Millburn Township Public Schools

Energy Savings Plan

Revision 2

May 29, 2015

Johnson Controls

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Millburn, NJ


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Section 1. Executive Summary

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

Priority items include:

- Upgrade lighting throughout the District and install occupancy sensors where they are not already in place.
- Upgrade the HVAC controls throughout the District to move towards an open protocol building controls system.
- Boiler replacements, most notably at Hartshorn Elementary School.
- Chiller replacement at Millburn High School to reduce noise experienced by neighbors.
- Unit ventilator rehabilitation/ replacement.

Energy Savings

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

Benefits

The measures investigated in this Energy Savings Plan could result in an annual utility savings of 1,457,099 kWh, 106,501 therms and 1,098,000 gallons of water. The total utility cost savings is $4,970,002 over the life of the project. Additionally, these energy savings will result in a net reduction of greenhouse gases and will reduce the school district's carbon footprint by 1,433 tons of CO_2 annually and over 21,495 tons of CO_2 over the life of the project.

All these savings are achieved while improving the classroom environment and renewing many items that have been in service beyond useful life expectancy

Section 2. Project Description

This Energy Savings Plan (ESP) addresses the following facilities:

Millburn Township Public Schools	
Deerfield Elementary School	26 Troy Lane, Short Hills, NJ 07078
Education Center	434 Millburn Ave, Millburn, NJ 07041
Glenwood Elementary School	325 Taylor Road, Short Hills, NJ 07078
Hartshorn Elementary School	400 Hartshorn Road, Short Hills, NJ 07078
High School	462 Millburn Ave, Millburn, NJ 07041
Middle School	25 Old Short Hills Road, Millburn, NJ 07041
South Mountain Elementary School	2 Southern Slope Road, Millburn, NJ 07041
Wyoming Elementary School	55 Myrtle Ave, Millburn, NJ 07041

Beginning January 20th, 2015, Subhasis Bhadra and Haiyan Zhao, along with other project engineers, visited the project sites and conducted a detailed energy assessment of the properties.

Deerfield Elementary School

Background Information

The Deerfield Elementary School is located on 26 Troy Lane, Short Hills, New Jersey. The school is 69,218 square feet and was built in 1962. The building is a two-story facility comprised of classrooms, gymnasium, multi-purpose room, mechanical room, and offices.

Building Occupancy

The typical hours of operation for the Deerfield Elementary School are Monday through Friday between 8:30 am and 3:00 pm with various after-school activities. Custodial staff is on site in two shifts, from 6:30 am to 3:30 pm, and 2:30 pm to 11 pm, 10 months a year. The School's population consists of 700 students and 65 staff.

Envelope

Overall, the building envelope was in good condition. Several areas were noted as requiring additional sealing of penetrations and cracks.

Construction Materials: Structural steel framing with concrete masonry unit exterior walls and minimal insulation. Interior walls are predominantly sheetrock, and plaster and lathe.

Façade: Brick and aluminum framed/window panels are in good condition.

Roof Type: Most of the roof is pitched; a small portion is flat. Roof is covered with an adhered membrane. Roof color is dark gray.

Windows: Double hung double pane windows with aluminum frames.

Exterior Doors: Most exterior doors are steel jacketed without windows. Main entrance doors are steel framed storefront style. The exterior door weather-stripping and astragals were noted to be in need of replacement.

Lighting

About 75% of the lighting within this school consists of T8 linear fluorescent fixtures with electronic ballasts, and in most cases the number of lamps per fixture is one or two. About 20% consists of T12 fluorescent fixtures. The gymnasium is a notable exception with twenty-five (25) 250-watt metal halide lamps. A few fluorescent CFLs and 60-watt incandescent lamps were also noted. Exterior lighting consists of 150-watt metal halide wall-pack lamps. There are existing lighting controls in most of the classrooms, and some offices and other miscellaneous spaces.

Mechanical Systems

Heating Systems: Two (2) H.B. Smith cast iron sectional hot water boilers, manufactured in 1996, provide heat for the majority of the school. Although the boilers were replaced in 1996, the burners were reported to be left in place from the original boilers. The boilers have a heating capacity of 3,325 MBH each and a combustion efficiency of approximately 82%. Heating hot water is delivered around the building by three pairs of zone pumps, each operating in a lead/lag manner. The first set are Taco base mounted with 3 HP motors that operate at a NEMA nominal efficiency of 90.2%; the second set of pumps (Armstrong) are also 3 HP base mounted, efficiency data was not available but was assumed to be 90%; and the third set are 2 HP Super E vertical inline pumps with a NEMA nominal efficiency of 86.9%. The first set of pumps is responsible for the 1962 primary building; the second set is responsible for the 1996 additions; and the vertical inline pumps are responsible for the latest 2008 (3rd grade) addition. None of the pumps are controlled by VFDs. Terminal units include unit ventilators, cabinet heaters, air handling units, unit heaters, and finned radiation. Three heating-only air handling units which previously provided ventilation to the corridors are no longer operational. A fourth heating-only air handling unit serves the gymnasium, the supply air is delivered to the space with a 2 HP motor operating at 84% NEMA nominal efficiency.

Cooling Systems: The school does not have a centralized mechanical cooling system. A number of spaces are cooled by Lennox and/or Trane split DX units. The multi-purpose room, which functions as a cafeteria during lunch time, is cooled by a 20-ton Daikin McQuay RTU installed in 2013.

Ventilation Systems: At one time, the building was ventilated with three (3) air handling units installed in mechanical equipment or storage rooms. These units are no longer operational. The gymnasium and the multi-purpose room are mechanically ventilated with air handling equipment, and every classroom is mechanically ventilated when the unit ventilators are actually turned on. The gymnasium additionally has two (2) large propeller ceiling fans to help recirculate upper stagnant air. During the site visit several

windows were observed open and were providing ventilation. In general, mechanical ventilation systems appear to be adequate.

Exhaust Systems: Exhaust fans are used to ventilate toilet rooms, the corridors, and the food serving area. Centrifugal exhaust fans, installed on the roof, provide exhaust for toilet rooms.

Controls Systems: Boiler operation is manual control; with at least one boiler running all day and all night during the colder months. Boiler switching is also performed manually. The entire school is under the control of a centralized Siemens control system. Access to the system is centralized. Only one or two individuals can control setpoints on individual pieces of equipment from a head-end at the Education Center or from a remote laptop. Despite this centralized control there are significant over and under-heating issues throughout the school. It was noted that a majority of unit ventilators were manually switched off, windows were open, and the boiler was running. Most changes to the school, such as changing temperature setpoints, or changing automatic damper or valve positions, etc., must be verbally communicated to, and then performed by the head-end. If this individual is not available, maintenance personnel will do their best to make rudimentary changes on site. Hot water heating pumps are not controlled by VFDs. On the coldest winter time days, the boiler hot water supply/return temperatures are set for 200F – 180F; 140F – 120F for standard winter operation, and 120F – 100F during shoulder months.

Domestic Hot Water Systems: One A.O. Smith gas fired water heater, with 80 gallons of capacity and 195 gallons per hour recovery, provides the domestic hot water for this facility. This tank was manufactured in 2013. The domestic hot water is pumped around the school to restrooms and sinks by a fractional horsepower B&G circulator pump.

Kitchen Equipment: The kitchen contains one residential sized electric range/oven and refrigerator, and is used primarily as a serving area. Food is brought in to the school from an outside vendor and no cooking is in the school.

Plumbing Systems: The school contains low flow fixtures in the 1996 and 2008 wings, and high flow toilet and urinal fixtures in the older 1962 areas. Urinals in newer wings are of the updated variety, while those in the 1962 sections are the older style with drains located on the floor. Most of the lavatory faucets are of the low flow metering type. Water usage is primarily toilet rooms, the kitchen, and lavatories.

Electrical Systems

Transformers: There are no building transformers present at this school.

Plug Load: The school has computers, copiers, smart boards, residential appliances (microwave, refrigerator), printers and portable electric heaters (personal) which contribute to the plug load.

Education Center

Background Information

The Education Center is located on 434 Millburn Ave, Millburn, New Jersey. The building is 14,375 square feet and was built in 1968. The building is a single story facility comprised of offices, conference rooms, lounge, I.M.C., storage rooms, toilet rooms and mechanical rooms.

Building Occupancy

The typical hours of operation for the Education Center are Monday through Friday between 8:30 am and 4:30 pm. Custodial staff are on site from 4:00 pm to 8:00 pm. The building's population consists of 35 staff.

Envelope

Overall, the building envelope was in good condition. Several areas were noted as requiring additional sealing of penetrations and cracks.

Construction Materials: Structure steel framing with concrete masonry unit exterior walls and minimal insulation. Interior walls are sheetrock.

Façade: Concrete masonry units and brick.

Roof: The roof is flat and covered with stone ballast.

Windows: Double hung, double pane windows with aluminum frames. The window weather-stripping was noted to be in need of replacement.

Exterior Doors: Most exterior doors are steel jacketed without windows. Main entrance doors are steel framed storefront style. The exterior door weather-stripping and astragals were noted to be in need of replacement.

Lighting

Most of the lighting within the building consists of 4' T12 linear fluorescent fixtures with magnetic ballasts, and typically the number of lamps per fixture is four. Exterior lighting consists of 150-watt metal halide wall-pack lamps. Lights in all of the areas are operated by manual switches or breakers.

Mechanical Systems

Heating Systems: One H.B. Smith gas-fired hot water boiler, manufactured in 1968 and rated for 1,820 MBH, provides heat for the building. Two (2) Armstrong pumps circulate the heating water around the building. These pumps are powered by 3 HP Baldor motors which have a NEMA nominal efficiency of 85.5% and operate in a lead/lag manner. Neither of the pumps are controlled by VFDs. The building utilizes a two-pipe hydronic piping system that circulates hot water in the winter months, and chilled water in the summer months. Terminal units include unit ventilators, floor mounted fan coils, cabinet heaters, air

handling units, unit heaters, and finned radiation. The air handing units provide heated conditioned air to interior office spaces and corridors. Most of the perimeter rooms and offices are heated by floor mounted fan coils and unit ventilators in conjunction with hydronic finned radiation.

Cooling Systems: The building has a centralized mechanical cooling system, which consists of an indoor Trane chiller bundle and an outdoor Trane cooling tower, with a capacity of 60 tons. The building utilizes a two-pipe hydronic piping system that circulates hot water in the winter months, and chilled water in the summer months. It was reported that the condensing unit was recently replaced and does not need to be addressed as part of this project.

Ventilation Systems: The air handling units provide ventilation to the interior office spaces and corridors but do to a re-configuration of space usage, there are some hot/cold issues in the building. Unit ventilators bring in outside air providing ventilation to many of the perimeter rooms.

Exhaust Systems: Exhaust fans are used to ventilate toilet rooms and storage rooms. A propeller type through-wall fan provides general boiler room exhaust. Centrifugal exhaust fans, installed on the roof, provide exhaust for toilet rooms. General building pressure relief is achieved via action of the return air fan in combination with the relief air damper on the air handling unit.

Controls Systems: The building is not on the District's school-wide DDC based control system. Nor is it pneumatically controlled, although there is a 2007 Speedaire pneumatic compressor model # 4XA64 located in the boiler mechanical room. This unit is no longer utilized to provide compressed air for the pneumatic end control devices (such as valve and damper actuators) on the existing HVAC equipment throughout the building. Currently the equipment in the building is controlled through manual on/off switches. Schedules are maintained manually by building personnel.

Domestic Hot Water Systems: One State Select gas-fired water heater, with 50 gallons of capacity and 40 gallons per hour recovery, provides the domestic hot water for the building. The tank was manufactured in 2003. The domestic hot water is pumped around the building to restrooms and sinks by a fractional horsepower B&G circulator pump.

Kitchen Equipment: The building does not have a kitchen, or any cooking or dishwashing equipment.

Plumbing Systems: The building contains two (2) toilet rooms, and fixtures are of the high flow variety. Water usage is primarily toilet rooms and lavatories.

Electrical Systems

Transformers: There are no building transformers present at this school.

Plug Load: The building has computers, copiers, smart boards, residential appliances (microwave, refrigerator), printers and portable electric heaters (personal) which contribute to the plug load.

Glenwood Elementary School

Background Information

The Glenwood Elementary School is located on 325 Taylor Road, Short Hills, New Jersey. The school is 54,062 square feet and was built in 1938. The building is a two-story facility comprised of classrooms, gymnasium, offices, multi-purpose room, storage rooms, toilet rooms and mechanical rooms and trailers primarily used for classrooms for special needs.

Building Occupancy

The typical hours of operation for the Glenwood Elementary School are Monday through Friday between 8:30 am and 3:00 pm with various after-school activities. Custodial staff are on site in three shifts, from 6:00 am to 3:00 pm, 10:00 am to 7:00 pm, and 2:00 pm to 10:30 pm, 10 months a year. The School's population consists of 500 students and 62 staff.

Envelope

Overall, the building envelope was in good condition. Several areas were noted as requiring additional sealing of penetrations and cracks.

Construction Materials: Structural steel framing with concrete masonry unit exterior walls and minimal insulation. Interior walls are plaster and lathe.

Façade: Concrete masonry units and brick.

Roof Type: Approximately half of the roof is flat and covered with an adhered black membrane. The balance of the roof is pitched and covered with asphalt shingles, some of which are showing wear.

Windows: Double hung, double pane windows with aluminum frames.

Exterior Doors: Most exterior doors are steel jacketed without windows. Main entrance doors are steel framed storefront style. The exterior door weather-stripping and astragals were noted to be in need of replacement.

Lighting

About 85% of the lighting within this school consists of T8 linear fluorescent fixtures with electronic ballasts, and in most cases the number of lamps per fixture is two or three. About 15% consists of T12 fluorescent fixtures. A few fluorescent CFLs and 60-watt incandescent lamps were also noted. Exterior lighting consists of 150-watt metal halide wall-pack lamps. There are existing lighting controls in most of the classrooms, and some offices and other miscellaneous spaces.

Mechanical Systems

Heating Systems: Three (3) H.B. Smith cast iron sectional hot water boilers, manufactured in 1997, provide heat for the school. Boilers #1 and #2 generate low pressure steam (5 psi) which is delivered by a

two-pipe steam system to cast iron radiators in all of the original areas of the building. The condensate is pumped back to the boilers via a condensate return system. Building maintenance personnel indicated that some steam traps have failed, and condensate leakage has caused floor damage. Boiler #3 is hydronic, and heating hot water is pumped to the 1997 sections of the school, and to new units installed in the original area. Two sets of pumps, both of which operate in a lead/lag manner, distribute the heating hot water around the building. P-1 and P-2 are vertical inline Taco pumps; HP and efficiency nameplate information is unavailable. P-3 and P-4 are 2.0 HP Armstrong vertical inline pumps with NEMA nominal efficiencies of 80%. Terminal units consist of unit ventilators, cabinet heaters, unit heaters, and finned radiation.

One area not heated by the primary boilers is the multi-purpose room, which is heated by a packaged, gas-fired 2004 Annexaire rooftop unit.

Adjacent to the main building is a smaller single story structure that houses two (2) temporary classrooms. Each of these classrooms is heated and cooled by a Bard electric exterior sidewall-mounted HVAC unit. These units are approximately ten (10) years old.

Cooling Systems: The school does not have a centralized mechanical cooling system, and most of the building is heating only. However, some areas are DX cooled: the multi-purpose room, which doubles as a cafeteria and an auditorium, is served by a packaged Annexaire RTU providing 15-tons of cooling. The library and adjacent computer classroom are served by a cooling only (DX) RTU. One classroom has a self-contained unit ventilator, which provides DX cooling. Several small window AC units and Friedrich split DX cooling units serve areas such as the faculty room and miscellaneous offices.

Ventilation Systems: At one time the building was ventilated with a large air handing unit installed in a second floor mechanical room. The unit is no longer operational. Currently classrooms are ventilated by unit ventilators. The 2004 Annexaire RTU serving the multi-purpose room is an energy recovery unit and thus both ventilates and exhausts the space simultaneously. The library and adjacent computer rom are ventilated by an RTU.

Exhaust Systems: Exhaust fans are used to ventilate toilet rooms, the corridors, and the food serving area. A through-window propeller fan is used to exhaust the boiler room. The multi-purpose room is exhausted by the energy recovery heat exchanger of the 2004 Annexaire RTU. Centrifugal exhaust fans, installed on the roof, provide exhaust for toilet rooms.

Controls Systems: Boiler operation is manual control; with at least one boiler running all day and all night during the colder months. Boiler switching is also performed manually. The entire school is under the control of a centralized Siemens control system. Access to the system is centralized. Only one or two individuals can control setpoints on individual pieces of equipment from a head-end at the Education Center or from a remote laptop. Despite this centralized control there are significant over and under-heating issues throughout the school. The school has both a hot water and a steam system, as well as DX split AC units. In the faculty room, where all three types of HVAC systems serve the same room, it was indicated there were times when both the steam heating system and the split AC units operate simultaneously. Most changes to the school's controls, such as changing temperature setpoints, or

changing automatic damper or valve positions, etc., must be verbally communicated to, and then performed by, the head-end. If this individual is not available, maintenance personnel will do their best to make rudimentary changes on site.

Domestic Hot Water Systems: One Rheem Ruud gas fired water heater, with 72 gallons of capacity and 227 gallons per hour recovery, provides the domestic hot water for this facility. This tank was manufactured in 2012. The domestic hot water is pumped around the school to restrooms and sinks by a fractional horsepower B&G circulator pump.

Kitchen Equipment: The kitchen contains one residential sized scullery sink and refrigerator, two (2) coffin type freezers, two (2) microwave ovens, and is used primarily as a serving area. Food that is provided to the student is brought in to the school from an outside vendor – no cooking is done at the school. The faculty room contains one residential style refrigerator, a small electric oven & range, and a small lavatory sink.

Plumbing Systems: The school contains low flow metering type lavatories and most toilets are of the low flow variety. However many urinals are of the older style with drains on the floor, and have high flow flush volume variety. Water usage is primarily toilet rooms, the kitchen, and lavatories' however the building also uses a greater quantity of township water due to the fact that it is partly heated by an aging steam system.

Electrical Systems

Transformers: There are no building transformers present at this school.

Plug Load: The school has computers, copiers, residential appliances (microwave, refrigerator), printers and portable electric heaters (personal) which contribute to the plug load.

Hartshorn Elementary School

Background Information

The Hartshorn Elementary School is located on 400 Hartshorn Road, Short Hills, New Jersey. The school is 65,664 square feet and was built in 1958. The building is a one-story facility comprised of classrooms, gymnasium, offices, multi-purpose room, stage, storage rooms, toilet rooms and mechanical rooms.

Building Occupancy

The typical hours of operation for the Hartshorn Elementary School are Monday through Friday between 8:30 am and 3:00 pm with various after-school activities. Custodial staff are on site in two shifts, from 6:30 am to 2:30 pm, and from 2:30 pm to 11 pm, 10 months a year. The School's population consists of 545 students and 70 staff.

Envelope

Overall, the building envelope was in good condition. Several areas were noted as requiring additional sealing of penetrations and cracks.

Construction Materials: Structural steel framing with concrete masonry unit exterior walls and minimal insulation. Interior walls are drywall in newer areas, and plaster and lathe in older sections.

Façade: Concrete masonry units and brick.

Roof Type: Most of the roofing is flat and covered with adhered membrane that in some areas is black, other areas white, and over much of the original 1958 portion is covered with stone ballast. Pitched areas are covered with membrane as well as asphalt shingles.

Windows: Double hung, double pane windows with aluminum frames. Single pane windows are in some of the older sections; as well as decorative block windows. The newer windows are in good condition, whereas the older windows are not.

Exterior Doors: Most exterior doors are steel jacketed without windows. Main entrance doors are steel framed storefront style. The exterior door weather-stripping and astragals were noted to be in need of replacement.

Lighting

About 80% of the lighting within this school consists of T8 linear fluorescent fixtures with electronic ballasts, and in most cases the number of lamps per fixture is two, three or four. About 20% consists of T12 fluorescent fixtures and 60-watt incandescent bulbs. Exterior lighting consists of 150-watt metal halide wall-pack lamps. There are existing lighting controls in most of the classrooms, and some offices and other miscellaneous spaces.

Mechanical Systems

Heating Systems: The school has three (3) boiler rooms. The primary boiler room in the original section contains two (2) gas fired Fitzgibbon water-tube hot water boilers, manufactured in 1957, with a heating capacity of 2,000 MBH each. The #2 boiler was down for tube repairs and maintenance in general on the boilers has been on the increase. Custodial personnel indicated that only one boiler is needed to keep the building warm on a heating design day. Two base mounted B&G 5 HP pumps powered by Leland Faraday motors, operating in a lead-lag manner, pump hot water to unit ventilators, cabinet heaters, unit heaters and finned tube radiation in the original section.

A second boiler room contains four (4) gas fired Caravan Slant-fin modular hot water boilers, which are approximately 15 to 20 years old and estimated heating outputs of 75,000 BTUH each. These boilers serve terminal equipment in the 1995 additions of the school. Two (2) Armstrong 1 HP vertical inline pumps, one for each zone, are tasked with circulating the hot water.

A third boiler room contains one (1) Rheem Raypak gas fired hot water boiler, manufactured in 2003, and rated for 546,000 BTUH at a combustion efficiency of 84%. One Grundfos vertical inline pump powered by a Baldor motor supplies heating hot water to the 2004 addition.

Additional heat is provided by several gas fired Carrier RTUs. These primarily serve the 1995 additions, which include the library, computer classrooms, multi-purpose room, offices and corridors.

Cooling Systems: The school has air conditioning in approximately 75% of the space. Original classrooms at the front of the school and in D-wing area are heating only. The multi-purpose room is cooled by two (2) Carrier 12.5 ton 1996 Weathermaster RTUs. Several 1996 Carrier Weathermaster RTUs are tasked to provide cooling for the library, computer room, selected offices and the corridors. These vary in tonnage from 3- to 10-tons. The teacher's lounge and a few classrooms are cooled by two (2) Fujitsu split AC units, typical tonnage 2- to 2.5-tons, which have wall mounted fan-evaporator units. A few classrooms contain Nesbitt self-contained unit ventilators, which come equipped with a DX cooling coil, compressor, and condenser. For the most part window AC units are not utilized at the school.

Ventilation Systems: Nesbitt and Nesbittaire unit ventilators provide outside air into classrooms. Several Carrier RTUs provide conditioned outside air into the library, multi-purpose room, computer room, selected offices, and the corridors. Two large air handling units, located in a basement mechanical room, pull outside ventilation air in from exterior louvers, condition it and deliver it to the gym.

Exhaust Systems: Approximately 25 exhaust fans located on the roof of the school serve restrooms, storage rooms, the library, corridors, and the kitchen. They are all fractional horsepower with the exception of the kitchen general exhaust, which is powered by a 1.5 HP motor. These centrifugal roof-mounted fans remove exhaust air from the building and provide general pressure relief.

Controls Systems: The entire school is under the control of a centralized Siemens control system. Access to the system is centralized. Only one or two individuals can control setpoints on individual pieces of equipment from a head-end at the Education Center or from a remote laptop. To implement changes, the head custodian is required to contact and make requests to the individual who has system-wide control, such as changing temperature setpoints, increasing or decreasing outside air, etc. If this individual is not available, the head custodian does his best to make rudimentary changes on site.

Domestic Hot Water Systems: Two separate domestic hot water heaters serve the school. One State Select gas-fired water heater, with 50 gallons of capacity and 40.9 gallons per hour recovery, manufactured in 2007, is located in the primary boiler room. A second A.O. Smith DHW heater, manufactured in 1996 and located in the secondary boiler room, has 100 gallons storage capacity and 179 gallons per hour recovery. The domestic hot water is pumped around the school to restrooms and sinks by fractional horsepower circulator pumps.

Kitchen Equipment: The kitchen contains one residential sized lavatory sink and refrigerator, two (2) coffin type freezers and a microwave oven. The kitchen is used primarily as a serving area. Food that is provided to the students is brought in to the school from an outside vendor – no cooking and no

dishwashing are done at the school. The faculty room contains one residential style refrigerator, a microwave oven, and a small lavatory sink.

Plumbing Systems: The school contains low flow lavatory faucets. However most toilets and urinals are of the high flow volume variety. Urinals are of the older variety with drains located on the floor. Water usage is primarily toilet rooms, the kitchen and lavatories.

Electrical Systems

Transformers: There are no building transformers present at this school.

Plug Load: The school has computers, copiers, smart boards, residential appliances (microwave, refrigerator), printers and portable electric heaters (personal) which contribute to the plug load.

High School

Background Information

The High School is located on 462 Millburn Ave, Millburn, New Jersey. The school is 236,592 square feet and was built in 1955. The building is a three-story facility comprised of classrooms, gymnasium, offices, cafeteria, auditorium, storage rooms, toilet rooms and mechanical rooms.

Building Occupancy

The typical hours of operation for the High School are Monday through Friday between 7:30 am and 3:00 pm with various after-school activities. Custodial staff are on site in two shifts, from 6:00 am to 3:00 pm, and from 2:30 pm to 11 pm, 10 months a year. The School's population consists of 1,600 students and 180 staff.

Envelope

Overall, the building envelope was in good condition. Several areas were noted as requiring additional sealing of penetrations and cracks.

Construction Materials: Structural steel framing with concrete masonry unit exterior walls and insulation. Interior walls are mostly sheetrock and painted concrete.

Façade: Concrete masonry units and brick.

Roof Type: The building has several wings which have flat roofs, and are covered with adhered membrane or stone ballast. Roofing over the auditorium and the old gym are pitched and covered with an adhered membrane. Insulation in attic spaces vary with age: higher insulation thickness are typically found in more recent construction. Roof color varies from light gray to dark gray.

Windows: Double hung, double pane windows with aluminum frames.

Exterior Doors: Most exterior doors are steel jacketed without windows. Main entrance doors are steel framed storefront style. The exterior door weather-stripping and astragals were noted to be in need of replacement.

Lighting

Approximately 85% of the lighting in the school is primarily 4' T8 linear fluorescent fixtures with electronic ballasts, and in most cases the number of lamps per fixture is two, three or four. About 15% of the lighting is T12, particularly in the older industrial arts wing and some corridors. Exterior lighting consists of both 38-watt PAR floodlights, and 150-watt metal halide wall-pack lamps. There are existing lighting controls in most of the classrooms, and some offices and other miscellaneous spaces.

Mechanical Systems

Heating Systems: Two (2) natural gas fired hot water H.B. Smith cast iron sectional boilers, installed in 2003, provide heat for most of the school. Although the boilers were replaced in 2003, the burners were reported to be left in place from the original boilers. Each of the boilers is rated for 4,517 MBH. Two (2) B&G base mounted pumps (DTWP-1 and DTWP-2) circulate the heating water around the building. The pumps are powered by 15 HP Baldor motors which have a NEMA nominal efficiency of 87.5% and operate in a lead/lag manner. Both pumps are controlled by Danfoss VFDs. The building utilizes a two-pipe hydronic piping system that circulates hot water in the winter months and chilled water in the summer months. Changeover between the two systems is typically April 15 in the spring, and October 15 in the fall, with final decision on timing made by the school principal. Terminal units include unit ventilators, floor mounted fan coils, cabinet heaters, air handling units, unit heaters and finned radiators.

Additional heat is provided into the newer 2009 section of the school by two (2) Patterson Kelly Mach Series hot water boilers manufactured in 2008, with a capacity of approximately 1,800 MBH each. Two base mounted Taco pumps, operating in a lead/lag manner, circulate the hot water around the building.

The D-wing is a three-story wing supplied by three (3) Carrier packaged energy recovery RTUs that provides gas fired heat and DX air conditioning for classrooms on each floor; these units also provide general building pressure relief. The C-wing is similarly served by three (3) packaged McQuay energy recovery RTUs. The old gymnasium is served by two 1.5 HP air handling units located in a mechanical equipment room. The new gymnasium is served by two (2) packaged Trane energy recovery heating-only RTUs, with some external ductwork lacking insulation.

The library is essentially a separate building within the courtyard of the school, and is heated by a gas fired Weil McLain hot water fire tube boiler. The boiler has an output of 408 MBH and an efficiency of 79%. Heating hot water is pumped to a 1987 Carrier air handling unit and a 1988 Carrier air handling unit, by a fractional HP B&G inline circulator pump. The Carrier AHUs have 3 HP supply fans and deliver heated and conditioned air via a ducted distribution system to the interior of the library.

Cooling Systems: Much of the school is cooled by a 250 ton Trane helical rotary chiller installed outside on a concrete pad by the loading dock at the west end of the school. Based on manufacturer's data, the chiller is rated at 9.7 EER. The chiller is only utilized during the summer months, and a single base

mounted 5 HP B&G pump located in the boiler room serves it. Chilled water pumped from the chiller is routed into the main two-pipe hydronic piping system at a 3-way valve, and from the pumps DTWP-1 and DTWP-2 circulate the chilled water around the building. The chiller is not available in the winter but is filled with propylene glycol and then drained.

Due to the fact that most of the school is heated and cooled utilizing the two-pipe hydronic system, some terminal units are valved off during the summer months. For example, chilled water running through perimeter finned tube radiation has caused condensation issues, while not providing much cooling. Shutting off the isolation valves to these types of units has helped to minimize these problems.

The library is cooled by three (3) Carrier air handling units outfitted with DX cooling coils. The air is delivered to the interior of the space by a ducted distribution system. A couple of offices within the library have wall-mounted Friedrich split AC units with DX condensing units installed outside.

The C-wing is cooled by three (3) packaged McQuay energy recovery RTUs with 15 tons each and one (1) Lennox DX of approximately 5 tons. The D-wing is similarly cooled by four DX cooling RTUs which vary between 2-ton and 2.5-tons.

Many areas of the school are cooled by individual Trane DX rooftop and air handing units, which vary in tonnage from 3- to 15-tons. Several classrooms in the Industrial Arts wing are cooled by fractional tonnage air conditioning units installed in windows. They are left in place year-round and are not covered in the winter-time. Since these are not automatically controlled, the window ACs may be inadvertently left on while the building is unoccupied.

Ventilation Systems: Ventilation is provided by a combination of rooftop units, air handling units, and classroom unit ventilators. These units are equipped with outside air dampers which automatically modulate and vary the percentage of outside air entering the space, based on indoor and outdoor air temperatures.

Exhaust Systems: Exhaust fans are used to ventilate toilet rooms and the kitchen. An 18'X4' kitchen range hood and associated ductwork connects to a roof mounted centrifugal up blast exhaust fan. Classroom laboratories are exhausted with propeller tube axial fans. Centrifugal exhaust fans, installed on the roof, provide exhaust for toilet rooms.

Controls Systems: Boiler operation is manual control; with at least one boiler running all day and all night during the colder months. Boiler switching is also performed manually; as well as boiler temperature. The school's newest HVAC equipment such as ERU, air handling units, and the newer unit ventilators are controlled by a centralized DDC Siemens control system. But the control is limited to only a few points, such as temperature setpoints – override on operations such as damper and valve positions are not available. Older equipment such as the boilers, pumps and other terminal units are manually controlled. Access to the system is centralized. Only one or two individuals can control setpoints on individual pieces of equipment from a head-end at the Education Center or from a remote laptop.

Domestic Hot Water Systems: The school has several different domestic hot water heaters. In the boiler room there is a 2007 Rheem gas fired DHW unit with 90 gallons capacity and 533.3 gallons per hour recovery. A 2008 Rheem gas fired DHW heater located in a mechanical room has 119 gallons capacity and 184 gallons per hour recovery. The library contains an electric State Industries water heater, and this has 30 gallons storage capacity. Two electric heating elements provide recovery for this unit: a 4,500 watt upper element, and a 3,500 watt lower element. In all cases, domestic hot water is pumped around the school to restrooms and sinks by fractional horsepower circulator pumps.

Kitchen Equipment: The kitchen contains one 18'X4' range exhaust hood, which is ducted and exhausted to an exterior rooftop exhaust fan. There is one True double-door type reach-in freezer, one Beverage air triple-door type reach-in cooler and another double door Traulsen reach-in cooler. One Bally walk-in cooler is also in the kitchen, which utilizes a Heatcraft evaporator system to maintain its 40^F temperature. For the most part the cooking equipment (such as the bread ovens) are manufactured by both Metro and Blodgett, and are natural gas fired. Dishes are washed by a Hobart automatic dishwasher.

Plumbing Systems: The school contains high flow lavatories, toilets and urinals in the original wings. Newer fixtures in the newest wing utilize electronic sensors to monitor water flow; older fixtures are spring loaded to perform the same task. Water usage is primarily toilet rooms, the kitchen, and lavatories.

Electrical Systems

Transformers: There is a single older transformer located in the second floor electrical room. The transformer has a nameplate rating of 150 kVA and appeared to be older and inefficient.

Plug Load: The school has computers, copiers, smart boards, residential appliances (microwave, refrigerator), printers and portable electric heaters (personal) which contribute to the plug load.

Middle School

Background Information

The Middle School is located on 25 Old Short Hills Road, Millburn, New Jersey. The school is 169,883 square feet and was built in 1922. The building is a three-story facility comprised of classrooms, gymnasium, offices, cafeteria, auditorium, stage, storage rooms, toilet rooms and mechanical rooms.

Building Occupancy

The typical hours of operation for the Middle School are Monday through Friday between 7:30 am and 2:30 pm with various after-school activities. Custodial staff are on site in two shifts, from 6:00 am to 3:00 pm, and from 2:30 pm to 11 pm, 10 months a year. The school is also utilized during summer months 8 am to noon, Monday through Friday. The School's population consists of 1,150 students and 145 staff.

Envelope

Overall, the building envelope was in good condition. Several areas were noted as requiring additional sealing of penetrations and cracks.

Construction Materials: Structural steel framing with concrete masonry unit exterior walls and insulation. Interior walls are plaster and lathe.

Façade: Concrete masonry units and brick.

Roof Type: The roof portion over the auditorium is pitched, and is covered with asphalt shingles; the majority of the roof is flat. The flat roof is covered with an adhered membrane. Roof color varies from white to dark gray.

Windows: Double hung, double pane windows with aluminum frames. Some single pane windows in older areas.

Exterior Doors: Most exterior doors are steel jacketed without windows. Main entrance doors are steel framed storefront style. The exterior door weather-stripping and astragals were noted to be in need of replacement.

Lighting

Approximately 80% of the school is lit with 4' T8 linear fluorescent fixtures with electronic ballasts, and in most cases the number of lamps per fixture is two, three or four. The remaining 20% of the space is lit with T12 linear fluorescent fixtures, particularly in the older wing, corridors, and the kitchen. The auditorium has four large chandeliers, each with thirty-four 40-watt incandescent lamps. Compact fluorescent round out the remaining interior lights. Exterior lighting consists of both 38-watt PAR floodlights, and 150-watt metal halide wall-pack lamps. There are existing lighting controls in most of the classrooms, and some offices and other miscellaneous spaces.

Mechanical Systems

Heating Systems: The school has two (2) main types of heating systems: 1) an older hot water system, supplied by two (2) gas fired boilers; and 2) a water source geothermal heat pump system, which utilizes approximately 100 boreholes that are approximately 400 feet deep. Boilers for the older hot water system consist of two (2) H.B. Smith cast iron sectional 28A Series boilers, manufactured in 2004, and rated for 3,098 MBH at 82% efficiency. Although only ten (10) years old, the boilers are exhibiting considerable corrosion. Boiler loop supply water temperature is manually controlled, and is set as high as 200^{F} during the coldest days of the year, but most typically is run at 180^{F} supply and 160^{F} return. During shoulder months the supply temperature is turned down to 160^{F} and boilers will only run a few hours in the morning. Heating hot water is pumped around the building by two (2) B&G 20 HP base mounted pumps which operate in a lead/lag manner. Terminal units consist of classroom unit ventilators, air handling units, PTACs (used in offices), cabinet heaters, unit heaters, and finned radiators. The auditorium and cafeteria are heated by HV-3 and HV-4 which use hot water coils.

Water for the geothermal system loop is circulated by two (2) 40 HP B&G base mounted pumps which operate in a lead/lag manner. The water in the geothermal loop is composed of a 20% propylene glycol mixture. The 2001 and 2009 portions of the building are served by the geothermal water loop system. The 2001 classroom wing does not use unit ventilators and finned radiators and all classroom heating is

accomplished with heat pumps installed above the drop ceilings. Additionally the two (2) auditorium rooftop units are also connected to the geothermal loop, as well as the heat pumps serving the Nurse's office. Heat pumps are designed to pull heat from the geothermal water loop (by use of the vapor compression cycle) and provide heated air into the space. In the event the heat pump is unable to maintain room temperature, electric resistance duct furnaces provide additional auxiliary heat. In older sections of the school, classroom heat is provided by heating-only hydronic unit ventilators; with ceiling mounted heat pumps primarily tasked with cooling.

There have been incidents of leaking pipes associated with the geothermal water loop. Building personnel indicated that dielectric fittings were not installed where ¾" copper run-outs connect to the larger diameter steel mains. Additionally, the caustic nature of the propylene glycol/water mixture of the geothermal water loop only contributes to the problem.

The newest 2009 addition is heated by both geothermal heat pumps and VRF (variable refrigerant flow) fan coil units. The multi-purpose room is heated strictly by the VRF units. Similar in some ways to both heat pump and DX split system units, the VRF units have interconnected refrigerant lines that can take heat from one area and move it to another area where there is a greater need. The system is also capable of variable/reduced flow, which saves energy.

Cooling Systems: Approximately 65% of the school is air conditioned, and many of these areas are cooled by the geothermal heat pump system. Individual room heat pumps installed above the ceiling reject heat to the geothermal water loop in the summer-time. Additionally, packaged rooftop units RTU-1 and RTU-2 provide DX cooling for the auditorium. The Media Center is cooled by three (3) wall mounted split Fujitsu AC units with associated outdoor condensing units located on the roof. Various offices are also cooled by these AC splits; as well as by PTAC units. The Vocal Music room is air conditioned by a 6-ton packaged Trane rooftop unit, installed in 2001. The multi-purpose room, which was added on in 2009, is cooled by a Trane variable refrigerant flow (VRF) system. VRF fan coil units that serve the space are interconnected with refrigerant lines, and by operating at varying speeds, the VRF units work only at the needed rate at partial-load conditions. Two roof mounted heat pumps HP-1 and HP-2, transfer heat to or from the outside air depending on temperature conditions. An energy recovery rooftop unit, AHU-1, equipped with a CO_2 sensor in the return air stream, controls the percentage of outside air that is delivered to the space.

Ventilation Systems: Ventilation air is provided for the school in the newer areas by rooftop energy recovery units (ERUs). The air is ducted to individual heat pump units, so that a minimum of required outside air is delivered into each classroom, office, and corridor in the school. In older sections of the school, unit ventilators bring in outside ventilation air through wall-mounted exterior louvers. The auditorium receives ventilation air from the rooftop units RTU-1 and RTU-2. The newest section of the school including the multi-purpose room is served by AHU-1, an energy recovery unit equipped with a CO_2 sensor, which monitors the quality of the indoor air.

Exhaust Systems: Exhaust fans are used to ventilate toilet rooms, storage rooms, and the kitchen. A 5 HP centrifugal rooftop upblast fan removes smoke and cooking vapors from the kitchen range. Centrifugal

exhaust fans, installed on the roof, provide exhaust for toilet rooms; and energy recovery rooftop units provide for general building pressure relief.

Controls Systems: Boiler operation is manual control; with at least one boiler running all day and all night during the colder months. Boiler switching is also performed manually; as well as boiler temperature. Lack of hot water terminal unit control is a complaint by building personnel. During the shoulder months, when the school's boilers are still providing hot water to unit ventilators and finned radiators, heat pumps will simultaneously provide cooling in order to keep spaces from over-heating. The school's newest HVAC equipment such as heat pumps, rooftop units, and the newer unit ventilators are controlled by a centralized DDC Siemens controls system, however, control is limited to only a few points – operations such as damper and valve positions are not available. Older equipment such as the boilers, pumps, and other terminal units are manually controlled. Access to the DDC system is not available onsite. Only one or two individuals can control setpoints on individual pieces of equipment from a head-end at the Education Center or from a remote laptop.

Domestic Hot Water Systems: Two separate domestic hot water heaters serve the school. One is an A.O. Smith gas fired water heater, with 100 gallons of capacity and 170.9 gallons per hour recovery, manufactured in 2008, is located in a storage room. A second gas fired DHW heater manufactured by Bradford White, and located in the main boiler room, has an unknown storage capacity and 606 gallons per hour recovery. The DHW heater is approximately 5 to 8 years old. Domestic hot water is pumped around the school to restrooms and sinks by fractional horsepower circulator pumps.

Kitchen Equipment: The kitchen contains one 4'X4' dishwashing exhaust hood, and one 12'X4' range exhaust hood, both of which are ducted and exhausted to exterior exhaust fans. There are two (2) Traulsen double-door type reach-in freezers, and two (2) top/bottom Traulsen reach-in coolers. One Bally walk-in freezer is also located in the kitchen. For the most part the cooking equipment (such as the bread ovens) are manufactured by both Market Forge and Blodgett, and are natural gas fired.

Plumbing Systems: The school contains high flow lavatory faucets. Most toilets and urinals are of the low flow flush volume variety. Water usage is primarily toilet rooms, the kitchen, and lavatories.

Electrical Systems

Transformers: There is a single older transformer located in the main electrical/ boiler room. The transformer has a nameplate rating of 750 kVA and appeared to be older and inefficient.

Plug Load: The school has computers, copiers, smart boards, residential appliances (microwave, refrigerator), printers and portable electric heaters (personal) which contribute to the plug load.

South Mountain Elementary School

Background Information

The South Mountain Elementary School is located on 2 Southern Slope Road, Millburn, New Jersey. The school is 50,372 square feet and was built in 1935. The building is a two-story facility comprised of

classrooms, gymnasium, offices, cafeteria, media center, storage rooms, toilet rooms and mechanical rooms.

Building Occupancy

The typical hours of operation for the South Mountain Elementary School are Monday through Friday between 8:30 am and 3:30 pm with various after-school activities. Custodial staff are on site in two shifts, from 6:30 am to 4:30 pm, and from 4:30 pm to 10 pm, 10 months a year. The School's population consists of 347 students and 55 staff.

Envelope

Overall, the building envelope was in good condition. Several areas were noted as requiring additional sealing of penetrations and cracks.

Construction Materials: Structural steel framing with concrete masonry unit exterior walls and minimal insulation. Interior walls are plaster and lathe.

Façade: Concrete masonry units and brick.

Roof Type: The roof portion over the media center, the kindergarten wing, and the gymnasium are flat; the majority of the roof is pitched. The flat roof is covered with an adhered membrane or stone ballast. Pitched sections are covered with asphalt shingles.

Windows: Double hung, double pane windows with aluminum frames.

Exterior Doors: Most exterior doors are steel jacketed without windows. Main entrance doors are steel framed storefront style.

Lighting

Approximately 75% of the school is lit with T8 linear fluorescent fixtures with electronic ballasts, and in most cases the number of lamps per fixture is two or three. About 20% consists of T12 fluorescent fixtures (the multi-purpose room is lit entirely by T12s). A few CFLs and 60-watt incandescent bulbs were also noted. Exterior lighting consists of 150-watt metal halide wall-pack lamps. There are existing lighting controls in most of the classrooms, and some offices and other miscellaneous spaces.

Mechanical Systems

Heating Systems: Twelve (12) natural gas fired Caravan Slant Fin cast iron sectional hot water modular boilers provide heat for the school. The boilers are piped up in two (2) rows of six (6) boiler modules, with each row providing 1,824 MBH output. They are sixteen (16) years old and operate at a combustion efficiency of approximately 81%. The heating hot water is pumped around the school by two (2) vertical inline pumps powered by 5 HP motors. Significant scale and corrosion have formed along the base of one pump, and it seems to be caused by leakage. Terminal heating units include AAF classroom unit ventilators, air handlers, cabinet heaters, and finned radiators. A 2013 Daikin/McQuay air handling unit, hung from the Stage ceiling and outfitted with a hot water heating coil, provides heated air for the multi-

purpose room. The media center is heated by two (2) gas fired packaged Trane rooftop units, manufactured in 1998. Classrooms in the lower level area heated by hydronic vertical Airedale unit ventilators.

Cooling Systems: The building has air conditioning in some areas. The multi-purpose room is cooled by the 2013 Daikin/McQuay 15-ton air handling unit, outfitted with a DX cooling coil. The media center is cooled by two Trane RTUs, one of which is an 8-ton unit, the other is a 6-ton unit. Many offices and some classrooms are cooled by DX split Fujitsu AC units, which have an indoor wall mounted fan coil coupled to an outdoor condensing unit. For the most part, existing split AC units are relatively new, and window AC units are not utilized in the school.

Ventilation Systems: Classroom AAF and Airedale unit ventilators provide outside air into classroom. Two Trane rooftop units provide conditioned outside air into the media center. The Daikin/McQuay air handling unit pulls outdoor air through a wall mounted louver, conditions the air and sends it into the multi-purpose room. One air handling unit pulls outside ventilation air from exterior louver into the gym.

Exhaust Systems: Approximately 15 exhaust fans located on the roof of the school serve restrooms, storage rooms, the library, corridors, and the kitchen. They are all fractional horsepower fans. The centrifugal roof-mounted fans remove exhaust air from the building, and provide general pressure relief.

Controls Systems: Boiler operation is under the control of a Caravan microprocessor based controller, designed to manage energy usage. The system automatically fires up boiler modules to meet building demands, shutting them off again when not needed. Boiler water loop temperature is controlled as a function of the outdoor air temperature; and the system allows for night-time temperature setback. The remainder of South Mountain HVAC equipment is managed by a centralized DDC Siemens controls system. Access to the DDC system is not available onsite. Only one or two individuals can control setpoints on individual pieces of equipment from a head-end at the Education Center or from a remote laptop.

Domestic Hot Water Systems: One Bradford White gas fired water heater, with 100 gallons of capacity and 82.4 gallons per hour recovery, provides the domestic hot water for the school. The tank was manufactured in 2008. The domestic hot water is pumped around the school to restrooms and sinks by a 1/6 horsepower B&G circulator pump.

Kitchen Equipment: The kitchen contains one residential sized lavatory sink and refrigerator, one coffin type freezer, a microwave oven, and is used primarily as a serving area. Food that is provided to the students is brought in to the school from an outside vendor – cooking is not typically done at the school.

Plumbing Systems: The school contains low flow lavatories with metering type faucets. Most toilets and urinals are of the high flow flush volume variety. Water usage is primarily toilet rooms, janitorial sinks and lavatories.

Electrical Systems

Transformers: There are no building transformers present at this school.

Plug Load: The school has computers, copiers, smart boards, residential appliances (microwave, refrigerator), printers and portable electric heaters (personal) which contribute to the plug load.

Wyoming Elementary School

Background Information

The Wyoming Elementary School is located on 55 Myrtle Ave, Millburn, New Jersey. The school is 56,182 square feet and was built in 1910. The building is a three-story facility comprised of classrooms, gymnasium, offices, cafeteria, media center, storage rooms, toilet rooms and mechanical rooms.

Building Occupancy

The typical hours of operation for the school are Monday through Friday between 8:30 am and 3:30 pm with various after-school activities. Custodial staff are on site in three shifts, from 6:00 am to 3:00 pm, 10:00 am to 7:00 pm, and from 2:00 pm to 10:30 pm, 10 months a year. The School's population consists of 400 students and 65 staff.

Envelope

Overall, the building envelope was in good condition. Several areas were noted as requiring additional sealing of penetrations and cracks.

Construction Materials: Structural steel framing with concrete walls with minimal insulation. Interior walls are plaster and lathe.

Façade: Concrete masonry units and brick.

Roof Type: The portion over the gymnasium and rear classrooms are flat; the majority of the roof is pitched. Flat portions are covered with an adhered membrane. Pitched portions are covered with light gray slate shingles.

Windows: Double hung double pane windows with aluminum frames.

Exterior Doors: Most exterior doors are steel jacketed without windows. Main entrance doors are steel framed storefront style. The exterior door weather-stripping and astragals were noted to be in need of replacement.

Lighting

Nearly 50% of the lighting within the school is 4' T8 linear fluorescent fixtures with electronic ballasts, and in most cases the number of lamps per fixture is two or three. Nearly 50% of the lighting is 4' T12 linear fluorescent fixtures. The gymnasium is lit entirely with T12 fluorescent lamps. The school also uses a few CFLs and incandescent lamps. Exterior lighting consists of both 150-watt metal halide wall-pack lamps and 150-watt HPS floodlights.

Mechanical Systems

Heating Systems: Two (2) natural gas fired H.B. Smith cast iron sectional steam boilers, approximate vintage 1980, provide heat for the school. Each of these is rated at 3,002 MBH, with combustion efficiencies of 80%. The steam pressure is generally maintained between 3 to 5 psi. During the heating season both boilers are fired up every morning to provide rapid warm-up; once this is accomplished one boiler is shut down and the building is heated by the other boiler for the rest of the day. Two (2) Bell and Gossett shell and tube heat exchangers transfer heat from the steam to hot water, which is pumped around the building. The condensate is pumped back to the boilers via a condensate return system. A single 1 HP inline circulator pump is tasked with distributing the water for one of the heating zones; two (2) base mounted B&G pumps powered by 5 HP Marathon motors pump the heating water through the second zone. Terminal units include self-contained unit ventilators, air handlers, cabinet heaters, unit heaters, and finned tube radiators. The gymnasium is served by an air handling unit installed in a basement mechanical room, but the unit is no longer being utilized. Perimeter hydronic cabinet heaters currently keep the space warm. The cafeteria is served by a Reznor unit installed outside, as well as two (2) hydronic ceiling mounted cabinet heaters. The auditorium is heated by perimeter hydronic cabinet heaters, recessed behind wall grilles. In addition, two (2) Daikin McQuay air handling units installed in 2013 and hung from the Stage ceiling are outfitted with hot water coils and supply heated air into the auditorium.

Cooling Systems: The school does not have a centralized mechanical cooling system, and much of the school is heating only. However some areas are DX cooled: the auditorium is served by two (2) Daikin McQuay air handling units which provide 12.5-tons of cooling. The condensing units for the AHUs, which utilized R-410A refrigerant, are installed at the rear of the school on concrete pads. The library and a number of classrooms are equipped with self-contained unit ventilators. The units, outfitted with compressors, condensers and utilizing R-22 refrigerant, are approximately twenty (20) years old and are becoming expensive to maintain. Several offices are cooled with Fujitsu split AC units, which are relatively new and in good condition. Some classrooms have window AC units, which are left in place year round and are not covered in the winter time. Since there is no automatic control, occasionally window ACs may be left on while the school is not occupied.

Ventilation Systems: Classrooms are ventilated with unit ventilators which bring outside air through exterior wall mounted louvers. The two (2) Daikin McQuay air handling units pull in outside air through exterior louvers, condition it and deliver it into the auditorium. The cafeteria is provided ventilation air via a Reznor air handling unit installed outside. At one time the gymnasium was ventilated with a large air handling unit installed in a basement mechanical room. The unit is no longer operational.

Exhaust Systems: Exhaust fans are used to ventilate toilet rooms and storage rooms. General pressure building relief is accomplished utilizing five (5) gravity relief turbines, installed on the upper flat roof. Centrifugal exhaust fans installed on the roof provide exhaust for toilet rooms.

Controls Systems: Boiler operation is under the manual control, with at least one boiler running all day and all night during the colder months. Boiler switching is also performed manually. The entire school is under the control of a centralized DDC Siemens system. Access to the DDC system is not available

onsite. Only one or two individuals can control setpoints on individual pieces of equipment from a head-end at the Education Center or from a remote laptop. To implement changes, the head custodian is required to contact and make requests to the individual who has system-wide control, such as changing temperature setpoints, increasing or decreasing outside air, etc. If this individual is not available, the head custodian will do his best to make rudimentary changes on site.

Domestic Hot Water Systems: One State Sandblaster gas fired water heater, with 70 gallons capacity and 340 gallons per hour recovery, provides the domestic hot water for the school. The water heater was manufactured in 2003. The domestic hot water is pumped around the school to restrooms and sinks by a fractional horsepower B&G circulator pump.

Kitchen Equipment: The kitchen contains two (2) reach-in coffin type freezers/coolers. One is manufactured by Powers, and the other is manufactured by Beverage Air. Food that is provided to the students is brought in to the school from an outside vendor – cooking is not typically done at the school.

Plumbing Systems: The entire school utilizes high flow lavatory faucets. First floor toilets and urinals are of the low flush volume variety. The second floor and basement toilets and urinals are high flow fixtures. Water usage is primarily toilet rooms, janitorial sinks and lavatories.

Electrical Systems

Transformers: There are no building transformers present at this school.

Plug Load: The school has computers, copiers, residential appliances (microwave, refrigerator), printers and portable electric heaters (personal) which contribute to the plug load.

Utility Baseline Analysis

Electric

Electrical energy is provided to Millburn Township Public Schools through Jersey Center Power & Light (JCP&L) under the GS3, GS1 and OLD classifications. 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 schools under Millburn Township Public Schools have individual rates per kWh which were used in this report.

Natural Gas

Millburn Township Public Schools acquires its natural gas from Public Service Electric & Gas (PSE&G) under the GSG and LGV classifications. The gas utility measures consumption in cubic feet x 100 (CCF) and converts the quantity into Therms of energy.

Water

Millburn Township Public Schools acquires its water from New Jersey American Water. The water utility measures consumption in 100 gallons.

The following table shows Millburn Township Public Schools building names, addresses and utility account numbers.

Building Name	Address	Electric Account No.	Gas Account No.	Water Account No.
Deerfield ES	26 Troy Ln, Short Hills, NJ 07078	JCP&L 100 006 418 923	PSE&G 65 755 939 09	1018-210027043526 & 1018-210023276010
Education Center	462 Millburn Ave, Millburn, NJ 07041	JCP&L 100 006 068 595	PSE&G 65 367 447 05	1018-210023203715, 1018-210023203913 (Fire service)
Glenwood ES	325 Taylor Rd, Short Hills, NJ 07078	JCP&L 100 004 804 769	PSE&G 66 751 358 05	1018-210023205506, 1018-210025943019
Hartshorn ES	400 Hartshorn Rd, Short Hills, NJ 07078	JCP&L 100 005 751 977	PSE&G 67 371 784 05	1018-210023205100 & 1018-210027799218
Millburn HS	434 Millburn Ave, Millburn NJ 07041	JCP&L 100 004 697 544 & 100 004 697 544	PSE&G 66 095 989 08	1018-210025955098, 1018-210027266329 (fire service),
Maintenance	434 Millburn Ave, Millburn NJ 07041	JCP&L 100 006 068 678	PSE&G 65 367 455 07	
Millburn MS	25 Old Short Hills Rd, Millburn, NJ 07041	JCP&L 100 005 879 976	PSE&G 65 148 518 00	1018-210023205001, 1018-210023204909 & 1018-210023229113
South Mountain ES	2 Southern Slope Rd, Millburn NJ 07041	JCP&L 100 006 558 314	PSE&G 66 661 467 00	1018-210023276706
Wyoming ES	55 Myrtle Ave, Millburn NJ 07041	JCP&L 100 005 266 554	PSE&G 66 793 578 02	1018-210023276799

Deerfield Elementary School

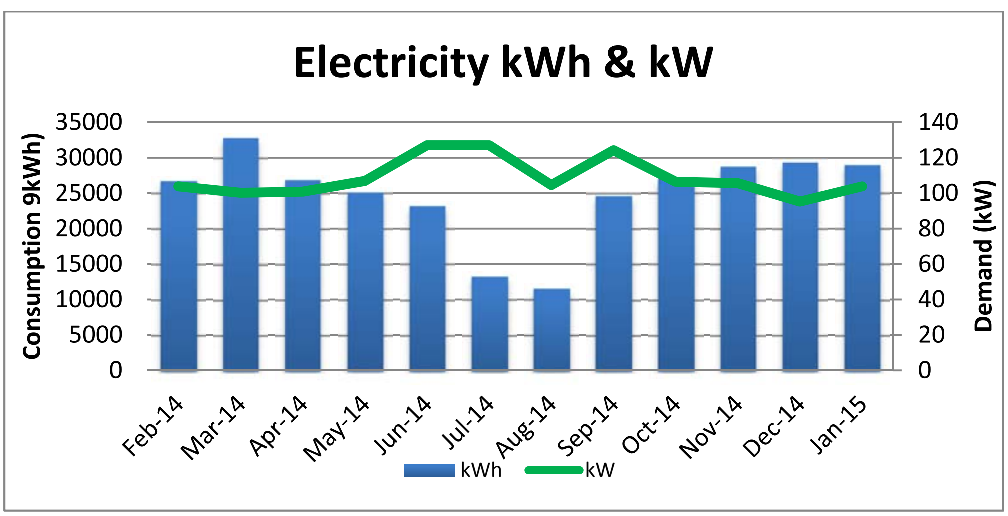
Electric Usage and Demand

A detailed look at the usage (kWh), demand (kW) and total electric cost per month in a typical year is shown below in table format.

Month	kWh	kW	Total Bill $
February-14	26720	104	$3,211
March-14	32800	100	$3,765
April-14	26880	101	$3,207
May-14	25120	107	$3,129
June-14	23200	127	$3,086
July-14	13280	127	$1,701
August-14	11520	105	$1,820
September-14	24640	124	$3,162
October-14	27040	106	$3,268
November-14	28800	106	$3,430
December-14	29280	95	$3,409
January-15	28960	104	$3,434
Totals	**298,240**	**1,305**	**$36,621**

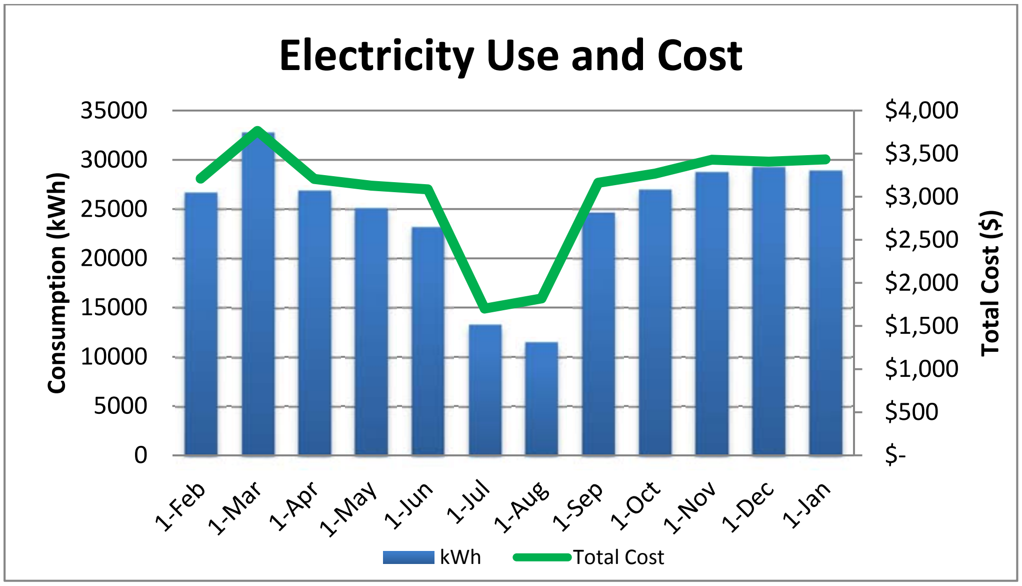
Based off of one year of utility bill information February 2014 to January 2015.

The figure below shows the usage (kW) and (kWh) over the same one year period.



Energy Consumption from February 2014 to January 2015

The figure below shows the usage (kWh) and (Cost) over the same one year period.



Energy Consumption vs Cost from February 2014 to January 2015

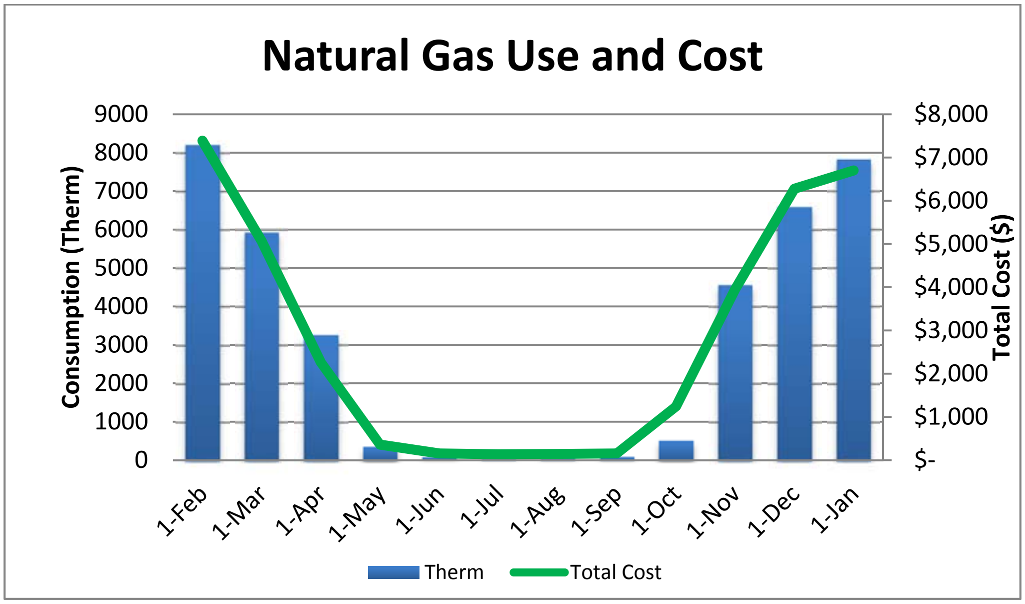
Natural Gas Usage

A detailed look at the consumption (Therms) and the dollar rate per (Therm) monthly in a typical year is shown below in table format

Month	Total Therms	Total Cost	$/Therm
February-14	8214	$7,388	$0.899
March-14	5930	$5,065	$0.854
April-14	3252	$2,263	$0.696
May-14	360	$357	$0.992
June-14	83	$155	$1.872
July-14	60	$137	$2.296
August-14	68	$143	$2.094
September-14	90	$155	$1.736
October-14	502	$1,239	$2.469
November-14	4560	$3,955	$0.867
December-14	6598	$6,277	$0.951
January-15	7818	$6,698	$0.857
Total	**37,534**	**$33,832**	**$0.901**

Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the monthly consumption over the same time period. Notice that the usage peaks in the winter months when heating is necessary.



Natural Gas Consumption versus cost from February 2014 to January 2015

Education Center

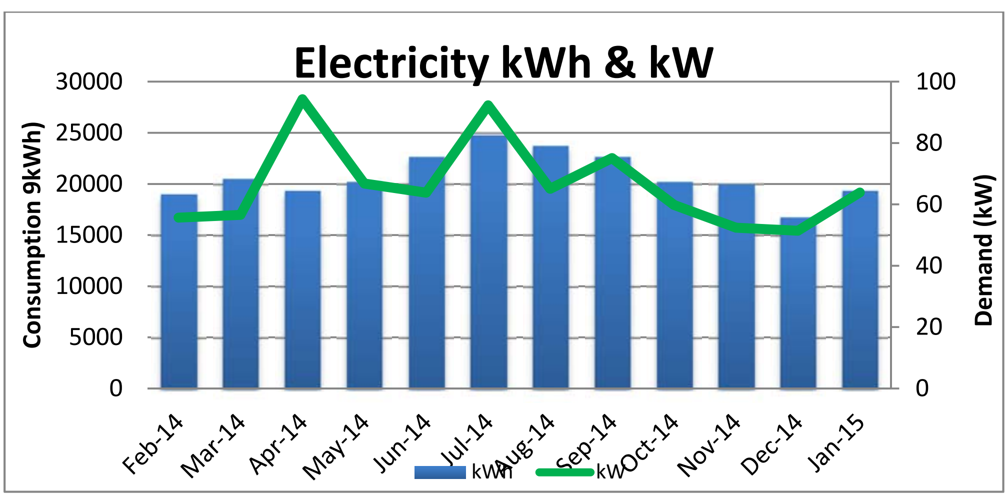
Electric Usage and Demand

A detailed look at the usage (kWh), demand (kW) and total electric cost per month in a typical year is shown below in table format.

Month	kWh	kW	Total Bill $
February-14	19006	56	$2,197
March-14	20526	57	$2,348
April-14	19326	94	$2,198
May-14	20206	67	$2,414
June-14	22686	64	$2,629
July-14	24766	92	$3,025
August-14	23726	65	$2,737
September-14	22686	75	$2,689
October-14	20206	60	$2,345
November-14	19966	52	$2,274
December-14	16766	51	$1,825
January-15	19326	64	$2,223
Totals	**249,192**	**797**	**$28,905**

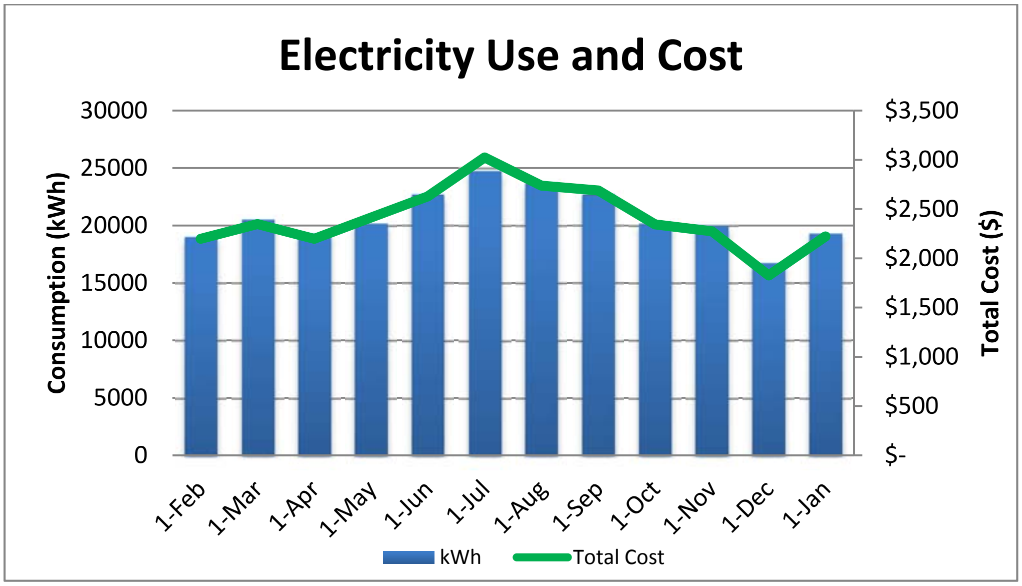
Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the usage (kW) and (kWh) over the same one year period.



Energy Consumption from February 2014 to January 2015

The figure below shows the usage (kWh) and (Cost) over the same one year period.



Energy Consumption versus cost from February 2014 to January 2015

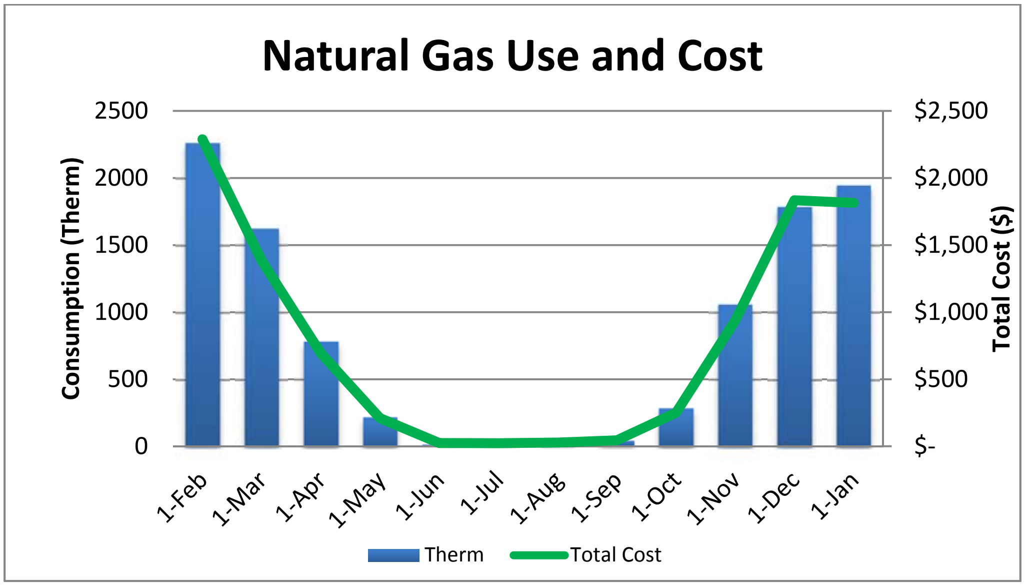
Natural Gas Usage

A detailed look at the consumption (Therms) and the dollar rate per (Therm) monthly in a typical year is shown below in table format

Month	Total THERMS	Total Cost	$/Therm
February-14	2264	$2,289	**$1.011**
March-14	1623	$1,383	**$0.853**
April-14	781	$694	**$0.888**
May-14	221	$209	**$0.946**
June-14	16	$24	**$1.531**
July-14	16	$23	**$1.482**
August-14	22	$28	**$1.293**
September-14	43	$45	**$1.047**
October-14	287	$250	**$0.873**
November-14	1058	$938	**$0.887**
December-14	1783	$1,834	**$1.029**
January-15	1946	$1,815	**$0.933**
Totals	**10,060**	**$9,534**	**$0.948**

Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the monthly consumption over the same time period. Notice that the usage peaks in the winter months when heating is necessary.



Natural Gas Consumption versus cost from February 2014 to January 2015.

Glenwood Elementary School

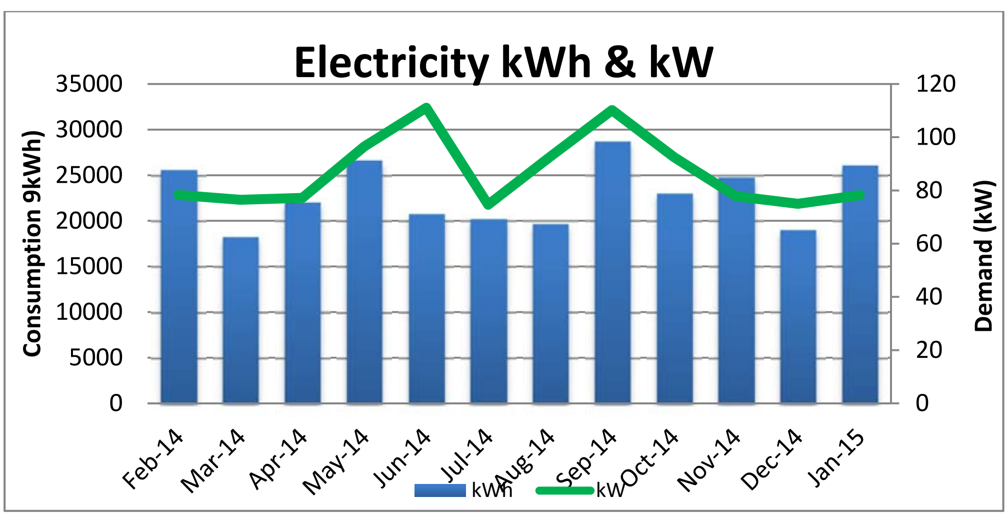
Electric Usage and Demand

A detailed look at the usage (kWh), demand (kW) and total electric cost per month in a typical year is shown below in table format.

Month	kWh	kW	Total Bill $
February-14	25600	78	$2,939
March-14	18240	77	$2,228
April-14	22000	77	$2,590
May-14	26640	97	$3,201
June-14	20800	111	$2,747
July-14	20240	75	$2,441
August-14	19680	93	$2,513
September-14	28720	110	$3,463
October-14	23040	93	$2,796
November-14	24800	78	$2,869
December-14	19040	75	$2,301
January-15	26080	78	$2,994
Totals	**274,880**	**1,041**	**$33,083**

Based off of one year of utility bill information February 2014 to January 2015

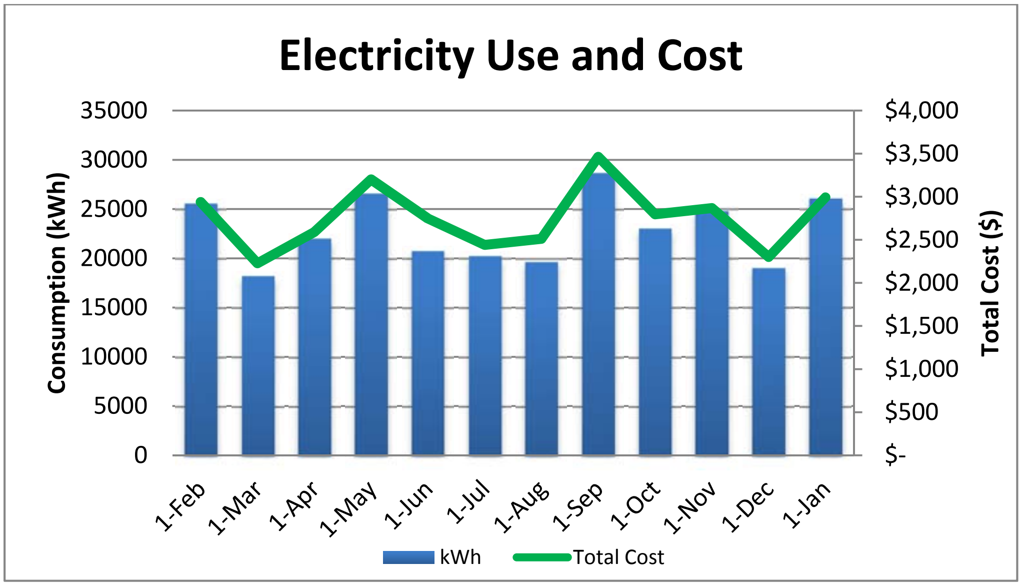
The figure below shows the usage (kW) and (kWh) over the same one year period.



Energy Consumption from February 2014 to January 2015

Johnson Controls

The figure below shows the usage (kWh) and (Cost) over the same one year period.



Energy Consumption versus cost from February 2014 to January 2015

Natural Gas Usage

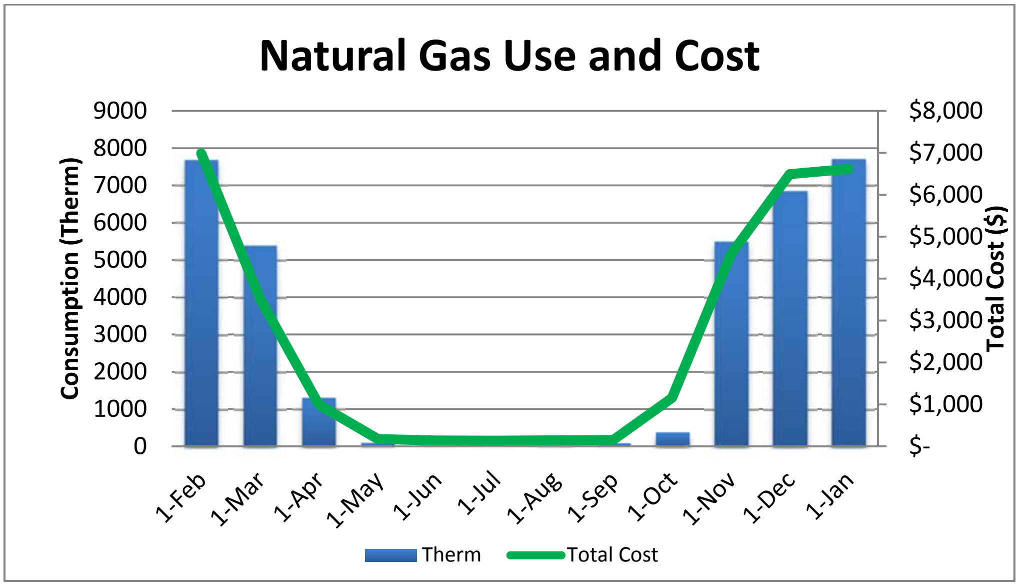
A detailed look at the consumption (Therms) and the dollar rate per (Therm) monthly in a typical year is shown below in table format

Month	Total THERMS	Total Cost	$/Therm
February-14	7690	$6,989	**$0.909**
March-14	5402	$3,516	**$0.651**
April-14	1308	$991	**$0.757**
May-14	100	$173	**$1.724**
June-14	56	$138	**$2.470**
July-14	55	$134	**$2.458**
August-14	70	$144	**$2.062**
September-14	83	$152	**$1.829**
October-14	375	$1,155	**$3.082**
November-14	5507	$4,582	**$0.832**
December-14	6866	$6,492	**$0.946**
January-15	7719	$6,618	**$0.857**
Totals	**35,230**	**$31,082**	**$0.882**

Based off of one year of utility bill information February 2014 to January 2015

Johnson Controls

The figure below shows the monthly consumption over the same time period. Notice that the usage peaks in the winter months when heating is necessary.



Natural Gas Consumption versus cost from February 2014 to January 2015.

Hartshorn Elementary School

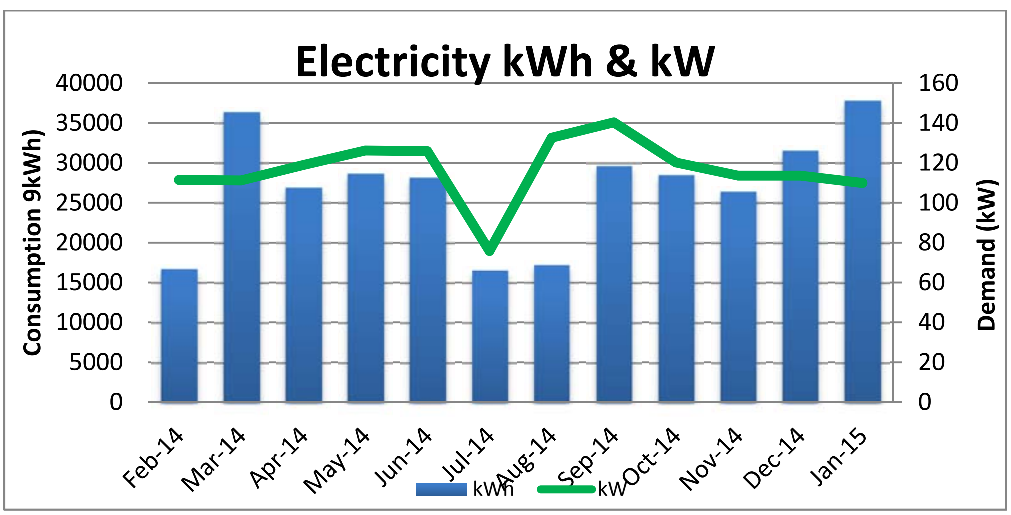
Electric Usage and Demand

A detailed look at the usage (kWh), demand (kW) and total electric cost per month in a typical year is shown below in table format.

Month	kWh	kW	Total Bill $
February-14	16686	111	$2,220
March-14	36366	111	$4,210
April-14	26926	119	$3,362
May-14	28686	126	$3,636
June-14	28206	126	$3,588
July-14	16526	76	$2,130
August-14	17166	133	$2,586
September-14	29646	140	$3,781
October-14	28526	120	$3,533
November-14	26446	114	$3,292
December-14	31566	114	$3,780
January-15	37806	110	$4,353
Totals	**324,552**	**1,400**	**$40,471**

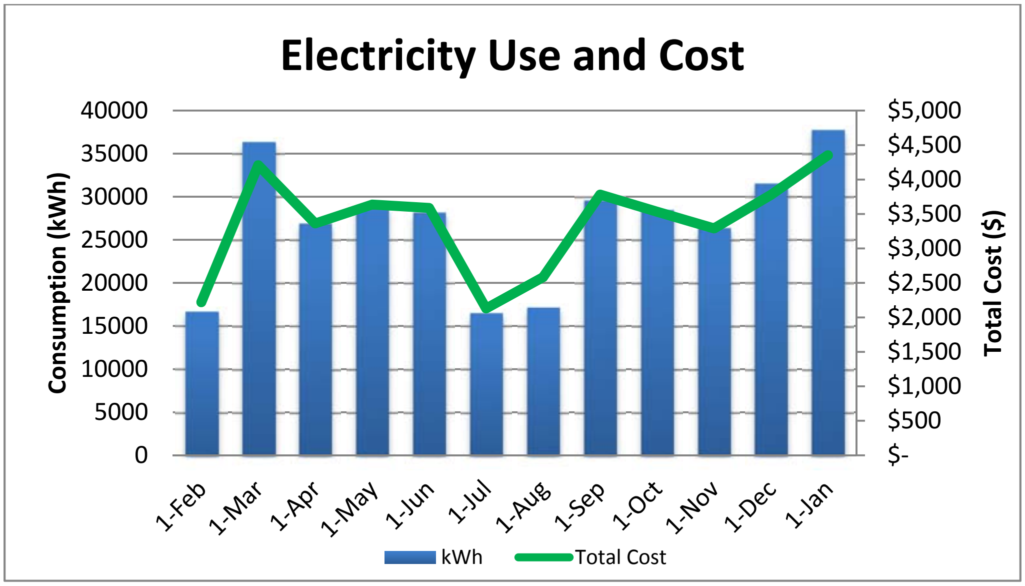
Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the usage (kW) and (kWh) over the same one year period.



Energy Consumption from February 2014 to January 2015

The figure below shows the usage (kWh) and (Cost) over the same one year period.



Energy Consumption versus cost from February 2014 to January 2015

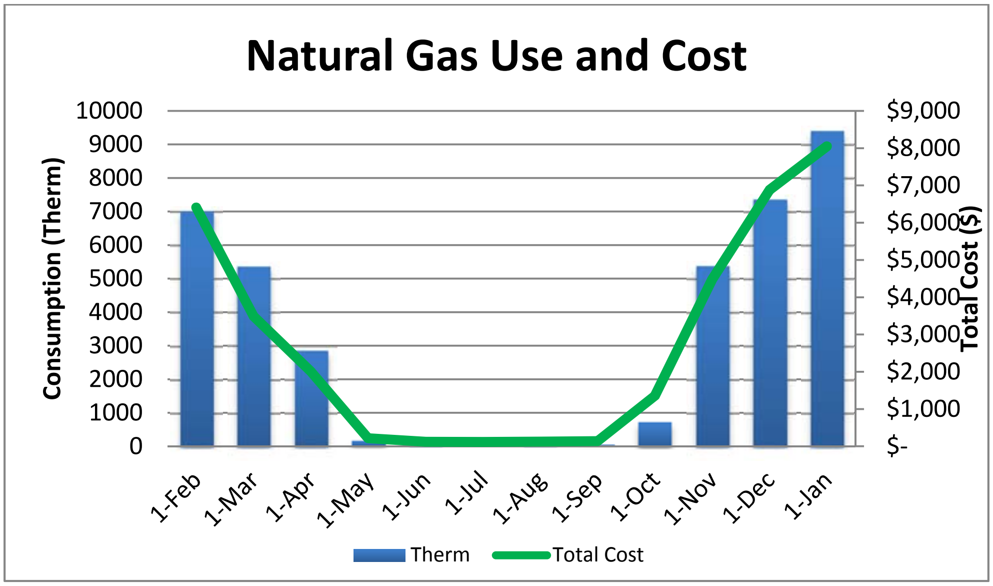
Natural Gas Usage

A detailed look at the consumption (Therms) and the dollar rate per (Therm) monthly in a typical year is shown below in table format

Month	Total THERMS	Total Cost	$/Therm
February-14	7018	$6,407	**$0.913**
March-14	5372	$3,497	**$0.651**
April-14	2865	$2,010	**$0.701**
May-14	163	$217	**$1.334**
June-14	34	$124	**$3.613**
July-14	27	$118	**$4.429**
August-14	39	$126	**$3.256**
September-14	60	$138	**$2.296**
October-14	720	$1,355	**$1.882**
November-14	5385	$4,478	**$0.832**
December-14	7373	$6,881	**$0.933**
January-15	9417	$8,050	**$0.855**
Totals	**38,472**	**$33,402**	**$0.868**

Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the monthly consumption over the same time period. Notice that the usage peaks in the winter months when heating is necessary.



Natural Gas Consumption versus cost from February 2014 to January 2015.

Millburn High School

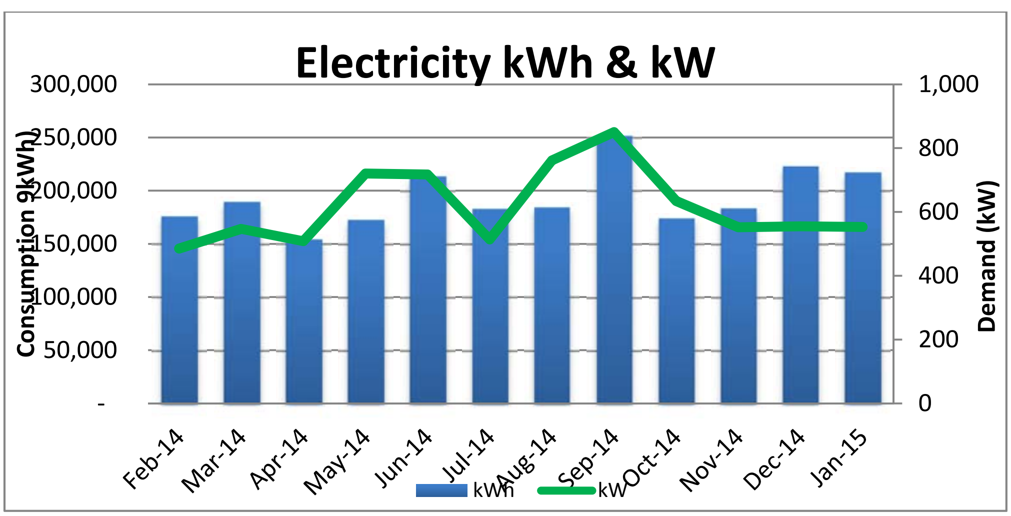
Electric Usage and Demand

A detailed look at the usage (kWh), demand (kW) and total electric cost per month in a typical year is shown below in table format.

Month	kWh	kW	Total Bill $
February-14	176,202	485	$20,040
March-14	189,962	547	$21,746
April-14	154,442	509	$18,122
May-14	173,002	721	$21,597
June-14	213,962	717	$25,468
July-14	183,242	514	$21,136
August-14	184,362	762	$21,069
September-14	251,722	851	$29,772
October-14	174,282	634	$20,881
November-14	183,882	552	$21,265
December-14	223,242	555	$25,041
January-15	217,482	553	$24,499
Totals	**2,325,784**	**7,399**	**$270,635**

Based off of one year of utility bill information February 2014 to January 2015

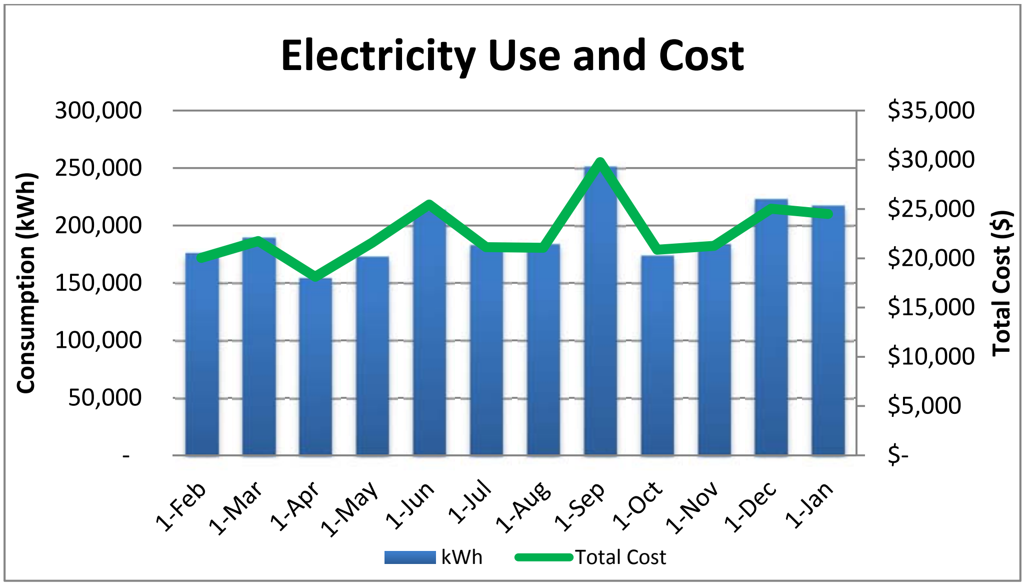
The figure below shows the usage (kW) and (kWh) over the same one year period.



Energy Consumption from February 2014 to January 2015

Johnson Controls

The figure below shows the usage (kWh) and (Cost) over the same one year period.



Energy Consumption versus cost from February 2014 to January 2015

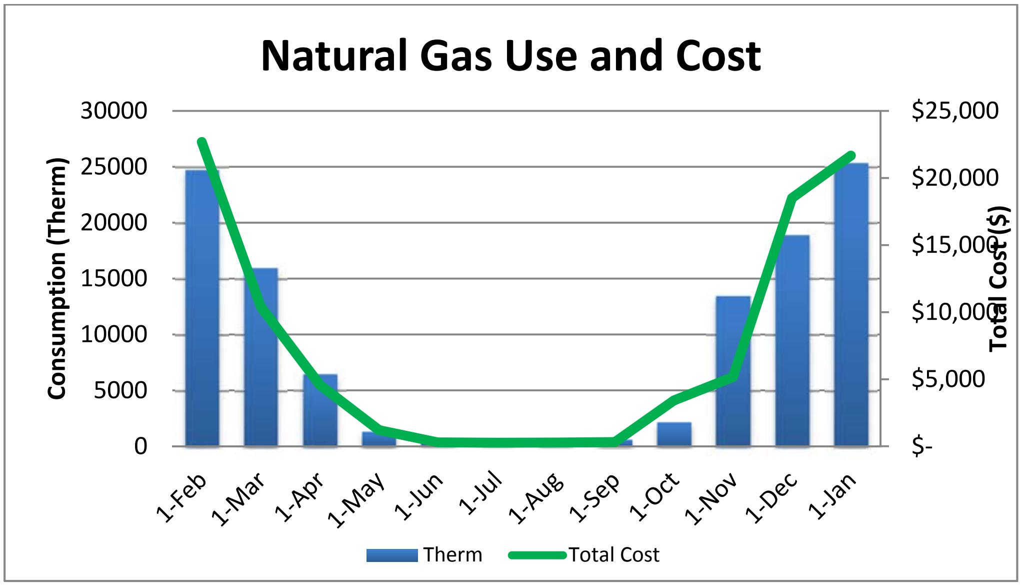
Natural Gas Usage

A detailed look at the consumption (Therms) and the dollar rate per (Therm) monthly in a typical year is shown below in table format

Month	Total THERMS	Total Cost	$/Therm
February-14	24767	$22,679	$0.916
March-14	16008	$10,403	$0.650
April-14	6465	$4,578	$0.708
May-14	1335	$1,215	$0.911
June-14	471	$290	$0.615
July-14	393	$269	$0.685
August-14	455	$279	$0.614
September-14	658	$321	$0.487
October-14	2197	$3,416	$1.555
November-14	13438	$5,163	$0.384
December-14	18915	$18,509	$0.978
January-15	25384	$21,663	$0.853
Totals	**110,486**	$88,785	$0.804

Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the monthly consumption over the same time period. Notice that the usage peaks in the winter months when heating is necessary.



Natural Gas Consumption versus cost from February 2014 to January 2015.

Maintenance

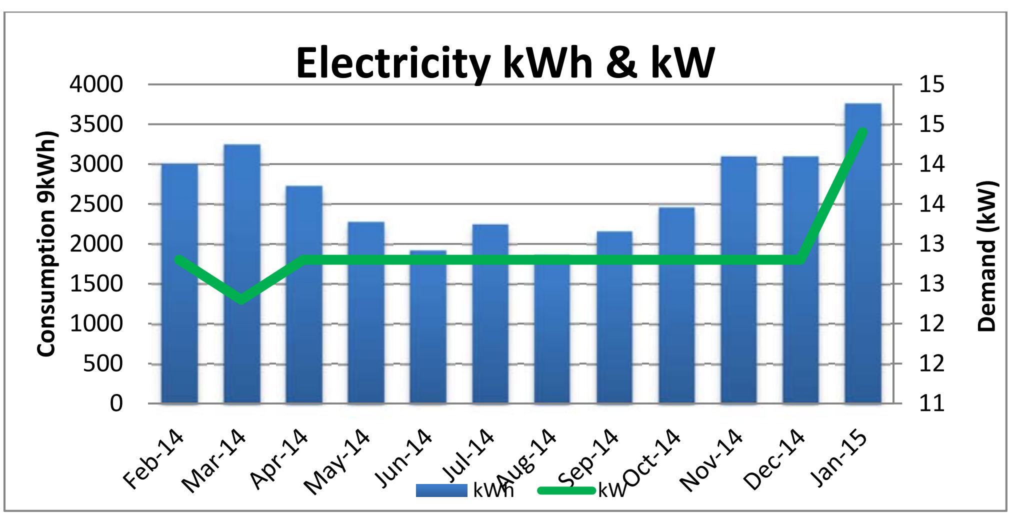
Electric Usage and Demand

A detailed look at the usage (kWh), demand (kW) and total electric cost per month in a typical year is shown below in table format.

Month	kWh	kW	Total Bill $
February-14	3004	13	$359
March-14	3255	12	$380
April-14	2733	13	$324
May-14	2283	13	$286
June-14	1924	13	$252
July-14	2246	13	$283
August-14	1868	13	$247
September-14	2159	13	$271
October-14	2461	13	$299
November-14	3096	13	$360
December-14	3101	13	$360
January-15	3765	14	$443
Totals	**31,895**	**155**	**$3,865**

Based off of one year of utility bill information February 2014 to January 2015

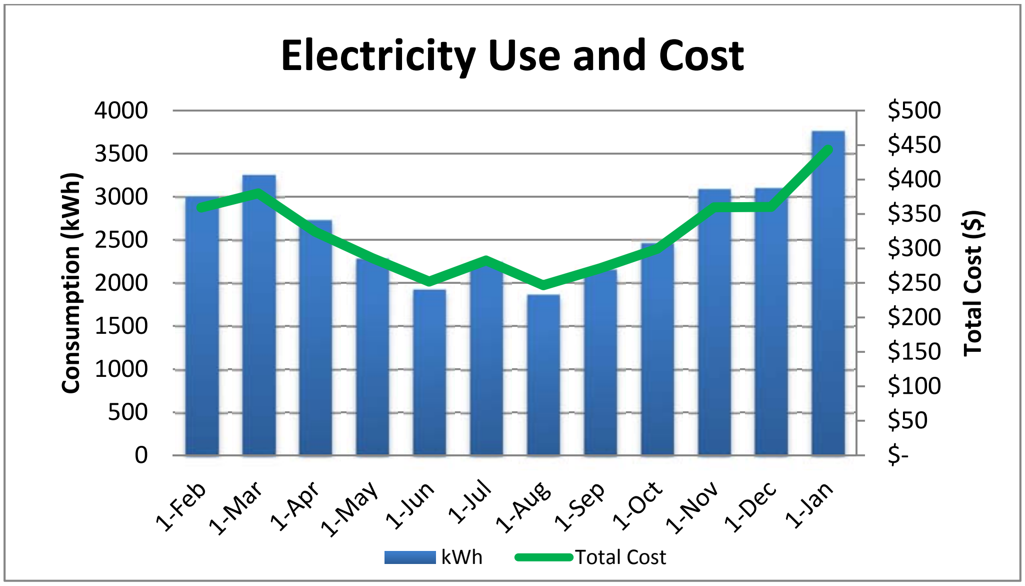
The figure below shows the usage (kW) and (kWh) over the same one year period.



Energy Consumption from February 2014 to January 2015

Johnson Controls

The figure below shows the usage (kWh) and (Cost) over the same one year period.



Energy Consumption versus cost from February 2014 to January 2015

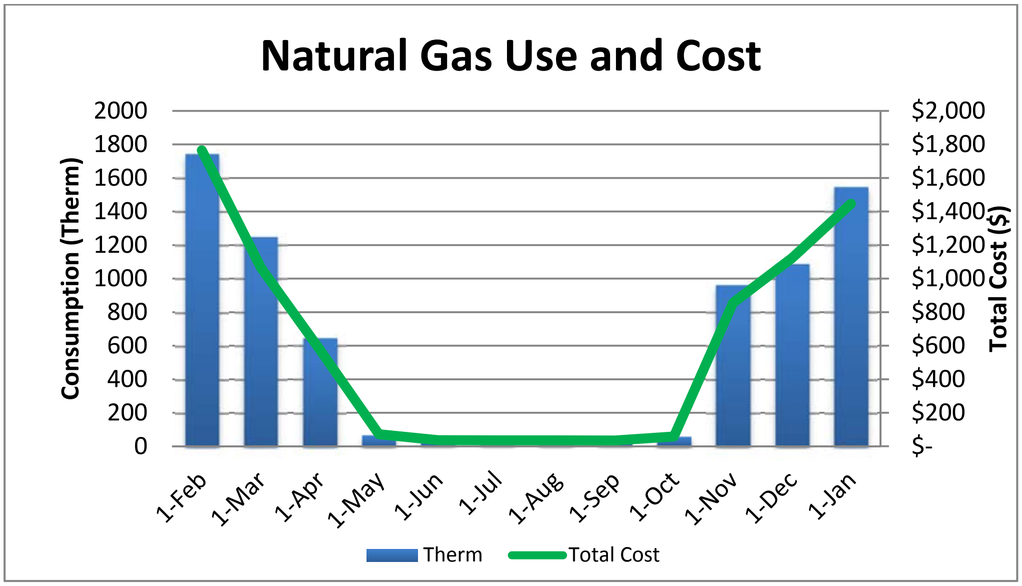
Natural Gas Usage

A detailed look at the consumption (Therms) and the dollar rate per (Therm) monthly in a typical year is shown below in table format

Month	Total THERMS	Total Cost	$/Therm
February-14	1745	$1,765	**$1.012**
March-14	1247	$1,066	**$0.855**
April-14	646	$576	**$0.891**
May-14	69	$72	**$1.057**
June-14	31	$37	**$1.182**
July-14	31	$35	**$1.126**
August-14	31	$36	**$1.141**
September-14	31	$35	**$1.154**
October-14	59	$59	**$0.997**
November-14	962	$855	**$0.889**
December-14	1087	$1,123	**$1.033**
January-15	1548	$1,446	**$0.934**
Totals	**7,488**	**$7,106**	**$0.949**

Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the monthly consumption over the same time period. Notice that the usage peaks in the winter months when heating is necessary.



Natural Gas Consumption versus cost from February 2014 to January 2015.

Millburn Middle School

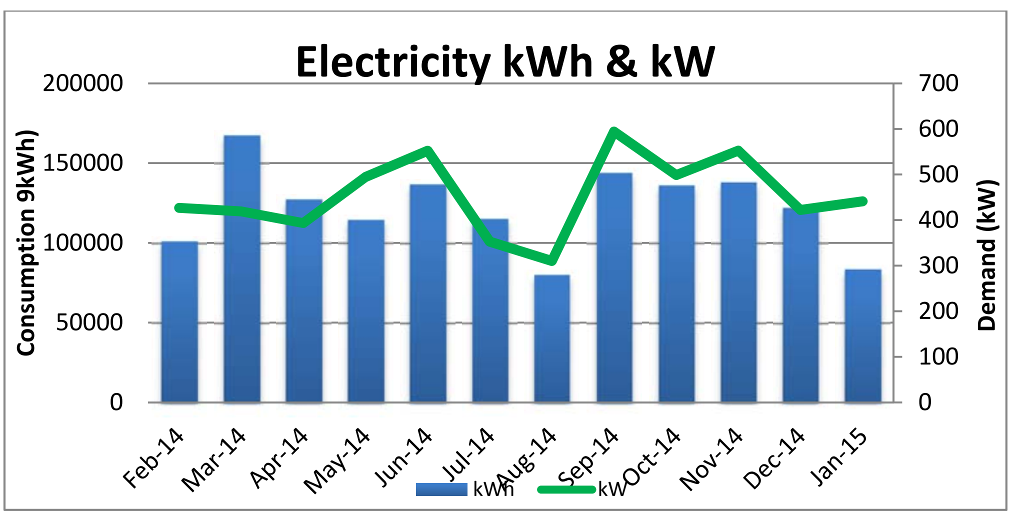
Electric Usage and Demand

A detailed look at the usage (kWh), demand (kW) and total electric cost per month in a typical year is shown below in table format.

Month	kWh	kW	Total Bill $
February-14	101223	427	$12,399
March-14	167463	419	$18,192
April-14	127303	393	$14,661
May-14	114663	494	$14,345
June-14	136903	552	$16,860
July-14	115463	353	$13,439
August-14	79943	310	$9,766
September-14	144103	594	$17,658
October-14	136263	499	$16,241
November-14	138023	553	$16,757
December-14	122023	422	$14,387
January-15	83463	441	$10,833
Totals	**1,466,836**	**5,458**	**$175,540**

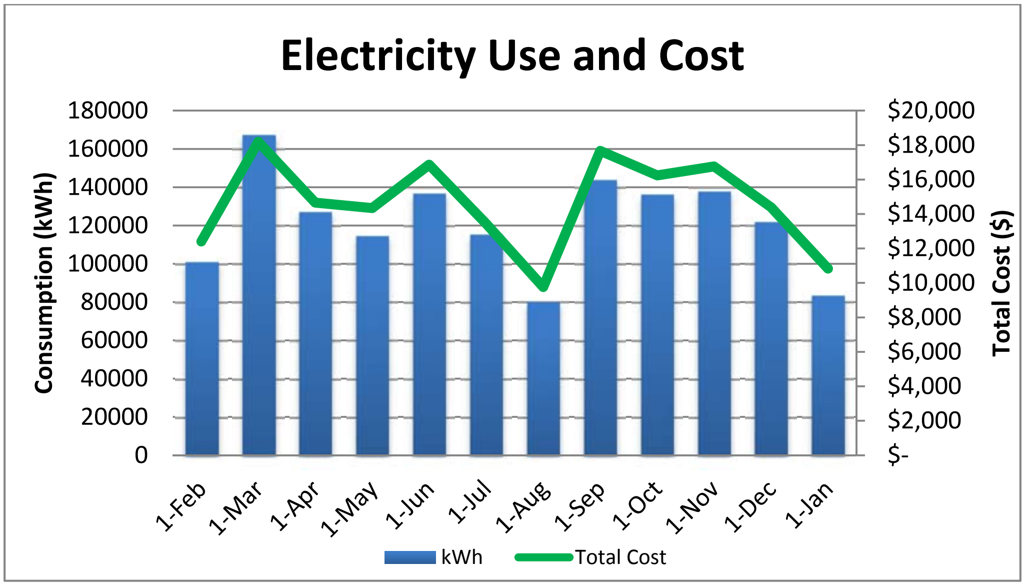
Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the usage (kW) and (kWh) over the same one year period.



Energy Consumption from February 2014 to January 2015

The figure below shows the usage (kWh) and (Cost) over the same one year period.



Energy Consumption versus cost from February 2014 to January 2015

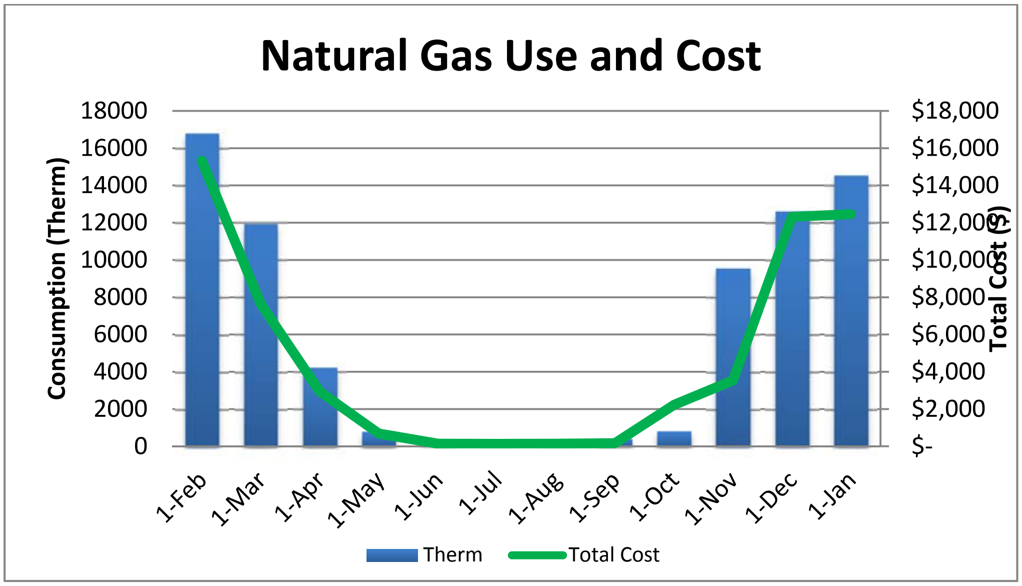
Natural Gas Usage

A detailed look at the consumption (Therms) and the dollar rate per (Therm) monthly in a typical year is shown below in table format

Month	Total THERMS	Total Cost	$/Therm
February-14	16816	$ 15,330	$ 0.912
March-14	11943	$ 7,631	$ 0.639
April-14	4237	$ 2,930	$ 0.692
May-14	788	$ 679	$ 0.862
June-14	201	$ 142	$ 0.708
July-14	173	$ 137	$ 0.791
August-14	175	$ 137	$ 0.783
September-14	419	$ 163	$ 0.389
October-14	833	$ 2,221	$ 2.666
November-14	9542	$ 3,533	$ 0.370
December-14	12601	$ 12,315	$ 0.977
January-15	14534	$ 12,457	$ 0.857
Totals	72261	$ 57,676	$ 0.798

Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the monthly consumption over the same time period. Notice that the usage peaks in the winter months when heating is necessary.



Natural Gas Consumption versus cost from February 2014 to January 2015.

South Mountain Elementary School

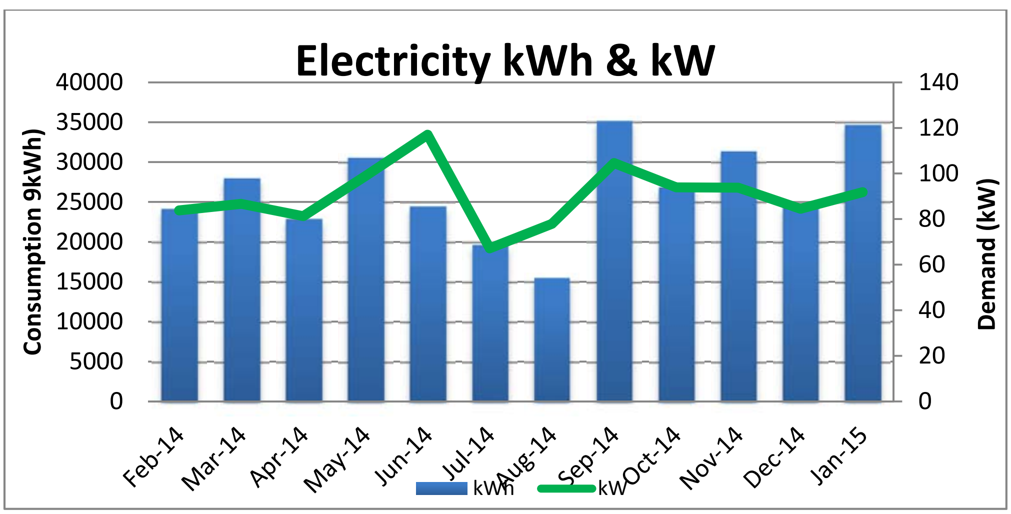
Electric Usage and Demand

A detailed look at the usage (kWh), demand (kW) and total electric cost per month in a typical year is shown below in table format.

Month	kWh	kW	Total Bill $
February-14	24160	84	$2,838
March-14	28000	87	$3,222
April-14	22880	81	$2,700
May-14	30560	99	$3,591
June-14	24480	117	$3,138
July-14	19680	67	$2,336
August-14	15520	78	$2,015
September-14	35200	105	$4,048
October-14	26880	94	$3,171
November-14	31360	94	$3,598
December-14	24480	85	$2,882
January-15	34720	92	$3,908
Totals	**317,920**	**1,081**	**$37,447**

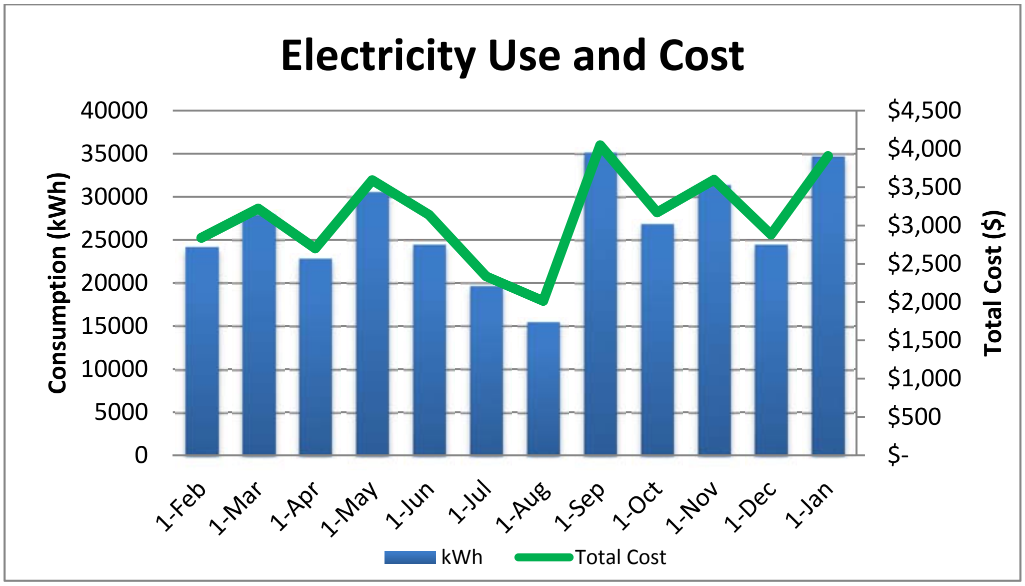
Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the usage (kW) and (kWh) over the same one year period.



Energy Consumption from February 2014 to January 2015

The figure below shows the usage (kWh) and (Cost) over the same one year period.



Energy Consumption versus cost from February 2014 to January 2015

Natural Gas Usage

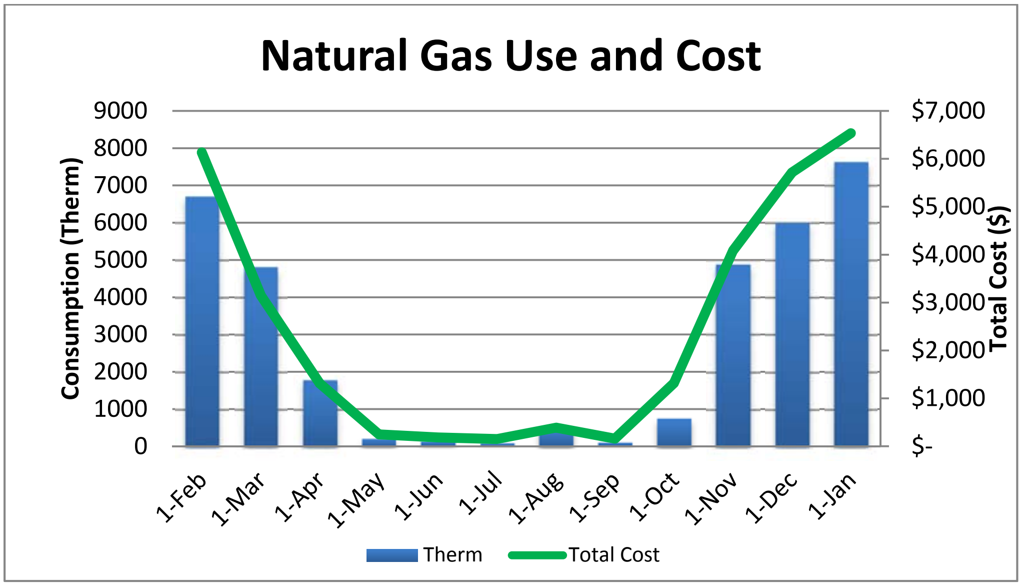
A detailed look at the consumption (Therms) and the dollar rate per (Therm) monthly in a typical year is shown below in table format

Month	Total THERMS	Total Cost	$/Therm
February-14	6702	$6,136	**$0.916**
March-14	4816	$3,149	**$0.654**
April-14	1793	$1,308	**$0.729**
May-14	208	$249	**$1.198**
June-14	131	$186	**$1.422**
July-14	86	$152	**$1.772**
August-14	492	$389	**$0.790**
September-14	96	$159	**$1.661**
October-14	750	$1,319	**$1.759**
November-14	4873	$4,082	**$0.838**
December-14	6006	$5,716	**$0.952**
January-15	7630	$6,534	**$0.856**
Totals	**33,582**	**$29,378**	**$0.875**

Based off of one year of utility bill information February 2014 to January 2015

Johnson Controls

The figure below shows the monthly consumption over the same time period. Notice that the usage peaks in the winter months when heating is necessary.



Natural Gas Consumption versus cost from February 2014 to January 2015.

Wyoming Elementary School

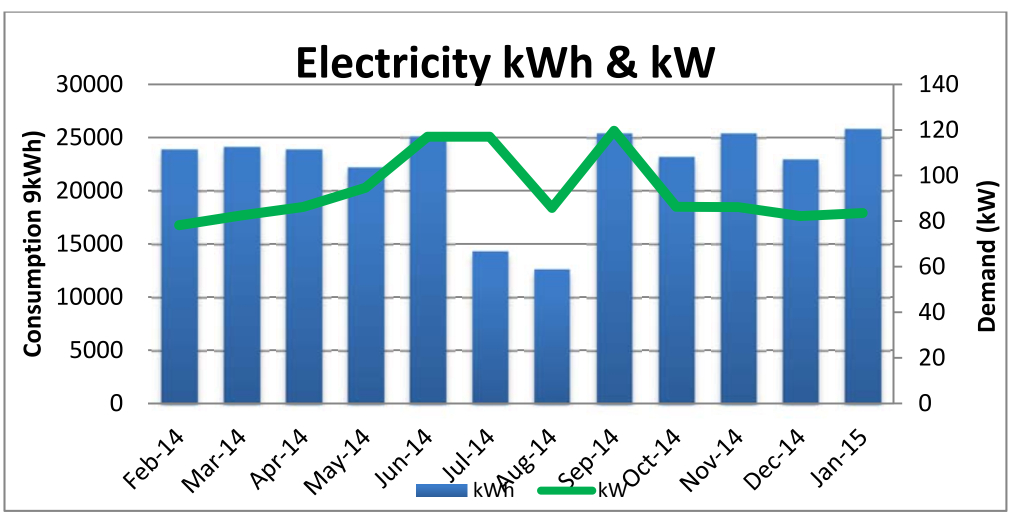
Electric Usage and Demand

A detailed look at the usage (kWh), demand (kW) and total electric cost per month in a typical year is shown below in table format.

Month	kWh	kW	Total Bill $
February-14	23920	78	$2,779
March-14	24160	83	$2,741
April-14	23920	86	$2,831
May-14	22240	95	$2,770
June-14	25120	117	$3,199
July-14	14320	117	$1,768
August-14	12640	86	$1,796
September-14	25440	120	$3,209
October-14	23200	86	$2,771
November-14	25440	86	$2,983
December-14	22960	82	$2,722
January-15	25840	84	$3,005
Totals	**269,200**	**1,119**	**$32,574**

Based off of one year of utility bill information February 2014 to January 2015

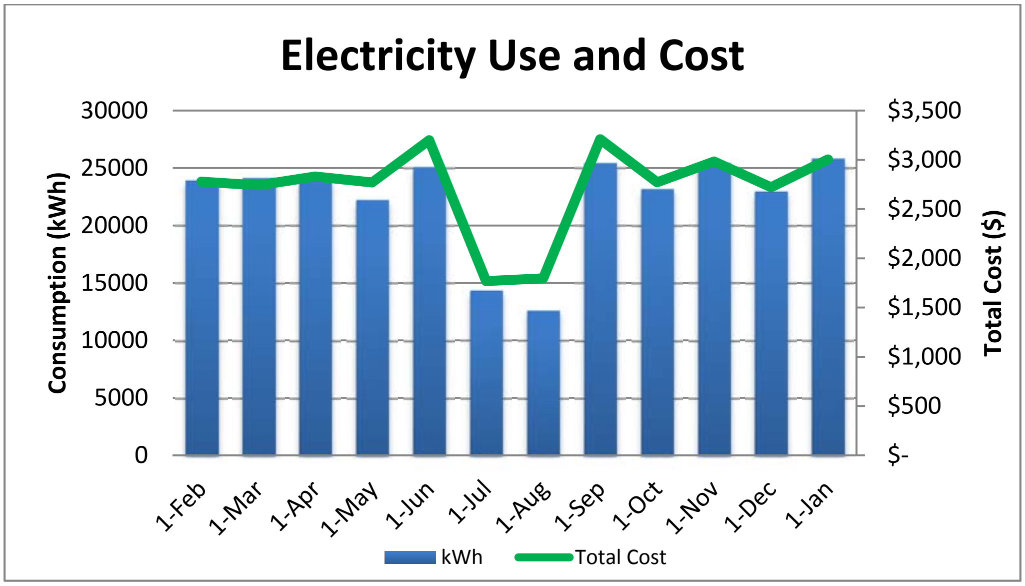
The figure below shows the usage (kW) and (kWh) over the same one year period.



Energy Consumption from February 2014 to January 2015

Johnson Controls

The figure below shows the usage (kWh) and (Cost) over the same one year period.



Energy Consumption versus cost from February 2014 to January 2015

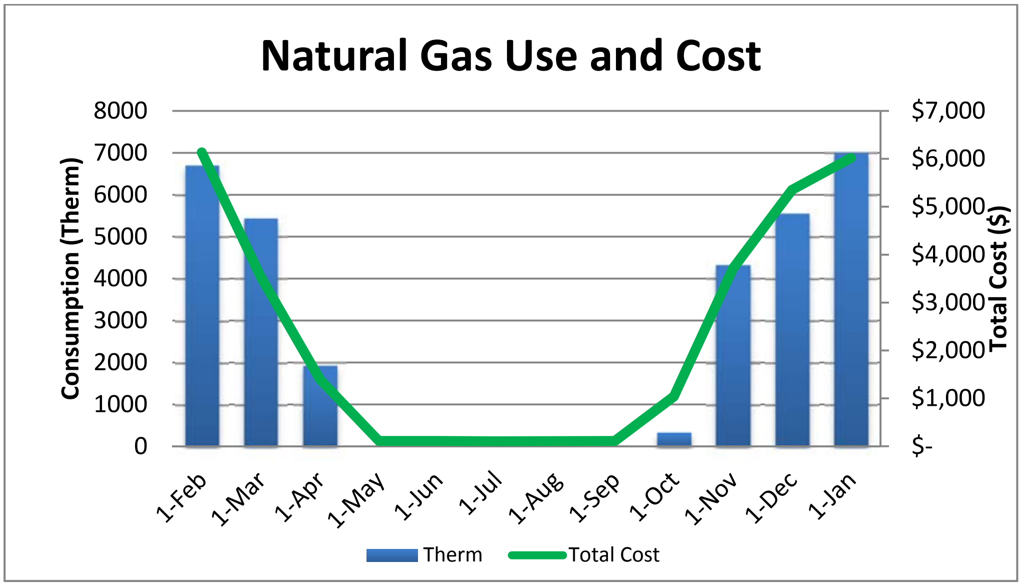
Natural Gas Usage

A detailed look at the consumption (Therms) and the dollar rate per (Therm) monthly in a typical year is shown below in table format

Month	Total THERMS	Total Cost	$/Therm
February-14	6707	$6,133	**$0.914**
March-14	5431	$3,534	**$0.651**
April-14	1931	$1,398	**$0.724**
May-14	14	$112	**$7.975**
June-14	15	$112	**$7.430**
July-14	5	$106	**$19.891**
August-14	6	$107	**$16.639**
September-14	13	$111	**$8.581**
October-14	330	$1,042	**$3.159**
November-14	4323	$3,711	**$0.858**
December-14	5562	$5,350	**$0.962**
January-15	7002	$6,017	**$0.859**
Totals	**31,340**	**$27,732**	**$0.885**

Based off of one year of utility bill information February 2014 to January 2015

The figure below shows the monthly consumption over the same time period. Notice that the usage peaks in the winter months when heating is necessary.

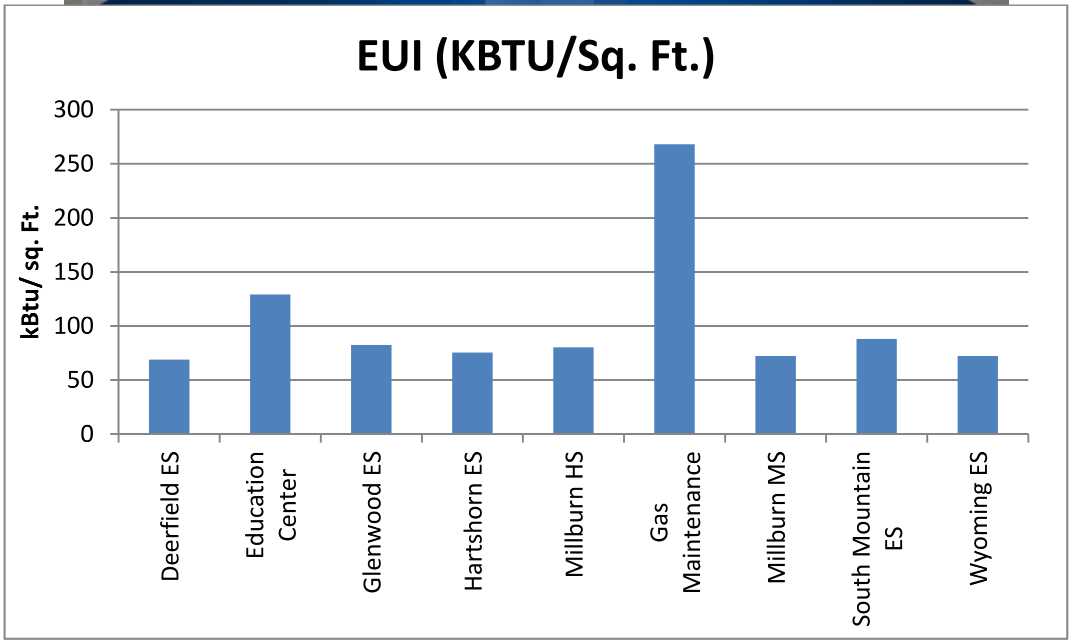


Natural Gas Consumption versus cost from February 2014 to January 2015.

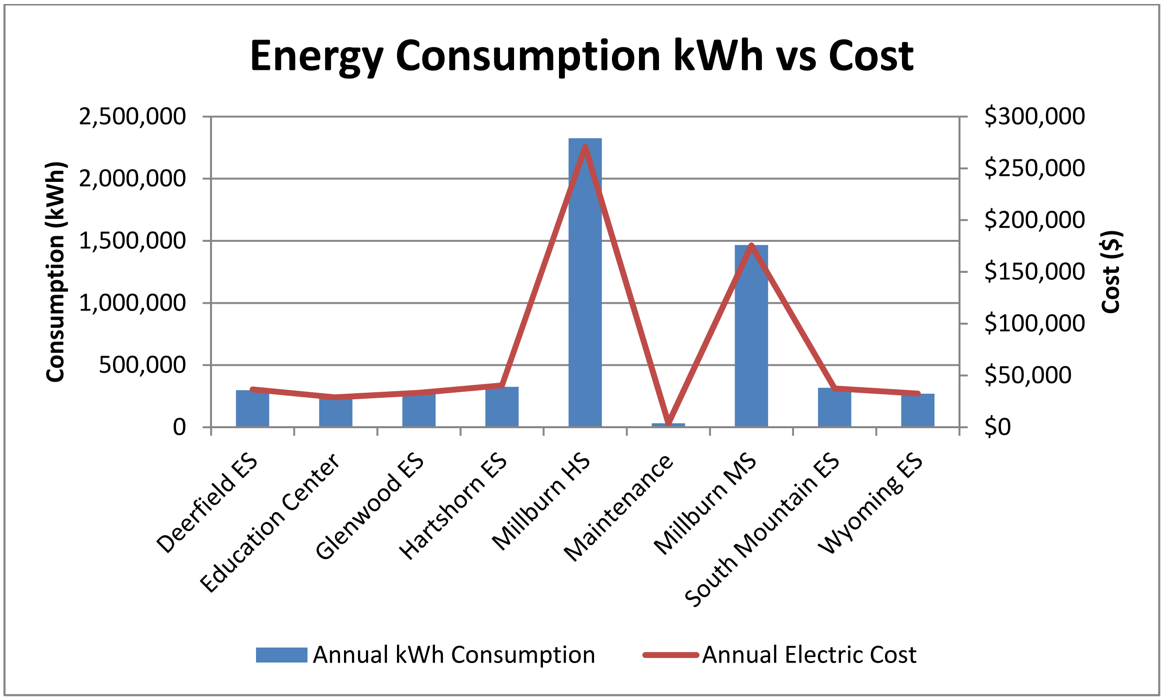
Energy Usage Summary

BUILDING	ANNUAL CONSUMPTION (KWH)	ANNUAL DEMAND (KW)	ANNUAL TOTAL COST	ANNUAL CONSUMPTION (THERM)	ANNUAL GAS COST	TOTAL ENERGY COST	$/kWh	$/kW	$/Therm
Deerfield ES	298,240	1,305	$36,621	37,534	$33,832	$70,453	$0.096	$6.65	$0.90
Education Center	249,192	797	$28,905	10,060	$9,534	$38,439	$0.106	$3.16	$0.95
Glenwood ES	274,880	1,041	$33,083	35,230	$31,082	$64,165	$0.098	$6.65	$0.88
Hartshorn ES	324,552	1,400	$40,471	38,472	$33,402	$73,873	$0.099	$6.63	$0.87
Millburn HS	2,325,784	7,399	$270,635	110,486	$97,715	$368,351	$0.096	$6.65	$0.88
Gas Maintenance	31,895	155	$3,865	7,488	$7,106	$10,971	$0.106	$3.16	$0.95
Millburn MS	1,466,836	5,458	$175,540	72,261	$63,453	$238,992	$0.096	$6.63	$0.88
South Mountain ES	317,920	1,081	$37,447	33,582	$29,378	$66,825	$0.098	$6.63	$0.87
Wyoming ES	269,200	1,119	$32,574	31,340	$27,732	$60,306	$0.096	$6.66	$0.88
Total	**5,558,499**	**19,755**	**$659,142**	**376,451**	**$333,234**	**$992,376**	**$0.096**	**$6.47**	**$0.89**

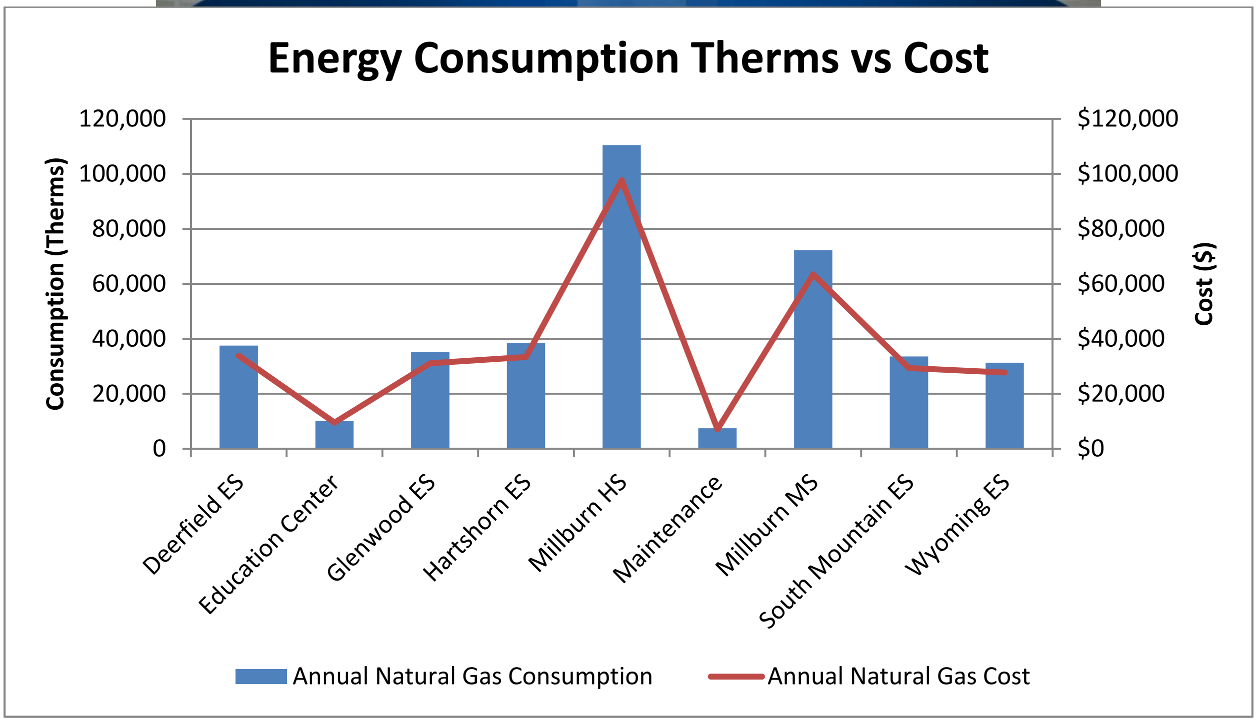
Millburn Township Public Schools Energy Summary Analysis



Millburn Township Public Schools Energy Summary Analysis

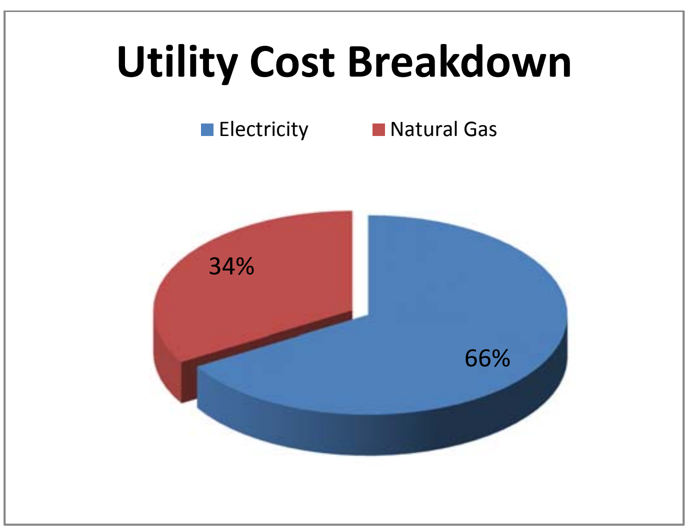


Millburn Township Public Schools Electric Consumption versus Cost



Millburn Township Public Schools Natural Gas Consumption versus Cost.

The pie chart below shows the distribtuion of these two energy sources relative to the entire District energy consumption. At 66% of the total consumption, electricity comprises a larger share of the energy usage.



Millburn Township Public Schools Percentile Energy Cost Distribution

Marginal Rates

The utility rates identified below were used for purposes of calculating the dollar effect of the energy savings at Millburn Township Public Schools.

Name of School	$/kWh	$/kW	$/Therm
Deerfield ES	$0.096	$6.65	$0.90
Education Center	$0.106	$3.16	$0.95
Glenwood ES	$0.098	$6.65	$0.88
Hartshorn ES	$0.099	$6.63	$0.87
Millburn HS	$0.096	$6.65	$0.88
Gas Maintenance	$0.106	$3.16	$0.95
Millburn MS	$0.096	$6.63	$0.88
South Mountain ES	$0.098	$6.63	$0.87
Wyoming ES	$0.096	$6.66	$0.88
Total (Average)	**$0.097**	**$6.47**	**$0.89**

Utility Escalation Rates

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

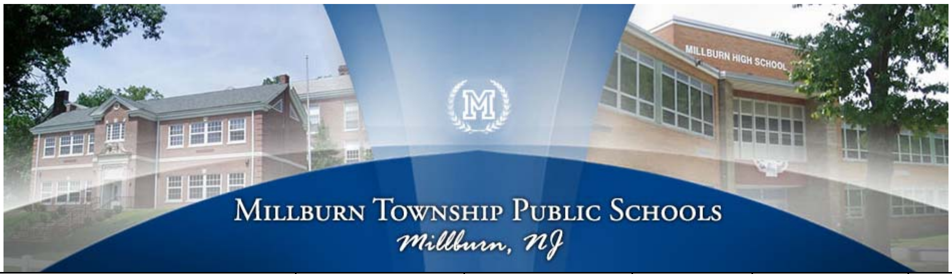
Name of School	Energy					
	Electric Consumption		Annual Electric Demand		Natural Gas	
	Escalation Rate	Start Year of Escalation	Escalation Rate	Start Year of Escalation	Escalation Rate	Start Year of Escalation
Deerfield ES	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Education Center	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Glenwood ES	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Hartshorn ES	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Millburn HS	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Gas Maintenance	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Millburn MS	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
South Mountain ES	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1
Wyoming ES	2.2%	Year 1	2.2%	Year 1	2.4%	Year 1

Section 3. Financial Impact

Energy Savings and Cost Summary

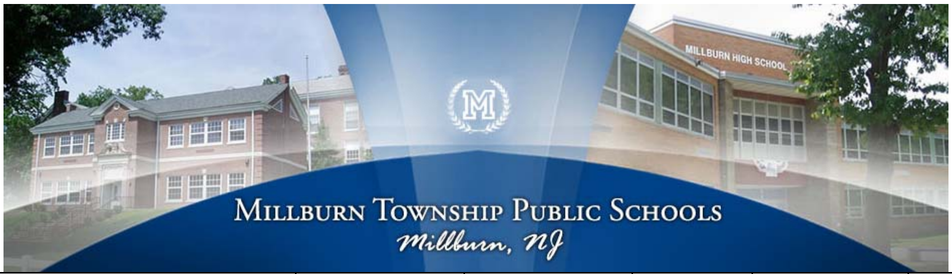
The table below provides a summary of the costs and savings associated with the measures investigated to create the three potential business cases for Millburn Township Public Schools. The details for the recommended project are outlined in Appendix 4. The savings have been calculated based on the savings 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 #	ECM	Total Construction Hard Cost	Year 1 Utility Savings	Simple Payback	Installation Plan	15 Year Model	18 Year Model	20 Year Model
3	Infiltration Reduction - Deerfield Elementary School	$19,025	$1,949	9.8	Public Bidding	Yes	Yes	Yes
4	Infiltration Reduction - Education Center	$10,454	$1,072	9.8	Public Bidding	Yes	Yes	Yes
5	Infiltration Reduction - Glenwood Elementary School	$39,041	$5,118	7.6	Public Bidding	Yes	Yes	Yes
6	Infiltration Reduction - Hartshorn Elementary School	$19,344	$1,870	10.3	Public Bidding	Yes	Yes	Yes
7	Infiltration Reduction - High School	$48,465	$4,797	10.1	Public Bidding	Yes	Yes	Yes
8	Infiltration Reduction - Middle School	$56,500	$6,832	8.3	Public Bidding	Yes	Yes	Yes
10	Infiltration Reduction - Wyoming Elementary School	$10,601	$879	12.1	Public Bidding	Yes	Yes	Yes
11-18	Solar Energy Window Film – District Wide	$265,000	$2,972	89.2	District Implement	Yes	Yes	Yes
19	Low Flow Water Fixtures - Deerfield Elementary School	$1,515	$306	5.0	JCI Implement	Yes	Yes	Yes
20	Low Flow Water Fixtures - Education Center	$703	$36	19.5	JCI Implement	Yes	Yes	Yes
21	Low Flow Water Fixtures - Glenwood Elementary School	$1,535	$297	5.2	JCI Implement	Yes	Yes	Yes
22	Low Flow Water Fixtures - Hartshorn Elementary School	$1,618	$235	6.9	JCI Implement	Yes	Yes	Yes
23	Low Flow Water Fixtures - High School	$2,526	$1,100	2.3	JCI Implement	Yes	Yes	Yes
24	Low Flow Water Fixtures - Middle School	$2,589	$623	4.2	JCI Implement	Yes	Yes	Yes



ID #	ECM	Total Construction Hard Cost	Year 1 Utility Savings	Simple Payback	Installation Plan	15 Year Model	18 Year Model	20 Year Model
25	Low Flow Water Fixtures - South Mountain Elementary School	$1,536	$153	10.0	JCI Implement	Yes	Yes	Yes
26	Low Flow Water Fixtures - Wyoming Elementary School	$1,556	$187	8.3	JCI Implement	Yes	Yes	Yes
27	Pedal Valves - Glenwood Elementary School	$3,216	$497	6.5	JCI Implement	Yes	Yes	Yes
28	Pedal Valves - Hartshorn Elementary School	$2,500	$328	7.6	JCI Implement	Yes	Yes	Yes
29	Pedal Valves - High School	$3,216	$1,233	2.6	JCI Implement	Yes	Yes	Yes
30	Pedal Valves - Middle School	$5,360	$2,124	2.5	JCI Implement	Yes	Yes	Yes
31	Academy of Energy Education	$10,000	$0	0.0	JCI Implement	Yes	Yes	Yes
32	Building Automation System Training	$15,000	$0	0.0	JCI Implement	Yes	Yes	Yes
33	Demand Response - Emergency Capacity Program	$24,000	$0	0.0	JCI Implement	Yes	Yes	Yes
34	Demand Response - Energy Efficiency Credit - LED	$0	$0	0.0	JCI Implement	Yes	Yes	Yes
39	Pay for Performance - High School	$10,000	$0	0.0	JCI Implement	Yes	Yes	Yes
53	Boiler Replacement - Hartshorn Elementary School	$295,475	$2,952	100.1	Public Bidding	Yes	Yes	Yes
57	Pipe Insulation & Blankets	$171,591	$15,750	10.9	Public Bidding	Yes	Yes	Yes
66	Steam Trap Replacements - Glenwood Elementary School	$35,420	$1,711	20.7	Public Bidding	Yes	Yes	Yes
76	Building Automation System Upgrades - District Wide	$255,375	$56,302	4.5	Public Bidding	Yes	Yes	Yes
79	Building Automation System Upgrades - Education Center - Central Plant	$16,000	$12,582	1.3	Public Bidding	Yes	Yes	Yes
82	Building Automation System Upgrades - High School - Exhaust Fans	$25,938	$2,508	10.3	Public Bidding	Yes	Yes	Yes
83	Building Automation System Upgrades - High School DCV	$23,125	$4,337	5.3	Public Bidding	Yes	Yes	Yes
84	Building Automation System Upgrades - Middle School - Exhaust Fans	$9,625	$716	13.4	Public Bidding	Yes	Yes	Yes

ID #	ECM	Total Construction Hard Cost	Year 1 Utility Savings	Simple Payback	Installation Plan	15 Year Model	18 Year Model	20 Year Model
86	Building Automation System Upgrades - South Mountain Elementary School - Exhaust Fans	$11,125	$893	12.5	Public Bidding	Yes	Yes	Yes
89	Plug Load Management	$36,630	$2,670	13.7	Public Bidding	Yes	Yes	Yes
103	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Deerfield Elementary School	$142,029	$10,591	13.4	Public Bidding	Yes	Yes	Yes
104	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Education Center	$58,753	$6,814	8.6	Public Bidding	Yes	Yes	Yes
105	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Glenwood Elementary School	$109,988	$7,970	13.8	Public Bidding	Yes	Yes	Yes
106	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Hartshorn Elementary School	$153,953	$13,512	11.4	Public Bidding	Yes	Yes	Yes
107	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - High School	$483,606	$43,353	11.2	Public Bidding	Yes	Yes	Yes
109	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Middle School	$448,314	$33,551	13.4	Public Bidding	Yes	Yes	Yes
110	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - South Mountain Elementary School	$117,970	$6,159	19.2	Public Bidding	Yes	Yes	Yes
111	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Wyoming Elementary School	$121,020	$6,338	19.1	Public Bidding	Yes	Yes	Yes
122	Football Field Lighting Upgrade - Behind Bleachers	$3,513	-$107	-32.7	Public Bidding	Yes	Yes	Yes
123	Vending Miser Controls - Education Center	$400	$393	1.0	Public Bidding	Yes	Yes	Yes
124	Vending Miser Controls - Glenwood Elementary School	$400	$161	2.5	Public Bidding	Yes	Yes	Yes
125	Vending Miser Controls - Hartshorn Elementary School	$400	$163	2.5	Public Bidding	Yes	Yes	Yes
126	Vending Miser Controls - High School	$2,400	$949	2.5	Public Bidding	Yes	Yes	Yes



ID #	ECM	Total Construction Hard Cost	Year 1 Utility Savings	Simple Payback	Installation Plan	15 Year Model	18 Year Model	20 Year Model
127	Vending Miser Controls - Middle School	$400	$158	2.5	Public Bidding	Yes	Yes	Yes
128	Vending Miser Controls - Wyoming Elementary School	$400	$158	2.5	Public Bidding	Yes	Yes	Yes
129	High Efficiency Transformers - High School	$12,697	$1,411	9.0	Public Bidding/ JCI Implement	Yes	Yes	Yes
130	High Efficiency Transformers - Middle School	$36,294	$2,854	12.7	Public Bidding/ JCI Implement	Yes	Yes	Yes
131	Air-Cooled Chiller Replacement - High School	$187,950	$9,533	19.7	Public Bidding	Yes	Yes	Yes
54	Burner Replacement - Deerfield Elementary School	$89,058	$738	120.7	Public Bidding	No	Yes	Yes
55	Burner Replacement - High School	$99,212	$2,565	38.7	Public Bidding	No	Yes	Yes
56	Combined Heater and Power - High School	$503,643	$24,773	20.3	Public Bidding	No	Yes	Yes
60	Rooftop Unit Replacement - Hartshorn - Library	$49,934	$712	70.1	Public Bidding	No	Yes	Yes
61	Rooftop Unit Replacement - Hartshorn - RTU 2	$75,068	$594	126.5	Public Bidding	No	Yes	Yes
62	Rooftop Unit Replacement - Hartshorn - Multipurpose Room	$169,323	$2,968	57.1	Public Bidding	No	Yes	Yes
63	Rooftop Unit Replacement - Hartshorn - Kindergarten Wing	$43,650	$594	73.5	Public Bidding	No	Yes	Yes
69	Steam-to-Hot Water Conversion - Wyoming Elementary School	$320,687	$2,560	125.3	Public Bidding	No	No	Yes
58	Rooftop Unit Replacement - Hartshorn - RTU 1	$35,796	$356	100.5	Public Bidding	No	No	Yes
59	Rooftop Unit Replacement - Hartshorn - New Wing	$59,359	$890	66.7	Public Bidding	No	No	Yes

Operational Savings Estimates

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

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

Operational Savings for Financial Model	
ECM Description	**Annual Savings**
Boiler Replacement - Hartshorn Elementary School	$11,580
Building Automation System Upgrades - District Wide	$69,346
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Deerfield Elementary School	$2,708
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Education Center	$1,475
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Glenwood Elementary School	$2,486
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Hartshorn Elementary School	$2,455
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - High School	$10,259
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Middle School	$6,397
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - South Mountain Elementary School	$1,529
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Wyoming Elementary School	$1,879
Totals	**$110,115**

Potential Revenue Generation Estimates

Rebates

As part of the ESP for Millburn Township Public Schools several avenues for rebates and incentives have been investigated which include:

- NJ Smart Start Equipment Incentives
- Pay for Performance
- Direct Install Program

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

NJ Smart Start Equipment Incentives

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

Building	Estimated Incentive
Boiler Replacement - Hartshorn Elementary School	$5,250
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Deerfield Elementary School	$14,885
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Education Center	$1,740
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Glenwood Elementary School	$9,675
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Hartshorn Elementary School	$15,630
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Middle School	$55,775
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - South Mountain Elementary School	$13,585
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Wyoming Elementary School	$13,815
Rooftop Unit Replacement – Hartshorn Elementary School	$11,937
Total	**$142,292**

Pay for Performance

Pay for Performance is a comprehensive energy efficiency program that provides incentives towards whole-building energy improvements. A minimum savings of 15% must be achieved to meet the Pay for Performance criteria in addition to project specific criteria. The P4P incentive is paid in three increments as outlined below:

- **Incentive #1 - Submittal of complete energy reduction plan prepared by an approved program partner -** Contingent on moving forward, incentives will be between $5,000 and $50,000 based on approximately $.10 per square foot, not to exceed 50% of the facility's annual energy expense.
    - When a Local Government Energy Audit has been completed, only 50% of Incentive #1 will be paid to the customer.
- **Incentive #2** - Installation of recommended measures - Incentives are based on the projected level of electricity and natural gas savings resulting from the installation of comprehensive energy-efficiency measures.
- **Incentive #3 - Completion of Post-Construction Benchmarking Report -** A completed report verifying energy reductions based on one year of post-implementation results. Incentives for electricity and natural gas savings will be paid based on actual savings, provided that the minimum performance threshold of 15% savings has been achieved.

Building	Estimated Incentive #1*	Estimated Incentive #2	Estimated Incentive #3	Estimated Total
Millburn High School	$11,830	$45,609	$45,609	**$103,047**

*Incentive #1 accounts for participation in LGEA.

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Cogeneration Incentives

Incentives are available for Combined Heat and Power (CHP)/ Cogeneration systems with heat recovery and productive use of waste heat that are located on-site. Cogeneration units that are powered by natural gas and under 500kW, as in the case of the system recommended for the High School, are eligible for an incentive of $2.00/ watt. Participation in the Pay for Performance program will add a bonus of $0.25/ watt. In order to be conservative, we have shown the incentives based on the $2.00/ watt figures. Any additional incentive would go directly to the school district and can be used to fund the project or additional work. The CHP incentive is paid in three increments as outlined below:

- Thirty percent (30%) of the incentive upon proof of equipment purchase
- Sixty (60%) percent upon project completion and verification of installation
- Remainder ten percent (10%) upon acceptance and confirmation the project is achieving the required performance thresholds based on twelve (12) months of operating data. proposed and/or minimum efficiency threshold

Building	Estimated Incentive #1	Estimated Incentive #2	Estimated Incentive #3	Estimated Total
Millburn High School	$45,000	$90,000	$15,000	**$150,000**

Demand Response Energy Efficiency Credit

The LED Lighting Upgrades and Chiller Replacement recommended for the District will be eligible for the Energy Efficiency Credit available through PJM. The Energy Efficiency Credit pays consumers based on the permanent load reduction through the installation of energy efficiency measures. The following table summarizes the available Demand Response Incentives available due to the lighting upgrades at all buildings and the chiller replacement at the High School.

Demand Response Energy - Efficiency Credit		
PJM Payment Year	**Approved Load (kW)**	**Annual Customer Capacity Benefit**
2016/2017	472 kW	$5,360
2017/2018	472 kW	$11,224
2018/2019	472 kW	$11,224
2019/2020	472 kW	$11,224
Totals		**$39,031**

Demand Response Emergency Capacity Program

The Peak Load Contribution Numbers (PLC #) for each school was obtained from the local utility in order to evaluate the potential for demand response participation. The table on the following page details the PLC for each building as well as the total district contribution to the peak load.

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Account Number	Building	PLC
100004697544	High School	594.88
100005879976	Middle School	354.2008
100004804769	Glenwood Elementary School	65.7828
100005266554	Wyoming Elementary School	57.7114
100006418923	Deerfield Elementary School	57.0201
100006558314	South Mountain Elementary School	80.3369
100006068595	Education Center	64.0105
100005751977	Hartshorn Elementary School	63.6046

The table below displays annual earnings to Millburn Township Public Schools by participating in the Emergency Response Program based on a 640 kW (aggregated) load drop for 2016/2017 and beyond.

PJM Payment Year (Year)	**Price Certainty** (Known / Forecast)	**Annual Customer Capacity Benefit ($ / year)**
2016/2017	KNOWN	$18,243
2017/2018	FORECAST	$19,653
2018/2019	FORECAST	$19,653
2019/2020	FORECAST	$19,653
2020/2021	FORECAST	$19,653
2021/2022	FORECAST	$19,653
2022/2023	FORECAST	$19,653
2023/2024	FORECAST	$19,653
2024/2025	FORECAST	$19,653
2025/2026	FORECAST	$19,653
Totals		**$195,118**

Business Case for Recommended Project

FORM VI

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
THE BOARD OF EDUCATION OF THE TOWNSHIP OF MILLBURN IN THE COUNTY OF ESSEX, NEW JERSEY
-ENERGY SAVING 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: 15 **years (180 Months)**
2. Construction Period [2] (months): **12 months**
3. Cash Flow Analysis Format:

Project Cost [1]: $4,482,853 Interest Rate: 2.8%

Year	Annual Energy Savings	Annual Operational Savings	Energy Rebates/ Incentives	Total Annual Savings	Annual Project Costs	Board Costs	Annual Service Costs [3]	Net Cash Flow to Client	Cumulative Cash Flow
Installation	$82,102	$0	$29,421	$111,523	$0	$0	$0	$111,523	$111,523
1	$276,988	$110,115	$219,183	$606,286	$586,498	$605,455	$18,957	$831	$112,354
2	$283,300	$110,115	$84,272	$477,687	$457,311	$476,837	$19,526	$850	$113,204
3	$289,756	$29,189	$30,876	$349,821	$328,840	$348,952	$20,112	$869	$114,074
4	$296,359	$29,189	$30,876	$356,424	$355,535	$355,535	$0	$889	$114,963
5	$303,113	$29,189	$19,653	$351,955	$351,045	$351,045	$0	$909	$115,872
6	$310,021	$0	$19,653	$329,674	$328,744	$328,744	$0	$930	$116,802
7	$317,088	$0	$19,653	$336,740	$335,789	$335,789	$0	$951	$117,753
8	$324,316	$0	$19,653	$343,968	$342,596	$342,596	$0	$1,372	$119,126
9	$331,709	$0	$19,653	$351,361	$342,596	$342,596	$0	$8,766	$127,891
10	$339,271	$0	$19,653	$358,924	$342,596	$342,596	$0	$16,328	$144,219
11	$347,006	$0	$0	$347,006	$342,596	$342,596	$0	$4,410	$148,629
12	$354,918	$0	$0	$354,918	$342,596	$342,596	$0	$12,322	$160,951
13	$363,011	$0	$0	$363,011	$342,596	$342,596	$0	$20,415	$181,366
14	$371,289	$0	$0	$371,289	$342,596	$342,596	$0	$28,693	$210,059
15	$379,756	$0	$0	$379,756	$342,596	$342,596	$0	$37,160	$247,219
Totals	$4,970,002	$307,797	$512,545	$5,790,344	$5,484,530	$5,543,125	$58,595	$247,219	$247,219

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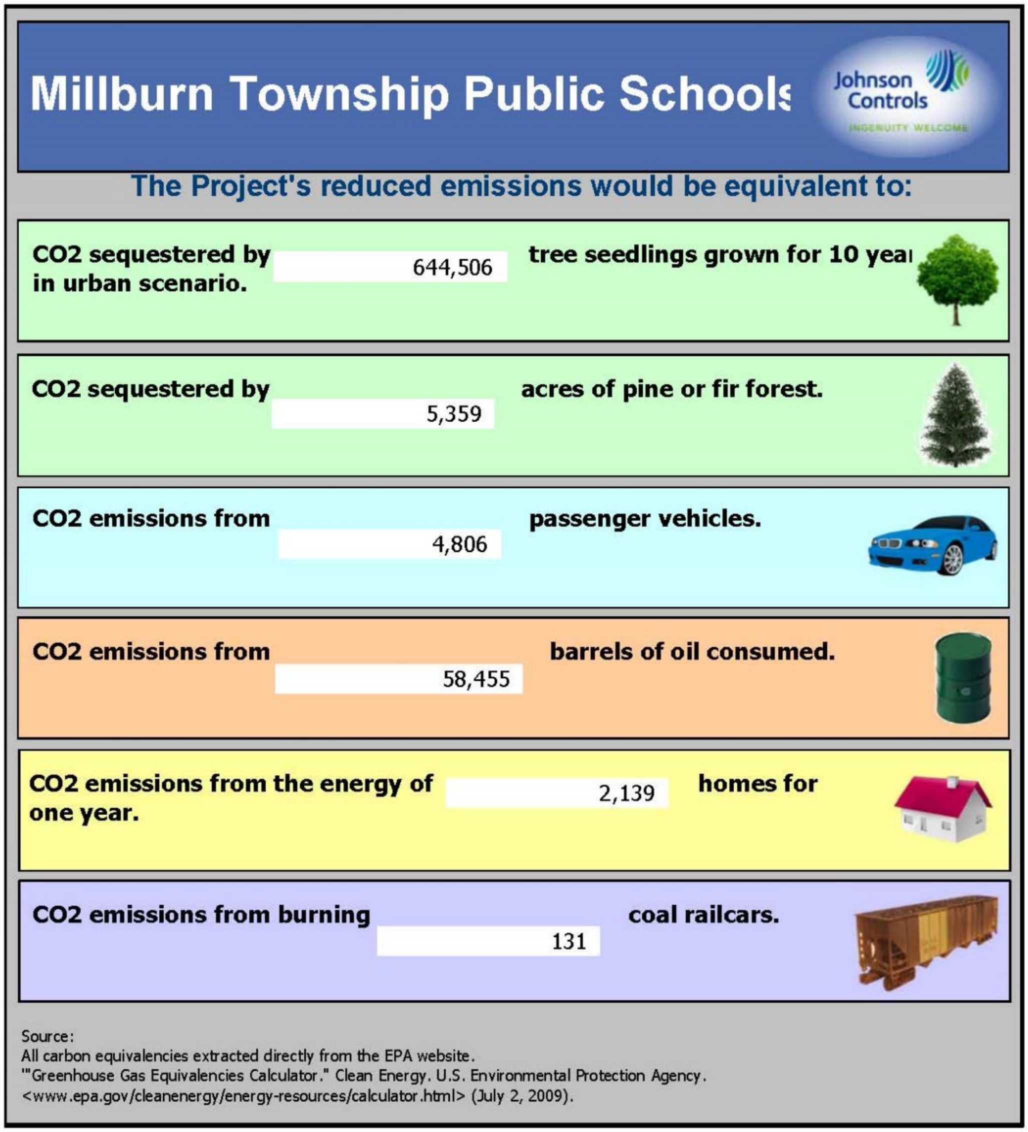
Greenhouse Gas Reductions



AVOIDED EMISSIONS	Total Electric Savings	Total Natural Gas Savings	Total Annual Avoided Emissions
Annual Unit Savings	1,457,099 kWh	106,501 Therms	
NO_X	1,384 lbs	980 lbs	2,364 lbs
SO_2	3,220 lbs	0 lbs	3,220 lbs
CO_2	1,619,988 lbs	1,246,062 lbs	2,866,050 lbs

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Section 4. Potential Energy Conservation Measures

The following Energy Conservation Measures have been investigated for Millburn Township Public Schools.

ECM #3-10 - Infiltration Reduction

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. Each building within the scope was surveyed in order to identify potential improvements for outside air infiltration reduction. The main observations are listed below:

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

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

Facilities Recommended for this Measure

- Deerfield Elementary School
- Education Center
- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School
- Wyoming Elementary School

Scope of Work

A building envelope audit was performed for the entire Millburn Township Public Schools. The results of the audit were the identification of several areas of envelope deficiency. The deficient areas were tabulated and their savings potential calculated.

Deerfield Elementary School

- Quantity Envelope Improvements
  - 2.21 Sq/ft - Penetrations sealed with polyurethane sealant
  - 476 LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant

- 23 Sets of weather-strip DF
- 28 Door sweeps
- 9 Astragals (weather-strip for center of double door)

Education Center

- Quantity Envelope Improvements
  - 0.11 Sq/ft - Penetrations sealed with polyurethane sealant
  - 460 LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant
  - 6 Sets of weather-strip DF
  - 6 Door sweeps
  - 3 Astragals (weather-strip for center of double door)
  - 23 Ea-Magnetite Window System (alternate scope)
  - 283 LF Weather strip around operable windows

Glenwood Elementary School

- Quantity Envelope Improvements
  - 1.77 Sq/ft - Penetrations sealed with polyurethane sealant
  - 3504 LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant
  - 15 Sets of weather-strip DF
  - 15 Door sweeps
  - 5 Astragals (weather-strip for center of double door)
  - 2800 sq/ft – Blown insulation to a depth of 10" (alternate scope)

Hartshorn Elementary School

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

High School

- Quantity Envelope Improvements
  - 6.92 Sq/ft - Penetrations sealed with polyurethane sealant
  - 179 LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant
  - 72 Sets of weather-strip DF
  - 72 Door sweeps
  - 34 Astragals (weather-strip for center of double door)
  - 1 EA – Replace vent cover (4"X16")
  - 1 EA – Replace electrical outlet cover

Middle School

- Quantity Envelope Improvements
  - 2.5 Sq/ft - Penetrations sealed with polyurethane sealant
  - 3586 LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant
  - 39 Sets of weather-strip DF
  - 40 Door sweeps
  - 10 Astragals (weather-strip for center of double door)

Wyoming Elementary School

- Quantity Envelope Improvements
  - 0.82 Sq/ft - Penetrations sealed with polyurethane sealant
  - 100 LF - Wall cracks, window/door frames and vents sealed with polyurethane sealant
  - 14 Sets of weather-strip DF
  - 18 Door sweeps
  - 5 Astragals (weather-strip for center of double door)
  - 9721 Sq/ft – Blown insulation to a depth of 10”
  - 1 EA – Replace 18”X18” damper

Savings Methodology

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

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

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

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

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

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

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

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

Cw = wind coefficient = 0.0104 average

V = wind speed = 8.8 average mph

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

ΔT = temperature difference = Tout – Tin

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

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

Maintenance

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

Benefits

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

ECM #11-18 – Solar Energy Window Film

ECM Summary

Window film helps prevent heat gain/loss on the glass from the sun. This measure proposes the installation of window film on the interior side of the windows to prevent further energy loss. In addition to the heat gain/loss benefits, security window film will improve the security of each of the schools.

Facilities Recommended for this Measure

- Deerfield Elementary School
- Education Center
- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School
- South Mountain Elementary School
- Wyoming Elementary School

Scope of Work

- Install 3M Security window film (Ultra600) and IPA on the entrances and 3M Tinted security film on interior side of windows located on the first floor and below 6'.
- Clean-up of all job related debris daily. Clean-up and store tools, equipment, etc. daily and remove after successful installation and operational check-out.

Deerfield Elementary School

Elevation	Ultra 600 on Main Entrance (sqft)	Tinted Security on Windows (sqft)
N	32	592
S	16	1,260
E	59	409
W	192	810
Total	**299**	**3,071**

Education Center

Elevation	Ultra 600 on Main Entrance (sqft)	Tinted Security on Windows (sqft)
N	N/A	120
S	9	80
E	N/A	147
W	70	120
Total	**79**	**467**

Glenwood Elementary School

Elevation	Ultra 600 on Main Entrance (sqft)	Tinted Security on Windows (sqft)
N	24	N/A
S	9	N/A
E	30	298
W	31	1,417
Total	**94**	**1,715**

High School

Elevation	Ultra 600 on Main Entrance (sqft)	Tinted Security on Windows (sqft)
N	119	740
S	175	699
E	115	164
W	331	1,077
Total	**740**	**2,680**

Middle School

Elevation	Ultra 600 on Main Entrance (sqft)	Tinted Security on Windows (sqft)
N	14	1,748
S	106	1,606
E	46	222
W	55	263
Total	**221**	**3,839**

South Mountain Elementary School

Elevation	Ultra 600 on Main Entrance (sqft)	Tinted Security on Windows (sqft)
N	N/A	59
S	N/A	143
E	22	535
W	46	540
Total	**68**	**1,277**

Wyoming Elementary School

Elevation	Ultra 600 on Main Entrance (sqft)	Tinted Security on Windows (sqft)
N	63	67
S	7	283
E	11	N/A
W	11	207
Total	**92**	**557**

Savings Methodology

Energy savings are based on the Excel-based Bin calculations. The calculation compares the direct solar heat gain and diffuse solar heat gain before and after the window film is installed. If the process reveals any variation in the as-built conditions, then savings will be adjusted accordingly.

Maintenance Requirements

Annual maintenance procedures should be followed as recommended by window film's manufacturer.

Benefits

- Increased security of building
- Reduced HVAC operation due to the improvement of heat gain/loss

ECM #19-26 – Low Flow Water Fixtures

ECM Summary

Although water and sewer costs are often a smaller percentage of a District's utility budget, reducing water consumption through low-flow water fixtures can save significant utility costs. This measure will focus on the faucet aerators in public restrooms to reduce the flow when used.

Facilities Recommended for this Measure

- Deerfield Elementary School
- Education Center
- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School
- South Mountain Elementary School
- Wyoming Elementary School

Scope of Work

- Remove the existing aerators from bathroom lavatory faucets and install 0.5 gpm flow rate aerators.

Building	Quantity Installed
Deerfield ES	19
Education Center	4
Glenwood ES	21
Hartshorn ES	29
High School	53
Middle School	60
South Mountain ES	21
Wyoming ES	23
Total	*230*

Savings Methodology

Savings are from the reduced water usage and the reduced heating fuel (natural gas) consumption associated with lower water flow. The savings were calculated utilizing Excel-based Bincalc. The savings calculation formula is presented below:

Water Usage (kGal/yr) = Quantity X (Fixture flow rate in gpm) X (Uses/Yr/Quantity of fixtures) X (0.5 Minutes/Use) X (1 kGal/1,000 gallons) X (50% of Hot water flow)

Energy Usage (Therms/yr) = (Water Usage in kGal/yr) X (8.34 lb/gal) X (1 BTU/lb-F) X (Hot water temp – City Water Temp) / (Boiler efficiency) X (1 therm/100,000 Btu)

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- Baseline Fixture flow Rate = 2.0 gpm
- Post-retrofit Fixture Flow Rate = 0.5 gpm

Maintenance Requirements

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

ECM #27-30 – Pedal Valves

ECM Summary

Food service sinks may be retrofitted with hands free foot pedal faucet controllers. These pedals eliminate existing faucet leaks as well as help prevent the user from walking away from the sink and leaving the water running. Customers prefer the pedal valve controls since they eliminate the need to touch the faucet controls and, therefore, eliminate hand contamination at the faucets; this is especially advantageous at food service and medical sinks.

Facilities Recommended for this Measure

- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School

Scope of Work

- Retrofit existing kitchen sinks by installing pedal valves (for both hot and cold water service). Three sinks will be updated appropriately, one dedicated to food preparation, one for pot wash, and the other one for hand cleaning.

Building	Quantity of Hand Cleaning	Quantity of Food Prep	Quantity of Pot Wash
Glenwood ES	1	0	0
Hartshorn ES	3	0	0
High School	1	1	1
Middle School	1	2	2
Total	***6***	***3***	***3***

Savings Methodology

Savings are from the reduced water usage and heating fuel (natural gas) usage by automatically shutting off the water while they are not used. The savings were calculated in Excel and compared to the water usage before and after the pedal valves are installed. The savings calculation formula is presented below:

Water Usage (kGal/yr) = Quantity X (Fixture flow rate in gpm) X (Days/yr) X (Usage mins/day) / (1 kGal/1,000 gallons)

Energy Usage (Therms/yr) = (Water Usage in Gal/yr) X (8.34 lb/gal) X (1 BTU/lb-F) X (Hot water temp – City Water Temp) / (Boiler efficiency) X (1 therm/100,000 Btu)

Where

Flow rate =	2.2 gpm
Days/yr =	200 days/yr
Avg water temp =	90^{F} for hand cleaning and food prep and 110F for pot wash
Hot water used =	50% for hand cleaning and food prep and 83.3% for pot wash
Hot water temp =	120^{F}
Cold water temp =	60^{F}

Maintenance Requirements

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

ECM #31 - Academy of Energy Education

This measure will provide an educational component to the Energy Savings Plan. No energy savings are claimed for the measure.

In combination with a Johnson Controls performance contract, The Academy of Energy Education program teaches individuals to modify their behavior which results in greater energy efficiency. The Academy is a proven way to deliver curriculum-enhancing programs that combine the study of exploratory science, energy and math with real world experience offering young students the opportunity to have fun while learning about energy in a wide variety of curriculum-enhancing packages. The Academy offers a comprehensive approach to energy education with a focus on sustainability.

In partnership with National Energy Foundation (NEF), a non-profit organization dedicated to the development, dissemination, and implementation of supplementary educational materials, programs, and courses, Johnson Controls developed the Academy of Energy Education. It is designed to educate and involve students in energy conservation at school and home.

The Academy training and materials go hand in hand to help educators efficiently use Academy materials and learn how they correlate with state/national standards. In addition to curriculum programs and training, Academy customers receive access to the Academy of Energy website. The website offers K12 curriculum, K12 and community awareness activities, training resources, blogs, competitions, and educational libraries.

Scope of Work

Energy Action Technology, grades 9-12, teaches advanced energy concepts. Over 72 learning activities and seven Sources of Energy posters and corresponding Energists teach students about energy technologies and society as they begin to make the transition from school to work. The sources are: Coal, Oil, Natural Gas, Nuclear, Water, Renewable Energy, and Electrical Generation. Five full color technical posters teach about the Science of Flames, Petroleum Technology, Natural Gas Technology, Recycling Used Oil and Electrotechnology. The Energy Action Challenge gives students the opportunity to put into action at home what they have learned at school.

Solar Energy in Action, grades K-12, this interdisciplinary program includes learning activities for the elementary and secondary levels plus a supply kit that students may use to investigate solar energy and its uses. Additional supplemental instructional materials include the Renewable Energy Sources poster and accompanying Energist, the Electrical Generation poster and Energist, the Energy Basics CD, and the Eye Chart poster. This program can stand alone or serve as an excellent complement to Energy Fun, Energy Fundamentals, Energy Action Technology, or Energy Action Patrol.

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

Career Exploration, grades 11-12, provides students with career related work experience while obtaining up to 40 hours of academic credit. The program allows students a superb opportunity to integrate classroom theory into the world of work, as well as providing career option exploration, practical experiences, new skill development, realistic perceptions of the work environment, and professional contacts. The externship experience is a vital component of any major technical level of instruction.

Externship, for college undergraduates, provides students with up to 100 hours of career-related work experience at a Johnson Controls office while obtaining three semester hours of college credit. This experience will offer students an on-site, hands-on opportunity to think about a career in the energy field. Whether a student has interest in technology, engineering, sales, administration, etc. this course will assist with workforce development decisions for the student and Johnson Controls.

Academy Geothermal: grades 4-12, is an interdisciplinary program that includes activities for the elementary and secondary levels. A supply kit is provided that includes materials to conduct the investigations that explore geothermal energy and its applications. Additional resources include the 23” X 35" Geothermal Energy Poster, an instructional poster that teachers about geothermal energy: history, technologies, residential and commercial applications, careers and the future of geothermal energy. Students will be guided through

a series of activities. For example, the activity titled: “Inside Out Earth”, describes the layers of the earth and some of the source for heat when using geothermal energy.

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

Academy Water: K-12, is a family of interdisciplinary curriculum materials designed to guide teachers through water basics, elementary water activities and then secondary activities that also include an exploration of technologies associated with water. The hydrologic cycle is explored as well as electric generation with water. Some of the activities are: Water in Your Own Backyard, Waterproof Savings, Building Water Turbines.

- Provide unlimited access to the Academy website via a user name and password.
- Access is valid for 3 years from execution date of contract. After 3 years, access may be renewed annually as part of a Planned Service Agreement.
- Academy of Energy Education Program website includes:
  - Classroom ready materials, plans and activities that align with K-12 curriculums
  - Activities for students, teachers and communities to encourage natural resource conservation
  - Teachers blog
  - Miscellaneous: laboratory materials, posters, training resources, competitions, educational libraries
- Provide a virtual orientation meeting to the Academy website

ECM #32 – Building Automation System Training

This measure will provide training to the onsite maintenance team. No energy savings are claimed for the measure.

In order to ensure the District is fully capable of achieving the energy savings and fully utilizing the new Building Automation Systems, Johnson Controls has included training for district employees. This measure will include either the Johnson Controls Training Institute or the Siemens controls equivalent of offsite training courses. This measure will be in addition to the on-site training included with all other upgrades.

ECM #33 - Demand Response – Emergency Capacity Program

Participation in the Emergency Response program requires a Customer to reduce electricity consumption when notified by Johnson Controls that an Event is called by PJM (the grid operator). Upon notification, Millburn Township Public Schools is obligated to reduce, or “curtail” electric consumption to or by the specified contracted curtailment until the Event has completed per the program’s specific requirements. In

addition, Millburn Schools is required to demonstrate the ability to curtail demand for electricity during a test to verify the curtailment capability. Notice of a test or Event shall be delivered as designated on the Property Information Form.

Terms used herein are defined as follows:

a. **Peak Load Contribution (PLC)** – The electrical peak demand as calculated by Customer's energy supplier or utility.
b. **Firm Service Level (FSL)** – The electric demand (in kW) to which the Property shall reduce if notified by ECI.
c. **Event** – A PJM Electric Grid Emergency, prompting ECI to notify Customer to reduce electric consumption.

Event call parameters:

Program Type	**Extended**	**Limited**
Customer Availability	June 1st – May 31st	June 1st – May 31st
Mandatory Period	June 1st – October 31st and following May 1st -31st	June 1st – September 30th
Potential Event Hours	10:00 am – 10:00 pm, 7 days a week	12:00 pm – 8:00 pm Weekdays excluding national holidays
Duration per Event	Up to ten hours	Up to six hours
Number of Events	Unlimited	Up to 10

Millburn Township Public Schools will be paid to be on standby to drop a portion of their load in response to a PJM-initiated emergency event. The season for which events can be called will be May 1 – October 31; up to 10 times per season, up to 6 hours per event from the hours of 10 a.m. to 10 p.m. JCI will provide a thirty minute notification to Millburn Township Public Schools prior to each event. To verify program integrity there is a mandatory one hour test to validate all committed load drops are indeed a reliable resource in the event of an actual grid emergency. Required communication verification will also be conducted. JCI will schedule both a communications verification and load drop test with Millburn Township Public Schools. The Millburn Township Public Schools is required to provide emergency contact information to JCI for dispatching purposes. Contact information will include both phone and email contact information.

The primary curtailment strategy for Emergency Capacity curtailment is, but not limited to, shut down cooling on selected units and pre-cooling of the spaces. JCI will provide a graphics user interface for the affected facility which will allow for enable and disable for HVAC zone(s) for curtailment. Millburn

Township Public Schools will be responsible for this user interface to curtail loads when dispatched by JCI. Upon receipt of a dispatch from JCI for a test or event called by PJM, Millburn Township Public Schools is required to initiate the curtailments at each of the affected facility.

Event notification:

Customer will be given 30 minute notification in which Customer must reduce electric demand to the specified contracted level and duration as determined by PJM.

Millburn Township Public Schools will be paid a Standby Price per kW as shown below for the respective performance season, up to the committed curtailment.

Performance Season	2015 -16 Extended	2016 -17 Extended	2017 -18 Extended	2018 and beyond
Customer Standby Price (per kW)	$45.97	$32.61	$29.02	TBD

Proposed System Interface
Through our web based portal branded GridConnect, JCI interfaces with PJM enabling our Demand Response energy curtailment programs. A GridConnect subscription will be authorized to Millburn Township Public Schools with user rights and will be provisioned for High School and Middle School. GridConnect will be the primary source for communication to the customer for event notification via phone and e-mail contacts. Building Automation Software will be used to interface and execute curtailment strategies. Site mechanical HVAC equipment and systems will be used to accomplish nominated curtailments. JCI will provide the necessary control points and engineering to sequence the curtailment(s) related to the Mechanical HVAC equipment and systems for each site.

Scope of Work

In this program, Millburn Township Public Schools is paid to be on standby to drop a portion of their load in response to a PJM-initiated emergency event. To verify program integrity, there is a mandatory one hour test to validate all committed load drops are indeed a reliable resource in the event of an actual grid emergency.

Total load contribution for Millburn Township Public Schools– 640 kW (2016/2017)

Participation in the Emergency Response program requires Millburn Township Public Schools to reduce electricity consumption when an Event is called by PJM. Notice of an Event shall be delivered by email and/or automated phone call. Upon notification, Millburn Township Public Schools is obligated to reduce electric consumption to or by the specified contracted load drop until the Event has completed per the program's specific requirements. In addition, Millburn Township Public Schools is required to demonstrate

the ability to reduce demand for electricity during a test to verify the reduction capability. Notice of a test or Event shall be delivered by email, pager and/or automated phone call.

Compliance in the Emergency Response program requires that each site reduce load at or below their pre-determined Firm Service Level. This is the actual electric load each school must drop to and maintain during the duration of the event.

Building Strategy Recommendations/Sequence of Operations

Below is the Sequence of Operations that should be followed when an event is called. It will be the responsibility of Millburn Township Public Schools to ensure that the following is implemented.

1. At the hour when the event begins, all areas served by equipment 3 will be put into unoccupied mode. During unoccupied mode all set point should be increased to 85^{o}F to ensure all fans, pumps, and roof top units will not come on.
2. When the event or test is complete, change back to normal setting.

School	Equipment	Curtailment Value
High School	New & Existing Cooling Units	420 KW
Middle School	Existing Cooling Units	220 KW
Total		**640 kW**

ECM #34 - Demand Response – Energy Efficiency Program

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

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

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

Facilities Recommended for this Measure

- Deerfield Elementary School

- Education Center
- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School
- South Mountain Elementary School
- Wyoming Elementary School

ECM #39 - Pay for Performance

ECM Summary

Johnson Controls is a partner in the New Jersey Pay for Performance Program. This program allows schools district to obtain rebate for energy savings project above and beyond the standard NJ Smart program when energy savings exceeds 15% of the baseline usage for each school.

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

Eligibility

Existing commercial, industrial and institutional buildings with a peak demand over 200 kW for any of the preceding twelve months are eligible to participate including hotels and casinos, large office buildings, multi-family buildings, supermarkets, manufacturing facilities, schools, shopping malls and restaurants. Buildings that fall into the following five customer classes are not required to meet the 200kW demand in order to participate in the program: hospitals, public colleges and universities, non-profits, affordable multifamily housing, and local governmental entities. Your energy reduction plan must define a comprehensive package of measures capable of reducing the existing energy consumption of your building by 15% or more.

Facilities Recommended for this Measure

- High School

Scope of Work

- The following services will be provided during the development of the ESP Millburn Township Public Schools:
  - Coordinate with the school district to complete and submit the Pay for Performance Application
  - Develop and submit Energy Reduction Plan to Pay for Performance Case Manager
  - Complete and submit Request for Incentive #1
  - Conduct necessary reviews with Pay for Performance Case Manager

- During and after installation of measures is complete the following services will be provided:
  - Complete and submit request for Incentive #2
  - Conduct necessary reviews with Pay for Performance Case Manager to ensure equipment has been installed according to scope of work submitted in ERP and ESIP
- After year 1 of performance period:
  - Complete post-construction benchmarking report
  - Complete and submit with request for Incentive #3
  - Conduct necessary reviews for Incentive #3
- At this time, Johnson Controls anticipates the receipt of the following Pay for Performance incentives for the project:

ECM #53 – Boiler Replacement

ECM Summary

JCI proposes to replace the two existing Fitzgibbons boilers with condensing boilers. These boilers will be sequenced to operate on a lead/lag basis when there is a call for heat from the building and they will be integrated with the existing building management system.

Facilities Recommended for this Measure

- Hartshorn Elementary School

Scope of Work

General

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

Demolition and Removal Work

- Disconnect, remove and properly dispose of existing two (2) Fitzgibbons HW boilers.
- Disconnect, remove and properly dispose of HW piping to nearest isolation valves or as required for new installation.
- Disconnect, remove and properly dispose of gas flue as required.
- Disconnect, remove and properly dispose of all other materials or debris related to this project.

New Installation Work

Provide and install three (3) new Lochinvar Crest, or Johnson Controls approved equal condensing HW boilers. The new boilers shall have an input rating of at minimum 1,000 MBH at full load.

a. The condensing boilers to have an output capacity of at minimum 930 MBH each.
b. Modulating burner with a turndown ratio of 15:1 or higher.
c. System efficiency >=90% at 120F entering water temperature (50% firing rate).
d. New boiler to have Boiler Management System.
e. New boiler to have controls that should be capable of integrating with the existing building management system.

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f. Boilers and controls to comply with applicable regulations.
g. Provide U.L. labeled burner(s).
h. Burners to have stack O_2 sensor based on optimal A/F ratio controls.
i. The boilers shall be located in the existing location with hot water piping and all other piping extended as required for connection. New hot water piping will be installed from the new boilers and tied into the existing header.
j. Insulate new piping, valves and fittings as required.
k. Provide and install new 3-way control valve for hot water reset, if necessary.
l. Provide boiler pad if use of existing is inadequate.
m. Install boilers based on manufacturer's installation procedures.
n. Provide and install new flue as required.
o. Patch and repair all penetrations.
p. Provide Valve Tags and ID Chart.
q. Provide pipe Labelling and Directional Arrows.
r. Start-up, checkout and verify all modes (stages) of operation (by factory authorized rep.) including measurement and verification of "part load" and "full load" efficiencies, combustion gas analysis and ALL Unit control features per manufacturer's start-up and checkout procedures.
s. Reuse existing piping, pipe fittings, pipe hangers, isolation valves, strainers, check valves, thermal wells, and pressure sensor wells where feasible and equipment serviceable.
t. Asbestos removal is responsibility of others.

Savings Methodology

Savings for the boiler replacements in Hartshorn Elementary School were calculated based on improvement in boiler efficiency. The existing boiler efficiency was based on the age of the boiler, published information from the manufacturer, and results of the building simulation models. Boiler replacement savings were calculated in Excel-based Bincalc.

- Existing Boiler Combustion Efficiency used in calculations is = 82%
- Proposed Boiler Combustion Efficiency used in calculations is = 82%
- Existing Boiler Radiant Jacket Losses used in calculations is = 3%
- Proposed Boiler Radiant Jacket Losses used in calculations is = 2%
- Existing Boiler Distribution & Parasitic Losses used in calculations is = 2%
- Proposed Boiler Distribution & Parasitic Losses used in calculations is = 1.5%

Maintenance Requirements

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

Benefits

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

ECM #54-55 – Burner Replacement

ECM Summary

JCI proposes to replace the two existing old burners with new linkage less A/F controlled burners.

Facilities Recommended for this Measure

- Deerfield Elementary School
- Millburn High School

Scope of Work

Replace the burner(s) in the existing boiler(s) listed in table below and install new combustion controls. New burners and controls will improve the part load efficiency of the boilers. New burners will be natural gas fired and will have a turn down ratio of 10:1 (maximum). The scope of burner replacement includes the following:

- Remove the existing burner including the combustion air damper controls, on each of the boilers. One boiler will be retrofitted and started prior to proceeding to the next unit. The older burners will be the property of Millburn Schools to use as spare parts.
- Provide and install a total of four (4) AutoFlame MK7 or Fireye or Johnson Controls approved equal Linkage-less burner controls.

Facility	No.	Proposed Burner Model		
		Make	Model	Linkage-less Controls
Millburn High School	Burner #1	PowerFlame	C3-GO-25	AutoFlame MK7
Millburn High School	Burner #2	PowerFlame	C3-GO-25	AutoFlame MK7
Deerfield Elementary School	Burner #1	PowerFlame	C3-GO-20	AutoFlame MK7
Deerfield Elementary School	Burner #2	PowerFlame	C3-GO-20	AutoFlame MK7

- Each burner will consist of a minimum of the following components: A wind box, an integral fan, an air register, a spark ignited natural gas pilot and natural gas built in accordance with the recommendations of factory mutual and in accordance with NFPA 85 standards.

Start-up and Service

- The contractor shall obtain the services of a factory-authorized agent to provide burner light off and adjustment. The start-up agent shall provide a burner light-off report as written proof that the burner was adjusted to optimum performance.
- The authorized agent shall provide a one-year service warranty after start-up.

Savings Methodology

Savings for the burner replacement in Deerfield Elementary School and the High School were calculated based on improvement in boiler efficiency. The existing boiler efficiency was based on the age of the

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boiler, published information from the manufacturer, and results of the building simulation models. Boiler replacement savings were calculated in Excel-based Bincalc.

- Existing Burner Combustion Efficiency used in calculations is = 81%
- Proposed Burner Combustion Efficiency used in calculations is = 83.5%

Maintenance Requirements

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

Benefits

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

ECM #56 – Combined Heat and Power

ECM Summary

JCI proposes to install one (1) 75 kW cogeneration machine at High School to supply electricity to the building offsetting a portion of the load and reject heat into the hot water heating system.

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

Facilities Recommended for this Measure

- Millburn High School

Scope of Work

- One (1) Tecogen or Aegis 75-kW unit, or Johnson Controls approved equal, cogeneration unit will be installed in the Millburn High School boiler room.
- One (1) pump and valve module station complete with circulating pump and thermostatic mixing valve to be located in the boiler room.
- Load modules for interfacing with the boiler plant, building space heating and other thermal loads encompassing pumps, heat exchangers, control values, and sensors for system monitoring and remote operation.
- 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 the local 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, variable speed drives, and devices for data communication for live monitoring and operating controls of the entire system. BAS package for CHP plant control panel.
- Provide BTU meter (flow & temperature) measurements in the heat recovery loop and interface these control points to the central BMS for trending.
- 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.

Savings Methodology

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

Energy:	75 kW/module x 1 module(s) x 1 net after "parasitics" = 75 net kW output x $/kWh avg displaced energy chg
Demand :	75 kW/module x 1 module(s) available x 1 net after "parasitics"
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. In order to be eligible for New Jersey Clean Energy incentives, Millburn Township Public Schools must demonstrate that they have contracted for an extended maintenance agreement to service the cogeneration units. This maintenance agreement will be conducted outside of the Energy Savings Improvement Program.

Benefits

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

ECM #57 - Pipe Insulation and Blankets

ECM Summary

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

Facilities Recommended for this Measure

- Deerfield Elementary School
- Education Center
- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School
- South Mountain Elementary School
- Wyoming Elementary School

Scope of Work

Piping insulation thickness will be added based on the following table:

Piping	Type	Pipe size	Type A insulation thickness
Domestic hot water	A	All	1”
Hot/Dual Temp Water Geothermal	A	½” – 1 ¼”	1.5”
Hot/Dual Temp Water Geothermal	A	1½” – 10”	2”
Steam	A	½” – 3 ½”	2.5”
Steam	A	4” – 10”	3”
Steam Condensate	A	½” – 1 ¼”	1.5”
Steam Condensate	A	1 ½” – 10”	2”
Chilled water	A	½” – 3 ½”	1”
Chilled water	A	4” – 8”	1.5”

- Insulation type:
  - Type A: Knauf 1000° Pipe Insulation, ASTM C547, Class 1, k value of 0.23 at 75 degrees F, with All Service Jacketing (ASJ) or equal.
  - Fittings: All fittings with Type A Pipe Insulation will be Proto Fitting Covers manufactured from 20-mil thick high-impact, ultra-violet-resistant PVC, or equal.

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    - Jacket: All type A Pipe insulation includes a Foil and Paper Jacket: Laminated glass fiber-reinforced, flame retardant kraft paper and aluminum foil – white exterior, Kraft reinforce foil vapor barrier with self-sealing adhesive joints.
    - Accessories: All Type A Pipe Insulation terminations will be neatly finished with Childers Vi-Cryl CP-11 Mastic, or equal
        - A detailed line-by-line scope of work has been included in the Appendix with the associated energy savings calculations for the insulation.
- Equipment insulation
    - Equipment: interior exposed above ambient temperature pumps, air separator, expansion tank.
    - Insulation type: Fiberglass/ w ASJ jacketing, 2” thickness.
- Insulation type:
    - Type A: Knauf Fiberglass, Kwikflex Pipe & Tank Insulation, ASTM C 1393, Types I,II, IIIA, IIIB Category 2, ASTM , flame spread rating is <25 and smoke developed rating is <50 as tested by ASTM E84,k value of 0.24 at 75 degrees F, with all service jacketing, or equal.

The following tables indicate the scope of work for each building:

Deerfield Elementary School

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Domestic Hot Water (900)	1/2	1.0	9	4	1	0			
Boiler Room	Domestic Hot Water (900)	3/4	1.0	3	5	2	0			
Boiler Room	Domestic Hot Water (900)	1	1.0	0	1	1	2			
Boiler Room	Domestic Hot Water (900)	1 1/4	1.0	19	11	0	0			
Boiler Room	Domestic Hot Water (900)	1 1/2	1.0	3	9	5	0			
Boiler Room	Domestic Hot Water (900)	2	1.0	2	0	0	0			
Boiler Room	Heating Hot Water (900)	1/2	1.0	50	25	17	0			
Boiler Room	Heating Hot Water (900)	3/4	1.0	22	15	13	0			
Boiler Room	Heating Hot Water (900)	1	1.0	30	31	8	2			
Boiler Room	Heating Hot Water (900)	1 1/2	1.0	0	0	0	2			
Boiler Room	Heating Hot Water (900)	2	1.0	7	4	9	4			
Boiler Room	Heating Hot Water (900)	2 1/2	1.0	0	0	0	2			

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Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Heating Hot Water (900)	3	1.0	6	6	2	12			
Boiler Room	Heating Hot Water (900)	4	1.0	16	19	6	8			
Boiler Room	Heating Hot Water (900)	5	1.5	5	4	2	2			
Boiler Room	Heating Hot Water (900)	10	1.5	0	2	0	0			
Boiler Room	Domestic Hot Water (900)	1	1.0						1	
Boiler Room	Domestic Hot Water (900)	1 1/2	1.5					1		
Boiler Room	Heating Hot Water (900)	Tank Shell	2.0	5						
Boiler Room	Heating Hot Water (900)	2	2.0					2	2	
Boiler Room	Heating Hot Water (900)	3	2.0							4
TOTAL				177	136	66	34	3	3	4

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Education Center

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Chilled Water	1/2	1.0	1	2	0	0			
Boiler Room	Chilled Water	1 1/4	1.0	1	1	1	0			
Boiler Room	Chilled Water	3	1.0	1	0	3	2			
Boiler Room	Domestic Hot Water (950)	1/2	1.0	3	4	0	2			
Boiler Room	Domestic Hot Water (950)	3/4	1.0	1	4	0	0			
Boiler Room	Domestic Hot Water (950)	1	1.0	2	2	1	0			
Boiler Room	Dual Temp Water (950)	3/4	1.5	2	4	0	0			
Boiler Room	Dual Temp Water (950)	1 1/4	1.5	5	8	5	0			
Boiler Room	Dual Temp Water (950)	1 1/2	2.0	1	5	0	0			
Boiler Room	Dual Temp Water (950)	3	2.0	1	0	2	3			
Boiler Room	Dual Temp Water (950)	3	2.0	0	1	0	2			
Boiler Room	Heating Hot Water (950)	1/2	1.0	12	5	4	0			

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Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Heating Hot Water (950)	3/4	1.0	12	9	1	0			
Boiler Room	Heating Hot Water (950)	1	1.0	9	8	1	0			
Boiler Room	Heating Hot Water (950)	1 1/4	1.0	1	1	4	0			
Boiler Room	Heating Hot Water (950)	1 1/2	1.0	5	3	0	0			
Boiler Room	Heating Hot Water (950)	3	1.0	4	5	1	0			
Boiler Room	Heating Hot Water (950)	4	1.0	1	2	0	0			
Boiler Room	Heating Hot Water (950)	6	1.5	6	2	0	0			
Boiler Room	Heating Hot Water (950)	7	1.5	3	2	0	0			
Boiler Room	Chilled Water	3	1.0					3		
Boiler Room	Domestic Hot Water (950)	1/2	1.0					1	1	
Boiler Room	Domestic Hot Water (950)	1	1.0					1		
Boiler Room	Dual Temp Water (950)	3	2.0					2		
Boiler Room	Dual Temp Water (950)	3	2.0							2

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Heating Hot Water (950)	1 1/2	1.5					3	1	
Boiler Room	Heating Hot Water (950)	Tank Shell	2.0	5						
Boiler Room	Heating Hot Water (950)	3	2.0					1		
Boiler Room	Dual Temp Water Cold	3/4	1.5	2	4	0	0			
Boiler Room	Dual Temp Water Cold	1 1/4	1.5	5	8	5	0			
Boiler Room	Dual Temp Water Cold	1 1/2	2.0	1	5	0	0			
Boiler Room	Dual Temp Water Cold	3	2.0	1	0	2	3			
Boiler Room	Dual Temp Water Cold	3	2.0	0	1	0	2			
Boiler Room	Dual Temp Water Cold	3	2.0					2		
Boiler Room	Dual Temp Water Cold	3	2.0							2
TOTAL				84	86	30	14	13	2	4

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Glenwood Elementary School

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS					
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)
Boiler Room	Domestic Hot Water (880)	1/2	1.0	42	9	1	2		
Boiler Room	Domestic Hot Water (880)	3/4	1.0	1	1	0	0		
Boiler Room	Domestic Hot Water (880)	1 1/4	1.0	11	9	0	0		
Boiler Room	Heating Hot Water (880)	1	1.0	1	1	0	0		
Boiler Room	Heating Hot Water (880)	1 1/4	1.0	1	0	1	0		
Boiler Room	Heating Hot Water (880)	2	1.0	1	1	0	10		
Boiler Room	Heating Hot Water (880)	2 1/2	1.0	0	0	2	2		
Boiler Room	Heating Hot Water (880)	3	1.0	4	3	9	0		
Boiler Room	Steam Condensate (880)	1/2	1.5	12	6	4	0		
Boiler Room	Steam Condensate (880)	3/4	1.5	58	25	2	0		

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS					
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)
Boiler Room	Steam Condensate (880)	1	1.5	146	64	13	0		
Boiler Room	Steam Condensate (880)	1 1/4	1.5	6	3	0	0		
Boiler Room	Steam Condensate (880)	1 1/2	2.0	74	11	0	0		
Boiler Room	Steam Condensate (880)	2	2.0	14	10	5	0		
Boiler Room	Steam Condensate (880)	2 1/2	2.0	40	10	2	1		
Boiler Room	Steam Condensate (880)	3	2.0	3	5	0	0		
Boiler Room	Steam Condensate (880)	4	2.0	7	13	0	0		
Boiler Room	Steam Condensate (880)	5	2.0	1	1	0	0		
Boiler Room	Steam (880)	1/2	2.5	2	2	5	0		

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS					
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)
Boiler Room	Steam (880)	3/4	2.5	14	9	6	0		
Boiler Room	Steam (880)	1	2.5	13	26	3	0		
Boiler Room	Steam (880)	1 1/2	2.5	1	0	0	0		
Boiler Room	Steam (880)	2	2.5	1	2	0	0		
Boiler Room	Steam (880)	2 1/2	2.5	17	2	0	0		
Boiler Room	Steam (880)	3	2.5	6	3	0	0		
Boiler Room	Steam (880)	4	3.0	0	0	0	1		
Boiler Room	Steam (880)	5	3.0	1	1	2	4		
Boiler Room	Steam (880)	6	3.0	0	0	1	0		
Boiler Room	Steam (880)	8	3.0	0	0	2	0		
Boiler Room	Steam (880)	12	3.0	0	1	0	0		
Boiler Room	Domestic Hot Water (880)	1/2	1.0						1
Boiler Room	Air Separator	Tank Shell	2.0	5					

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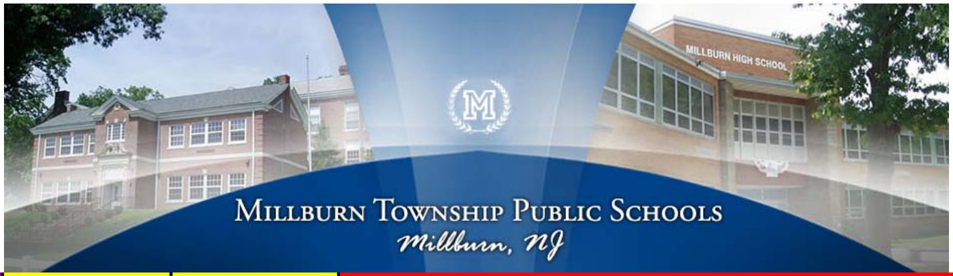
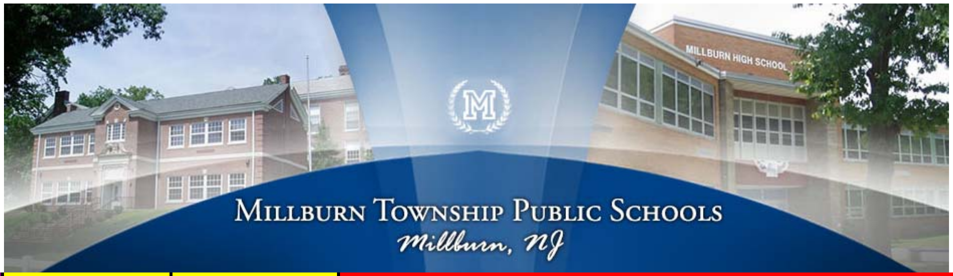
Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS					
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)
	Heating Hot Water (880)								
Boiler Room	Heating Hot Water (880)	2	2.0						4
Boiler Room	Chemical Feed Heating Hot Water (880)	Tank Shell	2.0	4					
Boiler Room	Steam Condensate (880)	1	1.5						6
Boiler Room	Condensate Receiver Steam Condensate (880)	Tank Shell	2.0	17					
Boiler Room	Condensate Receiver Steam Condensate (880)	Tank Shell	2.0	40					
Boiler Room	Steam (880)	3/4	1.5						
Boiler Room	Steam (880)	1	1.5						
Boiler Room	Steam (880)	2	1.5						



Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS					
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)
Boiler Room	Heat Exchanger Steam (880)	Tank Shell	2.0	5					
Boiler Room	Steam (880)	6	3.0					3	
Faculty Room	Steam (880)	2	2.5	22	6				
Faculty Room	Steam Condensate (880)	1	1.5	14	3				
Faculty Room	Steam Condensate (880)	3/4	1.5	29	5				
Room # 1	Steam Condensate (880)	1	1.5	1	2				
Room # 1-Bath	Steam (880)	3/4	2.5	4	3				
Room # 1-Bath	Steam (880)	1/2	2.5	1	2	1			
Room # 1-Bath	Steam Condensate (880)	1/2	1.5	1					
Room # 1-Bath	Steam Condensate (880)	3/4	1.5	1					



Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS					
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)
Boys Restroom	Steam (880)	3/4	2.5	4	3	1			
Boys Restroom	Steam Condensate (880)	1/2	1.5	3	3	1			
Gym	Steam (880)	1	2.5	6	3				
Gym	Steam (880)	1/2	2.5	2		3			
Gym	Steam Condensate (880)	1/2	1.5	2	4				
TOTAL				636	252	64	20	3	11

Hartshorn Elementary School

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
B114	Heating Hot Water (870)	2	1.0	5	2	9	4			
BR Storage	Heating Hot Water (870)	3/4	1.0	2	2	1	0			
BR Storage	Heating Hot Water (870)	2	1.0	5	4	1	0			
Main Boiler Rm	Domestic Hot Water (870)	1/2	1.0	27	10	2	0			
Main Boiler Rm	Domestic Hot Water (870)	3/4	1.0	11	7	4	2			
Main Boiler Rm	Domestic Hot Water (870)	1	1.0	1	4	0	0			

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Main Boiler Rm	Heating Hot Water (870)	1/2	1.0	3	5	4	0			
Main Boiler Rm	Heating Hot Water (870)	3/4	1.0	1	0	1	0			
Main Boiler Rm	Heating Hot Water (870)	1	1.0	47	52	4	0			
Main Boiler Rm	Heating Hot Water (870)	1 1/4	1.0	8	15	3	0			
Main Boiler Rm	Heating Hot Water (870)	1 1/2	1.0	2	3	0	0			
Main Boiler Rm	Heating Hot Water (870)	2	1.0	20	6	7	0			
Main Boiler Rm	Heating Hot	2 1/2	1.0	3	2	0	0			

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Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
	Water (870)									
Main Boiler Rm	Heating Hot Water (870)	3	1.0	2	3	1	5			
Main Boiler Rm	Heating Hot Water (870)	4	1.0	15	9	16	15			
Main Boiler Rm	Heating Hot Water (870)	6	1.5	0	0	0	2			
Main Boiler Rm	Heating Hot Water (870)	8	1.5	0	3	0	0			
Main Boiler Rm	Heating Hot Water (870)	10	1.5	0	2	0	0			
New Boiler Rm	Domestic Hot Water (870)	1/2	1.0	1	0	0	2			

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
New Boiler Rm	Domestic Hot Water (870)	1	1.0	1	2	0	0			
New Boiler Rm	Heating Hot Water (870)	1/2	1.0	1	4	0	0			
New Boiler Rm	Heating Hot Water (870)	3/4	1.0	1	0	4	0			
New Boiler Rm	Heating Hot Water (870)	1 1/4	1.0	7	9	1	0			
New Boiler Rm	Heating Hot Water (870)	1 1/2	1.0	8	16	0	0			
New Boiler Rm	Heating Hot Water (870)	2	1.0	2	0	2	4			
New Boiler Rm	Heating Hot	2 1/2	1.0	4	2	3	0			

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
	Water (870)									
New Boiler Rm	Heating Hot Water (870)	3	1.0	7	0	0	0			
New Boiler Rm	Heating Hot Water (870)	4	1.0	15	3	0	0			
B114	Heating Hot Water (870)	2	2.0						2	
Main Boiler Rm	Domestic Hot Water (870)	3/4	1.0						1	
Main Boiler Rm	Heating Hot Water (870)	1	1.5					1		
Main Boiler Rm	Heating Hot Water (870)	1 1/4	2.0					4		

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Main Boiler Rm	Heating Hot Water (870)	2	2.0					4		
Main Boiler Rm	Heating Hot Water (870)	3	2.0					2		
Main Boiler Rm	Heating Hot Water (870)	4	2.0							2
New Boiler Rm	Heating Hot Water (870)	1/2	1.5						1	
New Boiler Rm	Heating Hot Water (870)	2	2.0						2	
New Boiler Rm Air Sep	Heating Hot Water (870)	Tank Shell	2.0	4						
TOTAL				203	165	63	34	11	6	2

Johnson Controls

High School

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Chilled Water	2 1/2	1.0	2	0	2	1			
Boiler Room	Chilled Water	5	1.5	0	1	0	2			
Boiler Room	Chilled Water	6	1.5	0	1	0	0			
Boiler Room	Chilled Water	10	2.0	0	1	0	0			
Boiler Room	Domestic Hot Water (880)	1/2	1.0	0	1	1	0			
Boiler Room	Domestic Hot Water (880)	3/4	1.0	19	4	0	0			
Boiler Room	Domestic Hot Water (880)	1	1.0	17	7	6	4			
Boiler Room	Domestic Hot Water (880)	1 1/4	1.0	34	20	8	0			
Boiler Room	Domestic Hot Water (880)	1 1/2	1.0	3	8	0	0			

Johnson Controls

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Domestic Hot Water (880)	3	1.0	0	0	3	0			
Boiler Room	Dual Temp Water (880)	1/2	1.5	20	14	8	0			
Boiler Room	Dual Temp Water (880)	3/4	1.5	18	11	12	0			
Boiler Room	Dual Temp Water (880)	1	1.5	2	1	1	0			
Boiler Room	Dual Temp Water (880)	1 1/2	2.0	28	14	3	0			
Boiler Room	Dual Temp Water (880)	3	2.0	0	0	2	0			
Boiler Room	Dual Temp Water (880)	5	2.0	0	0	2	1			
Boiler Room	Heating Hot Water (880)	3/4	1.0	13	11	4	0			
Boiler Room	Heating Hot Water (880)	1	1.0	0	2	2	0			
Boiler Room	Heating Hot Water (880)	1 1/2	1.0	1	0	0	0			
Boiler Room	Heating Hot Water (880)	2	1.0	4	2	5	0			
Boiler Room	Heating Hot Water (880)	3	1.0	8	6	0	0			
Boiler Room	Heating Hot Water (880)	4	1.0	10	20	0	0			

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Heating Hot Water (880)	5	1.5	3	5	2	2			
Boiler Room	Heating Hot Water (880)	6	1.5	1	0	0	3			
Boiler Room	Heating Hot Water (880)	10	1.5	0	5	0	0			
Boiler Room	Chilled Water	5	1.5							1
Boiler Room	Domestic Hot Water (880)	1	1.0					3	2	
Boiler Room	Domestic Hot Water (880)	1 1/4	1.0					1		
Boiler Room	Dual Temp Water (880)	1 1/2	2.0							1
Boiler Room	Dual Temp Water (880)	5	2.0							1
Boiler Room Expan Tank (Qty 2)	Heating Hot Water (880)	Tank Shell	2.0	30						
Boiler Room	Heating Hot Water (880)	5	2.0					2		
Boiler Room	Dual Temp Water Cold	1/2	1.5	20	14	8	0			
Boiler Room	Dual Temp Water Cold	3/4	1.5	18	11	12	0			

Johnson Controls

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Dual Temp Water Cold	1	1.5	2	1	1	0			
Boiler Room	Dual Temp Water Cold	1 1/2	2.0	28	14	3	0			
Boiler Room	Dual Temp Water Cold	3	2.0	0	0	2	0			
Boiler Room	Dual Temp Water Cold	5	2.0	0	0	2	1			
Boiler Room	Dual Temp Water Cold	1 1/2	2.0							1
Boiler Room	Dual Temp Water Cold	5	2.0							1
TOTAL				280	174	89	14	6	2	5

Johnson Controls

Middle School

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Domestic Hot Water (880)	1/2	1.0	53	13	5	0			
Boiler Room	Domestic Hot Water (880)	3/4	1.0	14	5	2	4			
Boiler Room	Domestic Hot Water (880)	1 1/4	1.0	17	8	2	0			
Boiler Room	Domestic Hot Water (880)	1 1/2	1.0	1	4	0	0			
Boiler Room	Domestic Hot Water (880)	2	1.0	10	5	3	2			
Boiler Room	Domestic Hot Water (880)	2 1/2	1.0	3	4	2	0			
Boiler Room	Domestic Hot Water (880)	3	1.0	3	1	0	0			
Boiler Room	Geothermal	1/2	1.5	50	8	6	0			
Boiler Room	Geothermal	1 1/4	1.5	62	9	3	0			
Boiler Room	Geothermal	2	2.0	1	0	2	0			
Boiler Room	Geothermal	5	2.0	3	0	0	2			
Boiler Room	Geothermal	10	2.0	0	2	0	0			

Johnson Controls

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Heating Hot Water (880)	1/2	1.0	32	18	9	0			
Boiler Room	Heating Hot Water (880)	3/4	1.0	8	2	6	0			
Boiler Room	Heating Hot Water (880)	1	1.0	53	45	10	0			
Boiler Room	Heating Hot Water (880)	2	1.0	2	0	1	0			
Boiler Room	Heating Hot Water (880)	3	1.0	22	7	0	6			
Boiler Room	Heating Hot Water (880)	4	1.0	9	24	0	2			
Boiler Room	Heating Hot Water (880)	5	1.5	4	9	6	4			
Boiler Room	Heating Hot Water (880)	6	1.5	2	4	0	2			
Boiler Room	Heating Hot Water (880)	10	1.5	0	2	0	0			
Break Room	Heating Hot Water (880)	1	1.0	54	14	2	0			
Break Room	Heating Hot Water (880)	1 1/4	1.0	2	4	2	0			
Break Room	Heating Hot Water (880)	2	1.0	2	4	2	0			
Break Room	Heating Hot Water (880)	3	1.0	2	2	0	0			

Johnson Controls

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS						
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	Bonnets (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Domestic Hot Water (880)	3/4	1.0						2	
Boiler Room	Domestic Hot Water (880)	2	1.5						2	
Boiler Room	Domestic Hot Water (880)	2 1/2	1.5					2		
Boiler Room	Heating Hot Water (880)	Chem Feed Tank Shell	2.0	5						
Boiler Room	Heating Hot Water (880)	3	2.0							2
Boiler Room	Heating Hot Water (880)	5	2.0					2		
TOTAL				414	194	63	22	4	4	2

Johnson Controls

South Mountain Elementary School

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS				
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	In-line Pumps (#)
Attic MER	Heating Hot Water (870)	1 1/4	1.0	0	0	1	2	
Attic MER	Heating Hot Water (870)	1 1/2	1.0	1	2	2	0	
Attic MER	Heating Hot Water (870)	2	1.0	2	5	1	0	
Attic MER	Heating Hot Water (870)	2 1/2	1.0	1	2	0	0	
Boiler Room	Domestic Hot Water (870)	3/4	1.0	1	0	1	2	
Boiler Room	Domestic Hot Water (870)	1	1.0	4	4	0	0	
Boiler Room	Domestic Hot Water (870)	1 1/4	1.0	3	2	2	0	
Boiler Room	Domestic Hot Water (870)	2	1.0	5	1	4	1	
Boiler Room	Heating Hot Water (870)	1/2	1.0	2	4	4	0	
Boiler Room	Heating Hot Water (870)	3/4	1.0	1	0	3	0	
Boiler Room	Heating Hot Water (870)	1 1/4	1.0	1	0	2	0	
Boiler Room	Heating Hot Water (870)	1 1/2	1.0	7	9	0	0	

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS				
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	In-line Pumps (#)
Boiler Room	Heating Hot Water (870)	2 1/2	1.0	1	0	1	0	
Boiler Room	Heating Hot Water (870)	3	1.0	1	8	2	8	
Boiler Room	Heating Hot Water (870)	4	1.0	1	7	6	4	
Attic MER	Heating Hot Water (870)	1 1/4	1.5					1
Boiler Room	Domestic Hot Water (870)	3/4	1.0					1
Boiler Room	Heating Hot Water (870)	3	2.0					2
TOTAL				30	44	29	17	4

Johnson Controls

Wyoming Elementary School

Work Area/ Equipment	System Name	Pipe/Equip Info	Insulation Thickness	TAKE-OFF AMOUNTS					
		Size (in.)/Eq.(Type)	Size (in.)	Pipe (ft.)/Equ (sq)	Fittings (#)	Valves/Strainers (#)	Flange Pairs (#)	In-line Pumps (#)	Centrifugal Pumps (#)
Boiler Room	Domestic Hot Water (880)	1/2	1.0	15	8	0	0		
Boiler Room	Domestic Hot Water (880)	3/4	1.0	32	11	4	2		
Boiler Room	Domestic Hot Water (880)	1	1.0	31	19	8	0		
Boiler Room	Domestic Hot Water (880)	1 1/4	1.0	1	4	0	0		
Boiler Room	Domestic Hot Water (880)	2	1.0	1	1	0	0		
Boiler Room	Heating Hot Water (880)	1/2	1.0	18	6	5	0		
Boiler Room	Heating Hot Water (880)	1	1.0	3	9	4	0		
Boiler Room	Heating Hot Water (880)	1 1/2	1.0	0	1	1	0		
Boiler Room	Heating Hot Water (880)	2	1.0	1	4	5	2		
Boiler Room	Heating Hot Water (880)	3	1.0	1	1	4	9		
Boiler Room	Heating Hot Water (880)	4	1.0	11	7	12	7		
Boiler Room	Heating Hot Water (880)	6	1.5	0	0	0	1		

Johnson Controls

Boiler Room		Heating Hot Water (880)	8	1.5	0	1	0	0	
Boiler Room		Domestic Hot Water (880)	3/4	1.0				1	
Boiler Room		Domestic Hot Water (880)	1 1/4	1.0					2
Boiler Room	Air Sep (Qty 2)	Heating Hot Water (880)	Tank Shell	2.0	5				
Boiler Room		Heating Hot Water (880)	2	2.0				1	
Boiler Room		Heating Hot Water (880)	3	2.0					2
Boiler Room	Chemical Feed	Heating Hot Water (880)	Tank Shell	2.0	5				
TOTAL					122	72	43	21	2	4

Savings Methodology

Energy savings were calculated in 3E plus software. The inputs of the calculation are presented below:

System	Process Temp	Ambient Temp	Wind Speed	Fuel Name	Plant Efficiency	Annual Hours of Operation
Heating Hot Water (900)	170	80	0	Natural Gas	80%	4,200
Domestic Hot Water (900)	120	80	0	Natural Gas	80%	7,200
Heating Hot Water (950)	170	80	0	Natural Gas	80%	4,200
Domestic Hot Water (950)	120	80	0	Natural Gas	80%	7,200
Dual Temp Water (950)	170	80	0	Natural Gas	80%	4,200
Chilled Water	45	80	0	Electricity	90%	1,920
Dual Temp Water Cold	45	80	0	Electricity	90%	1,920

Maintenance Requirements

There is no related maintenance with the improvement.

Benefits

- Energy Savings
- Improved Site Safety
- Improved thermal comfort

ECM #58-63 – Roof Top Unit Replacement

ECM Summary

Rooftop units supply conditioned air to the various zones throughout a building. In buildings where the rooftop units are older and in poor condition, the installation of new high-efficiency rooftop units will result in significant energy and operational cost savings. The new rooftop units will distribute the air in a much more efficient manner by using premium efficiency motors, variable frequency drives (where applicable), tighter unit construction eliminating leakage, heat recovery and economizer options (when possible), and more efficient heating coil designs. In addition to energy and operational cost savings the units will provide a more pleasant indoor environment resulting in increased productivity and occupant comfort.

Facilities Recommended for this Measure

- Hartshorn Elementary School

Scope of Work

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

Demolish and Removal Work

- Disconnect, remove and properly dispose of existing RTU's specified in table below.
- Disconnect, remove and properly dispose of all other materials or debris related to this project.
- Isolate and turn off, and lock out the gas valves serving the roof mounted units.
- De-energize the power feeder serving the roof mounted units and lock out the same.
- De-energize and safe off the control wiring serving the roof mounted RTUs.
- Disconnect the power and control wiring from the RTUs the existing breakers shall be reused.
- Disconnect and safe off the existing controls serving the RTUs.

New Installation Work

- Furnish and install seven (7) new York or Johnson Controls approved equivalent RTU's as specified in the table below. The new RTUs shall match the capacities and specifications of the existing units. Install supply fan/return fan, DX and new gas piping where applicable.

Quantity	Manufacturer	Model #	Areas Served	Equipment Type
1	Carrier	48HJF004	RTU-1	Gas Heat/DX
1	Carrier	48HJ7008	Newer Wing	Gas Heat/DX
1	Carrier	48HJ7007	Library	Gas Heat/DX
1	Carrier	Not Readable	RTU-2	Gas Heat/DX
2	Carrier	48HJD014	Multipurpose Room	Gas Heat/DX
1	Carrier	48HJE006	Kindergarten Wing	Gas Heat/DX

- Reuse the existing curbs where applicable.
- Install and seal the new curb adapter to the existing curb.
- Provide and install required new EMT conduit with compression fittings and seal tight to connect the new units to the existing circuit breakers.
- Provide and install the required new EMT conduit and seal tight to connect the inter-locks into the control circuits.
- Connect the new units to the existing Building Management system.
- Start, commission and test the new RTUs.

Savings Methodology

Savings for the rooftop unit replacement were calculated based on an increase in efficiency of the units. Data for the existing and new equipment is based on manufacturer's cut sheets. The savings were calculated utilizing Excel-based Bincalcs.

- Baseline RTU cooling efficiency = 9 EER
- Post-Retrofit RTU cooling efficiency = 12.5 EER

Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance.

Benefits

- Electrical energy savings
- Capital improvements of HVAC systems
- Improved indoor air quality
- Improved occupant comfort

ECM #66 - Steam Trap Replacement

ECM Summary

The three important functions of steam traps are as follows:

1. To discharge condensate as soon as it is formed
2. Not to allow steam to escape
3. To be capable of discharging air and other incondensable gases

Steam traps can be split into three major types:

1. **Mechanical traps.** They have a float that rises and falls in relation to condensate level and this usually has a mechanical linkage attached that opens and closes the valve. Mechanical traps operate in direct relationship to condensate levels present in the body of the steam trap. **Inverted bucket** and **float traps** are examples of mechanical traps.
2. **Temperature traps.** They have a valve that is driven on / off the seat by either expansion / contraction caused by temperature change. They differ from mechanical traps in that their design requires them to hold back some condensate waiting for it to cool sufficiently to allow the valve to open. In most circumstances this is not desirable as condensate needs to be removed as soon as it is formed. Thermostatic traps and bimetallic traps are examples of temperature operated traps.
3. **Thermodynamic (TD) traps**. Thermodynamic traps work on the difference in dynamic response to velocity change in flow of compressible and incompressible fluids. As steam enters, static pressure above the disk forces the disk against the valve seat. The static pressure over a large area overcomes the high inlet pressure of the steam. As the steam starts to condense, the pressure against the disk lessens and the trap cycles. This essentially makes a TD trap a "time cycle" device: it will open even if there is only steam present, this can cause premature wear. If non condensable gas is trapped on top of the disc, it can cause the trap to be locked shut.

The steam trap survey tested 29 traps in the school and found one (1) was working properly, three (3) were out of service and twenty-five (25) traps were either failed open or blocked.

Facilities Recommended for this Measure

- Glenwood Elementary School

Scope of Work

- Based on the audit of the traps, a full replacement of all traps is recommended.

- As an option, a planned service contract may be included in order to properly test and service the steam trap system.
- The inputs of the savings calculations are presented below: The operating pressure is 5 psig and the annual operation hours are 4,200 hours a year.

ID #	Location	Elevation (feet)	Application Use	Make/Model	Type	Size (inches)	Orifice Diameter (inches)	Status
366	Boiler Room	3	Process	Hoffman-FT015H	Float & Thermostatic	1	0.0938	Failed Open
367	Boiler Room	3	Process	Spirax Sarco-FT-15	Float & Thermostatic	3/4	0.0938	Failed Open
368	Boiler Room	8	Process	Spirax Sarco-FT-15	Float & Thermostatic	3/4		OK
370	Boiler Room	2	Process	Armstrong-816 D289	Inverted Bucket	2 1/2	0.1094	Failed Open
371	Boiler Room	15	Process	Hoffman-FT015H	Float & Thermostatic	3/4	0.0938	Failed Open
372	Stairwell	1	Radiator	Spirax Sarco	Thermostatic	1/2		Out of Service
373	Hall (by room 15)	1	Radiator	Spirax Sarco-H	Thermostatic	1/2	0.0938	Failed Open
374	Stairwell	1	Radiator	Spirax Sarco-H	Thermostatic	1/2		Out of Service
450	Hall (across from Room # 2)	1	Radiator	Spirax Sarco-H	Thermostatic	1/2		Out of Service
451	Hall (next to Room # 2)	1	Radiator	Spirax Sarco-H	Thermostatic	1/2	0.0938	Failed Open
452	Hall (next to Room # 1)	1	Radiator	Spirax Sarco-H	Thermostatic	1/2	0.0938	Blocked
453	Faculty Room	1	Radiator	Hoffman-17-C	Thermostatic	1/2	0.0938	Blocked

ID #	Location	Elevation (feet)	Application Use	Make/Model	Type	Size (inches)	Orifice Diameter (inches)	Status
454	Room # 1-Restroom	0.5	Radiator	Spirax Sarco-H	Thermostatic	1/2	0.0938	Blocked
455	Nurse Office	0.5	Radiator	Spirax Sarco-A125	Thermostatic	1/2	0.0938	Blocked
456	Girls Restroom-1st Floor	1	Radiator	Spirax Sarco-H	Thermostatic	1/2	0.0938	Blocked
457	Boys Restroom-1st Floor	2	Radiator	Hoffman 8C	Thermostatic	3/4	0.0938	Blocked
458	Gym	0.5	Radiator	Hoffman-17-C	Thermostatic	1/2	0.0938	Blocked
459	Gym	0.5	Radiator	Hoffman-17-C	Thermostatic	1/2	0.0938	Blocked
460	Gym	0.5	Radiator	Spirax Sarco-H	Thermostatic	1/2	0.0938	Blocked
461	Lobby entrance right side	0.5	Radiator	Spirax Sarco-H	Thermostatic	1/2	0.0938	Blocked
462	Lobby entrance left side	0.5	Radiator	Spirax Sarco-H	Thermostatic	1/2	0.0938	Blocked
463	Boys Restroom-2nd Floor	1	Radiator	Spirax Sarco-H	Thermostatic	1/2	0.0938	Blocked
464	Room # 14-2nd Floor	2	Radiator	Hoffman 8C	Thermostatic	3/4	0.0938	Blocked
465	Room # 15-2nd Floor	2	Radiator	Hoffman 8C	Thermostatic	3/4	0.0938	Blocked
466	Room # 11-2nd Floor	2	Radiator	Hoffman 8C	Thermostatic	3/4	0.0938	Blocked
467	Room # 16-2nd Floor	2	Radiator	Hoffman 8C	Thermostatic	3/4	0.0938	Blocked

Johnson Controls

ID #	Location	Elevation (feet)	Application Use	Make/Model	Type	Size (inches)	Orifice Diameter (inches)	Status
468	Room # 17-2nd Floor	2	Radiator	Hoffman 8C	Thermostatic	3/4	0.0938	Blocked
469	Room # 18-2nd Floor	2	Radiator	Hoffman 8C	Thermostatic	3/4	0.0938	Blocked
470	Room # 18-2nd Floor	2	Radiator	Hoffman 8C	Thermostatic	3/4	0.0938	Blocked

Savings Methodology

Savings are calculated using a spreadsheet with the following methodology and based on the failed open traps only. The formula is presented below:

Fuel Loss (Therm/Yr) = (quantity) x (24.24) x (psig+14.7) x (3.1415) x (Orifice diameter/2) ^2 x (annual operating hours) / (boiler efficiency) x (total enthalpy steam) / (100,000)

Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance. It is recommended that an annual steam trap audit and test be completed in order to maintain the effectiveness of the steam system.

Benefits

- Steam savings
- Operational savings through new equipment and preventative maintenance plan

ECM #69 – Steam-to-Hot Water Conversion and Condensing Boiler Installation

ECM Summary

JCI proposes to replace the two existing HB Smith steam boilers with condensing boilers. The existing heat exchangers will be demolished and the new hot water boilers will be directly connected to the main hot water supply header. The boilers will be sequenced to operate on a lead/lag basis when there is a call for heat from the building and they will be integrated with the existing building management system.

Facilities Recommended for this Measure

- Wyoming Elementary School

Scope of Work

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

Demolition and Removal Work

- Disconnect, remove and properly dispose of the existing two (2) HB Smith steam boilers.
- Disconnect, remove and properly dispose existing two (2) heat exchangers, associated piping and traps.
- Disconnect, remove and properly dispose of steam piping to nearest hot water main header or as required for new installation.
- Disconnect, remove and properly dispose of gas flue as required.
- Disconnect, remove and properly dispose of all other materials or debris related to this project.

New Installation Work

- Provide and install three (3) new Lochinvar Crest, or Johnson Controls approved equal condensing HW Boiler. The boilers shall have a rated input capacity of 1,500 MBH at full load.
- The condensing boilers to have an output capacity of 1,395 MBH each.
- Modulating burner with a turndown ratio of 15:1 or higher.
- System efficiency >=90% at 120F EWT (50% firing rate).
- New boiler to have boiler management system
- New boiler to have controls that should be capable of integrating with the existing building management system.
- Boilers and controls to comply with applicable regulations.
- Provide U.L. labeled burners.
- Burners to have stack O_2 sensor based optimal A/F ratio controls.
- The boilers shall be located in the existing location with new hot water piping and all other piping extended as required for connection. New piping will be installed from the new boilers and tied into the existing header.
- Provide and install new electronic isolation valves for each boilers.
- Provide and install new expansion tank as required (Model: Taco CBX 300 or equal).
- Provide and install new Air/Dirt separator.
- Existing pumps and controls valves to remain.
- Insulate new piping, valves and fittings as required.
- Provide boiler pad if use of existing is inadequate.
- Install boilers based on manufacturer’s installation procedures.
- Provide and install new flue as required.
- Patch and repair all penetrations.
- Provide valve tags and ID Chart.
- Provide pipe labeling and directional arrows.
- Start-up, checkout and verify all modes (stages) of operation (by factory authorize rep), including measurement and verification of “part load” and “full load” efficiencies, combustion gas analysis and all unit control features per manufacturer’s start-up and checkout procedures.
- Reuse existing piping, pipe fittings, pipe hangers, isolation valves, strainers, check valves, thermal wells, and pressure sensor wells where feasible and equipment serviceable.
- Asbestos removal is responsibility of others.

Savings Methodology

In general, savings are calculated using Excel-based Bincalc. Savings result from the increased efficiency of the hot water heating system as compared to the older steam heating system.

Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance.

Benefits

- Steam savings
- Operational savings through new equipment and preventative maintenance plan

ECM #76, 79, 82, 83, 84, 86 - Building Automation Controls Upgrades

ECM Summary

The central plant of each building consists of all heating and cooling equipment, associated pumps, and typically represents the largest energy consumption used in the course of conditioning the building. Therefore, the central plant has the greatest potential for energy savings through upgraded building automation controls. Currently the entire school is under the control of a centralized Siemens control system. Access to the system is centralized. Only one or two individuals can control setpoints on individual pieces of equipment from a head-end at the Education Center or from a remote laptop. To implement changes, the head custodian is required to contact and make requests to the individual who has system-wide control, such as changing temperature setpoints, increasing or decreasing outside air, etc. If this individual is not available, the head custodian do his best to make rudimentary changes on site.

Integrating the Metasys DDC with the Siemens control system will reduce the energy consumption of the entire District as well as ease the burden on the maintenance personnel.

Facilities Recommended for this Measure

- Deerfield Elementary School
- Education Center
- Hartshorn Elementary School
- High School
- Middle School
- South Mountain Elementary School
- Wyoming Elementary School

Scope of Work

Metasys Server, User Interfaces and Network Integration

Furnish and install the following at a minimum:

- ADX10 Turn-Key Rack Mounted Server - (NEW BACnet Primary BAS Server – District-wide)
  - ADX10 SVR SUB SRVC 1 YR (Required software subscription)
  - Graphics Plus, RAP optional applications included
  - Graphical displays for each HVAC system connected from new or existing digital control systems including overview building floor plans
  - Scheduling and Historical trends
- NIE 8500 Rack Mounted Server – (Dedicated for Integration of existing BAS systems)
  - Perform BACnet IP integration of existing data points from the Siemens and ALC servers. (Approximately 11,000 data objects)

Clarification

- Customer to provide a dedicated V-LAN for BAS utilizing existing IT network.
- Customer to provide a network connection in each building as needed for BAS improvements.
- Customer to provide a VPN hardware / software for secured remote access to BAS network.
- Existing two BAS servers (Siemens and ALC Servers) shall remain by this networked integration approach.

<u>Deerfield Elementary School</u>

Network Supervisory Controller (Quantity 1)

Provide and field install Metasys NAE and UPS panel in mechanical room.

- Daisy Chain Field Bus communication wiring from NAE to new Metasys controller.
- Extend CAT5 communication wiring to customer provided switch LAN port.

<u>Education Center Building</u>

Provide and field install NEW Metasys NCE controls.

- Daisy Chain NEW Field Bus communication wiring.
- Extend CAT5 communication wiring to customer provided switch LAN port.

Furnish and install the following:

- Boilers enable, status, alarm per boiler (Qty 1 Boilers)
- Hot water supply temperature sensor
- Hot water return temperature sensor
- Hot water Pumps start/stop, status relays (Qty 2)
- Outside Air Temp sensors

Incorporate the following control strategies:

- Scheduling
- Hot water reset based on OAT
- Lead/Lag Pump control

<u>Hartshorn Elementary School</u>

Network Supervisory Controller (Quantity 1)

Provide and field install Metasys NAE and UPS panel in mechanical room.

- Daisy Chain Field Bus communication wiring from NAE to each new Metasys controller.
- Extend CAT5 communication wiring to customer provided switch LAN port.

New Boiler System

Provide and field install NEW Metasys NCE controls replacing existing DDC controls.
Furnish and install the following:

- Boilers enable, status, alarm per boiler (Qty 3 new Boilers)
- Connect BACnet MSTP communication wiring to NEW Boiler Management Panel
- Hot water supply temperature sensor
- Hot water return temperature sensor
- Hot water Pumps start/stop, status relays (Qty 2 new Pumps w/ VFD)
- Differential pressure sensor located near end of secondary loop
- Outside Air Temp sensors

Incorporate the following control strategies:

- Scheduling
- Hot Water reset based on OAT
- Lead/Lag Pump control

New Roof Top Units Replacement (Quantity 7)

Provide and field install Metasys FEC controls.

- Daisy Chain NEW Field Bus communication wiring.

Install and wire the following Input / Output points for each new Rooftop Unit:

- Supply Fan start/stop/status relays
- Control Damper Actuators
- Filter DP pressure switch
- (3) Duct Temperature sensors (RAT, MAT, DAT)
- (1) Zone temperature sensor w/ setpoint
- (1) Return Air duct CO_2 sensor (Gym and Cafeteria units only)

Incorporate the following strategies, into the control systems:

- Scheduling
- Night setup/setback
- Zone temperature Control
- Demand Control Ventilation (Gym and Cafeteria units only)

<u>High School</u>

Network Supervisory Controller (Quantity 1)

Provide and field install Metasys NAE and UPS panel in mechanical room.

- Daisy Chain NEW Field Bus communication wiring to each new Metasys controller.
- Extend CAT5 communication wiring to customer provided switch LAN port.

Existing Air Handling Unit (Quantity 2)

Provide and field install Metasys FEC controls replacing existing DDC controls

- Daisy Chain NEW Field Bus communication wiring.

Install and wire the following Input / Output points:

- Supply Fan start/stop/status relays
- Hot Water & Chilled Water control valves – reuse existing valves
- Control Damper Actuators – reuse existing actuators
- Filter DP pressure switch – reuse existing pressure switch
- Freezestat – reuse existing freezestat
- (3) Duct Temperature sensors (RAT, MAT, DAT) – install new sensors
- (1) Zone temperature sensor – install new sensor
- (1) Return Air duct CO2 sensor – install new sensor

Incorporate the following strategies, into the control systems:

- Scheduling
- Night setup/setback
- Zone temperature Control
- Demand Control Ventilation (DCV)

Existing Exhaust Fans (Total of 25 EF's)

Provide and field install (3) Metasys FEC controllers replacing existing DDC controls mounted in different electric closets.

- Daisy Chain NEW Field Bus communication wiring.

Install and wire the following Input / Output points:

- (Qty 25) Exhaust Fan start/stop
- (Qty 25) Exhaust Fan status - current switches

Incorporate the following strategies, into the control systems:

- Scheduling

Demand Response – Data Acquisition

Furnish and install the following at a minimum:

- Building Electrical Power Meter data pulse contact (Qty 1)
  (Meter pulse contact provided by others)

Incorporate the following strategies, into the control system upgrades:

- Demand Response – (data acquisition)
- Programming of the "Easy Button" on Main BAS screen for operator manual load shedding pre-determined loads. Restore of loads will be staggered.

<u>Middle School</u>

Network Supervisory Controller (Quantity 1)

Provide and field install Metasys NAE and UPS panel in mechanical room.

- Daisy Chain Field Bus communication wiring from NAE to each new Metasys controller.
- Extend CAT5 communication wiring to customer provided switch LAN port.

Existing Exhaust Fans (Total of 7 EF)

Provide and field install (1) Metasys FEC controllers replacing existing DDC controls

- Daisy Chain NEW Field Bus communication wiring.

Install and wire the following Input / Output points:

- (Qty 7) Exhaust Fan start/stop
- (Qty 7) Exhaust Fan status - current switches

Incorporate the following strategies, into the control systems:

- Scheduling

Demand Response – Data Acquisition

Furnish and install the following at a minimum:

- Building Electrical Power Meter data pulse contact (Qty 1)
  (Meter pulse contact provided by others)

Incorporate the following strategies, into the control system upgrades:

- Demand Response – (data acquisition)
- Programming of the "Easy Button" on Main BAS screen for operator manual load shedding pre-determined loads. Restore of loads will be staggered.

South Mountain Elementary School

Network Supervisory Controller (Quantity 1)

Provide and field install Metasys NAE and UPS panel.

- Daisy Chain Field Bus communication wiring from NAE to new Metasys controller.
- Extend CAT5 communication wiring to customer provided switch LAN port.

Existing Exhaust Fans (Total of 10 EF)

Provide and field install (2) Metasys FEC controllers replacing existing DDC controls mounted in different electrical closets.

- Daisy Chain NEW Field Bus communication wiring.

Install and wire the following Input / Output points:

- (Qty 10) Exhaust Fan start/stop
- (Qty 10) Exhaust Fan status - current switches

Incorporate the following strategies, into the control systems:

- Scheduling

Wyoming Elementary School

New Boiler System

Provide and field install new Metasys NCE controls replacing existing DDC controls.

Furnish and install the following:

- Boilers enable, status, alarm per boiler (Qty 2 NEW Boilers)
- Connect BACnet MSTP communication wiring to new Boiler Management Panel
- Hot water supply temperature sensor
- Hot water return temperature sensor
- HW Pumps start/stop, status relays (Qty 2 new Pumps w/ VFD)
- Differential pressure sensor located near end of secondary loop
- Outside Air Temp sensors

Incorporate the following control strategies:

- Scheduling
- Hot water reset based on OAT
- Lead/Lag Pump control

General - Clarifications & Exclusions

Clarifications:

- Existing safety devices will be reused (smoke detectors, low temperature lockouts, etc.). Deficiencies will be reported to the owner. The cost of repair or replacement to correct deficiencies is not included in this analysis.
- Existing control devices that will be reused (control valves, dampers, damper actuators, etc.) are expected to be in working order. Deficiencies will be reported to the owner. The cost of repair or replacement to correct deficiencies is not included in this proposal.
- The existing air lines that will be reused are expected to be in intact and usable. Deficiencies will be reported to the owner. The cost of repair or replacement to correct deficiencies is not included in this proposal.
- Existing mechanical and electrical equipment that will have not new control systems applied is expected to be in good working order. Deficiencies will be reported to the owner. The cost of repair or replacement to correct deficiencies is not included in this proposal.
- Electrical Wiring Installation Methods:
    - Plenum cable will be used above ceilings and in accessible concealed places. EMT conduit will be used where physical protection is required in mechanical rooms and warehouse areas.
    - Wire mold may be used in finished office and hallways in lieu of EMT conduit.
    - DDC panels and enclosures shall be NEMA 1 except panels in outside locations that will be NEMA 3R.
    - All electrical wiring located within concealed spaces such as within hollow core walls; above suspended ceilings and inside mechanical equipment enclosures will be plenum rated cable.
    - All electrical wiring located in within drywall will be installed in plenum rated cable without stub ups.
    - All electrical wiring located where exposed to outdoor elements (above ground), wet locations, between floors and in shafts shall be installed in IMC or rigid steel conduit. Final connections will be installed in weather-tight flexible metal conduit.

Equipment not included and Exclusions:

- Proposal excludes all network connectivity outside of the buildings.
- All control dampers shall be reused unless otherwise stated
- Smoke dampers and actuators shall be reused unless otherwise stated
- Fire/smoke dampers and actuators shall be reused unless otherwise stated
- Control or power wiring for fire/smoke dampers and actuators shall be reused unless otherwise stated
- Air measuring stations shall be reused unless otherwise stated
- Removal, Repair, Retrofit or Replacement of existing control systems excluded except as noted.
- Repair or replacement for retrofitted air handling unit mixing dampers.
- Repair or replacement for retrofitted exhaust fan dampers.

Johnson Controls

Savings Methodology

Savings were calculated from the Excel-based Bincalc. Savings result from implementing night setback temperatures, adjusting occupied heating and cooling setpoints, as well as implementing demand control ventilation strategies for large air handling units.

Maintenance Requirements

Follow manufacturers' recommendations for preventative maintenance. It is recommended that the District continue with the planned service agreement in order to keep the building automation system in proper working order.

Benefits

- Fuel energy savings.
- Improved occupant comfort
- Capital improvement of building automation system

ECM #89 – Plug Load Management

ECM Summary

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

Facilities Recommended for this Measure

- Deerfield Elementary School
- Education Center
- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School
- South Mountain Elementary School
- Wyoming Elementary School

Scope of Work

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

Quantity of Controllers								
Equipment	High School	Middle School	Glenwood ES	Deerfield ES	Wyoming ES	Hartshorn ES	South Mountain ES	Education center
Projector/Smart Board	51	69	30	10	13	13	10	
Large Copier (220)	3	3						2
Large Copier (110)	2	2	2	4	1	1	4	
Medium Printer	10	17	5	6	12	12	6	2
Laptop Charging Cart		18	5	3			3	
AC Units					1	1		
Hot Water Heaters		3		1	1	1	1	1
TOTAL	66	112	42	24	28	28	24	5

Savings Methodology

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

Savings Calculation Method

Baseline Energy Usage (kWh / yr) = Average kW x Baseline Weekly Hours x 4.348 wks/mon x Months/yr

Proposed Energy Usage (kWh/ yr) = Average kW x Proposed Weekly Hours x 4.348 wks/mon x Months/yr

Electrical Savings (kWh/ yr) = Baseline Energy Usage – Proposed Energy Usage

Where
Baseline weekly hours = 168 hrs/wk
Proposed weekly hours = 55 hrs/wk
Months/Yr = 10 months for schools and 12 months for Education Center

Maintenance Requirements

Periodically the equipment should be checked to ensure proper operation.

Benefits

- Electrical energy savings

ECM #103-111 – Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors

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 17.5-watt LED lamps offers an opportunity to lower energy consumption in areas lit by the standard 32-watt T8 and 40-watt T12.

Existing high intensity discharge (HID) exterior fixtures installed on the buildings throughout the District may 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 HID lamps. The installation of photocell control will allow the light fixtures to turn on when needed and remain off if possible. This will provide energy savings as well as provide a safe environment around the exterior of the buildings.

The standardization to LED lighting in all areas of the District will allow for reduced lighting maintenance throughout the project life and will provide consistent light levels throughout the District. Occupancy sensor installation will also further reduce the energy consumption of the lighting system resulting in further energy savings.

Facilities Recommended for this Measure

- Deerfield Elementary School
- Education Center
- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School
- South Mountain Elementary School
- Wyoming Elementary School

Scope of Work

Exterior Lighting

- Deerfield Elementary School

Qty	Existing Fixture Description	Proposed Fixture Description
2	Jelly-100A	16w LED Dim A

Qty	Existing Fixture Description	Proposed Fixture Description
2	Flood-HPS150	50w LED Flood
2	Flood-MH150	50w LED Flood
7	Wallpack-PL42	18w LED Wall pack
3	Sconce-60A	10w LED Dim A
7	Wallpack-MH175	74w LED Wall pack
2	Flood-500Q	50w LED Flood
1	Wallpack-HPS250	74w LED Wall pack
6	Pole Top – HPS200	45W LED
32	Total Retrofits	

- Education Center

Qty	Existing Fixture Description	Proposed Fixture Description
2	Flood-90PAR38	17w P38 LED
5	Square-100A	16w LED Dim A
5	Pole Top-HPS150	45w LED
12	Total Retrofits	

- Glenwood Elementary School

Qty	Existing Fixture Description	Proposed Fixture Description
6	Square-60A	10w LED Dim A
4	Flood-90PAR38	17w P38 LED
2	Wallpack-MH175	74w LED Wall pack
6	Flood-MH100	30w LED Flood
3	Sconce-(2)PL32	18w LED Wall pack
1	Wallpack-MH175	74w LED Wall pack
5	Sconce-150A	16w LED Dim A
1	Flood-250Q	30w LED Flood
1	Flood-MH400	140w LED Flood
1	Flood-MH100	30w LED Flood
1	Wallpack-HPS50	18w LED Wall pack
4	Flood-90PAR38	17w P38 LED
35	Total Retrofits	

- Hartshorn Elementary School

Qty	Existing Fixture Description	Proposed Fixture Description
3	Pole-Shoe-HPS250	91w LED Shoebox
5	Wallpack-HPS250	74w LED Wall pack
6	Square-100A	16w LED Dim A
7	Wallpack-HPS150	74w LED Wall pack
3	Flood-HPS150	50w LED Flood

Qty	Existing Fixture Description	Proposed Fixture Description
1	Square-(2)PL26	20w LED Canopy
4	Pole-Shoe-HPS250	91w LED Shoebox
29	Total Retrofits	

- High School

Qty	Existing Fixture Description	Proposed Fixture Description
36	Flood-MH150	50w LED Flood
12	Square-MH70	20w LED Canopy
5	Flood-90PAR38	17w P38 LED
1	Flood-CF23P38	17w P38 LED
2	Wallpack-HPS70	27w LED Wall pack
3	Sconce-CF23	13w LED Dim A
1	Wallpack-MH175	74w LED Wall pack
1	HH-CF23	14w P30 Dim LED
1	Square-60A	10w LED Dim A
3	Jelly-60A	10w LED Dim A
4	HH-MV250	43w LED Downlight
4	HH-HPS400	100w LED
5	Bare-CF23	13w LED Dim A
3	Flood-MH250	70w LED Flood
2	Flood-MH150	50w LED Flood
6	Flood-90PAR38	17w P38 LED
7	Pole-Cobra-HPS400	240w LED Cobra
5	**Pole Top-HPS150**	**45w LED**

- Middle School

Qty	Existing Fixture Description	Proposed Fixture Description
7	Flood-MH150	50w LED Flood
2	Chandelier-CF23	13w LED Dim A
7	Square-PL42	18w LED Wall pack
2	Flood-90PAR38	17w P38 LED
2	Wallpack-MH250	74w LED Wall pack
1	Flood-250Q	70w LED Flood
4	Globe-100A	16w LED Dim A
13	Pole Top-MH250	100w LED
13	Incand-100A	16w LED Dim A
51	Total Retrofits	

- South Mountain Elemetnary School

Qty	Existing Fixture Description	Proposed Fixture Description
12	Wallpack-HPS150	74w LED Wall pack
1	Wallpack-HPS70	27w LED Wall pack

Qty	Existing Fixture Description	Proposed Fixture Description
6	Flood-HPS150	50w LED Flood
2	Flood-CF23P38	14w P38 Dim LED
1	Wallpack-Cut-MH100	47w LED Wall pack
3	Square-HPS150	40w LED Canopy
2	Square-PL42	18w LED Wall pack
27		Total Retrofits

- Wyoming Elemetnary School

Qty	Existing Fixture Description	Proposed Fixture Description
5	Flood-HPS150	50w LED Flood
1	Flood-CF23P38	14w P38 Dim LED
2	Flood-90PAR38	17w P38 Dim LED
2	Sconce-60A	10w LED Dim A
4	Wallpack-MH150	74w LED Wall pack
2	Flood-250Q	50w LED Flood
16		Total Retrofits

Interior Lighting

- Deerfield Elementary School

Qty.	Lighting Upgrade Recommendation
5	Replace Existing Fixture with New 1'x4' 41 Watt LED Strip Fixture.
1	Replace Existing Fixture with New 1'x4' 27 Watt LED Surface-Mount Wrap Fixture.
114	Retrofit 2-Lamp 4' Fixtures with (2) 17.5 watt LED Tubes with Internal Driver and New Socket Bar Kit.
11	Replace Existing Fixture with New 1'x8' 53 Watt LED Surface-Mount Wrap Fixture.
1	Replace Existing Fixture with New 1'x8' 106 Watt LED Surface-Mount Wrap Fixture.
25	Install New 4' Full Body 131 Watt LED High Bay Fixture
2	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 23 watt P38 LED Lamp.
1	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 17 watt P38 Dimmable LED Lamp.
6	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 12 watt Dimmable LED A-Lamp.
3	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 16 watt Dimmable LED A-Lamp.
60	Retrofit U-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
2	Retrofit U-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
7	Retrofit 1-Lamp 4' Fixtures with (1) 17.5 Watt LED Tube with Internal Driver and New Socket Bar Kit.

Qty.	Lighting Upgrade Recommendation
108	Retrofit 3-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
109	Retrofit 4-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
222	Retrofit 4-Lamp 4' Fixtures with (4) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
27	Retrofit 6-Lamp 4' Fixtures with (6) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
3	Retrofit 4-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
3	Retrofit 2-Lamp 8' Fixtures with New Socket Bar Kit and (2) 17.5 Watt LED Tubes with Internal Driver.
710	**Total Retrofits**

- Education Center

Qty.	Lighting Upgrade Recommendation
35	Retrofit 2-Lamp 4' Fixtures with (2) 17.5 watt LED Tubes with Internal Driver and New Socket Bar Kit.
12	Retrofit 1-Lamp Incandescent Fixture with (1) 9 watt Compact Fluorescent Spring Lamp w/ Decorative G30 Globe.
21	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 8 watt R20 Dimmable LED Lamp.
8	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 12 watt R40 Dimmable LED Lamp.
6	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 12 watt Dimmable LED A-Lamp.
3	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 16 watt Dimmable LED A-Lamp.
3	Retrofit 2-Lamp Incandescent or Compact Fluorescent Fixture with (2) 12 watt Dimmable LED A-Lamps.
13	Retrofit 3-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver and New Socket Bar Kit.
2	Retrofit U-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
4	Retrofit U-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
14	Retrofit 3-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
1	Retrofit 3-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
159	Retrofit 4-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
281	**Total Retrofits**

- Glenwood Elementary School

Qty.	Lighting Upgrade Recommendation
2	Replace Existing Fixture with New 1'x4' 31 Watt LED Strip Fixture.
20	Replace Existing Fixture with New 1'x4' 27 Watt LED Surface-Mount Wrap Fixture.
105	Retrofit 2-Lamp 4' Fixtures with (2) 17.5 watt LED Tubes with Internal Driver and New Socket Bar Kit.
8	Replace Existing Fixture with New 1'x8' 106 Watt LED Surface-Mount Wrap Fixture.
16	Install New 4' Full Body 131 Watt LED High Bay Fixture.
12	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 17 watt P38 Dimmable LED Lamp.
11	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 12 watt Dimmable LED A-Lamp.
1	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 16 watt Dimmable LED A-Lamp.
1	Retrofit 2-Lamp Incandescent or Compact Fluorescent Fixture with (2) 12 watt Dimmable LED A-Lamps.
36	Retrofit Existing 8-inch Recessed Downlight Fixture with 40 watt LED Retrofit Module.
1	Replace Existing Fixture with New Surface Mounted 10 watt LED Drum Fixture.
1	Replace Existing Fixture with New Surface Mounted 16 watt LED Drum Fixture.
2	Retrofit U-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
4	Retrofit 1-Lamp 3' Fixtures with (1) 12 watt LED Tube with Internal Driver and New Socket Bar Kit.
1	Retrofit 6-Lamp 3' Fixtures with (6) 12 watt LED Tubes with Internal Driver and New Socket Bar Kit.
10	Retrofit 1-Lamp 4' Fixtures with (1) 17.5 Watt LED Tube with Internal Driver and New Socket Bar Kit.
122	Retrofit 3-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
2	Retrofit 4-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
4	Retrofit 4-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
8	Retrofit 4-Lamp 4' Fixtures with (4) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
113	Retrofit 6-Lamp 4' Fixtures with (6) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
2	Retrofit 3-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
2	Retrofit 2-Lamp 8' Fixtures with New Socket Bar Kit and (2) 17.5 Watt LED Tubes with Internal Driver.
13	Retrofit 4-Lamp 8' Fixtures with New Socket Bar Kit and (4) 17.5 Watt LED Tubes with Internal Driver.
497	**Total Retrofits**

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- Hartshorn Elementary School

Qty.	Lighting Upgrade Recommendation
4	Replace Existing Fixture with New 1'x4' 31 Watt LED Strip Fixture.
78	Retrofit 2-Lamp 4' Fixtures with (2) 17.5 watt LED Tubes with Internal Driver and New Socket Bar Kit.
1	Replace Existing Fixture with New 1'x8' 53 Watt LED Surface-Mount Wrap Fixture.
1	Install New 4' Full Body 98 Watt LED High Bay Fixture.
2	Remove Existing Fixture.
31	Retrofit Existing 10-inch Recessed Downlight Fixture with 57 watt LED Retrofit Downlight.
7	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 17 watt P38 Dimmable LED Lamp.
2	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 17 watt R40 Dimmable LED Lamp.
13	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 12 watt Dimmable LED A-Lamp.
3	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 16 watt Dimmable LED A-Lamp.
10	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 27 watt Dimmable LED A-Lamp.
24	Retrofit 3-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver and New Socket Bar Kit.
1	Retrofit 4-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver and New Socket Bar Kit.
10	Retrofit U-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
41	Retrofit U-Lamp 2' Fixtures with (4) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
13	Retrofit 1-Lamp 3' Fixtures with (1) 12 watt LED Tube with Internal Driver and New Socket Bar Kit.
1	Retrofit 1-Lamp 4' Fixtures with (1) 17.5 Watt LED Tube with Internal Driver and New Socket Bar Kit.
233	Retrofit 3-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
4	Retrofit 4-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
5	Retrofit 4-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
108	Retrofit 4-Lamp 4' Fixtures with (4) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
67	Retrofit 6-Lamp 4' Fixtures with (6) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
62	Retrofit 3-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.

Qty.	Lighting Upgrade Recommendation
25	Retrofit 4-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
12	Retrofit 4-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
758	**Total Retrofits**

- High School

Qty.	Lighting Upgrade Recommendation
9	Replace Existing Fixture with New 1'x4' 31 Watt LED Strip Fixture.
10	Replace Existing Fixture with New 1'x4' 27 Watt LED Surface-Mount Wrap Fixture.
1	Replace Existing Fixture with New 1'x4' 53 Watt LED Surface-Mount Wrap Fixture.
1	Replace Existing Fixture with New 1'x4' 36 Watt LED Surface-Mount Vapor Tite Fixture.
387	Retrofit 2-Lamp 4' Fixtures with (2) 17.5 watt LED Tubes with Internal Driver and New Socket Bar Kit.
10	Replace Existing Fixture with New 1'x8' 62 Watt LED Strip Fixture.
8	Replace Existing Fixture with New 1'x8' 82 Watt LED Strip Fixture.
61	Install New 4' Full Body 199 Watt LED High Bay Fixture.
4	Replace Existing Fixture with New 50 Watt LED Floodlight Fixture.
16	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 23 watt P38 LED Lamp.
8	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 17 watt P38 Dimmable LED Lamp.
30	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 10 watt R30 Dimmable LED Lamp.
12	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 17 watt R40 Dimmable LED Lamp.
51	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 8 watt Dimmable LED A-Lamp.
23	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 12 watt Dimmable LED A-Lamp.
40	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 16 watt Dimmable LED A-Lamp.
2	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 27 watt Dimmable LED A-Lamp.
5	Retrofit 2-Lamp Incandescent or Compact Fluorescent Fixture with (2) 12 watt Dimmable LED A-Lamps.
2	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 13 watt Dimmable LED A-Lamp.
51	Retrofit Existing 8-inch Recessed Downlight Fixture with 40 watt LED Retrofit Module.
15	Replace Existing Fixture with New Surface Mounted 10 watt LED Drum Fixture.
10	Replace Existing Fixture with New Surface Mounted 16 watt LED Drum Fixture.

Qty.	Lighting Upgrade Recommendation
1	Retrofit 1-Lamp 2' Fixtures with (1) 9 watt LED Tube with Internal Driver and New Socket Bar Kit.
7	Retrofit 2-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver and New Socket Bar Kit.
64	Retrofit 3-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver and New Socket Bar Kit.
7	Retrofit U-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
24	Retrofit U-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
39	Retrofit 1-Lamp 3' Fixtures with (1) 12 watt LED Tube with Internal Driver and New Socket Bar Kit.
1	Retrofit 4-Lamp 3' Fixtures with (4) 12 watt LED Tubes with Internal Driver and New Socket Bar Kit.
86	Retrofit 1-Lamp 4' Fixtures with (1) 17.5 Watt LED Tube with Internal Driver and New Socket Bar Kit.
904	Retrofit 3-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
9	Retrofit 4-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
38	Retrofit 4-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
513	Retrofit 4-Lamp 4' Fixtures with (4) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
5	Retrofit 6-Lamp 4' Fixtures with (6) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
159	Retrofit 3-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
110	Retrofit 4-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
28	Retrofit 4-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
20	Retrofit 2-Lamp 8' Fixtures with New Socket Bar Kit and (2) 17.5 Watt LED Tubes with Internal Driver.
20	Retrofit 4-Lamp 8' Fixtures with New Socket Bar Kit and (4) 17.5 Watt LED Tubes with Internal Driver.
2,791	**Total Retrofits**

- Middle School

Qty.	Lighting Upgrade Recommendation
6	Replace Existing Fixture with New 1'x4' 27 Watt LED Surface-Mount Wrap Fixture.
16	Replace Existing Fixture with New 1'x4' 53 Watt LED Surface-Mount Wrap Fixture.
22	Replace Existing Fixture with New 1'x4' 61 Watt LED Surface-Mount Wrap Fixture.

Qty.	Lighting Upgrade Recommendation
81	Retrofit 2-Lamp 4' Fixtures with (2) 17.5 watt LED Tubes with Internal Driver and New Socket Bar Kit.
2	Replace Existing Fixture with New 1'x8' 62 Watt LED Strip Fixture.
8	Replace Existing Fixture with New 1'x8' 82 Watt LED Strip Fixture.
33	Replace Existing Fixture with New 1'x8' 53 Watt LED Surface-Mount Wrap Fixture.
96	Replace Existing Fixture with New 1'x8' 106 Watt LED Surface-Mount Wrap Fixture.
188	Replace Existing Fixture with New 1'x8' 122 Watt LED Surface-Mount Wrap Fixture.
16	Install New 4' Full Body 131 Watt LED High Bay Fixture.
24	Install New 4' Full Body 199 Watt LED High Bay Fixture.
5	Replace Existing Fixture with New 40 Watt LED Canopy Fixture.
6	Replace Existing Fixture with New 60 Watt LED Canopy Fixture.
14	Replace Existing Fixture with New 140 Watt LED Floodlight Fixture.
31	Retrofit Existing 10-inch Recessed Downlight Fixture with 57 watt LED Retrofit Downlight.
136	Retrofit 1-Lamp Incandescent Fixture with (1) 5 watt Candelabra-Based LED Torpedo Lamp.
11	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 10 watt R30 Dimmable LED Lamp.
6	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 8 watt Dimmable LED A-Lamp.
17	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 12 watt Dimmable LED A-Lamp.
34	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 16 watt Dimmable LED A-Lamp.
4	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 27 watt Dimmable LED A-Lamp.
24	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 13 watt Dimmable LED A-Lamp.
7	Replace Existing Fixture with New Surface Mounted 10 watt LED Drum Fixture.
13	Retrofit 2-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver and New Socket Bar Kit.
1	Retrofit 3-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver and New Socket Bar Kit.
13	Retrofit U-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
8	Retrofit U-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
78	Retrofit 1-Lamp 4' Fixtures with (1) 17.5 Watt LED Tube with Internal Driver and New Socket Bar Kit.
254	Retrofit 3-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
296	Retrofit 4-Lamp 4' Fixtures with (4) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.

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Qty.	Lighting Upgrade Recommendation
54	Retrofit 3-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
154	Retrofit 4-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
104	Retrofit 4-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
86	Retrofit 2-Lamp 8' Fixtures with New Socket Bar Kit and (2) 17.5 Watt LED Tubes with Internal Driver.
22	Retrofit 4-Lamp 8' Fixtures with New Socket Bar Kit and (4) 17.5 Watt LED Tubes with Internal Driver.
1,870	**Total Retrofits**

- South Mountain Elementary School

Qty.	Lighting Upgrade Recommendation
67	Retrofit 2-Lamp 4' Fixtures with (2) 17.5 watt LED Tubes with Internal Driver and New Socket Bar Kit.
1	Replace Existing Fixture with New 1'x8' 82 Watt LED Strip Fixture.
9	Install New 4' Full Body 199 Watt LED High Bay Fixture.
11	Install New 4' Full Body 98 Watt LED High Bay Fixture.
14	Retrofit Existing 10-inch Recessed Downlight Fixture with 43 watt LED Retrofit Downlight.
5	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 17 watt P38 Dimmable LED Lamp.
12	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 16 watt Dimmable LED A-Lamp.
11	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 27 watt Dimmable LED A-Lamp.
3	Retrofit 3-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver and New Socket Bar Kit.
2	Retrofit U-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
2	Retrofit 1-Lamp 3' Fixtures with (1) 12 watt LED Tube with Internal Driver and New Socket Bar Kit.
359	Retrofit 3-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
1	Retrofit 4-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
45	Retrofit 4-Lamp 4' Fixtures with (4) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
21	Retrofit 3-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
1	Retrofit 4-Lamp 4' Fixtures with (2) 17.5 Watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
5	Retrofit 4-Lamp 8' Fixtures with New Socket Bar Kit and (4) 17.5 Watt LED Tubes with Internal Driver.

Qty.	Lighting Upgrade Recommendation
1	Replace Existing Exit Sign with New LED Exit Sign with Emergency Lighting Heads.
570	**Total Retrofits**

- Wyoming Elementary School

Qty.	Lighting Upgrade Recommendation
2	Replace Existing Fixture with New 1'x4' 31 Watt LED Strip Fixture.
17	Replace Existing Fixture with New 1'x4' 27 Watt LED Surface-Mount Wrap Fixture.
21	Replace Existing Fixture with New 1'x4' 61 Watt LED Surface-Mount Wrap Fixture.
172	Retrofit 2-Lamp 4' Fixtures with (2) 17.5 watt LED Tubes with Internal Driver and New Socket Bar Kit.
3	Replace Existing Fixture with New 1'x8' 82 Watt LED Strip Fixture.
9	Replace Existing Fixture with New 1'x8' 106 Watt LED Surface-Mount Wrap Fixture.
16	Install New 4' Full Body 131 Watt LED High Bay Fixture.
4	Remove Existing Fixture.
3	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 12 watt R40 Dimmable LED Lamp.
77	Retrofit 1-Lamp Incandescent or Compact Fluorescent Fixture with 12 watt Dimmable LED A-Lamp.
2	Retrofit 1-Lamp 2' Fixtures with (1) 9 watt LED Tube with Internal Driver and New Socket Bar Kit.
7	Retrofit 3-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver and New Socket Bar Kit.
11	Retrofit U-Lamp 2' Fixtures with (3) 9 watt LED Tubes with Internal Driver and New Socket Bar Kit.
14	Retrofit U-Lamp 2' Fixtures with (2) 9 watt LED Tubes with Internal Driver, New Socket Bar Kit and White Reflector.
277	Retrofit 3-Lamp 4' Fixtures with (3) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
24	Retrofit 4-Lamp 4' Fixtures with (4) 17.5 Watt LED Tubes with Internal Driver and New Socket Bar Kit.
659	**Total Retrofits**

The retrofit involves the removal and disposal of existing lamps, fixture cleaning, and the installation of new lamps (and fixtures where applicable). This measure will improve the energy efficiency of lighting fixtures, improve the overall quality of lighting, maintain appropriate levels of lighting, and reduce lighting system maintenance costs in the buildings.

All lighting work will be installed in a thoughtful manner with careful consideration of any personal belongings and surrounding equipment. Clean-up will take place at the end of each shift with all vacuuming, dusting, and trash removal being completed before leaving the premises. Interior lighting scope of work will be performed outside of regular office/ school hours if necessary.

All used lamps will be boxed at the end of each shift. Lamps will be recycled or disposed of according to local environmental regulations.

Occupancy Sensors

- Install in selected areas, ceiling mounted and/or wall mounted sensors with wide view.
- Sensor shall have dual technology and power packs.
- The following occupancy sensors will be installed in Education Center:

Building	Occupancy Sensor Count
Education Center	42

Savings Methodology

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

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

Maintenance

Lighting will need to be replaced in order to provide consistent light quality throughout the exterior space. It is recommended to conduct group re-lamping on regularly scheduled intervals in order to minimize maintenance requirements.

Benefits

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

ECM #122 – Football Field Lighting Upgrades – Behind Bleachers

ECM Summary

The existing wall mounted lights behind the bleachers do not provide sufficient lighting; these lights will be replaced and additional lights will be added to improve the light levels behind the bleachers.

Facilities Recommended for this Measure

- Millburn High School

Scope of Work

Existing Qty	Existing Fixture Description	Proposed Qty	Proposed Fixture Description
5	HPS150	10	45w LED

Savings methodology

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

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

Maintenance

Lighting will need to be replaced in order to provide consistent light quality throughout the exterior space. The longer life and extended warranty of the lamps will reduce or eliminate any maintenance on the lighting.

Benefits

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

ECM #123-128 – Vending Miser Controls

ECM Summary

Vending machines typically use electricity 24 hours per day even if no one is around to use them. Vending Misers use a motion sensor to automatically power down the vending machine when the areas around it is not occupied, and power up the machine when a person approaches it. A temperature sensor powers the machine back up as needed to keep drinks cold. Vending machine life is also extended by reducing lamp and compressor use.

Facilities Recommended for this Measure

- Education Center
- Glenwood Elementary School

- Hartshorn Elementary School
- Millburn High School
- Middle School
- Wyoming Elementary School

Scope of Work

- Install Vending Misers on soda machines through the school district

Space	Vending Machine	Vending Miser Count
Education Center	Soda Machine	1
Glenwood Elementary School	Soda Machine	1
Hartshorn Elementary School	Soda Machine	1
Millburn High School	Soda Machine	6
Middle School	Soda Machine	1
Wyoming Elementary School	Soda Machine	1
Total		11

Savings Methodology

Savings calculations for occupancy sensors used a custom spreadsheet using the following methodology:

Savings Calculation Method		
Baseline Energy Usage (kWh / yr)	=	Watts/Machine x Baseline Operating Hrs / yr x 1 kW / 1000 W
Post- Retrofit Energy Usage (kWh / yr)	=	Watts/Machine x Occupancy sensor Hrs / yr x 1 kW / 1000 W
Energy Savings (kWh / yr)	=	Baseline kWh Usage – Post-Retrofit kWh Usage

Where

- Baseline operating hours/yr 8,760 hrs/yr
- Occupancy sensor hours/yr 4,730 hrs/yr
- Watts/Machine 400 Watts

Maintenance Requirements

Periodically the sensors should be checked to ensure proper operation.

Benefits

- Electrical energy savings

ECM #129-130 – High Efficiency Transformer

ECM Summary

The E-Saver-C3 transformer is the ideal transformer for institutional and commercial environments where energy efficiency is a priority. Optimized for lowest life cycle cost, the E-Saver-C3 reduces waste by as

much as 74%. The E-Saver-C3 is a practical and affordable solution for K-12 schools and commercial buildings where lowest life cycle cost and energy savings are a priority.

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

Facilities Recommended for this Measure

- Millburn High School
- Middle School

Scope of Work

- Provide and install necessary transformers according to table below:

Building	Location	Transformer Designation	Existing kVA	Replacement kVA
High School	2nd Floor Hallway C Elec Rm	Panel DP1	150	150
Middle School	Main Electrical/Boiler	MDP	750	750

- Clean-up of area
- Training for facility staff on proper maintenance

Savings Methodology

Savings from the transformer replacement is a result of the improved efficiency of the proposed transformers. In general, the following methods are used to calculate savings:

The following calculations were conducted for both the existing transformers and the recommended transformers. The difference represents the energy savings.

Existing Transformers:

kW Losses (Occupied) [EKWO] = (Existing kVA x % Loading Occ x Load Power Factor / Efficiency) –

(Existing kVA x % Loading Occ x Load Power Factor)

kW Losses (Unoccupied) [EKWU] = (Existing kVA x % Loading Unocc x Load Power Factor / Efficiency) –

(Existing kVA x % Loading Unocc x Load Power Factor)

Annual Additional kWh use due to Transformers [EKWH] = Existing kW Losses Occupied x Annual Occupied Hours + Existing kW Losses Unoccupied x Annual Unoccupied Hours

Proposed Transformers:

kW Losses (Occupied) [PKWO] = (Proposed kVA x % Loading Occ x Load Power Factor / Efficiency) –

(Proposed kVA x % Loading Occ x Load Power Factor)

kW Losses (Unoccupied) [PKWU] = (Proposed kVA x % Loading Unocc x Load Power Factor / Efficiency) –

(Proposed kVA x % Loading Unocc x Load Power Factor)

Annual Additional kWh use due to Transformers [PKWH] = Proposed kW Losses Occupied x Annual Occupied Hours + Proposed kW Losses Unoccupied x Annual Unoccupied Hours

Electrical Savings

kW Savings = EKWO – PKWO

Annual kWh Savings = EKWH – PKWH

Maintenance Requirements

There are no additional maintenance requirements for this product.

Benefits

- Reduces electricity waste to help you meet your sustainability goals
- Optimized to provide quiet, efficient electrical power for improved productivity
- Significantly exceeds NEMA TP-1 efficiency for low operating cost over life of transformer
- Provides the lowest life cycle cost of any transformer on the market
- Produced in an ISO 9001 and ISO 14001 certified facility to ensure high quality and low environmental impact
- The E-Saver-C3's long life and dependable performance is backed up by Powersmiths' industry leading 25 year pro-rated warranty.

ECM #131 – Air-Cooled Chiller Replacement

ECM Summary

Chillers provide chilled water used to cooled spaces during summer months. Chillers at the end of its useful life or in bad condition were considered to be replaced with new high efficiency models. New chillers also operate with environmentally friendly refrigerants. The existing chiller at the High School is located adjacent to nearby homes and is causing noise complaints. The new chiller to be installed will come with ultra-quiet variable speed fans and sound enclosure package to reduce noise heard by the neighbors.

Facilities Recommended for this Measure

- Millburn High School

Scope of Work

This ECM proposes the replacement of the 250-ton chiller located on the pad outside of the main boiler room of the High School.

The following chillers are recommended for replacement.

Building	Quantity Removed	Model	Quantity Installed	Cooling Capacity	Rated Efficiency
Millburn High School	1	York YVAA	1	250 Tons	1.19 kW/ton

- Demolish and remove the existing Trane air-cooled chiller.
  - Properly remove and dispose of existing refrigerant/
- Furnish and install one new air-cooled chiller located on the existing equipment pad.
- Install all piping, valves and fittings to connect new chiller to existing distribution loop.
- Insulation of all disturbed and new pipe and fittings.
- Electrical power and control wiring.
- Tie new chiller to existing energy management system, provide new cooling plant sequence of operation to maximize the use of the new more efficient equipment.
- Chiller start-up and commissioning.

Savings Methodology

Savings for the chiller replacement at the school was calculated based on improvement in chiller efficiency. The existing chiller efficiency was based on the age of the equipment, published information from the manufacturer and results of the building simulation models. Data for new equipment was based on manufacturer's cut sheets. The savings were calculated utilizing the bin simulation excel workbook.

- Existing Chiller Efficiency used in calculations is = 9.7 EER
- Proposed Chiller Efficiency used in calculations is = 11.6 EER

Maintenance Requirements

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

Benefits

- Reduced electric consumption based on higher efficiency equipment.
- Removal of older refrigerant in favor of more environmentally friendly refrigerant.
- Operational savings based on new equipment requiring less maintenance
- Reduced noise.

Section 5. Measurement and Verification

Measurement & Verification (M&V) Methodologies

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

They have been developed and defined by three independent authorities:

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

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

Option A – Retrofit Isolation: Key Parameter Measurement

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

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

Option B – Retrofit Isolation: All Parameter Measurement

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

Option C – Whole Building Metering/Utility Bill Comparisons

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

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

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

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

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

Option D – Calibrated Simulation

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

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

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

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

Selecting M&V Options for a Specific Project

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

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

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

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

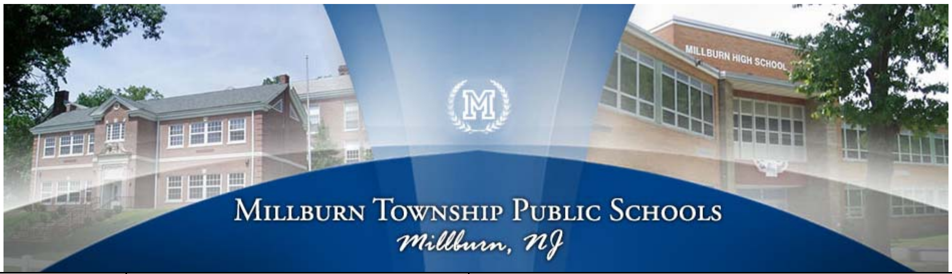
Savings can also be non-measured. If savings are non-measured, these savings are mutually agreed upon as achieved at substantial completion of the respective facility improvement measure and shall not be measured or monitored during the term of the performance contract. Non-measured energy savings are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

Recommended Performance Verification Methods

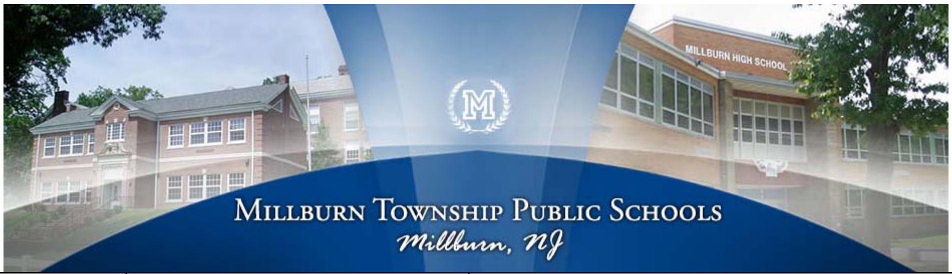
Johnson Controls' performance verification methods are designed to provide the facility's administration with the level of M&V necessary to protect them from an under-performing ECM, yet have a minimal impact on the project's financial success.

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

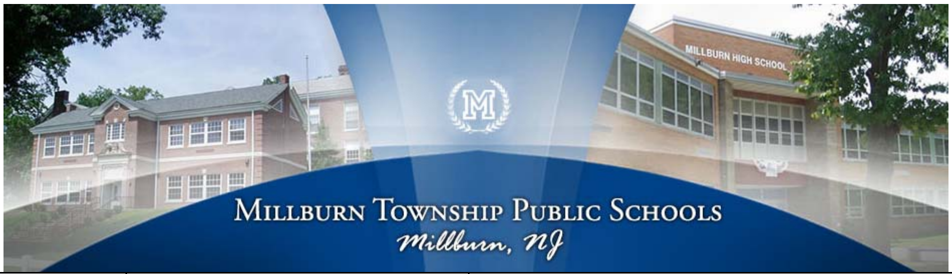
ECM Description	Measurement and Verification Method - Summary	Detail of M&V Methodology
Infiltration Reduction	**Option A:** Existing envelope deficiencies will be documented based on collected field data to provide a baseline for evaluating the effectiveness of the air barrier system. Post-retrofit verifications of improvements will be documented.	**Pre M&V:** The magnitude of the air infiltration caused by cracks and joint deficiencies was determined by field surveys. **Post M&V:** The areas identified for weatherization improvements will be verified to be complete through visual inspections and as-built documentation. A yearly infrared survey of the buildings, when seasonally appropriate, will be conducted for each year the M&V agreement is in effect. **Energy Savings:** Energy savings will be based on the ASHRAE crack method calculations. If the commissioning process reveals any variation in the as-built conditions, then savings will be adjusted accordingly.
Solar Energy Window Film	**Non-Measured:** Savings are from the improved security from installing security films on windows and doors.	**Pre M&V:** The size of windows and doors were determined in the field survey. **Post M&V:** The final as-built will be used to verify the size of the window film that is installed on windows and doors. **Energy Savings:** Savings are from the improved security from installing security films on windows and doors.
Low Flow Water Fixtures & Pedal Valves	**Option A:** Savings are from a reduction in domestic water usage through the use of low-flow water fixtures.	**Pre M&V**: Flow rates were determined during the field survey. Typical usage of those fixtures will be estimated using data from the AWWA. **Post M&V**: Flow rates will be determined through a one-time measurement post-installation. The typical fixture usage outlined in the baseline case will be used for the post retrofit case. **Water Savings**: Water savings will be calculated using the pre and post flow rates and agreed-upon usage characteristics.



ECM Description	Measurement and Verification Method - Summary	Detail of M&V Methodology
Chiller Replacement	**Option B:** Savings are from the improved efficiency of the new chiller.	***Pre M&V:*** Johnson Controls will use a simulation software to determine the cooling loads and baseline efficiencies of the equipment based on nameplate and collected field data. ***Post M&V:*** Chilled water flow will be measured one time to confirm flow rate. Chiller load will be verified using BAS trend data of the chilled water pump status and chilled water temperature difference. When the pump status is on, the measured pump flow rate will be used in the load calculations. ***Energy Savings:*** Savings for the new chiller will be determined using the base cooling loads and the difference in baseline and expected chiller loading.
Pipe Insulation/Blankets	**Option A:** Savings are from installing pipe insulation and insulation blankets.	**Pre M&V:** The surface temperature and the size of the space requiring insulation installation were measured during the field audit. **Post M&V:** Following installation, the size and the surface temperature of the space where the insulation is installed will be verified. **Energy Savings:** Savings are from a reduction in heat loss through uninsulated pipes and valves.
Steam Trap Replacements	**Option A:** Savings are from replacing failed steam traps and/or fixing steam trap leakage.	**Pre M&V:** An infrared survey was implemented to determine the location, quantity and size of failed steam traps. The information was used to determine the steam consumption baseline of steam traps. **Post M&V:** Once the installation is completed, the final as-built will be used to verify if the failed traps and/or leaking traps are replaced and/or fixed. It is recommended to implement an annual preventive maintenance program on steam traps. **Energy Savings:** Savings are from replacing failed steam traps and/or fixing steam trap leakage.



ECM Description	Measurement and Verification Method - Summary	Detail of M&V Methodology
Building Automation System Upgrades/Retro Commission Temperature Control	**Option A:** Baseline consumption and demand determined through computer simulation and verified using utility data. Post retrofit consumption and demand taken from computer simulation calibrated with actual operating conditions from the building management system.	**Pre M&V**: Accepted engineering practices/building simulations will be used to calculate energy consumption baselines. Pre-installation measurements will be taken, including temperature and occupancy hours. All calculations will be calibrated. **Post M&V**: Various control points within the building management system will be trended and/or totalized. This data will be used to verify that all control strategies are in place and functioning as intended. If differences are found due to the fault of Johnson Controls, savings will be adjusted accordingly. **Energy Savings**: The savings generated by the building model will be used for calculations. If differences occur between the as-built condition and the original design, the as-built conditions will be input into the model and savings will be re-calculated.
Plug Load Management	**Option A**: Savings are from the reduced operating hours of the plugged in equipment.	**Pre M&V:** Quantity of plug load devices was determined in the field survey. Nameplate data was used to determine the total kW of plugged in equipment. **Post M&V:** Once the installation is complete, the plug load control devices will be inspected to ensure proper operation. During the guarantee term, actual operating conditions will be downloaded from a sample of plug load devices to verify equipment schedules are still in place and equipment is being turned off. **Energy Savings:** Savings are from the reduced operating hours of the plugged in equipment.
Interior & Exterior LED Lighting (including lighting occupancy sensors)	**Option A:** One-time pre and post-retrofit kW measurement. Burn hours determined using logger data collected in the field.	**Pre M&V**: Lighting power readings will be taken on a sample of lighting fixtures. Lighting burn hours were measured through the use of light loggers. **Post M&V**: Lighting power readings will be taken on a sample of lighting fixtures. Measurements will occur once at the outset of the agreement. "Occupied" hours logged during the baseline data collection will be used as the post-installation burn hours. **Energy Savings**: Energy savings will be calculated using the actual measured wattage reduction and measured burn-hours.



ECM Description	Measurement and Verification Method - Summary	Detail of M&V Methodology
Football Field Lighting Upgrades	**Option A:** One-time post-retrofit kW measurement. Burn hours based on typical football field schedule.	**Pre M&V:** The quantity and energy input of the football field lighting fixtures were collected in the field survey. **Post M&V:** Lighting power readings will be taken on a sample of lighting fixtures. Measurements will occur once at the outset of the agreement. **Energy Savings:** Savings are from lower wattage of the new football field lights.
High Efficiency Transformers	**Non-Measured:** Savings are from the reduced energy loss with the replacement of new transformers.	**Pre M&V:** Transformer load percentage and energy loss were determined in the field survey. **Post M&V:** The energy loss of new transformers will be determined with the specification. The load percentage stays same as the pre-retrofit. **Energy Savings:** Energy savings will be calculated from the reduced energy loss with the replacement of new transformers.
Vending Miser	**Non-Measured:** Savings are from reduced operating hours of vending machines.	**Pre M&V:** The quantity and energy input of the vending machines were collected in the field survey. **Post M&V:** Once the installation is complete, the vending misers will be inspected to ensure proper operation. **Energy Savings:** Savings are from reduced operating hours of vending machines.

Measurement and Verification Services

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

Year	Annual Amount ($/Yr)
1	$18,957
2	$19,526
3	$20,112
Total	**$58,595**

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

- During the Installation Period, a JCI Performance Engineer will track Measured Project Benefits. JCI will report the Measured Project Benefits achieved during the Installation Period, as well as any Non-Measured Project Benefits applicable to the Installation Period, to Customer within 60 days of the commencement of the Guarantee Term.
- Within 60 days of each anniversary of the commencement of the Guarantee Term, JCI will provide Customer with an annual report containing:
  - An executive overview of the project’s performance and Project Benefits achieved to date;
  - A summary analysis of the Measured Project Benefits accounting; and
  - Depending on the M&V Option, a detailed analysis of the Measured Project Benefits calculations.
- During the Guarantee Term, a JCI Performance Engineer will monitor the on-going performance of the Improvement Measures, as specified in this Agreement, to determine whether anticipated Measured Project Benefits are being achieved. The Performance Engineer will visit Customer regularly and assist Customer on-site or remotely, with respect to the following activities:
  - review of information furnished by Customer from the facility management system to confirm that control strategies are in place and functioning;
  - Advise Customer’s designated personnel of any performance deficiencies based on such information;
  - coordinate with Customer’s designated personnel to address any performance deficiencies that affect the realization of Measured Project Benefits; and
  - Inform Customer of opportunities to further enhance project performance and of opportunities for the implementation of additional Improvement Measures.
  - Track utility bills on a monthly basis to determine current utility rate costs and to identify any billing anomalies.
- For specified Improvement Measures, JCI will:
  - Conduct pre and post installation measurements required under this Agreement;
  - Confirm the building management system employs the control strategies and set points specified in this Agreement; and

  - Analyze actual as-built information and adjust the Baseline and/or Measured Project Benefits to conform to actual installation conditions (e.g., final lighting benefits calculations will be determined from the as-built information to reflect the actual mix of retrofits encountered during installation).
  - Confirm that the appropriate metering and data points required to track the variables associated with the applicable Improvement Measures' benefits calculation formulas are established; and
  - Set up appropriate data capture systems (e.g., trend and totalization data on the facility management system) necessary to track and report Measured Project Benefits for the applicable Improvement Measure.
- Assist the customer in applying for Pay for Performance program.

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

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

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

- Building Automation Service Agreement including updates to subscription services
- Cogeneration Service Agreement to allow for emergency service and preventative maintenance on the new cogeneration systems. In order to receive the incentives for the cogeneration system, a 10-year maintenance contract must be in place. Johnson Controls has shown the savings paying for this maintenance agreement, but has not included the agreement within the ESIP.

Services for lighting upgrades and standard HVAC maintenance, such as filter changes, can be completed by District staff.

Design and Compliance Issues

Millburn Township Public Schools has enlisted Parette Somjen Architects to oversee and complete all design engineering for the purposes of public bidding of the work as well as completing construction drawings. Parette Somjen Architects is a DPMC qualified architectural firm and is working with a DPMC qualified engineering firm in order to complete the design documents and ensure that all compliance

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issues are addressed. Johnson Controls will work closely with Parette Somjen Architects and their engineering firm to ensure that the intent of the energy conservation measures outline here will be achieved in the design and construction drawings generated by Parette Somjen Architects.

As part of the Energy savings Plan 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 District. The proposed lighting solution will continue to adhere to current IES and NJ Education Code guidelines for light levels which in many cases may increase the current light levels to the spaces. At this time, Johnson Controls did not observe any compliance issues in the development of this Energy Savings Plan.

Customer Risks

Asbestos reports were 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 District. Any work associated with testing or remediation of asbestos containing material will be the responsibility of Millburn Township Public Schools. Based on the asbestos reports provided, we feel this is a low risk item.

The NJ SmartStart, Pay for Performance and Combined Heat and Power Incentives outline the anticipated incentive amounts to Millburn Township Public Schools. If the programs change or the incentive amounts differ, Millburn Township Public Schools will be responsible to make up the difference in received incentives for the financing. The difference could result from over performance of energy conservation measures, other rebates/ incentives that may be available, restructuring the loan payment for years 1 and 2, or capital contributions by the District.

Section 7: Implementation Schedule

A preliminary installation schedule for the measures implemented as part of the ESP is included below to provide a reasonable expectation for the timeline of construction. Once final bids are received and financing of the project is complete, the installation will be finalized in much greater detail and reviewed with the team from Millburn Township 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 Energy Savings Plan Pending necessary Reviews – April 27, 2015
- Complete Third Party Engineering Review of Energy Savings Plan – 2 weeks
- Complete Board of Public Utilities Review of Energy Savings Plan – 14 days
- Approval resolution to contract with Johnson Controls: June 22, 2015 School Board Meeting
- Financing of project: 30 days
- Complete 100% design drawings and bid specifications – September 2015
- Public bidding for Sub-Contractors – September – October 2015
- Installation – December 2015 – October 2016
- Maintenance: On-going

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

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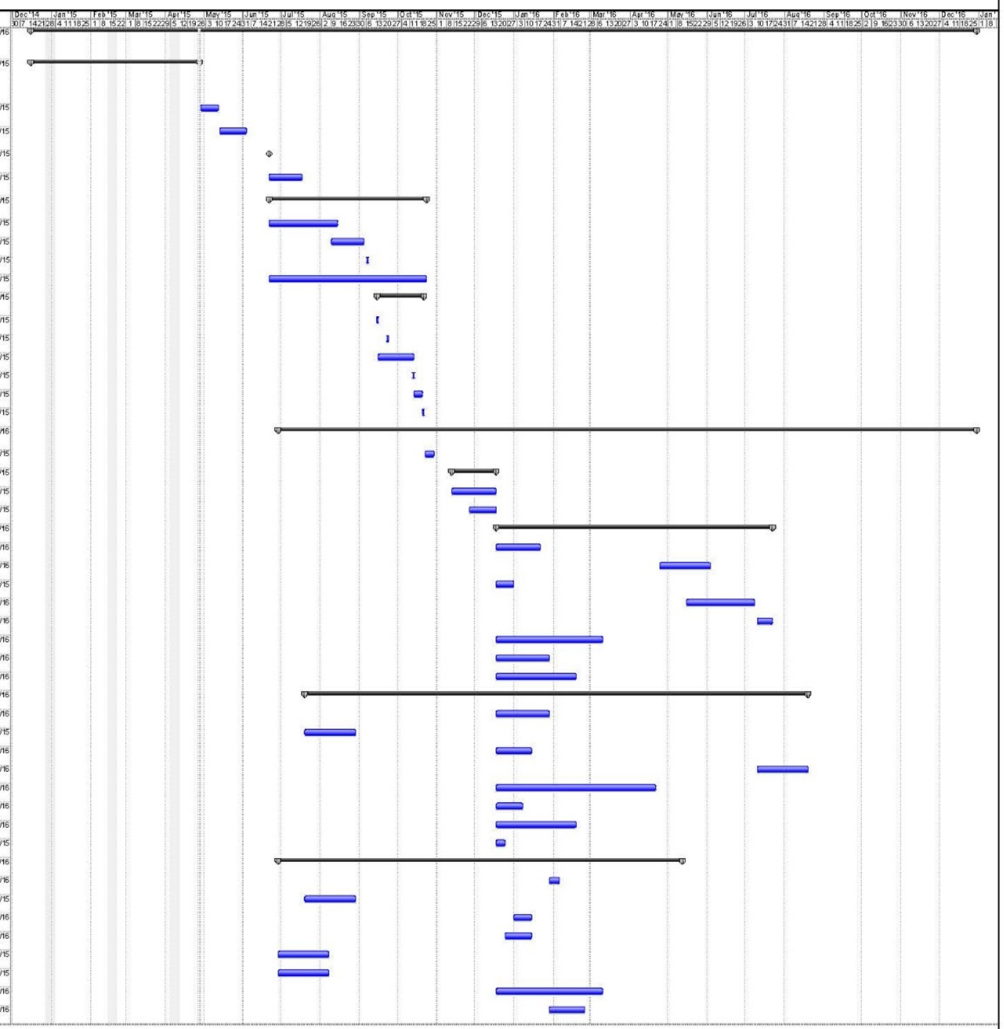
Millburn Township Public Schools
ESP Development & Installation Schedule

ID	Task Name	Predecessors	Duration	Start	Finish
1	**Millburn Township Public Schools**		514 days	Tue 12/16/14	Fri 12/30/16
2	**Phase 1: Investment Grade Audit/ Energy Savings Plan**		76 days	Tue 12/16/14	Mon 4/27/15
32	**3rd Party Engineering Review**	10FS+1 day	2 wks	Wed 4/29/15	Tue 5/12/15
33	**Submit Energy Savings Plan to BPU for Review**	32FS+1 day	14 days	Thu 5/14/15	Wed 6/3/15
34	**Board Approval & Acceptance of ESP & JCI Contr**		0 days	Mon 6/22/15	Mon 6/22/15
35	**Project Financing**	34	1 mon	Mon 6/22/15	Fri 7/17/15
36	**Phase 2: Design**		90 days	Mon 6/22/15	Fri 10/23/15
37	Final Design Engineering	34	8 wks	Mon 6/22/15	Fri 8/14/15
38	Bid Specification Development	37FF+3 wks	4 wks	Mon 8/10/15	Fri 9/4/15
39	Final Design Review Workshop	38	1 day	Mon 9/7/15	Mon 9/7/15
40	Pay for Performance/ Rebate Support	37SS	90 days	Mon 6/22/15	Fri 10/23/15
41	**Phase 3: Procurement**		27 days	Tue 9/15/15	Wed 10/21/15
42	Advertise Bids	39FS+1 wk	1 day	Tue 9/15/15	Tue 9/15/15
43	Pre-Proposal Conference & Site Visits	42FS+5 days	1 day	Wed 9/23/15	Wed 9/23/15
44	Bid Duration for Subcontractors	42SS+1 day	4 wks	Wed 9/16/15	Tue 10/13/15
45	Opening of Bids	44FF	1 hr	Tue 10/13/15	Tue 10/13/15
46	Evaluation of Bids and Confer on Selection of Sub-Contractors	45	1 wk	Wed 10/14/15	Tue 10/20/15
47	Subcontractor Selection	46	1 day	Wed 10/21/15	Wed 10/21/15
48	**Phase 4: Construction**		395 days	Mon 6/29/15	Fri 12/30/16
49	Issue Subcontracts	47FS+1 day	1 wk	Fri 10/23/15	Thu 10/29/15
50	Pre- Construction Activities		25 days	Fri 11/13/15	Thu 12/17/15
51	Planning / Engineering	49FS+10 days	25 days	Fri 11/13/15	Thu 12/17/15
52	Shop Drawing Approval	51FF	15 days	Fri 11/27/15	Thu 12/17/15
53	Deerfield Elementary School		156 days	Fri 12/18/15	Fri 7/22/16
54	Infiltration Reduction including Door Sweep	52	25 days	Fri 12/18/15	Thu 1/21/16
55	Solar Energy Window Film	35	30 days	Mon 4/25/16	Fri 6/3/16
56	Low Flow Water Fixtures	52	2 wks	Fri 12/18/15	Thu 12/31/15
57	Burner Replacement		8 wks	Mon 5/16/16	Fri 7/8/16
58	Pipe Insulation & Blankets	57	2 wks	Mon 7/11/16	Fri 7/22/16
59	Building Automation System Controls Upgrades	52	60 days	Fri 12/18/15	Thu 3/10/16
60	Plug Load Management	52	30 days	Fri 12/18/15	Thu 1/28/16
61	Lighting Upgrades to LED Interior/ Exterior & Occupancy S	52	45 days	Fri 12/18/15	Thu 2/18/16
62	Education Center		285 days	Mon 7/20/15	Fri 8/19/16
63	Infiltration Reduction including Door Sweep	52	30 days	Fri 12/18/15	Thu 1/28/16
64	Solar Energy Window Film	35	30 days	Mon 7/20/15	Fri 8/28/15
65	Low Flow Water Fixtures	52	20 days	Fri 12/18/15	Thu 1/14/16
66	Pipe Insulation & Blankets	58SS	30 days	Mon 7/11/16	Fri 8/19/16
67	Building Automation System Controls Upgrades	52	90 days	Fri 12/18/15	Thu 4/21/16
68	Plug Load Management	52	15 days	Fri 12/18/15	Thu 1/7/16
69	Lighting Upgrades to LED Interior/ Exterior & Occupancy S	52	45 days	Fri 12/18/15	Thu 2/18/16
70	Vending Miser Controls	52	5 days	Fri 12/18/15	Thu 12/24/15
71	Glenwood Elementary School		229 days	Mon 6/29/15	Thu 6/12/16
72	Infiltration Reduction including Door Sweep	63	6 days	Fri 1/29/16	Fri 2/5/16
73	Solar Energy Window Film	35	30 days	Mon 7/20/15	Fri 8/28/15
74	Low Flow Water Fixtures	56	2 wks	Fri 1/1/16	Thu 1/14/16
75	Pedal Valve	74FF	15 days	Fri 12/25/15	Thu 1/14/16
76	Pipe Insulation & Blankets	77SS	30 days	Mon 6/29/15	Fri 8/7/15
77	Steam Trap Replacements		30 days	Mon 6/29/15	Fri 8/7/15
78	Building Automation System Controls Upgrades	52	60 days	Fri 12/18/15	Thu 3/10/16
79	Plug Load Management	60	20 days	Fri 1/29/16	Thu 2/25/16



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Millburn Township Public Schools
ESP Development & Installation Schedule

ID	Task Name	Predecessors	Duration	Start	Finish
80	Lighting Upgrades to LED Interior/ Exterior & Occupancy S	61	60 days	Fri 2/19/16	Thu 5/12/16
81	Vending Miser Controls	52	30 days	Fri 12/18/15	Thu 1/28/16
82	Hartshorn Elementary School		300 days	Mon 7/20/15	Fri 9/9/16
83	Infiltration Reduction including Door Sweep	72	16 days	Mon 2/8/16	Mon 2/29/16
84	Solar Energy Window Film	35	30 days	Mon 7/20/15	Fri 8/28/15
85	Low Flow Water Fixtures	74	20 days	Fri 1/15/16	Thu 2/11/16
86	Pedal Valve	85FF	5 days	Fri 2/5/16	Thu 2/11/16
87	Boiler Replacement		45 days	Mon 6/27/16	Fri 8/26/16
88	Pipe Insulation & Blankets	87FF	20 days	Mon 8/1/16	Fri 8/26/16
89	Rooftop Unit Replacement		45 days	Mon 6/27/16	Fri 8/26/16
90	Building Automation System Controls Upgrades	87FF+2 wks	60 days	Mon 6/20/16	Fri 9/9/16
91	Plug Load Management	79	25 days	Fri 2/26/16	Thu 3/31/16
92	Lighting Upgrades to LED Interior/ Exterior & Occupancy S	80	60 days	Fri 5/13/16	Thu 8/4/16
93	Vending Miser Controls	52	60 days	Fri 12/18/15	Thu 3/10/16
94	Millburn High School		275 days	Mon 7/20/15	Fri 8/5/16
95	Infiltration Reduction including Door Sweep	63	5 days	Fri 1/29/16	Thu 2/4/16
96	Solar Energy Window Film	35	30 days	Mon 7/20/15	Fri 8/28/15
97	Low Flow Water Fixtures	66	30 days	Fri 1/15/16	Thu 2/25/16
98	Pedal Valve	97FF	5 days	Fri 2/19/16	Thu 2/25/16
99	Burner Replacement		30 days	Mon 5/16/16	Fri 6/24/16
100	Air-Cooled Chiller Replacement	52FS+4 wks	45 days	Fri 1/15/16	Thu 3/17/16
101	Combined Heat and Power	99SS	60 days	Mon 5/16/16	Fri 8/5/16
102	Pipe Insulation & Blankets	101FF	20 days	Mon 7/11/16	Fri 8/5/16
103	Building Automation System Controls Upgrades	52	90 days	Fri 12/18/15	Thu 4/21/16
104	Plug Load Management	79	30 days	Fri 2/26/16	Thu 4/7/16
105	Lighting Upgrades to LED Interior/ Exterior & Occupancy S	52FS+2 wks	90 days	Fri 1/1/16	Thu 5/5/16
106	Football Field Lighting Upgrade (behind bleachers)	105FF	15 days	Fri 4/15/16	Thu 5/5/16
107	High Efficiency Transformer Replacement		30 days	Mon 6/27/16	Fri 8/5/16
108	Vending Miser Controls	52	5 days	Fri 12/18/15	Thu 12/24/15
109	Middle School		275 days	Mon 7/20/15	Fri 8/5/16
110	Infiltration Reduction including Door Sweep	52FS+5 wks	30 days	Fri 1/22/16	Thu 3/3/16
111	Solar Energy Window Film	35	30 days	Mon 7/20/15	Fri 8/28/15
112	Low Flow Water Fixtures	52FS+2 wks	15 days	Fri 1/1/16	Thu 1/21/16
113	Pedal Valve	112FF	5 days	Fri 1/15/16	Thu 1/21/16
114	Pipe Insulation & Blankets	52FS+6 wks	30 days	Fri 1/29/16	Thu 3/10/16
115	Building Automation System Controls Upgrades	52FS+2 wks	60 days	Fri 1/1/16	Thu 3/24/16
116	Plug Load Management	104	20 days	Fri 4/8/16	Thu 5/5/16
117	Lighting Upgrades to LED Interior/ Exterior & Occupancy S	52FS+6 wks	90 days	Fri 1/29/16	Thu 6/2/16
118	High Efficiency Transformer Replacement		30 days	Mon 6/27/16	Fri 8/5/16
119	Vending Miser Controls	52	5 days	Fri 12/18/15	Thu 12/24/15
120	South Mountain Elementary School		285 days	Mon 7/20/15	Fri 8/19/16
121	Infiltration Reduction including Door Sweep	54	20 days	Fri 1/22/16	Thu 2/18/16
122	Solar Energy Window Film	35	30 days	Mon 7/20/15	Fri 8/28/15
123	Low Flow Water Fixtures	56	15 days	Fri 1/1/16	Thu 1/21/16
124	Pedal Valve	122FF	5 days	Mon 8/24/15	Fri 8/28/15
125	Pipe Insulation & Blankets	58	20 days	Mon 7/25/16	Fri 8/19/16
126	Building Automation System Controls Upgrades	59SS	45 days	Fri 12/18/15	Thu 2/18/16
127	Plug Load Management	60	20 days	Fri 1/29/16	Thu 2/25/16
128	Lighting Upgrades to LED Interior/ Exterior & Occupancy S	61	45 days	Fri 2/19/16	Thu 4/21/16
129	Wyoming Elementary School		305 days	Mon 7/20/15	Fri 9/16/16
130	Infiltration Reduction including Door Sweep	121	20 days	Fri 2/19/16	Thu 3/17/16
131	Solar Energy Window Film	35	30 days	Mon 7/20/15	Fri 8/28/15
132	Low Flow Water Fixtures	123	20 days	Fri 1/22/16	Thu 2/18/16
133	Steam-to-Hot Water Conversion		60 days	Mon 6/27/16	Fri 9/16/16

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Controls

Johnson Controls

Millburn Township Public Schools
ESP Development & Installation Schedule

ID	Task Name	Predecessors	Duration	Start	Finish
134	Pipe Insulation & Blankets	133FF	20 days	Mon 8/22/16	Fri 9/16/16
135	Building Automation System Controls Upgrades	134FF	30 days	Mon 8/8/16	Fri 9/16/16
136	Plug Load Management	137FF	20 days	Fri 5/27/16	Thu 6/23/16
137	Lighting Upgrades to LED Interior/ Exterior & Occupancy S	128	45 days	Fri 4/22/16	Thu 6/23/16
138	Vending Miser Controls	52	5 days	Fri 12/18/15	Thu 12/24/15
139	District Wide Measures		65 days	Mon 8/1/16	Fri 10/28/16
143	Punch List Items	109,120,129,139	30 days	Mon 10/31/16	Fri 12/9/16
144	Equipment Initial Training	143FF	5 days	Mon 12/5/16	Fri 12/9/16
145	System Commissioning	143FF	2 wks	Mon 11/28/16	Fri 12/9/16
146	Project Close Out	145	15 days	Mon 12/12/16	Fri 12/30/16

Controls

Section 8. Sample Energy Performance Contract

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

Appendix 1. Energy Conservation Measures Investigated But Not Recommended at This Time

ECM: Attic Insulation

- Glenwood Elementary School
- Wyoming Elementary School

A building envelope audit was performed for the entire Millburn Township Public Schools. The results of the audit identified the existing insulation of the attic spaces has settled and reduced thermal capacity. The savings of adding insulation in these spaces were calculated.

Scope of Work:

- Install insulation on the attic areas

This ECM was not included in the baseline financial analysis because of a high payback.

ECM: Add Insulation above Stage

- Middle School

A building envelope audit was performed for the entire Millburn Township Public Schools. The results of the audit identified the ceiling above the stage was lacking insulation. The savings of adding additional insulation were calculated

Scope of Work:

- Install insulation on the ceiling above the stage

This ECM was not included in the baseline financial analysis because of a high payback.

ECM: Replace Windows

- Hartshorn Elementary School
- Middle School
- Wyoming Elementary School

A building envelope audit was performed for the entire Millburn Township Public Schools. The results of the audit identified the some older sections of the schools still contained single pane windows. Energy loss due to excess air infiltration occurs between the building and its surroundings. The savings of replacing the single pane windows to double pane windows were calculated.

Scope of Work:

- Replace single pane windows to double pane windows.

This ECM was not included in the baseline financial analysis because of a high payback.

ECM: Roof Replacement & Insulation

- Education Center

The roof on the Education Center is constructed of metal roof decking, insulation, and rolled asphalt membrane system. This roof has reached the end of its useful life and should be repaired. The savings of replacing the existing roof with R-value of 13 to the roof with R-value of 30 were calculated.

Scope of Work:

- Replace the existing roof with the roof with R-value of 30.

This ECM was not included in the baseline financial analysis because of a high payback.

ECM: Solar PV

- Deerfield Elementary School
- Education Center
- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School
- South Mountain Elementary School
- Wyoming Elementary School

The buildings were evaluated for the potential to install rooftop photovoltaic (PV) solar panels for power generation. Present technology incorporates the use of solar cell arrays that produce direct current (DC) electricity. The DC current is converted to alternating current (AC) with the use of an electrical device known as an inverter. The amount of available roof area determines how large of a solar array can be installed on any given roof. The solar power generation model was utilized to calculate PV power generation.

Scope of Work:

- Install Solar PV arrays on the roof throughout the school district.

This ECM was not included in the baseline financial analysis because of a high payback.

ECM: Direct Install

- Deerfield Elementary School
- Education Center
- Glenwood Elementary School
- Hartshorn Elementary School

- South Mountain Elementary School
- Wyoming Elementary School

The Direct Install program applies to smaller facilities that have a peak electrical demand of 200 kW or less in any of the previous 12 months. Buildings must be located in New Jersey and served by one of the state's public, regulated electric utility companies.

Direct install is funded through New Jersey's Clean Energy Program and is designed to provide capital for building energy upgrade projects to fast track implementation. The program will pay up to 70% of the costs for lighting, HVAC, motors, refrigeration, and other equipment upgrades with higher efficiency alternatives. If a building is eligible for this funding, the Direct Install program can reduce the implementation cost of energy conservation projects.

The Direct Install program has specific HVAC equipment and lighting requirements and is generally applicable only to smaller package of HVAC units, small boilers and lighting retrofits.

The program pays a maximum amount of 75,000 per building, and up to $250,000 per customer per year. Installations must be completed by an approved Direct Install participating contractor, a list of which can be found on the New Jersey Clean Energy Website. Contractors will coordinate with the applicant to arrange installation of recommended measures identified in a previous energy assessment. The incentive is reimbursed to the owner upon successful replacement and payment of the equipment.

The elementary schools and the Education Center qualify for the program because their electrical demand is less than the maximum peak electrical demand of 200 kW for the last 12 month period.

Scope of Work:

- Johnson Controls will work with the District to apply for all applicable equipment incentives.
- Johnson Controls will complete all paper work and handle all administration with the Direct Install program coordinator.
- Incentive checks shall be mailed directly to Millburn Township Public Schools

This ECM was not included in the baseline financial analysis because the LED tube retrofits were not part of the Direct Install program during the development of the ESP; if the program changes, this measure may be re-evaluated.

ECM: Refrigerator Replacement

- Deerfield Elementary School
- Glenwood Elementary School
- Hartshorn Elementary School

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

Scope of Work:

- Any non- Energy Star refrigerator will be removed and properly disposed of.
- A new Energy Star refrigerator will be installed to match the exiting size of the removed refrigerator.

This ECM was not included in the baseline financial analysis because of a long payback.

ECM: Addition of Cooling in Gym

- Deerfield Elementary School
- Glenwood Elementary School
- Hartshorn Elementary School
- South Mountain Elementary School
- Wyoming Elementary School

There are large areas that contain no air conditioning and the District would like to investigate adding cooling to these areas. The installation of new units with high-efficiency units containing high-efficiency condensing units will provide cooling to the gymnasium. The cooling capacities is estimated at 400-600 ft^2/ton.

Scope of Work:

- Furnish and Install the following:

School	Quantity Installed	Cooling Capacity (Tons)	New Minimum Rated Efficiency
Deerfield ES	1	5	12.2 EER
Glenwood ES	1	5	12.2 EER
Hartshorn ES	1	7.5	12.2 EER
South Mountain ES	1	7.5	12.2 EER
Wyoming ES	1	5	12.2 EER

- York or equivalent high efficiency packaged units.
- Install all applicable piping.
- Install new roof curbs as needed for new equipment.
- Insulate all piping.
- Leak check piping.
- Electrical power and control wiring to new units.
- Coordinate with new DDC controls.
- Provide new unit start-up and commissioning.

This ECM was not included in the baseline financial analysis because of a long payback and the capital nature of the improvement.

ECM: Air Handling Unit Replacement

- Deerfield Elementary School
- High School
- Middle School

JCI proposes to replace the AHUs which are close to the end of life with high efficiency AHUs.

Scope of Work

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

Demolition and Removal Work

- Disconnect, remove and properly dispose of existing AHU's specified in the table below.
- Disconnect, remove and properly dispose of Hot Water/Chilled Water piping to nearest isolation valves or as required for new installation.
- Disconnect, remove and properly dispose of all other materials or debris related to this project.

New Installation Work

- Furnish and install York or Johnson Controls approved equivalent AHUs as specified in the table below. The new AHUs shall match the capacities and specifications of the existing units. Install supply fan/return fan, chilled and hot water coils where applicable.

School	Quantity	Manufacturer	Model #	Areas Served	Type/Utility
High School	1	Old unit	No name plate	Auditorium	AHU-HW & CW coil
High School	1	Carrier	09BB-012---300-	Library	DX Cooing
High School	1	Carrier	50BD-024---550-	Library	DX Cooing
High School	1	Carrier	50BU-012---510-	Library	DX Cooing
Middle School	1	Old unit	No name plate	Auditorium	Heat only HW coils
Middle School	1	Old unit	No name plate	Cafeteria	Heat only HW Coils
Deerfield ES	1	Kennard Nelson	H2150HV	Gymnasium	HW Coils

- Disconnect the existing chilled & hot water piping serving the existing AHUs.
- Disconnect the power and control wiring from the AHUs, the existing breakers shall be reused.
- Disconnect and safe off the existing controls serving the AHUs.
- Provide and install the required new black steel welded pipe & fittings to connect the new units to the existing chilled, gas & hot water piping system (where applicable).
- Insulate all HW, CHW and DX piping and leak check piping.
- Provide and install required new EMT conduit with compression fittings and seal tight to connect the new units to the existing circuit breakers.
- Provide and install the required new EMT conduit and seal tight to connect the inter-locks into the control circuits.
- Connect the new units to the existing Building Management System.
- Start, commission and test the new AHUs.

This ECM was not included in the baseline financial analysis because of a long payback.

ECM: Boiler Replacement

- Glenwood Elementary School

JCI proposes to replace the three existing Smith boilers with high efficiency boilers. The boilers will be sequenced to operate on a lead/lag basis when there is a call for heat from the building and they will be integrated with the existing building management system.

Scope of Work

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

Demolition and Removal Work

- Disconnect, remove and properly dispose of existing two (2) Smith Steam and one (1) HW boilers.
- Disconnect, remove and properly dispose of Steam/HW piping to nearest isolation valves or as required for new installation.
- Disconnect, remove and properly dispose of gas flue as required.
- Disconnect, remove and properly dispose of all other materials or debris related to this project.

New Installation Work – Steam Boilers

Provide and install two (2) new Smith Sectional Steam boilers, Model # GO-28HE-S-6 or Johnson Controls approved equal. The boilers shall have a gross output rating of 1458 MBH at full load.

- The boilers to have a steam output capacity 1110 MBH.
- Modulating dual fuel burner.
- Combustion efficiency>=83% for natural gas at full load.
- New boiler to have Boiler Management System.
- New boiler to have controls that should be capable of integrating with the existing building management system.
- Boilers and controls to comply with applicable regulations.
- Provide U.L. labeled burners.
- Burners to have stack O2 sensor based optimal A/F ratio controls.
- The boilers shall be located in the existing location with hot water piping and all other ripping extended as required for connection. New piping will be installed from the new boilers and tied into the existing header.
- Insulate new piping, valves and fittings as required.
- Provide boiler pad if use of existing is inadequate.
- Install boilers based on manufacturer's installation procedures.
- Provide and install new flue as required.
- Patch and repair all penetrations.
- Provide valve tags and ID Chart.
- Provide pipe labeling and directional arrows.

- Start-up, checkout and verify all modes (stages) of operation (by factory authorized rep.) including measurement and verification of “part load” and “full load” efficiencies, combustion gas analysis and All Unit control features per manufacturer’s start-up and checkout procedures.
- Reuse existing piping, pipe fittings, pipe hangers, isolation valves, strainers, check valves, thermal wells, and pressure sensor wells where feasible and equipment serviceable.
- Asbestos removals is responsibility of others.

New Installation Work – Hot Water Boilers

Provide and install one (1) new Lochinvar or Johnson Controls approved equal condensing HW boiler. The boilers shall have a gross output rating of 1000 MBH at full load.

- The boilers to have an output capacity 930 MBH.
- Modulating burner with a turndown ratio of 15:1 or higher.
- System efficiency>=90% at 120F EWT (50% firing rate).
- New boiler to have Boiler Management System.
- New boiler to have controls that should be capable of integrating with the existing building management system.
- Boilers and controls to comply with applicable regulations.
- Provide U.L. labeled burners.
- Burners to have stack O_2 sensor based optimal A/F ratio controls.
- The boilers shall be located in the existing location with hot water piping and all other ripping extended as required for connection. New piping will be installed from the new boilers and tied into the existing header.
- Insulate new piping, valves and fittings as required.
- Provide boiler pad if use of existing is inadequate.
- Install boilers based on manufacturer’s installation procedures.
- Provide and install new flue as required.
- Patch and repair all penetrations.
- Provide valve tags and ID Chart.
- Provide pipe labeling and directional arrows.
- Start-up, checkout and verify all modes (stages) of operation (by factory authorized rep.) including measurement and verification of “part load” and “full load” efficiencies, combustion gas analysis and All Unit control features per manufacturer’s start-up and checkout procedures.
- Reuse existing piping, pipe fittings, pipe hangers, isolation valves, strainers, check valves, thermal wells, and pressure sensor wells where feasible and equipment serviceable.
- Asbestos removals is responsibility of others.

This ECM was not included in the baseline financial analysis because of a long payback.

ECM: Rooftop Unit Replacement

- High School
- Middle School

Rooftop units supply conditioned air to the various zones throughout a building. In buildings where the rooftop units are older and in poor condition, the installation of new high-efficiency rooftop units will result in significant energy and operational cost savings. The new rooftop units will distribute the air in a much more efficient manner by using premium efficiency motors, variable frequency drives (where applicable),

tighter unit construction eliminating leakage, heat recovery and economizer options (when possible), and more efficient heating coil designs. In addition to energy and operational cost savings the units will provide a more pleasant indoor environment resulting in increased productivity and occupant comfort.

Scope of Work

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

Demolish and Removal Work

- Disconnect, remove and properly dispose of existing RTU's specified in table below.
- Disconnect, remove and properly dispose of hot water/Chilled water piping to nearest isolation valves or as required for new installation.
- Disconnect, remove and properly dispose of all other materials or debris related to this project.

New Installation Work

- Furnish and install new York or Johnson Controls approved equivalent RTU's as specified in the table below. The new RTUs shall match the capacities and specifications of the existing units. Install supply fan/return fan, chilled/DX and hot water coils where applicable.

Building	Quantity	Manufacturer	Model #	Areas Served	Equipment Type
HS*	1	York	D4CE060A25A		DX
HS*	2	Trane	GRDA15GDBB0NICK105C0PCV	New Gym	Gas Heat only
MS	1	Trane	Climate Changer – PCAA-10	Lower Gym	Gas Heat/DX

- Disconnect the power and control wiring from the RTUs the existing breakers shall be reused.
- Disconnect and safe off the existing controls serving the RTUs.
- Reuse the existing curbs where applicable.
- Provide the required dumpsters to remove the construction debris from the job site.
- Provide the required storage, trucking and crane to deliver and set the new units.
- Install and seal the new curb adapter to the existing curb.
- Provide and install the required new black steel welded pipe & fittings to connect the new roof mounted units the existing hot water piping systems.
- Insulate all hot water and DX piping and leak check piping.
- Install the HW ATC valves for the new RTUs as required by the specifications.
- Provide and install required new EMT conduit with compression fittings and seal tight to connect the new units to the existing circuit breakers.
- Provide and install the required new EMT conduit and seal tight to connect the inter-locks into the control circuits.
- Connect the new units to the existing Building Management system.
- Start, commission and test the new RTUs.

This ECM was not included in the baseline financial analysis because of a long payback.

ECM: Steam Trap Replacement

- Wyoming Elementary School

The subcontractor tested 6 traps in the school and found three (3) was ok, two (2) were out of service and one (1) was blocked.

This ECM was not included in the baseline financial analysis because the steam system in the school will be converted to the hot water system.

ECM: Steam-to-Hot Water Conversion and Condensing Boiler Installation

- Glenwood Elementary School

JCI proposes to replace the three existing Smith boilers with high efficiency boilers. All three boilers will be hot water units and the original sections of the building that is served by steam will be converted to a hydronic heating system. The boilers will be sequenced to operate on a lead/lag basis when there is a call for heat from the building and they will be integrated with the existing building management system.

Scope of Work

This measure would replace the existing steam and hot water boilers with a new hot water condensing boiler plant. In order to eliminate the steam system throughout the building, all terminal equipment would need to be replaced which is a significant capital project. The long payback and high cost of this measure were presented to the District for capital planning purposes but will not be part of the ESIP.

ECM: Unit Ventilator Replacement

- Deerfield Elementary School
- Glenwood Elementary School
- Hartshorn Elementary School
- South Mountain Elementary School
- Wyoming Elementary School

Unit ventilators are used throughout classrooms in most school districts to provide heating and sometime cooling to the areas. In buildings' where the unit ventilators are older and in poor condition, the installation of new high-efficiency units will result in significant energy and operational cost savings. New unit ventilators will distribute the air in a much more efficient manner by utilizing premium efficiency motors, tighter unit construction eliminating leakage, and more efficient heating and cooling coil designs. The installation of new units will also allow better control of the outside air due to improved damper design on new units and factory-mounted controls on the units. In addition to energy and operational cost savings, the units will provide a more pleasant indoor environment resulting in increased productivity and occupant comfort.

Johnson Controls

The capital cost to replace unit ventilators exceeds the payback of the ESIP project cash flow; however, refurbishment of unit ventilators may be feasible after all bids are received and final costs are known. This measure will be re-evaluated once bidding is complete and could include refurbishment of the unit ventilators.

ECM: Ventilation Improvement

- Wyoming Elementary School

Scope of Work

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

New Installation Work

- Furnish and install one (1) York heating only or Johnson Controls approved equivalent RTU.
- The rooftop unit will have a total supply air capacity of 5000 CFM (6ACH @ V=48000 ft2)
- The unit shall have direct fired natural gas heating system and the coil capacity shall not exceed 200,000 Btu/hr
- Provide and install natural gas piping to the new unit.
- Provide the required dumpsters to remove the construction debris from the job site.
- Provide the required storage, trucking and crane to deliver and set the new units.
- Provide and install necessary ductwork to distribute air evently in the cafeteria (Cafeteria = 60' X 40').
- Insulate all hot air ductwork if located outside or in the plenum space and leak check ductwork.
- Provide and install necessary electrical wiring to the new unit.
- Provide and install the required new EMT conduit and seal tight to connect the inter-locks into the control circuits.
- Connect the new units to the existing Building Management system.
- Start, commission and test the new RTUs.

This ECM was not included in the baseline financial analysis because of a long payback.

ECM: Smart Window A/C Control

- High School
- Middle School
- Wyoming Elementary School

Scope of Work

The window A/C units are used to cool the offices and classrooms and not on automatic control. They can be occasionally left on by occupants when they leave the room.

The programmable "smart" timers is proposed to be installed that interrupt the electrical supply to the window air conditioners when cooling is not needed due to the room being unoccupied. The timers are

configurable to operate as a standalone timer or they can be wirelessly interconnected to provide remote temperature control using software.

This ECM was identified as part of the Local Government Energy Audit and will be addressed through the Plug Load Controls where needed.

ECM: Kitchen Hood Controls

- High School
- Middle School

ECM Summary

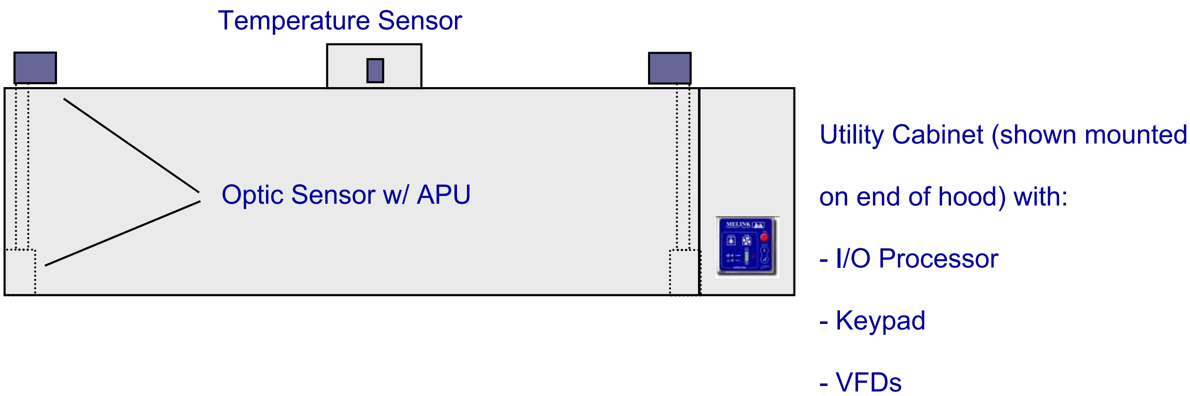
Kitchen fume hoods are usually operated from the time the first kitchen employee enters the kitchen to the time the last kitchen employee leaves the kitchen. Operating the fume hoods at full power all the time wastes electrical fan energy and the fume hood also draws conditioned air out of the space 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.

Scope of Work

- The Green Energy Hood System will automatically control the speed of the exhaust and make-up fans above to ensure optimal hood performance. The system includes the following components:
  - I / O Processor
  - Keypad
  - Temperature Sensors
  - Optic Sensors
  - Variable Frequency Drives (VFDs), which replace magnetic starters for 3-phase motors, and cables.
- The I/O processor shall be mounted above the hood closest to the keypad and the keypad shall be mounted next to the existing hood switch.
- The temperature sensors shall be mounted in each exhaust 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.

System

- The specified system will be as follows:
  - I/O Processor (120/1, 20A) - Sends RS-485 signals to the VFDs for up to four (4) independent exhaust fans and one (1) make-up air unit (multiple VFDs can be controlled with each signal).
  - Keypad - Controls lights and fans for up to four (4) hoods (one (1) keypad per I/O Processor).
  - Temperature Sensor - Monitors exhaust air temperature at duct (one (1) sensor per exhaust duct).
  - Optic Sensor with APU - Monitors smoke load inside hood (one (1) sensor set per Type 1 hood).
  - Variable Frequency Drive(s) - Varies fan speed (one (1) VFD per fan).
  - Cables - Links I/O Processor to keypad, sensors, and VFDs.



Kitchen Hood Controls Diagram

Building	Kitchen Hood Location	Quantity of Hoods
High School	Main Kitchen	1
Middle School	Main Kitchen	1

The limited run hours of the kitchens resulted in long paybacks which fell outside of the project cash flow.

ECM: Walk-In Cooler/Freezer Controls

- High School
- Middle School

The kitchens in the High School and Middle School contain several walk-in coolers and freezers. These units are controlled by a dry bulb temperature and as a result run continuously throughout the year. Installing a CoolTrol® Cooler Control System was assessed. The system will monitor both dry and wet bulb temperature within the walk-in and allow evaporators and compressors to modulate up and down based on enthalpy set points rather than by dry bulb temperature alone. Savings is a result of reduced run time of evaporator fans, compressors and door heaters.

Scope of Work

- Furnish and install CoolTrol Cooler Control System on the following:

Building	Type	Quantity
High School	Walk-In Freezers	2
Middle School	Walk-In Freezers	2

- Provide programming for each unit.
- Provide start up and warranty.

- Provide training for maintenance personnel

This measure was not included due to the longer paybacks.

ECM: Destratification Fans

- Deerfield Elementary School
- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School
- South Mountain Elementary School
- Wyoming Elementary School

Scope of Work

- Furnish and install destratification fans.
- Furnish and install the new power wiring to connect the fans
- Provide and install one (1) dedicated 20 amp power circuit from the existing power panel located in the gym area of each school to serve all of the new fans.
- Start and test the new fans.
- Clean up area.
- Provide warranty.
- Provide training for operating personnel.

This measure was not included because of the longer paybacks and in some cases, different types of fans were already in place.

ECM: Electric Hand Dryers

- Deerfield Elementary School
- Education Center
- Glenwood Elementary School
- Hartshorn Elementary School
- High School
- Middle School
- South Mountain Elementary School
- Wyoming Elementary School

Scope of Work

- High efficiency hand dryers are installed in restrooms located throughout the entire school district. The following hand dryers will be installed.

Building	Quantity
Deerfield ES	10

Building	Quantity
Education Center	2
Glenwood ES	13
Hartshorn ES	20
High School	34
Middle School	25
South Mountain ES	12
Wyoming ES	15
Total	*131*

This measure was not included in the baseline financial analysis because of the long payback.

Appendix 2. 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.

Operational Savings

New LED Fixtures

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

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

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

Mechanical and Controls Upgrades

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

Operational Savings Summary

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

	Sum of P/O Amount
All Buildings	**$205,669**
Building Automation Controls Upgrades	$90,890
Lighting Upgrades	$12,000
Low Flow Water Fixtures & Pedal Valves	$2,500
Misc.	$100,000
Unit Vent Replacement	$279
Deerfield Elementary School	**$1,175**
Boiler Replacement	$1,175
Ed Center	**$266**
Unit Vent Replacement	$266
Glenwood Elementary School	**$62,309**
Roof Replacement	$6,586
Steam to Hot Water Conversion	$55,723
Hartshorn Elementary School	$12,168
Boiler Replacement	$11,580
Unit Vent Replacement	$558
Maintenance Building	**$7,984**
Roof Replacement	$7,984
Millburn High School	**$30,380**
Boiler Replacement	$17,787
Roof Replacement	$12,593
Millburn Middle School	**$22,910**
AHU Replacement	$6,470
Boiler Replacement	$12,100
Roof Replacement	$4,340
South Mountain & Glenwood Elementary Schools	**$1,179**

	Sum of P/O Amount
Building Automation Controls Upgrades	$1,179
Wyoming Elementary School	$2,216
AHU Replacement	$1,946
Unit Vent Replacement	$270
Grand Total	**$346,226**

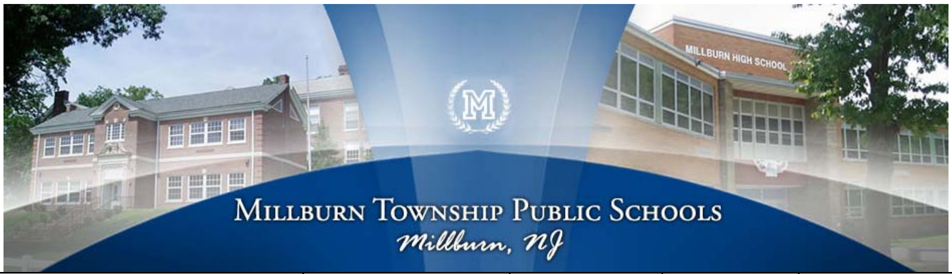
Operational Savings for Financial Model	
ECM Description	**Annual Savings**
Boiler Replacement - Hartshorn Elementary School	$11,580
Building Automation System Upgrades - District Wide	$69,346
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Deerfield Elementary School	$2,708
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Education Center	$1,475
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Glenwood Elementary School	$2,486
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Hartshorn Elementary School	$2,455
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - High School	$10,259
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Middle School	$6,397
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - South Mountain Elementary School	$1,529
Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Wyoming Elementary School	$1,879
Totals	**$110,115**

Appendix 3. Field Measurements

Field measurements are available electronically due to the size of the files.

Appendix 4. Recommended Project - ESP

ID #	ECM	Total Construction Hard Cost	Year 1 Utility Savings	Simple Payback	Installation Plan	15 Year Model
3	Infiltration Reduction - Deerfield Elementary School	$19,025	$1,949	9.8	Public Bidding	Yes
4	Infiltration Reduction - Education Center	$10,454	$1,072	9.8	Public Bidding	Yes
5	Infiltration Reduction - Glenwood Elementary School	$39,041	$5,118	7.6	Public Bidding	Yes
6	Infiltration Reduction - Hartshorn Elementary School	$19,344	$1,870	10.3	Public Bidding	Yes
7	Infiltration Reduction - High School	$48,465	$4,797	10.1	Public Bidding	Yes
8	Infiltration Reduction - Middle School	$56,500	$6,832	8.3	Public Bidding	Yes
10	Infiltration Reduction - Wyoming Elementary School	$10,601	$879	12.1	Public Bidding	Yes
11-18	Solar Energy Window Film – District Wide	$265,000	$2,972	89.2	District Implement	Yes
19	Low Flow Water Fixtures - Deerfield Elementary School	$1,515	$306	5.0	JCI Implement	Yes
20	Low Flow Water Fixtures - Education Center	$703	$36	19.5	JCI Implement	Yes
21	Low Flow Water Fixtures - Glenwood Elementary School	$1,535	$297	5.2	JCI Implement	Yes
22	Low Flow Water Fixtures - Hartshorn Elementary School	$1,618	$235	6.9	JCI Implement	Yes
23	Low Flow Water Fixtures - High School	$2,526	$1,100	2.3	JCI Implement	Yes
24	Low Flow Water Fixtures - Middle School	$2,589	$623	4.2	JCI Implement	Yes
25	Low Flow Water Fixtures - South Mountain Elementary School	$1,536	$153	10.0	JCI Implement	Yes
26	Low Flow Water Fixtures - Wyoming Elementary School	$1,556	$187	8.3	JCI Implement	Yes
27	Pedal Valves - Glenwood Elementary School	$3,216	$497	6.5	JCI Implement	Yes
28	Pedal Valves - Hartshorn Elementary School	$2,500	$328	7.6	JCI Implement	Yes
29	Pedal Valves - High School	$3,216	$1,233	2.6	JCI Implement	Yes



ID #	ECM	Total Construction Hard Cost	Year 1 Utility Savings	Simple Payback	Installation Plan	15 Year Model
30	Pedal Valves - Middle School	$5,360	$2,124	2.5	JCI Implement	Yes
31	Academy of Energy Education	$10,000	$0	0.0	JCI Implement	Yes
32	Building Automation System Training	$15,000	$0	0.0	JCI Implement	Yes
33	Demand Response - Emergency Capacity Program	$24,000	$0	0.0	JCI Implement	Yes
34	Demand Response - Energy Efficiency Credit - LED	$0	$0	0.0	JCI Implement	Yes
39	Pay for Performance - High School	$10,000	$0	0.0	JCI Implement	Yes
53	Boiler Replacement - Hartshorn Elementary School	$295,475	$2,952	100.1	Public Bidding	Yes
57	Pipe Insulation & Blankets	$171,591	$15,750	10.9	Public Bidding	Yes
66	Steam Trap Replacements - Glenwood Elementary School	$35,420	$1,711	20.7	Public Bidding	Yes
76	Building Automation System Upgrades - District Wide	$255,375	$56,302	4.5	Public Bidding	Yes
79	Building Automation System Upgrades - Education Center - Central Plant	$16,000	$12,582	1.3	Public Bidding	Yes
82	Building Automation System Upgrades - High School - Exhaust Fans	$25,938	$2,508	10.3	Public Bidding	Yes
83	Building Automation System Upgrades - High School DCV	$23,125	$4,337	5.3	Public Bidding	Yes
84	Building Automation System Upgrades - Middle School - Exhaust Fans	$9,625	$716	13.4	Public Bidding	Yes
86	Building Automation System Upgrades - South Mountain Elementary School - Exhaust Fans	$11,125	$893	12.5	Public Bidding	Yes
89	Plug Load Management	$36,630	$2,670	13.7	Public Bidding	Yes
103	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Deerfield Elementary School	$142,029	$10,591	13.4	Public Bidding	Yes
104	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Education Center	$58,753	$6,814	8.6	Public Bidding	Yes

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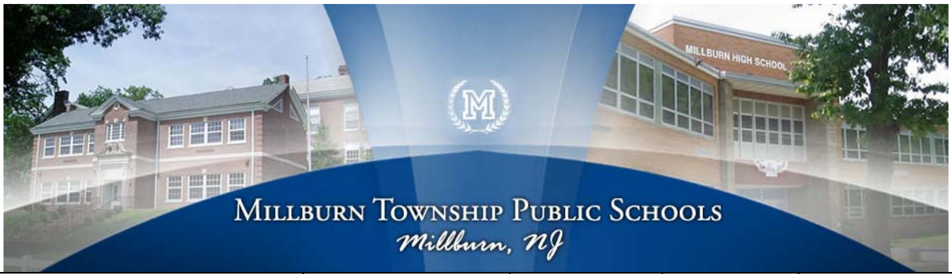

ID #	ECM	Total Construction Hard Cost	Year 1 Utility Savings	Simple Payback	Installation Plan	15 Year Model
105	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Glenwood Elementary School	$109,988	$7,970	13.8	Public Bidding	Yes
106	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Hartshorn Elementary School	$153,953	$13,512	11.4	Public Bidding	Yes
107	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - High School	$483,606	$43,353	11.2	Public Bidding	Yes
109	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Middle School	$448,314	$33,551	13.4	Public Bidding	Yes
110	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - South Mountain Elementary School	$117,970	$6,159	19.2	Public Bidding	Yes
111	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Wyoming Elementary School	$121,020	$6,338	19.1	Public Bidding	Yes
122	Football Field Lighting Upgrade - Behind Bleachers	$3,513	-$107	-32.7	Public Bidding	Yes
123	Vending Miser Controls - Education Center	$400	$393	1.0	Public Bidding	Yes
124	Vending Miser Controls - Glenwood Elementary School	$400	$161	2.5	Public Bidding	Yes
125	Vending Miser Controls - Hartshorn Elementary School	$400	$163	2.5	Public Bidding	Yes
126	Vending Miser Controls - High School	$2,400	$949	2.5	Public Bidding	Yes
127	Vending Miser Controls - Middle School	$400	$158	2.5	Public Bidding	Yes
128	Vending Miser Controls - Wyoming Elementary School	$400	$158	2.5	Public Bidding	Yes
129	High Efficiency Transformers - High School	$12,697	$1,411	9.0	Public Bidding/ JCI Implement	Yes
130	High Efficiency Transformers - Middle School	$36,294	$2,854	12.7	Public Bidding/ JCI Implement	Yes
131	Air-Cooled Chiller Replacement - High School	$187,950	$9,533	19.7	Public Bidding	Yes
	Total Hard Costs	$3,051,090	$276,988	5.0		

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15-Year Project		
ECM Hard Costs	**$3,051,090**	
Investment Grade Energy Audit	$45,766	1.5%
Design Engineering Fees	$0	0.0%
Construction Management & Project Administration	$183,065	6.0%
System Commissioning (JCI Services)	$22,883	0.75%
Equipment Initial Training Fees	$15,255	0.5%
ESCO Overhead	$274,598	9.0%
ESCO Profit	$152,555	5.0%
Parette Somjen Architects Fee Subtotal	$213,576	7.00%
Total Construction Costs	**$3,958,789**	
District Controlled Costs		
Total Contingency	$224,064	
Window Film Costs	$265,000	
Bond Council/ Finance Advisor Fees	$35,000	
Total Financed Amount	**$4,482,854**	

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

Year	Annual Amount ($/Yr)
1	$18,957
2	$19,526
3	$20,112
Total	**$58,595**

ECM #	ECM	Calculated Utility Savings								Total Annual Utility
		Electric Consumption		Peak Electric Demand		Natural Gas		Water		
		Dollars	Units	Dollars	Units	Dollars	Units	Dollars	Units	Dollars
3	Infiltration Reduction - Deerfield Elementary School	$157	1,638 kWh	$0	0 kW	$1,746	1,940 Therms	$0	0 kGal.	$1,903
4	Infiltration Reduction - Education Center	$97	915 kWh	$0	0 kW	$950	1,000 Therms	$0	0 kGal.	$1,047
5	Infiltration Reduction - Glenwood Elementary School	$414	4,229 kWh	$0	0 kW	$4,585	5,210 Therms	$0	0 kGal.	$4,999
6	Infiltration Reduction - Hartshorn Elementary School	$164	1,660 kWh	$0	0 kW	$1,662	1,910 Therms	$0	0 kGal.	$1,826
7	Infiltration Reduction - High School	$409	4,260 kWh	$0	0 kW	$4,277	4,860 Therms	$0	0 kGal.	$4,686
8	Infiltration Reduction - Middle School	$583	6,076 kWh	$0	0 kW	$6,090	6,920 Therms	$0	0 kGal.	$6,673
10	Infiltration Reduction - Wyoming Elementary School	$75	782 kWh	$0	0 kW	$783	890 Therms	$0	0 kGal.	$858
11	Solar/ Security Window Film - Deerfield Elementary School	$0	0 kWh	$0	0 kW	$437	486 Therms	$0	0 kGal.	$437
12	Solar/ Security Window Film - Education Center	$0	0 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$0
13	Solar/ Security Window Film - Glenwood Elementary School	$0	0 kWh	$0	0 kW	$173	197 Therms	$0	0 kGal.	$173
14	Solar/ Security Window Film - Hartshorn Elementary School	$0	0 kWh	$0	0 kW	$908	1,044 Therms	$0	0 kGal.	$908
15	Solar/ Security Window Film - High School	$0	0 kWh	$0	0 kW	$532	604 Therms	$0	0 kGal.	$532
16	Solar/ Security Window Film - Middle School	$0	0 kWh	$0	0 kW	$715	812 Therms	$0	0 kGal.	$715
17	Solar/ Security Window Film - South Mountain Elementary School	$0	0 kWh	$0	0 kW	$137	157 Therms	$0	0 kGal.	$137
18	Solar/ Security Window Film - Wyoming Elementary School	$0	0 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$0
19	Low Flow Water Fixtures - Deerfield Elementary School	$0	0 kWh	$0	0 kW	$299	332 Therms	$0	78 kGal.	$299
20	Low Flow Water Fixtures - Education Center	$0	0 kWh	$0	0 kW	$35	37 Therms	$0	9 kGal.	$35
21	Low Flow Water Fixtures - Glenwood Elementary School	$0	0 kWh	$0	0 kW	$290	329 Therms	$0	75 kGal.	$290

ECM #	ECM	Calculated Utility Savings								Total Annual Utility
		Electric Consumption		Peak Electric Demand		Natural Gas		Water		
		Dollars	Units	Dollars	Units	Dollars	Units	Dollars	Units	Dollars
22	Low Flow Water Fixtures - Hartshorn Elementary School	$0	0 kWh	$0	0 kW	$229	263 Therms	$0	62 kGal.	$229
23	Low Flow Water Fixtures - High School	$0	0 kWh	$0	0 kW	$1,074	1,220 Therms	$0	289 kGal.	$1,074
24	Low Flow Water Fixtures - Middle School	$0	0 kWh	$0	0 kW	$608	691 Therms	$0	164 kGal.	$608
25	Low Flow Water Fixtures - South Mountain Elementary School	$0	0 kWh	$0	0 kW	$150	172 Therms	$0	41 kGal.	$150
26	Low Flow Water Fixtures - Wyoming Elementary School	$0	0 kWh	$0	0 kW	$182	207 Therms	$0	47 kGal.	$182
27	Pedal Valves - Glenwood Elementary School	$0	0 kWh	$0	0 kW	$97	110 Therms	$386	35 kGal.	$483
28	Pedal Valves - Hartshorn Elementary School	$0	0 kWh	$0	0 kW	$72	83 Therms	$247	26 kGal.	$319
29	Pedal Valves - High School	$0	0 kWh	$0	0 kW	$339	385 Therms	$860	97 kGal.	$1,199
30	Pedal Valves - Middle School	$0	0 kWh	$0	0 kW	$630	716 Therms	$1,436	176 kGal.	$2,066
31	Academy of Energy Education	$0	0 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$0
32	Building Automation System Training	$0	0 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$0
33	Demand Response - Emergency Capacity Program	$0	0 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$0
34	Demand Response - Energy Efficiency Credit - LED	$0	0 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$0
39	Pay for Performance - High School	$0	0 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$0
53	Boiler Replacement - Hartshorn Elementary School	$0	0 kWh	$0	0 kW	$2,883	3,313 Therms	$0	0 kGal.	$2,883
57	Pipe Insulation & Blankets	$0	0 kWh	$0	0 kW	$15,381	17,282 Therms	$0	0 kGal.	$15,381
66	Steam Trap Replacements - Glenwood Elementary School	$0	0 kWh	$0	0 kW	$1,671	1,899 Therms	$0	0 kGal.	$1,671
76	Building Automation System Upgrades - District Wide	$16,255	167,573 kWh	$0	0 kW	$38,760	43,550 Therms	$0	0 kGal.	$55,014

ECM #	ECM	Calculated Utility Savings								Total Annual Utility
		Electric Consumption		Peak Electric Demand		Natural Gas		Water		
		Dollars	Units	Dollars	Units	Dollars	Units	Dollars	Units	Dollars
79	Building Automation System Upgrades - Education Center - Central Plant	$10,528	99,319 kWh	$0	0 kW	$1,780	1,874 Therms	$0	0 kGal.	$12,308
82	Building Automation System Upgrades - High School - Exhaust Fans	$734	7,641 kWh	$0	0 kW	$1,717	1,952 Therms	$0	0 kGal.	$2,451
83	Building Automation System Upgrades - High School DCV	$0	0 kWh	$0	0 kW	$4,235	4,813 Therms	$0	0 kGal.	$4,235
84	Building Automation System Upgrades - Middle School - Exhaust Fans	$214	2,224 kWh	$0	0 kW	$486	552 Therms	$0	0 kGal.	$699
86	Building Automation System Upgrades - South Mountain Elementary School - Exhaust Fans	$272	2,780 kWh	$0	0 kW	$600	690 Therms	$0	0 kGal.	$873
89	Plug Load Management	$2,612	26,931 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$2,612
103	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Deerfield Elementary School	$8,090	84,267 kWh	$2,273	31 kW	$0	0 Therms	$0	0 kGal.	$10,363
104	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Education Center	$5,859	55,276 kWh	$808	21 kW	$0	0 Therms	$0	0 kGal.	$6,667
105	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Glenwood Elementary School	$5,653	57,680 kWh	$2,146	30 kW	$0	0 Therms	$0	0 kGal.	$7,799
106	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Hartshorn Elementary School	$10,128	102,305 kWh	$3,093	43 kW	$0	0 Therms	$0	0 kGal.	$13,221
107	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - High School	$32,416	337,667 kWh	$10,003	127 kW	$0	0 Therms	$0	0 kGal.	$42,420
109	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Middle School	$24,579	256,030 kWh	$8,250	106 kW	$0	0 Therms	$0	0 kGal.	$32,829
110	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - South Mountain Elementary School	$4,703	47,988 kWh	$1,324	19 kW	$0	0 Therms	$0	0 kGal.	$6,027
111	Lighting Upgrades to LED Interior/ Exterior & Occupancy Sensors - Wyoming Elementary School	$4,610	48,016 kWh	$1,592	22 kW	$0	0 Therms	$0	0 kGal.	$6,201
122	Football Field Lighting Upgrade - Behind Bleachers	($105)	-1,095 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	($105)

ECM #	ECM	Calculated Utility Savings								Total Annual Utility
		Electric Consumption		Peak Electric Demand		Natural Gas		Water		
		Dollars	Units	Dollars	Units	Dollars	Units	Dollars	Units	Dollars
123	Vending Miser Controls - Education Center	$385	3,630 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$385
124	Vending Miser Controls - Glenwood Elementary School	$158	1,612 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$158
125	Vending Miser Controls - Hartshorn Elementary School	$160	1,612 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$160
126	Vending Miser Controls - High School	$928	9,671 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$928
127	Vending Miser Controls - Middle School	$155	1,612 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$155
128	Vending Miser Controls - Wyoming Elementary School	$155	1,612 kWh	$0	0 kW	$0	0 Therms	$0	0 kGal.	$155
129	High Efficiency Transformers - High School	$1,163	12,115 kWh	$217	3 kW	$0	0 Therms	$0	0 kGal.	$1,380
130	High Efficiency Transformers - Middle School	$2,357	24,549 kWh	$436	6 kW	$0	0 Therms	$0	0 kGal.	$2,793
131	Air-Cooled Chiller Replacement - High School	$8,267	86,523 kWh	$1,061	41 kW	$0	0 Therms	$0	0 kGal.	$9,328
Totals		$142,173	1,457,099 kWh	$31,203	449 kW	$94,512	106,501 Therms	$2,930	1,098 kGal.	$270,818

Business Case for Recommended Project

FORM VI

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
THE BOARD OF EDUCATION OF THE TOWNSHIP OF MILLBURN IN THE COUNTY OF ESSEX, NEW JERSEY
-ENERGY SAVING 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: 15 **years (180 Months)**
2. Construction Period [2] (months): **12 months**
3. Cash Flow Analysis Format:

Project Cost [1]: $4,482,853 Interest Rate: 2.8%

Year	Annual Energy Savings	Annual Operational Savings	Energy Rebates/ Incentives	Total Annual Savings	Annual Project Costs	Board Costs	Annual Service Costs [3]	Net Cash Flow to Client	Cumulative Cash Flow
Installation	$82,102	$0	$29,421	$111,523	$0	$0	$0	$111,523	$111,523
1	$276,988	$110,115	$219,183	$606,286	$586,498	$605,455	$18,957	$831	$112,354
2	$283,300	$110,115	$84,272	$477,687	$457,311	$476,837	$19,526	$850	$113,204
3	$289,756	$29,189	$30,876	$349,821	$328,840	$348,952	$20,112	$869	$114,074
4	$296,359	$29,189	$30,876	$356,424	$355,535	$355,535	$0	$889	$114,963
5	$303,113	$29,189	$19,653	$351,955	$351,045	$351,045	$0	$909	$115,872
6	$310,021	$0	$19,653	$329,674	$328,744	$328,744	$0	$930	$116,802
7	$317,088	$0	$19,653	$336,740	$335,789	$335,789	$0	$951	$117,753
8	$324,316	$0	$19,653	$343,968	$342,596	$342,596	$0	$1,372	$119,126
9	$331,709	$0	$19,653	$351,361	$342,596	$342,596	$0	$8,766	$127,891
10	$339,271	$0	$19,653	$358,924	$342,596	$342,596	$0	$16,328	$144,219
11	$347,006	$0	$0	$347,006	$342,596	$342,596	$0	$4,410	$148,629
12	$354,918	$0	$0	$354,918	$342,596	$342,596	$0	$12,322	$160,951
13	$363,011	$0	$0	$363,011	$342,596	$342,596	$0	$20,415	$181,366
14	$371,289	$0	$0	$371,289	$342,596	$342,596	$0	$28,693	$210,059
15	$379,756	$0	$0	$379,756	$342,596	$342,596	$0	$37,160	$247,219
Totals	$4,970,002	$307,797	$512,545	$5,790,344	$5,484,530	$5,543,125	$58,595	$247,219	$247,219

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Appendix 5. Third Party Energy Savings Plan Review Comments & Correspondence

The following Appendix represents the review comments provided by DLB Associates, who has been commissioned by the Millburn Township Public Schools to provide third party review of the Energy Savings Plan. The complete Third Party Energy Savings Plan Review can be found in Appendix 6 of the Millburn Township Public Schools Energy Savings Plan.

4.1.2 General Calculation Quality

The quality of the energy savings calculations is satisfactory and representative sample sets were checked for accuracy.

The approach and equations were summarized only broadly in the body of the report, with no results given in the ECM description sections. References for equations were listed for some ECMs.

DLB notes the following comments for the overall report:

1. In each of the ECM tables, it may be useful to document the baseline model values for each ECM. This may help the School further understand the savings.
    a. All savings calculations will be included electronically with the approved Energy Savings Plan for the District's records so that all baseline and post-retrofit assumptions are very clear. The Savings Methodology of the ECMs has been updated to reflect the major baseline and post-retrofit values which were changed in order to calculate energy savings. These changes can be seen on **pages 77, 86, 88, 121, and 155.**
2. Page 4, the values for cost savings (and if it's total or annually) and CO2 reduction values within the benefits section should be coordinated with those listed on page 69.
    a. **Page 4** has been re-worded for clarity and to match the data displayed on page 67 and 68 in Section 3.
3. There is a number of ECMs that are recommending replacing existing equipment where it may be useful to have some background information included in Section 2, Project Descriptions. Some of this information is included further along in the ECM descriptions in Section 4 under ECM numbers 3-10, 82, 84, 86, 129/130 & 131. For example, at the Deerfield Elementary School the burner replacement project (ECM # 54-55) does not include information such as the age of the existing burners or boiler.
    a. **Pages 5 through 26** have been updated to include further information on the building envelope evaluation, boiler and burner ages as well as chiller efficiency. The building automation controls systems are addressed as a subheading beneath the mechanical description of each building. An additional subheading for "electrical" has been included to further highlight the transformer and plug load conditions at each building.
4. The list in Section 4 depicting all the recommended projects, does not match the ECMs within the Appendix 4 recommended projects. A few ECMs that are not located in Appendix 4 are 54, 55,

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56, 58-63 & 69. ECMs being recommended should be coordinated and update section 4 and/or Appendix 4 as needed. Cost totals should be updated accordingly if needed.

a. The District requested Johnson Controls to investigate three project options based on differing project terms (15-, 18- and 20-years) and these are the ECMs described in Section 4. Section 4 heading has been updated to “Potential Energy Conservation Measures” to reflect that these measures could fit into one of the project options developed. Appendix 4 heading has also been updated to read “Recommended Project – ESP” to indicate this will be the basis for creating bid documents and moving forward with the Energy Savings Plan.

4.1.3 Mechanical and Electrical Energy Conservation Measures

All ECMs were evaluated using spreadsheet analyses. The ECMs submitted seem to agree with standard industry practice and BPU protocol requirements. Calculations were not submitted for review, which would be useful for DLB to review and the school district to have.

Some ECMs presented are not included in the recommended baseline financial analysis on page 187 of Appendix 4. These ECMs were only spot-checked with the protocol for consistency.

DLB didn’t note any specific issues with the ECM analysis other than minor issues addressed in remainder of report that should be reviewed.

4.1.4 Financial Calculations

The financial calculations included within the ESP incorporate a 2.8% interest rate for the loan and the BPU-required 2.2% electric and 2.4% natural gas utility escalation.

The baseline option includes **$4,482,853** and is analyzed over a 15-year financing term.

DLB notes the following potential issue with the financial calculations:

1. **Baseline ECMs Included:** The “Energy Savings and Cost Summary” table on page 59 of Section 3 shows all potential ECMs as part of the recommended baseline project. This cost is shown as $4,761,821; however, the “Business Case for Recommended Project” on page 25 of Section 3 states the project cost to be $4,080,832, and the recommended project cost total on page 189 shows $3,051,090. The tables should be updated to ensure the proposed baseline ESP scope of work is clear.
    a. The wording on **page 60** has been updated to clarify that the information in the table is for all three scenarios Johnson Controls was asked to model. In order to avoid conflicting and confusing information, the total row of the table, on **page 6**3**,** has been deleted. The business case in Section 3 is a screen shot from the financial modeling tool used during the development of the Investment Grade Audit and Energy Savings Plan, it has been

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replaced with the standard New Jersey Form VI for clarity. The customer will finance additional costs for contingency which is why there is a difference in hard costs and "Total Financed Cost".

2. **NJ Rebates & Incentives:** In years 1 through 10, NJ rebates and incentives totaling $629,488 are expected to be received. It is recommended that the impact on the overall project be analyzed and reviewed in the case that these incentives do not materialize.
    a. As part of the ESP development schedule with the District, Johnson Controls conducted a Business Case workshop with the District as well as their professional advisor, Parette Somjen Architects. The impact of the incentives were reviewed with the District and the District understands the impact of these incentives. JCI has already started the application process for many of the incentives to minimize any risk to the District.
3. **Savings Guarantee:** the recommended ECMs detailed on pages 187 through 189 shall be re-evaluated as there are missing ECMs detailed in section 4, Recommended Energy Conservation Measures. This value on page 189 does not reflect the value on the ESCO terms on page 195.
    a. The measurement and verification plan listed on pages 187 through 189 reflects the ECMs listed in the 15-year project option. The District asked Johnson Controls to reflect the recommended project in the measurement and verification approach. In order to provide clarity, we have added the measurement and verification costs associated with the guarantee to **page 193** in Append 4 – Recommended Project – ESP in addition to the table located on **page 163**.

4.1.5 Greenhouse Gas Calculations

Greenhouse Gas savings are mentioned as an overall figure in the Overview Section of the report with no supporting calculations. The factors used to calculate savings should be noted in accordance with the factors in the BPU guidelines. The current BPU factors are listed below should be updated in the report to reflect these units per factor.

- CO2 Electric Emissions: 1,111.79 lbs. per MWh saved
- CO2 Gas Emissions: 11.7 lbs. per therm saved
- NOX Electric Emissions: 0.95 lbs. per MWh saved
- NOX Gas Emissions: 0.0092 lbs. per therm saved
- SO2 Electric Emissions: 2.21 lbs. per MWh saved

The table in Section 3, Greenhouse Gas Reductions on ***page69*** *has been updated to include a "Total Avoided Emissions" column. The total* CO_2 *reductions are also reflected in Section 1 on* ***page 4****.*

4.1.6 Pay for Performance Measurement and Verification

For the Pay for Performance measurement and verification methodology included in the report, Option D from the International Performance Measurement and Verification Protocol (IPMVP) should be used.

The Pay for Performance utilizes a calibrated Building Model (eQuest) which will is used for the Energy Reduction Plan necessary to receive Incentive #1. At the completion of one (1) year of performance, the

Pay for Performance program utilizes utility bill information to determine the amount of Incentive #3. Johnson Controls will assist the District in completion of all Pay for Performance applications and requests for incentives.

The Recommended Preventative Maintenance Services provided in the Measurement and Verification section of the report should be amended to ensure all proposed equipment is included.

A preventative maintenance agreement can be obtained outside of the ESP project by the District. Once final design and bids are received, Johnson Controls will assist the district in preparing any necessary scope or bid packages to ensure all new equipment is included under a preventative maintenance plan.

Appendix 6. DLB Associates Independent Technical Review

MILLBURN TOWNSHIP PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

May 27, 2015

Revised June 1, 2015

Prepared by:
DLB Associates
(dlb # 12226)

MILLBURN TOWNSHIP PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

Table of Contents

SECTION 1: EXECUTIVE SUMMARY

MILLBURN TOWNSHIP PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

1.1 Executive Summary

1.1.1 Overview

DLB Associates has been commissioned by the Millburn Schools to provide a third-party review of an Energy Savings Plan (ESP) for conformance with state requirements for eight (8) of the board's facilities. State requirements are set forth in P.L. 2009, Chapter 4, "Energy Savings Improvement Program" and Local Finance Notices 2009-11 and 2011-17. Amendments to P.L. 2009, Chapter 4, are included in P.L. 2012, Chapter 55.

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

This report includes the summary and conclusions of DLB's third party review of the submitted Energy Savings Plan prepared by Johnson Controls, dated May 13, 2015.

1.1.2 Energy Savings Plan Review

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

1.1.3 Energy Savings Calculations Review

The review of the energy savings calculations included within the ESP concluded that the calculations were performed in accordance with industry standard practice and utilizing the intent of the BPU protocol. Spreadsheet analyses were used to calculate ECM savings, although not provided for review. The equations used to determine savings follow the protocol's calculation methods for energy efficient construction, but DLB recommends a few areas should be clarified as identified further in this report.

1.1.4 Draft Review Notes

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

The above comments have been addressed in the attached Appendix by Johnson Controls dated May 29, 2015 and they have been incorporated into the revision 2 ESP. The Energy Savings Plan is ready for review and adoption by Millburn Board Of Education.

1.1.5 Conclusion

We have reviewed the Millburn Board Of Education ESP dated May 29, 2015, as submitted by Johnson Controls in accordance with P.L. 2012, c. 55 (2009 c.4.).

MILLBURN TOWNSHIP PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

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

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

SECTION 2: ENERGY SAVINGS PLAN REVIEW

MILLBURN TOWNSHIP PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

2.1 Executive Summary

2.1.1 Energy Savings Plan Overview

The final ESP reviewed by DLB Associates was prepared by Johnson Controls, dated May 13, 2015. The ESP report includes an analysis for the following eight (8) facilities, and included at least 64 ECMs to implement:

FACILITY INFORMATION	
Building Name	**Street Address**
Deerfield Elementary School	26 Troy Lane, Short Hills, NJ 07078
Education Center	434 Millburn Ave, Millburn, NJ 07041
Glenwood Elementary School	325 Taylor Road, Short Hills, NJ 07078
Hartshorn Elementary School	400 Hartshorn Road, Short Hills, NJ 07078
High School	462 Millburn Ave, Millburn, NJ 07041
Middle School	25 Old Short Hills Road, Millburn, NJ 07041
South Mountain Elementary School	2 Southern Slope Road, Millburn, NJ 07041
Wyoming Elementary School	55 Myrtle Ave, Millburn, NJ 07041

SECTION 3: ENERGY SAVINGS PLAN REVIEW

3.1 Energy Savings Plan Review

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

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

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

3.1.2 Plan Components – Submitted Plan Review

The submitted ESP, dated May 13, 2015, is the basis for the third party review. The table below lists the required elements of the ESP as required by P.L. 2012, C.55, whether the items were addressed satisfactorily in the ESP, and any associated comments. Page numbers listed in the table below are the page numbers of the PDF, in order to identify items in the appendices.

ENERGY SAVINGS PLAN COMPONENT REVIEW			
Plan Component	**Included In Plan**	**Location In ESP**	**Comments**
Energy Audit Results	Yes	Section 3, Pages 26 – 69	None
ECM Descriptions	Yes	Section 4, Pages 70 - 153	None
Greenhouse Gas Calculations	Yes	Section 3, Page 69	Factors not provided as per BPU requirements. See notation in section 4.1.5
Design and Compliance Issues	Yes	Section 6, Pages 163/164	None
Implementation Risk Assessment	Yes	Section 6, Page 164	None

MILLBURN TOWNSHIP PUBLIC SCHOOLS - THIRD PARTY ENERGY SAVINGS PLAN REVIEW

ENERGY SAVINGS PLAN COMPONENT REVIEW			
Plan Component	**Included In Plan**	**Location In ESP**	**Comments**
Demand Response Program	Yes	Appendix 2, Page 97	None
Curtailable Energy Services	No	Section 4, Pages 80 - 83	None
Implementation Costs	Yes	Appendix 4, pages 188 - 191	None
Projected Energy Savings	Yes	Section 3, Pages 11 – 25 and Appendix 6, Pages 101 – 105	None
Maintenance Requirements	Yes	Section 4, Pages 70 - 153	The maintenance requirements are provided within each ECM description.
ESCO Savings Guarantee Information	No	Appendix 4, pages 186	No guarantee information found.
Measurement and Verification Plan	Yes	Section 5, Pages 154 – 162	None

SECTION 4: ENERGY SAVINGS CALCULATIONS REVIEW

4.1 Energy Savings Calculations Review

4.1.1 Methodology of Submitted Calculations

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

The ECMs analyzed and accepted in the base project include, at a minimum: lighting upgrades and the addition of occupancy controls, incorporating vending machine controls, utilizing plug load management, replacing rooftop units, converting remainder of the buildings to direct digital control (DDC), replacing existing transformers with high-efficiency models, and correcting power factor.

Building envelope and replacing plumbing fixtures also are included.

Implementing a combined heat and power plant at the Millburn High School is included in the analysis and base project.

4.1.2 General Calculation Quality

The quality of the energy savings calculations is satisfactory and representative sample sets were checked for accuracy.

The approach and equations were summarized only broadly in the body of the report, with no results given in the ECM description sections. References for equations were listed for some ECMs.

DLB notes the following comments for the overall report:

1. In each of the ECM tables, it may be useful to document the baseline model values for each ECM. This may help the School further understand the savings.
2. Page 4, the values for cost savings (and if it's total or annually) and CO2 reduction values within the benefits section should be coordinated with those listed on page 69.
3. There is a number of ECMs that are recommending replacing existing equipment where it may be useful to have some background information included in Section 2, Project Descriptions. Some of this information is included further along in the ECM descriptions in Section 4 under ECM numbers 3-10, 82, 84, 86, 129/130 & 131. For example, at the Deerfield Elementary School the burner replacement project (ECM # 54-55) does not include information such as the age of the existing burners or boiler.
4. The list in Section 4 depicting all the recommended projects, does not match the ECMs within the Appendix 4 recommended projects. A few ECMs that are not located in Appendix 4 are 54, 55, 56, 58-63 & 69. ECMs being recommended should be coordinated and update section 4 and/or Appendix 4 as needed. Cost totals should be updated accordingly if needed.

4.1.3 Mechanical and Electrical Energy Conservation Measures

All ECMs were evaluated using spreadsheet analyses. The ECMs submitted seem to agree with standard industry practice and BPU protocol requirements. Calculations were not submitted for review, which would be useful for DLB to review and the school district to have.

Some ECMs presented are not included in the recommended baseline financial analysis on page 187 of Appendix 4. These ECMs were only spot-checked with the protocol for consistency.

DLB didn't note any specific issues with the ECM analysis other than minor issues addressed in remainder of report that should be reviewed.

4.1.4 Financial Calculations

The financial calculations included within the ESP incorporate a 2.8% interest rate for the loan and the BPU-required 2.2% electric and 2.4% natural gas utility escalation.

The baseline option includes **$4,482,853** and is analyzed over a 15-year financing term.

DLB notes the following potential issue with the financial calculations:

1. **Baseline ECMs Included:** The "Energy Savings and Cost Summary" table on page 59 of Section 3 shows all potential ECMs as part of the recommended baseline project. This cost is shown as $4,761,821; however, the "Business Case for Recommended Project" on page 25 of Section 3 states the project cost to be $4,080,832, and the recommended project cost total on page 189 shows $3,051,090. The tables should be updated to ensure the proposed baseline ESP scope of work is clear.
2. **NJ Rebates & Incentives:** In years 1 through 10, NJ rebates and incentives totaling $629,488 are expected to be received. It is recommended that the impact on the overall project be analyzed and reviewed in the case that these incentives do not materialize.
3. **Savings Guarantee:** the recommended ECMs detailed on pages 187 through 189 shall be re-evaluated as there are missing ECMs detailed in section 4, Recommended Energy Conservation Measures. This value on page 189 does not reflect the value on the ESCO terms on page 195.

4.1.5 Greenhouse Gas Calculations

Greenhouse Gas savings are mentioned as an overall figure in the Overview Section of the report with no supporting calculations. The factors used to calculate savings should be noted in accordance with the factors in the BPU guidelines in the report. The current BPU factors are listed below should be updated in the report to reflect these units per factor:

- CO_2 Electric Emissions: lbs. per MWh saved
- CO_2 Gas Emissions: lbs. per therm saved
- NO_X Electric Emissions: lbs. per MWh saved

- NO_X Gas Emissions: lbs. per therm saved
- SO_2 Electric Emissions: lbs. per MWh saved

4.1.6 Pay for Performance Measurement and Verification

For the Pay for Performance measurement and verification methodology included in the report, Option D from the International Performance Measurement and Verification Protocol (IPMVP) should be used.

The Recommended Preventative Maintenance Services provided in the Measurement and Verification section of the report should be amended to ensure all proposed equipment is included.

SECTION 5: REVIEW DISCLAIMER

5.1 Review Disclaimer

DLB Associates, as part of the third party review services, is providing our professional opinion in the evaluation of the energy savings calculations, ESP and any other supporting documentation provided.

This evaluation is not a guarantee that the savings and assumptions stated are valid. DLB Associates will not be responsible for any failure in achieving the predicted energy and cost savings detailed. Our intention is to complete our due diligence in verifying the energy savings calculations in accordance with the BPU protocols; however, it is impractical to review all inputs in detail. As a result, bottom line numbers and a limited number of parameters have been verified to conclude validity of savings.

SECTION 6: ATTACHMENT

Appendix 5. Third party Energy Savings Plan Review Comments & Correspondence

The following Appendix represents the review comments provided by DLB Associates, who has been commissioned by the Millburn Schools to provide third party review of the Energy Savings Plan. The complete Third Party Energy Savings Plan Review can be found in Appendix 6 of the Millburn Township Public Schools Energy Savings Plan.

4.1.2 General Calculation Quality

The quality of the energy savings calculations is satisfactory and representative sample sets were checked for accuracy.

The approach and equations were summarized only broadly in the body of the report, with no results given in the ECM description sections. References for equations were listed for some ECMs.

DLB notes the following comments for the overall report:

1. In each of the ECM tables, it may be useful to document the baseline model values for each ECM. This may help the School further understand the savings.
    a. All savings calculations will be included electronically with the approved Energy Savings Plan for the District's records so that all baseline and post-retrofit assumptions are very clear. The Savings Methodology of the ECMs has been updated to reflect the major baseline and post-retrofit values which were changed in order to calculate energy savings. These changes can be seen on **pages 77, 86, 88, 121, 155.**
2. Page 4, the values for cost savings (and if it's total or annually) and CO2 reduction values within the benefits section should be coordinated with those listed on page 69.
    a. **Page 4** has been re-worded for clarity and to match the data displayed on page 67 and 68 in Section 3.
3. There is a number of ECMs that are recommending replacing existing equipment where it may be useful to have some background information included in Section 2, Project Descriptions. Some of this information is included further along in the ECM descriptions in Section 4 under ECM numbers 3-10, 82, 84, 86, 129/130 & 131. For example, at the Deerfield Elementary School the burner replacement project (ECM # 54-55) does not include information such as the age of the existing burners or boiler.
    a. **Pages 5 through 26** have been updated to include further information on the building envelope evaluation, boiler and burner ages as well as chiller efficiency. The building automation controls systems are addressed as a subheading beneath the mechanical description of each building. An additional subheading for "electrical" has been included to further highlight the transformer and plug load conditions at each building.
4. The list in Section 4 depicting all the recommended projects, does not match the ECMs within the Appendix 4 recommended projects. A few ECMs that are not located in Appendix 4 are 54, 55, 56, 58-63 & 69. ECMs being recommended should be coordinated and update section 4 and/or Appendix 4 as needed. Cost totals should be updated accordingly if needed.
    a. The District requested Johnson Controls to investigate three project options based on differing project terms (15-, 18- and 20-years) and these are the ECMs described in Section 4. Section 4 heading has been updated to "Potential Energy Conservation Measures" to reflect that these measures could fit into one of the project options developed. Appendix 4 heading has also been updated to read "Recommended Project – ESP" to indicate this will be the basis for creating bid documents and moving forward with the Energy Savings Plan.

4.1.3 Mechanical and Electrical Energy Conservation Measures

All ECMs were evaluated using spreadsheet analyses. The ECMs submitted seem to agree with standard industry practice and BPU protocol requirements. Calculations were not submitted for review, which would be useful for DLB to review and the school district to have.

Some ECMs presented are not included in the recommended baseline financial analysis on page 187 of Appendix 4. These ECMs were only spot-checked with the protocol for consistency.

DLB didn't note any specific issues with the ECM analysis other than minor issues addressed in remainder of report that should be reviewed.

4.1.4 Financial Calculations

The financial calculations included within the ESP incorporate a 2.8% interest rate for the loan and the BPU-required 2.2% electric and 2.4% natural gas utility escalation.

The baseline option includes **$4,482,853** and is analyzed over a 15-year financing term.

DLB notes the following potential issue with the financial calculations:

1. **Baseline ECMs Included:** The "Energy Savings and Cost Summary" table on page 59 of Section 3 shows all potential ECMs as part of the recommended baseline project. This cost is shown as $4,761,821; however, the "Business Case for Recommended Project" on page 25 of Section 3 states the project cost to be $4,080,832, and the recommended project cost total on page 189 shows $3,051,090. The tables should be updated to ensure the proposed baseline ESP scope of work is clear.
    a. The wording on **page 60** has been updated to clarify that the information in the table is for all three scenarios Johnson Controls was asked to model. In order to avoid conflicting and confusing information, the total row of the table, on **page 6**3**,** has been deleted. The business case in Section 3 is a screen shot from the financial modeling tool used during the development of the Investment Grade Audit and Energy Savings Plan, it has been replaced with the standard New Jersey Form VI for clarity. The customer will finance additional costs for contingency which is why there is a difference in hard costs and "Total Financed Cost".
2. **NJ Rebates & Incentives:** In years 1 through 10, NJ rebates and incentives totaling $629,488 are expected to be received. It is recommended that the impact on the overall project be analyzed and reviewed in the case that these incentives do not materialize.
    a. As part of the ESP development schedule with the District, Johnson Controls conducted a Business Case workshop with the District as well as their professional advisor, Parette Somjen Architects. The impact of the incentives were reviewed with the District and the District understands the impact of these incentives. JCI has already started the application process for many of the incentives to minimize any risk to the District.
3. **Savings Guarantee:** the recommended ECMs detailed on pages 187 through 189 shall be re-evaluated as there are missing ECMs detailed in section 4, Recommended Energy Conservation Measures. This value on page 189 does not reflect the value on the ESCO terms on page 195.
    a. The measurement and verification plan listed on pages 187 through 189 reflects the ECMs listed in the 15-year project option. The District asked Johnson Controls to reflect the recommended project in the measurement and verification approach. In order to provide clarity, we have added the measurement and verification costs associated with the guarantee to **page 193** in Append 4 – Recommended Project – ESP in addition to the table located on **page 163**.

4.1.5 Greenhouse Gas Calculations

Greenhouse Gas savings are mentioned as an overall figure in the Overview Section of the report with no supporting calculations. The factors used to calculate savings should be noted in accordance with the factors in the BPU guidelines. The current BPU factors are listed below should be updated in the report to reflect these units per factor.

- CO2 Electric Emissions: 1,111.79 lbs. per MWh saved
- CO2 Gas Emissions: 11.7 lbs. per therm saved
- NOX Electric Emissions: 0.95 lbs. per MWh saved
- NOX Gas Emissions: 0.0092 lbs. per therm saved
- SO2 Electric Emissions: 2.21 lbs. per MWh saved

The table in Section 3, Greenhouse Gas Reductions on ***page69*** *has been updated to include a "Total Avoided Emissions" column. The total* CO_2 *reductions are also reflected in Section 1 on* ***page 4****.*

4.1.6 Pay for Performance Measurement and Verification

For the Pay for Performance measurement and verification methodology included in the report, Option D from the International Performance Measurement and Verification Protocol (IPMVP) should be used.

The Pay for Performance utilizes a calibrated Building Model (eQuest) which will is used for the Energy Reduction Plan necessary to receive Incentive #1. At the completion of one (1) year of performance, the Pay for Performance program utilizes utility bill information to determine the amount of Incentive #3. Johnson Controls will assist the District in completion of all Pay for Performance applications and requests for incentives.

The Recommended Preventative Maintenance Services provided in the Measurement and Verification section of the report should be amended to ensure all proposed equipment is included.

A preventative maintenance agreement can be obtained outside of the ESP project by the District. Once final design and bids are received, Johnson Controls will assist the district in preparing any necessary scope or bid packages to ensure all new equipment is included under a preventative maintenance plan.