/install required control wiring between the existing chiller controls and the new chiller controls located on the existing chiller pad.
- Provide the required technician labor to interface the new chiller to the existing BAS system.
- Provide new fiberglass pipe insulation for the new piping. Exterior insulation shall be covered in aluminum covering. Insulation shall be 2" thick with service jacket and PVC fittings.
- Equipment start-up by factory authorized representative.
- Factory startup of the chiller.

Facilities Recommended for This Measure

- Williamstown High School

Savings Methodology

Savings were calculated from the excel-based computer generated models. Savings result from the increased efficiency of the new cooling system as compared to the older cooling system. The savings include the efficiency improvements of both chiller #1 and chiller #2.

Benefits

- Improved part-load performance
- Use of a more environmentally friendly refrigerant
- Reduced chiller repair and replacement expenditures
- Reduced utility cost

ECM #15: Chiller Re-Configuration at Middle School

Existing Conditions

Williamstown Middle School is currently served by one (1) 400-ton air cooled chiller and one (1) 50-ton Napps water cooled chiller. The mechanical room also hosts two (2) Napps 50-ton water cooled chillers currently not connected to the chilled water loop and not in use. Water cooled chillers are considered to be more efficient than the air cooled chiller.

Scope of Work

The intent of this measure is to utilize the existing three (3) Napps water cooled chillers as the primary source of cooling for the Middle School during the shoulder months and warm days during the winter months.. The new chiller system will be sequenced in a way that during periods of low load, only the water cooled chillers would operate. When the load increases beyond the water cooled chiller's capacity (150-ton), the air cooled chiller would cycle on. This also allows for chiller capacity to shift over to the other system in the event of equipment failure..

- Relocate three (3) Napps chiller modules onto the old absorber equipment pad.
- Manifold the modular chillers together and fasten to the concrete equipment pad.
- JCI shall fabricate/install required CHW pipe, valves and fittings to connect the modules to the main.
- JCI shall fabricate/install required steel dunnage to modify existing steel for the new cooling tower.
- JCI shall furnish, deliver, rig, and set new 150-ton closed circuit cooling tower on the modified steel.
- JCI shall fabricate/install required new tower water piping, valves, & fittings between tower & chillers.
- Fabricate/install required new PVC drain & overflow pipe, valves & fittings for cooling tower.
- Fabricate/install the copper make up water from existing main to new cooling tower.
- JCI shall furnish/install two (2) new cooling tower water pumps & associated pipe, valves, fittings & trim.
- Reconnect the existing water treatment system into the new chilled water system.
- Controls to be installed with a sequence of operation to prioritize the Napps chillers and bring the air cooled chiller on if the building load demands.

Facilities Recommended for This Measure

- Williamstown Middle School

Savings Methodology

Savings were calculated from the excel-based computer generated models.

Benefits

- Improved part-load performance
- Reduced utility cost

ECM #16: Variable Speed Drives on Chilled Water Pumps

ECM Summary

This measure proposes to install variable speed drive (VSD) controls on the chilled water pumps within the School District. This control will allow for a more efficient operation of the pumping systems and reduce electric consumption.

Facilities Recommended for This Measure

- Williamstown High School
- Williamstown Middle School

Existing Conditions

Johnson Controls identified that chilled water pumps operate without any type of modulation controls on them. The result is unnecessary excess pumping power especially when there is a decreased building cooling load.

Scope of Work

It is our recommendation that new Variable Speed Drives (VSDs) along with inverter-duty, high- efficiency motors be installed on the following chilled water pumps:

Building	Location	Equipment Type	GPM	Horsepower
Williamstown HS	Mechanical Room	Chilled Water Pump	819	40
Williamstown HS	Mechanical Room	Chilled Water Pump	819	40
Williamstown HS	Mechanical Room	Chilled Water Pump	819	40
Williamstown MS	Mechanical Room	Chilled Water Pump	800	50
Williamstown MS	Mechanical Room	Chilled Water Pump	800	50
Williamstown MS	Mechanical Room	Chilled Water Pump	800	50

The VSDs will include bypass to allow motor to operate at full speed in HAND, in the event of VSD failure. The VSD will be supplied complete with BACNet communications card for integration with existing Energy Management System (EMS) or a newly installed EMS. The VSD will be controlled by the EMS to maintain chilled water loop differential pressure set point. If necessary, 3-way valves will be converted to 2-way valves in order to ensure proper operation.

Varying the speed of a motor to match the actual load improves control and reduces electrical motor power (kW), which may result in both comfort improvement and electrical energy savings. We vary the speed of the motor by varying voltage and frequency to the motor. As the system's load changes, so does the required motor-driven output.

A control program and VSD will modulate the speed of the motor and match the output to the load. By reducing the speed of an electric motor, we significantly reduce the energy required by the motor. The actual power required is proportional to the cube of the speed. For example, if you reduce a motor's speed to 80%, the motor's energy consumption decreases by approximately 50%.

Johnson Controls has included the NJ Office of Clean Energy incentives for the Variable Speed Drives that qualify for this program.

Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Motor Savings kWh	kWh reduced = [(Pump kW) x (Reduced Flow/Orig. Flow)^2] x EFLH Where EFLH = Effective Full-load Hours

Equipment Information

Manufacturer and Type	Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections.
Equipment Identification	Product cut sheets and specifications for generally used product will be included in the comprehensive audit. As part of the measure design and approval process, specific product selection will be provided for your review and approval.

Customer Support and Coordination with Utilities

Coordination of the electrical lock out and tag out will be required. All interruptions (if necessary) will be coordinated and scheduled with the staff in advance.

Environmental Issues

Resource Use	Energy savings will result from reducing electrical usage by load following. The equipment uses no other resources.
Waste Production	This measure may produce waste by products. Old motors will be removed and disposed of according to all guidelines by the contractor.
Environmental Regulations	No environmental impact is expected.

ECM #17: Domestic Water VFD Booster Skid at High School

ECM Summary

This measure proposes to install variable speed drive (VSD) controls on the one (1) 7.5 – HP domestic pump at Williamstown High School. Varying the speed of a motor to match the actual load improves control as well as reduces electrical motor power (kW), water and electrical energy savings.

A variable speed booster system with a PLC based controller is capable of controlling the pump package system using a user-friendly color touchscreen to monitor the system conditions, and adjust the system settings. This system monitors the system discharge pressure via a signal pressure transducer. This provides a precise pressure control and user flexibility. In addition to this sensor, a suction pressure transducer and/or a flow meter can be added to extend the control and flexibility of the system. The main objective of this pumping package is to maintain a constant pressure, adjusting the speed and amount of pumps to run according to the building's demand.

Scope of Work

It is our recommendation that new Variable Speed Drive(s) along with inverter-duty, high- efficiency motors be installed on the domestic water pumps at Williamstown High School. The VSDs will include bypass to allow motor to operate at full speed in HAND, in the event of VSD failure. The VSD will be supplied complete with BACNet communications card for integration with existing Energy Management System (EMS) or newly installed EMS. The system is capable of staging pumps on and off based on pressure and/or flow, while alternating pumps to keep the run times balanced between them.

- Remove each existing pump motor starter, and safely disconnect electrical supply.
- Replace existing motors with new, inverter duty motors.
- Properly dispose of removed equipment and waste materials.
- Furnish and install new VSDs.
- Provide electrical power wiring from the main electrical panel to each new VSD.
- Reuse existing electrical wiring where possible.
- Modify electrical power wiring distribution panel as needed.
- Extend communication bus to/from each VSD to/from existing Energy Management System. Perform any required programming and graphics modifications.
- Start-up and commissioning of VFDs.

Facilities Recommended for This Measure

- Williamstown High School

Savings Methodology

Energy Savings (kWh) = 0.746 * *HP * *HRS * (ESF/η_{motor})
Demand Savings (kW) = 0.746 * *HP * (DSF/η_{motor})

HP = nameplate motor horsepower or manufacturer spec. sheet per application

η_{motor} = Motor efficiency at the peak load. Motor efficiency varies with load. At low loads relative to the rated hp (usually below 50%) efficiency often drops dramatically.

ESF = Energy Savings Factor. The energy savings factor is calculated by determining the ratio of the power requirement for baseline and VFD control at peak condition

DSF = Demand Savings Factor. The demand savings factor is calculated by determining the ratio of the power requirement for baseline and VFD control at peak conditions

HRS = annual operating hours

Benefits

- Fuel savings generated through an increased efficiency.
- Lower utility expenditures.
- Reduced operation and maintenance cost, new unit will be under warranty.

ECM #18: Domestic Water Heater System Holly Glen Elementary School

ECM Summary

This ECM replaces existing domestic water heating system at Holly Glen ES with gas-fired, high efficiency, condensing, hot water heaters. The domestic water heating in this building was observed to be provided by a heat exchanger coupled with the existing absorption chiller.

Existing System

The existing gas-fired absorption unit will be disconnected and removed from the boiler room. Therefore the existing tank/heat exchanger will need to be replaced by a standalone domestic water heater with the appropriate capacity. An existing hot water heater now services just the kitchen.

Proposed System

This ECM would replace the existing tank/heat exchanger with a gas-fired, high-efficiency, instantaneous domestic water heater. Instantaneous domestic water heaters can substantially improve the operating efficiency of the domestic water heating system. The natural gas-to- hot water efficiency of new instantaneous domestic water heaters with digital controls is approximately 94%.

Scope of Work

Domestic Hot Water Decoupling/New instantaneous Domestic Hot Water Unit

- Safe off and disconnect the existing DHW heat exchanger.
- Furnish and install one (1) new high-efficiency DHW heater.
- Install a new exhaust flue for the new DHW heater (reuse absorber opening).
- Fabricate/install DHW piping/valves/fittings to connect DHW unit to the existing system.
- Fabricate/install new natural gas line from the new DHW heater to the existing gas main.
- Furnish and install one (1) new DHW circulation pump.
- Provide and install the condensate drain piping and neutralization units for the DHW.
- Provide factory start-up for the new condensing DHW unit.

Facilities Recommended for This Measure

- Holly Glen Elementary School

Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Heating Cost =Existing kWh Usage x $/kWh

Proposed Heating Cost = Heating Therms x $/Therm

Energy Savings $ = Existing System Cost – Proposed System Cost

Equipment Information

Manufacturer and Type	Several quality and cost-effective manufacturers are available. Johnson Controls and the customer will determine final selections.
Equipment Identification	As part of the measure design and approval process, specific product selection will be provided for the customer's review and approval.

Changes in Infrastructure

No architectural or structural changes to the facility are anticipated with the implementation of this measure.

Customer Support and Coordination with Utilities

Minor support will be required for the interruption of utilities for brief tie-in periods. All interruptions will be coordinated and scheduled with the staff in advance.

Environmental Issues

Resource Use	Energy savings will result from using less costly fuel to heat the domestic hot water.
Waste Production	This measure will produce waste by products. Old units shall be disposed of in accordance with all federal, state and local codes.
Environmental Regulations	Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements.

ECM #19: Roof Upgrades and Repairs at High School and Middle School

ECM Summary

The roof of a building can cause significant amount of energy and maintenance costs throughout the year due to issue that may arise with roofs leaking through cracks and weather damage. Upgrading the roof with a High Solids Silicone Construction Coating roofing system will repair any leaks or holes in the structure and also provide long term warranty. Maintenance will be easier because many existing problems with the structure will be repaired.

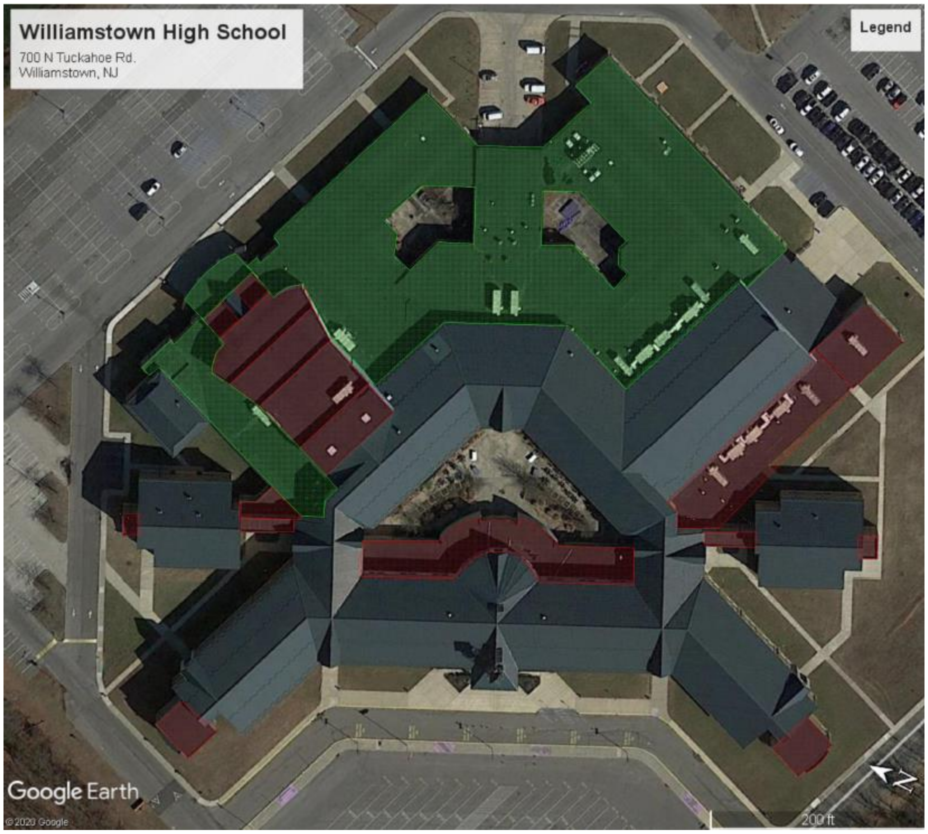
Existing System

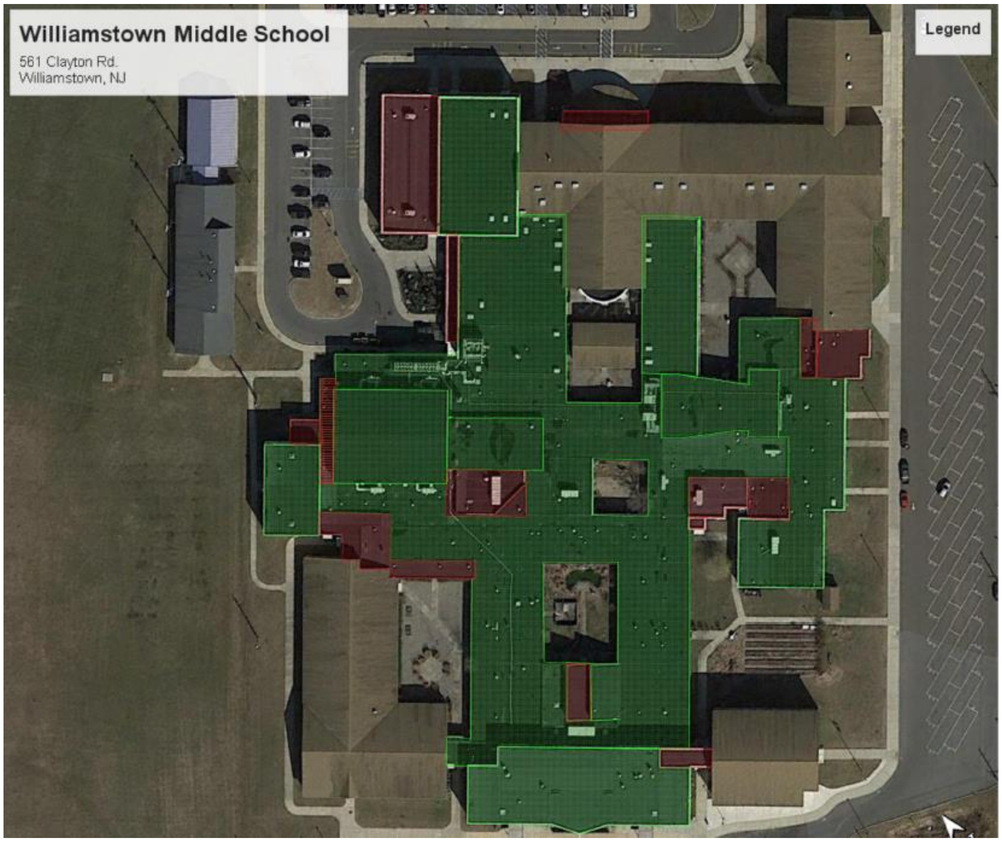
At the High School, although the roof is past its life expectancy it is in good shape. All of the roofs are past their life expectancy at the Middle School. Some are still in good condition and some are in need of removal and replacement.

Proposed System

The existing roof needs upgrades to install solar panels as part of the Solar Power Purchase Agreement and this measure will add a High Solids Silicone Construction Coating to ensure warranty and address any leaks and repairs to the current roof system.

The shaded areas in the below images are considered for roof repairs and upgrades. The green shaded areas in the below images are the tentative locations for solar PV installation and the red shaded area is without solar PV installation.





Facilities Recommended for this Measure

- Williamstown High School
- Williamstown Middle School

Scope of Work

- Supply owner with thermal imaging scan of the existing roofing. Anomalies will be marked in paint on the roof and the owner will receive a report of the findings.
- IR Scan is utilized to marks out wet or compromised roofing.
- Cut the existing membrane back on three sides. Exposing the wet or compromised insulation.
- Remove and replace the existing insulation in kind.
- Flap the existing membrane back and strip it off with new EPDM materials.
- Spot removal of existing non-asbestos roofing in accordance with local and state law. Debris will be properly disposed of offsite.
- Clean and prepare existing roof surface in accordance with manufacturer's recommendations and requirements.
- Supply and install primer as recommended by the manufacturer to the remaining roof surface.
- Prepare existing seams at necessary locations per the manufacturer's direction.
- Supply and install High Solids Silicone Construction Coating over the existing EPDM roofing system.

- Walls and curbs shall have double thickness of silicone as per manufacturer's specifications and recommendations.
- Supply to the owner a manufacturer's warranty.

Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Existing Clg. Gain (In mmBtu's) = (Avg. OA Temp. - Summer Inside Setpoint) x Roof SqFt. x Existing U Value of Roof x Total Bin Hours/1,000,000

Proposed Clg. Gain (In mmBtu's) = (Avg. OA Temp. - Summer Inside Setpoint) xRoof SqFt. x Proposed U Value of Roof x Total Bin Hours/1,000,000
Existing Htg. Loss (In mmBtu's) = (Avg. OA Temp. - Winter Inside Setpoint) x Roof SqFt. x Existing U Value of Roof x Total Bin Hours/1,000,000

Proposed Htg. Loss (In mmBtu's) = (Avg. OA Temp. - Winter Inside Setpoint) x Roof SqFt. x Proposed U Value of Roof x Total Bin Hours/1,000,000

Maintenance Requirements

There will be no additional maintenance responsibilities that the district staff is not already performing in order to keep the buildings in working order. The condition of the new roof will need to be monitored.

Benefits

- Electrical energy savings
- Fuel energy savings
- Capital improvement to building structure and roof system
- Occupant comfort improvement due to reduced thermal loading from roof and sealing gaps in building structure
- Operational savings based on repairing any roof leaks or issues

ECM #20: Solar PV- Power Purchase Agreement Savings

General Overview

Electricity generated from solar photovoltaic (PV) panels through a Solar Power Purchase Program (PPA) will reduce the quantity of power purchased from the local utility. Many factors affect the size of the solar PV installation, including onsite consumption load, suitable roof and parking space or open space.

Solar electrical energy is generated when the sun's energy strikes the solar PV panel. A series of PV panels are combined in a PV array. Electrical energy, in Direct Current (DC), is sent from the array to an inverter, which converts the electricity to Alternating Current (AC) power. The AC electrical output from the inverter is integrated into the building's electrical system.

A solar PPA is a financial agreement where a developer (3rd party PPA provider) arranges for the design, permitting, financing and installation of a solar energy system. The developer sells the power generated to the School District at a fixed rate that is lower than the baseline utility rate. This lower electricity price serves to offset the School District's purchase of electricity from the grid while the developer receives the income from these sales of electricity as well as any tax credits and other incentives generated from the system. The developer remains responsible for the operation and maintenance of the system for the duration of the agreement. Typically at the end of the PPA contract term, a customer may be able to extend the PPA, have the developer remove the system or choose to buy the solar energy system from the developer.

Through the MTPS' PPA with the township this ECM will reduce the cost of electrical power resulting in good financial benefits for the district.

Scope of Work

Monroe Township Public Schools and the Township are entering into a Solar PPA agreement independent of the ESIP process. JCI shall only carry the financial benefit of the solar PPA agreement as savings as part of the ESIP.

Benefits

- Energy cost savings
- Resiliency

ECM #21: Micro Combined Heat and Power (CHP) at Whitehall Elementary School

ECM Summary

Johnson Controls proposes to install one micro cogeneration machine 10kW or under at the Whitehall Elementary School to supply electricity to the building, and the recovered heat will offset the heating hot water boiler load at the school. The CHP unit will be located in the boiler room.

Scope of Work

The systems will include:

- One Micro Cogeneration, Johnson Controls approved, low emissions cogeneration module with appropriate appurtenances as required to tie into the existing hot water system.
- Load modules for interfacing with the boiler plant, building space heating and other thermal loads encompassing pumps, heat exchangers and control values.
- Hydronic piping distribution from cogeneration unit to interface with building thermal loads.
- Natural gas piping from the existing service location to the cogeneration unit.
- Engine exhaust piping including silencer.
- One (1) electrical system including necessary wiring, conduit, and fuse disconnect or circuit breaker with adequate fault duty utilizing the standard electrical interface and a utility grade relay for interconnection and parallel operation with utility. The electrical interconnection points will be in the boiler room, including conduit, wiring, and related electrical devices.
- MCC panel with control circuit protection, circuit protection for pumps and other electric devices and variable speed drives.
- Piping insulation and required insignia to identify flow direction, valves and system components.
- Other appurtenances to make the system operational.
- Provide rigging and shipping.
- Proper ventilation for the cogeneration system and required ductwork from the unit's exhaust to outside.
- System startup with factory authorized technicians.
- Professional engineered drawing package including as-built drawings.

Suggested Specifications of Unit

Model			CP5WN		CP10WN	
			CP5WN-SNB	CP5WN-SPB	CP10WN-SN (B)	CP10WN-SPB
Power	Output	Rated Output	5 kW		10 kW	
		Voltage	240/120 V, 60Hz (208V, 277V)		240/120 V, 60Hz (208V, 277V)	
		Phases/Wires	Single phase, 3 wire		Single phase, 3 wire	
		Modulation	*0.3 to 5 kW with optional CT/Transducer kit (*1)*		*0.3 to 10 kW with optional CT/Transducer kit (*1)*	
Fuel	Gas type		Natural gas	Propane gas	Natural gas	Propane gas
	Pressure	Standard	8 in WC (2kPa)	11 in W/C (2.8kPa)	8 in WC (2kPa)	11 in WC (2.8kPa)
		Range	4 – 10 in WC (1 – 2.5kPa)	8 ~ 13 in W/C (2 ~ 3.3kPa)	4 – 10 in WC (1 ~ 2.5kPa)	8 ~ 13 in WC (2 – 3.3kPa)
	Consumption (LHV)		60,700 BTU (17.8 kW)		107,500 BTU (31.5kW)	112,800 BTU (33.1kW)
			0.61 therms/hr	0.72 Gallon (*3)	1.08 therms/hr	1.34 Gallon (*3)
	Consumption (HHV) (*3, *4)		67,300 BTU (19.7 kW)	66,000 BTU (19.3 kW)	119,100 BTU (34.9 kW)	122,800 BTU (36.0 kW)
			0.67 therms/hr	0.72 Gallon (*3)	1.19 therms/hr	1.34 Gallon (*3)
Heat output	Rated recovered heat		34,100 BTU/h (10kW)		57,300 BTU/h	65,200 BTU/h
	Rated hot water temp.	Inlet	140 F (60 C)		149 F (65 C)	
		Outlet	149 F (65 C)		158 F (70 C)	
	Rated Hot water flow rate		7.3 GPM (27.6 L/min)		12.7 GPM (48.2 L/min)	
	Maximum hot water temp. (Outlet)		163 F (73 C)		172 F (78 C)	
Input power	Voltage, Frequency		240V, 60Hz		240V, 60Hz	
	Starting current		12.5 A		21.7 A	
	Power consumption	Radiator fan stop	0.23 kW		0.39 kW	
		Radiator fan run	0.33 kW		0.71 kW	
Gross Efficiency (LHV)	Overall efficiency		84%		85%	88%
	Electrical generation efficiency		28%		31.5%	30%
	Exhaust heat recovery ratio		56%		53.5%	58%
Sound level	Radiator fan stopped		51 dB (A)		54 dB (A)	
	Radiator fan operating		54 dB (A)		56 dB (A)	
Dimensions	Width		43.3 in (1,000 mm)		57.9 in (1,470 mm)	
	Depth		19.7 in (500 mm)		31.5 in (800 mm)	
	Height		59.1 in (1,500 mm)		70.5 in (1,790 mm)	
	Net weight		882 lb (400 kg)		1,653 lb (750 kg)	1,664 lb (755 kg)
Maintenance Interval			10,000 hrs		10,000 hrs	
Standard Warranty			2 Years; Unlimited Hours		2 Years; Unlimited Hours	
YES Product Protection	5 Years / 30,000 hrs		Optional		Optional	
	10 Years / 60,000 hrs		Optional		Optional	
	15 Years / 90,000 hrs		Optional		Optional	
Emissions & Certifications			EPA Certified UL2200 Certified CSAC22.2 No 14 Certified CSAC22.2 No 100 Certified UL1741/IEEE1547 Certified (*2)		EPA Certified UL2200 Certified CSAC22.2 No 14 Certified CSAC22.2 No 100 Certified UL1741/IEEE1547 Certified (*2)	

*1: The minimum modulation amount is dependent on the CT and Transducer specifications.
*2: External inverter models
*3: Propane gas calculations for fuel consumption are based on converting LHV to HHV: LHV=84,250 BTU/Gallon, HHV=91,420 BTU/Gallon
*4: Natural gas calculations for fuel consumption are based on converting LHV to HHV: LHV= 983 BTU/scf, HHV = 1,089 BTU/scf

Savings Methodology

Savings for cogeneration will be estimated using a custom spreadsheet using the following methodology:

Energy: 10 kW/module x 1 module(s) x 1 net after "parasitic loads"

= 10 net kW output x $/kWh avg. displaced energy

When Heat Used to Displace DHW Boiler Gas Use:

$$\frac{\left(\frac{Th}{hr\ module}\right)\ x}{boiler\ efficiency}\ x\ 1\ modules\ x\ \$/\text{Th boiler gas rate}$$

Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance. Johnson Controls recommends the School to be contracted for an extended maintenance agreement to service the cogeneration units. This maintenance agreement needs to be conducted outside of the Energy Savings Improvement Program.

Benefits

- The installation of a cogeneration unit will result in significant economic benefits to the overall ESP program by extending the project financing term up to 19-years.
- Electric generation while making heating hot water.

ECM #22: Commercial Kitchen Hood Controls

Existing Conditions

Kitchen hoods are usually operated from the time the first kitchen employee enters the kitchen to the time the last kitchen employee leaves the kitchen. Operating the fume hoods at full power all the time wastes electrical fan energy and the fume hood also draws conditioned air out of the space causing the heating and cooling systems to over work. There is significant energy to be saved by controlling the fume hood fans based on the cooking load directly below. The fan will be modulated based on monitoring of the exhaust air temperature and smoke load inside the hood.

The kitchens have constant flow exhaust hoods that are operated manually by the kitchen staff. The overall strategy for improving the performance of the kitchen hood systems is to install a MeLink Intelli Hood control system that determines kitchen hood fan speed based on the cooking load under the hood.

Facilities Recommended for This Measure

- Williamstown High School
- Williamstown Middle School

Scope of Work

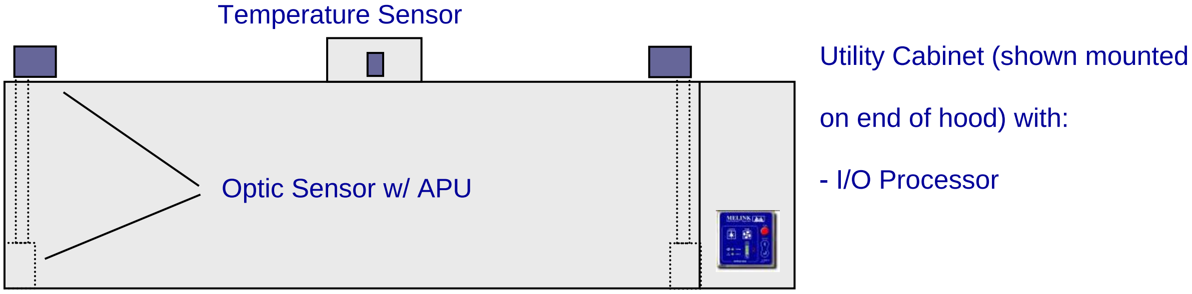
Johnson Controls will provide Melink (or equal) Kitchen Hood System for the kitchens at the above mentioned Monroe Township Public Schools kitchens. This measure will reduced annual energy costs and reduced maintenance. In addition, time of day (TOD) scheduling, manual timer controls are added to reduce the operation time of the exhaust fans where cost effective.

- The Melink Hood System will automatically control the speed of the exhaust and make-up fans above to ensure optimal hood performance. The system includes the following components:
- I / O Processor
- Keypad
- Temperature Sensors
- Optic Sensors
- Variable Frequency Drives (VFDs), which replace magnetic starters for 3-phase motors, and cables.

The I/O processor shall be mounted above the hood closest to the keypad and the keypad shall be mounted next to the existing hood switch. The temperature sensors shall be mounted in each exhaust

MeLink kitchen hood controls

collar while the optic sensors shall be mounted inside the ends of each Type 1 hood with air purge units (APU) mounted on top. The VFDs shall replace the existing magnetic starters for each fan.



Kitchen Hood Controls Diagram

Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

- Electric Fan Savings (kWh) = Q * (HP * *LF * 0.746/FEFF) * RH * PR
- Heating Savings (MMBtu) = SF * CFM/SF * OF * FR * HDD * 24 * 1.08 / (HEFF * 1,000,000)

- Q=Quantity of Kitchen Hood Fan Motors
- HP = Kitchen Hood Fan Motor HP
- LF = Existing Motor Loading Factor
- 0.746 = Conversion from HP to kW
- FEFF = Efficiency of Kitchen Hood Fan Motors (%)
- RH = Kitchen Hood Fan Run Hours
- PR = Fan Motor Power Reduction resultant from VFD/Control Installation
- SF = Kitchen Square Footage
- CFM/SF = Code required ventilation rate per square foot for Commercial Kitchen spaces

- OF = Ventilation rate oversize factor (compared to code requirement)
- FR = Flow Reduction resultant from VFD/Control Installation
- HDDmod = Modified Heating Degree Days based on location and facility type

- CDDmod = Modified Cooling Degree Days based on location and facility type

- 24 = Hours per Day
- 1.08 = Sensible heat factor for air ((Btu/hr) / (CFM * Deg F))
- HEFF = Efficiency of Heating System (AFUE %)

Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance.

Benefits

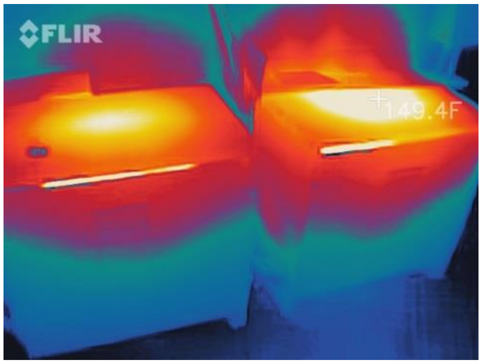
- Gas heating and electrical cooling costs

ECM #23: Transformer Replacement

Existing Conditions

The following measures address the electrical systems throughout the district to reduce utility bills and reduce electric losses through more efficient electrical systems. Among the benefits this ECM will provide is reduced electricity waste; optimized, quiet and efficient electrical power; improved efficiency for a lower operating cost over life of the transformer; new equipment with a 25-year pro-rated warranty.

During the site audit we identified several transformers throughout the district that were in need of replacement. These transformers were noticeably hot, which is an indication of energy waste. More efficient transformers will reduce the amount of electricity lost through the distribution system thus making the entire electrical system more efficient.



Typical transformers at a School with heat dissipation

Facilities Recommended for This Measure

- Williamstown High School
- Williamstown Middle School
- Radix Elementary School

Scope of Work

The E-Saver-C3 transformer is the ideal transformer for institutional and commercial environments where energy efficiency is a priority. Optimized for lowest life cycle cost, the E-Saver-C3 reduces waste by as much as 74%. The E-Saver-C3 is a practical and affordable solution for schools and commercial buildings where lowest life cycle cost and energy savings are a priority.

Typical Powersmith E-Saver high efficiency transformer

Powersmiths E-Saver-C3 is a three-phase common-core, ventilated, dry type isolation transformer, built in an ISO 9001 and ISO14001 environment to NEMA ST-20 and other applicable ANSI and IEEE standards. Primary and secondary terminals and voltage taps are readily accessible by removing the front cover plate; 10kV BIL. The E-Saver-C3 has 220°C class insulation, is rated for 60 Hz, and comes in a NEMA 1 ventilated indoor enclosure. It exceeds the efficiency requirements of a Department of Energy (DOE) candidate Standard Level 3 (CSL 3). The E-Saver-C3L comes in two models optimized for light loading: copper-wound k-7 listed, and aluminum-wound k-4 listed. Both have a 130°C temperature rise. The E-Saver-C3H is optimized for heavy loading, is copper-wound, has a UL listed k-13 rating, and a 105°C temperature rise. The C3H model has an 80°C option with k-20 rating.

Savings Methodology

Below is the general approach to calculate savings for this measure.

Cost per kWh = Average Site $/kWh

Cost of Existing Loss = kWh x (1-Efficiency of Transformer Existing)

Proposed Loss = kWh x (1-Efficiency of Transformer Proposed)

Energy Savings $ = (Existing kWh – Proposed kWh) x kWh Rate

Benefits

- Electrical energy savings
- Reduction in maintenance costs

ECM #24: Pay for Performance Incentive

Johnson Controls is a partner in the New Jersey Pay for Performance Program. This program allows our customers to obtain substantial rebates for energy savings projects (in excess of what could typically be obtained through the standard NJ SmartStart program) when energy savings exceeds 15% of the baseline usage for each building. We expect that the many of the buildings in the scope 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 building with a whole-building technical component of a traditional energy audit, an energy model, a financial plan for funding the energy efficient measures, and a construction schedule for installation.

Johnson Controls is one of the leading ESCOs in the state of New Jersey when it comes to successful completion of the Energy Reduction Plan which is required for participation in the program and culminates with receiving the first of three incentives. Johnson Controls will use this expertise to gain as many incentive dollars for the project as possible. At the same time, we feel 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 the District.

Scope of Work

The following services will be provided during the development of the ESP for the District:

- Coordinate with the District to complete and submit the Pay for Performance Application.
- Develop and submit Energy Reduction Plan to Pay for Performance Case Manager.
- Complete and submit Request for Incentive #1.
- Conduct necessary reviews with Pay for Performance Case Manager.

During and after installation of measures is complete the following services will be provided:

- Compile Installation Report for submission.
- Complete and submit request for Incentive #2.
- Conduct necessary reviews with Pay for Performance Case Manager to ensure equipment has been installed according to scope of work submitted in ERP and ESIP.

After Year 1 of performance period:

- Complete post-construction benchmarking report.
- Complete and submit with request for Incentive #3 if the schools are eligible.
- Conduct necessary reviews for Incentive #3.

Benefits

- Source of revenue throughout the project development and implementation.
- Public acknowledgement of District's efforts toward energy responsibility.

Measures Considered but Not Included

ECM #25: Boiler Burner Replacement

ECM Summary

JCI proposes to replace the burners at Williamstown High School with new Industrial Combustion natural gas burners and associated controls. This measure will improve the efficiency of the heating plant.

Existing System

Williamstown High School is heated by three (3) Clever Brooks 5,250 MBH non-condensing hot water boilers and the capacities of the boilers are shown in the table below. The boilers were originally installed in 1995.

	Manufacturer	Model	Input (MBH)
Boiler #1 ,#2 ,and #3	Cleaver Brooks	CB 700	5,250

Facilities Recommended for this Measure

- Williamstown High School

Scope of Work

Williamstown High School

The following general requirements are associated with HVAC / Mechanical / Electrical upgrades to the facilities. Work to be in accordance with prevailing industry practice, state and local codes.

- Remove the existing (2) gas gun power burners including the combustion air damper controls, on each of the boilers. Based on time of year, one boiler will be retrofitted and started prior to proceeding to the next unit. JCI will provide the schedule before starting the installation.
- Reconnect gas lines from existing to new burners.
- Inspect the each boiler. The front wall of the boiler will be demolished and the refractory rubble will be properly disposed of.
- Reconnect power and control wiring to new burners.
- Each new gas gun power burner will consist of a minimum of the following components: A wind box, an integral fan, an air register, a spark ignited natural gas pilot and natural gas built in accordance with the recommendations of factory mutual and in accordance with NFPA 85 standards.
- Includes a factory-authorized agent to provide burner light off and adjustment. The start-up agent shall provide a burner light-off report as written proof that the burner was adjusted to optimum performance.
- The authorized agent shall provide a one-year service warranty after start-up.

Savings Methodology

In general, savings are calculated using Excel-based Bincalc. Savings result from the increased efficiency of the new burner/heating system as compared to the older heating system. The table below shows the combustion efficiency of a gas fired burner as a function of excess air and stack temperature.

Efficiency Table

EXCESS AIR	O2 (%)	CO2 (%)	Net Stack Temperature (ºF)							
			280	290	300	310	320	330	340	350
9.5	2	10.7	83.6	83.3	83.1	82.9	82.6	82.4	82.2	82.9
12.1	2.5	10.4	83.4	83.2	83	82.7	82.5	82.3	82	81.8
15	*3*	*10.1*	*83.3*	*83*	*82.5*	*82.1*	*81.6*	*81.1*	*80.8*	*80.4*
18	3.5	9.8	83.1	82.9	82.6	82.4	82.2	81.9	81.7	81.4

Maintenance Requirements

Annual maintenance procedures should be followed as recommended by the boiler manufacturer.

Benefits

- Operational savings based on new equipment requiring less maintenance
- Capital improvements of heating plant

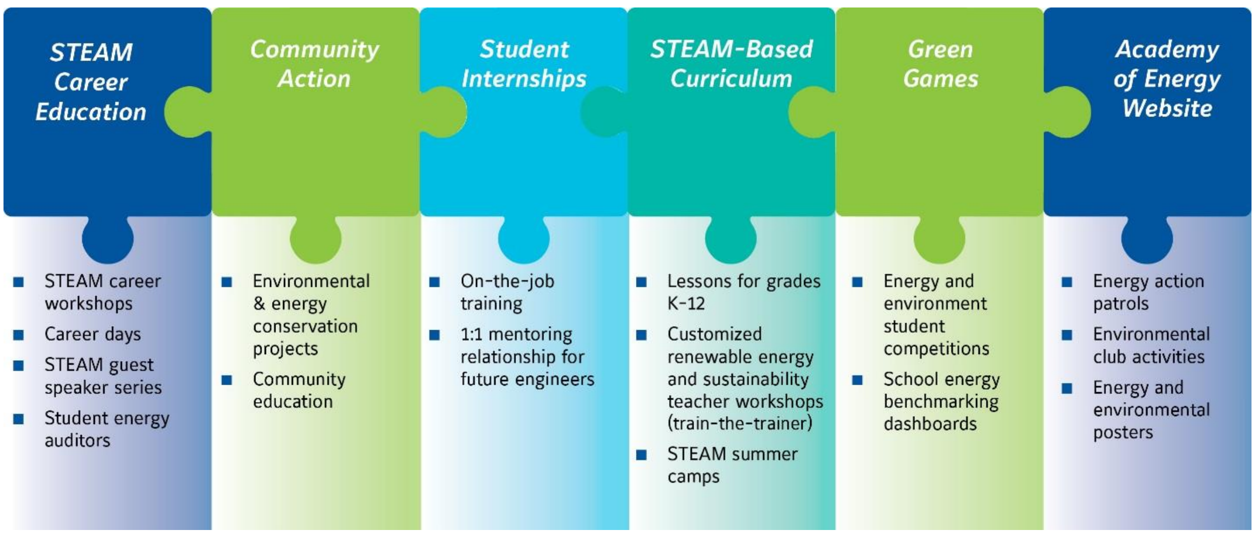
ECM #26: Student Engagement and Teacher Professional Development Programs

Students are part of the solution in saving energy. We know that engaging students in energy efficiency initiatives brings greater savings to our clients and provides benefits to student development. Johnson Controls and our K-12 leadership made a company-wide commitment to help schools create better environments for achievement through programs that focus on energy, the environment and classroom education.

We share your commitment to continually enhance your learning environments and help improve your curriculum. We offer several nationally recognized programs to engage students. We take your energy education program to the next level, including our curriculum based on Science, Technology, Engineering, Arts and Math (STEAM).

The following graphic speaks to the programs we offer. Our program director at Johnson Controls will collaborate with your District in the development of customized curricula on sustainability awareness and student workforce preparedness.

Student Engagement Programs Offered



Academy of Energy Education Programs

Over 20 years ago, Johnson Controls partnered with the National Energy Foundation (NEF) to form the Academy of Energy Education to help engage students in energy conservation at school, at home and in the community. The Academy is an award-winning energy education and curriculum enhancement program. Today, the Academy brings the latest energy awareness information and classroom-ready lessons on Science, Technology, Engineering, Arts and Math (STEAM) and resources to districts nationwide.

The Academy of Education website offers a downloadable K-12 STEAM curriculum, K-12 and community awareness activities, training resources, blogs, competitions, and educational libraries.

Snapshot of Academy of Education Website

The Academy delivers curriculum-enhancing programs correlated to state and national standards. They combine the study of exploratory science, energy and math with real work experience, offering young students the opportunity to have fun while engaging in a wide variety of curriculum-enhancing packages. In addition to curriculum programs and training, Academy customers receive access to the Academy of Energy website. Some of the course offerings available are shown below:

Energy Fun, grades K-3, introduces basic energy concepts to students in a fun and inviting way. Energy Fun is a guide that supports core curriculum requirements and offers basic energy use concepts that capture the attention of young students.

Energy Fundamentals, grades 4-6, includes an Energy Fundamental activity guide and the Energy Basics website containing background information on energy sources, a conceptual framework, an energy glossary, internet resources, skills and processes information, and over fifty just for fun energy activities. Activities support core curriculum requirements and offer basic fundamental energy and natural resource concepts that appeal to young students.

Energy Action Patrol Elementary School Edition, grades, 5-7, is an enhanced version of NEF's national award winning Energy Patrol program. Students wear patrol lanyards while conducting regularly scheduled energy audits of their school. A program binder contains guidelines and instructions, energy use reminder notices, off stickers, and an instructional video/DVD for teachers and students. A 14-page hands-on activities Energy Saver's Guide is included for each student.

Energy Action Patrol Secondary Edition, provides young adults the opportunity to work as a team while engaging in learning experiences including energy audits of their schools, research, preparation and eventual submission of an energy efficiency policy for their school.

Energy Action Technology, grades 9-12, teaches advanced energy concepts. Over 72 learning activities and seven Sources of Energy posters and corresponding energists teach students about energy technologies and society as they begin to make the transition from school to work. Sources include: Coal, Oil, Natural Gas, Nuclear, Water, Renewable Energy, and Electrical Generation. Five full color technical posters teach about the Science of Flames, Petroleum Technology, Natural Gas Technology, Recycling Used Oil and Electro-technology.

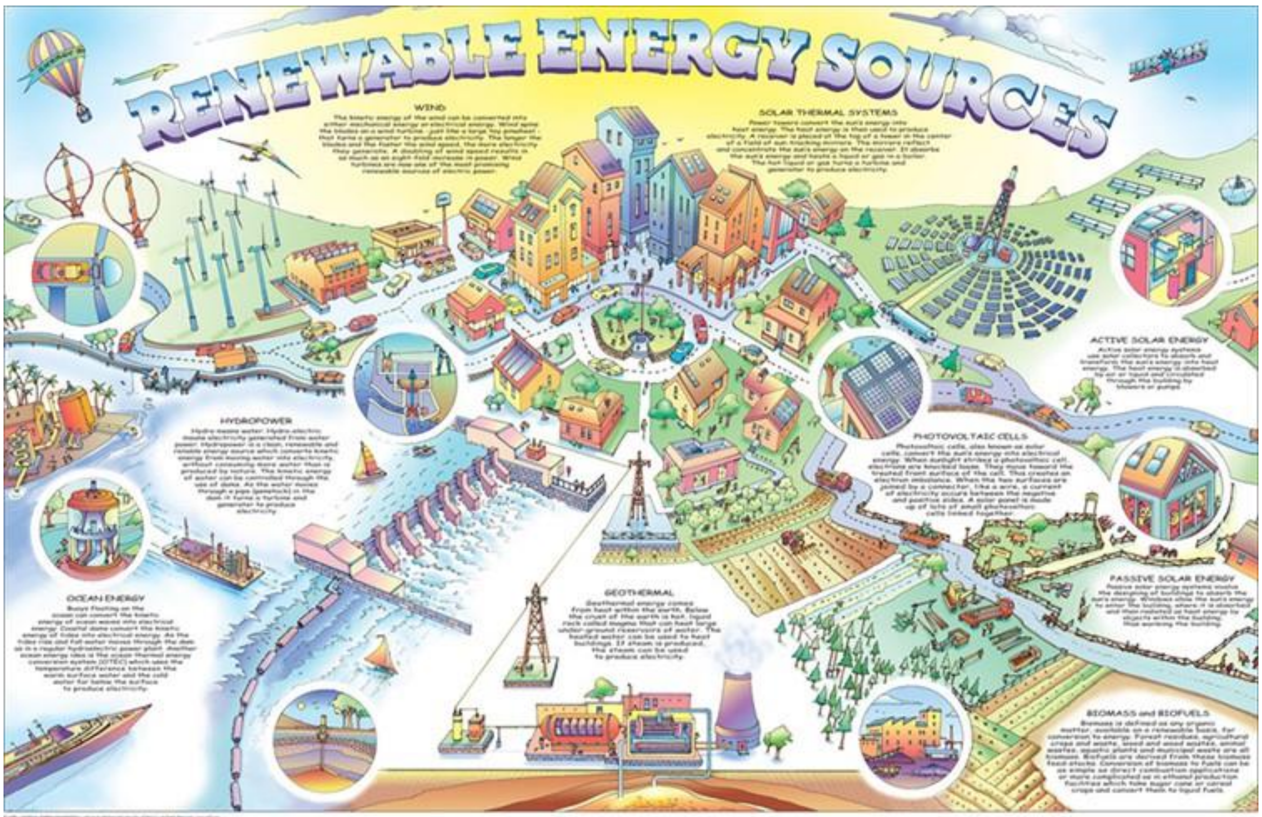
Wind Energy in Action, grades 4-12, this interdisciplinary program includes learning activities for the elementary and secondary levels plus a kit which enables the teacher and students in cooperative learning groups to investigate the complexities of electrical generation while building and testing model wind turbines for their classroom. This program can stand alone or serve as an excellent complement to Energy Fundamentals, Energy Action Technology and 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, practical experiences, new skill development, realistic perceptions of the work environment, and professional contacts.

Academy Renewables: grades K-12, is an interdisciplinary collection of three energy sources: solar, wind and geothermal. This comprehensive green energy collection provides curriculum and supplies to teach students three of these important energy sources. The Academy Renewable Kit includes the complete Academy Solar, Academy Wind and Academy Geothermal Kits, and the activity supplies that support the inquiry based activities.

Program Benefits

Deploying the Academy as part of this project offers several benefits. It engages all stakeholders, and enables your District to save additional dollars by raising energy awareness among students, teachers, staff members and the community. In addition to maximizing your energy savings, the program encourages natural resources conservation through motivational aspects for teachers and student participation, creating a culture of sustainability. It helps attract and retain quality teachers by offering fresh, timely classroom-ready STEAM materials, plans and activities that are aligned with the existing curriculum and state academic standards. Academy participants can partake in contests through the Academy of Energy website, download activities, chat with experts, exchange ideas with students nationwide, and more. Students can also receive credit for participating in high school and college school-to-work programs that help students prepare for STEAM careers.



The Academy posters, produced by National Energy Foundation, truly capture the imagination of students and deliver to teachers a ready-to-use, attractive, standards-based resource. An innovative method of blending colorful, engaging illustrations with solid instructional information into a 23”x35” poster has made Academy posters a mainstay in classes around the country.

Science, Technology, Engineering, Arts and Math

Johnson Controls is focused on working with school districts to develop and support career-themed curriculum, work-based learning and community partnerships to prepare students for college and careers of the 21st century. Our company is involved in several community programs designed to foster interest and excitement in science, technology, engineering, arts and math. We can work with you to develop similar efforts.

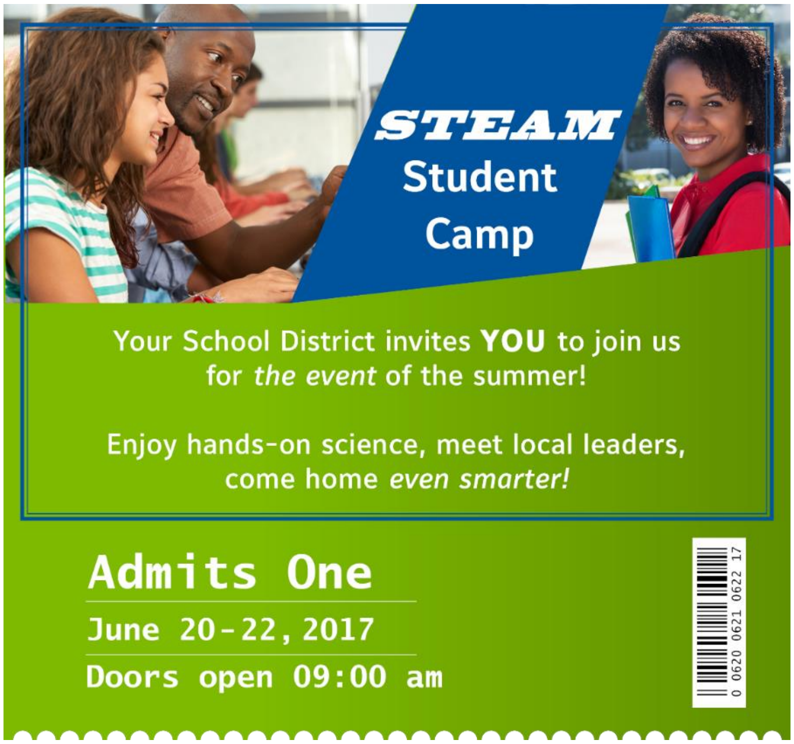
One of the STEAM programs we support is the F.I.R.S.T (For Inspiration and Recognition of Science and Technology) Robotics Competition. Robotics has proven to be a catalyst in sparking interests in STEAM fields. Each year, F.I.R.S.T. coordinates the efforts of more than 2,500 high school teams as they work with professional mentors to design, program and build a robot to meet that year's game strategy. Students involved in F.I.R.S.T. are nearly four times likely to pursue a career in engineering and science.

Recently the program involved a timed contest in developing a robot with as many colorful inner tubes as possible onto a huge pegboard set up in a basketball court-like area. The emphasis of the program was to promote teamwork, cooperation, and professionalism while instilling a sense of passion around the STEAM disciplines. The competition is fun and the results are encouraging.

STEAM Camp

Johnson Controls has collaborated with NEF in the development of a two and a half day STEAM Summer Camp for high school students. Through hands-on curriculum, activities, resource materials, and a community presentation, 25 high school students have an opportunity to learn about energy, water and utility reduction over the summer. As their capstone project, they will be applying and demonstrating what they have learned to MELD (Music Electricity, Lights, and Dance) presentation to their families and community.

The following is a sample ticket and student STEAM Camp Agenda that Johnson Controls can create for your students. These would be customized for your school district and include your district name and logo or as you prefer.



Teacher Workshop

Additionally, Johnson Controls and NEF have a professional development, one-day workshop for teachers. The Academy workshop shares with teachers:

- How to integrate the solar, wind, water and energy efficiency tool kit and STEAM lessons into classroom instruction.
- By what method to motivate students to take action at home and involve their families in wise energy practices that will save energy, money and the environment.

Agenda
STEAM Student Camp

	DAY 1 June 20th	DAY 2 June 21st	DAY 3 June 22nd
9:00 am	Welcome and Introductions Energy Types, Forms, Sources and Transformation Activities ■ A Bright Idea and the Energy Stick ■ What is Energy? ■ Energy for Electricity	Solar, Wind and Water Solar activities ■ What is Solar Energy? ■ Electricity from the Sun ■ Series and Parallel Circuits with Solar Cells	Half Day Show Me Up – The MELD (Music Electricity, Lights, and Dance) Student performance for parents, community leaders – review and showcase of knowledge of what they have learned.
Break-15 minutes	Break	Break	
	Renewable and Nonrenewable Resources Activities ■ The Search for Energy ■ Pass the Sack ■ Cookie Coal Mining	Wind Activities ■ Making Wind Work ■ Building and Testing Wind Turbines	
12:00 Lunch	Lunch	Lunch	Adjourn (no lunch)
	Energy Forms and Transformations ■ Roller Coaster Energy	Water Activities ■ Water energy, Hydropower ■ Building and testing water turbines ■ Water flow and efficiency (test flow bag experiment)	
Break-15 minutes	Break	Break	
	Energy Efficiency ■ LED, CFL and Incandescent ■ Controlling Consumption ■ Phantom Loads, Kill-A-Watt meters ■ Smart Power strips JCI Employees and/or Society of Women Engineers will share their job responsibilities. Review, questions and answers	Transportation Efficiency ■ Hitting the Road ■ Fuel Mix for Electrical Generation ■ Discovering Sources of Electricity Students break off into teams – Assignment given for Community Day Event- MELD (Music Electricity, Lights, and Dance)	
4:00 pm	Adjourn	Adjourn	

The training and materials go hand-in-hand to help educators efficiently use Academy content and learn how it correlates with state/national standards. Teachers will have an opportunity participate. Each teacher will leave with lesson plans, and a teacher kit. Teacher kit includes the following: 6 solar mini solar panels, 6 mini-motors and 6 propellers; 6 multi-meters, 3 wind stand kit (PVC pipes), 1 smart power strip, 1 Kill-A-Watt meter and 4 posters. The Academy workshop allows a variety of teachers from different disciplines to engage their students in energy education.

Hands on Discovery: Kiosk Displays

The Johnson Controls Green Kiosk is customized for each customer site for students, parents and staff to learn about the facilities they visit on a daily basis. Solutions can range from a simple, single display of building automation information, to a complete, custom solution to display all buildings in your schools. What sets the Green Kiosk apart is the fact that it’s available both online and with a standalone kiosk, for a one-time fee. There are no monthly service fees.

To the right is a screen example of what someone might see on the Green Kiosk in person or online.

ECM #27: Aris Wind Turbine

Executive Summary

Wind power reduces the quantity of purchased power from the local utility resulting in good financial benefits for both electric and fossil fuels; and provides an excellent platform for education.

Detailed Description of Measure

Scope of Work

Johnson Controls proposes to install one (1) Aris Remote Power Unit (RPU) that will include a 300-Watt wind turbine for electrical generation, a 250-watt polycrystalline solar panel, two LED lights and a 24V battery storage system. The physical location and system variation must be agreed upon with the District. The specifications of the unit is mentioned in the table below.

- 80 Watt LED Hybrid Streetlight (RPU) with single lamp arm
- Monroe School District banner print both sides and tailfin
- Data Monitoring and Maintenance of the RPU
- USB Charging station at the RPU
- Installation, foundation, cleanup and haul away (Prevailing Wages)

By installing a RPU system, you will receive the following benefits.

- LED lighting and enhanced security
- Save money on your system purchase with state rebates
- Utilize free energy from the wind and sun
- Provide a valuable teaching program to instill environmental awareness and responsibility

Wind Power (Permanent Magnetic Generator)	
Rated Power Output	300w
Rated Wind Speed	9 m/s (20 mph)
Cut in Wind Speed	2 m/s (4.5 mph)
Solar Power	
Number of Panels	1 Polycrystalline Panel
Rated Power Output	250w - 500w
LED Lighting	
Number of Lights	1 or 2 lamp arms/fixtures
Wattage/Fixture	60w, 80w, 100w Dimmable
Control System	
Charge Controller	Airsynergy Hybrid Controller
Voltage To Battery	24v
Batteries	
Type	Absorbent Glass Mat (AGM)
Number	(2) 12v Batteries for 24v Storage
Capacity (amp-hrs)	230 amp hour
Tower	
Material	Hot Dipped Galvanized Steel
Powder Coat Paint	White (std), Green/Brown (opt)

Energy Savings Methodology

In general, Johnson Controls uses the following approach to determine savings for this specific measure:

Cost per kWh = Average Site Data Package $/kWh

Developed kWh = As calculated by e2systems with the location average annual wind speed

Energy Savings $ = kWh x Average Site Data Package $/kWh

Changes in Infrastructure

New equipment will be installed and electric tie in required.

Support and Coordination with Utilities

Coordination of the electrical tie in to the main electric panels will be required as well as with local rebates associated with the installation.

ECM 28: Visitor Management System and Integration

ECM Summary

Today's educational environment represents a multitude of challenges regarding physical identity and access management. Multiple buildings; restricted areas; higher levels of security integration; and a wide variety of personnel can create significant hurdles to efficient identity management and related physical access. At the same time, the New Jersey Department of Education compliance requirements have increased, layering in a new level of complexity for security practitioners.

Detailed Description of Measure

Proposed System

Johnson Controls, through this ECM would provide a visitor management system that could be installed in each lobby and has the following features:

- Visitor badge printer that can provide security personnel an opportunity to review the printed badge.
- A high-resolution camera to photograph your visitor for an accurate record of the visitor's appearance.
- Scans any state driver license with 100% accuracy in less than one second with the included bar code scanner.

ECM 29: VOIP Telephone System

Existing Conditions

The existing phone system is traditional analog /digital voice system.

Scope of Work

Johnson Controls will provide and install a Voice-over Internet Protocol (VoIP) Private Branch Exchange (PBX) Phone System on a converged network of voice and data. The measure will replace the existing phone system with newer technology, server-based voice systems. Through the process of replacing the voice systems, the separate telecommunication infrastructures, supporting the voice network and the data network, will be combined. Leveraging the newer technologies will create a single, common infrastructure that will be capable of supporting voice, video, data and advanced applications. The implementation will include necessary equipment and services required to migrate the customer, and applicable remote sites, from the current systems, to a centralized VoIP PBX system based at a main facility.

The creation of a single telecommunication infrastructure for voice, video and data, provides the unique savings opportunity, as recurring carrier/ circuit costs will be reduced through the convergence. Additional savings opportunities will be presented in the areas of scheduled maintenance and system configuration, moves, additions, and changes, and system maintenance.

ECM 30: Roof Repairs at Elementary Schools

ECM Summary

The roof of a building can cause significant amount of energy and maintenance costs throughout the year due to issue that may arise with roofs leaking through cracks and weather damage. Upgrading the roof with a High Solids Silicone Construction Coating roofing system will repair any leaks or holes in the structure and also provide long term warranty. Maintenance will be easier because many existing problems with the structure will be repaired.

Existing System

At the Elementary Schools although the roof is past its life expectancy, some of them are in good shape.

Proposed System

The existing roof needs upgrades to ensure warranty and address any leaks and repairs to the current roof system. Roof upgrades and repairs will be considered as alternatives to the scope.

Section 5. Measurement and Verification

Measurement & Verification Methodologies

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

They have been developed and defined by the following independent authority:

- International Performance Measurement and Verification Protocol (IPMVP)

There are four guarantee options that may be used to measure and verify the performance of a particular ECM. 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. Also, 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. Also, 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 during the term of the performance contract.

Recommended Performance Verification Methods

Johnson Controls 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 Johnson Controls 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.

Measure	M&V Option	M&V Methodology
Retrofit LED Lighting - Interior with Smart Sensors and Exterior	A	Pre - lighting wattage from manufacturer readings, assumed operating hours align with JCI database. Post - Wattage will be measured on new lighting fixtures.
Weather Stripping & Air Sealing	NM	Pre – Site visit to determine the crack location and sizes. Post - Verify the crack location and sizes with as-built.
Building Controls Upgrade	A	Pre - Site audit to collect pre-retro schedules, space set points and heating/cooling sequences. Post - Setup trending and track to verify the proposed schedules and temperate setpoints.
Replacement of HVAC System	NM	Pre - Site audit to collect the information of the equipment that will be replaced. Post - Verify the installed equipment to ensure they are installed as expected.
Replace Heating & Ventilation Units and Add Cooling at Gyms of High School and Middle School	NM	Pre - Site audit to collect the information of the existing gym unit. Post - Verify the installed equipment and their operation schedule to ensure they match the design.
AHU Replacements at Oak Knoll ES	NM	Pre - Site audit to collect the information of the existing AHUs that will be replaced. Post - Verify the installed equipment and their efficiency to ensure they match the design.
Boiler Relocation and Domestic Hot Water Decoupling at Middle School	NM	Pre - Site audit to collect the information of the DHW heaters that will be decoupled. Post - Verify the installed equipment and collect the equipment information to ensure they are installed as expected.
Boiler Replacement	A	Pre – Existing boiler efficiency and annual heating load are determined through the site audit and annual natural gas bills. Post - Ongoing combustion efficiency and boiler operation parameters verification on BAS.
Premium Efficiency Motors on HVAC Equipment	NM	Pre - Site audit to collect the information of the motors that will be replaced. Post - Verify the installed equipment and their efficiency to ensure they are installed as expected.
Variable Speed Drives on Hot Water Pumps	A	Pre - kW test on pumps. Post - VFD speed data trending on BAS.
Chiller Replacement	NM	Pre - Site audit to collect the information of the chiller that will be replaced. Post - Verify the installed equipment to ensure they are installed as expected.

Measure	M&V Option	M&V Methodology
Chiller Reconfiguration at Middle School	B	Pre - Collect the operation parameters and sequence of operation of existing chillers. Post – Set up trending on operation parameters in BAS to verify the proposed sequence of operation.
Variable Speed Drives on Chilled Water Pumps	A	Pre - kW test on pumps. Post - VFD speed data trending on BAS.
Domestic Hot Water System Installation	NM	Pre - Site audit to collect the information of the DHW heaters that will be replaced. Post - Verify the installed equipment and their efficiency to ensure they are installed as expected.
Solar PV - Power Purchase Agreement	NM	Pre – The potential Solar PV kWh generation is determined through the existing annual electric consumption and the annual savings from the other ECMs. The annual kWh generation will be mutually agreed upon between JCI and the school district. Post – Verify the Solar PPA rate through the PPA invoices.
Kitchen Hood Controls	NM	Pre - Site audit to collect the information of the existing kitchen hoods. Post - Verify the installed equipment and their operation schedule to ensure they are installed as expected.
Micro CHP	NM	Pre – Site audit to determine the existing building heating load and electric consumption. Post - Verify the installed equipment to ensure it matches the design.
Transformer Replacement	NM	Pre - Site audit to collect the information of the existing transformers. Post - Verify the installed equipment and their efficiency to ensure they are installed as expected.
Water Conservation Rate Change Savings	NM	Pre – Collect the existing water bills to confirm the water rates. The annual savings are to be mutually agreed upon between JCI and the school district. Post - Collect the post water bills to ensure the new rate is reflected.

Measurement and Verification Services

M&V Services will be provided in association with the guarantee provided by Johnson Controls. The guarantee will be in effect for each year that the School elects to participate in the M&V Services. The cost of the M&V services is included in the business case in the "Annual Services" column as outlined in the table below:

Year	Annual Amount ($/yr)
1	$61,600
2	$61,600
3	$61,600
Total	$184,800

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

1. During the Installation Period, a Johnson Controls Performance Engineer will track Measured Project Benefits. Johnson Controls 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.
2. For specified Improvement Measures, Johnson Controls will:
    A. conduct pre and post installation measurements required under this Agreement;
    B. confirm the BAS employs the control strategies and setpoints specified in this Agreement;
    C. 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);
    D. 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
    E. 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. Trend data records maintained in the ordinary course of system operation shall be used and relied upon by Johnson Controls in connection with Project Benefit calculations. Johnson Controls will use commercially reasonable efforts to ensure the integrity of the data collected to calculate the required metrics. In the event data are lost due to equipment failure, power failure or other interruption in data collection, transmission or storage, Johnson Controls will use reasonable engineering methods to estimate or replace the lost data.
3. During the Guarantee Term, a Johnson Controls 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. In this regard, the Performance Engineer will periodically assist Customer, on-site or remotely, with respect to the following activities:
    A. review of information furnished by Customer from the facility management system to confirm that control strategies are in place and functioning;
    B. advise Customer's designated personnel of any performance deficiencies based on such information;
    C. coordinate with Customer's designated personnel to address any performance deficiencies that affect the realization of Measured Project Benefits; and
    D. inform Customer of opportunities to further enhance project performance and of opportunities for the implementation of additional Improvement Measures.

4. Within 60 days of each anniversary of the commencement of the Guarantee Term, Johnson Controls will provide Customer with an annual report containing:
   A. an executive overview of the project's performance and Project Benefits achieved to date;
   B. a summary analysis of the Measured Project Benefits accounting; and
   C. Depending on the M&V Option, a detailed analysis of the Measured Project Benefits calculations.
5. Johnson Controls will assist the School in applying for rebate incentives. This includes submitting application forms and data on behalf of the School and following up with the program administrators to answer any questions or provide additional information. Work is expected to take place during the Construction period and Year 1 only. **Note: Rebates are not guaranteed.**

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 Monroe Township School District; any warranty issues will be handled directly with the equipment manufacturer rather than with Johnson Controls.

The installation of the recommended measures will reduce the amount of emergency maintenance required by the School 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, Johnson Controls will assist the School 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 ESP project which will allow the School to complete the majority of maintenance and repair in-house in order to utilize School resources.

To ensure the School is fully capable of achieving its energy savings and utilize the new HVAC and BAS, Johnson Controls is including training for School employees.

Johnson Controls recommends the School 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:

- BAS Agreement including updates to subscription services
- Cogeneration Service Agreement to allow for emergency service and preventative maintenance on the new cogeneration systems.

Design and Compliance Issues

Johnson Controls will enlist a design engineering firm 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 ESIP development, Johnson Controls 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 School. 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, Johnson Controls did not observe any compliance issues in the development of this ESIP.

Customer Risks

Asbestos reports will be obtained for all schools as part of Johnson Controls 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, Johnson Controls will stop work and notify the School. Any work associated with testing or remediation of asbestos containing material will be the responsibility of Monroe Township School District.

Johnson Controls does not guarantee the rebate or state incentive structure. If the programs change or the incentive amounts differ, Monroe Township School District will be responsible to make up the difference in received incentives for the financing. The difference could result from over performance of ECMs, other rebates/ incentives that may be available, restructuring the loan payment for years 1 and 2, or capital contributions by the School.

Section 7: Implementation Schedule

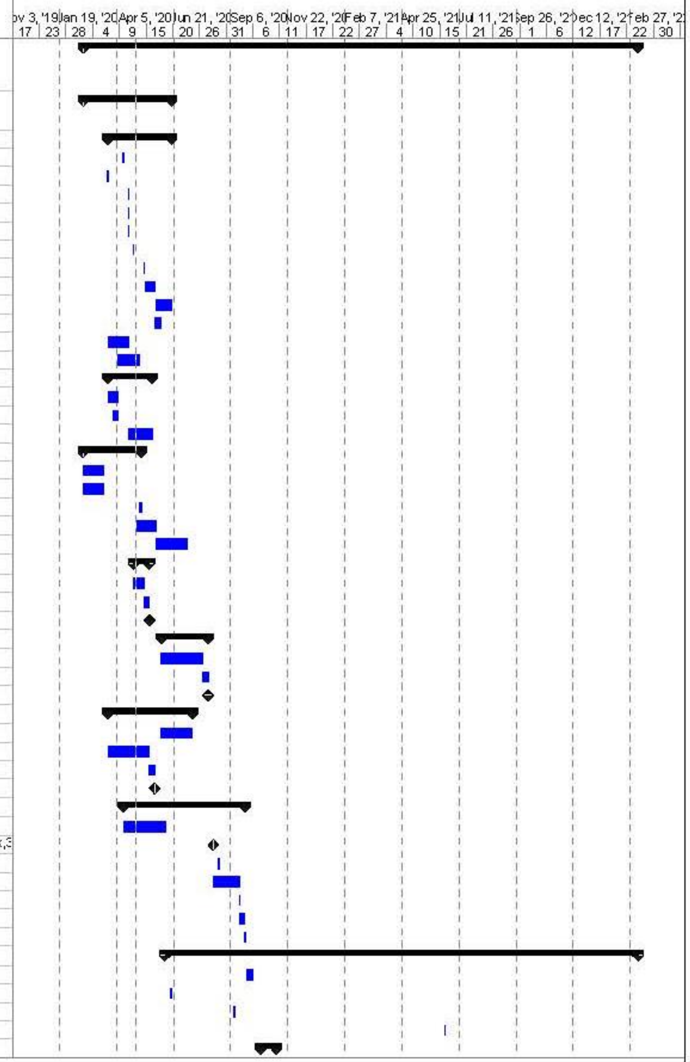
A preliminary installation schedule for the measures implemented as part of the ESIP is included below to provide a reasonable expectation for the timeline of construction. Once final bids are received and financing of the project is complete, the installation will be finalized in much greater detail and reviewed with the team from Monroe Township School District 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 ESIP Pending necessary Reviews – May 5th, 2020
- Complete Third Party Engineering Review of ESIP – May 18th, 2020
- Complete Board of Public Utilities Review of ESIP – May 28th, 2020
- Approval resolution to contract with Johnson Controls – June 4th, 2020
- Finance Bid Opening – May 19th, 2020
- Complete 100% design drawings and bid specifications for Holly Glen HVAC – June 4th, 2020
- Expected Finance Close – June 9th,2020
- Complete 100% design drawings and bid specifications for other ECMs – August 28th, 2020

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

Monroe Township Public Schools
ESP Development & Installation Schedule

ID	Task Name	Duration	Start	Finish	% Work Complete	Predecessors
1	**Monroe Township Public Schools ESIP**	**534 days**	**Thu 2/20/20**	**Tue 3/8/22**	**0%**	
2	**Phase 1: Investment Grade Audit/ Energy Savings Plan**	**85.5 days**	**Thu 2/20/20**	**Thu 6/18/20**	**0%**	
3	**Major Milestone**	**62.5 days**	**Tue 3/24/20**	**Thu 6/18/20**	**0%**	
4	Signed Investment Grade Audit Agreement	1 day	Tue 4/14/20	Tue 4/14/20	100%	
5	Customer Kick-off Workshop	2 hrs	Tue 3/24/20	Tue 3/24/20	0%	
6	ECM Verification Workshop	3 hrs	Tue 4/21/20	Tue 4/21/20	0%	14SS+1 wk,7FF
7	Baseline Utility Workshop	3 hrs	Tue 4/21/20	Tue 4/21/20	0%	18FS+10 days
8	Measurement & Verification Workshop	3 hrs	Tue 4/21/20	Tue 4/21/20	0%	7SS
9	Business Case Workshop	2 hrs	Tue 4/28/20	Tue 4/28/20	100%	
10	IGEA Results Presented to Board	2 hrs	Tue 5/12/20	Tue 5/12/20	0%	9FS+2 wks
11	3rd Party Engineering Review	10 days	Wed 5/13/20	Wed 5/27/20	0%	10FS+1 day
12	Submit Energy Savings Plan to BPU for Review	15 days	Thu 5/28/20	Thu 6/18/20	0%	11FS+1 day
13	Customer Approval & Acceptance of ESP & JCI Contract	6 days	Wed 5/27/20	Thu 6/4/20	0%	11
14	**Detailed Site Visits**	**3.95 wks**	**Tue 3/24/20**	**Mon 4/20/20**	0%	**5**
15	**Scope Design & Construction Cost Estimating**	**4 wks**	**Tue 4/7/20**	**Tue 5/5/20**	0%	14SS+2 wks
16	**Detailed Energy Analysis**	**43.75 days**	**Tue 3/24/20**	**Fri 5/22/20**	**0%**	
17	Solar Development	2 wks	Tue 3/24/20	Tue 4/7/20	0%	5
18	Update Utility Bills	1 wk	Tue 3/31/20	Tue 4/7/20	0%	5FS+1 wk
19	Energy Saving Calculations	4.8 wks	Tue 4/21/20	Fri 5/22/20	0%	14
20	**Data Logging**	**56.63 days**	**Thu 2/20/20**	**Fri 5/8/20**	**0%**	
21	Lighting Loggers	20 days	Thu 2/20/20	Wed 3/18/20	0%	
22	Temperature/ Motor Loggers	20 days	Thu 2/20/20	Wed 3/18/20	0%	
23	Field Measurements	3 days	Tue 5/5/20	Fri 5/8/20	0%	8FS+2 wks
24	ESP Report Development	18 days	Fri 5/1/20	Wed 5/27/20	0%	23FS-1 wk
25	**Project Financing**	6 wks	Wed 5/27/20	Wed 7/8/20	0%	24
26	**Phase 2: Design Holly Glen**	**15 days**	**Tue 4/28/20**	**Tue 5/19/20**	**0%**	
27	Final Design Engineering	2 wks	Tue 4/28/20	Tue 5/12/20	0%	5FS+5 wks
28	Bid Specification Development	1 wk	Tue 5/12/20	Tue 5/19/20	0%	27
29	Final Design Review/Workshop	0 days	Tue 5/19/20	Tue 5/19/20	0%	27FS+1 wk
30	**Phase 2: Design Remaining Work**	**45 days**	**Thu 6/4/20**	**Thu 8/6/20**	**0%**	
31	Final Design Engineering	8 wks	Thu 6/4/20	Thu 7/30/20	0%	13
32	Bid Specification Development	1 wk	Thu 7/30/20	Thu 8/6/20	0%	31
33	Final Design Review/Workshop	0 days	Thu 8/6/20	Thu 8/6/20	0%	31FS+1 wk
34	**Phase 2: Design Solar PPA**	**82.25 days**	**Tue 3/24/20**	**Thu 7/16/20**	**0%**	
35	Land Acquisition	6 wks	Thu 6/4/20	Thu 7/16/20	0%	13
36	Final Design Engineering	8 wks	Tue 3/24/20	Tue 5/19/20	0%	5
37	Bid Specification Development	1 wk	Tue 5/19/20	Tue 5/26/20	0%	36
38	Final Design Review/Workshop	0 days	Tue 5/26/20	Tue 5/26/20	0%	36FS+1 wk
39	**Phase 3: Procurement**	**118.25 days**	**Tue 4/14/20**	**Fri 9/25/20**	**0%**	
40	Holly Glen Equipment Procurement	8 wks	Tue 4/14/20	Tue 6/9/20	0%	27FS-4 wks
41	Advertise Bids	0 days	Thu 8/13/20	Thu 8/13/20	0%	28FS+1 wk,32FS+1 wk,3
42	Pre-Proposal Conference & Site Visits	1 day	Thu 8/20/20	Fri 8/21/20	0%	41FS+5 days
43	Bid Duration for Subcontractors	5 wks	Thu 8/13/20	Thu 9/17/20	0%	41SS
44	Opening of Bids	1 hr	Thu 9/17/20	Thu 9/17/20	0%	43FF
45	Evaluation of Bids and Confer on Selection of Sub-Contractors	1 wk	Thu 9/17/20	Thu 9/24/20	0%	44
46	Subcontractor Selection	1 day	Thu 9/24/20	Fri 9/25/20	0%	45
47	**Phase 4: Construction**	**455.75 days**	**Tue 6/9/20**	**Tue 3/8/22**	**0%**	
48	Issue Subcontracts	1 wk	Mon 9/28/20	Mon 10/5/20	0%	46FS+1 day,25
49	**Last Day of School 2019-2020**	1 day	Wed 6/17/20	Wed 6/17/20	0%	
50	**First Day of School 2020-2021**	1 day	Thu 9/10/20	Thu 9/10/20	0%	
51	**Last Day of School 2020-2021**	1 day	Mon 6/21/21	Mon 6/21/21	0%	
52	**Pre- Construction Activities**	**15 days**	**Fri 10/16/20**	**Fri 11/6/20**	**0%**	



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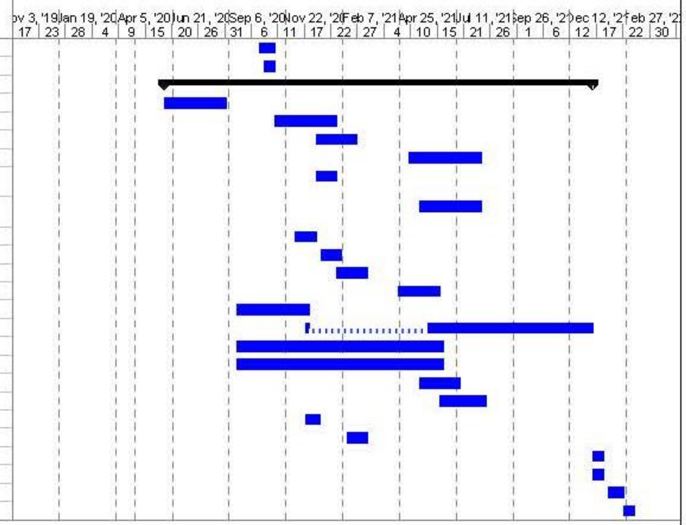
Johnson Controls

Monroe Township Public Schools
ESP Development & Installation Schedule

ID	Task Name	Duration	Start	Finish	% Work Complete	Predecessors
53	Mobilization / Planning / Engineering	3 wks	Fri 10/16/20	Fri 11/6/20	0%	48FS+9 days
54	Shop Drawing Approval	2 wks	Fri 10/23/20	Fri 11/6/20	0%	53FF
55	**Installation of Recommended ECMs**	**415.75 days**	**Tue 6/9/20**	**Tue 1/11/22**	**0%**	
56	Holly Glen HVAC Replacement	60 days	Tue 6/9/20	Tue 9/1/20	0%	40
57	Roofing Repair/Replacement	60 days	Fri 11/6/20	Fri 1/29/21	0%	54
58	Pipe and Valve Insulation	40 days	Fri 1/1/21	Fri 2/26/21	0%	54FS+8 wks
59	High Efficiency Modular Condensing Boilers	14 wks	Fri 5/7/21	Fri 8/13/21	0%	54FS+26 wks
60	Air Handling Unit Replacement at Oak Knoll Elementary School	4 wks	Fri 1/1/21	Fri 1/29/21	0%	54FS+8 wks
61	Replace Existing H&V/AHU Units and Add Cooling to High School and Middle School Gymnasiums	60 days	Fri 5/21/21	Fri 8/13/21	0%	54FS+28 wks
62	Ceramic and Welding Lab Ventilation Upgrades	20 days	Fri 12/4/20	Fri 1/1/21	0%	54FS+4 wks
63	Domestic Hot Water Heater Replacements	4 wks	Fri 1/8/21	Fri 2/5/21	0%	54FS+9 wks
64	Variable Speed Drives and Motor Replacements	6 wks	Fri 1/29/21	Fri 3/12/21	0%	54FS+12 wks
65	Replace Unit Ventilators	8 wks	Fri 4/23/21	Fri 6/18/21	0%	54FS+24 wks
66	Building Envelope Improvements	14 wks	Wed 9/16/20	Wed 12/23/20	0%	25FS+10 wks
67	Building Automation Controls Upgrade	32.6 wks	Fri 12/18/20	Tue 1/11/22	0%	54FS+6 wks
68	Interior/Exterior Lighting Upgrades	40 wks	Wed 9/16/20	Wed 6/23/21	0%	25FS+10 wks
69	Lighting Occupancy Sensors	40 wks	Wed 9/16/20	Wed 6/23/21	0%	25FS+10 wks
70	CHP System	8 wks	Fri 5/21/21	Fri 7/16/21	0%	54FS+28 wks
71	Chiller Replacement	45 days	Fri 6/18/21	Fri 8/20/21	0%	54FS+32 wks
72	Kitchen Hood Controls	14 days	Fri 12/18/20	Thu 1/7/21	0%	54FS+6 wks
73	Transformer Replacement	20 days	Fri 2/12/21	Fri 3/12/21	0%	54FS+14 wks
74	Punch List Items	2 wks	Wed 1/12/22	Tue 1/25/22	0%	55
75	Equipment Initial Training	2 wks	Wed 1/12/22	Tue 1/25/22	0%	74FF
76	System Commissioning	3 wks	Wed 2/2/22	Tue 2/22/22	0%	74FF+4 wks
77	Project Close Out	2 wks	Wed 2/23/22	Tue 3/8/22	0%	76



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Section 8. Sample Energy Performance Contract

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

Appendix 1. Energy Savings Calculations

Energy Savings

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

Appendix 2. Detailed Scope Descriptions

Detailed scopes of work will be defined by full drawings and specifications during the design phase of this project.

Construction documents for bidding purposes will be available electronically.

Appendix 3. Recommended Project – ESIP

Business Case for Recommended Project

Energy Savings and Cost Summary

The table below provides a summary of the costs and savings associated with the measures recommended in the ESP. 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.

ID #	Energy Conservation Measure	ECM Hard Cost	Year 1 Utility Savings*	Simple Payback
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - High School	$1,751,069	$114,964	15
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - Middle School	$1,212,756	$96,334	13
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior- DI - Holy Glen ES	$-	$22,786	
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior- W/Controls - Oak Knoll ES	$345,128	$22,022	16
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - Radix ES	$323,367	$27,146	12
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls- Whitehall ES	$188,706	$18,248	10
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - HS Auditorium	$146,699	$11,043	13
1 & 2	Lighting Redesign to Replace Pendant Fixtures at All ES Classrooms	$455,000	$-	
3	Weather Stripping & Air Sealing - High School	$31,304	$4,874	6
3	Weather Stripping & Air Sealing - Middle School	$38,795	$5,973	6
3	Weather Stripping & Air Sealing - Oak Knoll ES	$12,429	$2,251	6
3	Weather Stripping & Air Sealing - Radix ES	$23,317	$4,655	5
3	Weather Stripping & Air Sealing - Whitehall ES	$11,376	$1,835	6
4	Building Controls Upgrade - High School	$1,563,500	$91,722	17
4	Building Controls Upgrade - Middle School	$1,356,500	$19,568	69
4	Building Controls Upgrade - Holy Glen ES	$367,737	$10,543	35
4	Building Controls Upgrade - Oak Knoll ES	$398,800	$9,931	40
4	Building Controls Upgrade - Radix ES	$ 380,812	$ 11,117	34
4	Building Controls Upgrade - Whitehall ES	$ 388,487	$ 12,067	32
5	HVAC System Replacement at Holly Glen Elementary School	$ 4,750,255	$ 2,866	1657
5	Demo Existing Absorption Chiller and Cooling Tower at Holly Glen ES	$ 64,000	$ -	

ID #	Energy Conservation Measure	ECM Hard Cost	Year 1 Utility Savings*	Simple Payback
6	Replace Existing H&V Units and Add Cooling to High School Gymnasium	$ 943,750	$ (12,397)	
6	Replace Existing AHU Units and Add Cooling to Middle School Gymnasium	$ 482,500	$ (4,380)	
7	Air Handling Unit Replacement at Oak Knoll Elementary School	$ 72,782	$ 179	407
8	Ceramics and Welding Labs Ventilation Upgrades - Middle School	$ 213,000	$ (1,784)	
9	Boiler Relocation and Domestic Hot Water Decoupling at Middle School	$ 276,624	$ 6,062	46
10	Boiler Replacement and Domestic Hot Water Decoupling at Whitehall Elementary School	$ 516,659	$ 5,789	89
11	Boiler Replacement at High School	$ 913,332	$ 25,977	35
11	Boiler Replacement at Radix Elementary School	$ 97,147	$ 4,590	21
12	Premium Efficiency Motors on HVAC Equipment - High School	$ 118,375	$ 3,401	35
12	Premium Efficiency Motors on HVAC Equipment- Middle School	$ 6,005	$ 142	42
12	Premium Efficiency Motors on HVAC Equipment - Radix ES	$ 17,495	$ 154	113
12	Premium Efficiency Motors on HVAC Equipment- Whitehall ES	$ 17,668	$ 175	101
13	Variable Speed Drives on Hot Water Pumps - High School	$ 65,129	$ 6,799	10
13	Variable Speed Drives on Hot Water Pumps - Middle School	$ 70,425	$ 5,825	12
14	Chiller Replacement at High School	$ 456,169	$ 15,471	29
15	Chiller Re-Configuration at Middle School	$ 504,294	$ 10,271	49
16	Variable Speed Drives on Chilled Water Pumps - High School	$ 90,188	$ 5,741	16
16	Variable Speed Drives on Chilled Water Pumps - Middle School	$ 100,982	$ 7,165	14
17	Domestic Water VFD Booster Skid at High School	$ 57,853	$ 1,594	36
18	Domestic Hot Water System Installation at Holly Glen ES	$ 52,725	$ 1,993	26
19	Roof Upgrades and Repairs at High School	$ 627,325	$ 253	2480
19	Roof Upgrades and Repairs at Middle School	$ 836,275	$ 269	3109
20	Solar PV- Power Purchase Agreement Savings	$ -	$ 614,141	
21	Micro CHP - Whitehall ES	$ 80,000	$ 1,370	58
22	Kitchen Hood Controls - High School	$ 32,000	$ 1,666	19
22	Kitchen Hood Controls - Middle School	$ 31,000	$ 2,295	14
23	Transformer Replacement - High School	$ 175,297	$ 11,516	15
23	Transformer Replacement - Middle School	$ 99,752	$ 5,573	18

ID #	Energy Conservation Measure	ECM Hard Cost	Year 1 Utility Savings*	Simple Payback
23	Transformer Replacement - Radix ES	$ 32,981	$ 1,630	20
24	P4P Rebate Modeling - High School	$ 22,000	$ -	
24	P4P Rebate Modeling - Middle School	$ 22,000	$ -	
25	Score Board Electrical Service	$ 45,000	$ -	
26	Water and Sewer Rate Change		$ 120,503	
	Total	**$ 20,886,770**	**$ 1,331,928**	**16**

***Year 1 Utility Savings in the above table include a 2.2% escalation on Electric, 2.4% escalation on Natural Gas and 2.2% escalation on Water and Sewer for guaranteed savings.**

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 lighting and will generate material cost savings.

A brief description of the operational savings estimated for this project is included below. Johnson Controls has worked with the School 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	**Years to Carry**	**Annual Savings**
Retrofit LED Lighting Operational Savings	$44,310	5
Building Automation Controls Upgrade	$50,031	2
Boiler Replacement and DHW System Modification - Whitehall ES	$6,414	2
Boiler Replacement - Williamstown HS	$10,624	2
Chiller Replacement - Williamstown HS	$60,583	2
Chiller Re Configuration - Williamstown MS	$31,920	2
Premium Efficiency Motors Replacement	$1,862	2
Domestic Hot Water System Modification - Williamstown MS	$11,084	2
Total	**$216,828**	

Potential Revenue Generation Estimates

Rebates

As part of the ESP for the Monroe Township School District, several avenues for obtaining rebates and incentives have been investigated which include:

Smart Start Incentives

-

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.

P4P Rebates

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 building with a whole-building technical component of a traditional energy audit, an energy model, a financial plan for funding the energy efficient measures, and a construction schedule for installation.

School	First Incentive	Second Incentive	Third Incentive
High School	$25,000	$435,190	$217,595
Middle School	$23,513	$263,693	$131,847

JCI is taking a conservative approach to the P4P rebates and carrying only 50% of third P4P rebate estimate in the financial model of this project.

SmartStart Incentives

New Jersey SmartStart Buildings is a statewide energy efficiency program available to qualified K-12 customers planning to construct, expand, renovate, or remodel a facility, or to replace electric or gas equipment. Incentives are available for prescriptive measures or for custom measures that are selected and incorporated into the project to help offset the added cost to purchase qualifying energy-efficient equipment.

Inventive Type	Estimated Amount
Retrofit LED Lighting Rebates	$ 106,594
HVAC Upgrades at Holly Glenn ES	$16,130
Boiler Replacement at Whitehall ES	$8,510
Boiler Replacement at Radix ES	$3,750
Total	**$ 134,984**

Demand Response Energy Efficiency Credit

The LED Lighting and facility upgrades will qualify the school will be eligible for the Energy Efficiency Credit and the Energy Efficiency Credit pays consumers based on the permanent load reduction through the installation of energy efficiency measures. The following Energy Efficiency Credits are estimated for the demand reduction from lighting upgrades.

Year	Estimated Amount
Year 1	$11,800
Year 2	$8,670
Year 1	$8,670
Year 1	$8,670
Total	**$ 37,810**

Johnson Controls does not guaranteed any rebates carried in this project.

Greenhouse Gas Reductions

Avoided Emissions	Total Electric Savings	Total Natural Savings	Total Annual Avoided Emissions
Annual Unit Savings	3876.9 MWh	94,383 Therms	
NOX, , lbs	3,218	868	4,086
SO2 , lbs	2,598		2,598
CO2 , lbs	5,008,954	1,104,281	6,113,235

Factors Used In Calculations:

- 1,292 lbs. CO2 per MWh saved
- 0.83 lbs. NOx per MWh saved
- 0.67 lbs. SO2 per MWh saved
- 11.7 lbs. CO2 per therm saved
- 0.0092 lbs. NOx per therm saved

Baseline Utility Savings

ID#	Energy Conservation Measure	Electric Consumption		Annual Electric Demand		Natural Gas		Water and Sewer		Total Annual Utility
		Dollars	kWh	Dollars	kW	Dollars	Therms	Dollars	Units	Dollars
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - Williamstown HS	$84,783	840,375	$30,264	2,415	-$83	(819)			$114,964
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - Williamstown MS	$71,425	710,252	$24,973	2,297	-$64	(639)			$96,334
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior- DI - Holy Glen ES	$17,762	162,903	$5,038	463	-$14	(136)			$22,786
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior- W/Controls - Oak Knoll ES	$16,089	159,588	$5,948	556	-$15	(153)			$22,022
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - Radix ES	$21,533	213,359	$5,629	518	-$16	(158)			$27,146
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls- Whitehall ES	$13,625	132,018	$4,636	426	-$13	(126)			$18,248
1 & 2	Retrofit LED Lighting - Interior with Smart Sensors and Exterior - W/Controls - HS Auditorium	$6,539	64,811	$4,512	360	-$8	(84)			$11,043
3	Weather Stripping & Air Sealing - Williamstown HS	$361	3,572			$4,513	4,200			$4,874
3	Weather Stripping & Air Sealing - Williamstown MS	$445	4,419			$5,529	5,190			$5,973
3	Weather Stripping & Air Sealing - Oak Knoll ES	$149	1,418			$2,102	1,740			$2,251
3	Weather Stripping & Air Sealing - Radix ES	$280	2,776			$4,375	3,260			$4,655
3	Weather Stripping & Air Sealing - Whitehall ES	$115	1,123			$1,719	1,260			$1,835
3	Water Conservation Rate Change Savings							$120,503		$120,503
4	Building Controls Upgrade - Williamstown HS	$62,045	615,000			$29,676	2,768			$91,722
4	Building Controls Upgrade - Williamstown MS	$6,960	69,211			$12,609	11,840			$19,568
4	Building Controls Upgrade - Holy Glen ES	$7,581	71,820			$2,962	2,190			$10,543

ID#	Energy Conservation Measure	Electric Consumption		Annual Electric Demand		Natural Gas		Water and Sewer		Total Annual Utility
		Dollars	kWh	Dollars	kW	Dollars	Therms	Dollars	Units	Dollars
4	Building Controls Upgrade - Oak Knoll ES	$7,198	71,394			$2,733	2,263			$9,931
4	Building Controls Upgrade - Radix ES	$6,412	63,539			$4,705	3,505			$11,117
4	Building Controls Upgrade - Whitehall ES	$7,450	72,184			$4,617	3,386			$12,067
5	HVAC System Replacement at Holly Glen Elementary School	-$15,839	(150,059)			$18,705	13,850			$2,866
6	Replace Existing H&V Units and Add Cooling to High School Gymnasium	-$12,397	(122,877)							-$12,397
6	Replace Existing AHU Units and Add Cooling to Middle School Gymnasium	-$4,380	(43,558)							-$4,380
7	Air Handling Unit Replacement at Oak Knoll Elementary School	$179	1,774							$179
8	Ceramics and Welding Labs Ventilation Upgrades - Middle School	-$162	1,604			-$1,622	(1,343)			-$1,784
9	Boiler Relocation and Domestic Hot Water Decoupling at Middle School					$6,062	5,690			$6,062
10	Boiler Replacement and Domestic Hot Water Decoupling at Whitehall Elementary School					$5,789	4,247			$5,789
11	Boiler Replacement at High School					$25,977	24,235			$25,977
11	Boiler Replacement at Radix Elementary School					$4,590	3,420			$4,590
12	Premium Efficiency Motors on HVAC Equipment - High School	$3,401	33,714							$3,401
12	Premium Efficiency Motors on HVAC Equipment- Middle School	$142	1,408							$142
12	Premium Efficiency Motors on HVAC Equipment - Radix ES	$154	1,524							$154

ID#	Energy Conservation Measure	Electric Consumption		Annual Electric Demand		Natural Gas		Water and Sewer		Total Annual Utility
		Dollars	kWh	Dollars	kW	Dollars	Therms	Dollars	Units	Dollars
12	Premium Efficiency Motors on HVAC Equipment- Whitehall ES	$175	1,694							$175
13	Variable Speed Drives on Hot Water Pumps - High School	$6,799	67,391							$6,799
13	Variable Speed Drives on Hot Water Pumps - Middle School	$5,825	57,931							$5,825
14	Chiller Replacement at High School	$15,471	153,355							$15,471
15	Chiller Re-Configuration at Middle School	$10,271	102,128							$10,271
16	Variable Speed Drives on Chilled Water Pumps - High School	$5,741	56,904							$5,741
16	Variable Speed Drives on Chilled Water Pumps - Middle School	$7,165	71,249							$7,165
17	Domestic Water VFD Booster Skid at High School	$1,594	15,804							$1,594
18	Domestic Hot Water System Installation at Holly Glen ES					$1,993	1,480			$1,993
19	Roof Upgrades and Repairs at High School	$7	72			$246	229			$253
19	Roof Upgrades and Repairs at Middle School	$7	66			$262	25			$269
20	Solar PV- Power Purchase Agreement Savings	$614,141								$614,141
21	Micro CHP - Whitehall ES	$4,235	41,040			-$2,865	(2,104)			$1,370
22	Kitchen Hood Controls - High School	$910	9,020			$756	705			$1,666
22	Kitchen Hood Controls - Middle School	$1,608	15,989			$687	645			$2,295
23	Transformer Replacement - High School	$11,516	114,169							$11,516
23	Transformer Replacement - Middle School	$5,573	55,421							$5,573
23	Transformer Replacement - Radix ES	$1,630	16,146							$1,630
Total		**$994,507**	**3,761,532**	**$81,001**	**7,035**	**$135,396**	**90,311**	**$120,503**		**$1,331,928**

Business Case for Recommended Project

FORM VI

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
MONROE TOWNSHIP BOARD OF EDUCATION
ENERGY SAVINGS IMPROVEMENT PROGRAM

ESCO NAME: **Johnson Controls**

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, 2.2% water and sewer per year**; and

1. Term of Agreement: **19 years (228 Months)**
2. Construction Period [2] (months): **18 months**
3. Cash Flow Analysis Format:

Project Cost [1]:	**$25,554,963**
Other Fee :	**$75,000**
Capital Contribution:	**$78,000**
Project Finance Amount:	**$25,551,963**

Interest Rate to Be Used for Proposal Purposes: 2.25%

Year	ESIP Utility Savings	Solar PPA Savings	Annual Energy Savings	Annual Operational Savings	Energy Rebates/ Incentives	Total Annual Savings	Annual Project Costs	Board Costs	Annual Service Costs [3]	ESIP Cash Flow	Cumulative Cash Flow
Installation	$433,343		$433,343	$0	$48,513	$481,857	$0	$0	$0	$0	$542,108
1	$731,007	$600,921	$1,331,928	$216,827	$841,917	$2,390,672	$2,870,221	$2,930,381	$60,160	$2,400	$2,400
2	$761,185	$614,497	$1,375,682	$216,827	$8,670	$1,601,180	$1,538,620	$1,598,780	$60,160	$2,400	$4,800
3	$792,659	$628,285	$1,420,944	$44,310	$366,782	$1,832,035	$1,769,475	$1,829,635	$60,160	$2,400	$7,200
4	$825,478	$642,289	$1,467,767	$44,310	$0	$1,512,077	$1,509,677	$1,509,677	$0	$2,400	$9,600
5	$859,696	$656,513	$1,516,209	$44,310	$0	$1,560,518	$1,558,118	$1,558,118	$0	$2,400	$12,000
6	$895,366	$670,960	$1,566,326	$0	$0	$1,566,326	$1,563,926	$1,563,926	$0	$2,400	$14,400
7	$932,546	$685,634	$1,618,180	$0	$0	$1,618,180	$1,615,780	$1,615,780	$0	$2,400	$16,800
8	$971,294	$700,539	$1,671,833	$0	$0	$1,671,833	$1,669,433	$1,669,433	$0	$2,400	$19,200
9	$1,011,671	$715,680	$1,727,350	$0	$0	$1,727,350	$1,724,950	$1,724,950	$0	$2,400	$21,600
10	$1,053,740	$731,059	$1,784,799	$0	$0	$1,784,799	$1,782,399	$1,782,399	$0	$2,400	$24,000
11	$1,097,567	$746,682	$1,844,250	$0	$0	$1,844,250	$1,841,850	$1,841,850	$0	$2,400	$26,400
12	$1,143,221	$762,553	$1,905,774	$0	$0	$1,905,774	$1,903,374	$1,903,374	$0	$2,400	$28,800
13	$1,190,773	$778,675	$1,969,447	$0	$0	$1,969,447	$1,967,047	$1,967,047	$0	$2,400	$31,200
14	$1,240,295	$795,053	$2,035,348	$0	$0	$2,035,348	$2,032,948	$2,032,948	$0	$2,400	$33,600
15	$1,291,865	$811,692	$2,103,557	$0	$0	$2,103,557	$2,101,157	$2,101,157	$0	$2,400	$36,000
16	$1,000,459		$1,000,459	$0	$0	$1,000,459	$998,059	$998,059	$0	$2,400	$38,400
17	$1,022,857		$1,022,857	$0	$0	$1,022,857	$1,020,457	$1,020,457	$0	$2,400	$40,800
18	$1,045,757		$1,045,757	$0	$0	$1,045,757	$1,043,357	$1,043,357	$0	$2,400	$43,200
19	$1,069,170		$1,069,170	$0	$0	$1,069,170	$1,048,784	$1,048,784	$0	$20,386	$63,586
Totals	**$19,369,949**	**$10,541,032**	**$29,971,233**	**$566,584**	**$1,265,882**	**$31,803,698**	**$31,559,632**	**$31,740,112**	**$180,480**	**$63,586**	

NOTES:

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

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

(3) This figure should equal the value indicated on the ESCOs PROPOSED "FORM V". DO NOT include in the Financed Project Costs

Appendix 4. Third Party ESIP Review Comments & Correspondence

MONROE TOWNSHIP SCHOOL DISTRICT - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

May 8, 2020

Final Review May 14, 2020

Prepared by: DLB Associates
(dlb # 15058)

MONROE TOWNSHIP SCHOOL DISTRICT - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

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SECTION 1: EXECUTIVE SUMMARY

MONROE TOWNSHIP SCHOOL DISTRICT - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

1.1 Executive Summary

1.1.1 Overview

DLB Associates has been commissioned by the Monroe Township School District to provide a Third-Party Review of an Energy Savings Plan (ESP) for conformance with State requirements for six (6) of the Board's facilities. State requirements are set forth in P.L. 2009, Chapter 4, "Energy Savings Improvement Program" and Local Finance Notices 2009-11 and 2011-17. Amendments to P.L. 2009, Chapter 4, are included in P.L. 2012, Chapter 55.

DLB's review includes an analysis of the Energy Savings Plan for conformance with the New Jersey Board of Public Utilities (BPU) Standards and for verification that all required sections were submitted in the ESP Report. A review of the calculations methodology and plan savings as specified by the BPU protocol also was performed.

This report includes the summary and conclusions of DLB's Third-Party Review of the submitted Energy Savings Plan prepared by Johnson Controls (JCI) and dated May 1st, 2020.

1.1.2 Energy Savings Plan Review

The ESP appears to be complete and contains the required components. DLB has indicated items for further review and expect that the comments can be incorporated without affecting the ESP results significantly.

1.1.3 Energy Savings Calculations Review

The review of the energy savings calculations included within the ESP concluded that the calculations were performed in accordance with industry standard practice and utilizing the intent of the BPU protocol. Spreadsheet analyses were used to calculate Energy Conservation Measure (ECM) savings. The equations used to determine savings follow the protocol's calculation methods for energy efficient construction, but DLB recommends a few areas be clarified as identified in this report.

1.1.4 Conclusion

Both the ESP and the associated calculations appear to be completed with satisfactory effort and in accordance with P.L. 2012, Chapter 55, Amendments to "Energy Savings Improvement Program" and Local Finance Notices 2009-11 and 2011-17. A few calculations and concepts should be verified as indicated within the body of this report and revisions should be reviewed and addressed prior to adoption by the Monroe Township School District. Overall, DLB comments should have a low impact on the predicted savings.

DLB comments have been addressed in the attached Appendix by JCI, sent to DLB May 12, 2020, and have been incorporated into the revised ESP. The Energy Savings Plan is ready for review and adoption by the Monroe Township Board of Education.

We have reviewed the revised Monroe Township Board of Education Energy Savings Plan dated May 12, 2020, as submitted by JCI in accordance with P.L. 2012, c. 55 (2009 c.4.).

MONROE TOWNSHIP SCHOOL DISTRICT - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

According to this legislation, an independent third party must review the plan and certify that the plan savings were properly calculated pursuant to the Board of Public Utilities protocols and / or the International Performance Measurement and Verification Protocol.

As a qualified New Jersey licensed engineer and in accordance with good engineering principles, we have reviewed each calculation outlined in the plan along with the associated energy conservation measure described. Our review indicates that the plan was established and compiled with sound measurement and verification protocols and in compliance with established standards set by the NJBPU.

SECTION 2: ENERGY SAVINGS PLAN REVIEW

MONROE TOWNSHIP SCHOOL DISTRICT - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

2.1 Executive Summary

2.1.1 Energy Savings Plan Overview

The ESP reviewed by DLB Associates was prepared by Johnson Controls and dated May 1st, 2020. The ESP Report includes an analysis for the following six (6) facilities:

FACILITY INFORMATION	
Building Name	**Street Address**
Williamstown High School	700 N Tuckahoe Rd, Williamstown, NJ 08094 - 338,067 sf
Williamstown Middle School	561 Clayton Rd, Williamstown, NJ 08094 - 313,512 sf
Holly Glen Elementary School	900 N Main St, Williamstown, NJ 08094 - 79,055 sf
Oak Knoll Elementary School	23 Bodine Ave, Williamstown, NJ 08094 - 80,528 sf
Radix Elementary School	363 Radix Rd, Williamstown, NJ 08094 - 88,777 sf
Whitehall Elementary School	161 Whitehall Rd, Williamstown, NJ 08094 - 57,017 sf

SECTION 3: ENERGY SAVINGS PLAN REVIEW

MONROE TOWNSHIP SCHOOL DISTRICT - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

3.1 Energy Savings Plan Review

3.1.1 Plan Components – Required By P.L. 2012, C.55

The Energy Savings Plan is the core of the Energy Savings Implementation Program (ESIP) process. Planned ECMs are described and the cost calculations supporting how the plan will pay for itself in reduced energy costs are provided. Under the law, the ESP must address the following elements:

- Energy audit results
- Energy conservation measure descriptions
- Greenhouse gas reduction calculations based on energy savings
- Design and compliance issue identification and identification of who will provide these services
- Risk assessment for the successful implementation of the plan
- Identification of eligibility, costs and revenues for demand response and curtailable service activities
- Schedules showing calculations of all costs of implementing the proposed energy conservation measures and the projected energy savings
- Maintenance requirements necessary to ensure continued energy savings
- Description and cost estimates for energy services company (ESCO) savings guarantee

3.1.2 Plan Components – Submitted Plan Review

The submitted ESP, dated May 1st, 2020, is the basis for the Third-Party Review. The table below lists the required elements of the ESP as required by the law, whether the items were addressed satisfactorily in the ESP, and any associated comments.

ENERGY SAVINGS PLAN COMPONENT REVIEW			
Plan Component	**Included In Plan**	**Location In Plan**	**Comments**
Energy Audit Results	Yes	Entire Plan	See Below
ECM Descriptions	Yes	Section 4, Pages 33 – 98	See Section 4 of this Report
Greenhouse Gas Calculations	Yes	Section 3, Page 28	See Section 4.1.6 of this Report
Design and Compliance Issues	Yes	Section 6, Page 104	None
Implementation Risk Assessment	Yes	Section 6, Page 104 & 105	None
Demand Response Program / Curtailable Energy Services	Yes	Section 3, Page 28 & Appendix 3, Page 117	None
Implementation Costs	Yes	Appendix 3, Pages 113 - 115	See Section 4.1.5 of this Report
Projected Energy Savings	Yes	Appendix 3, Page 118 - 120	See Section 4 of this Report
Maintenance Requirements	Yes	Section 4, Pages 32 – 85 & Section 6, Page 104	None
Savings Guarantee Information	Yes	Section 5, Page 102 - 103	$184,800 across 3 years
Measurement and Verification Plan	Yes	Section 5, Pages 98 - 103	None

SECTION 4: ENERGY SAVINGS CALCULATIONS REVIEW

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 five (25) ECMs analyzed and accepted in the base project include:

1. Upgrade Interior and Exterior Lighting LED Retrofits with Pendent in Elementary School Class Rooms
2. Lighting Occupancy Controls
3. Building Envelope - Weatherization
4. Building Automation System Upgrades
5. HVAC System Replacement at Holly Glen Elementary School
6. Replace Existing H&V / AHU Units and Add Cooling to High School and Middle School Gymnasiums
7. Air Handling Unit Replacement at Oak Knoll Elementary School
8. Ceramic and Welding Lab Ventilation Upgrades
9. Boiler Relocation and Domestic Hot Water Decoupling at Middle School
10. Boiler Replacement and Domestic Hot Water Decoupling at Whitehall Elementary School
11. Boiler Replacement at High School and Radix Elementary School
12. Installation of Premium Efficiency Motors and Pumps
13. Variable Speed Drives on Hot Water Pumps
14. Chiller Replacement at High School
15. Chiller Re-Configuration at Middle School
16. Variable Speed Drives on Chilled Water Pumps
17. : Domestic Water VFD Booster Skid at High School
18. Domestic Water Heater System Holly Glen Elementary School

19. Roof Upgrades and Repairs at High School and Middle School
20. Solar PV- Power Purchase Agreement Savings
21. Micro Combined Heat and Power (CHP) at Whitehall Elementary School
22. Commercial Kitchen Hood Controls
23. Transformer Replacement
24. Score Board Electrical
25. Pay for Performance Incentive

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 JCI 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 for clarity, but they are included in the Appendix sections.

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.

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.

DLB notes the following possible issues with the ECM analysis:

ECM 1 & 2 – Upgrade Interior and Exterior Lighting LED Retrofits with Pendent Fixture Replacement in Elementary School Classrooms & Lighting Occupancy Controls

1. It may be beneficial to include details on the recommended model for the replacement lamp – not sure if lamp or line voltage upgrade kits are being proposed.

2. If line voltage upgrade kits are necessary, we would suggest model information is included to make sure the recommended retrofit maintains the UL listing of the light fixtures.
3. For lamp replacement projects, is a maintenance savings taken into account for extended life?
4. Please identify reduction in hours via lighting control. This appears to be a straight 32% reduction at all locations except for stairwells which are 16% reduction.
5. Please identify source of "Current Hours." There is a wide range of operational hours, which differs from the suggested hours of operation in the BPU protocol.
6. Please identify the existing lighting controls.
7. The energy savings calculations do not appear to utilize the Iterative Factor (IF) used in the BPU Protocols.
8. Confirm the proposed energy savings for Holly Glen Elementary School. The savings are nearly 50% of the current electrical cost.

ECM 3 – Building Envelope - Weatherization

1. It is recommended that floor plans be added to verify the extent of this scope of work.

ECM 4 – Building Automation System Upgrades

1. The age of the existing control system is not indicated and would be helpful in verifying proposed savings. Please indicate estimated age of existing control system.
2. When hot water reset is used, a lower supply temperature is employed. Additional pump energy likely will be required to account for lower delta t. Pump energy increases should be analyzed and discussed.
3. ECM notes HW system optimization and de-coupling of heating and domestic hot water systems. Will this impact the proposed savings from ECMs 9, 10, or 11?
4. Verify the savings for the High School and Whitehall Elementary School. The savings from these two schools account for over 10% of the overall school energy cost which seems high.
5. Confirm that the proposed VFD energy savings do not interfere with ECMs 12, 13, 16, or 17.
6. Would verify ECM4 savings for High School and Whitehall ES on Section 3 table. The savings for these two control items are over 10% of the overall school energy cost from energy usage table while others are < 5%.

ECM 5 – HVAC System Replacement at Holly Glen Elementary School

1. 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.

ECM 6 – Replace Existing H&V / AHU Units and Add Cooling to High School and Middle School Gymnasiums

1. 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.

ECM 7 – Air Handling Unit Replacement at Oak Knoll Elementary School

1. 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.

ECM 8 – Ceramic and Welding Lab Ventilation Upgrades

1. This is listed on the Energy Savings and Cost Summary Table with a negative savings. Just to confirm this is part of a BOE driven Capital Improvement project and not an Energy Conservation Measure.

ECM 9 – Boiler Relocation and Domestic Hot Water Decoupling at Middle School

1. Additional information about the existing boiler, including age and model number, would be beneficial to include so that scope can be verified.
2. Were reduced operating hours included as noted through elimination of black seal operators?
3. Have the proposed existing equipment relocation and new equipment installation been reviewed with facility personnel to confirm there is sufficient space available onsite?

ECM 10 – Boiler Replacement and Domestic Hot Water Decoupling at Whitehall Elementary School

1. Additional information about the existing boiler, including age and model number, would be beneficial to include so that savings can be verified.
2. The total capacities of the proposed new boilers (3000 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 domestic hot water decoupling should allow a reduction in boiler capacity.

ECM 11 – Boiler Replacement at High School and Radix Elementary School

1. Additional information about the existing boiler, including age and model number, would be beneficial to include so that savings can be verified.
2. The boiler output and number of boilers in the high school calculations do not match the report.

ECM 12 – Installation of Premium Efficiency Motors and Pumps

1. The baseline motor efficiencies used in the calculations are lower than those shown in the protocols. The factors should be revised.

2. The Annual Hours of Operation shown in the calculations are lower than those indicated in the protocols. The hours used should be verified with the school district.

ECM 13 – Variable Speed Drives on Hot Water Pumps

1. Please confirm any impact on the boiler replacement ECMs.
2. Please confirm that the pump motors being retrofitted will work with VFDs or if replacement with inverter duty motors is included in the cost for this ECM.

ECM 14 – Chiller Replacement at High School

1. Confirm that new chiller efficiency rating includes impact of 25% propylene glycol mixture.

ECM 15 – Chiller Re-Configuration at Middle School

1. Confirm that the proposed calculations include the added condenser water pump energy usage.

ECM 16 – Variable Speed Drives on Chilled Water Pumps

1. Please confirm any impact on the chiller replacement ECMs.
2. Please confirm that the pump motors being retrofitted will work with VFDs or if replacement with inverter duty motors is included in the cost for this ECM.

ECM 17 – Domestic Water VFD Booster Skid at High School

1. Does existing pump run constantly while the school is occupied?
2. Calculations appear to be tied to outside air temperature. Should domestic water load within the school be considered?

ECM 18 – Domestic Water Heater System Holly Glen Elementary School

1. Confirm that all costs related to the existing absorption chiller are carried in ECM-5.

ECM 19 – Roof Upgrades at High School and Middle School

1. No Comments

ECM 20 – Solar PV – Power Purchase Agreement Savings

1. DLB recommends noting some of the PPA agreement requirements for reference such as: panel warranty, panel removal terms, any specific insurance provisions or site licensure or access requirements.
3. If the new solar panels are proposed to be installed on sections of the roof of various buildings of various ages and roof materials, we suggest clarification be added on who would be responsible for any structural modifications required to support the weight of the new solar panels, and if applicable, include the associated costs in the financial analysis.
4. It is unclear if maintenance access was taken into account in the general panel layout which should be considered for any roof top equipment.
5. Also, it may be worthwhile to highlight any system downtime incorporated in the estimated production values. From what we have seen, some PPA vendors note this in their contracts and we have seen downtimes that stretch for months which would affect savings.
6. Are any of the proposed solar array sizes close to or higher than 80% of building usage / service sizes?
7. Provide the solar PPA resolution and projected PV sizes for each school.

ECM 21 – Micro Combined Heat and Power (CHP) at Whitehall Elementary School

2. ESP calls for the installation of a 10 kW CHP. It may be beneficial to include the equipment information on this unit to further detail performance, operational requirements, and maintenance of the system.
3. This ECM is listed to have a 58 year payback and it appears to be included to allow financing over 20 years.
4. Please confirm if the maintenance costs / contract is included in overall cost for this ECM. CHP systems typically have a very rigorous maintenance schedule.
5. It appears that the total expected operating hours that the CHP Plant is planned to be run is 4,150 per year and it is to be located in the boiler room. It would be good to confirm if these hours and the installation location will not cause any noise issues.
6. Since this is integral to the payment terms, it may be beneficial to confirm with the facility personnel that there is enough space at the site for the CHP system and the connections to the existing heating hot water system.

ECM 22 – Commercial Kitchen Hood Controls

1. Is there a current procedure present for hood control or are the fans turned on in the beginning of the day and turned off at the end of the day?
2. Note if this ECM includes any modifications to the volume of kitchen Make Up Air supplied to the kitchen areas to accommodate reduction in exhaust.

ECM 23 – Transformer Replacement

1. It would be beneficial to define where the "Baseline Transformer Losses" are based on. Not sure if these are manufacturer published data or field measured.
2. The age of the existing transformers to be replaced should be included in the report.
3. It appears that the savings do not match the P4P typical annual loss table for transformers; for example a 75 kVa is listed as 6,519 kWh savings and the P4P table uses 4,600 for pre TP-1. Double check these if the transformer savings is being used for P4P incentives.
4. Would be good to verify what incentive / rebates are tied to this Transformer Upgrade ECM.

ECM 24 – Pay for Performance Incentive

1. Has initial eligibility (Incentive 0 applications) been submitted for P4P to confirm base eligibility for these schools?
2. Table in section 3 lists dollar amounts anticipated for all three incentives. Please provide written explanation or example calculations to support those and verify that that ECMs being applied to these do not overlap.
3. Are there calculations / measurements indicating buildings' eligibility (200kW peak demand, 15% source energy savings) for this incentive available? It may be worthwhile to illustrate how close the proposed ECMS are to the 15% threshold.

ECM 25 – Score Board Electrical Service

1. This is listed on the Energy Savings and Cost Summary Table with a zero savings. Just to confirm this is part of a BOE driven Capital Improvement project and not an Energy Conservation Measure.

ECM 26 – Water and Sewer Rate Change

1. This ECM is included in the Energy Savings and Cost Summary Table as a Utility Savings but has no additional backup information.

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:

ECM 1 – Upgrade Interior and Exterior Lighting LED Retrofits with Pendent in Elementary School Class Rooms

1. It is recommended that cut sheets for proposed interior and exterior LED replacements be included to confirm DLC listings.

2. Confirm bypassing electronic ballast will not void UL listing on lighting fixture, provide information on retrofit kits if applicable.
3. Would verify ECM 1/ 2 savings for Holley Glen ES on Section 3 table. If have the numbers right Yearly Savings is listed at $ 22,786 and total electric for this school is $ 54,088.

ECM 2 – Lighting Occupancy Controls (All Facilities)

1. Recommend that cut sheets of proposed lighting occupancy controls be added.
2. Would also recommend that separate line items for estimated control installed hard costs be added to differentiate between controls and LED retrofits.
3. Provide kWh savings calculations for lighting controls per building.

4.1.5 Financial Calculations

The financial calculations included within the ESP incorporate a 2.25% interest rate for the loan and the BPU-required 2.4% natural gas, 2.2% electric, and 2.2% water per year utility escalation.

The recommended plan includes twenty-four (24) ECMs and is analyzed over a 20-year financing term.

DLB notes the following potential issues with the financial calculations:

1. Cash Flow Form shown on page 120 of the report shows an installation year savings of $48,513 and a total year 1 savings of $ 481,857 with no project costs. This should be confirmed and / or an explanation should be added to help define the savings and incentives gained at no cost.
2. LFN 2009-11 requires that any capital improvements be paid through other appropriations (i.e., bonds or capital improvement funds), not energy savings obligations. DLB recommends confirming that any capital improvements are planned to be funded appropriately.
3. Some ECMs have lengthy simple payback periods, beyond the overall ESP timeframe. Confirm that these measures are BOE-driven capital improvement projects.

4.1.6 Greenhouse Gas Calculations

Greenhouse Gas Calculations are provided, and the factors used to calculate savings are clearly called out in the report. The factors should be revised to meet the current BPU guidelines, shown on page 13 of the protocol:

- 1,374 lbs. CO_2 per MWh saved
- 1.11 lbs. NO_x per MWh saved
- 0.98 lbs. SO_2 per MWh saved

- 11.7 lbs. CO_2 per therm saved
- 0.0092 lbs. NO_x per therm saved

SECTION 5: REVIEW DISCLAIMER

5.1 Review Disclaimer

DLB Associates, as part of the Third-Party Review services, is providing our professional opinion in the evaluation of the energy savings calculations, ESP, and any other supporting documentation provided.

This evaluation is not a guarantee that the savings and assumptions stated are valid. DLB Associates will not be responsible for any failure in achieving the predicted energy and cost savings detailed.

Our intention is to complete our due diligence in verifying the energy savings calculations in accordance with the BPU protocols; however, it is impractical to review all inputs in detail. As a result, bottom line numbers and a limited number of parameters have been verified to conclude validity of savings.

SECTION 6: ATTACHMENT

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 five (25) ECMs analyzed and accepted in the base project include:

1. Upgrade Interior and Exterior Lighting LED Retrofits with Pendent in Elementary School Class Rooms
2. Lighting Occupancy Controls
3. Building Envelope - Weatherization
4. Building Automation System Upgrades
5. HVAC System Replacement at Holly Glen Elementary School
6. Replace Existing H&V / AHU Units and Add Cooling to High School and Middle School Gymnasiums
7. Air Handling Unit Replacement at Oak Knoll Elementary School
8. Ceramic and Welding Lab Ventilation Upgrades
9. Boiler Relocation and Domestic Hot Water Decoupling at Middle School
10. Boiler Replacement and Domestic Hot Water Decoupling at Whitehall Elementary School
11. Boiler Replacement at High School and Radix Elementary School
12. Installation of Premium Efficiency Motors and Pumps
13. Variable Speed Drives on Hot Water Pumps
14. Chiller Replacement at High School
15. Chiller Re-Configuration at Middle School
16. Variable Speed Drives on Chilled Water Pumps
17. : Domestic Water VFD Booster Skid at High School
18. Domestic Water Heater System Holly Glen Elementary School

19. Roof Upgrades and Repairs at High School and Middle School

20. Solar PV- Power Purchase Agreement Savings

21. Micro Combined Heat and Power (CHP) at Whitehall Elementary School

22. Commercial Kitchen Hood Controls

23. Transformer Replacement

24. Score Board Electrical

25. Pay for Performance Incentive

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 JCI 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 for clarity, but they are included in the Appendix sections.

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.

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.

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DLB notes the following possible issues with the ECM analysis:

ECM 1 & 2 – Upgrade Interior and Exterior Lighting LED Retrofits with Pendent Fixture Replacement in Elementary School Classrooms & Lighting Occupancy Controls

1. It may be beneficial to include details on the recommended model for the replacement lamp – not sure if lamp or line voltage upgrade kits are being proposed.

   Line voltage duel ended for lamps are being used for lamp replacement. Door kits that utilize a driver and LED strips are being proposed for kit retrofit. Please find the cut sheets attached.

2. If line voltage upgrade kits are necessary, we would suggest model information is included to make sure the recommended retrofit maintains the UL listing of the light fixtures.

   Removing ballast and running line voltage to the tombstones using a double ended LED tube which will maintain the UL listing of the existing fixture. New retrofit kits are UL listed (see attached cutsheets).

3. For lamp replacement projects, is a maintenance savings taken into account for extended life?

   Yes, maintenance savings are carried as part of the operations savings for a period of 5 years per BPU recommendation.

4. Please identify reduction in hours via lighting control. This appears to be a straight 32% reduction at all locations except for stairwells which are 16% reduction.

   As the lighting retrofit includes individual sensor per fixture the reduction in usage hours is based on historical averages based on JCI's extensive experience on similar projects where day light savings and occupancy controls are implemented.

5. Please identify source of "Current Hours." There is a wide range of operational hours, which differs from the suggested hours of operation in the BPU protocol.

   Based on site audits and input from school district staff and JCI's extensive experience on similar projects, the existing lighting system operation hours have been determined.

6. Please identify the existing lighting controls.

   Existing lighting controls are manual switch operation.

7. The energy savings calculations do not appear to utilize the Iterative Factor (IF) used in the BPU Protocols.

   JCI's iterative factor calculation is based on overall project impact on the HVAC space conditioning and Lighting Upgrades.

8. Confirm the proposed energy savings for Holly Glen Elementary School. The savings are nearly 50% of the current electrical cost.

   JCI confirms that Holly Glen lighting upgrades result in a 42.18% savings on the electric baseline spend. This can be attributed to low usage of the building during the year 2019 due to partial closure.

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ECM 3 – Building Envelope - Weatherization

1. It is recommended that floor plans be added to verify the extent of this scope of work.

   The current scope is identified as part of the Comprehensive Maintenance Plan provided by MTPS. The floor plans will be identified during the design phase.

ECM 4 – Building Automation System Upgrades

1. The age of the existing control system is not indicated and would be helpful in verifying proposed savings. Please indicate estimated age of existing control system.

   High School is a 25 years old Trane Summit and Middle School is 23 years old CM3 system with several updates since. Whitehall ES has Automated Logic Controls system with recent upgrades while the rest of the elementary schools have fragmented controls with no dedicated front end.

2. When hot water reset is used, a lower supply temperature is employed. Additional pump energy likely will be required to account for lower delta t. Pump energy increases should be analyzed and discussed.

   Pump energy usage is factored into the calculation of pump replacement as well as the mechanical and electrical cooling and heating components of the energy calculation.

3. ECM notes HW system optimization and de-coupling of heating and domestic hot water systems. Will this impact the proposed savings from ECMs 9, 10, or 11?

   Controls savings component is only accounted in this measure and savings for ECMs 9, 10 and 11 have been individually evaluated.

4. Verify the savings for the High School and Whitehall Elementary School. The savings from these two schools account for over 10% of the overall school energy cost which seems high.

   Based on site audits and input from school district staff and JCI's extensive experience on similar projects, the current controls systems are operating without much of controls or monitoring at these schools. New controls and sequence of operations will drastically improve the operational condition at the buildings and result in energy savings.

5. Confirm that the proposed VFD energy savings do not interfere with ECMs 12, 13, 16, or 17.

   VFD energy savings do not interfere with the ECMs 12, 13, 16, or 17.

6. Would verify ECM4 savings for High School and Whitehall ES on Section 3 table. The savings for these two control items are over 10% of the overall school energy cost from energy usage table while others are < 5%.

   Response is same as above for ECM 4 #4 comment.

ECM 5 – HVAC System Replacement at Holly Glen Elementary School

1. 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.
   The current HVAC system at Holly Glen ES is very inefficient in operation using an absorption chiller of 1.46 COP compared to the new VRF system (COP 3.8) and DOAS (EER 20) proposed as part of the ESIP. A very conservative savings approach has been used to estimate savings as design drawings are to be finalized. JCI expects the true energy, maintenance and operational savings of measure to outperform the ESIP estimates. This measure should be considered as an energy conservation measure as per the approval of Monroe Township BOE.

MONROE TOWNSHIP SCHOOL DISTRICT - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

ECM 6 – Replace Existing H&V / AHU Units and Add Cooling to High School and Middle School Gymnasiums

1. 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.

   JCI has calculated the negative impact of the added cooling at the High School and Middle School. This measure can be considered a capital improvement project.

ECM 7 – Air Handling Unit Replacement at Oak Knoll Elementary School

1. 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.

   Due various practical constraints the true energy, maintenance and operational savings cannot be quantified and difficult to model. This measure can be considered as an energy conservation measure.

ECM 8 – Ceramic and Welding Lab Ventilation Upgrades

1. This is listed on the Energy Savings and Cost Summary Table with a negative savings. Just to confirm this is part of a BOE driven Capital Improvement project and not an Energy Conservation Measure.

   JCI has calculated the negative impact of the added ventilation at the High School. This measure can be considered a capital improvement project.

ECM 9 – Boiler Relocation and Domestic Hot Water Decoupling at Middle School

1. Additional information about the existing boiler, including age and model number, would be beneficial to include so that scope can be verified.

   Existing HW boiler are Hydrotherm KN-30 boilers installed in 2014. JCI is only relocating and not replacing the boilers.

2. Were reduced operating hours included as noted through elimination of black seal operators?

   The reduced operating hours on the HW boilers is achieved through installation of a new dedicated DHW boiler. The BlackSeal operators are no longer necessary as the redesign and decoupling will reduce the combined head on the HW boiler system.

3. Have the proposed existing equipment relocation and new equipment installation been reviewed with facility personnel to confirm there is sufficient space available onsite?

   Yes, the existing mechanical room layout is adding to the inefficiencies of the system and the relocation has been planned with customer input and approval.

ECM 10 – Boiler Replacement and Domestic Hot Water Decoupling at Whitehall Elementary School

1. Additional information about the existing boiler, including age and model number, would be beneficial to include so that savings can be verified.

   Existing HW boiler are Smith Cast Iron G-28A boilers installed in 2002.

2. The total capacities of the proposed new boilers (3000 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 domestic hot water decoupling should allow a reduction in boiler capacity.

   The existing boilers are 2,636 MBH input capacity with an efficiency of 80%. The new boilers are rated at 2,500 MBH output capacity with an efficiency of 87%. Reduction in DHW load will reduce the sizing of the overall boilers. Heat load calculations will be performed during the design phase to right size the system.

ECM 11 – Boiler Replacement at High School and Radix Elementary School

1. Additional information about the existing boiler, including age and model number, would be beneficial to include so that savings can be verified.

   Existing HW boilers at High School are three (3) Clever Brooks CB 700 boilers installed original to the building in 1995. Existing HW boiler at Radix ES is a RBI HB2800 boiler installed in 2007.

2. The boiler output and number of boilers in the high school calculations do not match the report.

   Calculations will be adjusted to match the existing boiler capacity of 5250 MBH per boiler – 3 boilers in total.

ECM 12 – Installation of Premium Efficiency Motors and Pumps

1. The baseline motor efficiencies used in the calculations are lower than those shown in the protocols. The factors should be revised.

   Existing and proposed motor efficiencies are based on name plate details and DOE Motor Master Database.

2. The Annual Hours of Operation shown in the calculations are lower than those indicated in the protocols. The hours used should be verified with the school district.

   Annual run hours are based on current occupancy and usage of the buildings.

ECM 13 – Variable Speed Drives on Hot Water Pumps

1. Please confirm any impact on the boiler replacement ECMs.

   Boiler and pump replacement measures and their savings are accounted for during the calculation of VFD savings. No impact on other measures.

2. Please confirm that the pump motors being retrofitted will work with VFDs or if replacement with inverter duty motors is included in the cost for this ECM.

   New inverter duty motors will be installed to ensure proper operation.

ECM 14 – Chiller Replacement at High School

1. Confirm that new chiller efficiency rating includes impact of 25% propylene glycol mixture.

   Yes, new chiller efficiency rating includes impact of 25% propylene glycol mixture.

ECM 15 – Chiller Re-Configuration at Middle School

1. Confirm that the proposed calculations include the added condenser water pump energy usage.

   Yes, condenser water pump energy use is included in the proposed calculations.

MONROE TOWNSHIP SCHOOL DISTRICT - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

ECM 16 – Variable Speed Drives on Chilled Water Pumps

1. Please confirm any impact on the chiller replacement ECMs.

   Chiller and pump replacement measures and their savings are accounted for during the calculation of VFD savings. No impact on other measures.

2. Please confirm that the pump motors being retrofitted will work with VFDs or if replacement with inverter duty motors is included in the cost for this ECM.

   New inverter duty motors will be installed to ensure proper operation.

ECM 17 – Domestic Water VFD Booster Skid at High School

1. Does existing pump run constantly while the school is occupied?

   Yes, the existing pumps run constantly during all times.

2. Calculations appear to be tied to outside air temperature. Should domestic water load within the school be considered?

   The calculation applies the occupied and unoccupied modes of the school to estimate the domestic water load usage profile.

ECM 18 – Domestic Water Heater System Holly Glen Elementary School

1. Confirm that all costs related to the existing absorption chiller are carried in ECM-5.

   All costs related to decoupling the absorption chiller are carried in ECM-5. Measure ECM 18 carries the cost of installing a new DHW boiler only.

ECM 19 – Roof Upgrades at High School and Middle School

1. No Comments

ECM 20 – Solar PV – Power Purchase Agreement Savings

1. DLB recommends noting some of the PPA agreement requirements for reference such as: panel warranty, panel removal terms, any specific insurance provisions or site licensure or access requirements.

3. If the new solar panels are proposed to be installed on sections of the roof of various buildings of various ages and roof materials, we suggest clarification be added on who would be responsible for any structural modifications required to support the weight of the new solar panels, and if applicable, include the associated costs in the financial analysis.

4. It is unclear if maintenance access was taken into account in the general panel layout which should be considered for any roof top equipment.

5. Also, it may be worthwhile to highlight any system downtime incorporated in the estimated production values. From what we have seen, some PPA vendors note this in their contracts and we have seen downtimes that stretch for months which would affect savings.

Response for above 4 comments: JCI is not a party of the solar PPA agreement being signed by Monroe Township Board of Education and Monroe Township. ESIP contract is only carrying the energy savings estimated from the PPA and JCI does not design, install, operate or maintain the solar PV system.

6. Are any of the proposed solar array sizes close to or higher than 80% of building usage / service sizes?

   Proposed solar array sizes are under 80% of building usage and accounted for ESIP energy savings.

7. Provide the solar PPA resolution and projected PV sizes for each school.

   Solar PPA resolution and projected PV sizes are being finalized by the customer. Currently we are carrying a conservative estimate for the PPA rate and sizes.

ECM 21 – Micro Combined Heat and Power (CHP) at Whitehall Elementary School

2. ESP calls for the installation of a 10 kW CHP. It may be beneficial to include the equipment information on this unit to further detail performance, operational requirements, and maintenance of the system.

   Performance details are included in the write-up. Considering the small size of the unit, minimal operational and maintenance requirements are attributed to this measure. Customer agreed to be responsible for all ongoing maintenance of the unit.

3. This ECM is listed to have a 58 year payback and it appears to be included to allow financing over 20 years.

   Unit is being installed to apply micro CHP technology to offset HW energy load to the fullest extent and, in the process, generates electricity which allows the ESIP to be financed for 20 years, per ESIP legislation.

4. Please confirm if the maintenance costs / contract is included in overall cost for this ECM. CHP systems typically have a very rigorous maintenance schedule.

   No maintenance costs or contracts are included in the overall cost for the ECM. Due to the small size of the unit, minimal ongoing maintenance is needed for this unit.

5. It appears that the total expected operating hours that the CHP Plant is planned to be run is 4,150 per year and it is to be located in the boiler room. It would be good to confirm if these hours and the installation location will not cause any noise issues.

   Based on the building load profile and weather data, the building run hours have been estimated. Unit is rated for average sound level of 55 db, within the permissible limits for mechanical room space types.

6. Since this is integral to the payment terms, it may be beneficial to confirm with the facility personnel that there is enough space at the site for the CHP system and the connections to the existing heating hot water system.

   Location for the proposed unit has been identified and confirmed with the customer.

ECM 22 – Commercial Kitchen Hood Controls

1. Is there a current procedure present for hood control or are the fans turned on in the beginning of the day and turned off at the end of the day?

   No, only manual controls for the hood controls are available turned on in the beginning of the day and potentially turned off at the end of the day.

2. Note if this ECM includes any modifications to the volume of kitchen Make Up Air supplied to the kitchen areas to accommodate reduction in exhaust.

   Scope includes installation of VFD on the supply and exhaust side to balance the air distribution of the kitchen system.

ECM 23 – Transformer Replacement

1. It would be beneficial to define where the "Baseline Transformer Losses" are based on. Not sure if these are manufacturer published data or field measured.

   Baseline transformer losses are based on name plate details, age of the transformers and model details along JCI's extensive experience on similar projects.

2. The age of the existing transformers to be replaced should be included in the report.

   As per the input from the district, majority of the transformers included in the project are original to the buildings.

3. It appears that the savings do not match the P4P typical annual loss table for transformers; for example a 75 kVa is listed as 6,519 kWh savings and the P4P table uses 4,600 for pre TP-1. Double check these if the transformer savings is being used for P4P incentives.

   Transformer savings will be verified for P4P savings application purpose.

4. Would be good to verify what incentive / rebates are tied to this Transformer Upgrade ECM.

   Only P4P rebate is tied to the transformer upgrades.

ECM 24 – Pay for Performance Incentive

1. Has initial eligibility (Incentive 0 applications) been submitted for P4P to confirm base eligibility for these schools?

   No, JCI is the process of preparation of the application and will be submitted soon.

2. Table in section 3 lists dollar amounts anticipated for all three incentives. Please provide written explanation or example calculations to support those and verify that that ECMs being applied to these do not overlap.

   The Incentive #1 is the minimum of the $0.075 per sqft and $25000. The incentive #2 is determined using the calculation formula defined by the P4P Program Guideline FY20 which is listed below. Since Monroe Township School District is a public K12 school district, it is also qualified for the enhanced incentive #2 and #3.

Incentive #2: Installation of Recommended Measures			
	Minimum Performance Target:	15%	
Electric Incentives	Base Incentive based on 15% savings:	$0.09	per projected kWh saved
	For each % over 15% add:	$0.005	
	Maximum Incentive:	$0.11	
Gas Incentives	Base Incentive based on 15 % savings:	$0.90	per projected Therm saved
	For each % over 15% add:	$0.05	
	Maximum Incentive:	$1.25	
	Incentive Cap:	25%	of total project cost

To be conservative, the Incentive #3 only claims to be 50% of the Incentive #2. The P4P incentive is based on the ECMs that will be installed in HS and MS.

3. Are there calculations / measurements indicating buildings' eligibility (200kW peak demand, 15% source energy savings) for this incentive available? It may be worthwhile to illustrate how close the proposed ECMS are to the 15% threshold.

   The monthly peak demand of HS varies between 1200 kW and 1300 kW per month. The monthly peak demand of MS varies between 800 kW and 1000 kW per month. So both schools are eligible for the P4P application. The total electric and natural gas savings are about 23% reduction of the baseline in HS and 22% reduction in MS, which exceed the 15% threshold, so they are qualified for the P4P.

ECM 25 – Score Board Electrical Service

1. This is listed on the Energy Savings and Cost Summary Table with a zero savings. Just to confirm this is part of a BOE driven Capital Improvement project and not an Energy Conservation Measure.

   There are energy savings quantified for this measure and can be considered a capital improvement project.

ECM 26 – Water and Sewer Rate Change

1. This ECM is included in the Energy Savings and Cost Summary Table as a Utility Savings but has no additional backup information.

   Water and Sewer rate change savings are estimated based on reduction of the Monroe Municipal Utilities Authority's school rate structure from 20 gals per pupil per day (refer MMUA Rules and Regulations, pg 126) to 15 gals per pupil per day. The rate modification is in the process of MMUA board approval and JCI is only carrying the potential savings associated with the rate change per MTBOE direction.

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:

ECM 1 – Upgrade Interior and Exterior Lighting LED Retrofits with Pendent in Elementary School Class Rooms

1. It is recommended that cut sheets for proposed interior and exterior LED replacements be included to confirm DLC listings.

   Please find the cut sheet attached to the response.

2. Confirm bypassing electronic ballast will not void UL listing on lighting fixture, provide information on retrofit kits if applicable.

   Removing ballast and running line voltage to the tombstones using a double ended LED tube which will maintain the UL listing of the existing fixture.

3. Would verify ECM 1/ 2 savings for Holley Glen ES on Section 3 table. If have the numbers right Yearly Savings is listed at $ 22,786 and total electric for this school is $ 54,088.

   JCI confirms that Holly Glen lighting upgrades result in a 42.18% savings on the electric baseline spend. This can be attributed to low usage of the building during the year 2019.

ECM 2 – Lighting Occupancy Controls (All Facilities)

1. Recommend that cut sheets of proposed lighting occupancy controls be added.

   Please find the cut sheets attached to the response.

2. Would also recommend that separate line items for estimated control installed hard costs be added to differentiate between controls and LED retrofits.

   Cost cannot be broken down as majority of the sensors are integral to the retrofit kit replacement.

3. Provide kWh savings calculations for lighting controls per building.

   Controls savings per building are broken out in the line by lines.

4.1.5 Financial Calculations

The financial calculations included within the ESP incorporate a 2.25% interest rate for the loan and the BPU-required 2.4% natural gas, 2.2% electric, and 2.2% water per year utility escalation.

The recommended plan includes twenty-four (24) ECMs and is analyzed over a 20-year financing term.

DLB notes the following potential issues with the financial calculations:

1. Cash Flow Form shown on page 120 of the report shows an installation year savings of $48,513 and a total year 1 savings of $ 481,857 with no project costs. This should be confirmed and / or an explanation should be added to help define the savings and incentives gained at no cost.

   The $48,513 are rebates sourced during the installation period of 18 months. The $481,857 is a combination of rebates and construction period savings due to early installation of scope like lighting retrofits, Holly Glen HVAC upgrades etc.

2. LFN 2009-11 requires that any capital improvements be paid through other appropriations (i.e., bonds or capital improvement funds), not energy savings obligations. DLB recommends confirming that any capital improvements are planned to be funded appropriately.

   All capital improved projects are funded appropriately and within the regulatory boundaries of the ESIP process.

3. Some ECMs have lengthy simple payback periods, beyond the overall ESP timeframe. Confirm that these measures are BOE-driven capital improvement projects.

   The measures with high paybacks are BOE approved scope items with potential energy, maintenance and operational savings that were not quantified or difficult to quantify through the ESIP process.

4.1.6 Greenhouse Gas Calculations

Greenhouse Gas Calculations are provided, and the factors used to calculate savings are clearly called out in the report. The factors should be revised to meet the current BPU guidelines, shown on page 13 of the protocol:

- 1,374 lbs. CO_2 per MWh saved
- 1.11 lbs. NO_x per MWh saved
- 0.98 lbs. SO_2 per MWh saved
- 11.7 lbs. CO_2 per therm saved
- 0.0092 lbs. NO_x per therm saved

JCI has used BPU's Clean Energy Program Protocols FY 2020 to calculate the greenhouse gas calculations. The following values were used

- 1,292 lbs. CO_2 per MWh saved
- 0.83 lbs. NO_x per MWh saved
- 0.67 lbs. SO_2 per MWh saved
- 11.7 lbs. CO_2 per therm saved
- 0.0092 lbs. NO_x per therm saved