# Energy Savings Improvment Plan (ESIP)

# Hackensack Public Schools

**191 Second Street, Hackensack, NJ 07601**

**March 3, 2021**

The power behind **your mission**

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 Hackensack Public Schools 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 CHA. The original audit was used for building descriptions as well as an overall indication of the District needs.

Priority items include:

- Upgrade Interior Lighting with LED Retrofits and Advanced Sensor Controls
- Exterior Lighting with LED Retrofits
- Building Envelope Improvements – Weatherization
- Building Controls Upgrade with Enterprise Management System
- Ventilation addition to Media Center at Fanny Hillers School
- Unit Ventilator and Radiators Replacement at Fanny Hillers School
- Radiator replacement with new UV installation at Middle School
- Boiler Replacements at Fairmount School
- Air-Handling Units Replacement at High School
- Chiller Replacement at High School
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- Refrigeration Compressor Controllers at Middle School

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 823,142 kWh of electricity with a 1,116 kW reduction and the facility will save a total of 223,007 therms of natural gas. The natural gas savings include the purchase of approximately 1,103 therms of natural gas due to the micro combined heat and power usage. The total net utility cost savings are $10,864,921 over the life of the project (20 years) with a construction period savings of $189,623 plus $520,921 in operational savings and $250,632 in project incentives. Additionally, the project also leverages $4,395,441 in solar PPA savings. These energy savings will result in a net reduction of greenhouse gases and will reduce the Hackensack Public Schools' carbon footprint by 5,146,261 lbs. of $CO_2$ annually. All 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 |
|---|---|---|
| Hackensack High School | First and Beech Street, Hackensack, NJ 07601 | 261,588 |
| Hackensack Middle School | 360 Union Street, Hackensack, NJ 07601 | 231,216 |
| Fanny M Hillers School | 56 Longview Avenue, Hackensack, NJ 07601 | 67,781 |
| Jackson Avenue School | 421 Jackson Avenue, Hackensack, NJ 07601 | 55,993 |
| Nellie Parker School | 261 Maple Hill Drive, Hackensack, NJ 07601 | 80,452 |
| Fairmount School | 105 Grand Ave, Hackensack, NJ 07601 | 65,409 |
| Padovano Admin Building | 191 Second Street, Hackensack, NJ 07601 | 8,155 |

## Facility Descriptions

### Hackensack High School

Hackensack High School is a 261,588 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 1918. 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 231 staff and 1,821 students.

| Occupants | Number | Hours |
|---|---|---|
| Students, Staff | 1,821 & 231 | 7 am to 6 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. There are a mix of single and dual pane windows.

#### Lighting System

The lighting throughout the facility is primarily T-8 32-watt fixtures. There are some T-12 48-watt linear fluorescent lamps in the boiler room. The main gymnasium has LED fixtures. The light fixtures in the building are manually controlled by switches. The exterior lights consist of various metal halide wall-pack fixtures and 4 athletic field lighting poles.

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

### HVAC Systems

**Heating**: The primary source of heat is from three Unilux Sectional Steam boilers each with a capacity of 7,893 MBH. The boilers are fairly new and installed in 2017, Steam condensate return is by gravity and pumped back to the boilers by a boiler feed system equipped with two fractional horsepower pumps. The boilers supply steam to the unit ventilators throughout the facility.

The boiler room also houses one Weil McClain Model 88 Boiler for pool water heating with heating capacity of 1126 MBH.

**Cooling:** Two Trane chillers and one Carrier unit cool the science labs. Cooling to the special services and internal office space of the facility is provided by two exterior ground mounted condensing units. There are 41 window air conditioning units that are used to cool classrooms and offices. These units range from 8,000 Btu to 32,500 Btu. Window air conditioners appear to be in fair condition.

**Ventilation:** The Air-Handling Units have ducted air intake connections from outside air intake louvers. The gymnasiums and pool have numerous fan ventilation units.

**Exhaust:** This building has multiple fractional HP exhaust fans serving restrooms, science rooms, kitchen and general exhaust located on the roof. The fans are enclosed and therefore the capacities of fan motors are unknown.

### Controls Systems

The boilers are controlled by a pneumatic control system. Compressed air to the pneumatic control devices is provided by a compressed air system with two compressors each powered by a fractional HP motor. The boilers' operation is remotely monitored and controlled by Energy for America. The school provided a copy of the Energy for America operation manual that showed the setpoints for the cooling and heating systems.

It is recommended to replace the pneumatic system controlling the boilers to Direct Digital Control (DDC) system. The advantages of this type of system include individual unit controllability and scheduling, trending of setpoints and alarm notifications for malfunctioning devices. Front end graphics available in a DDC system enable the maintenance staff to see the functioning of all systems at one location and provide service to trouble spots quickly and efficiently. Web based control systems allow access and adjustment from remote locations.

### Domestic Hot Water Systems

The domestic hot water for the building is provided by two 200 gallon A.O Smith gas-fired water heater located in the boiler room. The heaters have an input rating of 500 MBH and a 576 GPH recovery rate. Both heaters are fairly new and were installed in 2019.

### Kitchen Equipment

There is a full use kitchen in this building. The kitchen equipment in the building includes various small appliances, commercial coolers, commercial freezers, walk-in freezers, industrial mixers, gas stoves, large food warmers and various small appliances.

### Plug Load

The facility has computers, copiers, printers, woodshop equipment, mechanic shop equipment and residential appliances (microwave, refrigerator) that contribute to the plug load in the building.

### Plumbing Systems

There are numerous restrooms in the building. The toilets, and urinals are high water consuming plumbing fixtures. The toilets use about 3.5 and urinals use about 1.5 gallons per flush. The sinks are high flow fixtures however most are self-metering.

## Hackensack Middle School

Hackensack Middle School is a 231,216 square foot facility comprised of various space types within a single building. The building is a mix of three-story sections that includes classrooms, offices, gymnasium, auditorium, library, media center and kitchen.

The original building was constructed in 1912. There have been several renovations and additions since then. The facility has replaced some of the hallway T8 fluorescent fixtures with LED 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 202 staff and 1,394 students.

| Occupants | Number | Hours |
|---|---|---|
| Students, Staff | 1,394 & 202 | 8 am to 6 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.

### Lighting System

The lighting throughout the facility is primarily T-8 32 watt fixtures. The gymnasium has LED fixtures. The light fixtures in the building are manually controlled by switches. The exterior lights consist of various metal halide wall-pack fixtures.

### HVAC Systems

**Heating:** The primary source of heat is from two steel fire tube Pacific boilers each with a capacity of 8,310 MBH. The equipment was installed in 1962. Steam condensate return is by gravity and pumped back to the boilers by a boiler feed system equipped with two fractional horsepower pumps. Steam is supplied to the building by a network of steam and condensate piping. The facilities heat is provided with unit ventilators and steam heating coils.

**Cooling:** Two 60 ton rooftop units cool the new addition completed in 2000. There are 31 window air conditioning units that are used to cool classrooms and offices. These units range from 10,000 Btu to 32,500 Btu and are in good condition.

**Ventilation:** The gymnasium has two fan ventilation units. The heating and ventilation units have ducted air intake connections from outside air intake louvers.

**Exhaust:** This building has multiple fractional HP exhaust fans serving restrooms and general exhaust located on the roof. The fans are enclosed and therefore the capacities of fan motors are unknown.

### Controls Systems

The window air conditioners are operated using integral thermostats in the unit. The heating system is controlled by a pneumatic control system. Compressed air to the pneumatic control devices is provided by a Quincy compressed air system with two compressors each powered by a 2 HP motor. The rooftop units are provided with integral controls. The control systems are remotely operated and monitored by Energy for America. The school provided a copy of the Energy for America operation manual that showed the setpoints for the cooling and heating systems. Cooling occupied setpoints are between 74°F and 78°F and unoccupied setpoint is set at 85 °F. The heating occupied setpoints are between 68°F and 72°F and unoccupied setpoint is set at 55 °F.

Although the existing pneumatic control system is in good working condition and provides basic day/night functions, the School District should consider replacing the existing pneumatic control system with a DDC system. The advantages of this type of system include individual unit controllability and scheduling, trending of setpoints and alarm notifications for malfunctioning devices. Front end graphics available in a DDC system enable the maintenance staff to see the functioning of all systems at one location and provide service to trouble spots quickly and efficiently. Web based control systems allow access and adjustment from remote locations.

### Domestic Hot Water Systems

The domestic hot water for the building is provided by two 78 gallon Rheem-Ruud gas-fired water heaters, with a name plate efficiency of 80%, located in the boiler room. The DHW heaters were installed in 2009 and 2013. The heaters have an input rating of 156,000 Btu per hour per DHW heater. The DHW heaters appear to be in good condition.

### Kitchen Equipment

The kitchen equipment in the building includes various small appliances, commercial coolers, commercial freezers, walk-in freezers, industrial mixers, gas stoves, large food warmers and various small appliances.

### Plug Load

The facility has computers, copiers, printers, wood shop equipment and residential appliances (microwave, refrigerator) that contribute to the plug load in the building.

### Plumbing Systems

There are numerous restrooms in the building. The sinks, toilets and urinals are high water consuming plumbing fixtures. The toilets and urinals use about 2.5 gallons per flush however, the sinks are self-metering.

## Fanny Meyer Hillers School

Fanny M. Hillers Elementary School is a 67,781 square foot facility comprised of various space types within a single building. The building is a mix of three-story sections that includes classrooms, offices, gymnasium, auditorium, library, media center and kitchen.

The original building was constructed in 1927. There have been several renovations and additions since then.

### 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 83 staff and 569 students.

| Occupants | Number | Hours |
|---|---|---|
| Students, Staff | 569 & 83 | 7:30 am to 6 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.

### Lighting System

The lighting throughout the facility is primarily T-8 32 watt fixtures. There are some T-12 48-watt linear fluorescent lamps in the boiler room. The gymnasium has 250W metal halide fixtures. The light fixtures in the building are manually controlled by switches. The exterior lights consist of various metal halide wall-pack fixtures.

### HVAC Systems

**Heating:** The primary source of heat is from two cast iron Weil-McLain low pressure steam boilers each with a capacity of 5,200 pounds per hour. Steam condensate return is by gravity and pumped back to the boilers by a boiler feed system equipped with two fractional horsepower pumps. Steam is supplied to the original building by a network of steam and condensate piping. Some classrooms in the original building are provided with unit ventilators and steam heating coils. Other spaces are heated and ventilated by two heating and ventilation units with steam heating coils installed on the second floor mechanical rooms. Corridors and stairwells are provided with steam radiators. The 1950 addition is heated by two Nesbitt rooftop units installed on the roof equipped with hot water coils. Heated air is distributed by sheet metal ductwork. Finned tube radiators are provided along the perimeter walls. The basement spaces of the 1950 addition are heated by 10 electric unit heaters. The 1970 section of the school is heated by a Carrier split unit equipped with hot water coils.

**Cooling:** Some classrooms and offices in the original building are cooled by window air conditioners. The 1950 section of the school is cooled by two Nesbitt rooftop units each of 40 tons capacity. The 1970 section of the building is cooled by a 25 ton capacity Carrier DX split air-conditioning system and variable air volume (VAV) units. The heating and cooling equipment is old and at the end of its useful life.

**Ventilation:** Unit ventilators provided in classrooms take in outside air for ventilation through a ducted connection to an outside air intake louver. Outside air is controlled by unit ventilator dampers that are pneumatically operated. The heating and ventilation units have ducted air intake connections from outside air intake louvers. The rooftop units and the DX split air-conditioning unit are equipped with integral outside air intakes with control dampers.

**Exhaust:** This building has multiple fractional HP exhaust fans serving restrooms and general exhaust located on the roof. The fans are enclosed and therefore the capacities of fan motors are unknown.

### Controls Systems

The heating system is controlled by a pneumatic control system. Compressed air to the pneumatic control devices is provided by a Quincy compressed air system with two compressors each powered by a 3HP motor. The rooftop units and the DX split air-conditioning unit are provided with integral controls. The control systems are remotely monitored and controlled by Energy for America. The school provided a copy of the Energy for America operation manual that showed the setpoints for the cooling and heating systems. Cooling occupied setpoints are between 74°F and 78°F and unoccupied setpoint is set at 85°F. The heating occupied setpoints are between 68°F and 72°F and unoccupied setpoint is set at 55°F.

Although the existing pneumatic control system is in good working condition and provides basic day/night functions, the School District should consider replacing the existing pneumatic control system with a DDC system. The advantages of this type of system include individual unit controllability and scheduling, trending of setpoints and alarm notifications for malfunctioning devices. Front end graphics available in a DDC system enable the maintenance staff to see the functioning of all systems at one location and provide service to trouble spots quickly and efficiently. Web based control systems allow access and adjustment from remote locations.

### Domestic Hot Water Systems

This building has a LAARS Mighty Therm 2 domestic hot water heater installed recently and in good working condition.

### Kitchen Equipment

There is no kitchen in the building.

### Plug Load

The facility has computers, copiers, printers, and residential appliances (microwave, refrigerator) that contribute to the plug load in the building.

### Plumbing Systems

The urinals and toilets appear to be high flow plumbing fixtures. The sinks are equipped with manual faucets.

## Jackson Avenue School

Jackson Avenue School is a 55,993 square foot facility comprised of various space types within a single building. The building is a mix of three-story elementary school and has classrooms, gym, cafeteria, kitchen, administrative offices, nurse's office, restrooms, storage and mechanical rooms.

The original building was constructed in 1922. There have been several renovations and additions since then.

### 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 59 staff and 433 students.

| Occupants | Number | Hours |
|---|---|---|
| Students, Staff | 433 & 59 | 7:30 am to 6 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.

### Lighting System

The lighting throughout the facility is primarily T-8 32 watt fixtures. There are some T-12 48-watt linear fluorescent lamps in the boiler room. The gymnasium has 250W metal halide fixtures. The light fixtures in the building are manually controlled by switches. The exterior lights consist of various metal halide wall-pack fixtures.

### HVAC Systems

**Heating:** The primary source of heat is from two cast iron Weil-McLain low pressure steam boilers each with a capacity of 5,520 pounds per hour. The boilers were installed in 1972. Steam condensate return is by gravity and pumped back to the boilers by a boiler feed system equipped with two fractional horsepower pumps. A steam to hot water heat exchanger is installed in the mechanical room. Heating and ventilation for the auditorium is provided by a York Air-Handling Unit installed in the mechanical room that is equipped with steam heating coils. All other spaces of the building are heated by hot water circulated by a centrifugal pump driven by a 2 HP motor. Floor mounted Air-Handling Units manufactured by Tempspec with hot water coils are installed in each classroom and ceiling mounted Air-Handling Units with hot water coils are installed for the nurse's, principal's and main offices. The gymnasium, kindergarten, and cafeteria are heated by three York rooftop units installed on the roof equipped with hot water coils. Heated air is distributed by sheet metal ductwork.

**Cooling:** The gymnasium, kindergarten, and cafeteria are cooled by three York rooftop units each of 20 tons cooling capacity. All other spaces of the building are cooled by two York air-cooled chillers each of 70 tons capacity. A glycol chilled water to chilled water heat exchanger is installed in the mechanical room. Glycol chilled water is circulated between the chillers and heat exchanger by two centrifugal pumps, one working and one standby, driven by 10 HP motors. Chilled water is circulated between the Air-Handling Units, rooftop units and the heat exchanger by two centrifugal pumps, one working and one standby, driven by a 7.5 HP motors.

The steam boilers and associated equipment was installed in 1972 and is past its useful life. The chillers and associated equipment and the three rooftop units were installed in 2005 and appear to be in good condition.

**Ventilation:** The Air-Handling Units have ducted air intake connections from outside air intake louvers. The rooftop units are equipped with integral outside air intakes with control dampers.

**Exhaust:** This building has multiple fractional HP exhaust fans serving restrooms and general exhaust located on the roof. The fans are enclosed and therefore the capacities of fan motors are unknown.

### Controls Systems

The boilers are controlled by a pneumatic control system. Compressed air to the pneumatic control devices is provided by a compressed air system with two compressors each powered by a fractional HP motor. The boilers' operation is remotely monitored and controlled by Energy for America. The school provided a copy of the Energy for America operation manual that showed the setpoints for the cooling and heating systems.

Cooling occupied setpoints are between 74°F and 78°F and unoccupied setpoint is set at 85°F. The heating occupied setpoints are between 68°F and 72°F and unoccupied setpoint is set at 55°F. The chilled water system, Air-Handling Units, rooftop units and exhaust fans are monitored and controlled by a DDC system by Staefa Controls. The system was installed in 2005. The front end is located in the boiler room and has graphics that show the status of equipment.

### Domestic Hot Water Systems

This building has an A.O Smith gas-fired DHW heater located in the boiler room. This DHW heater was installed in 2019. The heater has an input rating of 199 MBH, 193 GPH recovery rate, 81-gallon storage tank capacity and a nameplate efficiency of 80%.

### Kitchen Equipment

There is no kitchen in the building.

### Plug Load

The facility has computers, copiers, printers, and residential appliances (microwave, refrigerator) that contribute to the plug load in the building.

### Plumbing Systems

The urinals and toilets appear to be high flow plumbing fixtures. The sinks are equipped with manual faucets.

## Nellie K. Parker School

Nellie K. Parker Elementary School is a 80,452 square foot facility comprised of various space types within a single building. The building is a mix of four-story elementary school and has classrooms, gym, cafeteria, kitchen, administrative offices, nurse's office, restrooms, storage and mechanical rooms.

The original building was constructed in 1974.

### 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 95 staff and 579 students.

| Occupants | Number | Hours |
|---|---|---|
| Students, Staff | 579 & 95 | 7:30 am to 6 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.

### Lighting System

The lighting throughout the facility is primarily T-8 32 watt fixtures. There are some T-12 48-watt linear fluorescent lamps in the boiler room. The gymnasium has 250W metal halide fixtures. The light fixtures in the building are manually controlled by switches. The exterior lights consist of various metal halide wall-pack fixtures.

### HVAC Systems

**Heating:** The primary source of heat is from two Cyclotherm low pressure steam boilers each with a capacity of 2,760 pounds per hour. Steam condensate return is by gravity and pumped back to the boilers by a boiler feed system equipped with two (2) 1-HP pumps. A steam to hot water heat exchanger installed in the boiler room provides heating hot water to all spaces in the building. Heating and ventilation is provided by eight multi-zone Air-Handling Units manufactured by McQuay. Six of the eight Air-Handling Units are installed in three penthouses on the roof, one by the boiler room and another on the second floor. All Air-Handling Units are equipped with hot water heating coils. Hot water is circulated by a network of hot water piping and two centrifugal pumps, one working and one standby, each driven by a 15 HP motor.

Additionally, two classrooms on the third floor are each provided with a floor mounted Airedale heat pump unit.

**Cooling:** The building is cooled by a 250 ton capacity Trane rotary air-cooled chiller. The chiller is installed on-grade adjacent to the boiler room. Cooling and ventilation are provided by the same eight multi-zone Air-Handling Units that are described in the heating section above. All Air-Handling Units are also equipped with chilled water cooling coils. Chilled water is circulated by a network of chilled water piping and two centrifugal pumps, one working and one standby, each driven by a 15 HP motor.

The heating and cooling equipment installed in 1974 is original and is at the end of its useful life. However, the Air-Handling Units appear to be in good condition.

**Ventilation:** The Air-Handling Units have ducted air intake connections from outside air intake louvers. The rooftop units are equipped with integral outside air intakes with control dampers.

**Exhaust:** This building has multiple fractional HP exhaust fans serving restrooms and general exhaust located on the roof. The fans are enclosed and therefore the capacities of fan motors are unknown.

### Controls Systems

The heating system is controlled by a pneumatic control system. Compressed air to the pneumatic control devices is provided by a Quincy compressor air system with two compressors each powered by a 2 HP motor. The air-cooled chiller is equipped with an integral DDC control system. The control systems are remotely monitored and controlled by Energy for America. The school provided a copy of the Energy for America operation manual that showed the setpoints for the cooling and heating systems. Cooling occupied setpoints are between 74°F and 78°F and unoccupied setpoint is set at 85°F. The heating occupied setpoints are between 68°F and 72°F and unoccupied setpoint is set at 55°F.

Although the existing pneumatic control system is in good working condition and provides basic day/night functions, the School District should consider replacing the existing pneumatic control system with a DDC system. The advantages of this type of system include individual unit controllability and scheduling, trending of setpoints and alarm notifications for malfunctioning devices. Front end graphics available in a DDC system enable the maintenance staff to see the functioning of all systems at one location and provide service to trouble spots quickly and efficiently. Web based control systems allow access and adjustment from remote locations.

### Domestic Hot Water Systems

This building has an A.O Smith gas-fired DHW heater located in the boiler room. This DHW heater was installed in 2018. The heater has an input rating of 250 MBH, 242 GPH recovery rate, 100-gallon storage tank capacity and a nameplate efficiency of 80%.

### Kitchen Equipment

There is no kitchen in the building.

### Plug Load

The facility has computers, copiers, printers, and residential appliances (microwave, refrigerator) that contribute to the plug load in the building.

### Plumbing Systems

The urinals and toilets appear to be high flow plumbing fixtures. The sinks are equipped with manual faucets.

## Fairmount School

Fairmount Elementary School is a 65,409 square foot facility comprised of various space types within a single building. The building is a mix of three-story elementary school with basement and has classrooms, gym, cafeteria, kitchen, administrative offices, nurse's office, restrooms, storage and mechanical rooms.

The original building was constructed in 1909. There have been several renovations and additions since then.

### 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 80 staff and 578 students.

| Occupants | Number | Hours |
|---|---|---|
| Students, Staff | 578 & 80 | 7:30 am to 6 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.

### Lighting System

The lighting throughout the facility is primarily T-8 32-watt fixtures. There are some T-12 48-watt linear fluorescent lamps in the boiler room. The gymnasium has T-8 17W fixtures. The light fixtures in the building are manually controlled by switches. The exterior lights consist of one metal halide wall-pack fixtures.

### HVAC Systems

**Heating:** The primary source of heat is from two cast iron Weil-McLain boilers each with a capacity of 5,230 pounds per hour. The equipment was installed in 1980. Steam condensate return is by gravity and pumped back to the boilers by a boiler feed system equipped with two fractional horsepower pumps. The boilers supply hot water to the unit ventilators throughout the facilities classrooms, baseboard heaters in the cafeteria and supply's steam to wall mounted steam radiators and ceiling mounted unit ventilators in the gymnasium.

**Cooling:** There are 13 window air conditioning units that are used to cool classrooms and offices. These units range from 8,000 Btu to 32,500 Btu. There is no further cooling systems in this building. Window air conditioners appear to be in good condition.

**Ventilation:** The Air-Handling Units have ducted air intake connections from outside air intake louvers. The gymnasium has two fan ventilation units. One fan unit used to supply ventilation to the auditorium may no longer be in use.

**Exhaust:** This building has multiple fractional HP exhaust fans serving restrooms and general exhaust located on the roof. The fans are enclosed and therefore the capacities of fan motors are unknown.

### Controls Systems

The heating system is controlled by a pneumatic control system. Compressed air to the pneumatic control devices is provided by a Quincy compressor air system with two compressors each powered by a 2 HP motor. The air-cooled chiller is equipped with an integral DDC control system. The control systems are remotely monitored and controlled by Energy for America. The school provided a copy of the Energy for America operation manual that showed the setpoints for the cooling and heating systems. Cooling occupied setpoints are between 74°F and 78°F and unoccupied setpoint is set at 85°F. The heating occupied setpoints are between 68°F and 72°F and unoccupied setpoint is set at 55°F.

Although the existing pneumatic control system is in good working condition and provides basic day/night functions, the School District should consider replacing the existing pneumatic control system with a DDC system. The advantages of this type of system include individual unit controllability and scheduling, trending of setpoints and alarm notifications for malfunctioning devices. Front end graphics available in a DDC system enable the maintenance staff to see the functioning of all systems at one location and provide service to trouble spots quickly and efficiently. Web based control systems allow access and adjustment from remote locations.

### Domestic Hot Water Systems

This building has an A.O Smith gas-fired DHW heater located in the boiler room. This DHW heater was installed in 2018. The heater has an input rating of 250 MBH, 242 GPH recovery rate, 100-gallon storage tank capacity and a nameplate efficiency of 80%.

### Kitchen Equipment

There is a kitchen used for warming in the building. This kitchen has one 3x6 kitchen hood that sees minimal use. The kitchen also contains two large refrigerators, one large freezer and one warming unit.

### Plug Load

The facility has computers, copiers, printers, and residential appliances (microwave, refrigerator) that contribute to the plug load in the building.

### Plumbing Systems

There are numerous restrooms in the building. The toilets, and urinals are high water consuming plumbing fixtures. The toilets and urinals use about 2.5 gallons per flush. The sinks are high flow fixtures however most are self-metering.

## Padovano Admin Building

Padovano Administration Building is a 8,155 square foot office building used as offices, restrooms, conference room, multipurpose room, server room, storage and utility rooms. The building was constructed in 2009.

### Building Occupancy

The hours of operation are from 8.00 am to 4.00 pm Monday to Friday. The facility is occupied by 31 permanent employees.

| Occupants | Number | Hours |
|---|---|---|
| Staff | 31 | 8 am to 4 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.

### Lighting System

The lighting throughout the facility is primarily T-8 32 watt linear fixtures fluorescent fixtures. There are also compact fluorescent fixtures of various wattage bulbs in the building. Most of the lighting systems in the individual spaces are automatically controlled by occupancy sensors. There are manual control switches for the conference room, hallways, and entranceways. The exterior lights consists of metal halide wall-pack fixtures.

### HVAC Systems

**Heating:** The building is primarily heated by the natural gas furnaces in the three Carrier rooftop units, two of 10 ton cooling capacity and one of 4 ton cooling capacity. The two 10 ton rooftop units are associated with VAV provided with electric reheat. The VAV units serve the offices in the building. Utility room is heated by a ceiling mounted 10 kW electric unit heater by TPI Corporation. The three entrance lobbies are heated by concealed wall mounted cabinet electric heaters.

The cooling and heating equipment was installed in 2009 and appears to be in good condition. However, we have evaluated ECMs related to replacing the electric reheat coils in the VAV units with hot water coils and replacing electric unit heater and electric cabinet heaters with hot water units by installing a high efficiency condensing boiler and hot water piping.

**Ventilation:** Rooftop units are provided with integral outdoor air intakes.

**Exhaust:** This building has a fractional HP roof mounted exhaust fan serving restrooms and general exhaust located on the roof.

### Controls Systems

The building has a Carrier DDC control system that controls the rooftop units and VAV units.

### Domestic Hot Water Systems

This building has a 40 gallon A.O. Smith electric water located in the mechanical room. This DHW heater was installed in 2009 and appears to be in good condition. The heater has a rated heating capacity of 4.5 kW.

### Kitchen Equipment

There is no kitchen in the building.

### Plug Load

The facility has computers, copiers, printers, and residential appliances (microwave, refrigerator) that contribute to the plug load in the building.

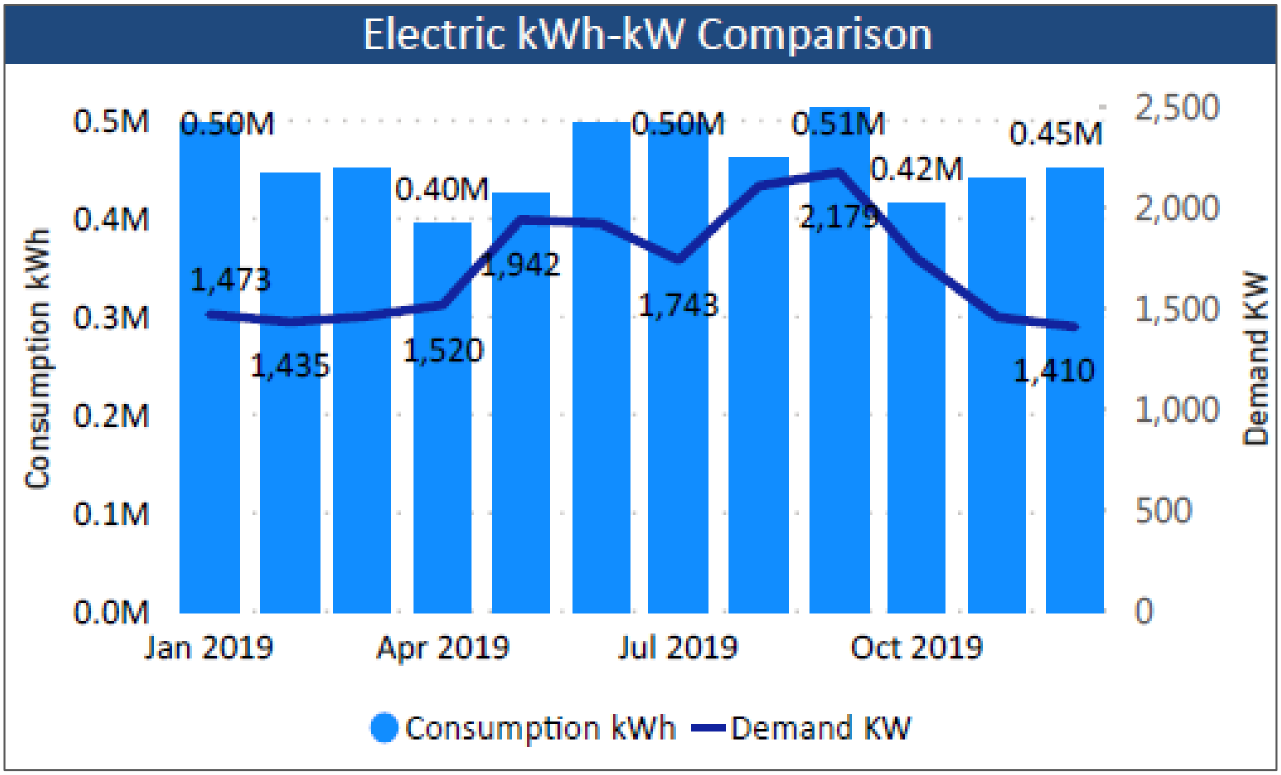
### Plumbing Systems

The urinals and toilets are equipped with automatic flush. They appear to be high flow plumbing fixtures. The sinks are equipped with manual faucets.

# Utility Baseline Analysis

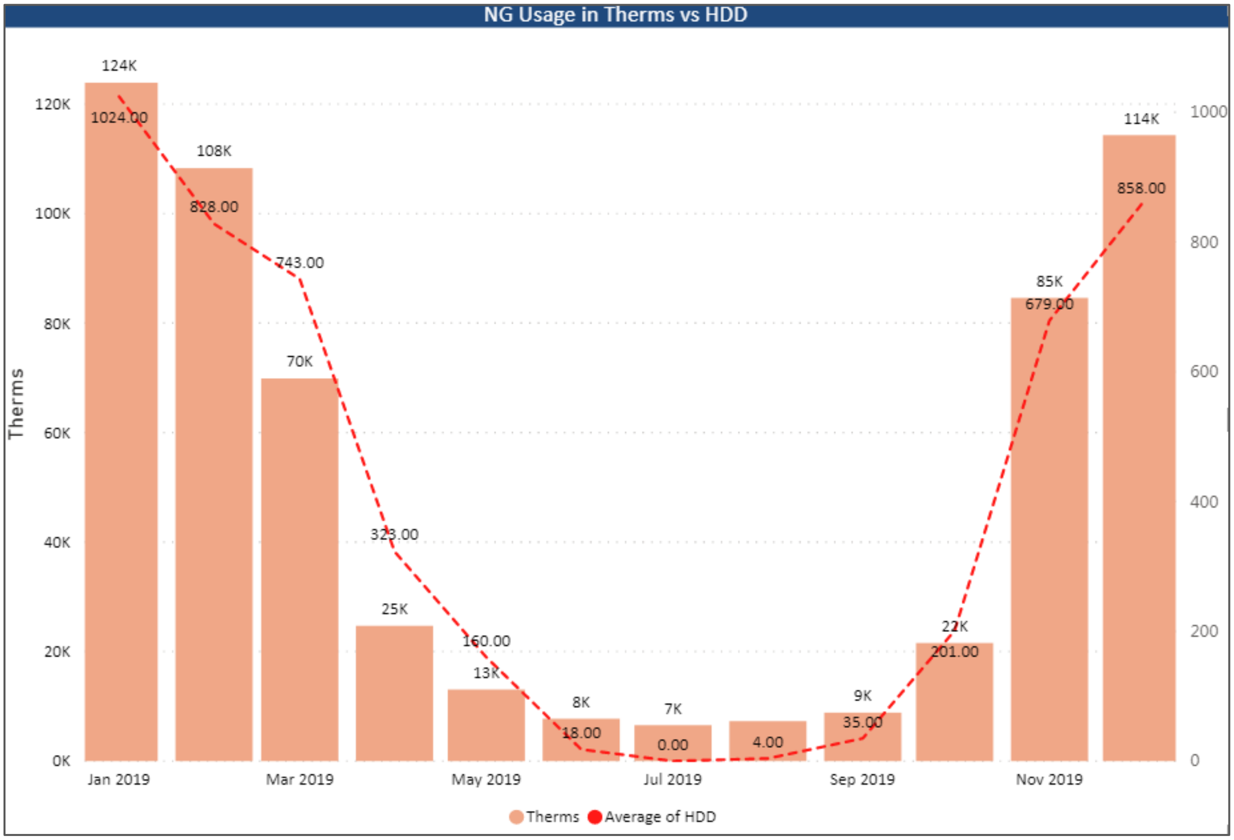
## Electric Utility

Electrical energy is delivered to Hackensack Public Schools through PSE&G. 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

Hackensack Public Schools acquires Natural Gas from PSE&G. The natural gas utility company measures consumption in Therms. The Baseline period for Natural Gas utility is January 2019 to December 2019.

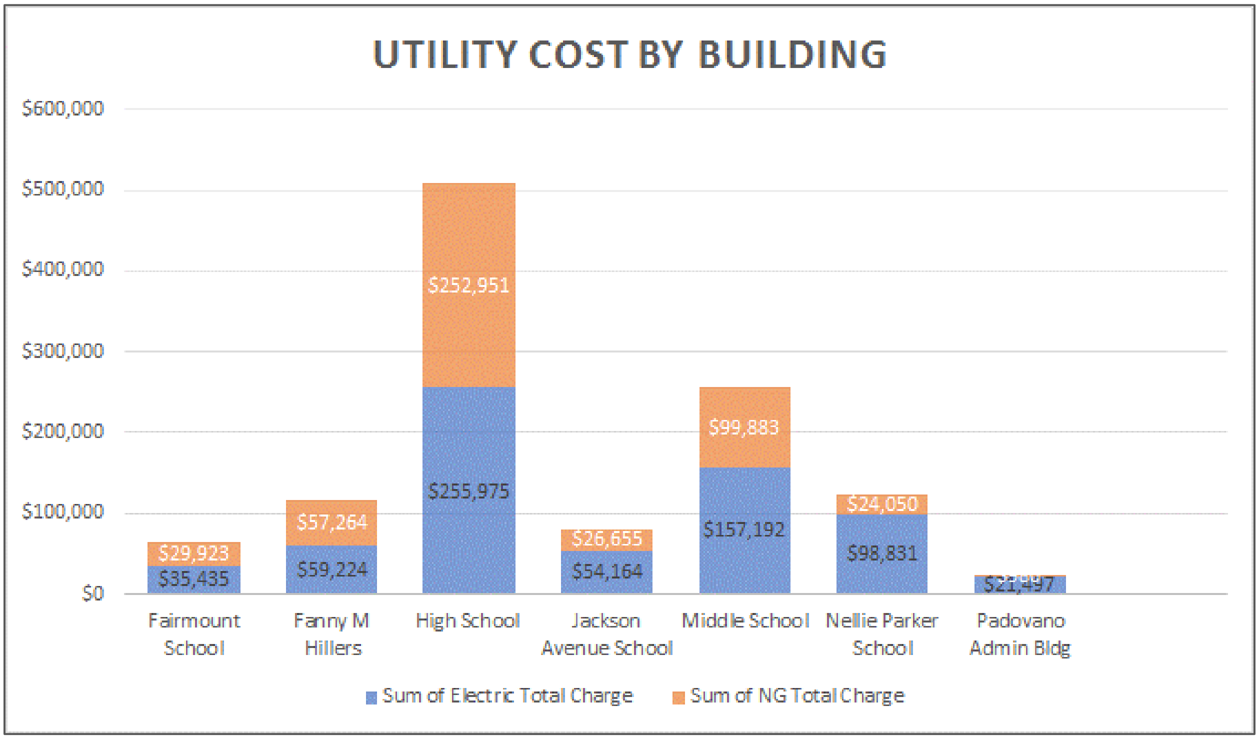



The following table shows the Schools' building names, addresses and utility account numbers considered for the baseline of this ESIP.

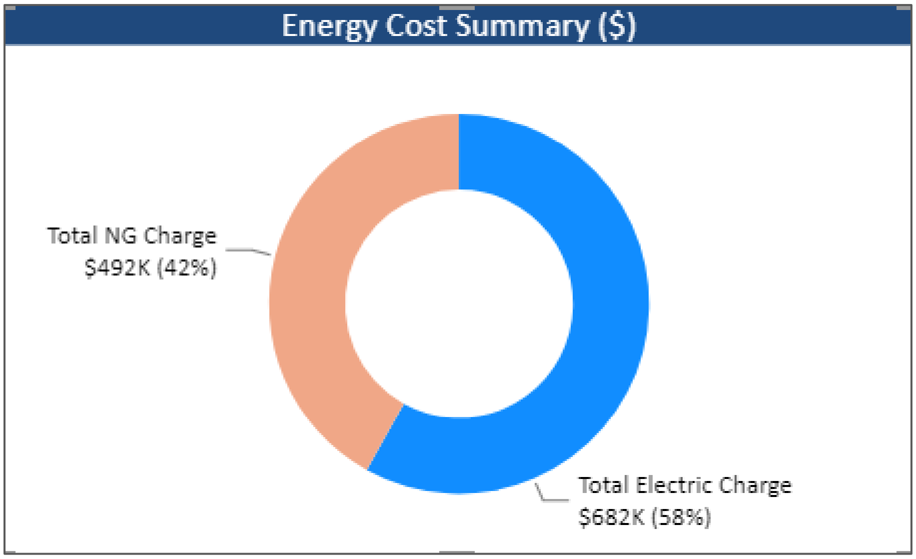
| Building | PSE&G Electric Account No. | PSE&G Natural Gas Account No. |
|---|---|---|
| Fairmount Elementary School | 4237552209 | 6961494803 |
| Fanny Hillers Elementary School | 4200050102 | 4200050102 |
| High School | 4200385600, 6567059109, 6961347703, 6961629407. 6961629407, 6961670806, 6961682809, 6962967004 | 4200385600, 6961433006, 6961584004, 6961629407 |
| Jackson Ave Elementary School | 4200425904 | 4200425904 |
| Middle School | 4200136309, 4200890100 | 4200890100 |
| Nellie Parker Elementary School | 4200267918 | 4200267918 |
| Padovano Administration Building | 6962694202 | 6962694202 |

## Energy Usage Summary

Based on JCI's utility analysis Hackensack Public Schools has a total spend of $1.17 million towards electric and natural gas utilities. The energy and utility spend breakdown is provided below.




| Building Name | Electric Cost | Natural Gas Cost |
|---|---|---|
| Fairmount Elementary School | $35,435 | $29,923 |
| Fanny Hillers Elementary School | $59,224 | $57,264 |
| High School | $255,975 | $252,951 |
| Jackson Ave Elementary School | $54,164 | $26,655 |
| Middle School | $157,192 | $99,883 |
| Nellie Parker Elementary School | $98,831 | $24,050 |
| Padovano Administration Building | $21,497 | $980 |
| Total | $682,317 | $491,706 |




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.

| BUILDING | EUI (KBtu/Sqft) |
|---|---|
| Fairmount Elementary School | 68 |
| Fanny Hillers Elementary School | 105 |
| High School | 145 |
| Jackson Ave Elementary School | 73 |
| Middle School | 113 |
| Nellie Parker Elementary School | 68 |
| Padovano Administration Building | 80 |

## Marginal Rates

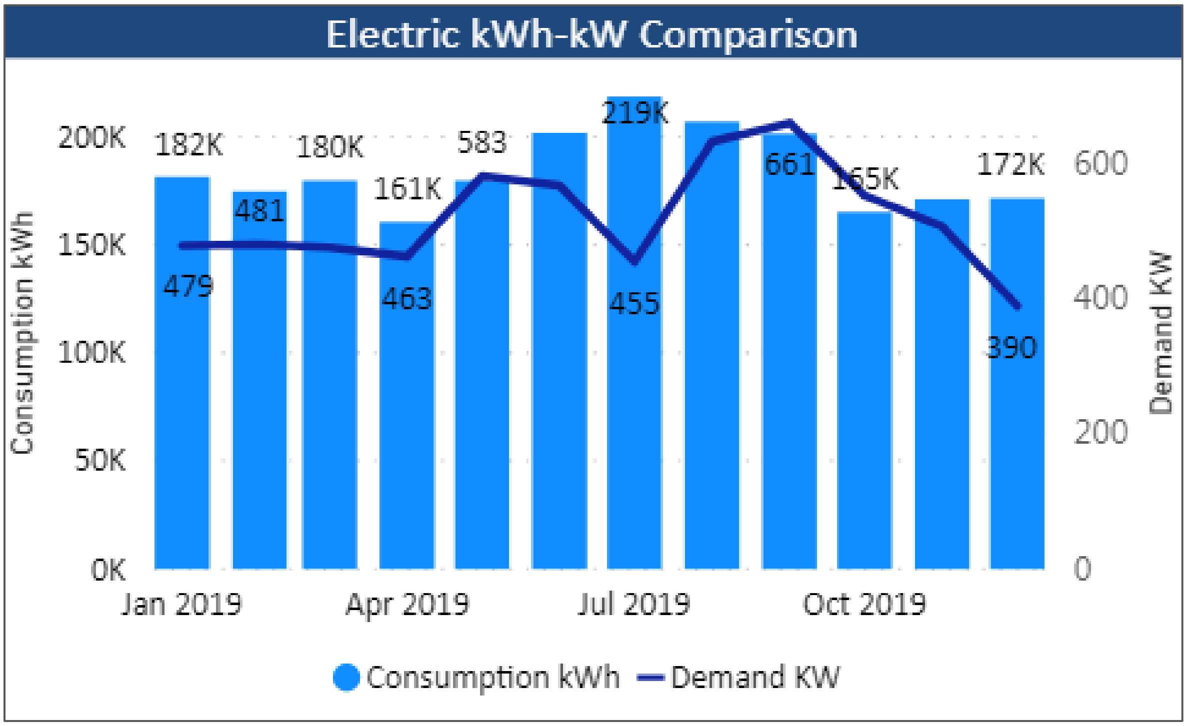
The utility rates identified below were used for purposes of calculating the dollar effect of the energy savings for the schools. These rates were determined based on data from tariff data and utility data.

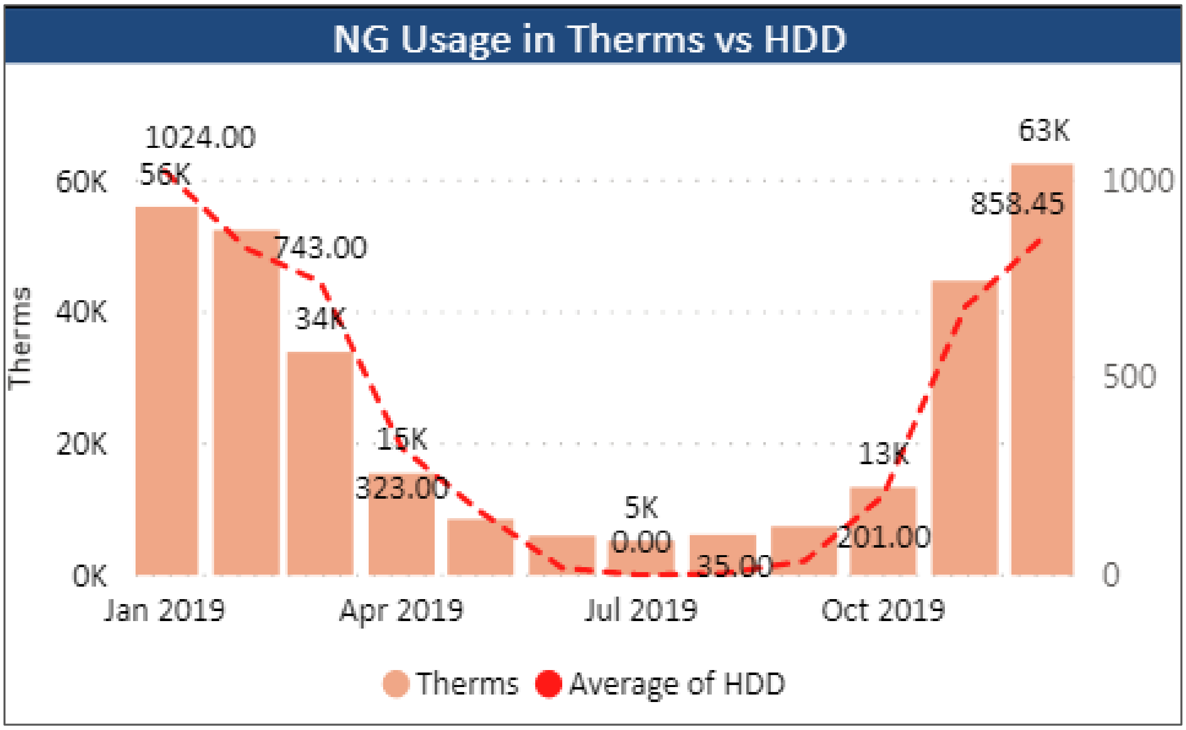
| Building | Utility Electric Rates | | Natural Gas |
|---|---|---|---|
| | $/kWh | $/kW | $/ THERM |
| Fairmount Elementary School | $0.117 | $7.510 | $0.892 |
| Fanny Hillers Elementary School | $0.097 | $7.510 | $0.843 |
| High School | $0.096 | $7.085 | $0.811 |
| Jackson Ave Elementary School | $0.106 | $7.664 | $0.861 |
| Middle School | $0.097 | $7.037 | $0.844 |
| Nellie Parker Elementary School | $0.090 | $7.070 | $0.886 |
| Padovano Administration Building | $0.128 | $3.931 | $1.126 |

## Utility Breakdown by Building

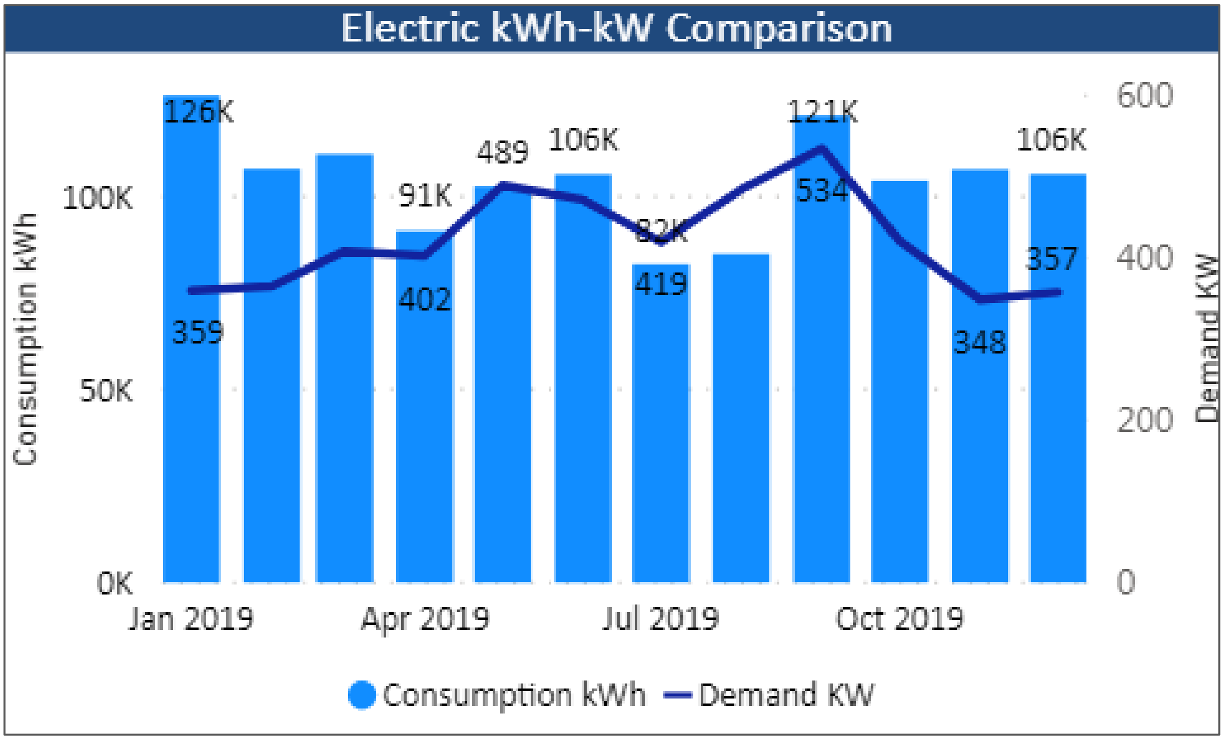
The baseline utility period used for all sites is calendar year 2019 due to the significant impact of the COVID-19 global pandemic to existing building operation. The use of 2019 data allows for the building impacts to be disregarded and the data to require no adjustments based on the major operational changes.

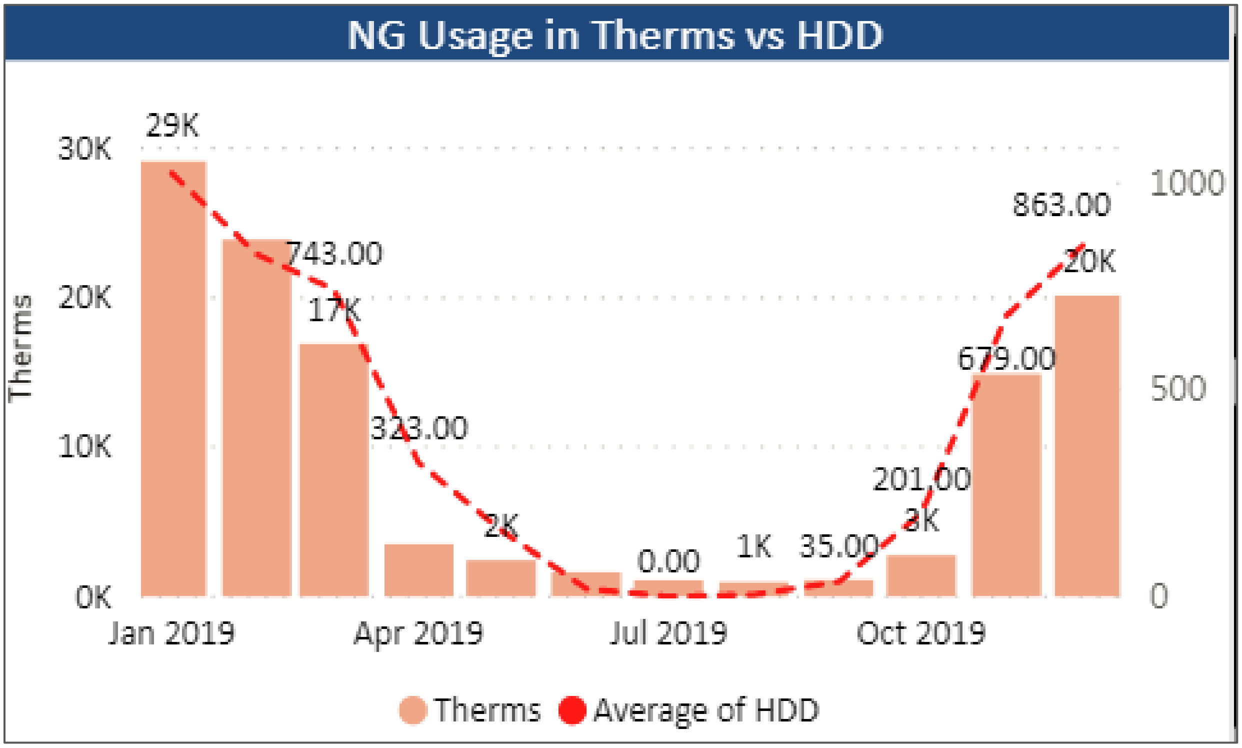
### High School



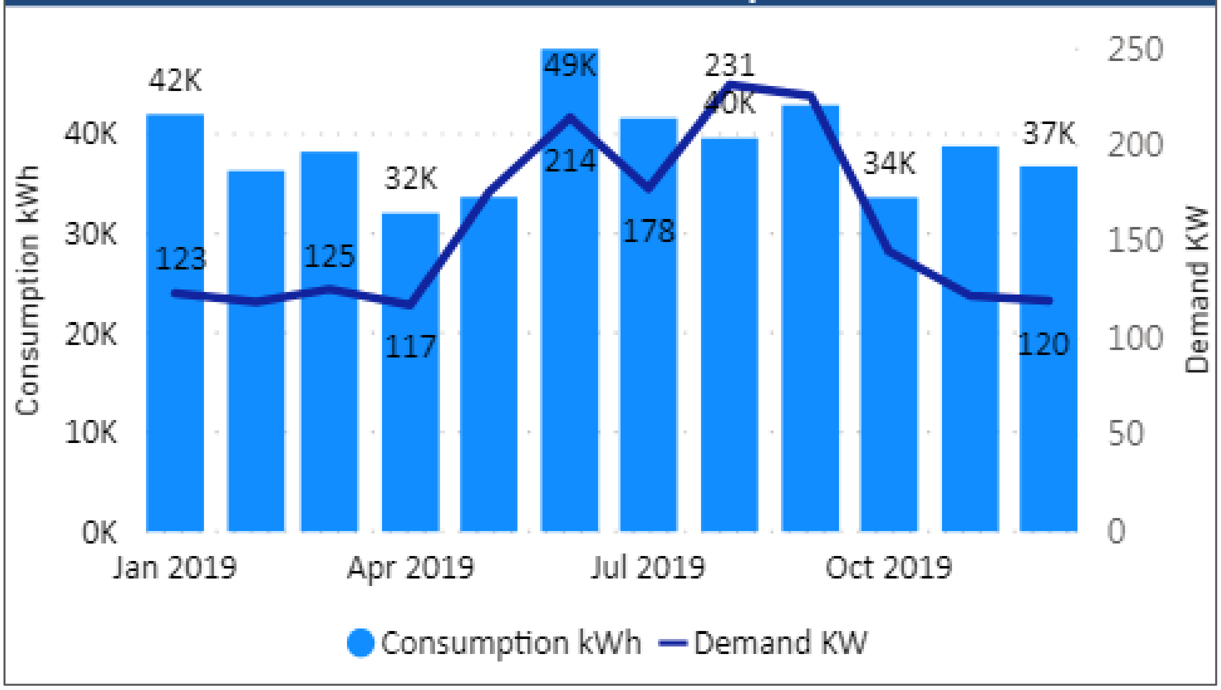
## Middle School



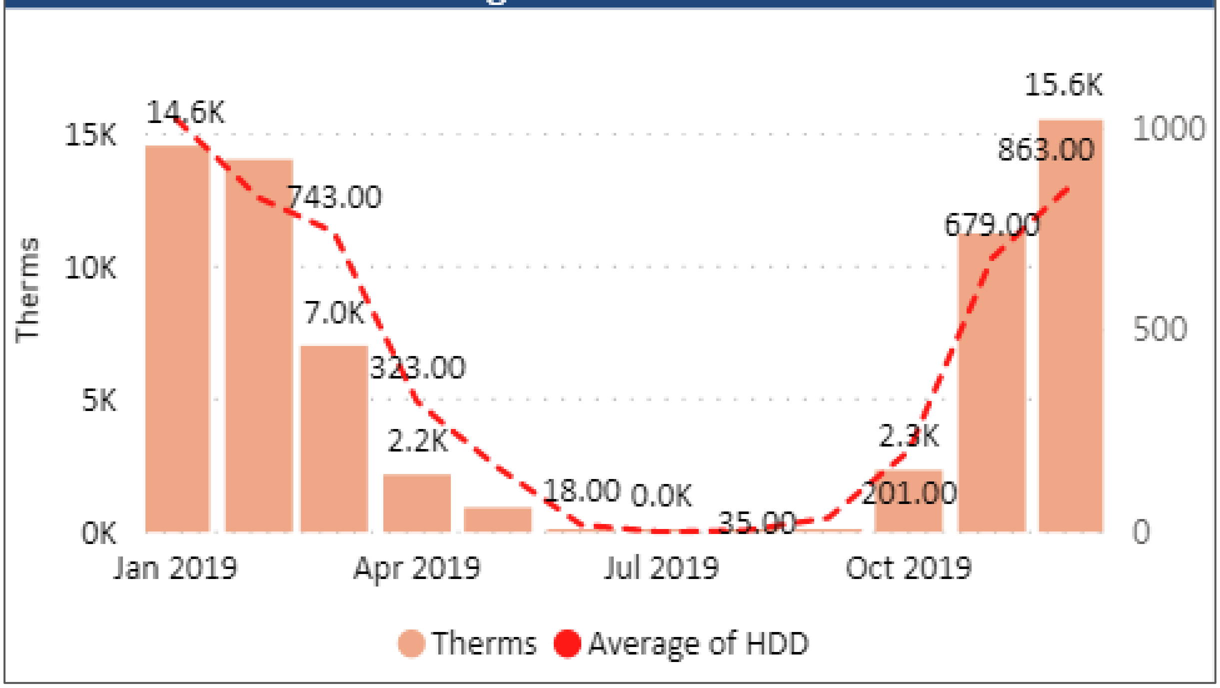



## Fanny Hillers Elementary School

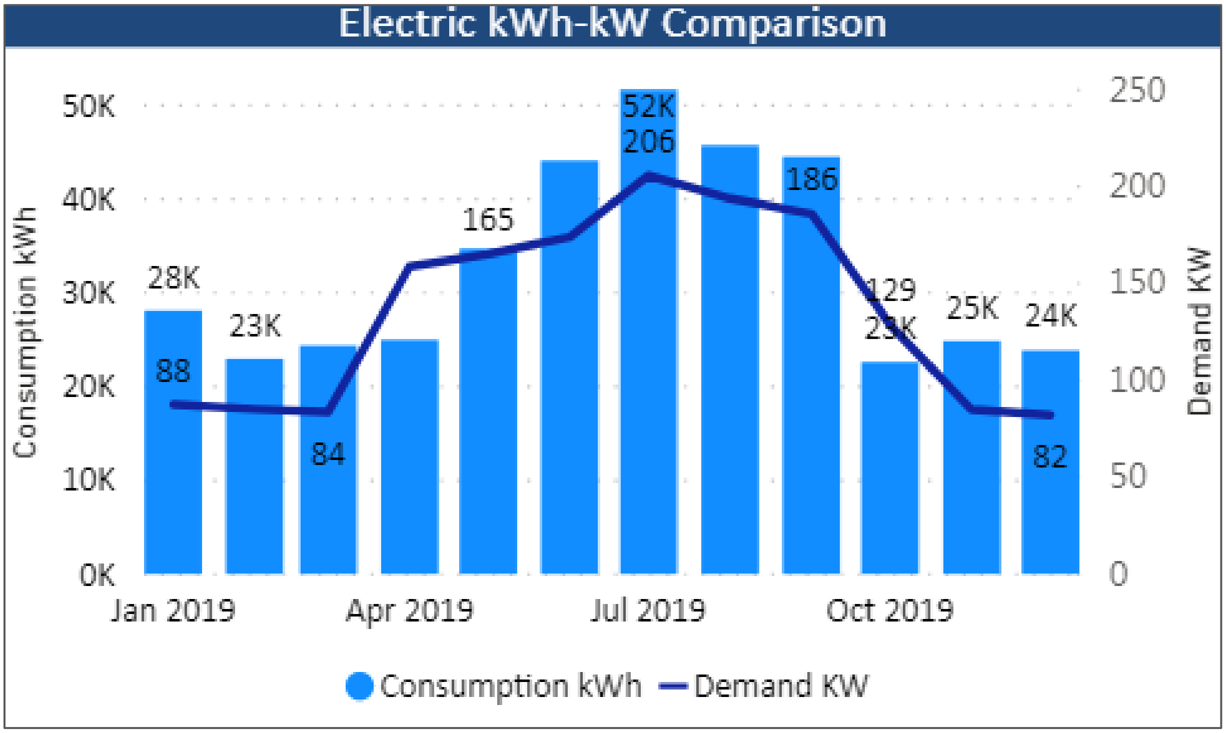
### Electric kWh-kW Comparison

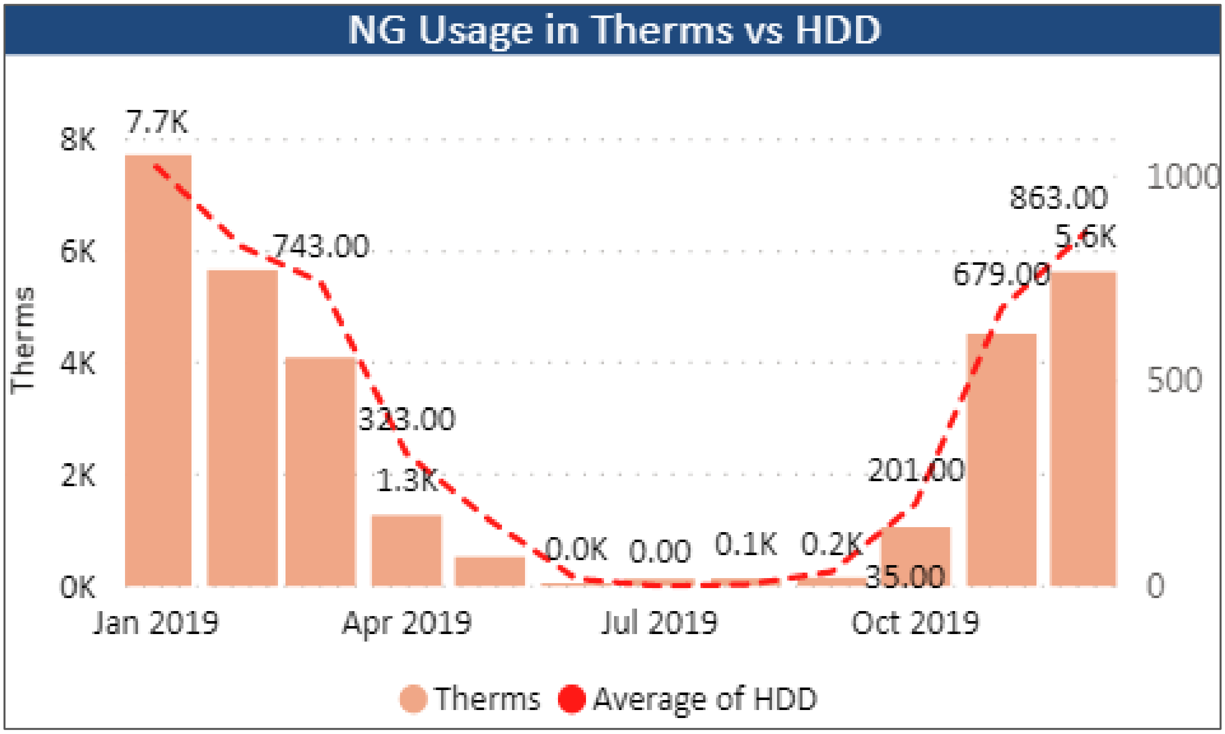



### NG Usage in Therms vs HDD

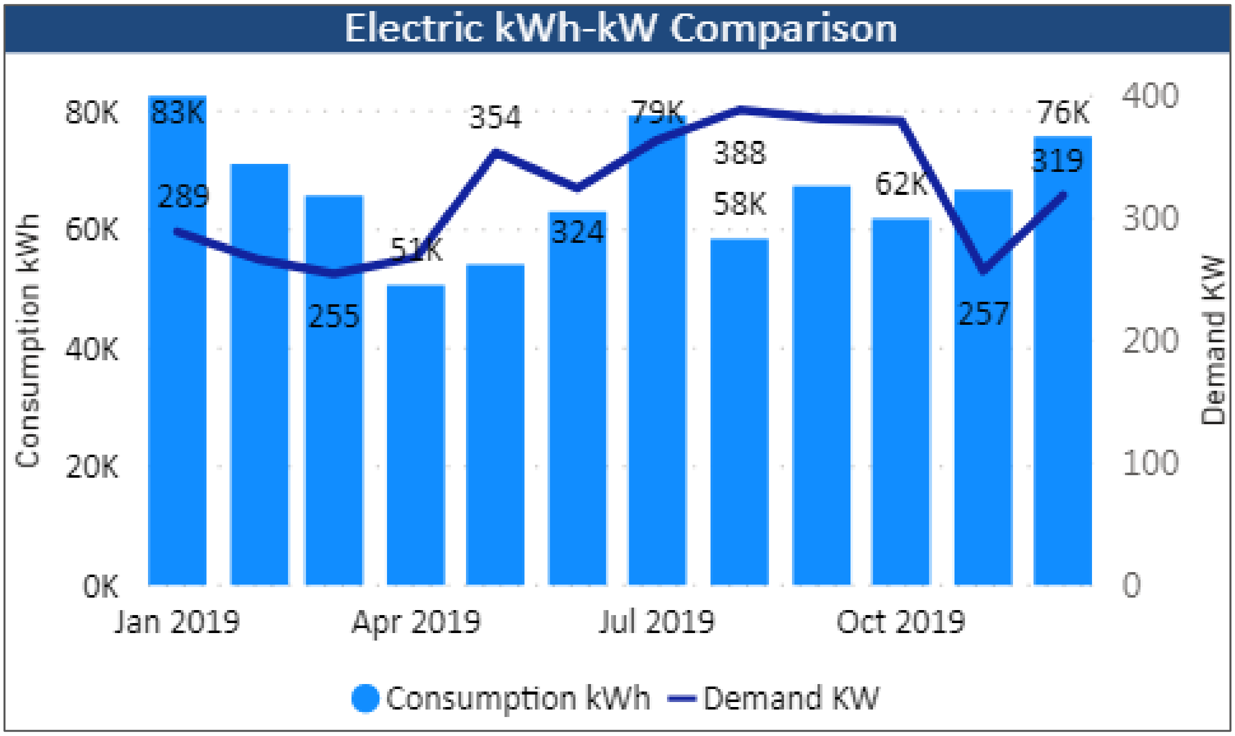


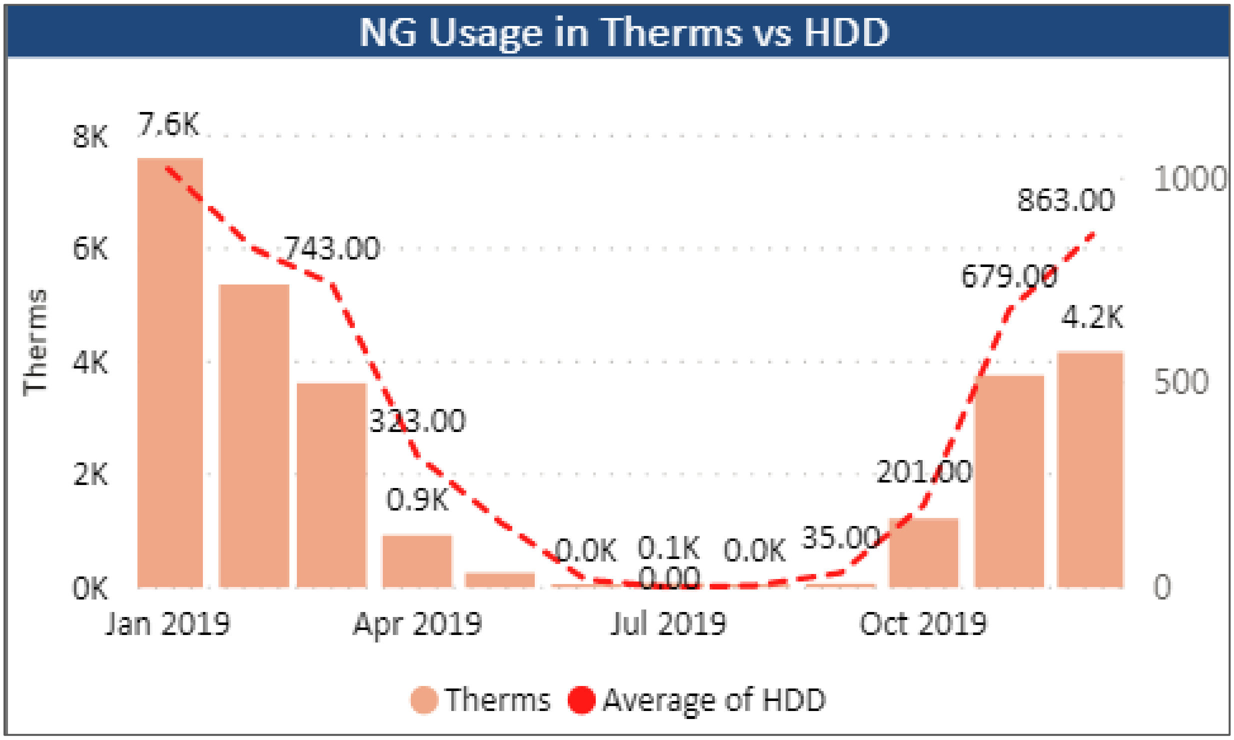
## Jackson Avenue Elementary School



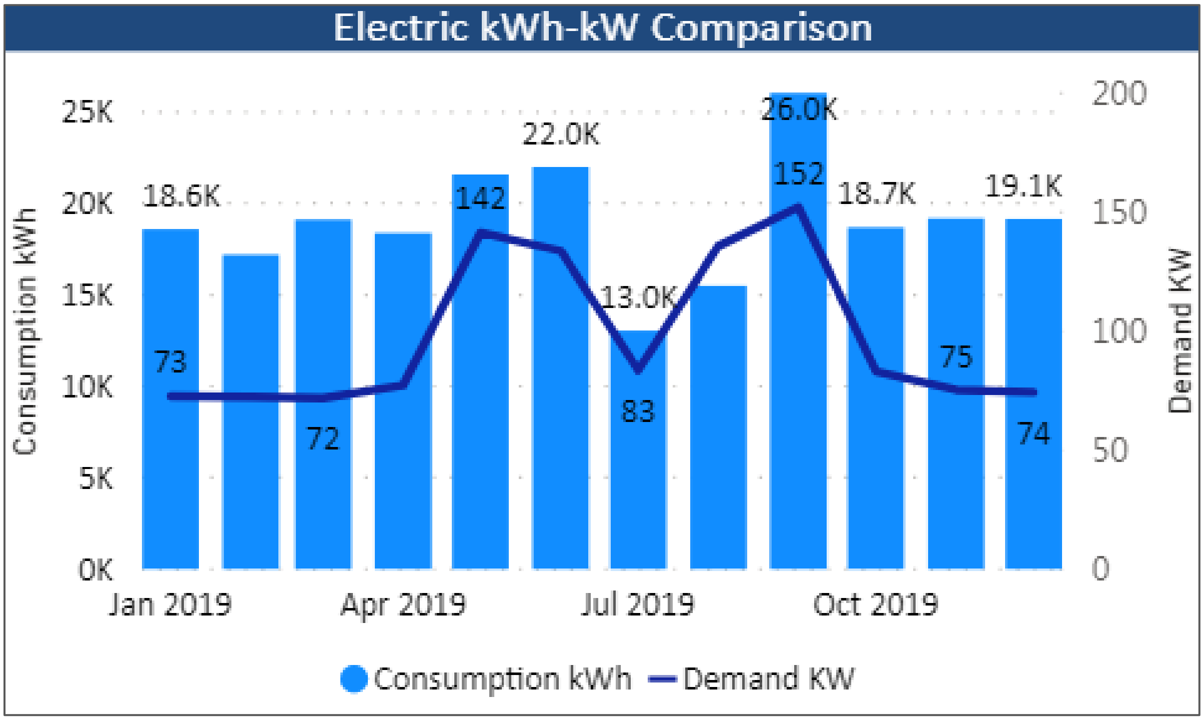



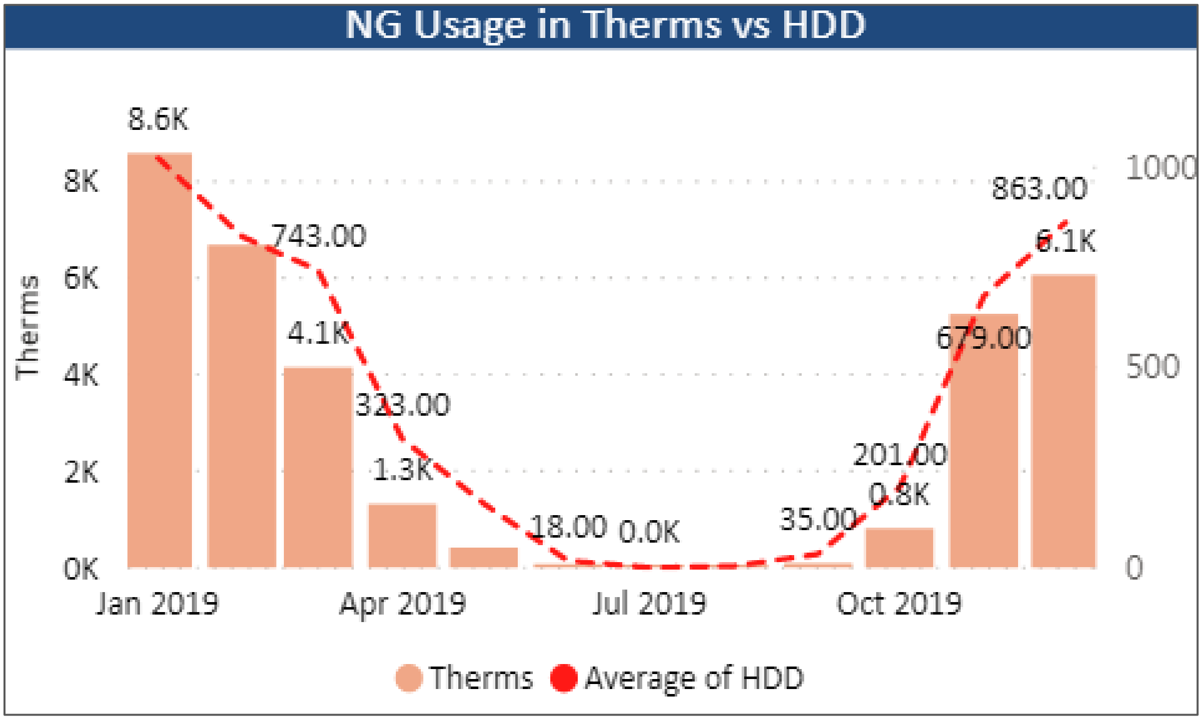
## Nellie Parker Elementary School



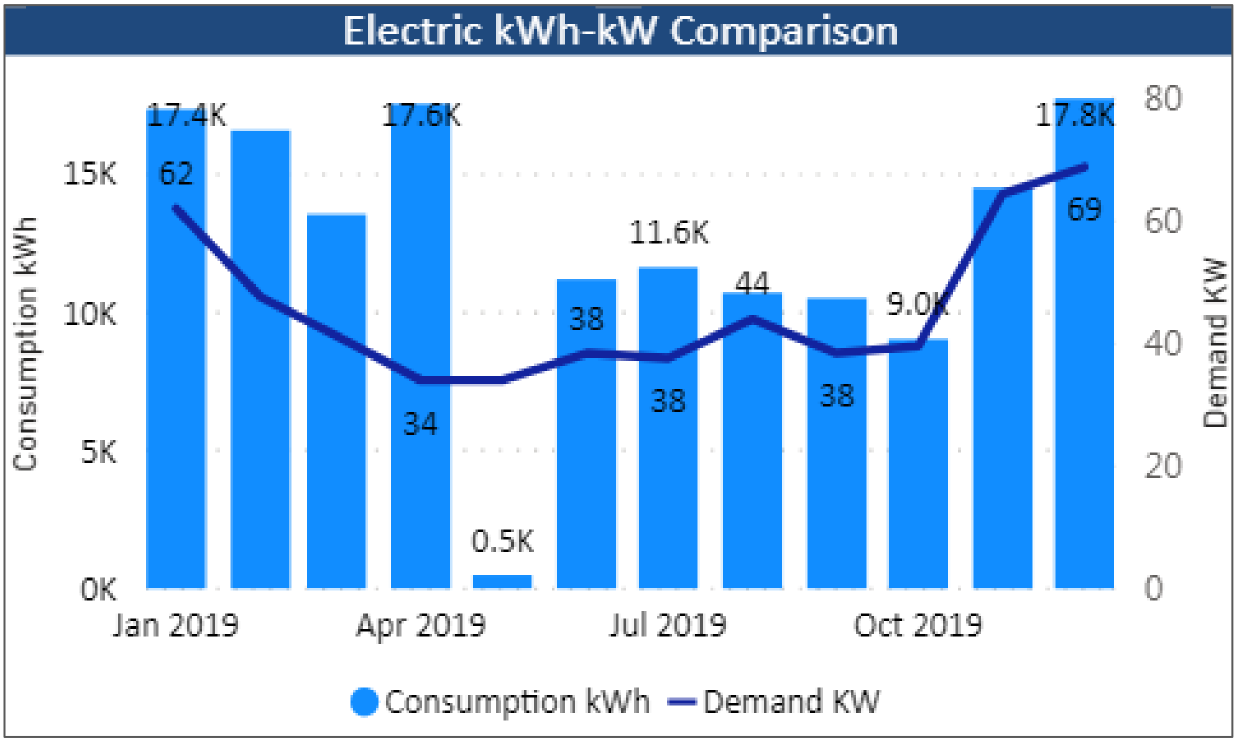



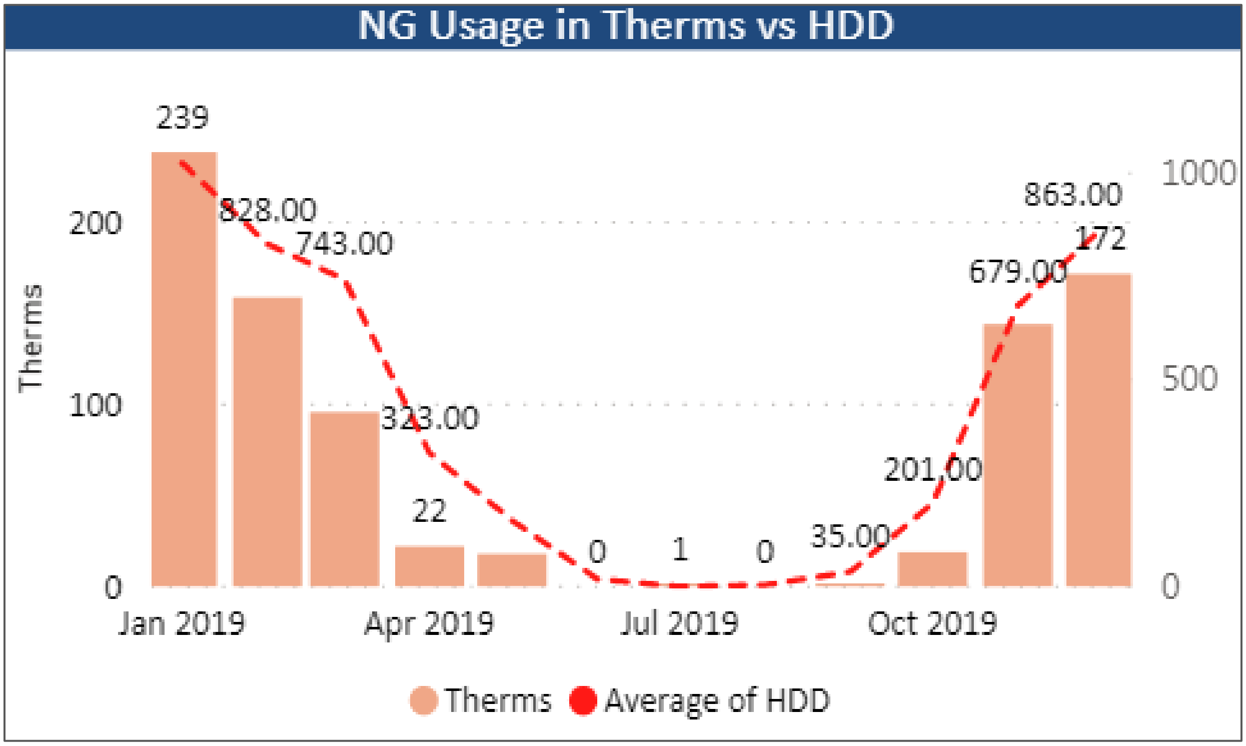
## Fairmount Elementary School



## Padovano Administration Building



## Utility Escalation Rates

Per BPU direction, for purposes of calculating the extended value of the energy savings of this project, the following utility escalation rates have been used.

| Electric Consumption | | Electric Demand | | Natural Gas | |
|---|---|---|---|---|---|
| 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 |

# 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 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - HS | $658,433 | $45,082 | 14.6 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - MS | $485,878 | $43,949 | 11.1 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - FMHS | $203,762 | $16,582 | 12.3 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - JAS | $105,110 | $12,670 | 8.3 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - NPES | $337,709 | $17,875 | 18.9 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - FS | $118,442 | $11,149 | 10.6 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - PAB | $30,712 | $3,258 | 9.4 |
| 2 | Weatherization and Building Envelope - All Schools | $132,570 | $16,776 | 7.9 |
| 3 | Window Replacement Savings Only - FMHS | $0 | $5,199 | 0.0 |
| 4 | Building Controls Upgrades -HS | $609,635 | $59,941 | 10.2 |
| 4 | Building Controls Upgrades -MS | $569,500 | $26,630 | 21.4 |
| 4 | Building Controls Upgrades -FMHS | $379,782 | $16,941 | 22.4 |
| 4 | Building Controls Upgrades -JAS | $303,647 | $10,673 | 28.4 |
| 4 | Building Controls Upgrades -NPES | $438,264 | $13,134 | 33.4 |
| 4 | Building Controls Upgrades -FS | $246,621 | $10,524 | 23.4 |
| 5 | Enterprise Management System - All Schools | $48,100 | N/A | N/A |
| 6 | Ventilation Addition to Media Center - FMHS | $137,125 | ($367) | (373.6) |
| 7 | Radiator and Unit Vent Replacement - FMHS | $603,678 | $9,329 | 64.7 |
| 7 | Radiator Replacement with Unit Vents - MS | $780,000 | $5,253 | 148.5 |
| 8 | Steam Boiler Replacement Savings Only - HS | $0 | $12,820 | 0.0 |
| 8 | Steam Boiler Replacement - FS | $935,052 | $6,672 | 140.1 |
| 9 | Air-Handling Units Replacement - HS | $548,847 | $9,813 | 55.9 |
| 9 | Air-Handling Units Replacement - FMHS | $523,294 | $9,167 | 57.1 |
| 10 | Ventilation Upgrades to Office Area - MS | $80,625 | ($158) | (510.3) |

| ID # | Energy Conservation Measure | ECM Hard Cost | Year 1 Utility Savings* | Simple Payback |
|---|---|---|---|---|
| 11 | Chiller Replacement - HS | $324,189 | $14,522 | 22.3 |
| 12 | Steam Traps Replacement | $98,865 | $17,621 | 5.6 |
| 13 | Pipe and Valve Insulation | $149,340 | $16,799 | 8.9 |
| 14 | Variable Speed Drives - NPES | $25,000 | $2,751 | 9.1 |
| 15 | Energy Efficient Transformers - NPES | $11,378 | $912 | 12.5 |
| 16 | Micro Combined Heat and Power - HS | $80,000 | $1,149 | 69.6 |
| 17 | Solar PPA Savings - All Schools | $0 | $262,498 | 0.0 |
| 18 | Roof Upgrades for Solar PV Install | $983,875 | $500 | 1,967.8 |
| 19 | Kitchen Hood Controls - HS and MS | $38,992 | $16,222 | 2.4 |
| 20 | Refrigeration Compressor Controls - MS | $4,650 | $1,265 | 3.7 |
| **Project Summary:** | | $9,993,075 | $697,153 | 14.3 |

***Year 1 Utility Savings in the above table include a 2.2% escalation on Electric and 2.4% escalation on Natural Gas 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 | $35,681 | 5 |
| Enterprise Management System | $57,000 | 2 |
| Replace Radiators and Unit Vents – MS and FMHS | $6,400 | 2 |
| Steam Boiler Replacement - FS | $40,117 | 2 |
| Air-Handling Units Replacement - HS | $30,254 | 2 |
| Air-Handling Units Replacement - FMHS | $12,085 | 2 |
| Chiller Replacement – HS | $6,002 | 2 |
| Ventilation Upgrades to Office Area - MS | $2,200 | 2 |
| Steam Trap Replacements | $17,200 | 2 |
| Total | $206,939 | |

# Potential Revenue Generation Estimates

## Rebates

As part of the ESP for the Hackensack Public Schools, several avenues for obtaining rebates and incentives have been investigated which include:

### 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 | $163,191 |
| Ventilation Addition to Media Center | $1,840 |
| Variable Frequency Drives (VFD) on Pumps | $9,600 |
| Replace Radiators & Install Unit Ventilators | $13,800 |
| Steam Boiler Replacement | $9,939 |
| Air-Handling Units (AHU Replacement | $18,960 |
| Chiller Replacement | $17,280 |
| Ventilation Upgrades to Office Area - MS | $1,022 |
| Total | $235,632 |

### 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. An Energy Efficiency Credit of **$15,000** is estimated for the demand reduction from lighting upgrades.

**Johnson Controls does not guarantee any rebates carried in this project.**

## Greenhouse Gas Reductions

| Avoided Emissions | Total Electric Savings | Total Natural Savings | Total Annual Avoided Emissions |
|---|---|---|---|
| Annual Unit Savings | 2,075 MWh | 210,736 Therms | |
| NOx, lb | 1,722 | 1,939 | 3,661 |
| $SO_2$, lb | 1,390 | | 1,390 |
| $CO_2$, lb | 2,680,650 | 2,465,611 | 5,146,261 |

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 | | Total Annual Utility |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - HS | $38,735 | 387,677 | $9,849 | 111 | ($3,502) | (4,119) | **$45,082** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - MS | $37,651 | 370,352 | $9,720 | 110 | ($3,423) | (3,867) | **$43,949** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - FMHS | $13,840 | 136,588 | $3,958 | 42 | ($1,215) | (1,374) | **$16,582** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - JAS | $10,234 | 92,381 | $3,247 | 34 | ($811) | (898) | **$12,670** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - NPES | $15,063 | 160,240 | $4,127 | 47 | ($1,315) | (1,415) | **$17,875** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - FS | $9,450 | 77,611 | $2,479 | 26 | ($780) | (834) | **$11,149** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - PAB | $3,420 | 25,566 | $281 | 6 | ($442) | (216) | **$3,258** |
| 2 | Weatherization and Building Envelope - All Schools | $2,842 | 27,951 | | | $13,933 | 15,863 | **$16,776** |
| 3 | Window Replacement Savings Only - FMHS | $821 | 8,102 | | | $4,378 | 4,952 | **$5,199** |
| 4 | Building Controls Upgrades -HS | $12,777 | 127,879 | | | $47,164 | 55,468 | **$59,941** |
| 4 | Building Controls Upgrades -MS | $7,494 | 73,710 | | | $19,137 | 21,627 | **$26,630** |
| 4 | Building Controls Upgrades -FMHS | $4,164 | 41,101 | | | $12,777 | 14,453 | **$16,941** |
| 4 | Building Controls Upgrades -JAS | $3,317 | 29,950 | | | $7,356 | 8,151 | **$10,673** |
| 4 | Building Controls Upgrades -NPES | $4,023 | 42,802 | | | $9,111 | 9,805 | **$13,134** |
| 4 | Building Controls Upgrades -FS | $2,034 | 16,707 | | | $8,490 | 9,081 | **$10,524** |
| 5 | Enterprise Management System - All Schools | | | | | | | **$0** |
| 6 | Ventilation Addition to Media Center - FMHS | ($367) | (3,626) | | | | | **($367)** |
| 7 | Radiator and Unit Vent Replacement - FMHS | $7,111 | 70,178 | | | $2,218 | 251 | **$9,329** |
| 7 | Radiator Replacement with Unit Vents - MS | ($757) | (7,446) | | | $6,010 | 6,790 | **$5,253** |

| ID# | Energy Conservation Measure | Electric Consumption | | Annual Electric Demand | | Natural Gas | | Total Annual Utility |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| 8 | Steam Boiler Replacement Savings Only - HS | | | | | $12,820 | 15,077 | **$12,820** |
| 8 | Steam Boiler Replacement - FS | | | | | $6,672 | 7,137 | **$6,672** |
| 9 | Air-Handling Units Replacement - HS | $9,813 | 98,212 | | | | | **$9,813** |
| 9 | Air-Handling Units Replacement - FMHS | $9,167 | 90,480 | | | | | **$9,167** |
| 10 | Ventilation Upgrades to Office Area - MS | ($158) | (1,556) | | | | | **($158)** |
| 11 | Chiller Replacement - HS | $11,605 | 116,148 | $2,917 | 88 | | | **$14,522** |
| 12 | Steam Traps Replacement | | | | | $17,621 | 19,767 | **$17,621** |
| 13 | Pipe and Valve Insulation | | | | | $16,799 | 19,301 | **$16,799** |
| 14 | Variable Speed Drives - NPES | $2,751 | 29,267 | | | | | **$2,751** |
| 15 | Energy Efficient Transformers - NPES | $912 | 9,698 | | | | | **$912** |
| 16 | Micro Combined Heat and Power - HS | $2,050 | 20,520 | $37 | 5 | ($938) | (1,103) | **$1,149** |
| 17 | Solar PPA Savings - All Schools | $262,498 | | | | | | **$262,498** |
| 18 | Roof Upgrades for Solar PV Install | $125 | 1,250 | | | $375 | 452 | **$500** |
| 19 | Kitchen Hood Controls - HS and MS | $2,075 | 20,621 | | | $14,148 | | **$16,222** |
| 20 | Refrigeration Compressor Controls - MS | $1,265 | 12,446 | | | | | **$1,265** |
| | | **$473,954** | **2,073,557** | **$36,616** | **468** | **$186,583** | **210,284** | **$697,153** |

# Business Case for Recommended Project

**FORM VI**

**ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):**
**ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM**
**HACKENSACK 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 per year**; and

1. Term of Agreement: **20 years (240 Months)**
2. Construction Period [(2)] (months): **18 months**
3. Cash Flow Analysis Format:

**Project Cost [(1)]: $12,586,279**

Interest Rate to Be Used for Proposal Purposes: 2.25%

| Year | Annual Energy Savings | Annual Solar PPA Savings | Annual Operational Savings | Energy Rebates/ Incentives | Total Annual Savings | Annual Project Costs | Board Costs | Annual Service Costs [(3)] | Net Cash Flow to Client | Cumulative Cash Flow |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| Installlation | $189,623 | | | | $189,623 | | | | | |
| 1 | $434,654 | $262,498 | $206,939 | $250,632 | $1,154,723 | $1,311,786 | $1,341,946 | $30,160 | $2,400 | $2,400 |
| 2 | $444,578 | $266,584 | $206,939 | $0 | $918,101 | $885,541 | $915,701 | $30,160 | $2,400 | $4,800 |
| 3 | $454,729 | $270,730 | $35,681 | $0 | $761,140 | $728,580 | $758,740 | $30,160 | $2,400 | $7,200 |
| 4 | $465,113 | $274,939 | $35,681 | $0 | $775,732 | $773,332 | $773,332 | $0 | $2,400 | $9,600 |
| 5 | $475,734 | $279,210 | $35,681 | $0 | $790,625 | $788,225 | $788,225 | $0 | $2,400 | $12,000 |
| 6 | $486,599 | $283,544 | $0 | $0 | $770,143 | $767,743 | $767,743 | $0 | $2,400 | $14,400 |
| 7 | $497,712 | $287,944 | $0 | $0 | $785,656 | $783,256 | $783,256 | $0 | $2,400 | $16,800 |
| 8 | $509,080 | $292,408 | $0 | $0 | $801,489 | $799,089 | $799,089 | $0 | $2,400 | $19,200 |
| 9 | $520,709 | $296,940 | $0 | $0 | $817,648 | $815,248 | $815,248 | $0 | $2,400 | $21,600 |
| 10 | $532,603 | $301,539 | $0 | $0 | $834,142 | $831,742 | $831,742 | $0 | $2,400 | $24,000 |
| 11 | $544,771 | $306,206 | $0 | $0 | $850,977 | $848,577 | $848,577 | $0 | $2,400 | $26,400 |
| 12 | $557,217 | $310,943 | $0 | $0 | $868,159 | $865,759 | $865,759 | $0 | $2,400 | $28,800 |
| 13 | $569,948 | $315,750 | $0 | $0 | $885,698 | $883,298 | $883,298 | $0 | $2,400 | $31,200 |
| 14 | $582,971 | $320,628 | $0 | $0 | $903,599 | $901,199 | $901,199 | $0 | $2,400 | $33,600 |
| 15 | $596,292 | $325,580 | $0 | $0 | $921,872 | $919,472 | $919,472 | $0 | $2,400 | $36,000 |
| 16 | $609,919 | | $0 | $0 | $609,919 | $607,519 | $607,519 | $0 | $2,400 | $38,400 |
| 17 | $623,857 | | $0 | $0 | $623,857 | $621,457 | $621,457 | $0 | $2,400 | $40,800 |
| 18 | $638,115 | | $0 | $0 | $638,115 | $635,715 | $635,715 | $0 | $2,400 | $43,200 |
| 19 | $652,700 | | $0 | $0 | $652,700 | $650,300 | $650,300 | $0 | $2,400 | $45,600 |
| 20 | $667,619 | | $0 | $0 | $667,619 | $664,662 | $664,662 | $0 | $2,958 | $48,558 |
| **Totals** | $11,054,543 | $4,395,441 | $520,921 | $250,632 | $16,221,537 | $16,082,499 | $16,172,979 | $90,480 | $48,558 | |

**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

- Deep Lighting Retrofit with Advanced Sensor Controls
- Building Envelope – Weatherization
- Window Replacement Savings Only – Fanny M Hillers School
- Building Automation System Upgrades
- Ventilation Addition to Media Center – Fanny M. Hillers School
- Replace Radiators and Install Unit Ventilators
- Steam Boiler Replacement – Fairmount School
- Steam Boiler Replacement (Savings Only) – High School
- Air Handling/Rooftop Unit Replacement
- Add Ventilation to Main Office – Middle School
- Chiller Replacement – High School
- Heating System: Steam Traps Replacement
- Heating System: Pipe and Valve Insulation
- Variable Speed Drives on Hot and Chilled Water Pumps
- Transformer Replacement – Nellie Parker
- Micro Combined Heat and Power – High School
- Solar PV – Power Purchase Agreement Savings
- Roof Upgrades and Repairs
- Commercial Kitchen Hood Controls – High School & Middle School
- Refrigeration Compressor Controllers – Middle School

# ECM #1: Deep Lighting Retrofit with Advanced Sensor 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 Hackensack 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 Illumination Engineering Society (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 Schools 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.

The standardization to LED lighting in all 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

A detailed room-by-room description of the existing and proposed fixture type, fixture count and lamp wattage are presented in the Appendix.

**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)

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

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

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

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 #2: 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 energy audit. 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 at all 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.

### Hackensack High School

| Quantity | Envelope Improvements |
|---|---|
| 8,554 | LF - Interior Seal Caulking |
| 34 | Door Weather Striping – Double Door |
| 34 | Door Weather Striping – Single Door |
| 52 | LF - Overhang Air Sealing |
| 3 | Overhead Door Weather Stripping |
| 430 | LF – Roof-Wall Intersection Air Sealing |
| 364 | SF - Roof-Wall Intersection Air Sealing |

### Hackensack Middle School

| Quantity | Envelope Improvements |
|---|---|
| 2 | Door Jamb Spacer |
| 11 | Door Weather Striping – Double Door |
| 14 | Door Weather Striping – Single Door |
| 1,104 | LF – Roof-Wall Intersection Air Sealing |

### Fanny M Hillers School

| Quantity | Envelope Improvements |
|---|---|
| 16 | Door Weather Striping – Double Door |
| 7 | Door Weather Striping – Single Door |

### Jackson Avenue School

| Quantity | Envelope Improvements |
|---|---|
| 12 | Door Weather Striping – Double Door |
| 4 | Door Weather Striping – Single Door |
| 128 | SF - Overhang Air Sealing |
| 255 | LF – Roof-Wall Intersection Air Sealing |

### Nellie Parker School

| Quantity | Envelope Improvements |
|---|---|
| 12 | Door Weather Striping – Double Door |
| 11 | Door Weather Striping – Single Door |
| 126 | LF – Penthouse Air Sealing |
| 26 | SF – Penthouse Air Sealing |

### Fairmount School

| Quantity | Envelope Improvements |
|---|---|
| 2 | Door Jamb Spacer |
| 16 | Door Weather Striping – Double Door |
| 7 | Door Weather Striping – Single Door |

## Savings Methodology

The energy savings derived from this measure are a result of the heating and cooling systems 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, Operations 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 #3: Window Replacement Savings Only – Fanny M Hillers School

## ECM Summary

### *Fanny M Hillers School*

JCI will utilize energy savings driven by the district's installation of window systems at Fanny M Hillers School. The proximity of Fanny Hillers School to a nearby airport and age of the infrastructure have potential impact on the occupant comfort due to single pane windows. Single pane glass windows have a substantial impact on the energy retention and comfort of the building.

The retrofitted windows will provide school building with the following:

- Energy savings
- Lower maintenance costs
- More comfortable environment
- Ease of cleaning

The purpose of replacing these windows is threefold:

- **Comfort and Building Integrity.** Most of the existing windows are original. The caulking around the windows is cracking that contribute to drafts. Many of the existing windows are single pane and inoperable. Some of the buildings need operable windows to bring in fresh air or cool the space.
- **Reduced Energy Consumption.** The existing windows are single pane, resulting in a large heat loss in the winter and in the summer, they create a high heating load. There are also drafts created by the loose fit. By installing double-pane windows we will be able to increase the R-value significantly that will reduce heating and cooling costs.
- **Reduced Size of Heating and Cooling Equipment Needed.** The new window systems will decrease the heating and cooling load. By reducing these loads, the new mechanical equipment will be less expensive to install and the existing equipment less expensive to operate.

## Savings Methodology

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

Existing Cooling. Gain (In MMBtu) = (Avg. OA Temp. - Summer Inside Setpoint) x Sqft. x Existing U Value x Total Bin Hours/1,000,000

Proposed Cooling. Gain (In MMBtu) = (Avg. OA Temp. - Summer Inside Setpoint) x Sqft. x Proposed U Value x Total Bin Hours/1,000,000

Existing Heating. Loss (In MMBtu) = (Avg. OA Temp. - Winter Inside Setpoint) x Sqft. x Existing U Value x Total Bin Hours/1,000,000

Proposed Heating. Loss (In MMBtu) = (Avg. OA Temp. - Winter Inside Setpoint) x Sqft. x Proposed U Value x Total Bin Hours/1,000,000

## Benefits

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

# ECM #4: Building Automation System Upgrades

# ECM #5: Enterprise Management System

## ECM Summary

Hackensack Public Schools currently utilize pneumatic control systems and some DDC controls to run the buildings' cooling and heating components. These include various measures to control unit run time and space temperature setpoints. 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 electro-pneumatic to only pneumatic controls with very limited controllability. All the operations are remotely monitored and controlled by Energy for America. However, local sensors and control devices are found to be unresponsive to temperature setpoint changes, resulting in continuous equipment operation.

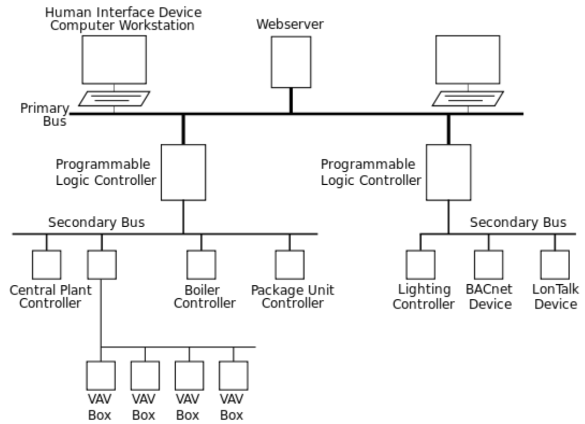
Older pneumatic controls systems often have issues because they are maintenance intensive. Building personnel must ensure the pressurized air stays clean and dry, calibrate the controls and gauges regularly, and ensure that controls strategies are being implemented correctly.

As a whole, it helps the system realize its full potential by implementing a re-commissioning and enhanced-programming strategy to ensure that all potential ECMs 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 include 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 DDC system and integrate some existing pneumatics controls to enable the District facilities to have superior scheduling, monitoring and controls capabilities. An upgraded DDC system will be provided to integrate all the mechanical systems to a Metasys front end.




All the buildings will be integrated to the latest controls technology with a combination of DDC and pneumatic to DDC overlay, moving away from the legacy systems. This enables a consistent mechanical system 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 all the new systems included in the building automation and integrated 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. 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.

**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 all 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.

The ESIP includes 3 years of license for an Enterprise Management System and the district has an option to extend it further.

## 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 building management system in proper working order.

## Benefits

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

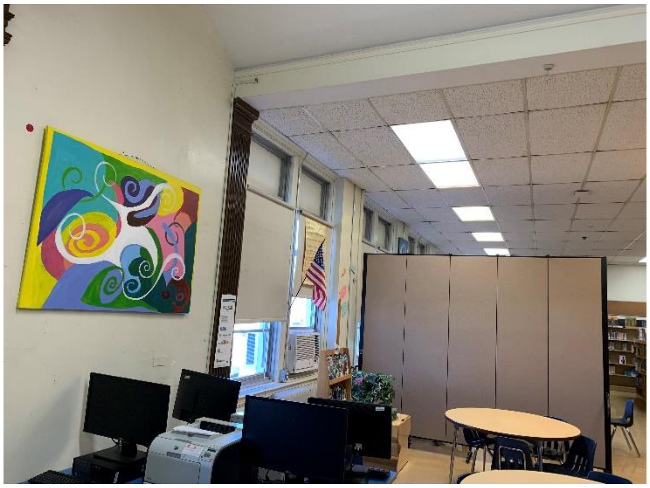
# ECM #6: Ventilation Addition to Media Center at Fanny M. Hillers Elementary School

## ECM Summary

During the site audits, ventilation issues in the Media Center of Fanny M Hillers School was brought to JCI's attention. JCI proposes to provide mechanical ventilation and add cooling capabilities to the 4th floor Media Center at Fanny M Hillers School as part of this measure.

## Existing System

Currently, the Media Center at Fanny Hillers School is not mechanically ventilated, and cooling is provided by two window air conditioners. Operable windows are being used to provide ventilation when space is overheated during winter months, resulting in excessive infiltration for adjacent spaces.



## Proposed System

This ECM will furnish and install a new high efficiency electric heat pump unit and associated equipment at the Media Center.

Johnson Controls proposes to install new high efficiency heat pump with cooling capacity, steam coil and an ultraviolet (UV) air purification device or comparable system. 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.

Final system design, specification and equipment selection will be determined during design phase.

## Scope of Work

The following scope is tentative and optimal design to be finalized during the design phase.

- Provide and install (1) vertical electric heat pump with remote steam coil rated @ 5 tons
- Saw cut the brick exterior wall to install the vertical heat pump wall sleeve
- Sketch, fabricate and install the required new supply air duct system above the drop ceiling
- Provide and install the required new 2x2 drop in supply air diffusers
- Provide a steel stud and drywall enclosure for the vertical heat pump with a man door for servicing. Return louver shall be installed in the door
- Provide and install the required supply duct, duct insulation

- Provide and install (1) steam coil installed in the supply air duct with related steam/condensate piping, valves, and fittings
- Provide and install the required local control of the steam coil tied into the new vertical package unit
- Provide and install the required steam/condensate pipe insulation
- Demo the existing steam radiators and associated piping
- Provide the required paint for the unit enclosure to match the room
- Provide the required electrical power wiring, conduit, breakers and disconnect switches to feed the new vertical heat pump from the nearest power panel
- Install the manufacture furnished Thermostat in the media center space
- Provide and install the required UV air purification device installed within the new Vertical heat pump
- Factory startup of the heat pump
- Air balance of the supply air duct system

The following controls scope will also be included**:**

- Install new factory installed BACnet DDC controls for the heat pump unit
- Implement control sequence of operation to include energy savings strategies including:
- Night time setback
- Scheduling of the building
- Optimal Start/Stop

## 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: Replace Radiators and Install Unit Ventilators

## ECM Summary

All locations were surveyed for the application of this measure. Based on the current condition, the existing unit ventilators within the District should be addressed. This measure will replace some the existing unit ventilators that supply the required amount of outside air into the classrooms while maintaining setpoint and reducing energy consumption. Similarly, a substantial number of classrooms are served only by radiators and operable windows for ventilation. Radiators will be replaced with unit ventilators as part of this scope.

## Facilities Recommended for This Measure

- Fanny M Hillers School
- Hackensack Middle School

## Existing System

### *Fanny M Hillers School*

Ten (10) classrooms at Fanny Hillers School utilize unit ventilators to provide heating and the required amount of ventilation to the spaces working in conjunction with the roof mounted exhaust fans. These unit ventilators are Herman Nelson units and original to the building and in poor condition. The original units have operational and maintenance requirements that warrant replacement and better.

Additionally, there are 14 classrooms with steam radiators without any means of ventilation.

### *Hackensack Middle School*

At the Middle School, there are 40 classrooms providing heating through existing steam radiators. Along with sixteen (16) classrooms at the Middle School utilize unit ventilators to provide heating and the required amount of ventilation to the spaces working in conjunction with the roof mounted exhaust fans. These unit ventilators are Herman Nelson units and original to the building and in poor condition. The original units have operational and maintenance requirements that warrant replacement and better control.

## Proposed System Upgrades

JCI proposes to install new unit ventilators per scope identified below. New unit ventilators will distribute the air in a much more efficient manner by utilizing premium efficiency motors, eliminating leakage through tighter unit construction, and the units will have more efficient heating. The installation of new units will also allow better control of the outside air due to integrated digital controls. In addition to energy and operational cost savings, the units will provide a more pleasant indoor environment resulting in increased productivity and occupant comfort.

### *Fanny M Hillers School*

Replace existing ten (10) unit ventilators with new unit ventilators at the locations indicated in the table:

| Building | Unit Ventilator Location |
|---|---|
| Fanny M Hillers | 305 |
| Fanny M Hillers | 303 |
| Fanny M Hillers | 204 |
| Fanny M Hillers | 205 |
| Fanny M Hillers | 206 |
| Fanny M Hillers | 207 |
| Fanny M Hillers | 104 |
| Fanny M Hillers | 106 |
| Fanny M Hillers | 111 |
| Fanny M Hillers | 113 |

- Remove existing steam radiators and replace with high efficiency unit ventilators in fourteen (14) rooms.

### *Middle School*

- Remove existing steam radiators from classrooms and replace with new forty (40) high efficiency unit ventilators.

## Scope of Work

- Provide and install electric ventilators with steam coil
- Provide the required modification to connect the new unit ventilators to the existing exterior louvers where available
- Add exterior louvers or outdoor access where applicable
- Provide and install the required steam / condensate piping to connect the new Unit Vent coils to the existing steam piping or units
- Provide and install the required local control of the steam coil tied into the new Horizontal unit vents
- Provide and install the required steam/condensate pipe insulation for the new & disturbed piping in the classrooms
- Demo the existing steam radiators / unit vents and associated piping, discard of properly
- Provide and install the required wall touch up and modification around the new unit ventilators
- Provide the required electrical power wiring, conduit, breakers and disconnect switches to feed the new Horizontal heat pump from the nearest power panel
- Install the manufacturer-furnished thermostats in the classroom space
- Provide and install the required UV air purification device installed within the new Horizontal unit ventilators
- Factory startup of the unit ventilators
- Air balance of the unit vents

## Savings Methodology

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

Available Annual Exhaust Air Energy Heating = [(OA Leakage CFM **x** 1.08 **x** (heat transfer efficiency) **x** hrs of operation]/boiler efficiency.

### Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective installers are available. The customer and Johnson Controls will determine the final selection. |
| 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

| | |
|---|---|
| Waste Production | This measure will produce waste by products. |
| Environmental Regulations | Air flow must meet state, local and ASHRAE standards. |

# ECM #8: Steam Boiler Replacement

## ECM Summary

This ECM replaces steam boilers that operate at low efficiencies and are beyond 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.

## Facilities Recommended for This Measure

- Fairmount School

## Existing System

The gas-fired steam boilers in Fairmount School 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 steam boilers at Fairmount School with higher efficiency gas-fired steam boilers.

JCI will also incorporate in the ESP the energy savings to be achieved by the District's replacement of the existing High School boilers with new high efficiency boilers.

## Proposed System Upgrades

JCI proposes to install two (2) 6,300 MBH input capacity gas-fired, high efficiency steam boilers at the Fairmount School.

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

## Scope of Work

- Perform selective Asbestos abatement required for the two (2) boiler replacements
- Safe off the two (2) existing boilers
- Safe off the power and control wiring from each boiler set aside for re-use
- Demo and remove the two (2) existing boilers from the below-grade boiler room
- Demo and remove the existing condensate return pump/tank
- Receive and rig into place the two (2) new steam boilers
- Receive and rig into place one (1) duplex boiler feed water tank skid system
- Provide and install one (1) modular boiler controller
- Furnish and Install the required new schedule 40 Black steel pipe, valves, and fittings to connect the new steam boilers to the existing steam mains. Replace existing gate valves with new valves
- Furnish and install the required new schedule 40 black steel pipe, valves & fittings to connect the new condensate return piping from the new boilers to the feedwater system
- Provide the required blow downs for each boiler
- Provide and install the required new relief valve piping down to the floor
- Provide and install the required black steel piping to connect the new feedwater system to the existing piping systems
- Provide and install the required new copper make-up water piping for each new boiler

- Provide and install the required new relief piping for each new boiler. Extend the piping to the floor
- Provide and install the required new natural gas piping to connect the new boilers to the existing gas piping
- Provide and install the required new breeching for the two (2) boilers. New breeching shall connect at each boiler and extend out the side wall and up the side exterior of the building
- Provide and install the required new Shut off valves, drain & vent valves to complete the installation
- Provide and install one (1) new pressure reducing valve with strainer and bypass for each boiler
- Provide and install the required new pressure/temperature gauges (supply/return or inlet –outlet of each boiler)
- Provide and install the required low water cut off safety for each boiler
- Provide and install the required pipe insulation for the new and disturbed steam, condensate and make-up water piping. Pipe insulation shall be fiberglass insulation 1-1/2" thick with all service jacket and PVC fittings
- Provide and install the required new power wiring (Greenfield and EMT) to connect the new boilers and pumps to the existing electrical circuits
- 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 startup the boiler/burner operation

Final design, specification and equipment selection to be performed during the design phase.

## 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 Ide**ntification** | As part of the measure design and approval process, specific **product s**election will be provided for the customer's review and approval. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## 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 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. |
| Envir**onmental Regulations** | Environmental impact is expected; all regulations will be adhered to in accordance with federal and local code requirements. |

# ECM #9: Air Handling/Rooftop unit Replacement

## Existing Conditions

Some of the air handling/ rooftop units serving the school buildings are in poor condition and require replacement. This measure proposes to replace the older, existing units with units that will have increased efficiency and reliability.

## Existing System

### *High School*

The vintage AHUs – HVAC-6 located in 2nd floor fan room and HVAC-7 in 3rd floor fan room – have surpassed their useful life and are in very poor condition. The table below provides information on these units:

| Building | Condensing Unit Location | AHU Location | Area Served | Manufacturer | Model Number | Cooling Capacity (Tons) |
|---|---|---|---|---|---|---|
| High School | Roof | 2nd FL Fan Room | Bridge North & South Classrooms | Trane | RAUBC306CE01AB | 30 |
| High School | Roof | 3rd FL Fan Room | Library | Trane | RAUBC406CE01AB | 40 |

### *Fanny M Hillers School*

The 1950 section of the Fanny Hillers Elementary School is served by two (2) Nesbitt multizone rooftop units providing conditioned air to the kindergarten and cafeteria sections directly below the units. Both units are in poor condition and require replacement.

| Building | AHU Location | Area Served | Equipment | Manufacturer | Model Number | Cooling Capacity (Tons) |
|---|---|---|---|---|---|---|
| Fanny Hillers School | Roof | 1950 Section | HVAC-1 | Nesbitt | RMA40033G2RDEM0B0 0F0CB1411 | 40 |
| Fanny Hillers School | Roof | 1950 Section | HVAC-2 | Nesbitt | RMA40033G2RDEM0B0 0F0CB1411 | 40 |

## Scope of Work

The heating and cooling efficiencies of the HVAC units could be vastly improved by replacing them with high efficiency heating and cooling units that feature digital controls, air side economizers and high efficiency fan motors. The units indicated above will be replaced with a new better seasonal energy efficiency rating (SEER) according to the New Jersey Energy Code or higher.

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.

### *High School*

The scope of work includes:

- Replace the (2) multizone air handlers with heating coils along with 40-ton and 30-ton DX cooling coils
- Safe off the (2) multi-zone units and return air units from all power sources, electrical and heating
- Disconnect the piping from the AHUs back to the nearest shut off valve in the mechanical room
- Reclaim the R-22 refrigerant from the DX system
- Disconnect the DX refrigerant piping from the AHU
- Disconnect the duct connections from the unit at the nearest duct joint. Cap off temporarily
- Demolish the (2) AHUs and discard of properly
- Provide and install two (2) new multizone air handlers equipped with supply fan/VFD, DX coil, heating coils and filter section with UV purification lights
- Rig and set the two (2) new AHUs in place
- Sketch, fabricate and install the required new duct work to connect the two (2) new AHUs to the existing duct systems
- Provide and install actuated zone dampers onto the existing duct work to serve the existing zones
- Sketch, fabricate and install the required new piping to connect the two (2) new AHUs to the existing piping systems
- Provide and install the required heating piping specialties, shut off valves, balance devices, pressure/Temperature devices, bleeder and drain valves
- Provide and install control valves
- Provide and install the required new refrigerant piping to connect the new DX coil to the new DX refrigerant piping from the new DX remote condensing unit
- Provide and install the required new condensate drain piping from the DX coil drain pan to the floor drain
- Provide and install the required new thermal expansion valves, solenoid valves, filter driers, refrigerant rated ball type isolation valves at the AHU
- Provide and install the required new pipe insulation for the new and disturbed piping
- Provide and install the required new Rubatex type pipe insulation for the new suction line
- Provide and install the required duct insulation for the new and disturbed duct system
- Provide and install new BACNet enabled DDC controls for the two (2) AHUs and interface with the existing controls system
- Furnish air balance of the two (2) new air handlers only
- Provide factory startup of the two (2) new AHUs

**Electricals**

- Safe off the existing power and control feeders. Lock-out tag-out all services
- Demolish the existing power feeders and pull conduit and wiring back to an appropriate location. Retain the existing feeders to be reused for the (2) new air handlers (supply/return motor circuits)
- Provide and install properly sized breakers/fuses for the two (2) new air handlers
- Provide and install the required new EMT conduit, fittings junction boxes, disconnect switches and cable to connect the two (2) new AHUs to the existing power circuits
- Provide and install two (2) new smoke detectors (fire system interface by others)
- Provide and install the required new EMT conduit, fittings junction boxes, disconnect switches and cable to connect the new AHUs to the new control system
- Provide the required conduit and cable marking. Provide and install the required equipment and breaker labels

**Controls**

- Provide and install a new BACNet enabled DDC controller for AHUs and related zone dampers & actuators
- Sequence of operations review (corrective measure if required)
- Valve controls
- Return air temperature sensor
- Outdoor air sensor
- Mixed air temperature
- System duct pressure sensor

***Fanny M Hillers School***

- Provide roof protection around the two (2) units and work path across the roof
- Provide the proper roof edge protection for the work area
- Inspect the two (2) existing roof curb connection to the roof for any roof leaks
- Safe off the two (2) existing Nesbitt rooftop units from the electrical power and control sources
- Disconnect the power feeders, control wiring and supply / return connections. Reserve the services for re-connection to the new units
- Manually check the connections of the duct systems located within the curb is not connected to the rooftop unit prior to lifting the unit with a crane
- Reclaim the refrigerant R-22 from the two (2) units and dispose of properly
- Furnish and install the required crane to lift the two (2) existing rooftops off the roof and place the two (2) new packaged units on the roof
- Furnish and install the required storage, trucking of the new units to the site and old units from the site for disposal
- Provide and install the required new roof curb gasket to be installed between the new units and the existing roof curbs. Clean the existing roof curb flange surfaces to accept the new gasket
- Lift the old units off the roof and set the new units (single day operation)

- Connect the existing power wiring to the new units (check phasing)
- Provide factory installed smoke detector (connection to fire system by others)
- Provide and install Bac-Net connections, (1) for each unit
- Provide factory startup assistance of the installing trades (electrical, mechanical)
- Provide air balancing of the new units
- Provide factory startup of the units
- Provide startup and balance reports within 5 days of startup
- Clean off the work areas

## 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 #10: Add Ventilation to Main Office at Middle School

## ECM Summary

During the site audits, ventilation issues in the Main Office area of the Middle School were brought to JCI's attention. JCI proposes to provide mechanical ventilation capabilities to the Middle School's main office area as part of this measure.

## Facilities Recommended for This Measure

- Hackensack Middle School

## Existing System

Currently the Main Office area at the Middle School is heated through fan coil units and provided with window air-conditioning units for air-conditioning.

## Proposed System

JCI will design and install a suitable ventilation and space conditioning system for the Main Office areas.

## Scope of Work

The current tentative basis of the design is two (2) outdoor mounted condensing units with 4-circuits each serving a total of eight (8) indoor heads of various sizes reflective of each area served. Final design, specifications and unit selections will be determined during the design phase.

## 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. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## 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 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: Chiller Replacement at High School

## Existing Conditions

The chillers serving the Natatorium in the Hackensack High School are less efficient than the new generation of air-cooled chillers. Estimated efficiency of the existing chillers is 1.15 kW/Ton at full load capacity (FLV) while the FLV of new, high efficiency is 1.04 kW/Ton.

## Facilities Recommended for This Measure

- Hackensack High School

## Scope of Work

Johnson Controls proposes to replace the existing two (2) nominal efficiency 60 ton chillers serving the Natatorium. The proposed chiller improves part-load performance and uses environmentally friendly R-134A refrigerant. Replacing the old chillers will avoid future chiller repair and replacement expenditures. The latest generation of air-cooled chillers also have VFD compressors, improved DDC and operating sequences to improve efficiency, reliability and turndown capacity.

- Reclaim refrigerant from the two (2) existing air-cooled chillers and dispose of properly
- Demo the two (2) motor starters and safe off the power circuit
- Remove the existing two (2) air-cooled chiller located on the roof and dispose of properly
- Provide and install two (2) new air-cooled chillers
- Provide the required trucking of the old and new equipment to and from the site
- Provide the required crane to load the old chillers onto trucks and install the new chillers
- Provide and install schedule 40 steel pipe and fittings to connect the new two (2) air-cooled chillers to the chilled water piping connections on the roof
- Provide and install the required drains on the new chilled water piping
- Provide and install four (4) new chilled water isolation valves, two (2) for each new chiller
- Provide and install four (4) rubber isolation spheres at the chiller
- Provide the required new electrical conduit and cable to connect the new chiller to the existing power connection over to the new chillers
- Provide new fiberglass pipe insulation for the new chilled water piping exterior of the building. Exterior pipe insulation shall be covered in aluminum covering. Insulation shall be 2" thick
- Fill and test the new piping
- Provide factory startup and test the system
- Set up the chilled water flow across the chiller

## 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 chillers.

## Benefits

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

# ECM #12: Heating System: Steam Traps Replacement

## Executive Summary

All locations were surveyed for the application of this measure. Johnson Controls has performed a preliminary audit of steam traps throughout the District. A significant amount of energy is lost during a “failed open” steam trap scenario. Johnson Controls proposes to replace the steam traps which will reduce heat losses significantly.

This measure will consist of two parts:

- **Inspection** - The first process involves providing a complete steam trap survey (and report) conducted by a trained and qualified steam trap survey technician. Typically, steam traps are checked by measuring the temperature difference between the inlet and outlet of the trap. In addition, sound measuring instruments are used to listen to the flow in the trap to verify proper operation. The technician conducting the survey will inspect the installation and application of the steam trap. In many cases the incorrect type or rating of steam trap is installed or the incorrect steam trap is used in a particular application. During the survey all condensate systems including pumping systems should be inspected for proper operation.
- **Steam Trap Survey Report Analysis** - The second process involves studying the steam trap report, verifying deficiencies, selecting the proper steam trap for the application and replacing the defective steam traps.

## Facilities Recommended for this Measure

- Hackensack High School
- Hackensack Middle School
- Fanny M Hillers Elementary School
- Nellie Parker School
- Fairmount Elementary School

## Existing System

The steam operated facility consists of steam and condensate main piping, steam and condensate distribution piping, strainers, steam control valves terminal equipment (steam coils, heaters, etc.), condensate pumps and steam traps. The function of the steam trap is to vent air and drain condensate formed in the steam distribution systems and prevent live steam from exiting when condensate is discharged.

The condensate is trapped and removed via various styles of steam traps (float and thermostatic, inverted bucket and thermodynamic types), each having a specific function and range of applications. These traps require constant maintenance to assure proper operation.

**Steam Trap Characteristics**

| Type of Trap | Maintenance Characteristics |
|---|---|
| Float Type Mechanical Traps | Float operated valve located under water level prevents steam escape. Does not vent air and gas, but usually has thermostatic vent |
| Inverted Bucket Mechanical Trap | Resistant to water hammer and steam leaks. Prone to freezing, vents only a limited amount of air. |
| Bimetallic Thermostatic Trap | Not vulnerable to water hammer |
| Thermodynamic Disk Trap | Will dump live steam if cool air surrounds trap. May need insulation for proper operation. |

## Proposed System

Johnson Controls proposes to replace the steam traps located at multiple steam heating system buildings in Hackensack Public Schools. A detailed list of existing and proposed traps are presented in the Appendix.

Thermostatic steam traps will be replaced with new Barnes and Jones cage units and covers.

Float and thermostatic steam traps will include complete replacement with new steam traps manufactured by Barnes & Jones Inc. All existing strainers, isolation valves, check valves, and fittings in good repair will be reused.

Existing strainers, isolation valves, check valves, and fittings in good condition will be reused.

## Energy Savings Methodology

The results of those traps that have failed open have been itemized and steam volumes have been calculated. This additional energy will be saved through the implementation of this measure. In general, Johnson Controls uses the following approach to determine savings for this specific measure:

MMBtu /yr = Lb/yr Steam Trap Leakage x Enthalpy at operating pressure

Energy Savings $ = (MMBtu /yr/Boiler Efficiency) x Cost/MMBtu

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. The following is an example of equipment being utilized. 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 your review and approval. |

## Changes in Infrastructure

The scope of work will be mostly limited to areas directly adjacent to the existing steam trap location. The steam to the trap will be turned off and the trap will be replaced. No architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

The steam service to the specific steam traps will require interruption to allow for the repair or replacement. Coordination with site personnel will be required to minimize interruption to the buildings affected. All interruptions will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings for this measure result from a reduction in steam losses due to failed steam traps in the steam distribution system. The equipment uses no other resources. |
| Waste Production | This measure will produce waste by products. Waste will consist of old steam traps. |
| Environmental Regulations | Asbestos abatement may be required for connections into the existing steam headers. |

# ECM #13: Heating System: Pipe and Valve Insulation

## Executive Summary

All locations were surveyed for the application of this measure. The insulation audit was conducted identifying a definite value of heat that is lost at a number of locations. These heat losses result from piping and surfaces giving off energy to the surrounding spaces. This measure will insulate these surfaces resulting in energy savings and improved comfort of those areas in or near occupied spaces.

## Facilities Recommended for This Measure

- Hackensack High School
- Hackensack Middle School
- Fanny M Hillers Elementary School
- Jackson Avenue School
- Fairmount Elementary School

## Existing System

Some of the energy in the steam or hot water distribution systems at the buildings is wasted through radiant thermal energy loss from a wide range of sources, including piping, valves and tanks. Escaping heat can lead to uncomfortable temperatures in areas adjacent to machine rooms. In addition, with surface temperatures in some cases exceeding 200°F the exposed service piping and fittings represent a safety hazard and wasted energy. During the detailed energy audit a number of valves, fittings, lengths pipe were identified as not having insulation. There are some pipes and valves on the building heating systems that do not have insulation, either as a result of frequent maintenance or because none ever existed. All of these conditions lead to excessive energy use. Hot water piping, tanks and valves/flanges throughout the District were found to be un-insulated. These pipes, tanks and valves/flanges should be insulated to improve the overall efficiency of the heating system. The figures below show the typical fittings/pipes that are un-insulated throughout the buildings.

**Figure 1 Tank Insulation**


**Figure 2 Valve Insulation**

**Figure 3 Pipe Insulation**

**Figure 4 Tank Insulation**

The following table lists the items that were found to be un-insulated:

| Task | Fairmount School | Fanny M Hillers | High School | Jackson Avenue School | Middle School | Total Quantity |
|---|---|---|---|---|---|---|
| Ball Valve Insulation (Units) | | | 16 | 3 | 12 | 31 |
| Bonnet Insulation (Units) | | 2 | 1 | | 16 | 19 |
| Butterfly Valve Insulation (Units) | 1 | | 7 | 1 | | 9 |
| Check Valve Insulation (Units) | | 1 | 4 | | | 5 |
| Control Valve Insulation (Units) | | 1 | 2 | | 1 | 4 |
| End Cap Insulation (Units) | | 1 | 4 | | 4 | 9 |
| Flange Insulation (Units) | 3 | 14 | 115 | 6 | 17 | 155 |
| Flex Fitting Insulation (UT) | | 2 | 6 | | | 8 |
| Gate Valve Insulation (Units) | 2 | 2 | 28 | 3 | 4 | 39 |
| Pipe Fitting Insulation (Units) | 72 | 31 | 102 | 26 | 28 | 259 |
| Pipe Reducer Insulation (Units) | | | 4 | | 1 | 5 |
| Pump Insulation (Units) | 3 | 5 | 12 | 2 | 9 | 31 |
| Steam Trap Insulation (Units) | 4 | 3 | 4 | 1 | 11 | 23 |
| Straight Pipe Insulation (LF) | 308 | 196 | 399 | 76 | 52 | 1,031 |
| Strainer Insulation (Units) | 3 | 1 | 10 | | 17 | 31 |
| Suction Diffuser Insulation (Units) | | | 1 | | | 1 |
| Tank Insulation (Units) | 1 | 2 | 5 | 1 | 3 | 12 |
| Triple Duty Valve Insulation (Units) | | 2 | | | | 2 |

The Nellie Parker School is not included in the scope of work for this measure. The existing conditions related to likely asbestos containing material in the boiler room at Nellie Parker prevents safe implementation of all mechanical insulation retrofit work. There are no recommendations for the Nellie Parker School.

## Proposed System

Bare piping and valves identified should be insulated as required.

Johnson Controls will insulate the exposed piping and valves identified in the buildings. The insulation will prevent the loss of heat from the pipes, thereby saving boiler energy as well as reducing overheating conditions in adjacent spaces. This will result in improved comfort conditions.

Johnson Controls will install an energy-saving thermal blanket system on valves and fittings identified during the field engineering survey. The thermal blanket system consists of high-quality insulation, custom fit to match gate valves, pressure reducing valves, flanges, strainers, steam traps, heat exchanger heads, and condensate pumps. The thermal blanket insulation system is designed for ease of installation through the application of prefabricated two-piece jackets and the use of stainless steel lacing.

## Energy Savings Methodology

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

Energy Savings $ = ((Heat Loss Rate per foot of Un-Insulated Pipe – Heat Loss Rate per foot of Insulated Pipe) x (length of Pipe x Hours of Operation) x Cost/Btu) / (Boiler Efficiency))

Reference is made to the ASHRAE 1989 Fundamentals text page 22.19 Table 9A "Heat Loss from Bare Steel Pipe to Still Air at 80 degrees F, Btu/hr-ft" for losses from un-insulated lines and Table 11 "Recommended Thickness for Pipe and Equipment Insulation".

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective manufacturers are available. JCI 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. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

# ECM #14: Variable Speed Drives on Hot and Chilled Water Pumps

## Existing Conditions

The heating hot water and chilled water circulating pumps in Nellie Parker are constant volume pumps without any flow control. The result is unnecessary excess pumping power especially when there is a decreased building heating load.

## Facilities Recommended for This Measure

- Nellie Parker School

## Scope of Work

Johnson Controls will provide the labor and materials to install VFDs 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 a VFD failure. The VFD will be supplied complete with a 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 replacement inverter-duty rated high efficiency motors for these pumps.

| Building | Location | Equipment Type | GPM | Horsepower |
|---|---|---|---|---|
| Nellie Parker School | Mechanical Room | Heating Hot Water Pump | | 15 |
| Nellie Parker School | Mechanical Room | Chilled Water Pump | | 15 |

## Savings Methodology

Energy Savings (kWh) = 0.746 * *HP * *HRS * ($ESF/\eta_{motor}$)

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

$\eta_{motor}$ = 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 conditions.

HRS = annual operating hours

## Benefits

- Fuel savings generated through an increased efficiency
- Lower utility expenditures
- Reduced operations 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. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## 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

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 #15: Transformer Replacement

## Executive Summary

All locations were surveyed for the application of this measure. Energy savings can be obtained by replacing the standard efficiency transformers located at Nellie Parker Elementary.

## Facilities Recommended for This Measure

- Nellie Parker School

## Existing System

The original 480-120/208 D-Y transformers were found to be operating with evidence of harmonic disturbance, they are also not high efficiency units. The electrical systems that are installed in the buildings experience harmonic losses developed on the 3$^{rd}$, 5$^{th}$ and 9$^{th}$ harmonic waves. These waves are caused by non-linear power supplies that are connected to the load side of the transformer. These loads include lighting ballasts, fax machines, copiers, printers and computer power supplies. These waves do not provide useful power to the loads but are reflected back to the transformer and are dissipated in the form of heat along the conductors and in the transformer core. This condition allows current to flow on the neutral which should be current free. Furthermore, the additional load that is translated back to the transformer actually de-rates the transformer lowering its efficiency and ability to supply the loads with rated voltage.

Transformers are typically purchased as part of a total electrical distribution package, installed, and forgotten for 40-50 years. The majority of these transformers are operating at a small fraction of their nameplate capacity, resulting in very low efficiency, and are often producing large amounts of excess heat, resulting in energy losses, and higher electric costs. According to the Department of Energy, half of all existing transformers are approaching a mean time to failure of 32 years. Replacing these units prior to a sudden end of life, results in lower risk of facility down time.

## Proposed System

Johnson Controls proposes replacing the existing transformer installed at the locations specified, with new high efficiency transformers.

| Building | Location | Equipment Type | Manufacturer | Serial Number | Capacity | %IMP |
|---|---|---|---|---|---|---|
| Nellie Parker Elementary | Boiler Room Electric | Transformer | B-K Electrical Products | 24752-030 | 112.5 | 4.1 |

## Scope of Work

Johnson Controls will install the following scope:

- Work to be performed (normal hours) from 7:00am – 3:30am (Monday- Friday).
- Utilize existing supports for ceiling mounted transformers, if applicable.
- Accept delivery of transformers.
- Rigging of transformers from staging area to transformer location, pads where needed.
- Disconnect and remove existing transformer.
- Install new high efficiency transformer of same size, utilizing existing feeds and grounds.

## Energy Savings Methodology

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

## 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. |

## Warranty

All installed equipment and workmanship will be warranted for a period of one year after customer acceptance. All parts, labor and costs will be covered by Johnson Controls during this period.

## Changes in Infrastructure

New transformers will be installed in place of the transformers. No architectural or structural changes to the facility are anticipated with the implementation of this measure.

## Customer Support and Coordination with Utilities

Coordination of the electrical tie-in will be required. All interruptions will be coordinated and scheduled with the staff in advance.

## Environmental Issues

| | |
|---|---|
| Resource Use | Energy savings will result from a combination of reduced harmonic loses and increased transformer efficiency resulting in the reduction of electric consumption. The equipment uses no other resources. |
| Waste Production | This measure will produce waste by products. Existing units will be demolished, removed and disposed of according to proper guidelines by contractor. |
| Environmental Regulations | No environmental impact is expected. |

# ECM #16: Micro Combined Heat and Power at High School

## ECM Summary

Johnson Controls proposes to install one 4.4 kW micro cogeneration machine at the Hackensack High School to supply electricity to the building, and the recovered heat will offset the pool heating hot water boiler load at the school. The combined heat and power unit will be located in the boiler room. Final equipment selection will be made during the design phase.

## Scope of Work

The systems will include:

- One micro cogeneration, Johnson Controls-approved, low emissions cogeneration module with all appropriate appurtenances as required to tie into the existing hot water system.
- Load modules for interfacing with the pool boiler plant, 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 all 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 all control circuit protection, circuit protection for all pumps and other electric devices and variable speed drives.
- Piping insulation and all required insignia to identify flow direction, valves and system components.
- Other appurtenances to make the system operational.
- Provide all 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**

**SYSTEM SPECIFICATIONS**

| ***ecopower microCHP Specifications*** | |
|---|---|
| Operating Voltage (single phase) | 240 VAC / 208 VAC (207 - 253V) |
| Frequency | 60 Hz |
| Dimensions (L x W x H) | 54" x 30.375" x 43" |
| Power Factor | 0.98 - 1 |
| Exhaust Gas Temperature | < 180° F |
| ***Certified Test Data*** | |
| Electrical Output Range | 1.2 - 4.4 kW |
| Thermal Output Range | NG 13,000 - 42,000 BTU/hr<br>LPG 15,000 - 47,000 BTU/hr |
| Gas Consumption Range | NG 0.21 - 0.65 therms/hr<br>LPG 0.26 - 0.78 gal/hr |
| Overall Efficiency | 93% |
| Average Sound Level @ 1m | 55 dB (A) |
| Average NOx Emissions | 0.005 lb/MWh |
| ***Approvals*** | |
| UL Standards | UL 1741, UL 2200 |
| CSA Standards | CSA C22.2 No. 14-10, 100-04, 107.1-01 |
| Emissions Compliance | EPA Certified |

## Savings Methodology

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

**Energy:**

4.4 kW/module x 1 module(s) x 1 net after "parasitic loads"

= 4.4 net kW output x $/kWh avg. displaced energy

**When Heat Used to Displace Boiler Gas Use:**

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

## Maintenance 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 ESIP Program.

## Benefits

- The installation of a cogeneration unit will result in significant economic benefits to the overall ESIP program by extending the project financing term up to 20-years.
- Electric generation while making heating hot water.

# ECM #17: 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 operations 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 PPA with the school district this ECM will reduce the cost of electrical power resulting in good financial benefits for the district.

## Scope of Work

Hackensack Public Schools is 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 #18: Roof Upgrades and Repairs

## ECM Summary

The roof of a building can cause significant energy loss and maintenance costs throughout the year due to issues 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 protection. Maintenance will be easier because many existing problems with the structure will be repaired.

## Facilities Recommended for this Measure

- Hackensack High School
- Hackensack Middle School
- Fanny M Hillers Elementary School
- Jackson Avenue School
- Fairmount Elementary School
- Nellie Parker School

## Existing System

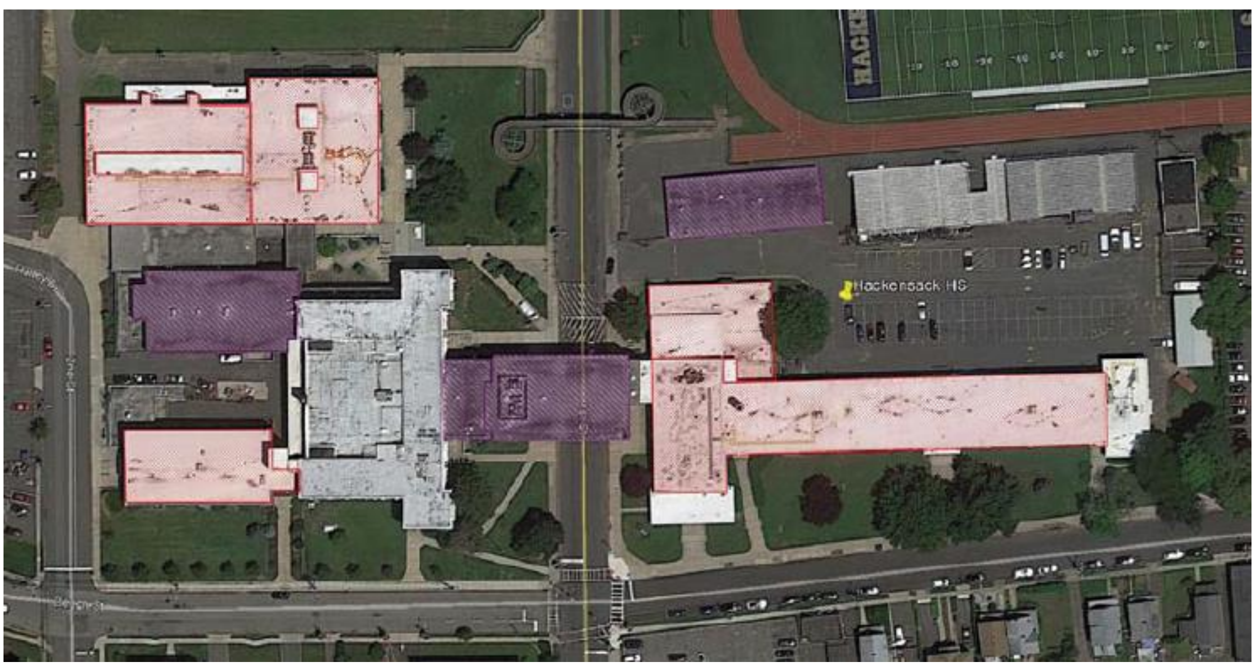
At the High School, although the roof is past its life expectancy, it is in good shape. All of the roofs are past their life expectancy at the Middle School. Some are still in good condition and some are in need of removal and replacement.

## Proposed System

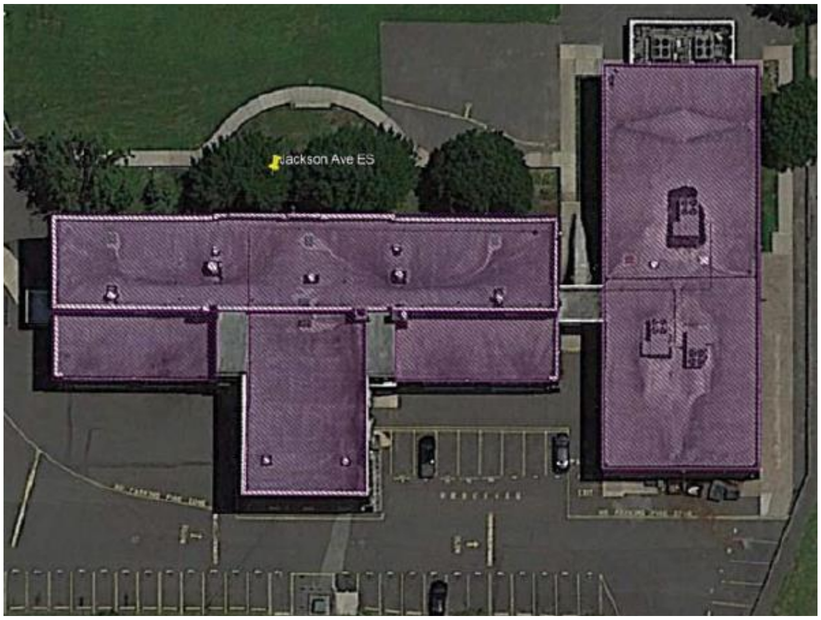
The existing roof needs to be upgraded in order to install solar panels as part of the Solar Power Purchase Agreement and this measure will add a High Solids Silicone Construction Coating to ensure warranty and address any leaks and repairs to the current roof system.

The purple shaded areas in the below images are considered for roof repairs and upgrades.

**High School**

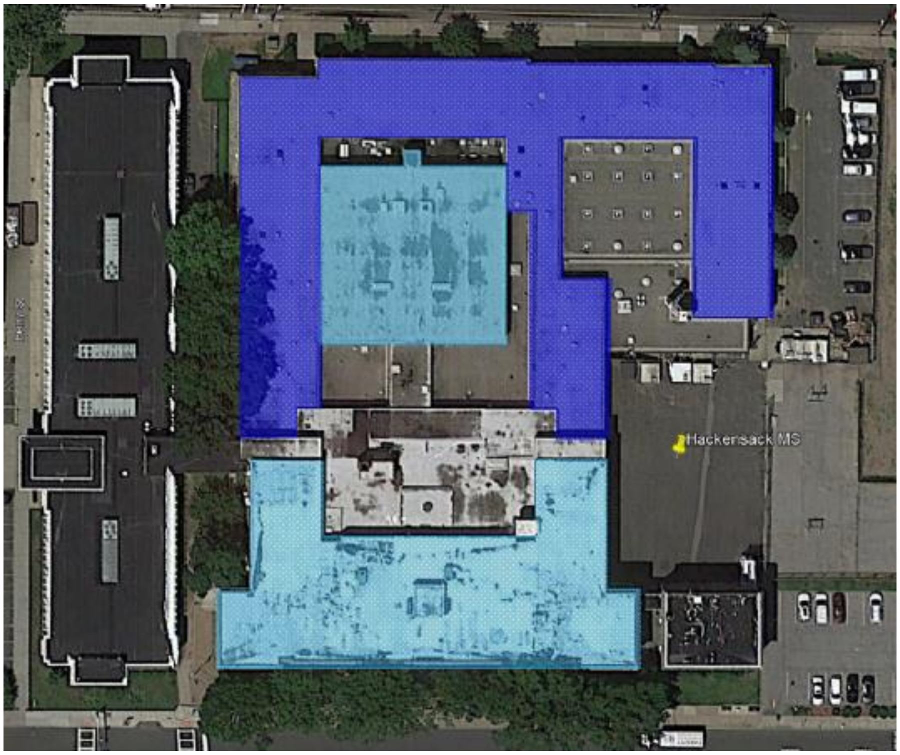


**Jackson Ave ES**

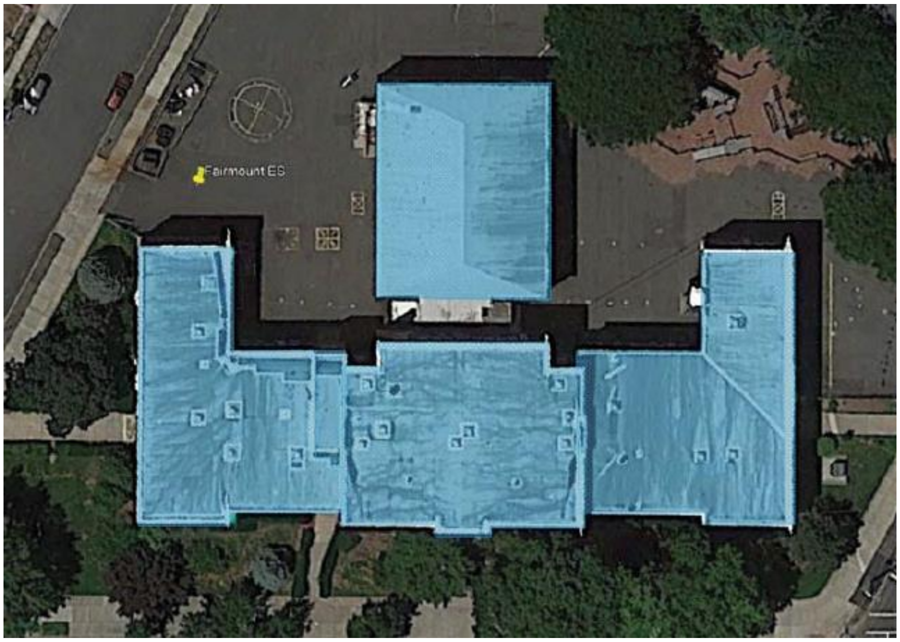



The lighter blue shaded areas in the below images are considered for roof repairs and upgrades.

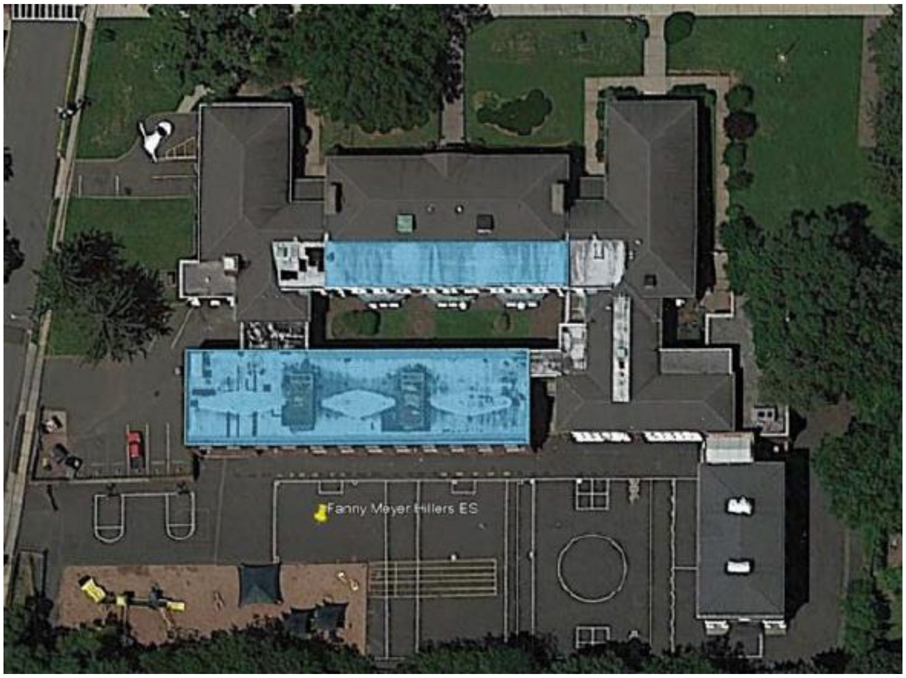
**Middle School**



**Fairmount School**




**Fanny M Hillers ES**



The red shaded areas in the below image are considered for roof repairs and upgrades.

**Nellie Parker ES**


## Scope of Work

- Coordinate with Solar PPA panel locations based on final design. Reconcile any changes to solar scope with roofing upgrades and provide District with option to proceed.
- Supply the District with thermal imaging scan of the existing roofing. Anomalies will be marked in paint on the roof and the District will receive a report of the findings.
- An infrared scan is utilized to mark 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.
- Spot removal of existing non-asbestos roofing in accordance with local and state law. All 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 all necessary locations per the manufacturer's direction.
- Supply and install High Solids Silicone Construction Coating over the existing EPDM roofing system.

- All walls and curbs shall have double thickness of silicone as per manufacturer's specifications and recommendations.
- Supply to the District 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 #19: 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

- Hackensack High School
- Hackensack Middle School

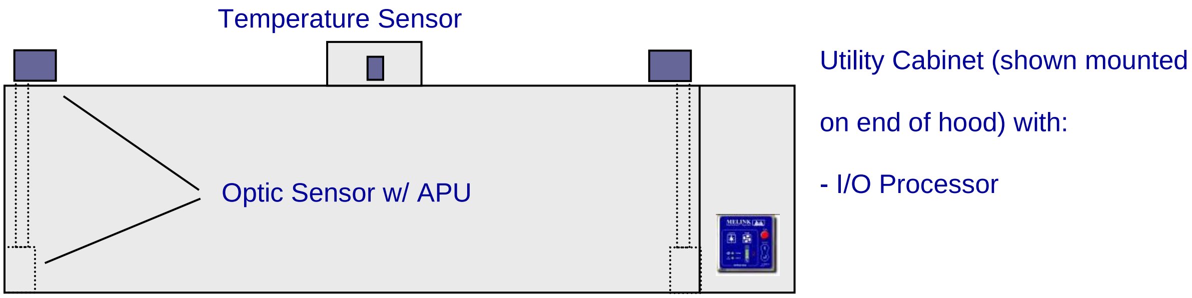
## Scope of Work

Johnson Controls will provide a Melink (or equal) Kitchen Hood System for the kitchens at the High School and Middle School kitchens. This measure will reduce annual energy costs and reduce maintenance. In addition, time of day scheduling and 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
  - 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 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.


MeLink kitchen hood controls




**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 #20: Refrigeration Compressor Controllers

## Executive Summary

All locations were surveyed for the application of this measure. The existing refrigeration units that are installed at the itemized buildings are good candidates for improved controllers to improve the efficiency of the system operation. Johnson Controls proposes to install new controllers on the individual compressor units located in the District that provide sufficient financial support in energy savings.

## Facilities Recommended for This Measure

- Hackensack Middle School

## Existing System

The buildings are fitted with large refrigeration equipment for food storage. The controls for these units use standard pressure switches that do not utilize advanced control methodology.

## Proposed System

The i-Con 2500 is a microprocessor-based, UL listed, electronic control that automatically adjusts the compressor cycles to achieve the greatest efficiency and reduced electrical usage. The sizing of refrigeration systems is based upon a number of factors. When any of the design considerations are not met, the refrigeration system can become oversized for the load and thus less efficient. Intelligent Control Systems' intelligent Dynamic Cycle Management (DCM) Technology analyzes the demands and thermal characteristics of the entire refrigeration system, and dynamically modifies the compressor cycle pattern. These new patterns result in less frequent and more efficient compressor cycles. Just as computer control has increased the gas mileage of automobiles, the unit improves the electrical efficiency of refrigeration systems, by supplementing the antiquated on/off action of the thermostat or pressuretrol with the analysis and control capabilities of a computer. The IntelliCon DCM Technology "intelligent modification of compressor cycling" will result in significant electrical energy savings. IntelliCon's innovative and intelligent algorithms have field proven electrical savings not only on properly sized and operating systems, but also on units that were undersized or those that had not been properly maintained.

The i-Con 2500 works in conjunction with the existing temperature controls and will not void the compressor manufacturer's warranty.

An additional feature of the i-Con 2500 is the accepted industry practice of compressor anti-short-cycling control. Installation by a qualified HVAC/R service technician is recommended. The unit does not require any programming, adjustments or maintenance.

The i-Con 2500 will reduce electric consumption— typically 10% to 20%—when installed on commercial refrigeration/freezer (refrigeration) systems. Intelligent DCM Technology represents a major advancement in refrigeration system energy-saving technology, unsurpassed in today's commercial refrigeration marketplace. The unit is easily installed by a qualified installer, maintenance free and guaranteed to save energy.

Johnson Controls proposes to install new I-Con 2500 controllers on the individual compressor units, listed below that provide sufficient financial support in energy savings.

| Location | No. of Compressors |
|---|---:|
| Middle School | 6 |
| **Total** | **6** |

| Building | Location | System Served | Equipment Type | Manufacturer |
|---|---|---|---|---|
| Middle School | Outside | Walk-In Cooler Kitchen | Water Cooled Refrigeration Compressor | Bally |

## Energy Savings Methodology

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

Baseline Energy Usage (kWh/yr) = Existing Watts x Operating Hours/yr x 1 kW/1000 Watts

Estimated Energy Usage (kWh/yr) = Proposed Watts x Op. Hours/yr x 1 kW/1000 Watts

Energy Savings (kWh/yr) = Baseline Energy Usage – Estimated Energy Usage

## Equipment Information

| | |
|---|---|
| Manufacturer and Type | Several quality and cost-effective installers are available. JCI 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. |

# Measures Considered but Not Included

## ECM #21: Air-Handling Unit Replacement & Refurbishment

### Existing Conditions

The AHUs serving the High School, Middle School and Nellie Parker are at the end of their useful life and of low efficiency. The units in the Middle School and Nellie Parker were looked at for possible replacement while some units at the High School and Middle School were considered for refurbishment. The AHUs serving the Bridge and Library at the High School are included in the project under ECM #9.

### Facilities Recommended for This Measure

- Hackensack High School
- Hackensack Middle School
- Nellie Parker Elementary School

### Scope of Work

This ECM will replace and upgrade existing AHUs 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 all 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 #22: Replace Unit Ventilators – Other Buildings

## ECM Summary

All locations were surveyed for the application of this measure. Based on the current condition, the existing unit ventilators within the District should be addressed. This measure will replace some of the existing unit ventilators that supply the required amount of outside air into the classrooms while maintaining setpoint and reducing energy consumption. Replacing radiators and installing unit ventilators at Fanny Hillers and the Middle School are included as part of ECM #7.

## Facilities Recommended for This Measure

- Hackensack High School
- Hackensack Middle School
- Fairmount School

## Existing System

### *High School*

A total of 75 (seventy five) unit ventilators are serving the High School classrooms to provide heating and the required amount of ventilation to the spaces. Some of the units are in poor condition. The original units have operational and maintenance requirements that warrant replacement and better control.

### *Hackensack Middle School*

A total of 30 (thirty) unit ventilators are serving the classrooms at the Middle School to provide heating and the required amount of ventilation to the spaces. The original units have operational and maintenance requirements that warrant replacement and better control.

### *Fairmount School*

A total of 30 (thirty) unit ventilators are serving the classrooms at the Middle School to provide heating and the required amount of ventilation to the spaces. The original units have operational and maintenance requirements that warrant replacement and better control.

## Proposed System Upgrades

JCI evaluated installing new unit ventilators. New unit ventilators will distribute the air in a much more efficient manner by utilizing premium efficiency motors, eliminating leakage through tighter unit construction, and the units will have more efficient heating. The installation of new units will also allow better control of the outside air due to integrated digital controls. In addition to energy and operational cost savings, the units will provide a more pleasant indoor environment resulting in increased productivity and occupant comfort.

# ECM #23: Steam Boiler Replacement – Other Buildings

## ECM Summary

This ECM replaces steam boilers that operate at low efficiencies and are beyond 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. Fairmount Schools boiler replacement is included in the project as part of ECM#8.

## Facilities Recommended for This Measure

- Fanny Hillers School
- Jackson Avenue School
- Nellie Parker Elementary School

## Existing System

The gas-fired steam boilers in the above listed schools 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 steam boilers with higher efficiency gas-fired steam boilers.

## Proposed System Upgrades

JCI considered to install gas-fired, high efficiency steam boilers at the above listed schools. The boiler replacements are based on the output capacity of the existing boilers.

# ECM #24: Chiller Replacement at Nellie Parker ES

## Existing Conditions

The air-cooled chiller serving the Nellie Parker Elementary School is less efficient than the new generation of air-cooled chillers. Estimated efficiency of the existing chillers is 1.15 kW/Ton at full load capacity (FLV) while the FLV of a new, high efficiency chiller is 1.04 kW/Ton.

## Facilities Recommended for This Measure

- Nellie Parker Elementary School

## Scope of Work

Johnson Controls proposes to replace the existing nominal efficiency 250 ton chillers serving the building. The proposed chiller improves part-load performance and uses environmentally friendly R-134A refrigerant. Replacing the old chiller will avoid future chiller repair and replacement expenditures. The latest generation of air-cooled chillers also have VFD compressors, improved DDC and operating sequences to improve efficiency, reliability and turndown capacity.

# ECM #25: 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.

## 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, one (1) or two (2) 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 are outlined below:

- 80 Watt LED Hybrid Streetlight (RPU) with single lamp arm
- Hackensack Public Schools banner with logo printed on both sides and tailfin
- Data monitoring and maintenance of the RPU
- USB charging station at the RPU
- Installation, foundation, cleanup and haul away

By installing an RPU system, it will provide the following benefits.

- LED lighting and enhanced security
- Utilize free energy from the wind and the 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.

# 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 are 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 judgement. 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 are 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 ECM
- 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 ECMs proposed for this project will be verified.

| Measure | M&V Option | M&V Methodology |
|---|---|---|
| Retrofit LED Lighting - Interior with Smart Sensors | A | Pre - lighting wattage from manufacturer readings, assumed operating hours align with JCI database.<br>Post - Wattage will be measured on new lighting fixtures. |
| Weather Stripping & Window Replacement | NM | Pre – Site visit to determine the location and sizes of the building cracks/doors/windows where the weather stripping will be installed.<br>Post - Verify the location, sizes and efficiencies where weather stripping and new windows will be installed with as-built and manufacturer specs. |
| Building Controls Upgrade | A | Pre - Site audit to collect pre-retro schedules, space setpoints and heating/cooling sequences.<br>Post - Setup trending and track to verify the proposed schedules and temperate setpoints. |
| Ventilation Addition to Media Center & Main Office Areas | NM | Pre - Site audit to collect the information of the existing unit where ventilation will be added.<br>Post - Use the final as-built to verify if the new ventilation unit is installed as expected. |
| Variable Speed Drives on Pumps | NM | Pre - Site audit to collect the information of the pumps.<br>Post - Use the final as-built to verify if the VFDs are installed as expected. |
| Replace Radiators and Install Unit Ventilators | NM | Pre - Site audit to collect the information of the equipment that will be replaced.<br>Post - Verify the installed equipment to ensure they are installed as expected. |
| Steam Boiler Replacement | A | Pre – Existing boiler efficiency and annual heating load are determined through the site audit and annual natural gas bills.<br>Post – One-time combustion efficiency test on new boilers and boiler operation parameters verification on BAS. |
| AHU Replacement | A | Pre - Site audit to collect the nameplate efficiency information of the equipment that will be replaced. Efficiency will be derated based on age and engineering judgement.<br>Post - Use the final as-built to verify if the system is installed as expected and efficiency as expected. Post power kW wattage will be measured. BAS will be checked to ensure all control points are mapped in. |

| Measure | M&V Option | M&V Methodology |
|---|---|---|
| Chiller Replacement | A | Pre - Site audit to collect the baseline name plate chiller efficiency information of the existing chillers. The efficiency will be derated based on age and engineering judgement. Floor cooling ton-hours will be established from operator logs and conversation w/ customer.<br>Post - Post-installation chiller efficiency will be measured using the control system. The kwh used by the chiller and the Btu delivered will be totalized. Ton-hours measured will be utilized if higher than the baseline, otherwise the baseline ton-hours will be used. |
| Steam Trap Replacement | A | Pre - Site audit to collect the information of the steam traps.<br>Post - Use the final as-built to verify if the steam traps is installed as expected. Infrared test will be performed to ensure the new steam traps function well. |
| Pipe & Valve Insulation | A | Pre - Site audit to collect the information of the heating pipes and valves such as the site and surface temperature.<br>Post - Use the final as-built to verify if the insulation is installed as expected. Infrared test will be performed to check if the surface temperature with the insulation is close to the ambient temperature. |
| Transformer Replacement | NM | Pre - Site audit to collect the information of the existing transformers.<br>Post - Verify the installed equipment and their efficiency to ensure they are installed as expected. |
| Micro Combined Heat and Power | NM | Pre – Site audit to determine the existing building heating load and electric consumption.<br>Post - Verify the installed equipment to ensure it matches the design. |
| 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.<br>Post – Verify the Solar PPA rate through the PPA invoices. |
| Roof Upgrades | NM | Pre – Site visit to determine the location and sizes of the roof areas where upgrade is needed.<br>Post - Verify the location, sizes and efficiencies where new roof is installed with as-built and manufacturer specs. |
| Kitchen Hood Controls | NM | Pre - Site audit to collect the information of the existing kitchen hoods.<br>Post - Verify the installed equipment and their operation schedule to ensure they are installed as expected. |
| Refrigeration Compressor Controls | NM | Pre - Site audit to collect the information of the refrigeration compressors.<br>Post - Use the final as-built to verify if the controls are installed as expected. |

## 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 | $30,160 |
| 2 | $30,160 |
| 3 | $30,160 |
| Total | $90,480 |

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 Project Benefits. Johnson Controls will report the Project Benefits achieved during 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, onsite 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 Hackensack Public Schools; 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 ESIP 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 Hackensack Public Schools.

Johnson Controls does not guarantee the rebate or state incentive structure. If the programs change or the incentive amounts differ, Hackensack Public Schools 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 Hackensack Public Schools 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 – February 22, 2021
- Complete Third Party Engineering Review of ESIP – March 5, 2021
- Complete Board of Public Utilities Review of ESIP – March 16, 2021
- Approval resolution to contract with Johnson Controls – March 22, 2021
- Submit to Local Finance Board – March 24, 2021
- Present to Local Finance Board – April 14, 2021
- Complete 100% design drawings and bid specifications for unit ventilator replacements – April 16, 2021
- Expected Finance Close – May 6, 2021
- Complete 100% design drawings and bid specifications for other ECMs – September 3, 2021

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

| ID | Task Mode | Task Name | Start | Finish | Duration |
|---|---|---|---|---|---|
| 1 | | **Hackensack Schools** | Thu 2/4/21 | Tue 5/25/21 | 79 days |
| 2 | | School Board Approval | Mon 2/22/21 | Mon 2/22/21 | 0 days |
| 3 | | Approval for Hillier's Accelerated Engineering | Thu 2/4/21 | Thu 2/4/21 | 1 day |
| 4 | | Approval for Hillier's Equipment procurement | Mon 3/29/21 | Mon 3/29/21 | 1 day |
| 5 | | Approval of JCI contract | Mon 3/22/21 | Mon 3/22/21 | 1 day |
| 6 | | JCI release remaining Engineering | Mon 3/29/21 | Tue 5/25/21 | 42 days |
| 7 | | | | | |
| 8 | | **Hillier's School** | Thu 4/1/21 | Fri 10/7/22 | 397 days? |
| 9 | | Lighting Retro-Fit | Mon 6/14/21 | Fri 10/8/21 | 85 days |
| 10 | | Radator / Unit vent replacment | Mon 6/14/21 | Tue 8/31/21 | 57 days |
| 11 | | Nesbitt Multizone replacment | Mon 10/4/21 | Fri 10/29/21 | 20 days |
| 12 | | Air Handler Replacement | Mon 6/13/22 | Fri 7/29/22 | 35 days |
| 13 | | Medai center Ventilation | Mon 6/21/21 | Tue 8/31/21 | 52 days |
| 14 | | Building Controls Upgrade | Thu 4/1/21 | Fri 10/7/22 | 397 days |
| 15 | | Weatherization | Mon 6/14/21 | Fri 10/8/21 | 85 days |
| 16 | | Enterprise Management Systems | | | |
| 17 | | | | | |
| 18 | | **High School** | Mon 6/14/21 | Fri 10/7/22 | 345 days? |
| 19 | | Lighting Retro-Fit | Mon 6/14/21 | Fri 10/8/21 | 85 days |
| 20 | | Air Handler replacment | Mon 6/6/22 | Fri 9/2/22 | 65 days |
| 21 | | Pool Chiller Replacment | Mon 11/15/21 | Tue 11/23/21 | 7 days |
| 22 | | Micro-Combined Power/Heat (CHP) | Mon 6/13/22 | Fri 10/7/22 | 85 days |
| 23 | | Building Controls Upgrade | Mon 6/14/21 | Fri 10/7/22 | 345 days |
| 24 | | Weatherization | Mon 6/14/21 | Fri 10/8/21 | 85 days |
| 25 | | Kitchen Hood Controls | Mon 7/12/21 | Fri 8/27/21 | 35 days |
| 26 | | Enterprise Management Systems | | | |
| 27 | | | | | |
| 28 | | **Fairmount School** | Mon 5/10/21 | Fri 10/7/22 | 370 days? |
| 29 | | Lighting Retro-Fit | Mon 6/14/21 | Sat 10/9/21 | 86 days |
| 30 | | Steam Boiler Replacement | Mon 5/10/21 | Fri 9/24/21 | 100 days |
| 31 | | Building Controls Upgrade | Mon 6/14/21 | Fri 10/7/22 | 345 days |
| 32 | | Weatherization | Mon 6/14/21 | Fri 10/8/21 | 85 days |
| 33 | | Enterprise Management Systems | | | |
| 34 | | | | | |
| 35 | | **Middle School** | Mon 6/14/21 | Fri 10/7/22 | 345 days? |
| 36 | | Lighting Retro-Fit | Mon 6/14/21 | Fri 10/7/22 | 345 days |
| 37 | | Radiator Replacment with Unit Vents | Mon 6/13/22 | Fri 10/7/22 | 85 days |
| 38 | | Office Area Ventilation Addition | Mon 10/4/21 | Fri 1/28/22 | 85 days |


Project: Construction Schedule
Date: Tue 2/16/21

| | | | |
|---|---|---|---|
| Task | Project Summary | Manual Task | Start-only |
| Split | Inactive Task | Duration-only | Finish-only |
| Milestone | Inactive Milestone | Manual Summary Rollup | External Tasks |
| Summary | Inactive Summary | Manual Summary | External Milestone |
| Deadline | Progress | Manual Progress | |

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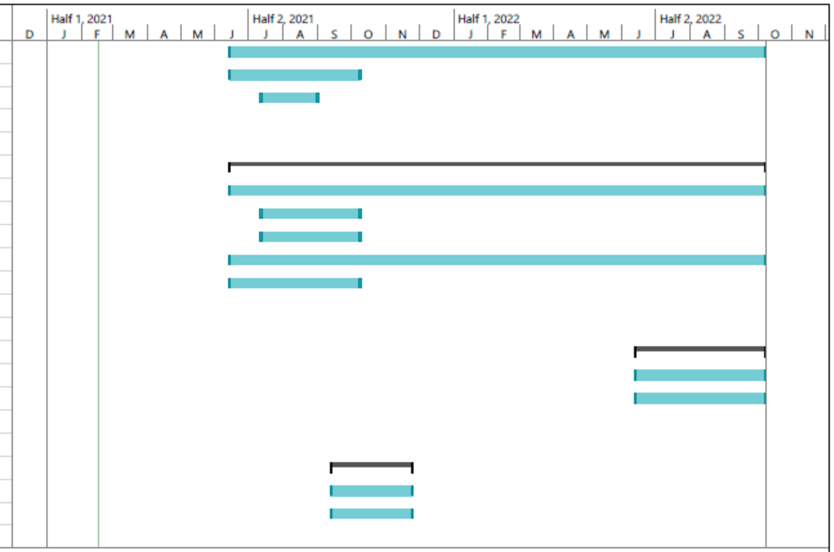
| ID | Task Mode | Task Name | Start | Finish | Duration |
|---|---|---|---|---|---|
| 39 | | Building Controls Upgrade | Mon 6/14/21 | Fri 10/7/22 | 345 days |
| 40 | | Weatherization | Mon 6/14/21 | Fri 10/8/21 | 85 days |
| 41 | | Kitchn Hood Controls | Mon 7/12/21 | Tue 8/31/21 | 37 days |
| 42 | | Enterprise Management Systems | | | |
| 43 | | | | | |
| 44 | | **Nellie Parker School** | **Mon 6/14/21** | **Fri 10/7/22** | **345 days?** |
| 45 | | Lighting Retro-Fit | Mon 6/14/21 | Fri 10/7/22 | 345 days |
| 46 | | Energy Efficent Transformers Penthouse | Mon 7/12/21 | Fri 10/8/21 | 65 days |
| 47 | | Variable speed Drives | Mon 7/12/21 | Fri 10/8/21 | 65 days |
| 48 | | Building Controls Upgrade | Mon 6/14/21 | Fri 10/7/22 | 345 days |
| 49 | | Weatherization | Mon 6/14/21 | Fri 10/8/21 | 85 days |
| 50 | | Enterprise Management Systems | | | |
| 51 | | | | | |
| 52 | | **Jackson School** | **Mon 6/13/22** | **Fri 10/7/22** | **85 days?** |
| 53 | | Lighting Retro-Fit | Mon 6/13/22 | Fri 10/7/22 | 85 days |
| 54 | | Weatherization | Mon 6/13/22 | Fri 10/7/22 | 85 days |
| 55 | | Enterprise Management Systems | | | |
| 56 | | | | | |
| 57 | | **Padovano Adminastration** | **Mon 9/13/21** | **Wed 11/24/21** | **53 days** |
| 58 | | Lighting Retro-Fit | Mon 9/13/21 | Wed 11/24/21 | 53 days |
| 59 | | Weatherization | Mon 9/13/21 | Wed 11/24/21 | 53 days |
| 60 | | Enterprise Management Systems | | | |




Project: Construction Schedule
Date: Tue 2/16/21

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

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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

## 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 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - HS | $658,433 | $45,082 | 14.6 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - MS | $485,878 | $43,949 | 11.1 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - FMHS | $203,762 | $16,582 | 12.3 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - JAS | $105,110 | $12,670 | 8.3 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - NPES | $337,709 | $17,875 | 18.9 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - FS | $118,442 | $11,149 | 10.6 |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - PAB | $30,712 | $3,258 | 9.4 |
| 2 | Weatherization and Building Envelope - All Schools | $132,570 | $16,776 | 7.9 |
| 3 | Window Replacement Savings Only - FMHS | $0 | $5,199 | 0.0 |
| 4 | Building Controls Upgrades -HS | $609,635 | $59,941 | 10.2 |
| 4 | Building Controls Upgrades -MS | $569,500 | $26,630 | 21.4 |
| 4 | Building Controls Upgrades -FMHS | $379,782 | $16,941 | 22.4 |
| 4 | Building Controls Upgrades -JAS | $303,647 | $10,673 | 28.4 |
| 4 | Building Controls Upgrades -NPES | $438,264 | $13,134 | 33.4 |
| 4 | Building Controls Upgrades -FS | $246,621 | $10,524 | 23.4 |
| 5 | Enterprise Management System - All Schools | $48,100 | N/A | N/A |
| 6 | Ventilation Addition to Media Center - FMHS | $137,125 | ($367) | (373.6) |
| 7 | Radiator and Unit Vent Replacement - FMHS | $603,678 | $9,329 | 64.7 |
| 7 | Radiator Replacement with Unit Vents - MS | $780,000 | $5,253 | 148.5 |
| 8 | Steam Boiler Replacement Savings Only - HS | $0 | $12,820 | 0.0 |
| 8 | Steam Boiler Replacement - FS | $935,052 | $6,672 | 140.1 |
| 9 | Air-Handling Units Replacement - HS | $548,847 | $9,813 | 55.9 |

| ID # | Energy Conservation Measure | ECM Hard Cost | Year 1 Utility Savings* | Simple Payback |
|---|---|---|---|---|
| 9 | Air-Handling Units Replacement - FMHS | $523,294 | $9,167 | 57.1 |
| 10 | Ventilation Upgrades to Office Area - MS | $80,625 | ($158) | (510.3) |
| 11 | Chiller Replacement - HS | $324,189 | $14,522 | 22.3 |
| 12 | Steam Traps Replacement | $98,865 | $17,621 | 5.6 |
| 13 | Pipe and Valve Insulation | $149,340 | $16,799 | 8.9 |
| 14 | Variable Speed Drives - NPES | $25,000 | $2,751 | 9.1 |
| 15 | Energy Efficient Transformers - NPES | $11,378 | $912 | 12.5 |
| 16 | Micro Combined Heat and Power - HS | $80,000 | $1,149 | 69.6 |
| 17 | Solar PPA Savings - All Schools | $0 | $262,498 | 0.0 |
| 18 | Roof Upgrades for Solar PV Install | $983,875 | $500 | 1,967.8 |
| 19 | Kitchen Hood Controls - HS and MS | $38,992 | $16,222 | 2.4 |
| 20 | Refrigeration Compressor Controls - MS | $4,650 | $1,265 | 3.7 |
| **Project Summary:** | | **$9,993,075** | **$697,153** | **14.3** |

***Year 1 Utility Savings in the above table include a 2.2% escalation on Electric and 2.4% escalation on Natural Gas 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 | $35,681 | 5 |
| Enterprise Management System | $57,000 | 2 |
| Replace Radiators and Unit Vents – MS and FMHS | $6,400 | 2 |
| Steam Boiler Replacement - FS | $40,117 | 2 |
| Air-Handling Units Replacement - HS | $30,254 | 2 |
| Air-Handling Units Replacement - FMHS | $12,085 | 2 |
| Chiller Replacement – HS | $6,002 | 2 |
| Ventilation Upgrades to Office Area - MS | $2,200 | 2 |
| Steam Trap Replacements | $17,200 | 2 |
| Total | $206,939 | |

# Potential Revenue Generation Estimates

## Rebates

As part of the ESP for the Hackensack Public Schools, several avenues for obtaining rebates and incentives have been investigated which include:

### 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 | $163,191 |
| Ventilation Addition to Media Center | $1,840 |
| VFD on Pumps | $9,600 |
| Replace Radiators & Install Unit Ventilators | $13,800 |
| Steam Boiler Replacement | $9,939 |
| AHU Replacement | $18,960 |
| Chiller Replacement | $17,280 |
| Ventilation Upgrades to Office Area - MS | $1,022 |
| **Total** | **$235,632** |

### 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. An Energy Efficiency Credit of **$15,000** is estimated for the demand reduction from lighting upgrades.

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

## Greenhouse Gas Reductions

| Avoided Emissions | Total Electric Savings | Total Natural Savings | Total Annual Avoided Emissions |
|---|---|---|---|
| Annual Unit Savings | 2,075 MWh | 210,736 Therms | |
| NOx, lb | 1,722 | 1,939 | 3,661 |
| $SO_2$, lb | 1,390 | | 1,390 |
| $CO_2$, lb | 2,680,650 | 2,465,611 | 5,146,261 |

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 | | Total Annual Utility |
|---|---|---|---|---|---|---|---|---|
| | | Dollars | kWh | Dollars | kW | Dollars | Therms | Dollars |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - HS | $38,735 | 387,677 | $9,849 | 111 | ($3,502) | (4,119) | **$45,082** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - MS | $37,651 | 370,352 | $9,720 | 110 | ($3,423) | (3,867) | **$43,949** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - FMHS | $13,840 | 136,588 | $3,958 | 42 | ($1,215) | (1,374) | **$16,582** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - JAS | $10,234 | 92,381 | $3,247 | 34 | ($811) | (898) | **$12,670** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - NPES | $15,063 | 160,240 | $4,127 | 47 | ($1,315) | (1,415) | **$17,875** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - FS | $9,450 | 77,611 | $2,479 | 26 | ($780) | (834) | **$11,149** |
| 1 | Deep Lighting Retrofit - Interior and Exterior Lighting and Advanced Sensor Controls - PAB | $3,420 | 25,566 | $281 | 6 | ($442) | (216) | **$3,258** |
| 2 | Weatherization and Building Envelope - All Schools | $2,842 | 27,951 | | | $13,933 | 15,863 | **$16,776** |
| 3 | Window Replacement Savings Only - FMHS | $821 | 8,102 | | | $4,378 | 4,952 | **$5,199** |
| 4 | Building Controls Upgrades -HS | $12,777 | 127,879 | | | $47,164 | 55,468 | **$59,941** |
| 4 | Building Controls Upgrades -MS | $7,494 | 73,710 | | | $19,137 | 21,627 | **$26,630** |
| 4 | Building Controls Upgrades -FMHS | $4,164 | 41,101 | | | $12,777 | 14,453 | **$16,941** |
| 4 | Building Controls Upgrades -JAS | $3,317 | 29,950 | | | $7,356 | 8,151 | **$10,673** |
| 4 | Building Controls Upgrades -NPES | $4,023 | 42,802 | | | $9,111 | 9,805 | **$13,134** |
| 4 | Building Controls Upgrades -FS | $2,034 | 16,707 | | | $8,490 | 9,081 | **$10,524** |
| 5 | Enterprise Management System - All Schools | | | | | | | **$0** |
| 6 | Ventilation Addition to Media Center - FMHS | ($367) | (3,626) | | | | | **($367)** |
| 7 | Radiator and Unit Vent Replacement - FMHS | $7,111 | 70,178 | | | $2,218 | 251 | **$9,329** |
| 7 | Radiator Replacement with Unit Vents - MS | ($757) | (7,446) | | | $6,010 | 6,790 | **$5,253** |

| ID# | Energy Conservation Measure | Electric Consumption | | Annual Electric Demand | | Natural Gas | | Total Annual Utility |
|---|---|---|---|---|---|---|---|---|
| | | Dollars | kWh | Dollars | kW | Dollars | Therms | Dollars |
| 8 | Steam Boiler Replacement Savings Only - HS | | | | | $12,820 | 15,077 | **$12,820** |
| 8 | Steam Boiler Replacement - FS | | | | | $6,672 | 7,137 | **$6,672** |
| 9 | Air-Handling Units Replacement - HS | $9,813 | 98,212 | | | | | **$9,813** |
| 9 | Air-Handling Units Replacement - FMHS | $9,167 | 90,480 | | | | | **$9,167** |
| 10 | Ventilation Upgrades to Office Area - MS | ($158) | (1,556) | | | | | **($158)** |
| 11 | Chiller Replacement - HS | $11,605 | 116,148 | $2,917 | 88 | | | **$14,522** |
| 12 | Steam Traps Replacement | | | | | $17,621 | 19,767 | **$17,621** |
| 13 | Pipe and Valve Insulation | | | | | $16,799 | 19,301 | **$16,799** |
| 14 | Variable Speed Drives - NPES | $2,751 | 29,267 | | | | | **$2,751** |
| 15 | Energy Efficient Transformers - NPES | $912 | 9,698 | | | | | **$912** |
| 16 | Micro Combined Heat and Power - HS | $2,050 | 20,520 | $37 | 5 | ($938) | (1,103) | **$1,149** |
| 17 | Solar PPA Savings - All Schools | $262,498 | | | | | | **$262,498** |
| 18 | Roof Upgrades for Solar PV Install | $125 | 1,250 | | | $375 | 452 | **$500** |
| 19 | Kitchen Hood Controls - HS and MS | $2,075 | 20,621 | | | $14,148 | | **$16,222** |
| 20 | Refrigeration Compressor Controls - MS | $1,265 | 12,446 | | | | | **$1,265** |
| | | **$473,954** | **2,073,557** | **$36,616** | **468** | **$186,583** | **210,284** | **$697,153** |

# Business Case for Recommended Project

**FORM VI**

**ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):**
**ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM**
**HACKENSACK 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 per year**; and

1. Term of Agreement: **20 years (240 Months)**
2. Construction Period [(2)] (months): **18 months**
3. Cash Flow Analysis Format:

**Project Cost [(1)]:** **$12,586,279**

Interest Rate to Be Used for Proposal Purposes: 2.25%

| Year | Annual Energy Savings | Annual Solar PPA Savings | Annual Operational Savings | Energy Rebates/ Incentives | Total Annual Savings | Annual Project Costs | Board Costs | Annual Service Costs [(3)] | Net Cash Flow to Client | Cumulative Cash Flow |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| Installlation | $189,623 | | | | $189,623 | | | | | |
| 1 | $434,654 | $262,498 | $206,939 | $250,632 | $1,154,723 | $1,311,786 | $1,341,946 | $30,160 | $2,400 | $2,400 |
| 2 | $444,578 | $266,584 | $206,939 | $0 | $918,101 | $885,541 | $915,701 | $30,160 | $2,400 | $4,800 |
| 3 | $454,729 | $270,730 | $35,681 | $0 | $761,140 | $728,580 | $758,740 | $30,160 | $2,400 | $7,200 |
| 4 | $465,113 | $274,939 | $35,681 | $0 | $775,732 | $773,332 | $773,332 | $0 | $2,400 | $9,600 |
| 5 | $475,734 | $279,210 | $35,681 | $0 | $790,625 | $788,225 | $788,225 | $0 | $2,400 | $12,000 |
| 6 | $486,599 | $283,544 | $0 | $0 | $770,143 | $767,743 | $767,743 | $0 | $2,400 | $14,400 |
| 7 | $497,712 | $287,944 | $0 | $0 | $785,656 | $783,256 | $783,256 | $0 | $2,400 | $16,800 |
| 8 | $509,080 | $292,408 | $0 | $0 | $801,489 | $799,089 | $799,089 | $0 | $2,400 | $19,200 |
| 9 | $520,709 | $296,940 | $0 | $0 | $817,648 | $815,248 | $815,248 | $0 | $2,400 | $21,600 |
| 10 | $532,603 | $301,539 | $0 | $0 | $834,142 | $831,742 | $831,742 | $0 | $2,400 | $24,000 |
| 11 | $544,771 | $306,206 | $0 | $0 | $850,977 | $848,577 | $848,577 | $0 | $2,400 | $26,400 |
| 12 | $557,217 | $310,943 | $0 | $0 | $868,159 | $865,759 | $865,759 | $0 | $2,400 | $28,800 |
| 13 | $569,948 | $315,750 | $0 | $0 | $885,698 | $883,298 | $883,298 | $0 | $2,400 | $31,200 |
| 14 | $582,971 | $320,628 | $0 | $0 | $903,599 | $901,199 | $901,199 | $0 | $2,400 | $33,600 |
| 15 | $596,292 | $325,580 | $0 | $0 | $921,872 | $919,472 | $919,472 | $0 | $2,400 | $36,000 |
| 16 | $609,919 | | $0 | $0 | $609,919 | $607,519 | $607,519 | $0 | $2,400 | $38,400 |
| 17 | $623,857 | | $0 | $0 | $623,857 | $621,457 | $621,457 | $0 | $2,400 | $40,800 |
| 18 | $638,115 | | $0 | $0 | $638,115 | $635,715 | $635,715 | $0 | $2,400 | $43,200 |
| 19 | $652,700 | | $0 | $0 | $652,700 | $650,300 | $650,300 | $0 | $2,400 | $45,600 |
| 20 | $667,619 | | $0 | $0 | $667,619 | $664,662 | $664,662 | $0 | $2,958 | $48,558 |
| **Totals** | $11,054,543 | $4,395,441 | $520,921 | $250,632 | $16,221,537 | $16,082,499 | $16,172,979 | $90,480 | $48,558 | |

**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

March 2, 2021

Ms. Dora E. Zeno
**Hackensack Board of Education**
191 2nd Street
Hackensack, NJ 07601
Via email: dzeno@hackensackschools.org

RE: **Hackensack BOE Energy Savings Plan 3rd Party Review**
**Hackensack, NJ 07601**
**J&U #21-017**

Dear Ms. Zeno,

Johnson and Urban Consulting Engineers (J&U) has been retained to perform an independent third-party review of an Energy Savings Plan (ESP) developed by Johnson Controls in accordance with NJ statutes for financing of energy savings construction projects. The ESP is the core of the Energy Savings Improvement Plan (ESIP) process. The plan describes proposed Energy Conservation Measures (ECMs) and the energy cost savings calculations that pay for the construction costs through reduced energy costs for the (7) seven district owned buildings.

We are in receipt of and have reviewed the Energy Savings Plan for Hackensack Public Schools, Report Submission dated February 16, 2021, as prepared by Johnson Controls. Johnson Controls has responded to J&U original comments and inquiries, provided between February 22nd & March 2nd, 2021. No updates were required to the ESP report.

Our services have included an independent third-party review of the ESP, required by State statutes set forth in Chapter 4 of the Laws of 2009 "Energy Savings Improvement Plan", Public Law 2012, Chapter 55 and Local Finance Notice 2009-11 prior to the implementation of an ESIP plan.

The Hackensack BOE did not receive a Local Government Energy Audit (LGEAs) for any of the buildings within the Hackensack Public School District. The basis of this third-party review is the ESP prepared by Johnson Controls. The ESP report is based on the results of Investment Grade Audits (IGAs) for the Hackensack Public Schools, performed by Johnson Controls.

Per the applicable statute, the ESP must successfully address nine "plan components" in order to proceed with the ESIP process. The reviewed ESP includes the required components, and in our opinion satisfies the requirements of the statute.

The following table lists whether each of the 9 required plan components was addressed in the ESP.

| Plan Component | Addressed in Plan? |
|---|---|
| Energy Audit Results | Yes |
| ECM Descriptions | Yes |
| Green House Gas Reductions | Yes |
| Design and Compliance Issues | Yes |
| Risk Assessment | Yes |
| Eligibility for PJM ISO Demand Response and Curtailable Services | Yes |
| Implementation Cost Estimates | Yes |
| Identification of Maintenance Requirements | Yes |
| Energy Savings Guarantee | Yes |

Energy savings calculations were prepared by Johnson Controls, and our review indicates that they were performed in accordance with BPU protocols, which is a requirement of the ESP.

J&U believes the ESP, as currently submitted, is likely to be approved by the BPU as it stands, which is a prerequisite to proceeding with implementation of the ESIP. As such, **Johnson and Urban, LLC hereby provides our approval of the referenced Energy Savings Plan for Hackensack Public Schools.**

J&U has provided all reasonable due diligence in this review of the ESP prepared for Hackensack BOE. This review is not a guarantee that the costs and savings stated in the ESP are valid. J&U will not be held responsible for failure to achieve the predicted savings, nor the estimated construction costs.

The calculations included in an ESP include many variables and assumptions which can alter the energy savings predictions. It is impractical to review all inputs, software algorithms and assumptions in detail. J&U has reviewed bottom line figures and parameters presented for reasonableness and validity of results, has checked calculations and assumptions provided, and has identified areas where more information is required for assurance of compliance with ESIP statutes and sound engineering principles. Johnson Controls has satisfactorily responded to our initial comments and inquiries.

**Johnson & Urban, LLC**

Kevin Dwyer, PE – Senior Associate