ENERGY SAVINGS PLAN

SUBMITTED BY:
DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648
Rev 2
5/01/2024

Table of Contents

SECTION 1 – PROJECT OVERVIEW 3
SECTION 2 – ENERGY BASELINE 29
SECTION 3 – ENERGY CONSERVATION MEASURES 74
SECTION 4 – FINANCIAL ANALYSIS 181
SECTION 5 – RISK, DESIGN, & COMPLIANCE 188
SECTION 6 – OPERATION & MAINTENANCE 196
SECTION 7 – OPTIONAL ENERGY GUARANTEE 218
APPENDICIES 221

ENERGY SAVINGS PLAN

SECTION 1 – PROJECT OVERVIEW

Project Overview

The Energy Savings Plan (ESP) is the core of the Energy Savings Improvement Program (ESIP) process. It describes the Willingboro Township Public Schools' preferred Energy Conservation Measures (ECMs), the budget cost for each ECM and the ECM energy savings calculations that self-fund the project via reduced operating costs. The ESP provides the Willingboro Township Public Schools with the necessary information to decide which proposed ECMs to implement as part of your (ESIP) project. Willingboro Township Public Schools has decided to utilize the ESCO ESIP model, with DCO Energy preparing the Energy Savings Plan. Phoenix Advisors, LLC is acting as the financial advisor and Wilentz, Goldman & Spitzer, P.A. is the bond counsel. Working with the School District's staff, your selected ESIP project would:

1. Fund a $17,222,348 project.
2. Generate $625,741 in annual energy savings– 39% of current utility spend.
3. Eligible for $533,927 in rebates and incentives
4. Reduce utility related annual CO2 emissions by 2,470 metric tons – a 56% reduction.

NOTE: This submitted ESP doesn't constitute any contractual obligation between Willingboro Township Public Schools and DCO Energy (DCO). Any contractual obligations will be performed under separate legal documents per mutually signed agreement of the parties involved and subject to the applicable laws and requirements of the ESIP legislation and State of New Jersey.

To ensure conformance with the requirements of Public Finance Notice LFN 2009-11, the ESP must address the following elements:

- *The results of the energy audit (APPENDIX H)*
- *A description of the energy conservation measures that will comprise the program; (Section 3)*
- *An estimate of greenhouse gas reductions resulting from those energy savings; (Section 3)*
- *Identification of all design and compliance issues and identification of who will provide these services; (Section 5)*
- *An assessment of risks involved in the successful implementation of the plan; (Section 5)*
- *Identify the eligibility for, and costs and revenues associated with the PJM Independent System Operator for demand response and curtailable service activities; (Section 3)*

- *Schedules showing calculations of all costs of implementing the proposed energy conservation measures and the projected energy savings; (Section 3)*
- *Maintenance requirements necessary to ensure continued energy savings, and describe how they will be provided; and (Section 6)*
- *If developed by an ESCO, a description of, and cost estimates of, a proposed energy savings guarantee. (Section 7)*

In addition, and per LFN 2009-11, the ESP requires several other important elements:

- *The calculations of energy savings must be made in accordance with protocols for their calculation adopted by the BPU. The calculation shall include all applicable State and federal rebates and tax credits but shall not include the cost of an energy audit and the cost of verifying energy savings. (Section 3)*
- *An independent third party must review the plan and certify that the plan savings were properly calculated pursuant to the BPU protocols.*
- *If an ESCO is used to prepare the plan, the ESCO must provide an estimate of the cost of a guarantee of energy savings. When adopting the plan, the local unit must decide whether to accept the guarantee (covered below). (Section 7)*
- *The plan must be verified by an independent third party to ensure that the calculations were made in accordance with the BPU standards and that all required elements of the ESP are covered.*
- *After verification is completed, the governing body must formally adopt the plan. At that point, the plan must be submitted to the Board of Public Utilities where it will be posted on the BPU website. BPU approval is not required. If the contracting unit maintains its own website, the plan must also be posted on that site.*

Bookbinder School

Bookbinder School is a 1-story, 58,745 square foot building built in 1959. Spaces include: classrooms, gymnasium, offices, a commercial kitchen, and a mechanical space. This building does not have operating hours or occupancy like a regular school, hence the facility's low energy consumption. As part of this ESIP, the District intends to renovate the facility and bring the occupancy back to normal conditions. DCO and Willingboro Township Public Schools have agreed to an adjusted baseline to account for energy consumption that will be typical once normal occupancy is restored. Currently, the facility is occupied from September through June. Typical weekday occupancy is 67 members.

Description of Building HVAC

There are 10 unit ventilators that have supply fan motors and are pneumatically controlled. This system is original to the building and appears to be in fair operating condition. Many classrooms are cooled using Friedrich window AC units with cooling capacities ranging from 1.5-2 tons. These units were installed in 2007 and have been evaluated for replacement. Room 29 and 30 are cooled using split air-source Johnson Control heat pumps having cooling capacities of 3 tons. These units were installed in 2018 and are in good condition. The space temperatures are controlled locally using thermostats.

Space heating is provided using two gas-fired non-condensing hot water York Shipley – Steam Pak boilers from 1959 and 1964. The boilers have an output capacity of 4,000MBH and 3,600 MBh and an efficiency of 75.3%. Hot water is distributed to the various air handlers and unit ventilators in the school using two constant speed pumps. The boiler loop temperatures are pneumatically controlled using an air compressor. Hot water is produced with a 75 gallon 125 MBh gas-fired storage Bradford White water heater with a 75% efficiency. Hot water is distributed to its end uses using fractional horsepower circulation pumps. The water heater was installed in the year 2007 and has been evaluated for replacement.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. Additionally, there are some 26W and 30W compact fluorescent lamps (CFL), 60W incandescent, and 10W LED general purpose lamps serving smaller spaces. Typically, T8 fluorescent lamps use electronic ballasts. Fixture types include 2- 3- or 4-lamp, 2- or 4-foot long troffers, surface mounted fixtures, and 2-foot fixtures with U-bend lamps. All exit signs are 2W LED units. Most fixtures are in good condition. Interior lighting levels were generally sufficient. Lighting fixtures in controlled by wall switches.

Exterior fixtures include wall packs, pole lights, ceiling mounted fixtures, and canopy fixtures. The fixtures include 100W metal halide lamps, 400W high pressure sodium lamps, 130W incandescent lamps and 30W CFLs respectively. All fixtures are controlled by a time clock or photocells.

Country Club Administration Building

Country Club Administration Building is a 1-story, 38,585 square foot building built in 1962. Spaces include classrooms, offices, a cafeteria, corridors, stairwells, a paint shop, conference rooms, breakrooms, a kitchen, and a boiler room. Recent

Description of Building HVAC

The unit ventilators have supply fan motors, outside air dampers, and radiant heating hot water coils that serve the heating requirements for most of the building. This system is original to the building and appears to be in fair operating condition. The multipurpose room is served by an AHU and associated condensing unit that are planned to be replaced in summer 2024.

The offices use window air conditioning (AC) units. These vary in capacity between 1 – 2 tons. The units are in good condition. Some areas in the building are served by split system air conditioning units with capacities ranging between 2.5 – 3.0 tons. Two areas are served by split system heat pumps units with capacities of 2.0 and 3.5 tons. The heating efficiencies are 2.40 COP for both units. There are two electric resistance heaters with capacities of 16.38 MBh and 34.12 MBh. One is wall mounted, and the other is ceiling mounted.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. There are also several 40- Watt T12 fixtures. Additionally, there are some compact fluorescent lamps, incandescent and LED general purpose lamps. Typically, T8 fluorescent lamps use electronic ballasts and T12 fluorescent lamps use magnetic ballasts. Fixture types include 1-, 2- and 4-lamp, 2-, 3-, 4-, and 8-foot long troffers and surface mounted fixtures and 2-foot fixtures with U-bend tube lamps. All exit signs are LED. Most fixtures are in fair condition. Interior lighting levels were generally sufficient. Most interior lighting fixtures are controlled manually.

Exterior fixtures include LED lamps controlled by a timeclock. High pressure sodium (HPS) fixtures are controlled by photocells.

Garfield East Elementary School

Garfield East Elementary School is a 1-story, 51,493 square foot building built in 1968. Spaces include classrooms, a multipurpose room, offices, a cafeteria, corridors, a kitchen, and mechanical spaces. The facility is occupied year-round. Typical weekday occupancy is 436 staff and students. Summer occupancy includes a summer day camp and continuing maintenance activities. There are no weekend activities.

Description of Building HVAC

Unit ventilators have supply fan motors, controlled outside air dampers, and radiant heating hot water coils that serve the heating requirements of the classrooms. This system is original to the building and appears to be in fair operating condition. Packaged Units The main office and library are served by two split system condensing air conditioners and indoor air handler unit. The tonnage of the systems are 4 and 5 tons. The multipurpose room is served by a split condensing unit and the and science lab is served by a packaged roof top units (RTU). The tonnage of the condensing unit is 30 tons and the RTU is 5 tons. Air Conditioners The classrooms use window air conditioning (AC) units. These vary in capacity between 1.2 and 2 tons. The units are in good condition.

Two Hydrotherm 2,000 MBh hot water boilers serve the building heating load. The burners are nonmodulating with a nominal efficiency of 87%. Installed in 2010, they are in fair condition. The boilers serve a primary/secondary distribution system with two constant speed 2 hp pumps circulating the primary loop and two VFD controlled 10 hp heating hot water pumps operating in lead/lag fashion on the secondary loop. Hot water is produced with an 80 gallon, 199.99 MBh gas-fired storage water heater with an 80% efficiency rating. A 1/25 hp circulation pump distributes water to end uses. The circulation pump operates continuously.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. Additionally, there are compact fluorescent lamps (CFL), a few incandescents, and a few LED general purpose lamps. Typically, T8 fluorescent lamps use electronic ballasts. Fixture types include 2-3- or 4-lamp, 4-foot long troffer and surface mounted fixtures and 2-foot fixtures with linear

tube lamps. Most fixtures are in fair condition. All exit signs are LED units. Interior lighting levels were generally sufficient.

Exterior fixtures include wall mounts and canopy lights with CFL and LED lamps. There are also a few LED plug in lamps and incandescent lamps. The pole mounted flood fixtures contain high pressure sodium lamps and are controlled by photocells.

Hawthorne Elementary School

Hawthorne Elementary School is a 1-story, 58,745 square foot building built in 1962. Spaces include classrooms, gymnasium, offices, cafeteria, corridors, a commercial kitchen, and a mechanical space. The school is 100 % heated and 90% cooled. The facility is occupied from September through June. Typical weekday occupancy is 513 people including full time staff and students. Typical operating hours are from 7:30 AM – 3:30 PM.

Description of Building HVAC

There are approximately 35-unit ventilators with supply fan motors, pneumatically controlled outside air dampers, and fan coil valves that provide heating to classroom areas. This system is original to the building and appears to be in fair operating condition The multipurpose room is served using a 30-ton McQuay condensing unit. The unit also includes hot water coils supplied by the central heating boiler system. This unit was installed in 2002 and has reached the end of its useful life. This system packaged unit has been evaluated for replacement.

The computer lab, faculty lounge and a few offices are cooled using split AC units with cooling capacities ranging from 1.5 ton to 4-ton. Temperatures on these units are controlled using programmable thermostats. A few of them are passed their useful life and have been evaluated for replacement. Most classrooms are cooled using window AC units with cooling capacities ranging from 1.25-ton to 2- ton. All units are in good condition and well maintained. Temperatures for these units are controlled locally. Space heating in the facility is provided using three gas-fired condensing hot water.

Hydrotherm boilers with an input capacity 2,000 MBh and an efficiency of 87%. The hot water is circulated to the McQuay air handlers and unit ventilators using two variable speed pumps. Each of the boilers also has a loop pump to maintain water temperature. The boilers were installed in the year 2012 and are in good condition. All the air handlers are constant volume systems.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. There are also a significant number of 13-Watt and 18-Watt compact fluorescent lamps (CFL), plus a few 60-Watt incandescent, and several 10-Watt LED general purpose lamps serving smaller spaces such as storages, closets, restrooms, and smaller offices. Typically, T8 fluorescent lamps use electronic ballasts. Fixture types include 2- 3- or 4-lamp, 2- or 4-foot long troffers and surface mounted fixtures. The interior lighting is controlled using wall switches. This report evaluates and recommends occupancy sensors in appropriate spaces. All exit signs are 2-Watt LED fixtures. Most fixtures are in good condition and the general interior lighting levels are sufficient.

Exterior lighting in the facility consists 10-Watt LED lamps, wall mount, and canopy fixtures. There were also 18-Watt CFL in wall mount fixtures and 250-Watt high pressure sodium lamp in pole fixtures serving the parking lot. Exterior lighting is controlled using a timeclock or photocells.

J. Cresswell Stuart Early Childhood Development Center

J. C. Stuart is a 1-story, 61,459 square foot building built in 1958. Spaces include: classrooms, gymnasium, offices, cafeteria, corridors, a commercial kitchen, and a mechanical space. The building is a 100% heated using condensing hot water boilers and 95% cooled using window and split AC units. Recent improvements include the installation of a HVAC between 2012 and 2013. The facility is occupied from September through June during the hours mentioned below. There are maintenance activities that take place until late in the night. Typical weekday occupancy is 516 people including full time staff and students.

Description of Building HVAC

There are approximately 38-unit ventilators with hot water coils and supply fan motors that provide heating to the respective spaces. This system is original to the building and appears to be in good operating condition. Air Handling Units There are seven air handlers (marked AHU 1-7) serving various spaces, predominantly serving the corridors in the school. The air handlers have hot water coils served by the boilers and DX coils served by the split AC units. The building is cooled using window AC units and split AC units. Window AC units are mainly 2-ton Friedrich units, serving the classrooms. These units were found in good condition and well maintained. The split AC units have cooling capacities ranging from 2 ton to 28 tons. They serve various zones, including the main office, principal office, and nurse's office. The split units were installed in 2011 and are in good condition. Depending on the system, temperature controls are either internal to the units or provided by programmable thermostats in the respective zones.

Space heating is provided by three gas fired condensing hot water Hydrotherm boilers, each with an input capacity of 2,000 MBh and a nominal efficiency of 87%. The hot water from the boilers are distributed to the unit ventilators and air handling units using five heating hot water (HHW) pumps. The two 10 hp pumps are equipped with variable frequency drives and the three 2 hp pumps operate as constant speed. The air handlers are all constant volume systems. The boilers were installed in the 2011, are in good condition, and well maintained.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. There is a 40-Watt T12 fixture in the display case. Additionally, there are a significant number of compact fluorescent lamps (CFL), a few 60-Watt incandescent lamps, and a sizable quantity of 9- and 10-Watt LED general purpose lamps. Typically, T8 fluorescent lamps use electronic ballasts and T12 fluorescent lamps use magnetic ballasts. Fixture types include 1- or 2-lamp 4-foot long troffers, surface mounted fixtures, and 2-foot fixtures with U-bend tube lamps. Most fixtures are in good condition. All exit signs are 2-Watt LED units. The majority of lighting is controlled using manual wall switches, but the restrooms are all controlled using occupancy sensors. Interior lighting levels were generally sufficient. Exterior lighting consists of wall pack fixtures with 100-Watt metal-halide lamps; wall mount scones with 18-Watt CFLs; parking lot pole fixtures with 250-Watt high pressure sodium; and ceiling mount 10-Watt LED fixtures. All wall and ceiling mounted exterior fixtures are controlled using time switches while pole fixtures are controlled using photocells.

James A. Cotten Intermediate School

James A. Cotten Intermediate is a 1-story, 125,000 square foot building built in 1960. Spaces include: classrooms, gymnasium, auditorium, offices, cafeteria, corridors, offices, a commercial kitchen, and basement mechanical space. The school is heated using hot water boilers and cooled using split AC units and split air-source heat pumps. The facility is occupied from September through June. Typical weekday occupancy is 53 staff and 568 students.

Description of Building HVAC

There are approximately 66 unit ventilators (UV) with supply fan motors and pneumatically controlled VAV fan coil valves. Some UVs are heating and ventilating units only while others have hot water coils and DX coils. These unit ventilators were installed in 2004 and are in good condition. The stage and cafeteria areas are cooled using Trane and McQuay packaged AC units with cooling capacities of 7.5 and 18 tons respectively. The Trane unit was installed in 2008 and has been evaluated for replacement. The McQuay unit is in good condition and well maintained. Spaces such as classrooms, offices, and other smaller spaces are cooled using various split AC unit and split air-source heat pumps from various manufacturers such as Ingersoll Rand, AAF, EMI, Thermal Zone, Trane, Dayton, Daikin, Mitsubishi, and ICP. The cooling capacities of these units range from 0.75 tons to 14 tons. The units were installed at different beginning in 2005. The space temperatures are controlled locally using programmable thermostats.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. There are a couple of 40- Watt T12 fixtures. Additionally, there are some 18W compact fluorescent lamps (CFL), 60W incandescent and 9 or 10W LED lamps serving smaller spaces. Typically, T8 fluorescent lamps use electronic ballasts and T12 fluorescent lamps use magnetic ballasts. Fixture types include 1- 2- 3- or 4-lamp, 2- or 4-foot long troffer or surface mounted fixtures and 2-foot fixtures with U-bend tube lamps. Most fixtures are in good condition. All exit signs are LED units. The gymnasium is lit using 60W high bay LED fixtures that are controlled using

wall switches. Some restrooms are also illuminated by LED sources. The interior lighting control throughout the facility is provided by wall switches. We have evaluated occupancy sensors at the facility at the appropriate spaces. Interior lighting levels were generally sufficient. Exterior fixtures at the facility include pole fixtures, wall packs and bollard fixtures. These fixtures have 65W and 75W incandescent lamps, 30W CFL, 100W and 200W halogen incandescent lamps, 150W metal halide lamps and 250W high pressure sodium lamps. The fixtures are controlled using photocells or timeclocks.

Joseph A. McGinley School

Joseph A. McGinley School is a 1-story, 58,745 square foot building built in 1960. This building is currently not used for educational purposes and is currently used for storage. The District intends to upgrade this school in the coming years and bring it back online. The building is heated using gas fired hot water boilers, and it is cooled using window air conditioning (AC) units.

Description of Building HVAC

There are approximately 16 heating and ventilating units serving both the occupied and the unoccupied zones. The units in both the zones are operated for the number of hours set by the timeclock, regardless of whether the area is occupied. These have supply fan motors that are pneumatically controlled with an air compressor. This system is original to the building and appears to be in fair operating condition Most of the classrooms are cooled using GE or Friedrich window AC units with cooling capacities between 0.5 and 2 tons each, and energy efficiency ratio values of either 10.3 or 10.7. The units were installed in 2010 or later and are in good condition. Temperatures in these zones are controlled by thermostats local to the units.

There are two gas-fired non-condensing York Shipley hot water boilers with output capacities of 5,000 MBh and 4,500 MBh, both with efficiency ratings of 80%. Heating hot water is distributed to the heating and ventilating units and air handlers using three (P1, P2 and P3) constant speed hot water pumps. P1 provides water to the occupied portions of the building, while P2 and P3 serve the unoccupied portions. The terminal units are all constant volume systems. The boiler is old, installed in 1964 and has passed its useful life. The boilers have been evaluated for replacement

Hot water is produced with a 74 gallon 199 MBh gas-fired storage water heater with an 80% efficiency rating. The hot water is distributed to the end uses by a fractional horsepower circulation pump. The water heater was installed in 2003 and has been evaluated for replacement.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. The display case has 40- Watt T12 fixtures. T8 fluorescent lamps use electronic ballasts, and T12

fluorescent lamps use magnetic ballasts. There is a mixture of general-purpose lamps, including 23W compact fluorescent lamps (CFL); 60W, 75W, and 130W incandescent; 90W halogen incandescent, and 10W LED sources. The general purpose lamps serve smaller spaces or provide supplemental lighting in larger spaces. Fixture types include 2- 3- or 4-lamp, 2- or 4-foot long troffers or surface mounted fixtures. Most fixtures are in good condition. All exit signs are 2W LED units. Interior lighting control includes wall switches. Interior lighting levels were generally sufficient. Lighting in unoccupied spaces have very low-operating hours. Exterior lighting includes canopy fixtures with 60W incandescent lamps; parking lot fixtures with 250W high pressure lamps; and wall mount fixtures with 30W CFLs. The exterior lighting control includes wall switches and photocells.

Memorial Middle School

Memorial Middle School is a 2-story, 159,000 square foot building built in 1968. Spaces include: classrooms, main gymnasium, auxiliary gymnasiums, a resource center, an all purpose room, offices, cafeteria, corridors, stairwells, storage, restrooms, locker rooms, a kitchen, and electrical and mechanical spaces. Around 2013 the school upgraded the HVAC system, installing new packaged terminal heat pumps, ductless mini-split air-conditioning and heat pump units, unit ventilators, and associated DX condensing units as well as replacing hot water boilers with condensing boilers. The facility is occupied ten months of the year. Typical weekday occupancy is 68 staff and 519 students. There are no weekend activities and minimal summer activities related to maintenance.

Description of Building HVAC

Heating, cooling, and ventilation of classrooms is provided by unit ventilators (UV). These units have constant volume supply fans with either one or two ¼ hp motors. Each UV has hot water heating and reheat coils. Cooling is provided by a DX coil with associated split-system condensing unit on the roof. There is a total of 73 Trane split-system condensing units and each have a cooling capacity of either 2.5, 3, or 3.5 tons. UVs are controlled by thermostats in the classrooms that are tied into the EMS. This system was upgraded around 2013 and is in good operating condition. Administrative areas of the building are served with packaged terminal heat pump (PTHP) units controlled by room thermostats. These units have a heating capacity of either 8.1 or 10.8 MBh and cooling capacities of either ¾ or 1-ton. Each PTHP has a supplementary 3.5 kW electric resistance heater. Units are controlled by integrated thermostats on the units. Common areas and some classrooms are served by packaged roof top units (RTUs) and split-system AC or HP units. Packaged AC units are hot water heating capacity units ranging in size from 32 to 102 MBh. These units are equipped with economizers that are in good condition. The table below provides additional information on the split-system and packaged units.

The Gym and Resource Center use air-handling units (AHU) for both heating and cooling. The Gym AHU has a constant volume supply fan with a 2 hp motor. It appears to be used for heating only, with heating coils fed from the hot water heating system. The exact capacity

could not be determined. The Resource Center AHUs (AHU 12 and 14) each have 12.5 ton DX coils for cooling and hot water coils. Each have a heating capacity of 171 MBh. Four Hydrotherm 2,781 MBh hot water condensing boilers serve the main portion of the building's heating load. The burners are fully-modulating with a nominal efficiency of 86%. The boilers are configured in a lead-lag-standby control scheme. Multiple boilers are required under high load conditions. They were installed around 2013 and are in good condition. The hydronic distribution system is a 2-pipe heating only system. The boilers are configured in a variable flow primary distribution with two 20 hp VFD controlled hot water pumps operating in a lead-lag control scheme. The boilers provide hot water to air handlers, packaged AC units, unit ventilators, and unit heaters throughout the building.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps, although there are a considerable number of LED tube lamps. There are also a few 40-Watt T12 fixtures. Additionally, there are some compact fluorescent lamps (CFL), incandescent, and LED general purpose lamps. Typically, T8 fluorescent lamps use electronic ballasts and T12 fluorescent lamps use magnetic ballasts. Fixture types include 2- 3- or 4-lamp, 2- or 4-foot long recessed or surface mounted fixtures and 2-foot fixtures with U-bend or linear tube lamps. Gymnasium fixtures have high bay LED fixtures and are manually controlled via a breaker panel. All exit signs are LED units. Most fixtures are in good condition. Interior lighting levels were generally sufficient.

Twin Hills Elementary School

Twin Hills is a one-story, 51,305 square foot building built in 1971. Spaces include: classrooms, gymnasium, auditorium, library, offices, cafeteria, corridors, stairwells, offices, kitchen, and a boiler room. Recent improvements include: Over the last several years the facility has replaced heating, ventilation, and air conditioning (HVAC) equipment and two condensing boilers. The facility is occupied year-round. Typical weekday occupancy is 417 staff and students. Summer occupancy includes a summer day camp and continuing maintenance activities. There are no weekend activities.

Description of Building HVAC

Unit ventilators have supply fan motors, pneumatically controlled outside air dampers, and fan coil valves to distribute heat to the zones. This system is original to the building and appears to be in fair operating condition. The multipurpose room is served with a packaged terminal heat pump unit controlled by room thermostats. The main office is served by a packaged roof top unit. The classroom cooling loads are met by window air conditioning (AC) units. These vary in capacity between 1.25 and 2 tons. The units are in good condition. There is one electric resistance heating unit serving the faculty lounge. The capacity of this unit is 5.00 MBh. The unit is in good condition. The library and assistant principal office are served by three split-system air conditioning units ranging in size from 2 to 4 tons. The units are in good condition.

Two Hydrotherm 2,000 MBh condensing hot water boilers serve the building heating load. The burners are modulating with a nominal efficiency of 87%. The boilers are configured in an automated control scheme. Both boilers are required under high load conditions. Installed in 2010, they are in fair condition. The boilers serve a primary/secondary distribution system with two constant speed 2.0 hp pumps circulating the primary loop and two variable frequency drive (VFD) controlled 10.0 hp heating hot water pumps on the secondary loop. Heating hot water is circulated to the unit ventilators for distribution to the zones.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. Additionally, there are some compact fluorescent lamps , incandescent, and LED general purpose lamps.

Typically, T8 fluorescent lamps use electronic ballasts. Fixture types include 1-2- 3- and 4-lamp, 4-foot long surface mounted fixtures and 2-foot fixtures with Ubend tube lamps. All exit signs are LED. Most fixtures are in fair condition. Interior lighting levels were generally sufficient. Most interior lighting fixtures are controlled by wall switches. Exterior fixtures include compact fluorescent canopy lights and pole-mounted high pressure sodium lamps controlled by time clocks and photocells.

W.R. James St. Elementary School

W.R. James St. Elementary School is a 1-story, 58,745 square foot building built in 1960. Spaces include: classrooms, multipurpose room, offices, cafeteria, corridors, stairwells, ballrooms, offices, a commercial kitchen, and basement mechanical space. The facility is occupied year-round. Typical weekday occupancy is 522 staff and students. Summer occupancy includes a summer day camp and continuing maintenance activities. There are no weekend activities.

Description of Building HVAC

Unit ventilators have supply fan motors and radiant heating hot water coils that serve the heating requirements for most classrooms. This system appears to be in fair operating condition. There are six split-system outdoor condensing units serving indoor air handlers. The cooling capacity range between 3 to 4 tons. The units serve the corridors, kitchen, and administration corridors. Multipurpose room heating and cooling needs are met by a split system air conditioner unit and a 10 hp air handler equipped with hot water heating coils. The unit is rated at 30 tons. The classrooms use window air conditioning (AC) units. These vary in capacity between 1.25 and 2.00. The units are in good condition.

Three Hydrotherm 2,000 MBh hot water boilers serve the building heating load. The burners are modulating with a nominal efficiency of 87%. They were installed in 2012 and are in fair condition. The boilers serve a primary and secondary distribution system with three constant speed 2 hp pumps circulating the primary loop and two variable flow controlled 10 hp heating hot water pumps operating in a lead lag fashion on the secondary loop. The boilers provide hot water to the unit ventilators. Hot water is produced by an 80 gallon 425 MBh gas-fired storage water heater at an 80% efficiency. The boiler was installed in 2007

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. Additionally, there are a substantial quantity of compact fluorescent lamps (CFL), incandescent, and a few LED general purpose lamps. Typically, T8 fluorescent lamps use electronic ballasts. Fixture types include 1- 2- 3- and 4-lamp, 4-foot long surface mounted and recessed fixtures and 2-foot fixtures with U-bend tube lamps. Most fixtures are in fair condition. All exit signs are LED

units. Interior light levels were generally sufficient. Most interior lighting fixtures are controlled manually.

Exterior fixtures include wall packs and canopy lights with high intensity discharge (HID), CFL, and LED lamps. The pole mounted fixtures contain high pressure sodium lamps. Exterior light fixtures are controlled by time clocks and photocells depending on the fixture.

Warehouse

The warehouse is a multi-facility, 24,500 square foot complex, built in 1960. Spaces include: offices, corridors, stairwells, conference rooms, server rooms, ground shed room, a paint shed, maintenance shop, workshops, and mechanical spaces.

Description of Building HVAC

The offices throughout the buildings use window air conditioning (AC) units for space cooling. These vary in capacity between 0.57 and 2.0 tons. The units are in good condition. The Paint Shed, Ground Shed, and various offices throughout the buildings use electric resistance heaters for space heating. These vary in capacity between 2.56 to 34.13 MBh. Some units are in poor condition. The trailer uses a 2-ton wall mount package unit. Two Well McClain 702.0 MBh hot water boilers serve the main warehouse building heating load. The burners are modulating with a nominal efficiency of 87%. The boilers are configured in a lead-lag control scheme. They were installed in 2007 and are in fair condition. The boilers serve a distribution system with two constant speed, 0.3 hp pumps, circulating the loop, and one constant speed 1.0 hp heating supply hot water pump. The hot water serves the fan coils in the electric unit heaters. Hot water is produced with a 40 gallon 36 MBh gas-fired storage water heater with a 78% efficiency. This unit serves the main warehouse. Four electric water heaters with capacities between 1.44 and 4.5 kW and tank capacities ranging from 3 to 50 gallons serve all other areas.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. There are also several 40- Watt T12 fixtures. Additionally, there are some compact fluorescent lamps (CFL), halogen incandescent, and LED general purpose lamps. Typically, T8 fluorescent lamps use electronic ballasts and T12 fluorescent lamps use magnetic ballasts. Fixture types include 1- 2- or 4-lamp, 4-foot long surface mounted fixtures. Most fixtures are in fair condition. Maintenance fixtures have high bay LED lamps and are manually controlled. All exit signs are LED units. Interior lighting levels were generally sufficient. Most lighting fixtures are controlled manually.

Exterior fixtures include wall packs and flood lights with high intensity discharge (HID), CFL, LED, and halogen incandescent flood lamps. Exterior light fixtures are controlled by a time clock and photocell depending on the fixture.

Willingboro High School

Willingboro High School is a 2-story, 227,623 square foot building built in 1975. Spaces include classrooms, a gymnasium, an auxiliary gym, an auditorium, offices, a cafeteria, corridors, stairwells, a media center, resource centers, a kitchen, and electrical and mechanical spaces. Around 2013, the school upgraded the heating, ventilation, and air conditioning (HVAC) system, installing new rooftop packaged air conditioning (AC) units, unit ventilators and associated direct expansion (DX) condensing units as well as replacing hot water boilers with condensing boilers. The air-cooled chillers are also new and were installed in 2020. The facility is occupied ten months of the year. Typical weekday occupancy is 88 staff and 646 students. Summar occupancy is minimal and includes continuing maintenance and custodial activities only. There are limited weekend activities, where the school is partially occupied for sports practices on Saturdays.

Description of Building HVAC

Unit ventilators have constant volume fractional horsepower supply fan motors, outside air dampers, and either DX cooling coils or chilled water-cooling coils that operate with a building energy management control system. Units also have hot water coils for space heating and reheat applications. This system was upgraded around 2013 and is in good operating condition. Most of the common area spaces are served by packaged roof top units (RTUs). There are 17 units with hot water heating coils ranging in size from 150 to 500 MBh capacity. Cooling capacities for these units range from 6 to 15 tons each. Supply fans are constant volume and have either 3.6 or 5 hp motors. The RTUs are equipped with economizers that are in good condition. Some of the office spaces are served by mini-split roof top units. The auditorium, cafeteria, computer lab, and some of the classrooms are served by air-handling units. These units have hot water coils for heating and reheat and chilled water coils for cooling. Supply fans are variable volume controlled by variable frequency drives (VFD). Motor sizes range from 1.5 hp to 15 hp each. The units are in good condition.

Six Hydrotherm 3,000 MBh condensing hot water boilers serve the building heating load. The burners are fully-modulating with a nominal efficiency of 86%. The boilers are configured in a lead-lag control scheme. Multiple boilers may be required under high load conditions. Installed

around 2013, they are in good condition. The hydronic distribution system is a two-pipe heating only system. The boilers are configured in a variable flow primary distribution with two 50 hp VFD controlled hot water pumps operating with a lead-lag control scheme. The boilers provide hot water for space heating and reheat to air-handing units, rooftop packaged units, and unit ventilators throughout the school. Hot water is produced with a Bradford White 98 gallon 250 MBh gas-fired storage water heater(s) with an 80% efficiency. The domestic hot water pipes are insulated, and the insulation is in good condition.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. There are also a few 40- Watt T12 and 28-Watt T5 fixtures. Additionally, there are compact fluorescent lamps (CFL), incandescent, and LED general purpose lamps. Typically, T8 and T5 fluorescent lamps use electronic ballasts and T12 fluorescent lamps use magnetic ballasts. Fixture types include 2- 3- or 4-lamp, 2- or 4-foot long recessed and surface mounted fixtures and 2-foot fixtures with U-bend or linear tube lamps. Gymnasium fixtures have high bay high intensity discharge (HID) lamps and are manually controlled. Auditorium fixtures have high bay linear fluorescent and incandescent lamps and are manually controlled. All exit signs are LED units. Most fixtures are in good condition. Lighting fixtures are controlled manually. Interior lighting levels were generally sufficient.

Exterior fixtures include wall packs and canopy lights with HID, CFL, or LED lamps. The pole mounted fixtures in the parking lot have LED lamps, and the other roadway pole mounted fixtures have HID lamps. Exterior light fixtures are controlled by a time clock, switch, breaker panel, or photocell, depending on the fixture. The athletic field and tennis court are illuminated with HID lamps and are manually controlled by a breaker panel.

ENERGY SAVINGS PLAN

SECTION 2 – ENERGY BASELINE

Total Utility Consumption and Site EUI

The Willingboro Township Public Schools Energy Savings Plan includes 12 buildings. There are 5 Elementary Schools, 2 Middle Schools, 1 High School, 1 Alternative School, 1 Administration Building, 1 Warehouse and 1 Non-Occupied School. To develop the ESP, DCO Energy was provided with all available utility data (electric, natural gas). DCO Energy tracked and documented this utility data from January of 2022 through December of 2022. A listing of the buildings, the total utility consumption, and Energy Usage Index for the 12 sites are detailed below.

Willingboro Township Public Schools BUILDINGS/FACILITIES	
BUILDING/FACILITY NAME	SQFT
Bookbinder School	58,745
Country Club Administration Building	38,585
Garfield East Elementary School	51,493
Hawthorne Elementary School	58,745
J. Cresswell Stuart Early Childhood Development Center	61,459
James A. Cotten Intermediate School	125,000
Joseph A. McGinley School	58,745
Memorial Middle School	159,000
Twin Hills Elementary School	51,305
W.R. James Elementary School	58,745
Warehouse	24,500
Willingboro High School	227,623
TOTALS	**973,945**

Willingboro Township Public Schools- Energy Use Summary

Willingboro Township Public Schools BUILDINGS/FACILITIES		ELECTRIC				
BUILDING/FACILITY NAME	SQFT	CONSUMPTION kWh	DEMAND kW	USAGE BTU / SQFT	TOTAL COST $$	MARGINAL RATE $$ / kWh
Bookbinder School	58,745	278,397	278	16,170	$16,966	$0.113
Country Club Administration Building	38,585	198,224	197	17,529	$33,202	$0.156
Garfield East Elementary School	51,493	261,078	135	17,299	$42,441	$0.111
Hawthorne Elementary School	58,745	298,874	110	17,359	$48,371	$0.131
J. Cresswell Stuart Early Childhood Development Center	61,459	381,175	178	21,162	$59,994	$0.117
James A. Cotten Intermediate School	125,000	981,549	558	26,792	$144,140	$0.124
Joseph A. McGinley School	58,745	126,597	298	7,353	$26,787	$0.153
Memorial Middle School	159,000	1,300,769	778	27,913	$200,495	$0.128
Twin Hills Elementary School	51,305	343,856	181	22,868	$61,250	$0.126
W.R. James Elementary School	58,745	302,400	148	17,564	$58,233	$0.158
Warehouse	24,500	176,631	49	24,599	$26,800	$0.146
Willingboro High School	227,623	2,485,874	760	37,263	$417,296	$0.146
TOTALS	**973,945**	**7,135,424**	**3,668**	**24,997**	**$1,135,974**	**-**

*Note: DCO and Willingboro Township Public Schools have agreed to adjusting the baseline for electric consumption and demand based on existing and proposed projects that will add cooling to classrooms. Adjustments will be reflected in our M&V Plan as well as future energy cost budgeting to be performed by the district so that future costs of electricity will be accounted for.

Willingboro Township Public Schools BUILDINGS/FACILITIES		NATURAL GAS			
BUILDING/FACILITY NAME	SQFT	USAGE THERMS	USAGE BTU / SQFT	TOTAL COST $$	MARGINAL RATE $$ / THERM
Bookbinder School	58,745	31,877	54,263	$37,201	$1.10
Country Club Administration Building	38,585	19,263	49,922	$24,219	$1.15
Garfield East Elementary School	51,493	17,212	33,427	$24,189	$1.28
Hawthorne Elementary School	58,745	29,861	50,832	$35,872	$1.13
J. Cresswell Stuart Early Childhood Development Center	61,459	26,053	42,391	$29,542	$1.05
James A. Cotten Intermediate School	125,000	74,179	59,343	$81,922	$1.08
Joseph A. McGinley School	58,745	41,117	69,992	$49,692	$1.16
Memorial Middle School	159,000	58,956	37,079	$60,030	$0.98
Twin Hills Elementary School	51,305	18,264	35,600	$21,241	$1.05
W.R. James Elementary School	58,745	23,517	40,032	$27,439	$1.08
Warehouse	24,500	6,974	28,465	$8,877	$1.24
Willingboro High School	227,623	86,627	38,057	$74,680	$0.83
TOTALS	**973,945**	**433,900**	**44,551**	**$474,905**	**-**

Willingboro Township Public Schools BUILDINGS/FACILITIES		Water & Sewer			
BUILDING/FACILITY NAME	SQFT	USAGE GAL	USAGE BTU / SQFT	TOTAL COST $$	MARGINAL RATE OVER 10,000 GAL/ QUARTER $$/ GAL
Bookbinder School	58,745	62,500	0.00	$1,588	$0.0138
Country Club Administration Building	38,585	106,200	0.00	$1,975	$0.0168
Garfield East Elementary School	51,493	408,800	0.00	$8,072	$0.0196
Hawthorne Elementary School	58,745	380,300	0.00	$7,496	$0.0195
J. Cresswell Stuart Early Childhood Development Center	61,459	487,200	0.00	$9,657	$0.0197
James A. Cotten Intermediate School	125,000	618,600	0.00	$12,314	$0.0198
Joseph A. McGinley School	58,745	222,500	0.00	$4,415	$0.0098
Memorial Middle School	159,000	539,400	0.00	$10,713	$0.0197
Twin Hills Elementary School	51,305	320,400	0.00	$6,284	$0.0193
W.R. James Elementary School	58,745	334,900	0.00	$6,578	$0.0194
Warehouse	24,500	53,400	0.0	$1,081	$0.0164
Willingboro High School	227,623	842,900	0.0	$16,849	$0.0199
TOTALS	**973,945**	**4,377,100**	**0.00**	**$87,021**	**-**

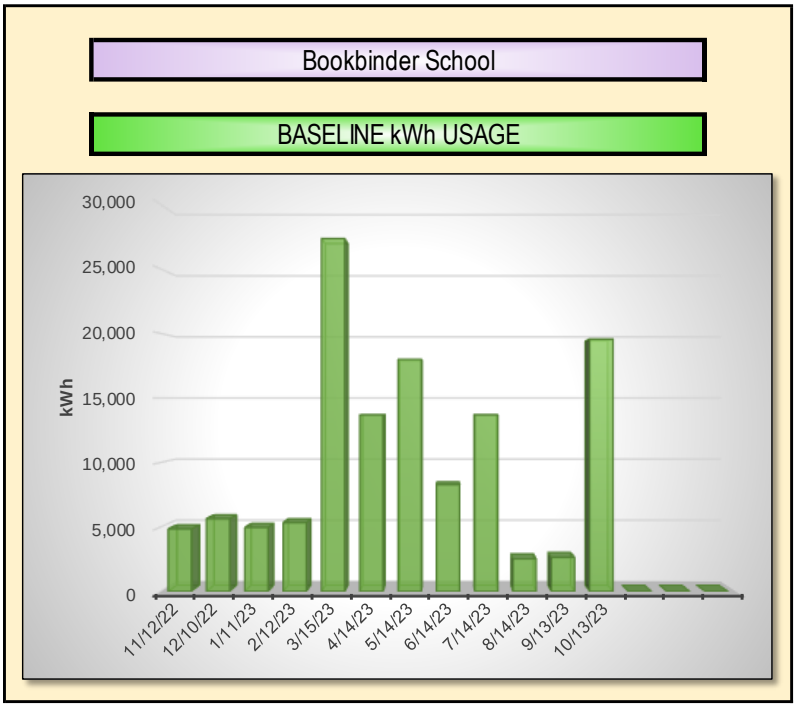
Willingboro Township Public Schools BUILDINGS/FACILITIES		TOTAL ENERGY	TOTAL COST
BUILDING/FACILITY NAME	SQFT	USAGE BTUs	$$
Bookbinder School	58,745	4,137,568,740	$55,755
Country Club Administration Building	38,585	2,602,594,474	$59,397
Garfield East Elementary School	51,493	2,612,044,236	$74,702
Hawthorne Elementary School	58,745	4,005,874,688	$91,739
J. Cresswell Stuart Early Childhood Development Center	61,459	3,905,853,100	$99,194
James A. Cotten Intermediate School	125,000	10,766,947,944	$238,376
Joseph A. McGinley School	58,745	4,543,634,678	$80,894
Memorial Middle School	159,000	10,333,861,188	$271,237
Twin Hills Elementary School	51,305	2,999,681,372	$88,776
W.R. James Elementary School	58,745	3,383,458,200	$92,249
Warehouse	24,500	1,300,065,211	$36,758
Willingboro High School	227,623	17,144,529,024	$508,825
TOTALS	**973,945**	**67,736,112,855**	**$1,697,900**

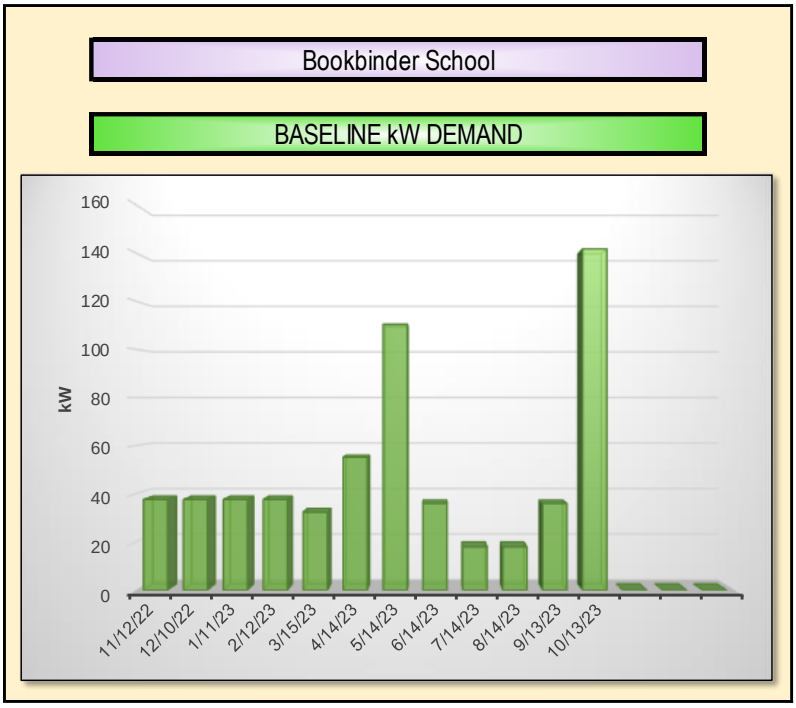
Willingboro Township Public Schools– Energy Use & Cost Index

Willingboro Township Public Schools BUILDINGS/FACILITIES		SITE EUI		
BUILDING/FACILITY NAME	SQFT	USAGE BTU / SQFT	NATIONAL MEDIAN BTU / SQFT	NATIONAL MEDIAN +/- %
Bookbinder School	58,745	70,433	68,800	-2%
Country Club Administration Building	38,585	67,451	68,800	2%
Garfield East Elementary School	51,493	50,726	68,800	26%
Hawthorne Elementary School	58,745	68,191	68,800	1%
J. Cresswell Stuart Early Childhood Development Center	61,459	63,552	68,800	8%
James A. Cotten Intermediate School	125,000	86,136	68,800	-25%
Joseph A. McGinley School	58,745	77,345	59,200	-31%
Memorial Middle School	159,000	64,993	68,800	6%
Twin Hills Elementary School	51,305	58,468	68,800	15%
W.R. James Elementary School	58,745	57,596	68,800	16%
Warehouse	24,500	53,064	68,800	23%
Willingboro High School	227,623	75,320	68,800	-9%
TOTALS	**973,945**	**69,548**	**68,221**	**-2%**

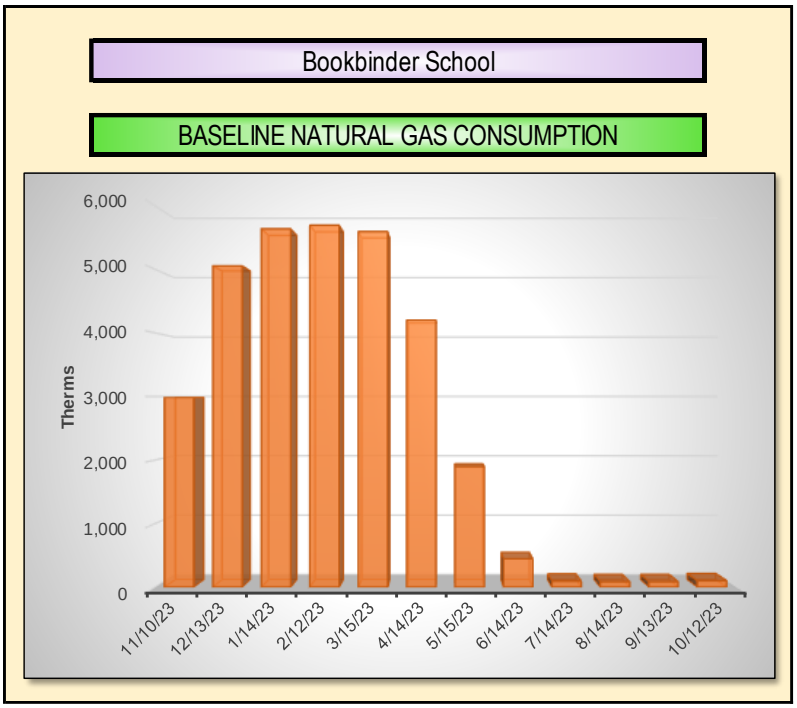
Willingboro Township Public Schools BUILDINGS/FACILITIES		SITE ECI		
BUILDING/FACILITY NAME	SQFT	COST $$ / SQFT	NATIONAL MEDIAN $$ / SQFT	NATIONAL MEDIAN +/- %
Bookbinder School	58,745	$0.95	$1.38	31%
Country Club Administration Building	38,585	$1.54	$1.38	-12%
Garfield East Elementary School	51,493	$1.45	$1.38	-5%
Hawthorne Elementary School	58,745	$1.56	$1.38	-13%
J. Cresswell Stuart Early Childhood Development Center	61,459	$1.61	$1.38	-17%
James A. Cotten Intermediate School	125,000	$1.91	$1.38	-38%
Joseph A. McGinley School	58,745	$1.38	$1.19	-16%
Memorial Middle School	159,000	$1.71	$1.38	-24%
Twin Hills Elementary School	51,305	$1.73	$1.38	-25%
W.R. James Elementary School	58,745	$1.57	$1.38	-14%
Warehouse	24,500	$1.50	$1.38	-9%
Willingboro High School	227,623	$2.24	$1.38	-62%
TOTALS	**973,945**	**$1.74**	**$1.37**	**-28%**

Bookbinder School Baseline Energy Use





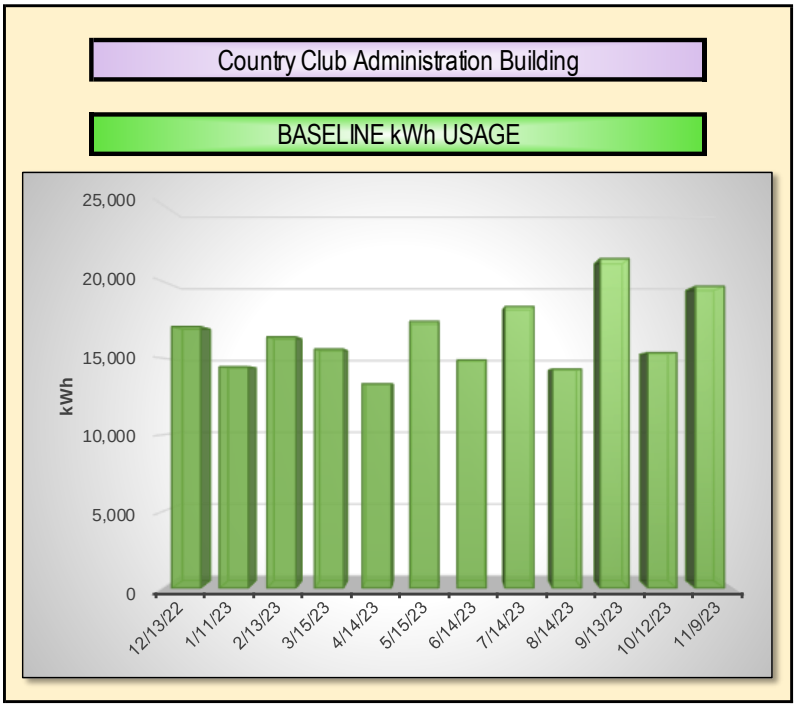
Bookbinder School						ELECTRIC METER #1						
Provider:	PSE&G			Account #	73 407 631 04				Meter #	728004399		
Commodity:	Direct Energy			Account #	1836531				Rate:	General Lighting & Power (GLP)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
10/11/22	11/12/22	4,852	38	$116	$479	$103	$5	$703	$0.123	33	16%	16,554,535
11/13/22	12/10/22	5,649	38	$135	$558	$103	$5	$801	$0.123	28	22%	19,273,724
12/11/22	1/11/23	4,961	38	$118	$490	$103	$5	$716	$0.123	32	17%	16,928,073
1/12/23	2/12/23	5,334	38	$127	$527	$103	$5	$762	$0.123	32	18%	18,198,103
2/13/23	3/15/23	27,360	32	$656	$2,044	$151	$5	$2,856	$0.099	31	114%	93,352,320
3/16/23	4/14/23	13,680	55	$328	$1,195	$257	$5	$1,785	$0.111	30	34%	46,676,160
4/15/23	5/14/23	18,000	110	$432	$1,484	$258	$5	$2,179	$0.106	30	23%	61,416,000
5/15/23	6/14/23	8,280	36	$166	$851	$270	$5	$1,293	$0.123	31	31%	28,251,360
6/15/23	7/14/23	13,680	18	$292	$1,245	$276	$5	$1,818	$0.112	30	106%	46,676,160
7/15/23	8/14/23	2,520	18	$54	$425	$276	$5	$760	$0.190	31	19%	8,598,240
8/15/23	9/13/23	2,640	36	$57	$426	$276	$5	$764	$0.183	30	10%	9,007,680
9/14/23	10/13/23	19,560	142	$521	$1,627	$375	$5	$2,529	$0.110	30	19%	66,738,720
TOTALS		126,515.56	142	$3,001	$11,353	$2,551	$60	$16,966	$0.113	368	10%	431,671,075

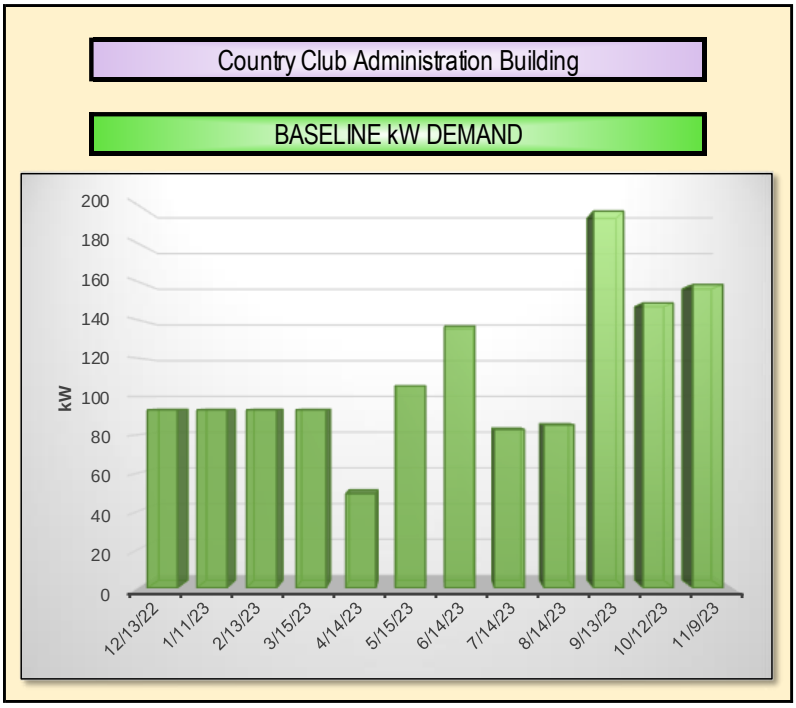


Bookbinder School						Natural Gas Meter #1		
Provider	PSE&G		Account #	73 407 631 04		Meter #	2808965	
Commodity	PSE&G		Account #			Rate:	Large Volume Gas (LVG)	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
10/9/23	11/10/23	2,982	$1,306	$2,597	$173	$4,075	$1.31	298,246,603
11/11/23	12/13/23	5,053	$2,212	$4,400	$173	$6,785	$1.31	505,330,411
2/13/23	1/14/23	5,636	$2,467	$4,907	$173	$7,547	$1.31	563,591,501
1/15/23	2/12/23	5,693	$2,492	$4,956	$173	$7,622	$1.31	569,274,822
2/13/23	3/15/23	5,594	$1,912	$3,182	$176	$5,270	$0.91	559,400,300
3/16/23	4/14/23	4,200	$757	$2,167	$176	$3,100	$0.70	419,975,600
4/15/23	5/15/23	1,897	$329	$923	$176	$1,428	$0.66	189,680,700
5/16/23	6/14/23	447	$31	$221	$178	$430	$0.56	44,733,000
6/15/23	7/14/23	96	$7	$50	$180	$236	$0.59	9,590,700
7/15/23	8/14/23	88	$6	$48	$180	$233	$0.61	8,810,500
8/15/23	9/13/23	88	$5	$47	$180	$232	$0.60	8,802,000
9/14/23	10/12/23	102	$6	$56	$180	$242	$0.61	10,242,200
TOTALS		31,877	$11,531	$23,552	$2,117	$37,201	$1.10	3,187,678,337

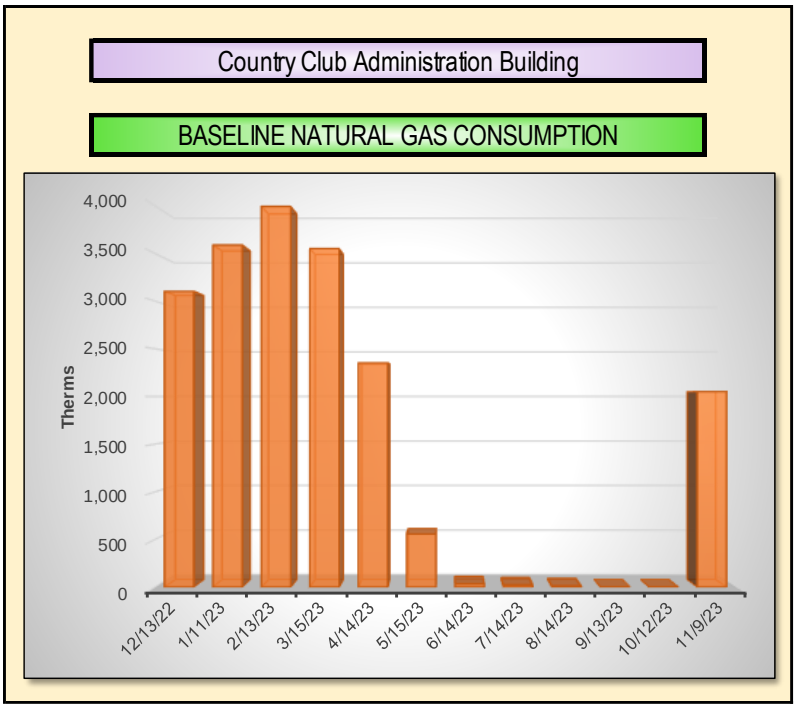
Bookbinder School							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct # / ID No	11110857-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/23	12/29/22	4,100	215	$0	$215	$0.0000	0
12/30/22	4/1/23	5,400	$215	$0	$215	$0.0000	0
4/2/23	6/30/23	49,000	$215	$727	$942	$0.0186	0
7/1/23	9/29/23	4,000	$215	$0	$215	$0.0000	0
TOTALS		62,500	$861	$727	$1,588	$0.0138	0

Country Club Admin Building Baseline Energy Use





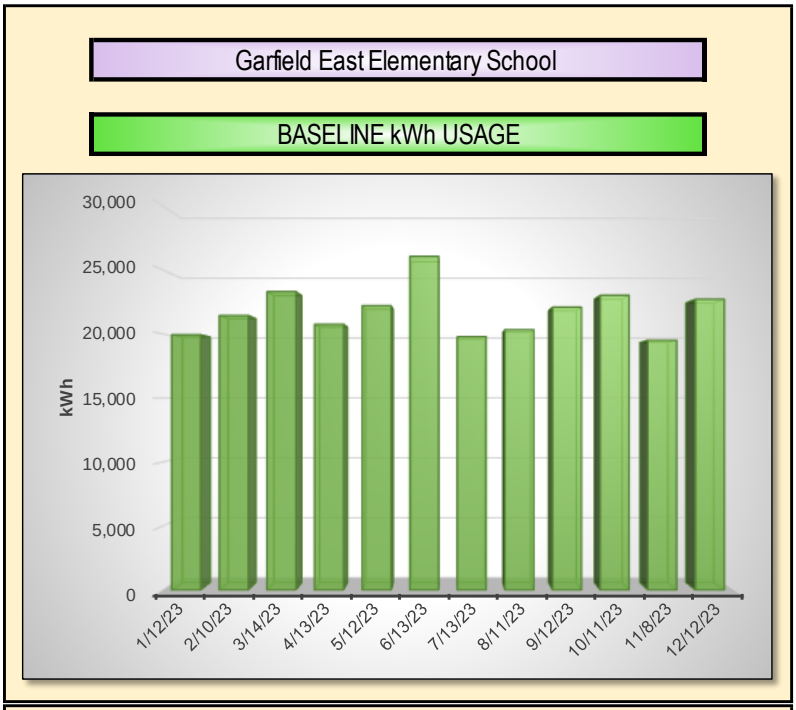
Country Club Administration Building						ELECTRIC METER #1						
Provider:	PSE&G			Account #	73 407 611 01				Meter #	728010615		
Commodity:	Direct Energy			Account #	1836525				Rate:	General Lighting & Power (GLP)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
11/11/22	12/13/22	17,052	93	$406	$2,190	$265	$5.09					
12/14/22	1/11/23	14,434	93	$344	$1,854	$265	$5.09					
1/12/23	2/13/23	16,391	93	$391	$2,105	$265	$5	$2,766	$0.152	33	22%	55,924,634
2/14/23	3/15/23	15,587	93	$372	$2,002	$265	$5	$2,643	$0.152	30	23%	53,182,119
3/16/23	4/14/23	13,320	49	$319	$2,045	$229	$5	$2,599	$0.178	30	38%	45,447,840
4/15/23	5/15/23	17,400	106	$418	$2,336	$247	$5	$3,006	$0.158	31	22%	59,368,800
5/16/23	6/14/23	14,880	137	$298	$2,189	$1,027	$5	$3,519	$0.167	30	15%	50,770,560
6/15/23	7/14/23	18,360	83	$391	$2,437	$1,270	$5	$4,103	$0.154	30	31%	62,644,320
7/15/23	8/14/23	14,280	85	$306	$2,119	$1,307	$5	$3,737	$0.170	31	23%	48,723,360
8/15/23	9/13/23	21,480	197	$463	$2,595	$1,510	$5	$4,573	$0.142	30	15%	73,289,760
9/14/23	10/12/23	15,360	149	$396	$2,157	$395	$5	$2,952	$0.166	29	15%	52,408,320
10/13/23	11/9/23	19,680	158	$483	$2,397	$420	$5	$3,305	$0.146	28	18%	67,148,160
TOTALS		198,224.11	197	$4,587	$26,426	$7,464	$61	$33,202	$0.156	302	14%	676,340,674

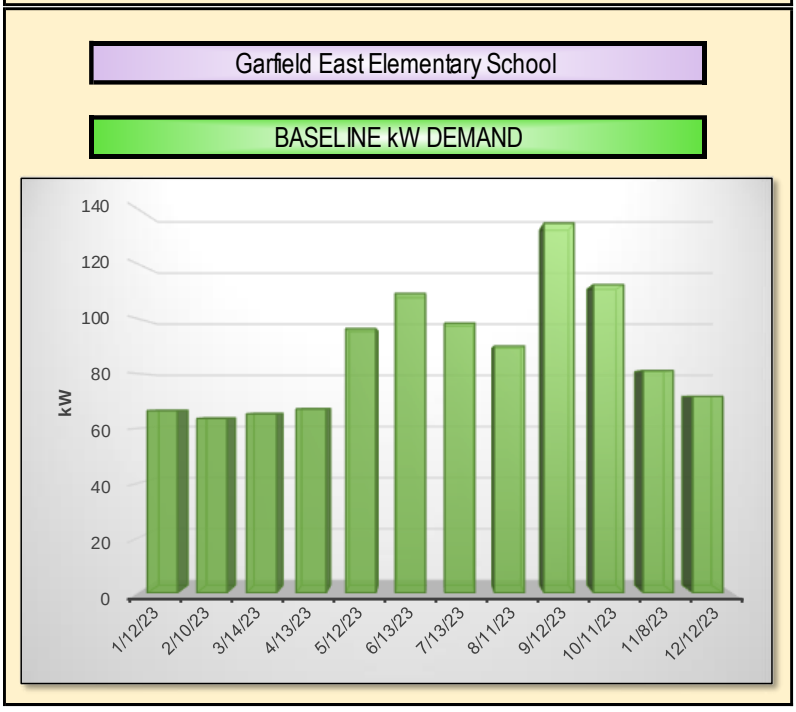


Country Club Administration Building						Natural Gas Meter #1		
Provider	PSE&G		Account #	734 407 611 01		Meter #	3765201	
Commodity	Direct Energy		Account #	349133-30915		Rate:	Large Volume Gas (LVG)	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
11/11/22	12/13/22	3,102	$1,189	$2,674	$173	$4,037	$1.25	310,170,000
12/14/22	1/11/23	3,587	$1,376	$3,280	$173	$4,829	$1.30	358,740,000
1/12/23	2/13/23	3,992	$1,531	$3,259	$173	$4,964	$1.20	399,170,000
2/14/23	3/15/23	3,550	$1,361	$2,661	$173	$4,196	$1.13	355,020,000
3/16/23	4/14/23	2,352	$420	$1,565	$176	$2,161	$0.84	235,164,200
4/15/23	5/15/23	558	$93	$332	$176	$601	$0.76	55,775,400
5/16/23	6/14/23	35	$2	$21	$178	$202	$0.67	3,534,500
6/15/23	7/14/23	23	$2	$14	$180	$196	$0.69	2,315,000
7/15/23	8/14/23	13	$1	$8	$180	$189	$0.70	1,321,600
8/15/23	9/13/23	0	$0	$0	$180	$180	$0.00	0
9/14/23	10/12/23	0	$0	$0	$180	$180	$0.00	0
10/13/23	11/9/23	2,050	$950	$1,357	$180	$2,486	$1.12	205,043,100
TOTALS		19,263	$6,926	$15,171	$2,123	$24,219	$1.15	1,926,253,800

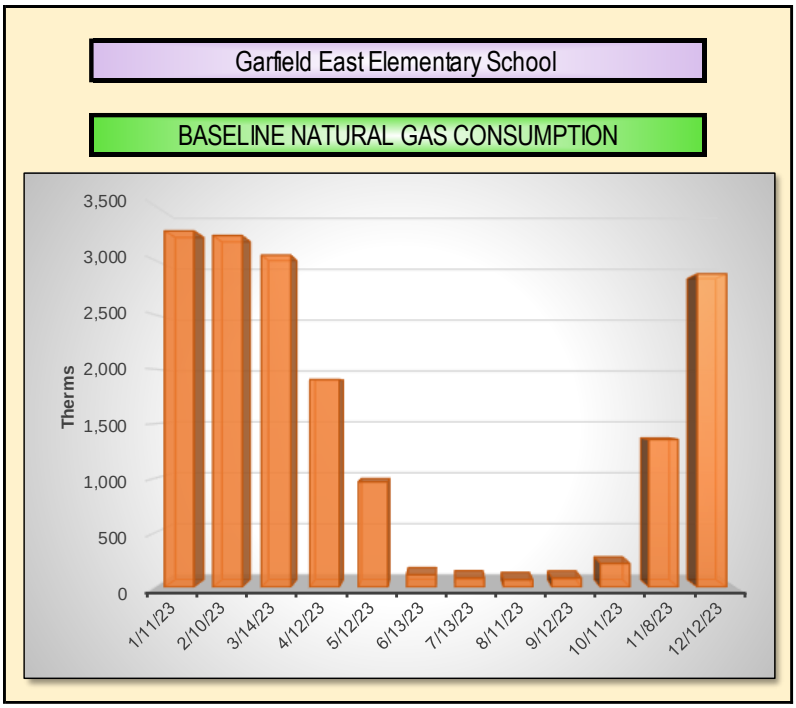
Country Club Administration Building							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct # / ID No	11110863-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/22	1/1/23	21,900	215	$195	$410	$0.0164	0
1/2/23	3/31/23	24,600	$215	$239	$454	$0.0164	0
4/1/23	6/30/23	26,400	$215	$270	$485	$0.0165	0
7/1/23	9/30/23	33,300	$215	$410	$625	$0.0176	0
TOTALS		106,200	$861	$1,113	$1,975	$0.0168	0

Garfield East ES Baseline Energy Use





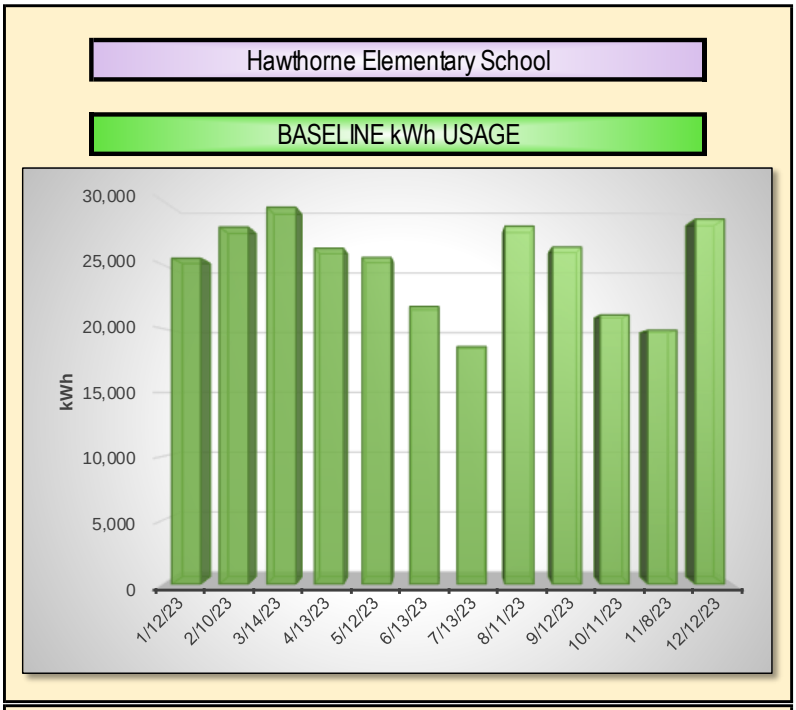
Garfield East Elementary School				ELECTRIC METER #1							
Provider:	PSE&G		Account #	42 146 000 02			Meter #	9207097			
Commodity:	Direct Energy		Account #	1836534			Rate:	Large Power & Lighting Secondary (LPLS)			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/12/22	1/12/23	19,940	67	$326	$1,840	$297	$371	$2,833	$0.109	32	39%	68,035,280
1/13/23	2/10/23	21,436	64	$351	$1,911	$284	$371	$2,917	$0.106	29	48%	73,139,632
2/11/23	3/14/23	23,299	65	$383	$2,075	$292	$371	$3,121	$0.106	32	46%	79,496,188
3/15/23	4/13/23	20,751	67	$341	$1,952	$300	$371	$2,964	$0.110	30	43%	70,802,412
4/14/23	5/12/23	22,201	96	$365	$2,065	$432	$371	$3,232	$0.109	29	33%	75,749,812
5/13/23	6/13/23	26,050	109	$456	$2,418	$1,510	$371	$4,755	$0.110	32	31%	88,882,600
6/14/23	7/13/23	19,782	98	$372	$2,014	$1,387	$371	$4,144	$0.121	30	28%	67,496,184
7/14/23	8/11/23	20,327	90	$384	$1,932	$1,268	$371	$3,955	$0.114	29	32%	69,355,724
8/12/23	9/12/23	22,082	135	$420	$2,107	$1,900	$371	$4,798	$0.114	32	21%	75,343,784
9/13/23	10/11/23	23,007	112	$419	$2,122	$556	$371	$3,468	$0.110	29	29%	78,499,884
10/12/23	11/8/23	19,500	81	$329	$1,857	$401	$371	$2,958	$0.112	28	36%	66,534,000
11/9/23	12/12/23	22,703	72	$384	$2,185	$356	$371	$3,295	$0.113	34	39%	77,462,636
TOTALS		261,078.00	135	$4,531	$24,478	$8,982	$4,450	$42,441	$0.111	366	22%	890,798,136

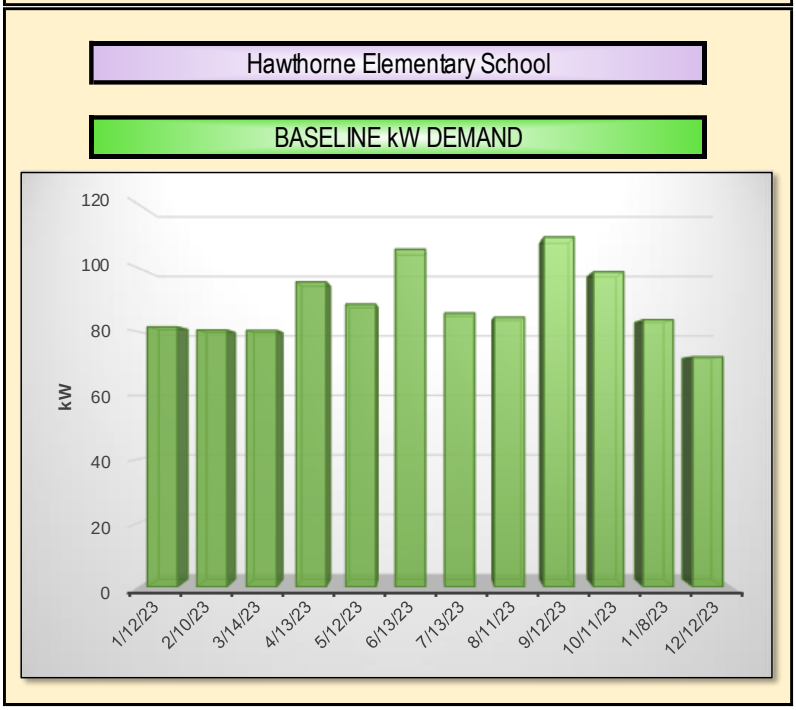


Garfield East Elementary School						Natural Gas Meter #1		
Provider	PSE&G		Account #	70 072 551 08		Meter #	3861716	
Commodity	Direct Energy		Account #	349133-30910		Rate:	Large Volume Gas (LVG)	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
12/13/22	1/11/23	3,268	$1,271	$3,000	$176	$4,447	$1.31	326,842,000
1/12/23	2/10/23	3,226	$4,519	$2,655	$176	$7,349	$2.22	322,590,000
2/11/23	3/14/23	3,046	$1,054	$2,290	$176	$3,519	$1.10	304,623,900
3/15/23	4/12/23	1,906	$330	$1,277	$176	$1,783	$0.84	190,566,000
4/13/23	5/12/23	966	$157	$574	$176	$907	$0.76	96,611,000
5/13/23	6/13/23	115	$8	$69	$178	$255	$0.67	11,487,000
6/14/23	7/13/23	85	$6	$53	$180	$238	$0.69	8,488,300
7/14/23	8/11/23	69	$5	$44	$180	$228	$0.70	6,938,300
8/12/23	9/12/23	84	$5	$53	$180	$238	$0.69	8,361,900
9/13/23	10/11/23	218	$27	$140	$180	$347	$0.77	21,806,000
10/12/23	11/8/23	1,355	$737	$895	$180	$1,811	$1.20	135,482,800
11/9/23	12/12/23	2,874	$1,009	$1,878	$180	$3,066	$1.00	287,448,900
TOTALS		17,212	$9,128	$12,925	$2,136	$24,189	$1.28	1,721,246,100

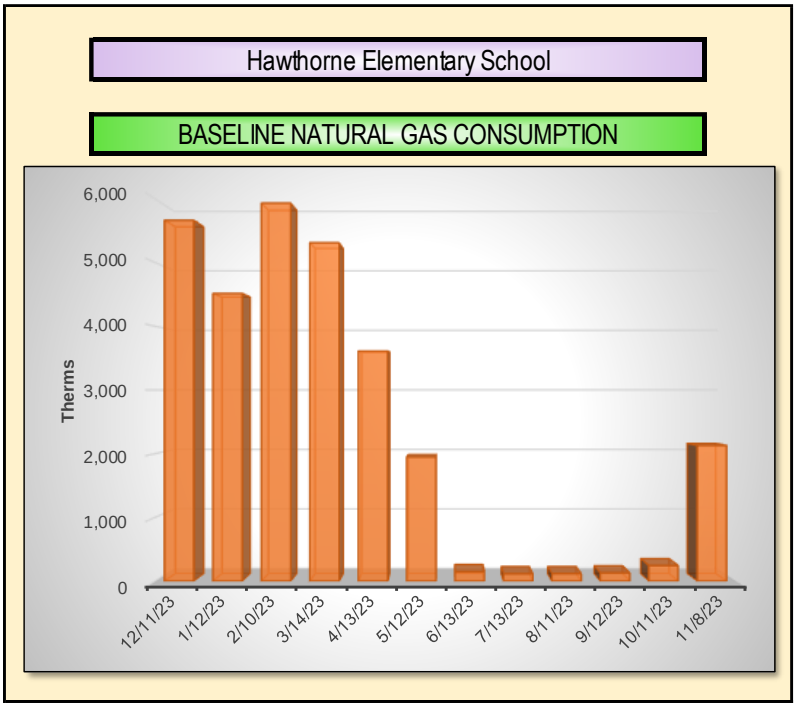
Garfield East Elementary School							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct # / ID No	11110868-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/22	1/1/23	114,700	215	$2,055	$2,271	$0.0196	0
1/2/23	3/31/23	138,800	$215	$2,543	$2,758	$0.0197	0
4/1/23	6/30/23	109,400	$215	$1,948	$2,164	$0.0196	0
7/1/23	9/30/23	45,900	$215	$664	$880	$0.0185	0
TOTALS		408,800	$861	$7,211	$8,072	$0.0196	0

Hawthorne ES Baseline Energy Use





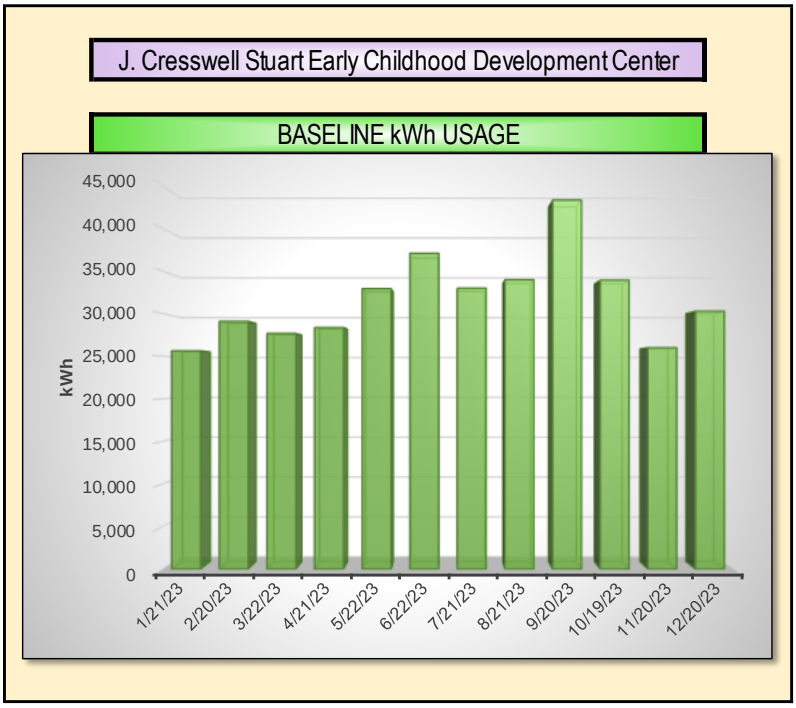
Hawthorne Elementary School						ELECTRIC METER #1						
Provider:	PSE&G			Account #	42 233 001 05				Meter #	92 0707 4		
Commodity:	Direct Energy			Account #	1836535				Rate:	General Lighting & Power (GLP)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/12/22	1/12/23	25,487	82	$608	$2,568	$380	$5	$3,562	$0.125	32	41%	86,961,644
1/13/23	2/10/23	27,928	81	$668	$2,751	$375	$5	$3,799	$0.122	29	50%	95,290,336
2/13/23	3/14/23	29,486	80	$707	$2,913	$375	$5	$4,000	$0.123	30	51%	100,606,232
3/15/23	4/13/23	26,276	96	$630	$2,761	$445	$5	$3,842	$0.129	30	38%	89,653,712
4/14/23	5/12/23	25,557	89	$613	$2,732	$414	$5	$3,763	$0.131	29	41%	87,200,484
5/13/23	6/13/23	21,714	106	$434	$2,529	$1,584	$5	$4,552	$0.136	32	27%	74,088,168
6/14/23	7/13/23	18,582	86	$396	$2,321	$1,316	$5	$4,039	$0.146	30	30%	63,401,784
7/14/23	8/11/23	28,003	85	$599	$2,898	$1,296	$5	$4,798	$0.125	29	48%	95,546,236
8/12/23	9/12/23	26,366	110	$568	$2,876	$1,681	$5	$5,131	$0.131	32	31%	89,960,792
9/13/23	10/11/23	21,056	99	$545	$2,405	$523	$5	$3,478	$0.140	29	31%	71,843,072
10/12/23	11/8/23	19,866	84	$487	$2,289	$444	$5	$3,226	$0.140	28	35%	67,782,792
11/9/23	12/12/23	28,553	72	$701	$3,095	$383	$5	$4,184	$0.133	34	49%	97,422,836
TOTALS		298,874.00	110	$6,956	$32,138	$9,217	$60	$48,371	$0.131	364	31%	1,019,758,088

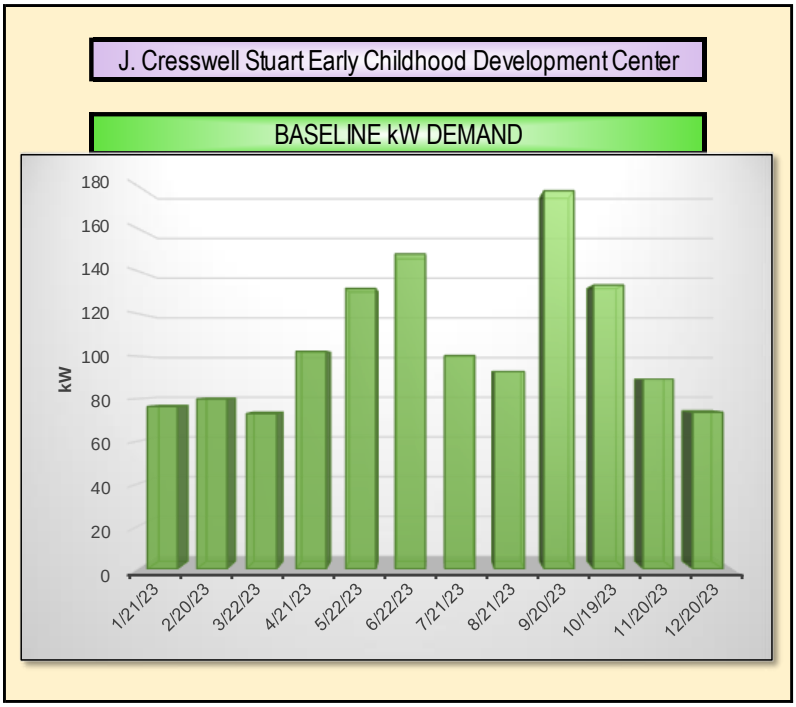


Hawthorne Elementary School						Natural Gas Meter #1		
Provider	PSE&G		Account #	73 407 613 06		Meter #	4019177	
Commodity	Direct Energy		Account #	349133-30908		Rate:	Large Volume Gas (LVG)	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
11/10/23	12/11/23	5,663	$2,166	$4,854	$173	$7,193	$1.24	566,270,000
12/12/23	1/12/23	4,514	$1,727	$4,143	$173	$6,043	$1.30	451,420,000
1/13/23	2/10/23	5,931	$2,269	$4,880	$173	$7,322	$1.21	593,050,000
2/11/23	3/14/23	5,309	$1,905	$3,990	$176	$6,072	$1.11	530,931,800
3/15/23	4/13/23	3,612	$648	$2,421	$176	$3,244	$0.85	361,212,300
4/14/23	5/12/23	1,947	$339	$1,156	$176	$1,671	$0.77	194,660,600
5/13/23	6/13/23	148	$10	$89	$178	$277	$0.67	14,800,600
6/14/23	7/13/23	116	$8	$72	$180	$259	$0.69	11,575,000
7/14/23	8/11/23	118	$8	$75	$180	$262	$0.70	11,784,100
8/12/23	9/12/23	130	$8	$82	$180	$270	$0.69	12,982,900
9/13/23	10/11/23	246	$28	$157	$180	$365	$0.76	24,559,300
10/12/23	11/8/23	2,129	$1,308	$1,406	$180	$2,893	$1.27	212,870,000
TOTALS		29,861	$10,424	$23,325	$2,124	$35,872	$1.13	2,986,116,600

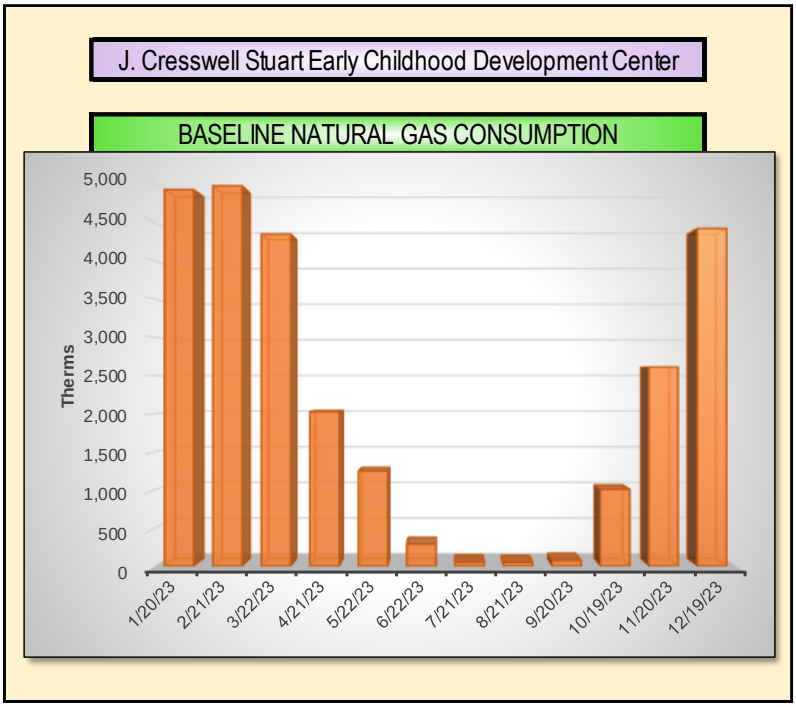
Hawthorne Elementary School							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct #	11110862-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/22	1/1/23	98,600	215	$1,730	$1,945	$0.0195	0
1/2/23	3/31/23	116,300	$215	$2,088	$2,303	$0.0196	0
4/1/23	6/30/23	96,600	$215	$1,689	$1,905	$0.0195	0
7/1/23	9/30/23	68,800	$215	$1,127	$1,343	$0.0192	0
TOTALS		380,300	$861	$6,634	$7,496	$0.0195	0

J. Cresswell Stuart ECDC Baseline Energy Use





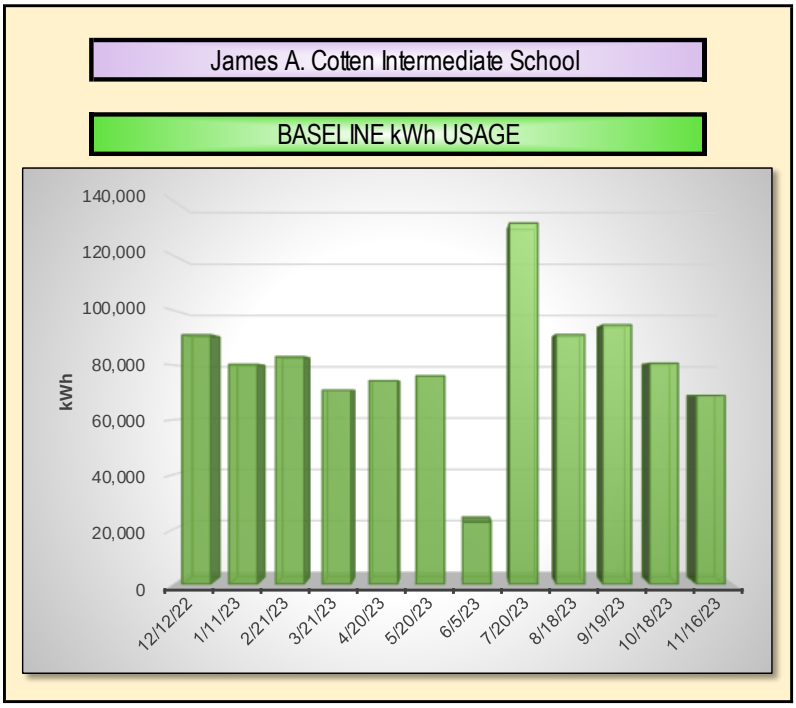
J. Cresswell Stuart Early Childhood Development Center						ELECTRIC METER #1						
Provider:	PSE&G			Account #	42 327 017 02				Meter #	9 208 460		
Commodity:	Direct Energy			Account #	1836530				Rate:	Large Power & Lighting Secondary (LPLS)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/20/22	1/21/23	25,626	76	$419	$2,620	$341	$371	$3,751	$0.119	33	42%	87,435,912
1/18/23	2/20/23	29,099	80	$477	$2,858	$357	$371	$4,064	$0.115	34	45%	99,285,788
2/21/23	3/22/23	27,672	73	$455	$2,854	$326	$371	$4,006	$0.120	30	53%	94,416,864
3/23/23	4/21/23	28,368	102	$466	$2,923	$457	$371	$4,218	$0.119	30	39%	96,791,616
4/22/23	5/22/23	32,926	132	$541	$3,253	$592	$371	$4,757	$0.115	31	34%	112,343,512
5/23/23	6/22/23	37,072	148	$674	$3,686	$2,067	$371	$6,797	$0.118	31	34%	126,489,664
6/23/23	7/21/23	32,981	100	$620	$3,354	$1,414	$371	$5,759	$0.121	29	47%	112,531,172
7/22/23	8/21/23	33,958	93	$644	$3,350	$1,308	$371	$5,672	$0.118	31	49%	115,864,696
8/22/23	9/20/23	43,306	178	$824	$3,984	$2,504	$371	$7,683	$0.111	30	34%	147,760,072
9/21/23	10/19/23	33,899	133	$597	$3,286	$659	$371	$4,914	$0.115	29	37%	115,663,388
10/20/23	11/20/23	25,994	89	$439	$2,725	$442	$371	$3,977	$0.122	32	38%	88,691,528
11/21/23	12/20/23	30,274	74	$511	$3,150	$366	$371	$4,398	$0.121	30	57%	103,294,888
TOTALS		381175	178	$6,669	$38,044	$10,832	$4,450	$59,994	$0.117	370	24%	1,300,569,100

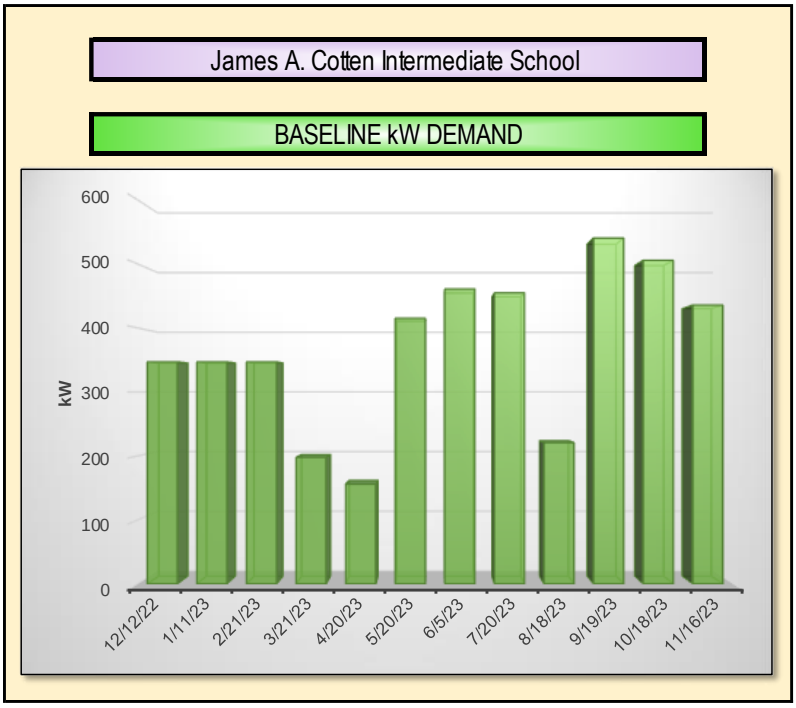


J. Cresswell Stuart Early Childhood Development Center						Natural Gas Meter #1		
Provider	PSE&G		Account #	42 327 017 02		Meter #	4239354	
Commodity	Direct Energy		Account #	349133-30909		Rate:	Large Volume Gas (LVG)	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
12/20/22	1/20/23	4,935	$1,774	$4,393	$176	$6,343	$1.25	493,499,000
1/21/23	2/21/23	4,985	$1,627	$3,969	$176	$5,773	$1.12	498,475,500
2/22/23	3/22/23	4,352	$1,511	$3,222	$176	$4,909	$1.09	435,247,500
3/23/23	4/21/23	2,025	$351	$1,280	$176	$1,807	$0.81	202,517,900
4/22/23	5/22/23	1,245	$207	$743	$177	$1,127	$0.76	124,498,700
5/23/23	6/22/23	290	$20	$175	$179	$374	$0.67	29,020,800
6/23/23	7/21/23	54	$4	$34	$180	$217	$0.70	5,396,400
7/22/23	8/21/23	48	$3	$31	$180	$213	$0.70	4,841,100
8/22/23	9/20/23	74	$5	$47	$180	$231	$0.69	7,378,800
9/21/23	10/19/23	1,008	$158	$651	$180	$988	$0.80	100,770,200
10/20/23	11/20/23	2,612	$1,176	$1,753	$180	$3,109	$1.12	261,154,400
11/21/23	12/19/23	4,425	$1,494	$2,777	$180	$4,451	$0.97	442,483,700
TOTALS		26,053	$8,330	$19,075	$2,137	$29,542	$1.05	2,605,284,000

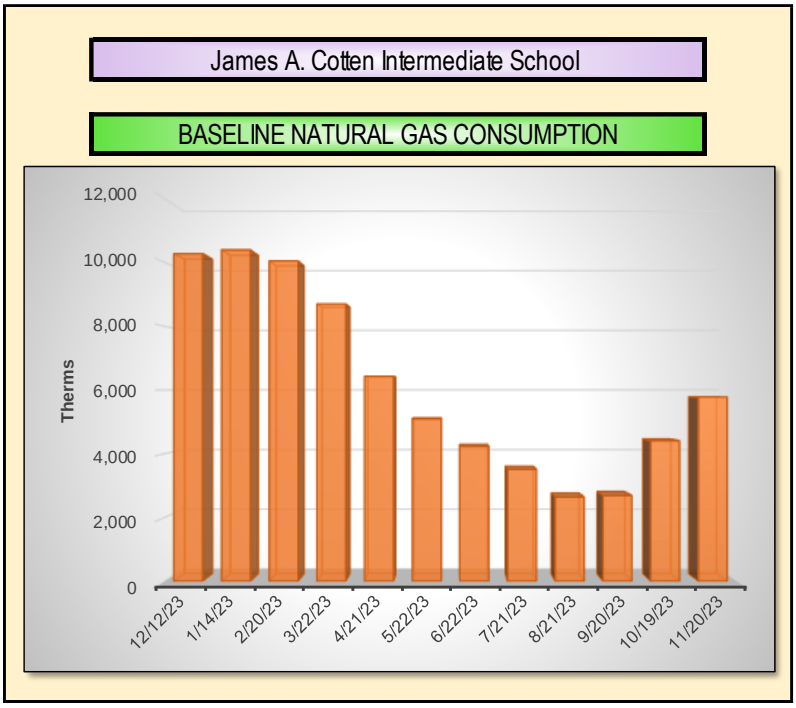
J. Cresswell Stuart Early Childhood Development Center							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct #	11110856-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/22	1/1/23	135,300	215	$2,472	$2,687	$0.0197	0
1/2/23	3/31/23	156,300	$215	$2,897	$3,112	$0.0198	0
4/1/23	6/30/23	140,300	$215	$2,573	$2,788	$0.0197	0
7/1/23	9/29/23	55,300	$215	$854	$1,070	$0.0189	0
TOTALS		487,200	$861	$8,796	$9,657	$0.0197	0

James A. Cotten IS Baseline Energy Use





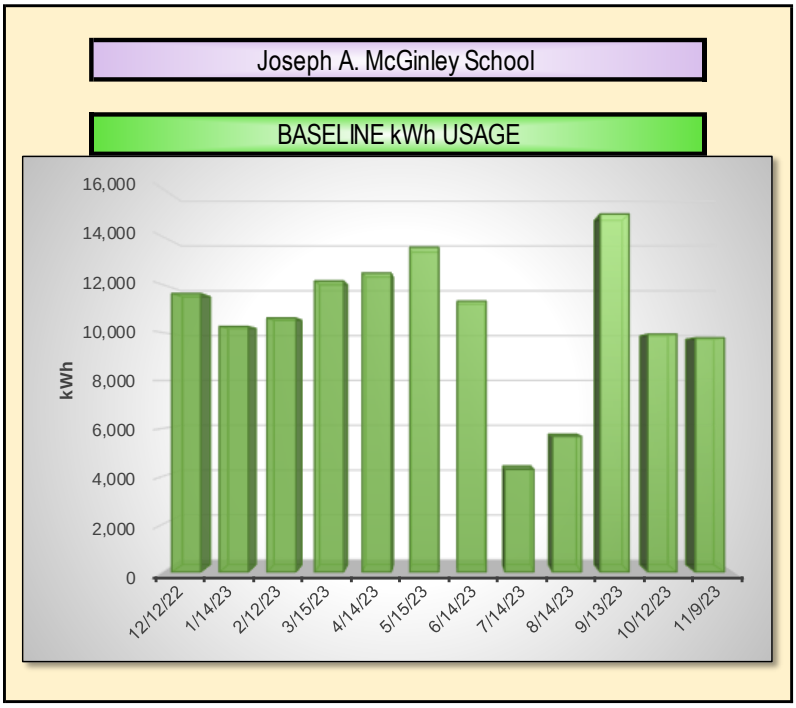
James A. Cotten Intermediate School				ELECTRIC METER #1								
Provider:	PSE&G			Account #	42 455 561 02				Meter #	9203742		
Commodity:	Direct Energy			Account #	1836537				Rate:	General Lighting & Power		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
11/19/22	12/12/22	91,032	347	$2,165	$7,575	$1,006	$5	$10,752	$0.107	24	46%	310,600,520
12/13/22	1/11/23	80,261	347	$1,909	$6,679	$1,006	$5	$9,599	$0.107	30	32%	273,851,774
1/12/23	2/21/23	83,034	347	$1,974	$6,910	$1,006	$5	$9,896	$0.107	41	24%	283,311,755
2/22/23	3/21/23	70,800	198	$1,698	$7,682	$923	$5	$10,307	$0.132	28	53%	241,569,600
3/22/23	4/20/23	74,280	156	$1,781	$7,974	$727	$5	$10,487	$0.131	30	66%	253,443,360
4/21/23	5/20/23	76,080	415	$1,827	$8,178	$970	$5	$10,980	$0.131	30	25%	259,584,960
5/21/23	6/5/23	22,680	461	$1,756	$3,326	$635	$3	$5,721	$0.224	16	13%	77,384,160
6/6/23	7/20/23	131,781	455	$2,479	$14,250	$4,857	$569	$22,154	$0.127	45	27%	449,636,772
7/21/23	8/18/23	91,123	221	$1,726	$9,288	$3,112	$371	$14,496	$0.121	29	59%	310,911,676
8/19/23	9/19/23	94,700	540	$1,802	$9,834	$3,808	$371	$15,815	$0.123	32	23%	323,116,400
9/20/23	10/18/23	80,649	506	$1,429	$8,546	$1,250	$371	$11,596	$0.124	29	23%	275,174,388
10/19/23	11/16/23	68,849	436	$1,163	$7,708	$1,079	$371	$10,321	$0.129	29	23%	234,912,788
TOTALS		965269	540	$21,708	$97,951	$20,379	$2,084	$142,122	$0.124	363	21%	3,293,498,154

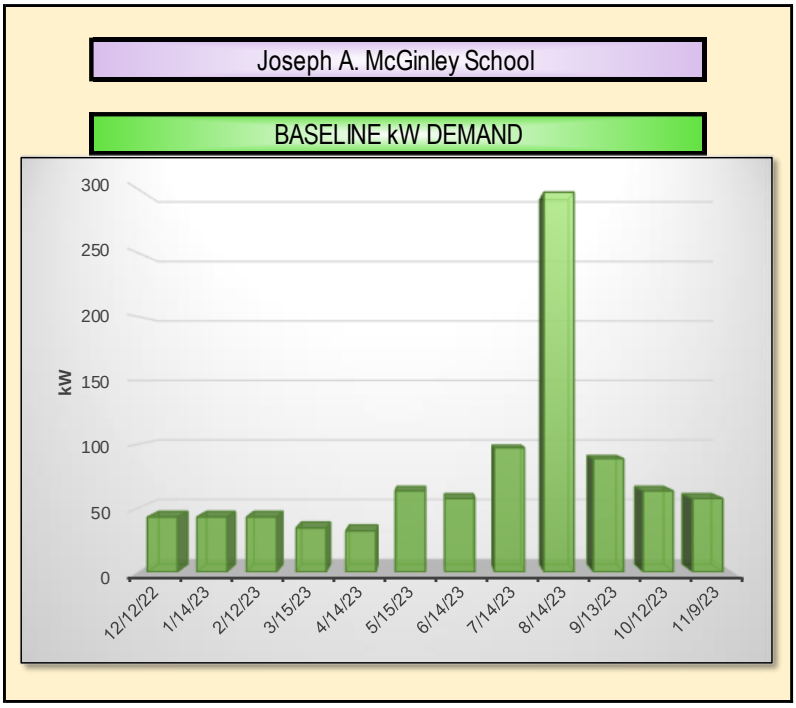


James A. Cotten Intermediate School						Natural Gas Meter #1		
Provider	PSE&G		Account #	42 455 561 02		Meter #	3832925	
Commodity	Direct Energy		Account #	349133 - 949500		Rate:	Large Volume Gas (LVG)	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
11/9/23	12/12/23	10,271	$5,643	$9,203	$173	$15,019	$1.45	1,027,090,000
12/13/23	1/14/23	10,394	$5,710	$9,252	$173	$15,136	$1.44	1,039,350,000
1/15/23	2/20/23	10,047	$5,520	$8,001	$173	$13,694	$1.35	1,004,710,000
2/13/23	3/22/23	8,698	$2,821	$6,439	$176	$9,436	$1.06	869,831,000
3/16/23	4/21/23	6,430	$911	$4,065	$176	$5,152	$0.77	642,966,700
4/15/23	5/22/23	5,091	$654	$3,037	$177	$3,867	$0.73	509,061,400
5/15/23	6/22/23	4,226	$352	$2,549	$179	$3,080	$0.69	422,621,600
6/23/23	7/21/23	3,513	$292	$2,210	$180	$2,681	$0.71	351,319,200
7/22/23	8/21/23	2,641	$200	$1,669	$180	$2,049	$0.71	264,059,000
8/22/23	9/20/23	2,687	$197	$1,700	$180	$2,077	$0.71	268,720,700
9/21/23	10/19/23	4,405	$469	$2,844	$180	$3,492	$0.75	440,525,700
10/20/23	11/20/23	5,776	$2,181	$3,878	$180	$6,239	$1.05	577,648,400
TOTALS		74,179	$24,949	$54,848	$2,125	$81,922	$1.08	7,417,903,700

James A. Cotten Intermediate School							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct #	11110860-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/22	1/1/23	203,300	215	$3,847	$4,062	$0.0199	0
1/2/23	3/31/23	155,100	$215	$2,872	$3,088	$0.0198	0
4/1/23	6/30/23	158,900	$215	$2,949	$3,164	$0.0198	0
7/1/23	9/23/23	101,300	$215	$1,784	$2,000	$0.0195	0
TOTALS		618,600	$861	$11,453	$12,314	$0.0198	0

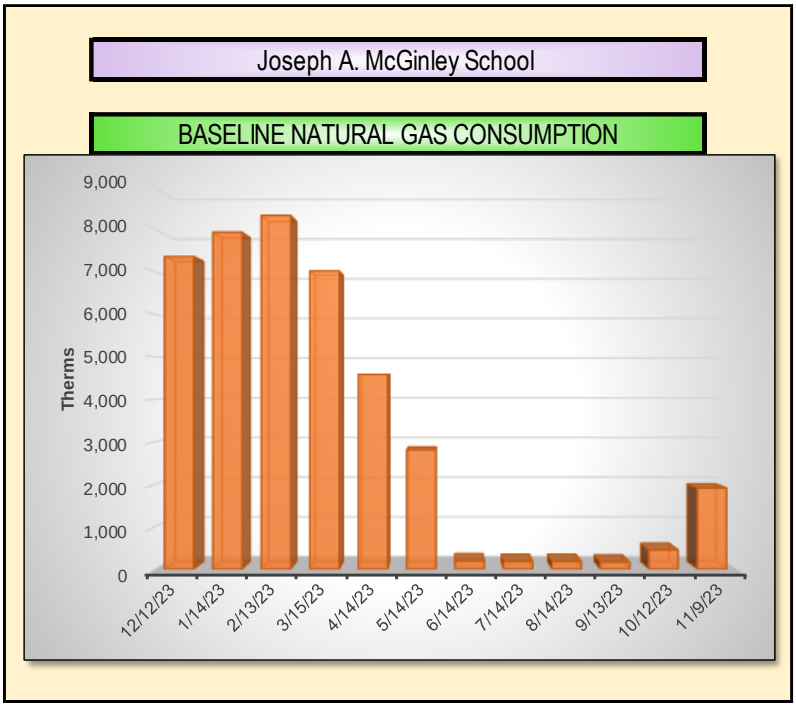
Joseph A. McGinley School Baseline Energy Use





DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

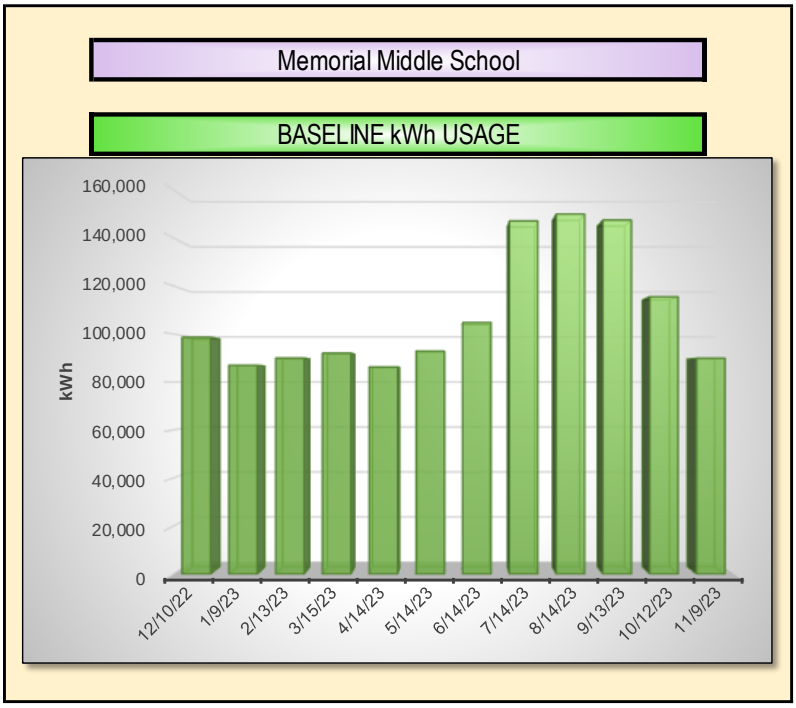
Joseph A. McGinley School						ELECTRIC METER #1						
Provider:	PSE&G			Account #	73 407 617 05				Meter #	59585765		
Commodity:	PSE&G			Account #	1836524				Rate:	General Lighting & Power (GLP)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
11/9/22	12/12/22	11,628	43	$277	$1,608	$143	$5	$2,033	$0.162	34	33%	39,675,709
12/13/22	1/14/23	10,252	43	$244	$1,418	$143	$5	$1,810	$0.162	33	30%	34,981,472
1/15/23	2/12/23	10,607	43	$252	$1,467	$143	$5	$1,867	$0.162	29	35%	36,189,877
2/13/23	3/15/23	12,150	35	$291	$1,352	$161	$5	$1,809	$0.135	31	47%	41,455,800
3/16/23	4/14/23	12,480	32	$299	$1,395	$150	$5	$1,849	$0.136	30	54%	42,581,760
4/15/23	5/15/23	13,560	64	$300	$1,478	$149	$5	$1,932	$0.131	31	29%	46,266,720
5/15/23	6/14/23	11,310	58	$227	$1,356	$432	$5	$2,020	$0.140	31	26%	38,589,720
6/15/23	7/14/23	4,290	97	$89	$1,422	$1,040	$10	$2,560	$0.352	30	6%	14,637,480
7/15/23	8/14/23	5,670	298	$122	$952	$3,986	$6	$5,067	$0.189	31	3%	19,346,040
8/15/23	9/13/23	14,940	89	$322	$1,593	$681	$5	$2,601	$0.128	30	23%	50,975,280
9/14/23	10/12/23	9,930	64	$256	$1,220	$169	$5	$1,649	$0.149	29	22%	33,881,160
10/13/23	11/9/23	9,780	58	$240	$1,191	$153	$5	$1,589	$0.146	28	25%	33,369,360
TOTALS		126597	298	$2,919	$16,452	$7,349	$66	$26,787	$0.153	367	5%	431,950,378

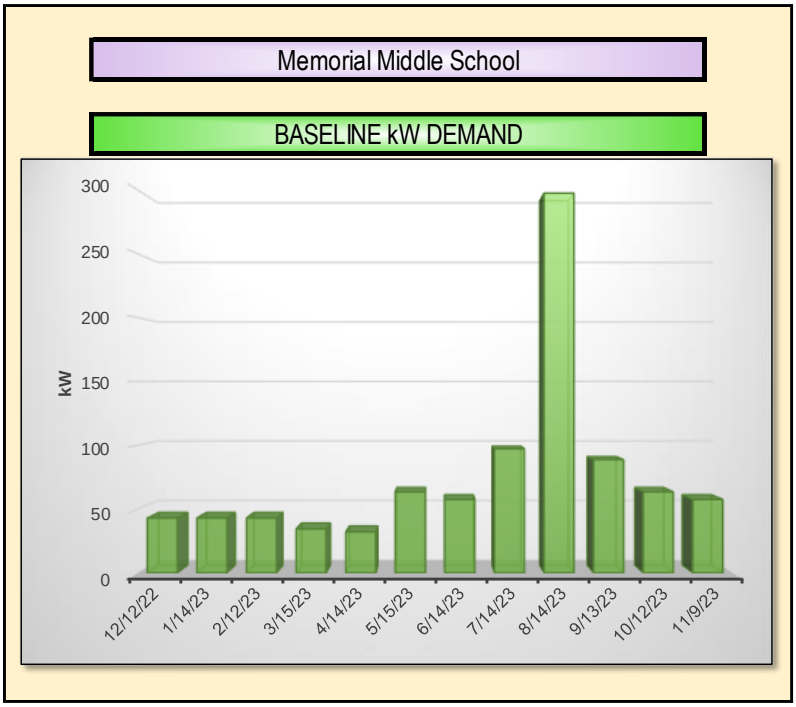


James A. Cotten Intermediate School						Natural Gas Meter #1		
Provider	PSE&G		Account #	42 455 561 02		Meter #	3832925	
Commodity	Direct Energy		Account #	349133 - 949500		Rate:	Large Volume Gas (LVG)	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
11/9/23	12/12/23	10,271	$5,643	$9,203	$173	$15,019	$1.45	1,027,090,000
12/13/23	1/14/23	10,394	$5,710	$9,252	$173	$15,136	$1.44	1,039,350,000
1/15/23	2/20/23	10,047	$5,520	$8,001	$173	$13,694	$1.35	1,004,710,000
2/13/23	3/22/23	8,698	$2,821	$6,439	$176	$9,436	$1.06	869,831,000
3/16/23	4/21/23	6,430	$911	$4,065	$176	$5,152	$0.77	642,966,700
4/15/23	5/22/23	5,091	$654	$3,037	$177	$3,867	$0.73	509,061,400
5/15/23	6/22/23	4,226	$352	$2,549	$179	$3,080	$0.69	422,621,600
6/23/23	7/21/23	3,513	$292	$2,210	$180	$2,681	$0.71	351,319,200
7/22/23	8/21/23	2,641	$200	$1,669	$180	$2,049	$0.71	264,059,000
8/22/23	9/20/23	2,687	$197	$1,700	$180	$2,077	$0.71	268,720,700
9/21/23	10/19/23	4,405	$469	$2,844	$180	$3,492	$0.75	440,525,700
10/20/23	11/20/23	5,776	$2,181	$3,878	$180	$6,239	$1.05	577,648,400
TOTALS		74,179	$24,949	$54,848	$2,125	$81,922	$1.08	7,417,903,700

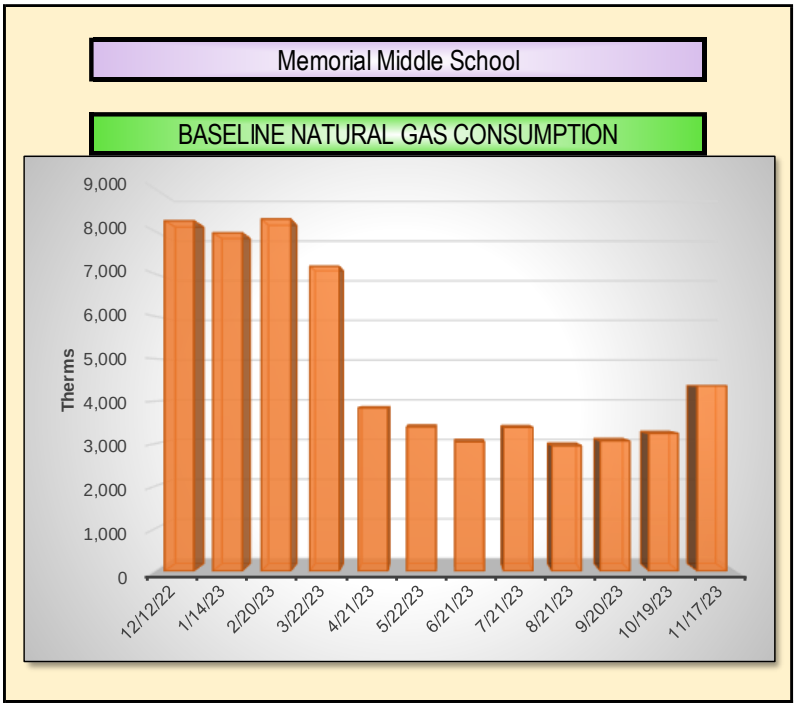
Joseph A. McGinley School							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct #	11110859-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/22	1/1/23	10,100	215	$2	$217	$0.0164	0
1/2/23	3/31/23	13,400	$215	$56	$271	$0.0164	0
4/1/23	6/30/23	93,200	$215	$1,621	$1,836	$0.0195	0
7/1/23	9/29/23	105,800	$215	$1,875	$2,091	$0.0196	0
TOTALS		222,500	$861	$3,553	$4,415	$0.0098	0

Memorial MS Baseline Energy Use





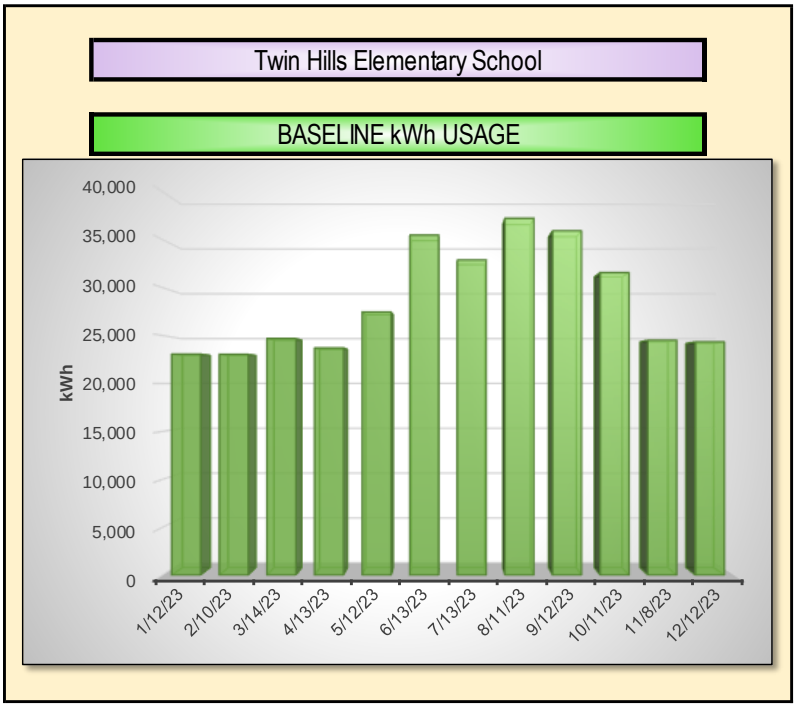
Memorial Middle School				ELECTRIC METER #1								
Provider:	PSE&G		Account #	42 455 560 05				Meter #	9210936			
Commodity:	Direct Energy		Account #	1836516				Meter #	Large Power & Lighting Secondary (LPS)			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
11/9/22	12/10/22	98,608	453	$1,601	$10,409	$1,136	$371	$13,517	$0.122	32	28%	336,450,992
12/11/22	1/9/23	86,941	453	$1,411	$9,177	$1,136	$371	$12,096	$0.122	30	27%	296,643,743
1/10/23	2/13/23	89,945	453	$1,460	$9,494	$1,136	$371	$12,461	$0.122	35	24%	306,891,054
2/14/23	3/15/23	92,027	201	$1,513	$10,993	$899	$371	$13,776	$0.136	30	64%	313,996,124
3/16/23	4/14/23	86,262	211	$1,418	$10,779	$942	$371	$13,510	$0.141	30	57%	294,325,944
4/15/23	5/14/23	92,903	579	$1,528	$11,311	$1,298	$371	$14,508	$0.138	30	22%	316,985,036
5/15/23	6/14/23	104,710	712	$1,845	$12,384	$4,931	$371	$19,531	$0.136	31	20%	357,270,520
6/15/23	7/14/23	146,952	334	$2,764	$15,520	$4,703	$371	$23,358	$0.124	30	61%	501,400,224
7/15/23	8/14/23	149,792	334	$2,831	$15,376	$4,707	$371	$23,284	$0.122	31	60%	511,090,304
8/15/23	9/13/23	147,337	778	$2,803	$15,050	$5,479	$371	$23,703	$0.121	30	26%	502,713,844
9/14/23	10/12/23	115,425	689	$2,091	$12,633	$1,703	$371	$16,798	$0.128	29	24%	393,830,100
10/13/23	11/9/23	89,867	564	$1,518	$10,666	$1,396	$371	$13,951	$0.136	28	24%	306,626,204
TOTALS		1300769	778	$22,784	$143,792	$29,469	$4,450	$200,495	$0.128	366	19%	4,438,224,088

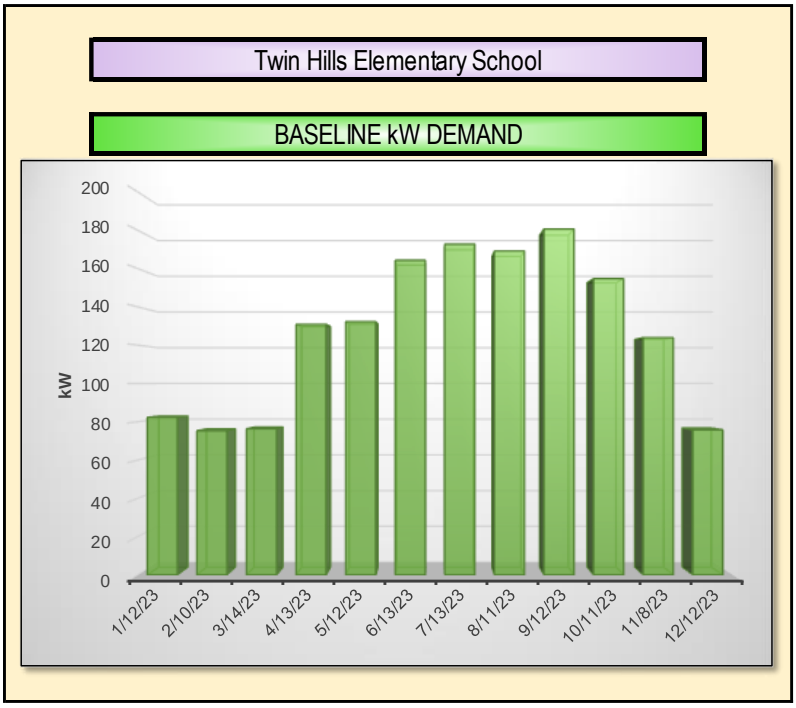


Memorial Middle School						Natural Gas Meter #1		
Provider	PSE&G		Account #	42 455 560 05		Meter #	3499613	
Commodity	Direct Energy		Account #	349133-3479		Rate:	Large Volume Gas (LVG)	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
11/18/22	12/12/22	8,246	$2,798	$7,389	$173	$10,360	$1.24	824,620,000
12/13/22	1/14/23	7,962	$2,702	$7,088	$173	$9,963	$1.23	796,240,000
1/15/23	2/20/23	8,286	$2,812	$6,598	$173	$9,584	$1.14	828,620,000
2/21/23	3/22/23	7,175	$2,254	$5,312	$176	$7,742	$1.05	717,548,700
3/23/23	4/21/23	3,844	$433	$2,430	$176	$3,039	$0.74	384,438,400
4/22/23	5/22/23	3,396	$341	$2,026	$177	$2,544	$0.70	339,578,500
5/23/23	6/21/23	3,043	$249	$1,835	$179	$2,263	$0.68	304,267,600
6/22/23	7/21/23	3,383	$281	$2,125	$180	$2,585	$0.71	338,254,900
7/22/23	8/21/23	2,953	$226	$1,866	$180	$2,272	$0.71	295,293,700
8/22/23	9/20/23	3,065	$227	$1,939	$180	$2,346	$0.71	306,481,700
9/21/23	10/19/23	3,241	$274	$2,092	$180	$2,546	$0.73	324,131,300
10/20/23	11/17/23	4,362	$1,683	$2,923	$180	$4,786	$1.06	436,162,300
TOTALS		58,956	$14,279	$43,625	$2,125	$60,030	$0.98	5,895,637,100

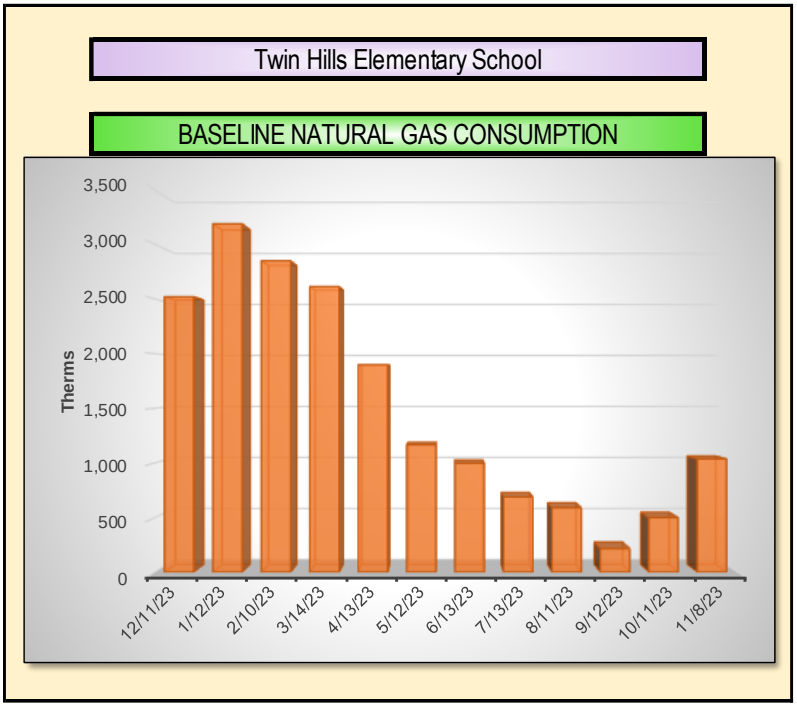
Memorial Middle School							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct #	11110869-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/22	1/1/23	137,600	215	$2,518	$2,734	$0.0197	0
1/2/23	3/31/23	160,600	$215	$2,984	$3,199	$0.0198	0
4/1/23	6/30/23	124,100	$215	$2,246	$2,461	$0.0197	0
7/1/23	9/30/23	117,100	$215	$2,104	$2,319	$0.0196	0
TOTALS		539,400	$861	$9,851	$10,713	$0.0197	0

Twin Hills ES Baseline Energy Use





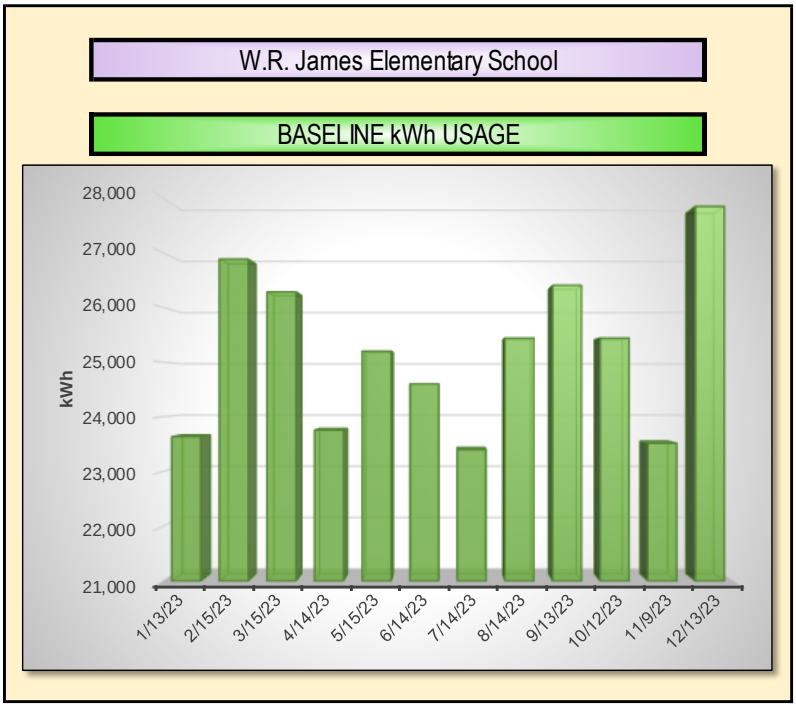
Twin Hills Elementary School						ELECTRIC METER #1						
Provider:	PSE&G			Account #	42 145 001 05				Meter #	9207073		
Commodity:	Direct Energy			Account #	1836533				Rate:	Large Power & Lighting Secondary (LPS)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/13/22	1/12/23	23,061	82	$377	$2,543	$368	$371	$3,658	$0.127	31	38%	78,684,132
1/13/23	2/10/23	23,042	75	$377	$2,594	$336	$371	$3,678	$0.129	29	44%	78,619,304
2/11/23	3/14/23	24,698	76	$406	$2,757	$341	$371	$3,875	$0.128	32	42%	84,269,576
3/15/23	4/13/23	23,707	131	$390	$2,743	$585	$371	$4,088	$0.132	30	25%	80,888,284
4/14/23	5/12/23	27,455	132	$451	$3,019	$593	$371	$4,433	$0.126	29	30%	93,676,460
5/13/23	6/13/23	35,473	164	$621	$3,680	$2,272	$371	$6,944	$0.121	32	28%	121,033,876
6/14/23	7/13/23	32,876	173	$618	$3,569	$2,434	$371	$6,993	$0.127	30	26%	112,172,912
7/14/23	8/11/23	37,223	169	$703	$3,664	$2,383	$371	$7,122	$0.117	29	32%	127,004,876
8/12/23	9/12/23	35,916	181	$683	$3,678	$2,545	$371	$7,277	$0.121	32	26%	122,545,392
9/13/23	10/11/23	31,556	155	$573	$3,263	$765	$371	$4,972	$0.122	29	29%	107,669,072
10/12/23	11/8/23	24,513	124	$414	$2,728	$613	$371	$4,126	$0.128	28	29%	83,638,356
11/9/23	12/12/23	24,336	76	$411	$2,927	$376	$371	$4,085	$0.137	34	39%	83,034,432
TOTALS		343856	181	$6,026	$37,164	$13,610	$4,450	$61,250	$0.126	365	22%	1,173,236,672

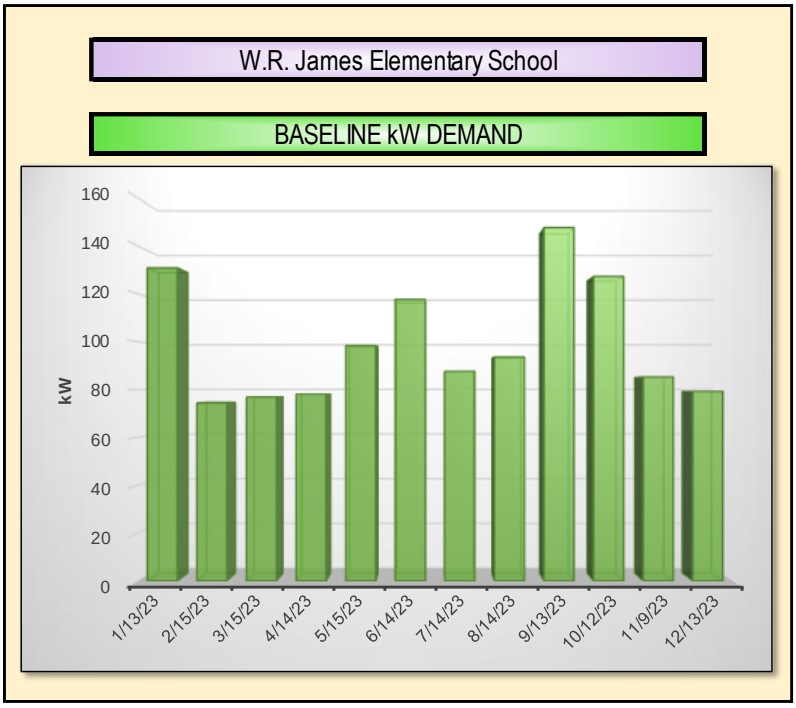


Twin Hills Elementary School						Natural Gas Meter #1		
Provider	PSE&G		Account #	73 407 615 00		Meter #	2413415	
Commodity	Direct Energy		Account #	349133-30907		Rate:	Large Volume Gas (LVG)	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
11/10/23	12/11/23	2,520	$931	$2,160	$173	$3,265	$1.23	252,010,000
12/12/23	1/12/23	3,188	$1,178	$2,926	$173	$4,277	$1.29	318,790,000
1/13/23	2/10/23	2,850	$1,053	$2,345	$173	$3,571	$1.19	284,960,000
2/11/23	3/14/23	2,614	$857	$1,965	$176	$2,998	$1.08	261,422,700
3/15/23	4/13/23	1,899	$276	$1,273	$176	$1,724	$0.82	189,902,000
4/14/23	5/12/23	1,166	$142	$693	$176	$1,011	$0.72	116,641,500
5/13/23	6/13/23	997	$73	$600	$178	$851	$0.68	99,738,000
6/14/23	7/13/23	688	$48	$426	$180	$654	$0.69	68,788,700
7/14/23	8/11/23	590	$40	$375	$180	$594	$0.70	59,003,400
8/12/23	9/12/23	216	$13	$136	$180	$329	$0.69	21,564,800
9/13/23	10/11/23	500	$32	$320	$180	$532	$0.70	49,999,700
10/12/23	11/8/23	1,036	$571	$684	$180	$1,435	$1.21	103,623,900
TOTALS		18,264	$5,215	$13,903	$2,124	$21,241	$1.05	1,826,444,700

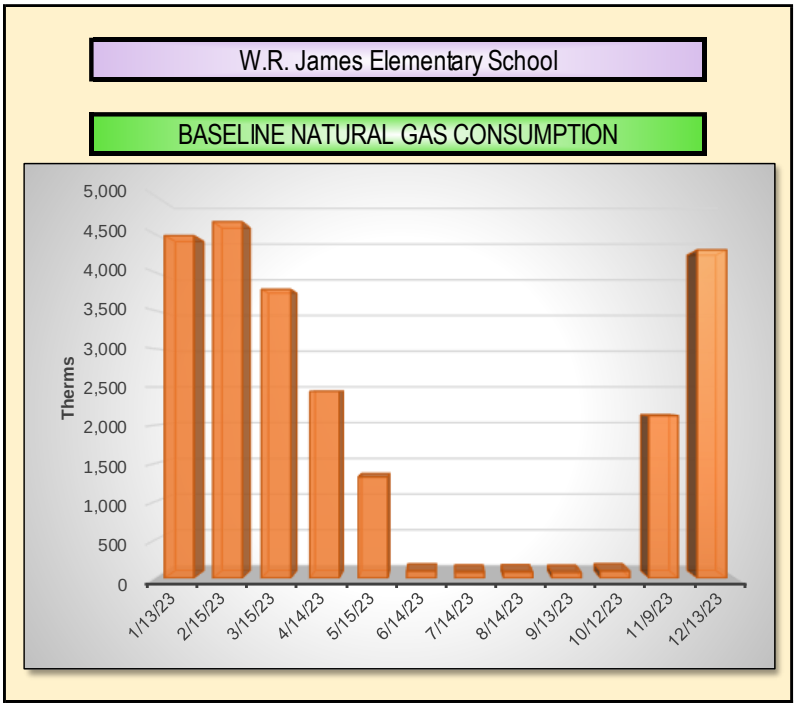
Twin Hills Elementary School							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct #	11110871-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/22	1/1/23	75,300	215	$1,259	$1,474	$0.0193	0
1/2/23	3/31/23	89,800	$215	$1,552	$1,767	$0.0194	0
4/1/23	6/30/23	71,000	$215	$1,172	$1,387	$0.0192	0
7/1/23	9/29/23	84,300	$215	$1,441	$1,656	$0.0194	0
TOTALS		320,400	$861	$5,423	$6,284	$0.0193	0

W.R. James ES Baseline Energy Use





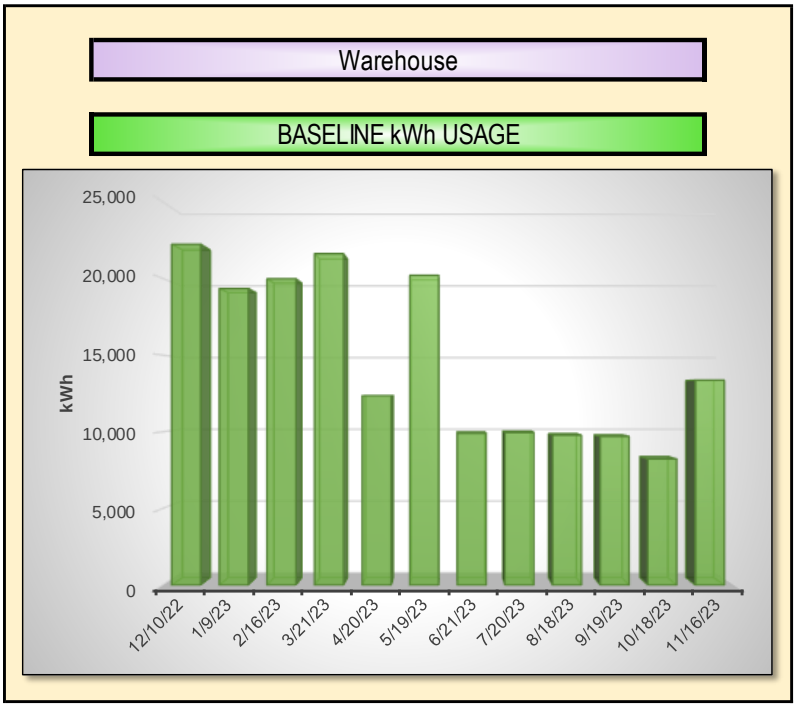
W.R. James Elementary School						ELECTRIC METER #1						
Provider:	PSE&G			Account #	70 073 044 00				Meter #	9 2012 97		
Commodity:	Direct Energy			Account #	1836515				Rate:	Large Power & Lighting Secondary (LPS)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/14/22	1/13/23	23,640	131	$564	$3,111	$609	$5	$4,289	$0.155	31	24%	80,659,680
1/14/23	2/15/23	26,880	74	$643	$3,369	$347	$5	$4,363	$0.149	33	46%	91,714,560
2/16/23	3/15/23	26,280	77	$630	$3,406	$358	$5	$4,399	$0.154	28	51%	89,667,360
3/16/23	4/14/23	23,760	78	$570	$3,288	$363	$5	$4,226	$0.162	30	42%	81,069,120
4/15/23	5/15/23	25,200	98	$605	$3,417	$460	$5	$4,486	$0.160	31	34%	85,982,400
5/16/23	6/14/23	24,600	118	$493	$3,420	$1,765	$5	$5,683	$0.159	30	29%	83,935,200
6/15/23	7/14/23	23,400	88	$499	$3,337	$1,344	$5	$5,185	$0.164	30	37%	79,840,800
7/15/23	8/14/23	25,440	94	$545	$3,450	$1,436	$5	$5,436	$0.157	31	37%	86,801,280
8/15/23	9/13/23	26,400	148	$569	$3,465	$2,264	$5	$6,304	$0.153	30	25%	90,076,800
9/14/23	10/12/23	25,440	127	$655	$3,397	$675	$5	$4,732	$0.159	29	29%	86,801,280
10/13/23	11/9/23	23,520	85	$577	$3,156	$452	$5	$4,190	$0.159	28	41%	80,250,240
11/10/23	12/13/23	27,840	79	$683	$3,831	$421	$5	$4,940	$0.162	34	43%	94,990,080
TOTALS		302400	148	$7,033	$40,646	$10,494	$60	$58,233	$0.158	365	23%	1,031,788,800

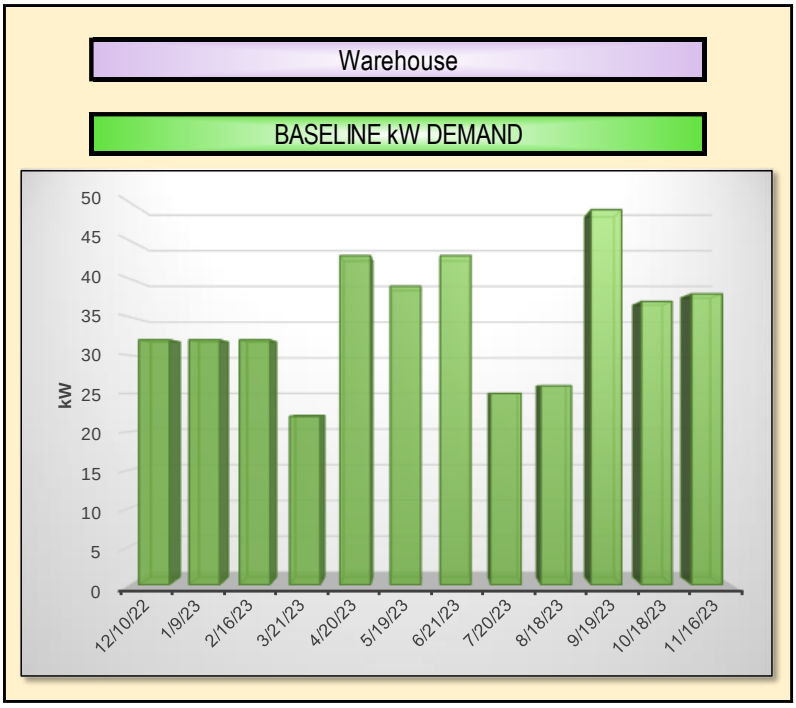


W.R. James Elementary School						Natural Gas Meter #1		
Provider	PSE&G		Account #	70 073 044 00		Meter #	4229307	
Commodity	Direct Energy		Account #	349133-30912		Rate:	Large Volume Gas (LVG)	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
12/13/22	1/13/23	4,479	$1,599	$4,095	$176	$5,870	$1.27	447,890,600
1/14/23	2/15/23	4,660	$1,537	$3,805	$176	$5,518	$1.15	466,012,500
2/16/23	3/15/23	3,776	$1,373	$2,830	$176	$4,379	$1.11	377,622,900
3/16/23	4/14/23	2,443	$432	$1,626	$176	$2,234	$0.84	244,349,500
4/15/23	5/15/23	1,322	$224	$786	$176	$1,186	$0.76	132,245,300
5/16/23	6/14/23	93	$6	$56	$178	$241	$0.67	9,278,000
6/15/23	7/14/23	77	$5	$48	$180	$233	$0.69	7,716,700
7/15/23	8/14/23	80	$5	$51	$180	$236	$0.70	8,039,600
8/15/23	9/13/23	74	$5	$47	$180	$231	$0.69	7,371,600
9/14/23	10/12/23	95	$8	$61	$180	$248	$0.72	9,471,300
10/13/23	11/9/23	2,124	$1,058	$1,406	$180	$2,643	$1.16	212,429,100
11/10/23	12/13/23	4,292	$1,447	$2,794	$180	$4,420	$0.99	429,242,300
TOTALS		23,517	$7,699	$17,603	$2,136	$27,439	$1.08	2,351,669,400

W.R. James Elementary School							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct #	11110858-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/02	1/1/23	80,300	215	$1,360	$1,575	$0.0193	0
1/2/23	3/31/23	106,700	$215	$1,894	$2,109	$0.0196	0
4/1/23	6/30/23	92,300	$215	$1,603	$1,818	$0.0195	0
7/1/23	9/29/23	55,600	$215	$860	$1,076	$0.0189	0
TOTALS		334,900	$861	$5,716	$6,578	$0.0194	0

Warehouse Baseline Energy Use



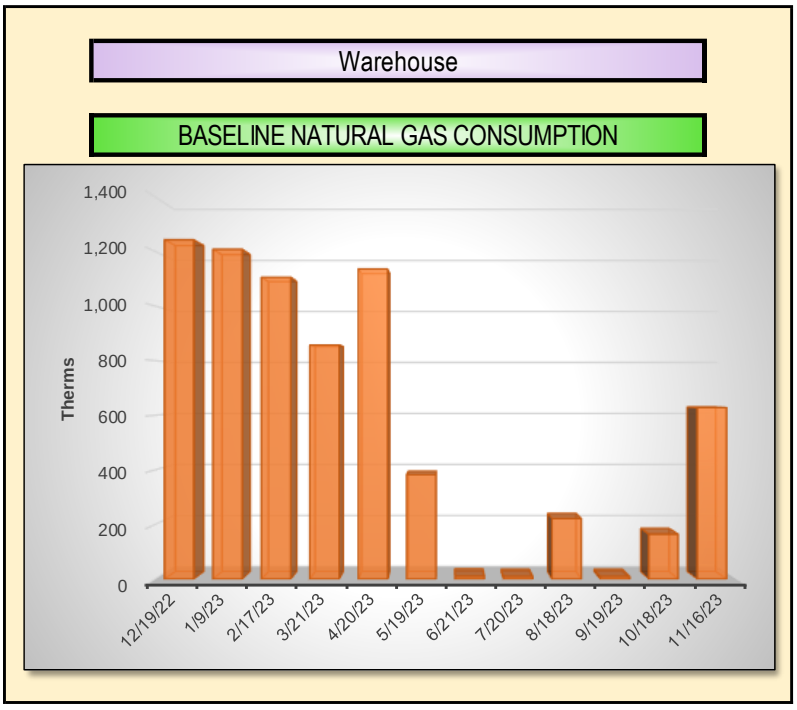


Warehouse						ELECTRIC METER #1						
Provider:	PSE&G			Account #	73 407 625 07 Garage				Meter #	22 601 6495		
Commodity:	Direct Energy			Account #	1836526				Rate:	General Lighting & Power (GLP)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
11/15/22	12/10/22	8,392	32	$200	$748	$105	$5	$1,058	$0.113	26	42%	28,634,842
12/11/22	1/9/23	7,399	32	$176	$659	$105	$5	$946	$0.113	30	32%	25,246,906
1/10/23	2/16/23	7,655	32	$182	$682	$105	$5	$975	$0.113	38	26%	26,119,040
2/17/23	3/21/23	9,490	22	$228	$960	$104	$5	$1,297	$0.125	33	54%	32,379,880
3/22/23	4/20/23	7,490	43	$180	$1,185	$201	$10	$1,575	$0.182	30	24%	25,555,880
4/21/23	5/19/23	17,110	39	$411	$1,483	$91	$5	$1,990	$0.111	29	63%	58,379,320
5/20/23	6/21/23	7,220	43	$148	$863	$322	$5	$1,337	$0.140	33	21%	24,634,640
6/22/23	7/20/23	6,980	25	$149	$859	$380	$5	$1,393	$0.144	29	40%	23,815,760
7/21/23	8/18/23	6,790	26	$146	$811	$400	$5	$1,362	$0.141	29	38%	23,167,480
8/19/23	9/19/23	7,060	49	$152	$865	$377	$5	$1,400	$0.144	32	19%	24,088,720
9/20/23	10/18/23	5,820	37	$147	$743	$97	$5	$992	$0.153	29	23%	19,857,840
10/19/23	11/16/23	5,960	38	$146	$753	$101	$5	$1,005	$0.151	29	23%	20,335,520
TOTALS		97367	49	$2,265	$10,611	$2,390	$65	$15,330	$0.132	367	23%	332,215,828

Warehouse						ELECTRIC METER #2						
Provider:	PSE&G			Account #	73 407 634 06 Maint. Bldg				Meter #	62 601 3027		
Commodity:	Direct Energy			Account #	1836521				Rate:	General Lighting & Power (GLP)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
11/15/22	12/10/22	4,898	30	$117	$356	$75	$5	$553	0.0965	26	26%	16,710,426
12/11/22	1/9/23	4,318	30	$103	$314	$75	$5	$497	0.0965	30	20%	14,733,329
1/10/23	2/16/23	4,467	30	$107	$324	$75	$5	$511	0.0965	38	16%	15,242,280
9/19/22	3/20/23	6,636	18	$159	$503	$82	$5	$748	0.10	183	8%	22,642,032
2/18/23	4/20/23	2,724	15	$65	$254	$68	$5	$393	0.12	62	12%	9,294,288
3/21/23	5/20/23	1,290	19	$31	$162	$44	$5	$242	0.15	61	5%	4,401,480
4/21/23	6/20/23	720	7	$15	$124	$51	$5	$195	0.19	61	7%	2,456,640
6/21/23	7/20/23	888	5	$19	$135	$80	$5	$239	0.17	30	25%	3,029,856
7/21/23	8/18/23	780	3	$17	$122	$52	$5	$196	0.18	29	37%	2,661,360
8/19/23	9/19/23	396	6	$9	$102	$48	$5	$163	0.28	32	9%	1,351,152
9/20/23	10/18/23	504	17	$13	$102	$44	$5	$164	0.23	29	4%	1,719,648
10/19/23	11/16/23	2,232	27	$55	$225	$73	$5	$358	0.13	29	12%	7,615,584
TOTALS		29853	30	$709	$2,724	$767	$60	$4,259	0.11	610	7%	101,858,075

Warehouse						ELECTRIC METER #3						
Provider:	PSE&G			Account #	73 407 635 03 OFC				Meter #	22 602 1498		
Commodity:	Direct Energy			Account #	1836522				Rate:	General Lighting & Power (GLP)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
11/15/22	12/10/22	3,285	18	$78	$278	$54	$5	$416	$0.11	26	30%	11,207,495
12/11/22	1/9/23	2,896	18	$69	$245	$54	$5	$374	$0.11	30	23%	9,881,479
1/10/23	2/17/23	2,996	18	$71	$254	$54	$5	$385	$0.11	39	18%	10,222,826
2/18/23	3/21/23	3,774	13	$90	$341	$61	$5	$498	$0.11	32	38%	12,876,888
3/22/23	4/20/23	2,022	12	$48	$231	$55	$5	$340	$0.14	30	24%	6,899,064
4/21/23	5/19/23	1,686	26	$40	$211	$61	$5	$318	$0.15	29	9%	5,752,632
5/20/23	6/21/23	1,860	14	$38	$227	$107	$5	$378	$0.14	33	17%	6,346,320
6/22/23	7/20/23	1,938	7	$41	$235	$109	$5	$390	$0.14	29	39%	6,612,456
7/21/23	8/19/23	2,070	7	$44	$235	$109	$5	$393	$0.13	30	41%	7,062,840
8/20/23	9/19/23	2,094	14	$45	$246	$109	$5	$405	$0.14	31	20%	7,144,728
9/20/23	10/18/23	1,440	24	$36	$190	$63	$5	$295	$0.16	29	9%	4,913,280
10/19/23	11/16/23	2,286	26	$56	$250	$70	$5	$381	$0.13	29	13%	7,799,832
TOTALS		28347	26	$660	$2,944	$907	$60	$4,571	$0.13	367	12%	96,719,840

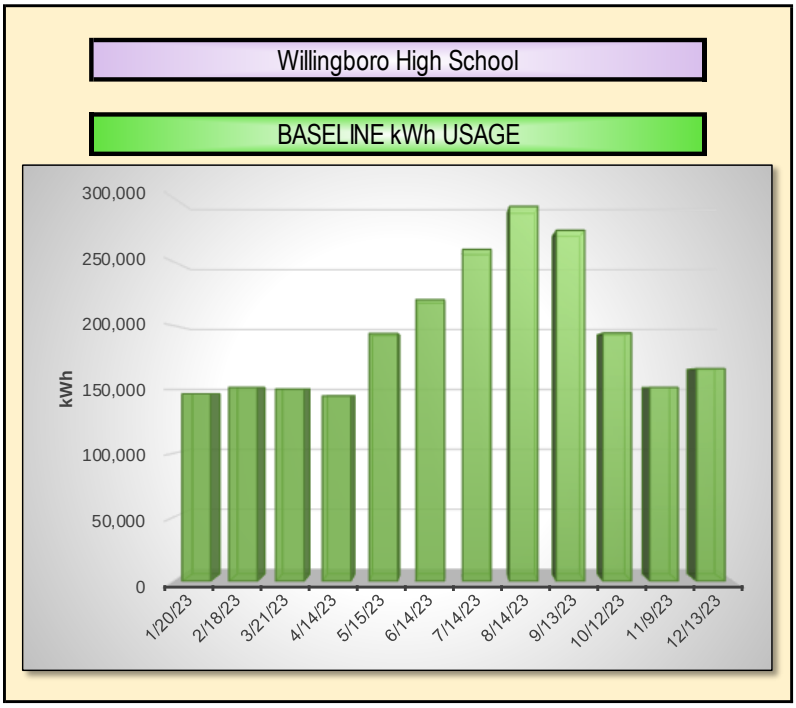
Warehouse						ELECTRIC METER #4						
Provider:	PSE&G			Account #	7399809305				Meter #	626111202		
Commodity:	PSE&G			Area:	Garage				Rate:	Gneral Lighting & Power (GLP)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/19/22	1/20/23	5,648	12	$135	$369	$57	$5	$566	$0.089	33	58%	19,270,976
1/21/23	2/17/23	4,723	13	$113	$319	$62	$5	$499	$0.092	28	53%	16,114,876
2/18/23	3/21/23	4,855	11	$116	$339	$53	$5	$513	$0.094	32	56%	16,565,260
3/22/23	4/20/23	1,710	10	$41	$139	$47	$5	$232	$0.105	30	24%	5,834,520
4/21/23	5/19/23	119	2	$3	$35	$8	$5	$51	$0.320	29	9%	406,028
5/20/23	6/21/23	109	1	$2	$37	$18	$5	$62	$0.359	33	11%	371,908
6/22/23	7/20/23	99	1	$2	$37	$8	$5	$52	$0.397	29	28%	337,788
7/21/23	8/19/23	145	1	$3	$40	$18	$5	$67	$0.299	30	17%	494,740
8/20/23	9/19/23	145	1	$3	$40	$18	$5	$67	$0.299	31	16%	494,740
9/20/23	10/18/23	151	1	$4	$40	$7	$5	$55	$0.288	29	17%	515,212
10/19/23	11/16/23	465	10	$11	$60	$52	$5	$129	$0.154	29	7%	1,586,580
11/17/23	12/19/23	2,895	9	$71	$222	$47	$5	$345	$0.101	33	42%	9,877,740
TOTALS		21064	13	$505	$1,679	$395		$2,639	$0.104	366	18%	71,870,368

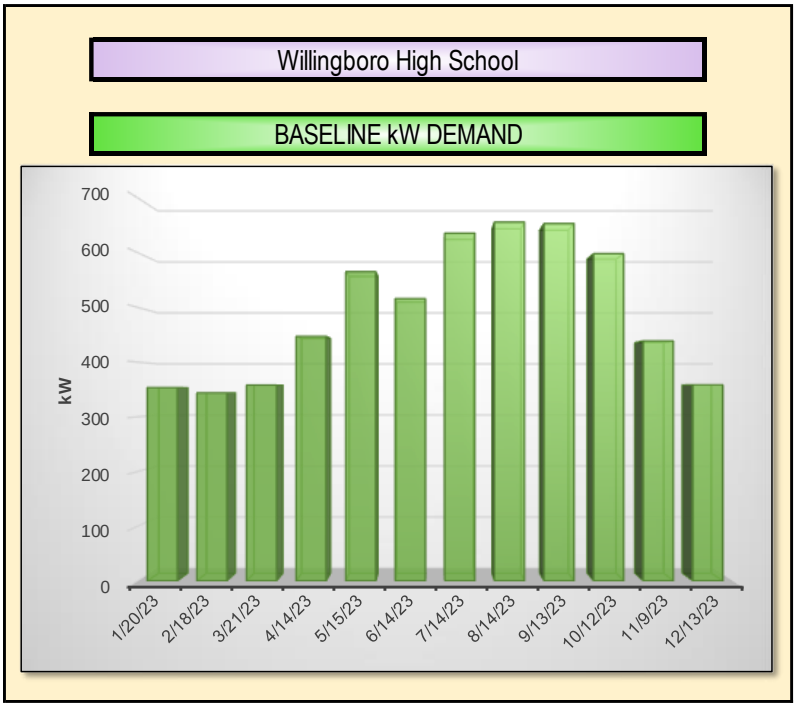


Warehouse						Natural Gas Meter #1		
Provider	PSE&G		Account #	73 407 625 07			Meter #	15 95 500
Commodity	Direct Energy		Account #	349133-30914			Rate:	General Service Gas Heating - GSG (HTG)
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
11/10/23	12/19/22	1,242	$591	$1,107	$20	$1,718	$1.37	124,220,000
12/20/22	1/9/23	1,208	$574	$1,078	$20	$1,672	$1.37	120,750,000
1/21/23	2/17/23	1,105	$525	$885	$20	$1,430	$1.28	110,500,000
2/18/23	3/21/23	857	$410	$638	$20	$1,068	$1.22	85,734,800
3/22/23	4/20/23	1,136	$543	$723	$20	$1,286	$1.12	113,550,000
4/21/23	5/19/23	383	$181	$228	$20	$429	$1.07	38,267,800
5/20/23	6/21/23	10	$4	$6	$20	$30	$0.99	1,045,400
6/22/23	7/20/23	9	$4	$6	$20	$30	$1.02	939,000
7/21/23	8/18/23	222	$84	$140	$20	$244	$1.01	22,202,300
8/19/23	9/19/23	9	$3	$6	$20	$30	$1.00	939,000
9/20/23	10/18/23	165	$75	$106	$20	$201	$1.10	16,485,300
10/19/23	11/16/23	628	$300	$420	$20	$741	$1.15	62,767,500
TOTALS		6,974	$3,294	$5,343	$241	$8,877	$1.24	697,401,100

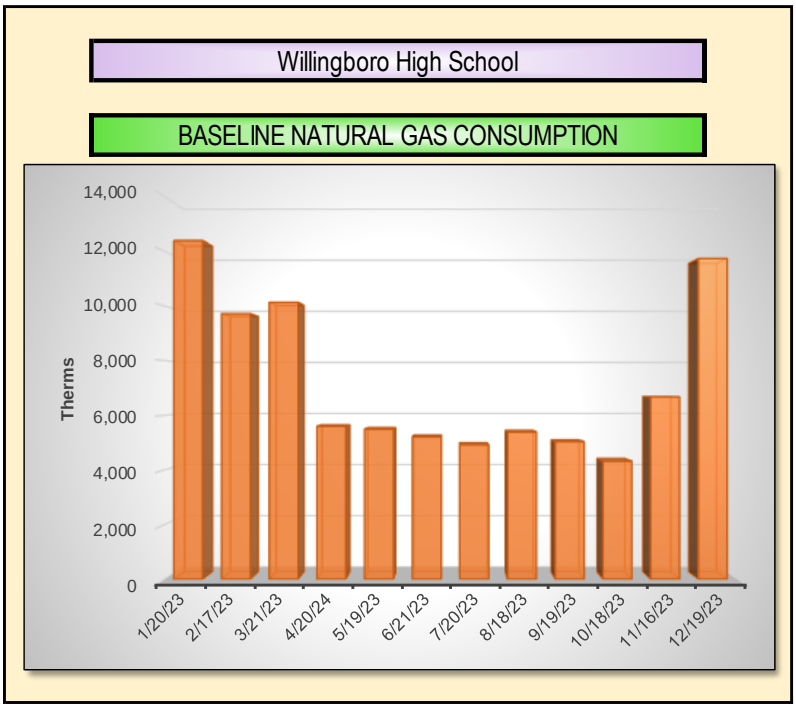
Warehouse							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct #	11110557-0						
Billing Period Start Date	Actual Reading	Gal	Service Charge $	Usage Charge $	Total	Cost / Unit Checksum	BTU
10/1/22	1/1/23	11,600	215	$26	$241	$0.0164	0
1/2/23	3/31/23	16,300	$215	$103	$318	$0.0164	0
4/1/23	6/30/23	13,400	$215	$56	$271	$0.0164	0
7/1/23	9/29/23	12,100	$215	$34	$250	$0.0164	0
TOTALS		53,400	$861	$219	$1,081	$0.0164	0

Willingboro High School Baseline Energy Use





Willingboro High School						ELECTRIC METER #1						
Provider:	PSE&G			Account #	42 009 234 08				Meter #	9207090		
Commodity:	Constellation Energy			Account #	10910868				Rate:	Large Power & Lighting Secondary (LPLS)		
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
12/20/22	1/20/23	146,566	353	$2,394	$21,436	$1,579	$371	$25,781	$0.163	32	54%	500,083,192
1/21/23	2/18/23	151,629	344	$2,484	$22,022	$1,536	$371	$26,412	$0.162	29	63%	517,358,148
2/19/23	3/21/23	150,349	358	$2,472	$21,667	$1,600	$371	$26,110	$0.161	31	56%	512,990,788
3/16/23	4/14/23	144,856	447	$2,382	$21,208	$1,999	$371	$25,960	$0.163	30	45%	494,248,672
4/15/23	5/15/23	193,811	565	$3,187	$25,786	$2,533	$371	$31,877	$0.149	31	46%	661,283,132
5/16/23	6/14/23	220,145	516	$3,893	$27,302	$5,474	$371	$37,040	$0.142	30	59%	751,134,740
6/15/23	7/14/23	259,467	636	$4,922	$30,165	$8,957	$371	$44,416	$0.135	30	57%	885,301,404
7/15/23	8/14/23	293,059	656	$5,587	$33,375	$9,242	$371	$48,574	$0.133	31	60%	999,917,308
8/15/23	9/13/23	274,347	653	$5,264	$31,476	$9,204	$371	$46,314	$0.134	30	58%	936,071,964
9/14/23	10/12/23	194,149	598	$3,559	$24,189	$2,957	$371	$31,075	$0.143	29	47%	662,436,388
10/13/23	11/9/23	151,557	439	$2,585	$20,209	$2,171	$371	$25,336	$0.150	28	51%	517,112,484
11/10/23	12/13/23	166,234	359	$2,835	$22,970	$1,779	$371	$27,954	$0.155	34	57%	567,190,408
TOTALS		2346169	656	$41,564	$301,806	$49,030	$4,450	$396,849	$0.146	365	41%	8,005,128,628



Willingboro High School						Natural Gas Meter #1		
Provider	PSE&G		Account #	42 009 234 08			Meter #	3740265
Commodity	Direct Energy		Account #	349133-3478			Rate:	General Service Gas Heating - GSG (HTG)
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
12/20/22	1/20/23	414	$163	$370	$20	$552	$1.28	41,437,800
1/21/23	2/17/23	391	$156	$313	$20	$489	$1.20	39,144,300
2/18/23	3/21/23	440	$174	$327	$20	$521	$1.14	43,971,700
3/22/23	4/20/24	388	$151	$247	$20	$418	$1.03	38,792,000
4/21/24	5/19/23	386	$152	$230	$20	$402	$0.99	38,582,300
5/20/23	6/21/23	427	$164	$257	$20	$441	$0.99	42,652,200
6/22/23	7/20/23	351	$136	$220	$20	$376	$1.02	35,057,300
7/21/23	8/18/23	352	$133	$223	$20	$376	$1.01	35,231,800
8/19/23	9/19/23	396	$147	$251	$20	$418	$1.00	39,648,100
9/20/23	10/18/23	393	$154	$254	$20	$428	$1.04	39,335,100
10/19/23	11/16/23	385	$153	$258	$20	$431	$1.07	38,537,800
11/17/23	12/19/23	456	$182	$289	$20	$492	$1.03	45,579,300
TOTALS		4,780	$1,866	$3,239	$239	$5,344	$1.07	477,969,700

Willingboro High School						Natural Gas Meter #2		
Provider	PSE&G		Account #	42 009 234 08		Meter #	3637130	
Commodity	PSE&G		Rate:	Large Volume Gas (LVG)		Meter #		
Billing Period Start Date	**Actual Reading**	**Therms**	**Gas Delivery Charges**	**Gas Commodity Charges**	**Fixed Customer Charge**	**Gas Total Charges**	**Cost/Therm Checksum**	**BTU**
12/19/23	1/20/23	11980	$3,779	$10,285	$176	$14,240	$1.17	1,197,961,100
1/21/23	2/17/23	9330	$2,851	$6,316	$176	$9,344	$0.98	933,035,400
2/18/23	3/21/23	9696	$2,853	$5,397	$176	$8,426	$0.85	969,590,300
3/22/23	4/20/23	5215	$454	$2,600	$176	$3,230	$0.59	521,455,900
4/21/23	5/19/23	5109	$451	$2,499	$177	$3,128	$0.58	510,942,700
5/20/23	6/21/23	4781	$400	$2,374	$179	$2,952	$0.58	478,125,100
6/22/23	7/20/23	4567	$385	$2,424	$180	$2,988	$0.61	456,715,000
7/21/23	8/18/23	5036	$401	$2,706	$180	$3,287	$0.62	503,582,600
8/19/23	9/19/23	4635	$353	$2,489	$180	$3,022	$0.61	463,543,100
9/20/23	10/18/23	3925	$301	$2,182	$180	$2,663	$0.63	392,508,400
10/19/23	11/16/23	6291	$2,294	$3,711	$180	$6,185	$0.95	629,129,600
11/17/23	12/19/23	11282	$3,108	$6,585	$180	$9,873	$0.86	1,128,167,900
TOTALS		81848	$17,630	$49,569	$2,137	$69,336	$0.85	8,184,757,100

Willingboro High School							
Provider	Willingboro MUA			Water & Sewer (Gal)			
Acct #	11110872-0						
Billing Period Start Date	**Actual Reading**	**Gal**	**Service Charge $**	**Usage Charge $**	**Total**	**Cost / Unit Checksum**	**BTU**
9/30/22	1/1/23	205,700	215	$3,895	$4,111	$0.0199	0
1/2/23	3/31/23	245,400	$215	$4,698	$4,913	$0.0200	0
4/1/23	6/30/23	242,600	$215	$4,642	$4,857	$0.0200	0
7/1/23	9/29/23	149,200	$215	$2,753	$2,968	$0.0198	0
TOTALS		842,900	$861	$15,988	$16,849	$0.0199	0

Energy Savings Utility Rates

DCO Energy used the following marginal rates to calculate energy cost savings:

CALCULATED UTILITY RATES BY BUILDING				
BUILDING/FACILITY	ELECTRIC		NATURAL GAS	Water & Sewer
	$$ / kW	$$ / kWh	$$ / Therm	$$ / Gal (over 10,000 Gal per quarter)
Bookbinder School	$4.26	$0.113	$1.10	$0.0138
Country Club Administration Building	$5.59	$0.156	$1.15	$0.0168
Garfield East Elementary School	$8.50	$0.111	$1.28	$0.0196
Hawthorne Elementary School	$8.64	$0.131	$1.13	$0.0195
J. Cresswell Stuart Early Childhood Development Center	$8.47	$0.117	$1.05	$0.0197
James A. Cotten Intermediate School	$4.60	$0.124	$1.08	$0.0198
Joseph A. McGinley School	$7.97	$0.153	$1.16	$0.0098
Memorial Middle School	$5.12	$0.128	$0.98	$0.0197
Twin Hills Elementary School	$8.85	$0.126	$1.05	$0.0193
W.R. James Elementary School	$8.77	$0.158	$1.08	$0.0194
Warehouse	$8.28	$0.146	$1.24	$0.0164
Willingboro High School	$8.28	$0.146	$0.83	$0.0199

ENERGY SAVINGS PLAN

SECTION 3 – ENERGY CONSERVATION MEASURES

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Energy Conservation Measure Breakdown by Building

The matrix below details which ECMs were applied and evaluated by building.

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
1	LED Lighting Upgrades	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2	Lighting Controls	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
3	District Wide Energy Management System Tier 1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
4	District Wide Energy Management System Tier 2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
5	Roof Renovations			✔			✔		✔				✔
6	Pipe and Valve Insulation		✔	✔	✔	✔	✔		✔	✔	✔	✔	✔
7	Building Envelope Weatherization	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
8	Plug Load Controls	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔
9	eTemp Refrigeration Sensors	✔	✔	✔	✔	✔	✔		✔	✔	✔		✔
10	Retro-Commissioning	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
11	Combined Heating & Power												✔
12	Boiler Plant Replacement	✔											
13	RTU & Split System HVAC Replacement	✔											
14	Destratification Fans		✔	✔			✔		✔	✔		✔	✔
15	Solar Ownership		✔	✔	✔	✔	✔		✔	✔	✔		✔
16	Solar PPA		✔	✔	✔	✔	✔		✔	✔	✔		✔
17	Unit Ventilator Replacement w/ Addition of Cooling	✔	✔										
18	Field Lighting Upgrade												✔
19	Window Film			✔		✔	✔		✔	✔			✔

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ECM Breakdown by Cost & Savings

Willingboro Public School District ESIP		INSTALLED COST	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS
ECM #	ENERGY CONSERVATION MEASURE	$	$	$
1	LED Lighting Upgrades	$1,818,217	$242,913	($7,398)
2	Lighting Controls	$406,059	$20,406	($712)
3	District Wide Energy Management System Tier 1	$474,045	$3,618	$38,085
4	District Wide Energy Management System Tier 2	$2,977,249	$56,976	$46,052
5	Roof Renovations	$0	$0	$0
6	Pipe and Valve Insulation	$120,195	$0	$27,084
7	Building Envelope Weatherization	$344,200	$10,482	$28,734
8	Plug Load Controls	$109,832	$12,379	$0
9	eTemp Refrigeration Sensors	$47,292	$12,952	$0
10	Retro-Commissioning	$83,000	$14,164	$5,763
11	Combined Heating & Power	$187,830	$4,066	($862)
12	Boiler Plant Replacement	$931,753	$1,096	$10,764
13	RTU & Split System HVAC Replacement	$1,826,688	$731	$0
14	Destratification Fans	$161,950	($1,473)	$12,359
15	Solar Ownership	$0	$0	$0
16	Solar PPA	$0	$0	$0
17	Unit Ventilator Replacement w/ Addition of Cooling	$3,558,347	$905	$0
18	Field Lighting Upgrade	$0	$1,850	$0
19	Window Film	$189,569	$25,684	$6,960
	TOTALS	$13,236,226	$406,748	$166,828

Willingboro Public School District ESIP		ANNUAL ENERGY COST SAVINGS	ANNUAL O&M COST SAVINGS	TOTAL ANNUAL COST SAVINGS	SIMPLE PAYBACK WITHOUT INCENTIVES
ECM #	ENERGY CONSERVATION MEASURE	$	$	$	YEARS
1	LED Lighting Upgrades	$235,516	$54,700	$290,215	6.3
2	Lighting Controls	$19,693	$0	$19,693	20.6
3	District Wide Energy Management System Tier 1	$41,702	$37,298	$79,001	6.0
4	District Wide Energy Management System Tier 2	$103,028	$0	$103,028	28.9
5	Roof Renovations	$0	$0	$0	0.0
6	Pipe and Valve Insulation	$27,084	$11,993	$39,077	3.1
7	Building Envelope Weatherization	$39,216	$0	$39,216	8.8
8	Plug Load Controls	$12,379	$0	$12,379	8.9
9	eTemp Refrigeration Sensors	$12,952	$0	$12,952	3.7
10	Retro-Commissioning	$19,927	$12,653	$32,580	2.5
11	Combined Heating & Power	$3,204	$0	$3,204	58.6
12	Boiler Plant Replacement	$11,860	$6,500	$18,360	50.8
13	RTU & Split System HVAC Replacement	$731	$12,732	$13,463	135.7
14	Destratification Fans	$10,886	$0	$10,886	14.9
15	Solar Ownership	$0	$0	$0	0.0
16	Solar PPA	$0	$0	$0	0.0
17	Unit Ventilator Replacement w/ Addition of Cooling	$905	$11,289	$12,194	291.8
18	Field Lighting Upgrade	$1,850	$0	$1,850	0.0
19	Window Film	$32,644	$0	$32,644	5.8
	TOTALS	$573,576	$147,166	$720,742	18.4

Willingboro Public School District ESIP		ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	NATURAL GAS SAVINGS	TOTAL SITE ENERGY SAVINGS	TOTAL SOURCE ENERGY SAVINGS
ECM #	ENERGY CONSERVATION MEASURE	kWh	kW	THERMS	MMBTU	MMBTU
1	LED Lighting Upgrades	1,571,066	369	(6,890)	4,672	14,286
2	Lighting Controls	131,430	34	(659)	383	1,186
3	District Wide Energy Management System Tier 1	24,720	0	36,285	3,713	4,046
4	District Wide Energy Management System Tier 2	317,225	188	47,058	5,788	7,972
5	Roof Renovations	0	0	0	0	0
6	Pipe and Valve Insulation	0	0	25,001	2,500	2,625
7	Building Envelope Weatherization	46,554	52	27,447	2,904	3,327
8	Plug Load Controls	94,719	0	0	323	905
9	eTemp Refrigeration Sensors	97,865	0	0	334	935
10	Retro-Commissioning	104,751	0	5,686	926	1,598
11	Combined Heating & Power	24,798	4	(1,033)	-19	128
12	Boiler Plant Replacement	9,288	1	9,780	1,010	1,116
13	RTU & Split System HVAC Replacement	4,095	5	0	14	39
14	Destratification Fans	(10,640)	0	12,437	1,207	1,204
15	Solar Ownership	0	0	0	0	0
16	Solar PPA	0	0	0	0	0
17	Unit Ventilator Replacement w/ Addition of Cooling	5,243	6	0	18	50
18	Field Lighting Upgrade	12,642	0	0	43	121
19	Window Film	146,878	74	7,360	1,237	2,176
TOTALS		2,580,634	734	162,473	25,052.4	41,714.0

ECM Breakdown by Greenhouse Gas Reduction

Willingboro Public School District ESIP		Reduction of CO_2	Reduction of No_x	Reduction of SO_2	Reduction of Hg
ECM #	ENERGY CONSERVATION MEASURE	LBS	LBS	LBS	LBS
1	LED Lighting Upgrades	2,078,036	1,680	1,540	1,728.2
2	Lighting Controls	172,874	140	129	144.6
3	District Wide Energy Management System Tier 1	458,504	361	24	27.2
4	District Wide Energy Management System Tier 2	986,450	785	311	348.9
5	Roof Renovations	0	0	0	0.0
6	Pipe and Valve Insulation	292,510	230	0	0.0
7	Building Envelope Weatherization	385,098	304	46	51.2
8	Plug Load Controls	130,144	105	93	104.2
9	eTemp Refrigeration Sensors	134,467	109	96	107.7
10	Retro-Commissioning	210,455	169	103	115.2
11	Combined Heating & Power	19,950	11	17	0.0
12	Boiler Plant Replacement	127,188	100	9	10.2
13	RTU & Split System HVAC Replacement	5,626	5	4	4.5
14	Destratification Fans	130,896	103	-10	-11.7
15	Solar Ownership	0	0	0	0.0
16	Solar PPA	0	0	0	0.0
17	Unit Ventilator Replacement w/ Addition of Cooling	7,204	6	5	5.8
18	Field Lighting Upgrade	17,370	14	12	13.9
19	Window Film	287,919	231	144	161.6
	TOTALS	5,444,693.2	4,352.3	2,521.3	2,811.4

Note: Factors used to calculate Greenhouse Gas Reductions are as follows.

	UTILITIES			
	ELECTRIC	NATURAL GAS	OTHER ENERGY #2	OTHER ENERGY #3
UNITS	kW & kWh	Therms	Solar PPA (kWh)	Water & Sewer (Gal)
BTU MULTIPLIER	3,412	100,000	3,412	0
CO2 EMISSION FACTOR (LB CO2/UNIT FUEL)	1.10	11.70	0.00	0.00
SITE-SOURCE MULTIPLIER	2.80	1.05	1.00	0.00

- ***NOx = (0.00095*kWh Savings) + (0.0092*Therm Savings)***
- ***SO2 = (0.00221*kWh Savings)***
- ***Hg = (0.00465*kWh Savings)***

See Combined Heat and Power ECM for emission calculation per NJ BPU Protocols.

ECM Breakdown by Building

Please see Appendix F for ECM Breakdown by Building.

ECM Budgeting Narrative

Detailed plans, schematics and specifications for Willingboro Township Public Schools were not available to deliver a cost estimate for each ECM. The budgetary costs carried out in the project are based on good faith estimates, contractor supplied budgets for similar ECMs on other recent projects and a database of actual installed costs for various ECMs.

Willingboro Township Public Schools

ECM #	ENERGY CONSERVATION MEASURE	INSTALLED COST
1	LED Lighting Upgrades	$1,818,217
2	Lighting Controls	$406,059
3	District Wide Energy Management System Tier 1	$474,045
4	District Wide Energy Management System Tier 2	$2,977,249
5	Roof Renovations	$0
6	Pipe and Valve Insulation	$120,195
7	Building Envelope Weatherization	$344,200
8	Plug Load Controls	$109,832
9	eTemp Refrigeration Sensors	$47,292
10	Retro-Commissioning	$83,000
11	Combined Heating & Power	$187,830
12	Boiler Plant Replacement	$931,753
13	RTU & Split System HVAC Replacement	$1,826,688
14	Destratification Fans	$161,950
15	Solar Ownership	$0
16	Solar PPA	$0
17	Unit Ventilator Replacement w/ Addition of Cooling	$3,558,347
18	Field Lighting Upgrade	$0
19	Window Film	$189,569

Prescriptive Rebate

As part of the Energy Savings Plan for Willingboro Township Public Schools, prescriptive rebates through PSE&G were investigated. The estimated incentive amount is listed below. Upon final selection of the project scope and award of subcontractor bids, the incentive applications will be filed.

Incentive Calculations

BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	Estimated Incentive $
Bookbinder School	Boiler Plant Replacement	$16,740
Bookbinder School	LED Lighting Upgrades	$9,464
Country Club Administration Building	LED Lighting Upgrades	$8,444
Garfield East Elementary School	LED Lighting Upgrades	$9,205
Hawthorne Elementary School	LED Lighting Upgrades	$9,147
J. Cresswell Stuart Early Childhood Development Center	LED Lighting Upgrades	$12,561
James A. Cotten Intermediate School	LED Lighting Upgrades	$15,832
Joseph A. McGinley School	LED Lighting Upgrades	$8,383
Memorial Middle School	LED Lighting Upgrades	$27,818
Twin Hills Elementary School	LED Lighting Upgrades	$9,782
W.R. James Elementary School	LED Lighting Upgrades	$10,100
Warehouse	LED Lighting Upgrades	$2,991
Willingboro High School	LED Lighting Upgrades	$42,566
Bookbinder School	Lighting Controls	$19,367
Country Club Administration Building	Lighting Controls	$19,205
Garfield East Elementary School	Lighting Controls	$22,785
Hawthorne Elementary School	Lighting Controls	$18,298
J. Cresswell Stuart Early Childhood Development Center	Lighting Controls	$26,389
James A. Cotten Intermediate School	Lighting Controls	$38,711
Joseph A. McGinley School	Lighting Controls	$17,856
Memorial Middle School	Lighting Controls	$56,637
Twin Hills Elementary School	Lighting Controls	$19,995
W.R. James Elementary School	Lighting Controls	$18,647
Warehouse	Lighting Controls	$837
Willingboro High School	Lighting Controls	$79,934
Bookbinder School	Plug Load Controls	$474
Country Club Administration Building	Plug Load Controls	$990
Garfield East Elementary School	Plug Load Controls	$809
Hawthorne Elementary School	Plug Load Controls	$628
J. Cresswell Stuart Early Childhood Development Center	Plug Load Controls	$837
James A. Cotten Intermediate School	Plug Load Controls	$628
Memorial Middle School	Plug Load Controls	$56
Twin Hills Elementary School	Plug Load Controls	$432
W.R. James Elementary School	Plug Load Controls	$781
Warehouse	Plug Load Controls	$70
Willingboro High School	Plug Load Controls	$56
Bookbinder School	RTU & Split System HVAC Replacement	$6,473
	Total Incentive:	$533,927

All estimated incentive values for Willingboro Township Public Schools ESIP project were calculated using JCP&L prescriptive rebates. The total incentive amount was calculated to be $533,927.

No implied and/or written guarantee is made regarding the receipt of incentives. All incentives estimates carry inherent risks that may jeopardize the receipt of them. Therefore, Willingboro Township Public Schools acknowledges and accepts that any project proposed should not rely on the receipt of incentives as a reason to implement it.

Combined Heat & Power

One of the goals of the State of New Jersey is to enhance energy efficiency through on-site power generation with recovery and productive use of waste heat, and to reduce existing and new demands to the electric power grid. The Board of Public Utilities seeks to accomplish this goal by providing generous financial incentives for Combined Heat & Power (CHP) and Fuel Cell (FC) installations.

Eligible CHP or Waste Heat to Power (WHP) projects must achieve an annual system efficiency of at least 60% (Higher Heating Value - HHV), based on total energy input and total utilized energy output. Mechanical energy may be included in the efficiency evaluation.

In order to qualify for incentives, systems must operate a minimum of 5,000 full-load equivalent hours per year (i.e. run at least 5,000 hours per year at full rated kW output). The Office of Clean Energy (OCE) may grant exceptions to this minimum operating hours requirement for Critical Facilities, provided the proposed system operates a minimum of 3,500 full-load equivalent hours per year and is equipped with blackstart and islanding capability. For this program, a Critical Facility is defined as any:

(a) public facility, including any federal, state, county, or municipal facility,

(b) non-profit and/or private facility, including any hospital, police station, fire station, water/wastewater treatment facility, school, multifamily building, or similar facility that:

(A) is determined to be either Tier 1 or critical infrastructure by the New Jersey Office of Emergency Management or the State Office of Homeland Security and Preparedness or

(B) could serve as a Shelter during a power outage. A Shelter is a facility able to provide food, sleeping arrangements, and other amenities to its residents and the community.

The CHP, FC, or WHP system must have a ten (10) year all-inclusive warranty. The warranty must cover the major components of the system eligible for the incentive, to protect against breakdown or degradation in electrical output of more than ten percent from the originally rated electrical output. The warranty shall cover the full cost of repair or replacement of defective components or systems, including coverage for labor costs to remove and reinstall defective components or systems. In the event the system warranty does not meet program requirements, customer must purchase an extended warranty or a ten (10) year maintenance/service contract. The cost of the ten (10) year warranty or service contract may be considered as part of the cost of the project. Notwithstanding the foregoing, public entities that are prohibited from entering into agreements for the full ten (10) years may comply with the 10-year requirement by:

(a) providing an agreement for the longest lawful term,
(b) committing the entity to purchase an agreement for the remaining years, and
(c) either:
(i) providing the vendor's commitment for specific pricing for those remaining years, or
(ii) assuming the pricing for the remaining years will increase by 2.5% each year

Incentive Structure:

Eligible Technologies	Size (Installed Rated Capacity)	Incentive ($/kW)	% of Total Cost Cap per project[3]	$ Cap per project[3]
Powered by non-renewable or renewable fuel source, or combination[4]: Gas Internal Combustion Engine	≤500 kW	$2,000	30-40%[2]	$2 million
	>500 kW - 1 MW	$1,000		
Gas Combustion Turbine Microturbine	> 1 MW - 3 MW	$550	30%	$3 million
Fuel Cells with Heat Recovery (FCHR)	>3 MW	$350		
Fuel Cell without Heat Recover (FCwoHR)	Same as above(1)	Applicable amount above	30%	$1 million
Waste Heat to Power	≤ 1MW	$1,000	30%	$2 million
	> 1MW	$500		$3 million

Footnotes:

(1) Incentives are tiered, which means the incentive levels vary based upon the installed rated capacity, as listed in the chart above. For example, a 4 MW CHP system would receive $2.00/watt for the first 500 kW, $1.00/watt for the second 500 kW, $0.55/watt for the next 2 MW and $0.35/watt for the last 1 MW (up to the caps listed).

(2) The maximum incentive will be limited to 30% of total project. For CHP-FC projects up to 1 MW, this cap will be increased to 40% where a cooling application is used or included with the CHP system (e.g. absorption chiller).

(3) Projects will be eligible for incentives shown above, not to exceed the lesser of % of total project cost per project cap or maximum $ per project cap. Projects installing CHP or FC with WHP will be eligible for incentive shown above, not to exceed the lesser caps of the CHP or FC incentive. Minimum efficiency will be calculated based on annual total electricity generated, utilized waste heat at the host site (i.e. not lost/rejected), and energy input.

(4) Systems fueled by a Class 1 Renewable Fuel Source, as defined by N.J.A.C. 14:8-2.5, are eligible for a 30% incentive bonus. If the fuel is mixed, the bonus will be prorated accordingly. For example, if the mix is 60/40 (60% being a Class 1 renewable), the bonus will be 18%. This bonus will be included in the final performance incentive payment, based on system performance and fuel mix consumption data. Total incentive, inclusive of bonus, shall not exceed above stipulated caps.

(5) CHP or FC systems located at Critical Facility and incorporating blackstart and islanding technology are eligible for a 25% incentive bonus. This bonus incentive will be paid with the second/Installation incentive payment. Total incentive, inclusive of bonus, shall not exceed above stipulated caps.

Incentive Payment Schedule

The total incentive is divided into three partial payments. Each stage of payment requires additional documentation and/or has conditions that must be met. At approval, the maximum incentive partial payment amounts are calculated by multiplying the total incentive by the ratios listed in the following table.

Purchase	Installation	Acceptance of 12 months post-installation performance data
30%	50%	20%

(e.g., for the purpose of calculating a payback period)

ECM 1 & 2– LED Lighting Upgrades & Lighting Controls

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
1	LED Lighting Upgrades	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2	Lighting Controls	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Lighting retrofits can greatly reduce energy consumption and lower energy bills, while maintaining lighting levels and quality by upgrading lighting components to more efficient and advanced technologies. Upgrading technologies can also offer employees greater control over lighting, allowing for additional energy savings.

Improvements in lighting technologies have led to increased lifetimes for components that will result in fewer failures and lengthen the time between maintenance activities.

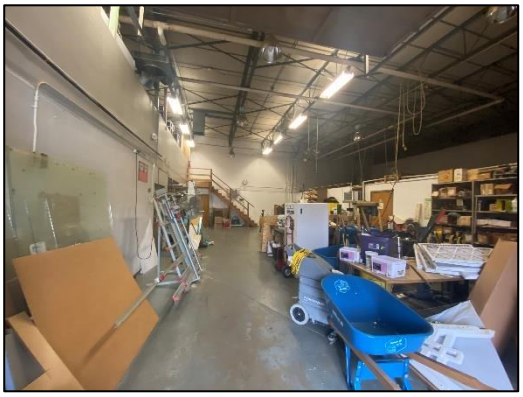
The implementation of a routine maintenance program in addition to the lighting retrofit will greatly simplify the maintenance practices and reduce the operational costs.

Lighting controls can save energy and reduce peak demand in offices and other facilities. Controls save money while providing the user convenience and an improved lighting environment. There are several different kinds of controls. The choice of control type should be based on lighting usage patterns and the type of space served.

Areas with intermittent occupancy are well-suited to occupancy sensors. In large, open office areas with many occupants, scheduled switching (“time scheduling”) is often an effective energy-saving strategy. In daylight offices, properly adjusted daylight sensors with dimming ballasts make sense. Because some workers prefer lower lighting levels, bi-level manual switching is another option. Advanced lighting controls can be used for demand limiting to allow building managers to reduce lighting loads when electricity demand costs are high.

Existing Conditions



Scope of Work – LED Lighting Retrofit

Retrofit or replace existing interior and exterior fixtures with LED bulbs/fixtures as proposed in the line-by-lines provided in Appendix G – Energy Savings Supplemental Information. The new LED tubes do not require the existing fluorescent ballasts to operate (Type B retrofit). The existing ballasts across the district will be removed during this implementation.

Scope of Work – Lighting Controls

Add vacancy sensors to existing spaces to control LED tubes. Refer to appendix G for additional details.

ECM Calculations

BPU Protocols were used to calculate LED lighting retrofit and control savings. A coincidence factor is applied to estimate peak demand savings. The impact on the HVAC systems is captured as well. See Appendix G for Lighting Line-by-Lines.

LED Lighting Upgrades Savings

BUILDING	SPACE	kW_b	LPD_b	kW_q	LPD_q	ΔkW	CF	Hours per Year	$HVAC_d$	$HVAC_e$	$HVAC_g$	Peak Demand Savings (kW)	Replacement Energy Savings (kWh)	Replacement Fuel Savings (Therms)
Bookbinder School	INTERIOR	39.3	0.67	14.4	0.24	24.9	0.50	2575	0.44	0.10	-0.000230	17.9	70,529.25	-147.5
	EXTERIOR	0.3	0.01	0.2	-	0.1	0.00	4380				0.0	525.6	0.0
Country Club Administration Building	INTERIOR	42.5	1.10	18.0	0.47	24.5	0.50	2575	0.35	0.10	-0.001075	16.6	69487	-679.1
	EXTERIOR	0.2	0.01	0.2	-	0.1	0.00	4380				0.0	307	0.0
Garfield East Elementary School	INTERIOR	45.1	0.88	20.3	0.39	24.8	0.50	2575	0.44	0.10	-0.001075	17.9	70302.7	-687.0
	EXTERIOR	0.0	0.00	0.0	-	0.0	0.00	4380				0.0	0.0	0.0
Hawthorne Elementary School	INTERIOR	42.4	0.72	14.7	0.25	27.6	0.50	2575	0.44	0.10	-0.001075	19.9	78233.7	-764.6
	EXTERIOR	0.5	0.01	0.4	-	0.1	0.00	4380				0.0	525.6	0.0
J. Cresswell Stuart Early Childhood Development Center	INTERIOR	54.6	0.89	19.8	0.32	34.8	0.50	2575	0.44	0.10	-0.001075	25.1	98627.7	-963.9
	EXTERIOR	1.6	0.03	0.7	-	0.9	0.00	4380				0.0	3942.0	0.0
James A. Cotten Intermediate School	INTERIOR	80.5	0.64	28.6	0.23	51.9	0.50	2575	0.44	0.10	-0.000230	37.4	147006.8	-307.4
	EXTERIOR	1.2	0.01	0.3	-	0.9	0.00	4380				0.0	3810.6	0.0
Joseph A. McGinley School	INTERIOR	37.5	0.64	13.7	0.23	23.8	0.50	1287.5	0.44	0.10	-0.000230	17.1	33706.8	-70.5
	EXTERIOR	0.0	-	0.0	-	0.0	0.00	4380				0.0	0.0	0.0
Memorial Middle School	INTERIOR	130.25	0.81918239	46.5	0.29245283	83.75	0.50	2575	0.44	0.10	-0.000230	60.3	237221.875	-496.009375
	EXTERIOR	29.14	-	4.14	-	25	0.00	4380				0	109500	0
Twin Hills Elementary School	INTERIOR	46.64	0.90907319	16.63	0.32413995	30.01	0.50	2575	0.44	0.10	-0.001075	21.6072	85003.325	-830.7143125
	EXTERIOR	0.36	-	0.26	-	0.1	0.00	4380				0	438	0
W.R. James Elementary School	INTERIOR	41.55	0.70729424	14.93	0.25414929	26.62	0.50	2575	0.44	0.10	-0.001075	19.1664	75401.15	-736.874875
	EXTERIOR	0.76	-	0.52	-	0.24	0.00	4380				0	1051.2	0
Warehouse	INTERIOR	17.56	0.71673469	5.97	0.24367347	11.59	0.50	2575	0.44	0.10	-0.001075	8.3448	32828.675	-320.8256875
	EXTERIOR	3.36	-	1	-	2.36	0.00	4380				0	10336.8	0
Willingboro High School	INTERIOR	227.75	1.00055794	78.254	0.34378775	149.496	0.50	2575	0.44	0.10	-0.000230	107.63712	423447.42	-885.39006
	EXTERIOR	5.56	-	1.26	-	4.3	0.00	4380				0	18834	0

Lighting Control Savings											
BUILDING	SPACE	CF	Hours per Year	$HVAC_d$	$HVAC_e$	$HVAC_g$	kWc (Lighting Controls)	SVG	Lighting Control Demand Savings (kW)	Lighting Control Electric Savings (kWh)	Lighting Control Fuel Savings (Therms)
Bookbinder School	INTERIOR	0.50	2575	0.44	0.10	-0.00023	8.8	31%	2.0	7683.2	-16.1
Country Club Administration Building	INTERIOR	0.50	2575	0.35	0.10	-0.001075	8.7	31%	1.8	7612.9	-74.4
Garfield East Elementary School	INTERIOR	0.50	2575	0.44	0.10	-0.001075	10.3	31%	2.3	9035.4	-88.3
Hawthorne Elementary School	INTERIOR	0.50	2575	0.44	0.10	-0.001075	8.3	31%	1.8	7252.9	-70.9
well Stuart Early Childhood Developmer	INTERIOR	0.50	2575	0.44	0.10	-0.001075	11.9	31%	2.7	10466.7	-102.3
James A. Cotten Intermediate School	INTERIOR	0.50	2575	0.44	0.10	-0.00023	17.5	31%	3.9	15348.8	-32.1
Joseph A. McGinley School	INTERIOR	0.50	1287.5	0.44	0.10	-0.00023	8.1	31%	1.8	3538.6	-7.4
Memorial Middle School	INTERIOR	0.50	2575	0.44	0.10	-0.00023	25.58	31%	5.709456	22461.1585	-47.0
Twin Hills Elementary School	INTERIOR	0.50	2575	0.44	0.10	-0.001075	9.03	31%	2.015496	7929.01725	-77.5
W.R. James Elementary School	INTERIOR	0.50	2575	0.44	0.10	-0.001075	8.42	31%	1.879344	7393.3915	-72.3
Warehouse	INTERIOR	0.50	2575	0.44	0.10	-0.001075	0.38	31%	0.084816	333.6685	-3.3
Willingboro High School	INTERIOR	0.50	2575	0.44	0.10	-0.00023	36.87	31%	8.229384	32374.62525	-67.7

Algorithms

$$\text{DkW} = (\#\ of\ replaced\ fixtures) * (Watts_b) - (\#\ of\ fixtures\ installed) * (Watts_q) = (LPD_b - LPD_q) * (\text{SF})$$

$$\text{Energy Savings}\left(\frac{\text{kWh}}{\text{yr}}\right) = (\Delta\text{kW}) * (\text{Hrs}) * (1 + HVAC_e)$$

$$\text{Peak Demand Savings (kW)} = (\Delta\text{kW}) * (\text{CF}) * (1 + HVAC_d)$$

$$\text{Fuel Savings}\left(\frac{\text{MMBtu}}{\text{yr}}\right) = (\Delta\text{kW}) * (\text{Hrs}) * (\text{HVAC}_g)$$

Definition of Variables

- ΔkW = Change in connected load from baseline to efficient lighting
- $Watts_{b,q}$ = Wattage of existing baseline and qualifying equipment
- LPD_b = Baseline lighting power density in Watt per square foot of space floor area
- LPD_q = Lighting power density of qualified fixtures, equal to the sum of installed fixture wattage divided by floor area of the space where the fixtures are installed.
- SF = Space floor area, in square feet
- CF = Coincidence factor
- Hrs = Annual operating hours
- $HVAC_d$ = HVAC Interactive Factor for peak demand savings
- $HVAC_e$ = HVAC Interactive Factor for annual energy savings
- $HVAC_g$ = HVAC Interactive Factor for annual energy savings

Summary of Inputs

Lighting Verification Performance Lighting

Component	Type	Value	Source
$Watts_{b,q}$	Variable	See NGrid Fixture Wattage Table Fixture counts and types, space type, floor area from customer application.	1
SF	Variable	From Customer Application	Application
CF	Fixed	See Table by Building Type	4
Hrs	Fixed	See Table by Building Type	4
$HVAC_d$	Fixed	See Table by Building Type	3, 5
$HVAC_e$	Fixed	See Table by Building Type	3, 5
$HVAC_g$	Fixed	See Table by Building Type	6
LPD_b	Variable	Lighting Power Density for, W/SF	2
LPD_q	Variable	Lighting Power Density, W/SF	Application

Hours of Operation and Coincidence Factor by Building Type

Building Type	Sector	CF	Hours
Grocery	Large Commercial/Industrial & Small Commercial	0.96	7,134
Medical - Clinic	Large Commercial/Industrial & Small Commercial	0.8	3,909
Medical - Hospital	Large Commercial/Industrial & Small Commercial	0.8	8,760[54]
Office	Large Commercial/Industrial	0.7	2,969
	Small Commercial	0.67	2,950
Other	Large Commercial/Industrial & Small Commercial	0.66	4,573
Retail	Large Commercial/Industrial	0.96	4,920
	Small Commercial	0.86	4,926
School	Large Commercial/Industrial & Small Commercial	0.50	2,575
Warehouse/ Industrial	Large Commercial/Industrial	0.7	4,116
	Small Commercial	0.68	3,799

- Typical exterior lighting fixtures should be modeled as lit twelve (12) hours per day on average.

Building Type	Sector	CF	Hours
Multifamily – Common Areas[55]	Multifamily	0.86	5,950
Multifamily – In-Unit[36]	Multifamily	0.59	679
Multifamily – Exterior[36]	Multifamily	0.00	3,338

HVAC Interactive Effects

Building Type	Demand Waste Heat Factor ($HVAC_d$)		Annual Energy Waste Heat Factor by Cooling/Heating Type ($HVAC_e$)			
	AC (Utility)	AC (PJM)	AC/ NonElec	AC/ ElecRes	Heat Pump	NoAC/ ElecRes
Office	0.35	0.32	0.10	-0.15	-0.06	-0.25
Retail	0.27	0.26	0.06	-0.17	-0.05	-0.23
Education	0.44	0.44	0.10	-0.19	-0.04	-0.29
Warehouse	0.22	0.23	0.02	-0.25	-0.11	-0.27
Other[56]	0.34	0.32	0.08	-0.18	-0.07	-0.26

Interactive Factor (HVACg) for Annual Fuel Savings

Project Type	Fuel Type	Impact (MMBtu/ΔkWh)
Large Retrofit (> 200 kW)	C&I Gas Heat	-0.00023
Large Retrofit (> 200 kW)	Oil	-0.00046
Small Retrofit (≤ 200 kW)	Gas Heat	-0.001075
Small Retrofit (> 200 kW)	Oil Heat	-0.000120

Sources

1. Device Codes and Rated Lighting System Wattage Table Retrofit Program, National Grid, January 13, 2015. https://www1.nationalgridus.com/files/AddedPDF/POA/RILightingRetrofit1.pdf

Lighting Controls

Lighting controls include occupancy sensors, daylight dimmer systems, and occupancy controlled hi-low controls for fluorescent, LED and HID fixtures. The measurement of energy savings is based on algorithms with key variables (i.e., coincidence factor, equivalent full load hours) provided through existing end-use metering of a sample of facilities or from other utility programs with experience with these measures (i.e., % of annual lighting energy saved by lighting control). For lighting controls, the baseline is a manual switch, based on the findings of the New Jersey Commercial Energy Efficient Construction Baseline Study.

Algorithms

$$\text{Energy Savings } \left(\frac{\text{kWh}}{\text{yr}}\right) = \text{kW}_c * \text{SVG} * \text{Hrs} * (1 + HVAC_e)$$

$$\text{Peak Demand Savings (kW)} = \text{kW}_c * \text{SVG} * \text{CF} * (1 + HVAC_d)$$

$$\text{Fuel Savings } \left(\frac{\text{MMBtu}}{\text{yr}}\right) = \text{kW}_c * \text{SVG} * (\text{Hrs}) * (\text{HVAC}_g)$$

Definition of Variables

SVG	= % of annual lighting energy saved by lighting control; refer to table by control type
kW_c	= kW lighting load connected to control
$HVAC_d$	= Interactive Factor – This applies to C&I interior lighting only. This represents the secondary demand in reduced HVAC consumption resulting from decreased indoor lighting wattage.
$HVAC_e$	= Interactive Factor – This applies to C&I interior lighting only. This represents the secondary energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage.
$HVAC_g$	= Interactive Factor – This applies to C&I interior lighting only. This represents the secondary energy savings in reduced HVAC consumption resulting from decreased indoor lighting wattage.
CF	= Coincidence factor
Hrs	= Annual hours of operation prior to installation of controls

Summary of Inputs

Lighting Controls

Component	Type	Value	Source
kW_c	Variable	Load connected to control	Application
SVG	Fixed	Occupancy Sensor, Controlled Hi-Low Fluorescent Control, LED and controlled HID = 31% Daylight Dimmer System= 40%	4, 5, 6
CF	Fixed	See Table by Building in Performance Lighting Section Above	1
Hrs	Fixed	See Table by Building in Performance Lighting Section Above	1
$HVAC_d$	Fixed	See Table by Building Type in Performance Lighting Section Above	2
$HVAC_e$	Fixed	See Table by Building Type in Performance Lighting Table Above	2
$HVAC_g$	Fixed	See Table by Building Type in Performance Lighting Table Above	3

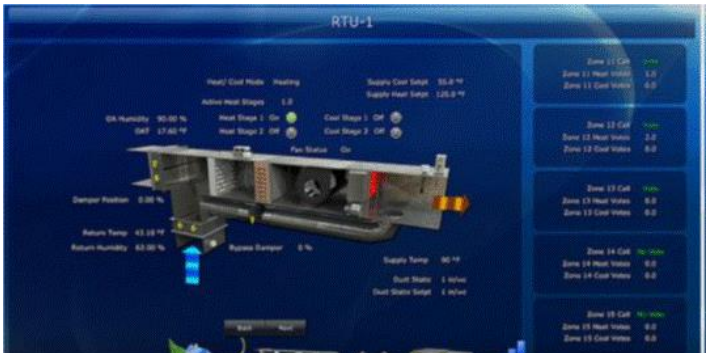
ECM 3 & 4 – District Wide Energy Management System Tiers 1 & 2

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
3	District Wide Energy Management System Tier 1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
4	District Wide Energy Management System Tier 2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔

Energy Management Systems (EMS) are systems comprised of sensors, operators, processors, and a front-end user interface that controls and monitors electrical and mechanical building systems. Such systems provide automated control and monitoring of the heating, cooling, ventilation, lighting and performance of a building or group of buildings. The energy management system will provide Willingboro Township Public Schools with continuous monitoring & reporting.

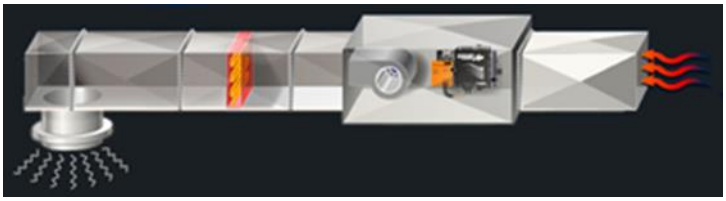


Web Based Building Automation Interface

Having building systems monitored from a central location enables the operator to receive alerts and predict future problems or troublesome conditions. The data obtained from this can be used to produce a trend analysis and annual consumption forecasts. Advanced control strategies implemented using these systems such as time scheduling, optimum start and stop, night set-back, demand-controlled ventilation, and peak demand limiting. The auditor will be able to use the EMS to diagnose current building system problems as well as tailor specific energy savings strategies that utilize the full capability of the given EMS.

The upgraded District Wide EMS will integrate existing proprietary systems with the new Open Protocol DDC Controls. Control strategies will be designed and programmed into the system to maintain building comfort while operating the building mechanical system in the most efficient manner possible. Strategies include:

1. Occupancy Scheduling
2. Building Wide Night Set Back
3. Morning Warm Up
4. Individual Room Temperature Set Point Control
5. Supply Air Temperature Reset
6. Chilled & Heating Supply Water Temperature Resets
7. Economizer Control
8. CO2 Ventilation Control

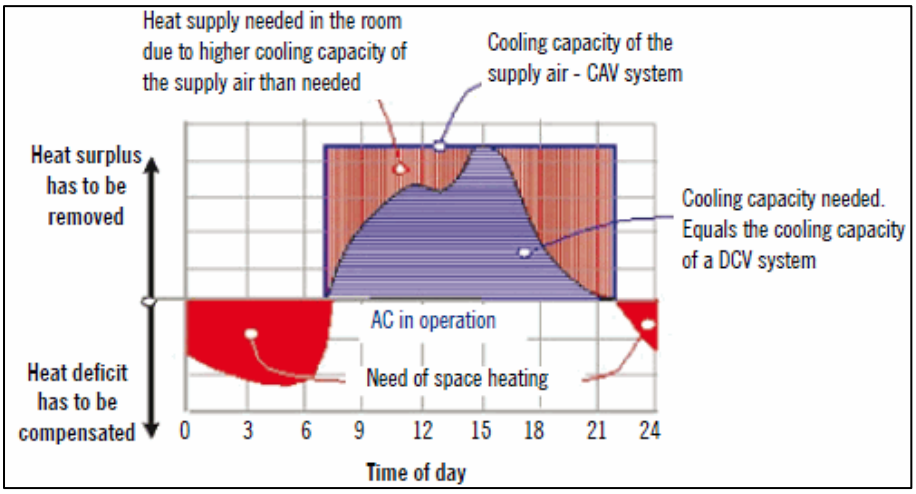


Demand Control Ventilation

In most commercial occupancies, ventilation is provided to deal with two types of indoor pollution: (1) odors from people, and (2) off-gassing from building components and furniture. When a space is vacant, it has no people pollution, so the people-related ventilation rate is not needed. Many types of high-occupancy spaces, such as classrooms, multipurpose rooms, theaters, conference rooms, or lobbies have ventilation designed for a high peak occupancy that rarely occurs. Ventilation can be reduced during the many hours of operation when spaces are vacant or at lower than peak occupancy. When ventilation is reduced, building owners or operators save energy because it is not necessary to heat or cool as much outside air. In colder climates, heating for ventilation air is greater and DCV saves the most energy.

Demand Control Ventilation Operation

The objective of a CO2 control strategy is to modulate ventilation to maintain target cfm/person ventilation rates based on actual occupancy. The strategy should allow for reduced overall ventilation during periods of less than full occupancy which will save energy. Typical control approaches have used a proportional or proportional-integral control algorithm to modulate ventilation between a base ventilation rate established for non-occupant-related sources and the design ventilation rate for the space. Typically, modulation of outside air above base ventilation begins when indoor CO2 is 100 ppm above outside levels and continues until the target CO2 levels are reached and the design ventilation rate is provided.



Duct sensors are best used where a single space or multiple spaces with common occupancy patterns are being ventilated. An example of this approach would be to place a sensor in the return duct of an air handler that serves multiple classrooms, using an upper limit set point of 500 or 600 ppm CO2 above ambient (instead of 700 ppm). This approach works best when the AHU system is serving spaces that are occupied with very similar schedules and rates.

Existing Conditions



Scope of Work

This measure involves upgrading the existing control system with an open-protocol, web-based Energy Management system. A Direct Digital Controller, which leverages current. technology and advanced capabilities for the control of the new HVAC equipment, will tie into the new EMS's architecture. This allows the owner the advantage of having the availability of obtaining replacement and services of the proposed EMS through multiple commercial channels and provides an additional benefit of an Open-Source Building Management System. This distinctive feature prevents the owner from obtaining support from only a single source provider, allowing them instead to obtain support from readily available multiple sources.

The proposed energy management system will be able to vary the operation of the unit, outdoor air damper, space temperature set points, and air conditioning systems (if applicable). This will include zone scheduling, temperature setback and unoccupied outdoor air shut off. Each building will be provided with electric and natural gas submetering for continuous monitoring and reporting of building energy consumption via Energy Dashboards.

A more specific scope of work includes:

- Building Automation Systems shall be accessible via the Internet.
- Users shall have the ability to view the system graphics, change set points, perform overrides, view schedules, change schedules, view alarms, acknowledge alarms, view trend information as well as print, save & e-mail trend information.
- A Secure Internet Connection to the District Network shall be provided and managed by the District IT Department.
- 3-D Graphics Package will be provided for navigating the Building Automation System as well as viewing floor plans, system graphics and equipment graphics.
- The District Facilities and IT Staff will receive full training on the operation of the system.
- Humidity monitoring in all classroom spaces
- Demand Control Ventilation (DCV) will be utilized in applicable occupied spaces.

Bookbinder School

- **(Tier 1) Front End PC at Site, Control of Central Heating Plant**
  New site PC, New AS Controller, New MPC controller for Boilers and related Pumps, and running new communication for new controllers. Sensors, Alarms, programming, and work required to meet specified sequences.

- **(Tier 2) Control over larger Mechanical Systems**

  - **New Controls for 4 New AHU's/RTU/DOAS.**

  Install new controller, new sensors for units, control valves/actuators, start/stop supply fan command, status for supply fan, freeze stat, CO2 and space temp, etc.
  New graphics, programs, and schedules for units

  - **Unit Ventilators (32 new) BACnet Controls and necessary components (incl valves) by mfr**

  Field install all the wiring for the communications, new control valves/actuators, discharge sensor, fan command, valve control, and CO2 Space & RH for dcv

  - **VAV's (4)**

  Field install all the wiring for the communications, new controller and CO2 Space & RH for dcv

Country Club Administration Building

- **(Tier 1) Front End PC at Site, control of Central Heating Plant**
  New site PC, New AS Controller, New MPC controller for boilers and related pumps, and running new communication for new controllers, Sensors, alarms, programming, and work required to meet specified sequences of operation.

- **(Tier 2) Control over larger Mechanical Systems**
  - **New Controller for *existing Rooftop/AHU Controls (1*)**

  Install new controller, new sensors for unit, control valves/actuators, start/stop supply command, status for supply fan, freeze stat, CO2 and space temp, etc.

Garfield East Elementary School

- **(Tier 1) Front End PC at Site, control of Central Heating Plant**
  New site PC, AS Controller, new MPC for control of existing Boilers and related Pumps. Sensors, Alarms, programming, and work required to meet specified sequences of operation.

- **(Tier 2) Control over larger Mechanical Systems**
  - **AHU (1)**

  Replace the existing controller with a new MPC controller to communicate back to the new front end. Replace existing actuators with new ones, replace existing sensors with new sensors (supply, Return, Etc.), replace status for fan, start/stop for fans etc.

  - **UV's (38) FTR DDC Controller (3) Unit Heater DDC Controller (7)**

  Field installed controls for Cabinet/Unit Heaters (7); FTR (3). UV's replace control valve, replace controller w/ schneider, run new comm, CO2 RH and space temp for DCV.

Hawthorne Elementary School

- **(Tier 1) Front End PC at Site, control of Central Heating Plant**
  New site PC, AS Controller, new MPC for control of existing Boilers and related Pumps. Sensors, Alarms, programming, and work required to meet specified sequences of operation.
- **(Tier 2) Control over larger Mechanical Systems**
  - **AHU (8)**

  Replace the existing controller with new MPC controllers to communicate back to the new front end. Replace existing actuators with new ones, replace existing sensors with new sensors (supply, Return, Etc.), replace status for fan, start/stop for fans etc.

  - **UV's (42) Exhaust fans (11) Unit Heater DDC Controller (5)**

  Field installed controls for Cabinet/Unit Heaters (5); Exhaust Fans (11). UV's replace control valve, replace controller w/ schneider, run new comm, CO2 RH and space temp for DCV.

J. Creswell Stuart Early Childhood Development Center

- **(Tier 1) Front End PC at Site, control of Central Heating Plant**
  New site PC, AS Controller, new MPC for control of existing Boilers and related Pumps. Sensors, Alarms, programming, and work required to meet specified sequences of operation.

- **(Tier 2) Control over larger Mechanical Systems**
  - **AHU (7)**

  Replace the existing controller with new MPC controllers to communicate back to the new front end. Replace existing actuators with new ones, replace existing sensors with new sensors (supply, Return, Etc.), replace status for fan, start/stop for fans etc.

  - **UV's (57) FTR DDC (3) Unit Heater DDC Controller (12)**

  Field installed controls for Cabinet/Unit Heaters (12); FTR DDC (3). UV's replace control valve, replace controller w/ schneider, run new comm, CO2 RH and space temp for DCV.

James A Cotton Intermediate School

- **(Tier 1) Front End PC at Site, control of Central Heating Plant**
  New site PC, AS Controller, new MPC for control of existing Boilers and related Pumps. Sensors, Alarms, programming, and work required to meet specified sequences of operation for Energy Project.

- **(Tier 2) Control over larger Mechanical Systems**
  - **AHU (2)**

  Replace the existing controller with new MPC controllers to communicate back to the new front end. Replace existing actuators with new ones, replace existing sensors with new sensors (supply, Return, Etc.), replace status for fan, start/stop for fans etc. The second unit will be integrated since it's currently running as a third party packaged unit.

  - **UV's (52) FTR DDC w/ EF Control (11) VRF/VRV (15 cassettes) (7 condensing units)**

  Field installed controls for FTR DDC w/ EF Control (11). Integrate to VRF/VRV system (15 cassettes and 7 condensing units). UV's replace control valve, replace controller w/ schneider, run new comm, CO2 RH and space temp for DCV.

Joseph A. McGinley School

- **(Tier 1) Front End PC at Site, control of Central Heating Plant**
  New site PC, AS Controller, necessary I/O for control of existing Boilers and related Pumps. Sensors, Alarms, programming, and work required to meet specified sequences of operation.

Memorial Middle School

- **(Tier 1) Control of Heating Plant**
  Necessary I/O for control of existing Boilers and related Pumps. Sensors, Alarms, programming, and work required to meet specified sequences of operation for Energy Project.

- **(Tier 2) Control over larger Mechanical Systems**
  - **UV (77)/AHU's & RTU's (24)/BB & EF (5) DCV Upgrade**

  Add new CO2, RH, Space sensor to existing UV's for DCV. Update graphics and programs accordingly w/ alarms to coincide w/ additional points.

Twin Hills Elementary School

- **(Tier 1) Front End PC at Site, control of Central Heating Plant**
  New site PC, AS Controller, new MPC for control of existing Boilers and related Pumps. Sensors, Alarms, programming, and work required to meet specified sequences of operation.

- **(Tier 2) Control over larger Mechanical Systems**
  - **AHU (2)**

  Replace the existing controller with new MPC controllers to communicate back to the new front end. Replace existing actuators with new ones, replace existing sensors with new sensors (supply, Return, Etc.), replace status for fan, start/stop for fans etc. The second unit will be integrated since it's currently running as a third party packaged unit.

  - **UV's (36) FTR DDC (6) Cabinet Unit Heater (8)**

  Field installed controls for FTR DDC (6) and cabinet heaters (8). UV's replace control valve, replace controller w/ schneider, run new comm, CO2 RH and space temp for DCV.

WR James Elementary School

- **(Tier 1) Front End PC at Site, control of Central Heating Plant**
  New site PC, AS Controller, new MPC for control of existing Boilers and related Pumps. Sensors, Alarms, programming, and work required to meet specified sequences of operation.

- **(Tier 2) Control over larger Mechanical Systems**
  - **AHU (8)**

  Replace the existing controller with new MPC controllers to communicate back to the new front end. Replace existing actuators with new ones, replace existing sensors with new sensors (supply, Return, Etc.), replace status for fan, start/stop for fans etc. The second unit will be integrated since it's currently running as a third party packaged unit.

  - **UV's (29) Exhaust Fans (9) Cabinet Unit Heater (5)**

  Field installed controls for Exhaust Fans (9) and cabinet heaters (5). UV's replace control valve, replace controller w/ schneider, run new comm, CO2 RH and space temp for DCV.

Warehouse

- **(Tier 1) Front End PC at Site, control of Central Heating Plant**
  New site PC, AS Controller, new MPC for control of existing Boilers and related Pumps. Sensors, Alarms, programming, and work required to meet specified sequences of operation.

Willingboro High School

- **(Tier 1) Control of Heating Plant**
  Necessary I/O for control of existing Boilers and related Pumps. Sensors, Alarms, programming, and work required to meet specified sequences of operation.

- **(Tier 2) Control over larger Mechanical Systems**
  - **UV (29)/RHC (59)/AHU & RTU (23) DCV Upgrade**

  Add new CO2, RH, Space sensor to existing UV's for DCV. Update graphics and programs accordingly w/ alarms to coincide w/ additional points.

ECM Calculations

Energy savings from upgrading the district Energy Management System were calculated using the BPU protocols. The upgraded system will have improved and precise occupied/unoccupied scheduling capabilities programed through user interface at a central computer dashboard. The proposed controls have a heating setpoint of 70F during occupied hours and 65F setpoint during unoccupied hours, and a cooling setpoint of 72F during occupied hours and 77 during unoccupied hours. To be conservative with savings estimates, DCO is claiming savings on 5F setback temperatures during unoccupied hours – typically setbacks greater than 5F are achievable. Demand Control Ventilation energy savings for the specific units reflected in the scope of work are calculated using BPU Protocols and based off ASHRAE STANDARD 62.1 - 2016 calculated outdoor air rates. The calculations are shown below.

District Wide Energy Management System Savings

BUILDING	Tier	Proposed Weekly Occupied Heat Hours [H]	RTU Cooling (tons) [CAPrtu]	RTU Cooling Efficiency (EER) [EERrtu]	Chiller Cooling Cap (tons)	Chiller Cooling Efficiency (EER)	Boiler Heating (Btu/hr) [CAPboiler]	Boiler Heating Efficiency (%) [AFUEh]
Bookbinder School	Tier 1	80			0.00	0.00	6,000,000	87%
Bookbinder School	Tier 2	80	203	12.7				
Country Club Administration Building	Tier 1	80			0.00	0.00	2,250,000	87%
Country Club Administration Building	Tier 2	80	25	12.0				
Garfield East Elementary School	Tier 1	80			0.00	0.00	2,000,000	83%
Garfield East Elementary School	Tier 2	80	30	9.2				
Hawthorne Elementary School	Tier 1	80			0.00	0.00	3,500,000	84%
Hawthorne Elementary School	Tier 2	80	30	10.5				
J. Cresswell Stuart Early Childhood Development Center	Tier 1	80			0.00	0.00	3,000,000	83%
J. Cresswell Stuart Early Childhood Development Center	Tier 2	80	52	9.9				
James A. Cotten Intermediate School	Tier 1	80			0.00	0.00	6,750,000	83%
James A. Cotten Intermediate School	Tier 2	80	170	10.3				
Joseph A. McGinley School	Tier 1	80			0.00	0.00	4,750,000	75%
Joseph A. McGinley School	Tier 2	80	0	0.0				
Memorial Middle School	Tier 1	80			0.00	0.00	6,000,000	83%
Memorial Middle School	Tier 2	80	425	9.7				
Twin Hills Elementary School	Tier 1	80			0.00	0.00	2,000,000	83%
Twin Hills Elementary School	Tier 2	80	46	10.1				
W.R. James Elementary School	Tier 1	80			0.00	0.00	2,500,000	84%
W.R. James Elementary School	Tier 2	80	49	10.3				
Warehouse	Tier 1	100			0.00	0.00	750,000	83%
Willingboro High School	Tier 1	80			624.00	20.92	7,500,000	83%
Willingboro High School	Tier 2	80	197	10.0				

District Wide Energy Management System Savings										
BUILDING	Tier	Proposed Weekly Occupied Heat Hours [H]	ELFHc	ELFHh	DCV Savings (kWh)	DCV Demand Savings (kW)	DCV Heating Savings (therms)	RTU Cooling Energy Savings (kWh)	Chiller Cooling Energy Savings (kWh)	Boiler Heating Energy Savings (therms)
Bookbinder School	Tier 1	80	394	840				0	0	4,293
Bookbinder School	Tier 2	80	394	840	16,193	20	4,352	11,167	0	0
Country Club Administration Building	Tier 1	80	394	840				0	0	1,615
Country Club Administration Building	Tier 2	80	394	840				1,460	0	0
Garfield East Elementary School	Tier 1	80	394	840				0	0	1,499
Garfield East Elementary School	Tier 2	80	394	840	4,810	6	1,293	2,282	0	0
Hawthorne Elementary School	Tier 1	80	394	840				0	0	2,608
Hawthorne Elementary School	Tier 2	80	394	840	12,951	16	3,481	1,993	0	0
J. Cresswell Stuart Early Childhood Development Center	Tier 1	80	394	840				0	0	2,249
J. Cresswell Stuart Early Childhood Development Center	Tier 2	80	394	840	9,963	12	2,678	3,713	0	0
James A. Cotten Intermediate School	Tier 1	80	466	901				0	0	5,413
James A. Cotten Intermediate School	Tier 2	80	466	901	21,254	26	2,955	13,713	0	0
Joseph A. McGinley School	Tier 1	80	394	840				0	0	3,925
Joseph A. McGinley School	Tier 2	80	394	840	0	0	0	0	0	0
Memorial Middle School	Tier 1	80	466	901				0	0	4,841
Memorial Middle School	Tier 2	80	466	901	73,998	44	10,241	36,430	0	0
Twin Hills Elementary School	Tier 1	80	394	840				0	0	1,499
Twin Hills Elementary School	Tier 2	80	394	840	12,435	15	1,729	3,185	0	0
W.R. James Elementary School	Tier 1	80	394	840				0	0	1,863
W.R. James Elementary School	Tier 2	80	394	840	12,951	16	3,481	3,334	0	0
Warehouse	Tier 1	100	394	840				0	0	429
Willingboro High School	Tier 1	80	466	901				0	24,720	6,051
Willingboro High School	Tier 2	80	466	901	59,185	35	16,850	16,210	0	0

District Wide Energy Management System Savings					
BUILDING	Tier	Proposed Weekly Occupied Heat Hours [H]	Total Electric Savings (kWh)	Total Gas Savings (therms)	Total Cooling Demand Savings
Bookbinder School	Tier 1	80	0	4,293	0
Bookbinder School	Tier 2	80	27,360	4,352	20
Country Club Administration Building	Tier 1	80	0	1,615	0
Country Club Administration Building	Tier 2	80	1,460	0	0
Garfield East Elementary School	Tier 1	80	0	1,499	0
Garfield East Elementary School	Tier 2	80	7,091	1,293	6
Hawthorne Elementary School	Tier 1	80	0	2,608	0
Hawthorne Elementary School	Tier 2	80	14,944	3,481	16
J. Cresswell Stuart Early Childhood Development Center	Tier 1	80	0	2,249	0.00
J. Cresswell Stuart Early Childhood Development Center	Tier 2	80	13,676	2,678	12.00
James A. Cotten Intermediate School	Tier 1	80	0	5,413	0.00
James A. Cotten Intermediate School	Tier 2	80	34,967	2,955	25.61
Joseph A. McGinley School	Tier 1	80	0	3,925	0.00
Joseph A. McGinley School	Tier 2	80	0	0	0.00
Memorial Middle School	Tier 1	80	0	4,841	0.00
Memorial Middle School	Tier 2	80	110,428	10,241	43.89
Twin Hills Elementary School	Tier 1	80	0	1,499	0.00
Twin Hills Elementary School	Tier 2	80	15,619	1,729	14.98
W.R. James Elementary School	Tier 1	80	0	1,863	0.00
W.R. James Elementary School	Tier 2	80	16,284	3,481	15.60
Warehouse	Tier 1	100	0	429	0.00
Willingboro High School	Tier 1	80	24,720	6,051	0.00
Willingboro High School	Tier 2	80	75,395	16,850	35.10

Occupancy Controlled Thermostat Savings Calculation	
Th (F)	70
Tc (F)	72
Sh (F)	65
Sc (F)	77
H (hrs per week)	Varies
EFLHc (hrs per year)	Varies
EFLHh (hrs per year)	Varies
Ph (%)	3%
Pc (%)	6%

NJ BPU FY 2020 Protocols - Occupancy Controlled Thermostats

Algorithms

Cooling Energy Savings (kWh/yr) = $(((T_c * (H+5) + S_c * (168 - (H+5)))/168) - T_c) * (P_c * Cap_{hp} * 12 * EFLH_c/EER_{hp})$

Heating Energy Savings (kWh/yr) = $(T_h - ((T_h * (H+5) + S_h * (168 - (H+5)))/168)) * (P_h * Cap_{hp} * 12 * EFLH_h/EER_{hp})$

Heating Energy Savings (Therms/yr) = $(T_h - ((T_h * (H+5) + S_h * (168 - (H+5)))/168) * (P_h * Cap_h * EFLH_h/AFUE_h/100{,}000)$

Definition of Variables

T_h = Heating Season Facility Temp. (°F)
T_c = Cooling Season Facility Temp. (°F)
S_h = Heating Season Setback Temp. (°F)
S_c = Cooling Season Setup Temp. (°F)
H = Weekly Occupied Hours
Cap_{hp} = Connected load capacity of heat pump/AC (Tons) – Provided on Application.
Cap_h = Connected heating load capacity (Btu/hr) – Provided on Application.
$EFLH_c$ = Equivalent full load cooling hours
$EFLH_h$ = Equivalent full load heating hours
P_h = Heating season percent savings per degree setback
P_c = Cooling season percent savings per degree setup
$AFUE_h$ = Heating equipment efficiency – Provided on Application.
EER_{hp} = Heat pump/AC equipment efficiency – Provided on Application

12 = Conversion factor from Tons to kBtu/hr to acquire consumption in kWh.

168 = Hours per week.

7 = Assumed weekly hours for setback/setup adjustment period (based on 1 setback/setup per day, 7 days per week).

Summary of Inputs

Occupancy Controlled Thermostats

Component	Type	Value	Source
T_h	Variable		Application
T_c	Variable		Application
S_h	Fixed	T_h-5°	
S_c	Fixed	T_c+5°	
H	Variable		Application; Default of 84 hrs/week
Cap_{hp}	Variable		Application
Cap_h	Variable		Application
$EFLH_{c,h}$	Variable	See Table Below	1
P_h	Fixed	3%	2
P_c	Fixed	6%	2
$AFUE_h$	Variable		Application
EER_{hp}	Variable		Application

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Cooling	507	550	562
Low-rise, Heating	757	723	503
High-rise, Cooling	793	843	954
High-rise, Heating	526	395	219

Demand Control Ventilation Savings											
BUILDING	Occupancy Category	% of area served	People Outdoor Air Rate (cfm/person)	Area Outdoor Air Rate (cfm/sqft)	Occupant Density (#/1000 sqft)	CESF	CDSF	HSF	DCV Electric Savings (kWh)	DCV Demand Savings (kW)	DCV Gas Savings (Th)
Bookbinder School	Classroom w/ UV	55.2%	10	0.12	25	1.079	0.0013	0.029	12,951	16	3,481
Bookbinder School	Gymatorium - No Bleachers	6.3%	8	0.06	100	1.079	0.0013	0.029	3,243	4	871
Country Club Administration Building	Classroom w/ UV	55.8%	5	0.06	5	2.544	0.0013	0.069	4,661	2	1,264
Garfield East Elementary School	Classroom w/ UV	39.3%	10	0.12	10	1.079	0.0013	0.029	4,810	6	1,293
Hawthorne Elementary School	Classroom w/ UV	55.2%	10	0.12	25	1.079	0.0013	0.029	12,951	16	3,481
J. Cresswell Stuart Early Childhood Development Center	Classroom w/ UV	55.6%	10.0	0.12	15	1.079	0.0013	0.029	9,963	12	2,678
James A. Cotten Intermediate School	Classroom w/ UV	34%	10.0	0.12	35	1.079	0.0013	0.015	21,254	26	2,955
Joseph A. McGinley School	Classroom w/ UV	0%	10.0	0.12	25	1.079	0.0013	0.029	0	0	0
Memorial Middle School	Classroom w/ UV	39%	10	0.12	35	2.529	0.0015	0.035	73,998	44	10,241
Twin Hills Elementary School	Classroom w/ UV	61%	10	0.12	25	1.079	0.0013	0.015	12,435	15	1,729
W.R. James Elementary School	Classroom w/ UV	55%	10	0.12	25	1.079	0.0013	0.029	12,951	16	3,481
Willingboro High School	Classroom w/ UV	22%	10.0	0.12	35	2.529	0.0015	0.072	59,185	35	16,850

Calculated Outdoor Air Rates refence ANSI ASHRAE STANDARD 62.1 -2016

NJ BPU FY 2020 Protocols – Demand Control Ventilation

Algorithms

Energy Savings (kWh/yr) = CESF * CFM

Peak Demand Savings (kW) = CDSF * CFM

Fuel Savings (MMBtu/yr) = HSF * CFM

Definition of Variables

CESF = Cooling Energy Savings Factor (kWh/CFM)

CDSF = Cooling Demand Savings Factor (kW/CFM)

HSF = Heating Savings Factor (MMBtu/CFM)

CFM = Baseline Design Ventilation Rate of Controlled Space (CFM)

Summary of Inputs

Demand Controlled Ventilation Using CO_2 SensorsComponent	Type	Value	Source
CESF	Fixed	0.0484 MMBtu/CFM See Table 2	1

Demand Controlled Ventilation Using CO_2 SensorsComponent	Type	Value	Source
CDSF	Fixed		1
HSF	Fixed		1
CFM	Variable		Application

Savings Factors for Demand-Controlled Ventilation Using CO_2 Sensors

Component	CESF	CDSF	HSF
Assembly	2.720	0.0014	0.074
Auditorium – Community Center	1.500	0.0015	0.043
Gymnasium	2.558	0.0013	0.069
Office Building	2.544	0.0013	0.068
Elementary School	1.079	0.0013	0.029
High School	2.529	0.0015	0.072
Shopping Center	1.934	0.0012	0.050
Other	2.544	0.0013	0.068

ECM 6 – Pipe and Valve Insulation

Willingboro Township Public Schools ECM Matrix

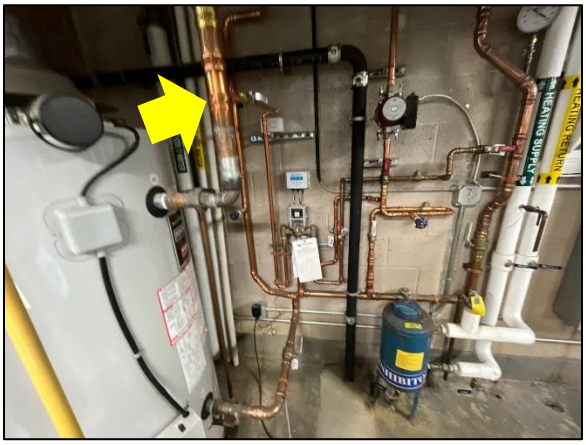
✔	ECM was evaluated
✔	ECM included in the project

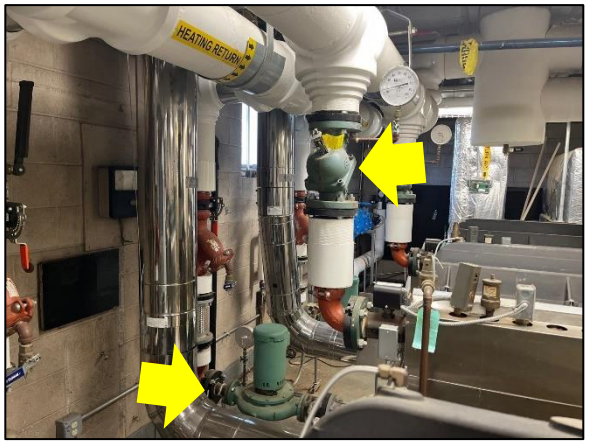
ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
6	Pipe and Valve Insulation		✔	✔	✔	✔	✔		✔	✔	✔	✔	✔

Piping insulation is a critical part of energy management. It controls condensation, pipe freezing, and noise amongst other things. A percentage of heating (or cooling) can be lost through conduction if a pipe is not properly insulated.

Higher operational costs are a direct result of this for both heating and cooling systems. This ECM entails wrapping the existing bare metal pipe with an approved high-performance fiberglass insulation jacketing material.

Existing Conditions





Scope of Work

Insulation will be installed on exposed pipes and valves. Failed insulation will be replaced. Poorly insulated pipes in the heating and cooling distribution system are leading to unnecessary distribution losses and wasted energy. The scope of work will include.

- Installation of pipe insulation to meet the insulation requirements of the fluid temperature in the pipe.
- Utilize and install pipe wrap covering and jackets to protect the insulation material as required in the work area.
- Materials will vary by the application and workspace.
    - Fiberglass, mineral wool, foam glass, Styrofoam, urethane, closed cell rubber

Pipe and Valve Insulation Savings

BUILDING	Component	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*
Country Club Administration Building	Air Seperator Tank	MTHW	15 4/9
Country Club Administration Building	Triple Duty Valve	MTHW	5
Country Club Administration Building	Suction Diffuser	MTHW	5
Country Club Administration Building	Strainer	MTHW	5
Country Club Administration Building	Flex Fitting	MTHW	5
Country Club Administration Building	Flange	MTHW	5
Country Club Administration Building	Flange	MTHW	4
Country Club Administration Building	Flange	MTHW	3
Country Club Administration Building	Centrifugal Pump	MTHW	3
Country Club Administration Building	Butterfly Valve	MTHW	5
Garfield East Elementary School	T Intersection	DHW	1 1/2
Garfield East Elementary School	Straight Pipe	DHW	1 1/2
Garfield East Elementary School	90 Degree Elbow	DHW	1 1/2
Garfield East Elementary School	45 Degree Elbow	DHW	1 1/2
Garfield East Elementary School	Ball valve	DHW	1 1/2
Garfield East Elementary School	End Cap	MTHW	4
Garfield East Elementary School	Air Seperator Tank	MTHW	9 1/2
Garfield East Elementary School	Triple Duty Valve	MTHW	4
Garfield East Elementary School	Triple Duty Valve	MTHW	3
Garfield East Elementary School	Suction Diffuser	MTHW	4
Garfield East Elementary School	Strainer	MTHW	4
Garfield East Elementary School	Strainer	MTHW	3
Garfield East Elementary School	Strainer	MTHW	1 1/2
Garfield East Elementary School	In-Line Pump	MTHW	3
Garfield East Elementary School	Flex Fitting	MTHW	4
Garfield East Elementary School	Flex Fitting	MTHW	3
Garfield East Elementary School	Flange	MTHW	4
Garfield East Elementary School	Flange	MTHW	3
Garfield East Elementary School	Check Valve	MTHW	1 1/2
Garfield East Elementary School	Centrifugal Pump	MTHW	2 1/2
Garfield East Elementary School	Butterfly Valve	MTHW	4
Garfield East Elementary School	Ball valve	MTHW	1 1/2
Hawthorne Elementary School	T Intersection	DHW	2
Hawthorne Elementary School	T Intersection	DHW	1 1/2
Hawthorne Elementary School	T Intersection	DHW	1 1/4
Hawthorne Elementary School	Straight Pipe	DHW	2
Hawthorne Elementary School	Straight Pipe	DHW	1 1/2
Hawthorne Elementary School	Straight Pipe	DHW	1 1/4
Hawthorne Elementary School	90 Degree Elbow	DHW	2
Hawthorne Elementary School	90 Degree Elbow	DHW	1 1/2
Hawthorne Elementary School	90 Degree Elbow	DHW	1 1/4
Hawthorne Elementary School	45 Degree Elbow	DHW	1 1/2
Hawthorne Elementary School	45 Degree Elbow	DHW	1 1/4
Hawthorne Elementary School	Ball valve	DHW	2
Hawthorne Elementary School	Ball valve	DHW	1 1/2
Hawthorne Elementary School	Ball valve	DHW	1 1/4
Hawthorne Elementary School	90 Degree Elbow	MTHW	3
Hawthorne Elementary School	Triple Duty Valve	MTHW	4
Hawthorne Elementary School	Triple Duty Valve	MTHW	3
Hawthorne Elementary School	Suction Diffuser	MTHW	4
Hawthorne Elementary School	Strainer	MTHW	4
Hawthorne Elementary School	Strainer	MTHW	3
Hawthorne Elementary School	Strainer	MTHW	2
Hawthorne Elementary School	In-Line Pump	MTHW	3
Hawthorne Elementary School	Flex Fitting	MTHW	4
Hawthorne Elementary School	Flange	MTHW	4
Hawthorne Elementary School	Flange	MTHW	3
Hawthorne Elementary School	Flange	MTHW	2
Hawthorne Elementary School	Centrifugal Pump	MTHW	3
Hawthorne Elementary School	Butterfly Valve	MTHW	4
Hawthorne Elementary School	Butterfly Valve	MTHW	3
Hawthorne Elementary School	Ball valve	MTHW	2

Pipe and Valve Insulation Savings

BUILDING	Component	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*
J. Cresswell Stuart Early Childhood De	T Intersection	DHW	1 1/2
J. Cresswell Stuart Early Childhood De	T Intersection	DHW	1 1/4
J. Cresswell Stuart Early Childhood De	Straight Pipe	DHW	1 1/2
J. Cresswell Stuart Early Childhood De	Straight Pipe	DHW	1 1/4
J. Cresswell Stuart Early Childhood De	Straight Pipe	DHW	1
J. Cresswell Stuart Early Childhood De	90 Degree Elbow	DHW	1 1/2
J. Cresswell Stuart Early Childhood De	90 Degree Elbow	DHW	1 1/4
J. Cresswell Stuart Early Childhood De	90 Degree Elbow	DHW	1
J. Cresswell Stuart Early Childhood De	45 Degree Elbow	DHW	1 1/2
J. Cresswell Stuart Early Childhood De	45 Degree Elbow	DHW	1 1/4
J. Cresswell Stuart Early Childhood De	Ball valve	DHW	1 1/2
J. Cresswell Stuart Early Childhood De	Ball valve	DHW	1 1/4
J. Cresswell Stuart Early Childhood De	Ball valve	DHW	1
J. Cresswell Stuart Early Childhood De	End Cap	MTHW	4
J. Cresswell Stuart Early Childhood De	Air Seperator Tank	MTHW	11 2/7
J. Cresswell Stuart Early Childhood De	Suction Diffuser	MTHW	4
J. Cresswell Stuart Early Childhood De	Strainer	MTHW	4
J. Cresswell Stuart Early Childhood De	Strainer	MTHW	3
J. Cresswell Stuart Early Childhood De	In-Line Pump	MTHW	3
J. Cresswell Stuart Early Childhood De	Flex Fitting	MTHW	4
J. Cresswell Stuart Early Childhood De	Flange	MTHW	4
J. Cresswell Stuart Early Childhood De	Flange	MTHW	3
J. Cresswell Stuart Early Childhood De	Check Valve	MTHW	4
J. Cresswell Stuart Early Childhood De	Centrifugal Pump	MTHW	3
J. Cresswell Stuart Early Childhood De	Butterfly Valve	MTHW	4
J. Cresswell Stuart Early Childhood De	Butterfly Valve	MTHW	3
J. Cresswell Stuart Early Childhood De	Balance Valve	MTHW	3
James A. Cotten Intermediate School	Condensate Tank	Cond	21 1/4
James A. Cotten Intermediate School	90 Degree Elbow	Cond	3
James A. Cotten Intermediate School	In-Line Pump	Cond	1 1/2
James A. Cotten Intermediate School	Flange	Cond	3
James A. Cotten Intermediate School	Check Valve	Cond	3
James A. Cotten Intermediate School	Strainer	LPS	1
James A. Cotten Intermediate School	Steam Trap	LPS	1
James A. Cotten Intermediate School	Flange	LPS	3
James A. Cotten Intermediate School	Bonnet	LPS	4
James A. Cotten Intermediate School	Bonnet	LPS	3
James A. Cotten Intermediate School	Air Seperator Tank	MTHW	31 2/5
James A. Cotten Intermediate School	90 Degree Elbow	MTHW	4
James A. Cotten Intermediate School	45 Degree Elbow	MTHW	4
James A. Cotten Intermediate School	Triple Duty Valve	MTHW	6
James A. Cotten Intermediate School	Suction Diffuser	MTHW	6
James A. Cotten Intermediate School	Flex Fitting	MTHW	6
James A. Cotten Intermediate School	Flex Fitting	MTHW	4
James A. Cotten Intermediate School	Flange	MTHW	6
James A. Cotten Intermediate School	Flange	MTHW	4
James A. Cotten Intermediate School	Check Valve	MTHW	4
James A. Cotten Intermediate School	Centrifugal Pump	MTHW	4
James A. Cotten Intermediate School	Butterfly Valve	MTHW	4
Memorial Middle School	Straight Pipe	MTHW	4
Memorial Middle School	Air Seperator Tank	MTHW	15.441892
Memorial Middle School	90 Degree Elbow	MTHW	4
Memorial Middle School	Triple Duty Valve	MTHW	6
Memorial Middle School	Suction Diffuser	MTHW	6
Memorial Middle School	Flex Fitting	MTHW	6
Memorial Middle School	Flex Fitting	MTHW	4
Memorial Middle School	Flange	MTHW	6
Memorial Middle School	Flange	MTHW	5
Memorial Middle School	Flange	MTHW	4
Memorial Middle School	Check Valve	MTHW	4
Memorial Middle School	Centrifugal Pump	MTHW	4
Memorial Middle School	Butterfly Valve	MTHW	6
Memorial Middle School	Butterfly Valve	MTHW	5
Memorial Middle School	Butterfly Valve	MTHW	4

Pipe and Valve Insulation Savings

BUILDING	Component	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*
Twin Hills Elementary School	Air Seperator Tank	MTHW	11.2952778
Twin Hills Elementary School	90 Degree Elbow	MTHW	4
Twin Hills Elementary School	Triple Duty Valve	MTHW	4
Twin Hills Elementary School	Triple Duty Valve	MTHW	3
Twin Hills Elementary School	Suction Diffuser	MTHW	4
Twin Hills Elementary School	Strainer	MTHW	4
Twin Hills Elementary School	Strainer	MTHW	1.5
Twin Hills Elementary School	In-Line Pump	MTHW	4
Twin Hills Elementary School	Flex Fitting	MTHW	4
Twin Hills Elementary School	Flange	MTHW	4
Twin Hills Elementary School	Flange	MTHW	3
Twin Hills Elementary School	Flange	MTHW	2
Twin Hills Elementary School	Check Valve	MTHW	1.5
Twin Hills Elementary School	Centrifugal Pump	MTHW	3
Twin Hills Elementary School	Butterfly Valve	MTHW	4
Twin Hills Elementary School	Butterfly Valve	MTHW	3
Twin Hills Elementary School	Ball valve	MTHW	2
Twin Hills Elementary School	Ball valve	MTHW	1.5
W.R. James Elementary School	T Intersection	DHW	1.5
W.R. James Elementary School	Straight Pipe	DHW	2
W.R. James Elementary School	Straight Pipe	DHW	1.5
W.R. James Elementary School	90 Degree Elbow	DHW	2
W.R. James Elementary School	90 Degree Elbow	DHW	1.5
W.R. James Elementary School	Ball valve	DHW	2
W.R. James Elementary School	Ball valve	DHW	1.5
W.R. James Elementary School	Straight Pipe	MTHW	1
W.R. James Elementary School	90 Degree Elbow	MTHW	1
W.R. James Elementary School	Suction Diffuser	MTHW	4
W.R. James Elementary School	Strainer	MTHW	4
W.R. James Elementary School	In-Line Pump	MTHW	3
W.R. James Elementary School	Flex Fitting	MTHW	4
W.R. James Elementary School	Flex Fitting	MTHW	3
W.R. James Elementary School	Flange	MTHW	5
W.R. James Elementary School	Flange	MTHW	4
W.R. James Elementary School	Flange	MTHW	3
W.R. James Elementary School	Flange	MTHW	2
W.R. James Elementary School	Centrifugal Pump	MTHW	2
W.R. James Elementary School	Ball valve	MTHW	1
Warehouse	T Intersection	MTHW	2
Warehouse	Straight Pipe	MTHW	2
Warehouse	90 Degree Elbow	MTHW	2
Warehouse	45 Degree Elbow	MTHW	2
Warehouse	In-Line Pump	MTHW	2
Warehouse	Flo-Check	MTHW	2
Warehouse	Ball valve	MTHW	2
Warehouse	Air Scoop	MTHW	2
Willingboro High School	Air Seperator Tank	MTHW	37.68
Willingboro High School	Triple Duty Valve	MTHW	6
Willingboro High School	Suction Diffuser	MTHW	6
Willingboro High School	Flex Fitting	MTHW	6
Willingboro High School	Flange	MTHW	6
Willingboro High School	Flange	MTHW	4
Willingboro High School	Check Valve	MTHW	4
Willingboro High School	Centrifugal Pump	MTHW	4

ECM Calculations

Pipe and valve insulation savings are calculated using NJ BPU Protocols.

Pipe and Valve Insulation Savings

BUILDING	Component	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	PIPE OD ""	Total Quantity or Length	Total Eq Length(LF) or Total Area(SF)*	AMBIENT TEMP	Fluid Temperature	Savings Factor	OPERATION HOURS/YEAR	Heating / Cooling Efficiency	Proposed Insulation Type	Proposed Jacket Type	Proposed Insulation Thickness	Scaling Factor	Fuel Savings Therms
Country Club Administration Building	Air Seperator Tank	MTHW	15 4/9	#N/A	1	1	85	185	281	5,110	0.87	Cellular Glass	ASJ	2.0	0.77	16.55
Country Club Administration Building	Triple Duty Valve	MTHW	5	5.563	2	8.8	85	185	281	5,110	0.87	Removable Blanket	Fiberglass Fabric	1.5	0.77	145.68
Country Club Administration Building	Suction Diffuser	MTHW	5	5.563	2	8.8	85	185	281	5,110	0.87	Removable Blanket	Fiberglass Fabric	1.5	0.77	145.68
Country Club Administration Building	Strainer	MTHW	5	5.563	2	10	85	185	281	5,110	0.87	Removable Blanket	Fiberglass Fabric	1.5	0.77	165.54
Country Club Administration Building	Flex Fitting	MTHW	5	5	4	6	85	185	281	5,110	0.87	Removable Blanket	Fiberglass Fabric	1.5	0.77	99.33
Country Club Administration Building	Flange	MTHW	5	5.563	10	18	85	185	281	5,110	0.87	Removable Blanket	Fiberglass Fabric	1.5	0.77	297.98
Country Club Administration Building	Flange	MTHW	4	4.5	2	3.6	85	185	274	5,110	0.87	Removable Blanket	Fiberglass Fabric	1.5	0.77	58.11
Country Club Administration Building	Flange	MTHW	3	3.5	2	3.6	85	185	230	5,110	0.87	Removable Blanket	Fiberglass Fabric	1.5	0.77	48.78
Country Club Administration Building	Centrifugal Pump	MTHW	3	3.5	2	10	85	185	230	5,110	0.87	Removable Blanket	Fiberglass Fabric	1.5	0.77	135.50
Country Club Administration Building	Butterfly Valve	MTHW	5	5.563	2	8.2	85	185	281	5,110	0.87	Removable Blanket	Fiberglass Fabric	1.5	0.77	135.75
Garfield East Elementary School	T Intersection	DHW	1 1/2	1.9	5	6	85	125	120	8,760	0.83	Cellular Glass	PVC	1.5	0.31	75.96
Garfield East Elementary School	Straight Pipe	DHW	1 1/2	1.9	20	20	85	125	120	8,760	0.83	Cellular Glass	ASJ	1.5	0.31	253.20
Garfield East Elementary School	90 Degree Elbow	DHW	1 1/2	1.9	12	21.6	85	125	120	8,760	0.83	Cellular Glass	PVC	1.5	0.31	273.46
Garfield East Elementary School	45 Degree Elbow	DHW	1 1/2	1.9	6	6	85	125	120	8,760	0.83	Cellular Glass	PVC	1.5	0.31	75.96
Garfield East Elementary School	Ball valve	DHW	1 1/2	1.9	6	24.6	85	125	120	8,760	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.31	311.44
Garfield East Elementary School	End Cap	MTHW	4	4.5	1	1.8	85	185	281	5,110	0.83	Cellular Glass	ASJ	2.0	0.77	31.13
Garfield East Elementary School	Air Seperator Tank	MTHW	9 1/2	#N/A	1	1	85	185	281	5,110	0.83	Cellular Glass	ASJ	2.0	0.77	17.29
Garfield East Elementary School	Triple Duty Valve	MTHW	4	4.5	2	8.8	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	148.39
Garfield East Elementary School	Triple Duty Valve	MTHW	3	3	2	8.8	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	124.56
Garfield East Elementary School	Suction Diffuser	MTHW	4	4.5	2	8.8	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	148.39
Garfield East Elementary School	Strainer	MTHW	4	4.5	2	10	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	168.62
Garfield East Elementary School	Strainer	MTHW	3	3.5	2	10	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	141.55
Garfield East Elementary School	Strainer	MTHW	1 1/2	1.9	1	5	85	185	120	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	36.93
Garfield East Elementary School	In-Line Pump	MTHW	3	3.5	2	10	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	141.55
Garfield East Elementary School	Flex Fitting	MTHW	4	4.5	4	6	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	101.17
Garfield East Elementary School	Flex Fitting	MTHW	3	3.5	4	6	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	84.93
Garfield East Elementary School	Flange	MTHW	4	4.5	18	32.4	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	546.34
Garfield East Elementary School	Flange	MTHW	3	3.5	12	21.6	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	305.74
Garfield East Elementary School	Check Valve	MTHW	1 1/2	1.9	1	4.1	85	185	120	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	30.28
Garfield East Elementary School	Centrifugal Pump	MTHW	2 1/2	2.875	2	10	85	185	182	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	112.01
Garfield East Elementary School	Butterfly Valve	MTHW	4	4.5	2	8.2	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	138.27
Garfield East Elementary School	Ball valve	MTHW	1 1/2	1.9	2	8.2	85	185	120	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	60.56

Pipe and Valve Insulation Savings

BUILDING	Component	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	PIPE OD ""	Total Quantity or Length	Total Eq Length(LF) or Total Area(SF)*	AMBIENT TEMP	Fluid Temperature	Savings Factor	OPERATION HOURS/YEAR	Heating / Cooling Efficiency	Proposed Insulation Type	Proposed Jacket Type	Proposed Insulation Thickness	Scaling Factor	Fuel Savings Therms
Hawthorne Elementary School	T Intersection	DHW	2	2.375	3	3.6	85	125	148	8,760	0.84	Cellular Glass	PVC	1.5	0.31	55.87
Hawthorne Elementary School	T Intersection	DHW	1 1/2	1.9	2	2.4	85	125	120	8,760	0.84	Cellular Glass	PVC	1.5	0.31	30.20
Hawthorne Elementary School	T Intersection	DHW	1 1/4	1.66	1	1.2	85	125	100	8,760	0.84	Cellular Glass	PVC	1.0	0.31	12.58
Hawthorne Elementary School	Straight Pipe	DHW	2	2.375	12	12	85	125	148	8,760	0.84	Cellular Glass	ASJ	1.5	0.31	186.25
Hawthorne Elementary School	Straight Pipe	DHW	1 1/2	1.9	9	9	85	125	120	8,760	0.84	Cellular Glass	ASJ	1.5	0.31	113.26
Hawthorne Elementary School	Straight Pipe	DHW	1 1/4	1.66	9	9	85	125	100	8,760	0.84	Cellular Glass	ASJ	1.0	0.31	94.38
Hawthorne Elementary School	90 Degree Elbow	DHW	2	2.375	4	7.2	85	125	148	8,760	0.84	Cellular Glass	PVC	1.5	0.31	111.75
Hawthorne Elementary School	90 Degree Elbow	DHW	1 1/2	1.9	4	7.2	85	125	120	8,760	0.84	Cellular Glass	PVC	1.5	0.31	90.61
Hawthorne Elementary School	90 Degree Elbow	DHW	1 1/4	1.66	3	5.4	85	125	100	8,760	0.84	Cellular Glass	PVC	1.0	0.31	56.63
Hawthorne Elementary School	45 Degree Elbow	DHW	1 1/2	1.9	4	4	85	125	120	8,760	0.84	Cellular Glass	PVC	1.5	0.31	50.34
Hawthorne Elementary School	45 Degree Elbow	DHW	1 1/4	1.66	2	2	85	125	100	8,760	0.84	Cellular Glass	PVC	1.0	0.31	20.97
Hawthorne Elementary School	Ball valve	DHW	2	2.375	2	8.2	85	125	148	8,760	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.31	127.27
Hawthorne Elementary School	Ball valve	DHW	1 1/2	1.9	3	12.3	85	125	120	8,760	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.31	154.79
Hawthorne Elementary School	Ball valve	DHW	1 1/4	1.66	1	4.1	85	125	107	8,760	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.31	46.01
Hawthorne Elementary School	90 Degree Elbow	MTHW	3	3.5	9	16.2	85	185	236	5,110	0.84	Cellular Glass	PVC	2.0	0.77	233.88
Hawthorne Elementary School	Triple Duty Valve	MTHW	4	4.5	2	8.8	85	185	274	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	147.50
Hawthorne Elementary School	Triple Duty Valve	MTHW	3	3.5	3	13.2	85	185	230	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	185.72
Hawthorne Elementary School	Suction Diffuser	MTHW	4	4.5	2	8.8	85	185	274	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	147.50
Hawthorne Elementary School	Strainer	MTHW	4	4.5	2	10	85	185	274	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	167.61
Hawthorne Elementary School	Strainer	MTHW	3	3.5	3	15	85	185	230	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	211.05
Hawthorne Elementary School	Strainer	MTHW	2	2.375	1	5	85	185	148	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	45.27
Hawthorne Elementary School	In-Line Pump	MTHW	3	3.5	3	15	85	185	230	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	211.05
Hawthorne Elementary School	Flex Fitting	MTHW	4	4.5	4	6	85	185	274	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	100.57
Hawthorne Elementary School	Flange	MTHW	4	4.5	14	25.2	85	185	274	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	422.39
Hawthorne Elementary School	Flange	MTHW	3	3.5	30	54	85	185	230	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	759.77
Hawthorne Elementary School	Flange	MTHW	2	2.375	2	3.6	85	185	148	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	32.59
Hawthorne Elementary School	Centrifugal Pump	MTHW	3	3.5	2	10	85	185	230	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	140.70
Hawthorne Elementary School	Butterfly Valve	MTHW	4	4.5	2	8.2	85	185	274	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	137.44
Hawthorne Elementary School	Butterfly Valve	MTHW	3	3.5	3	12.3	85	185	230	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	173.06
Hawthorne Elementary School	Ball valve	MTHW	2	2.375	1	4.1	85	185	148	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.77	37.12
J. Cresswell Stuart Early Childhood Dev	T Intersection	DHW	1 1/2	1.9	5	6	85	125	120	8,760	0.83	Cellular Glass	PVC	1.5	0.31	75.96
J. Cresswell Stuart Early Childhood Dev	T Intersection	DHW	1 1/4	1.66	3	3.6	85	125	100	8,760	0.83	Cellular Glass	PVC	1.0	0.31	37.98
J. Cresswell Stuart Early Childhood Dev	Straight Pipe	DHW	1 1/2	1.9	27	27	85	125	120	8,760	0.83	Cellular Glass	ASJ	1.5	0.31	341.82
J. Cresswell Stuart Early Childhood Dev	Straight Pipe	DHW	1 1/4	1.66	12	12	85	125	100	8,760	0.83	Cellular Glass	ASJ	1.0	0.31	126.60
J. Cresswell Stuart Early Childhood Dev	Straight Pipe	DHW	1	1.315	18	18	85	125	82	8,760	0.83	Cellular Glass	ASJ	1.0	0.31	155.72
J. Cresswell Stuart Early Childhood Dev	90 Degree Elbow	DHW	1 1/2	1.9	11	19.8	85	125	120	8,760	0.83	Cellular Glass	PVC	1.5	0.31	250.67
J. Cresswell Stuart Early Childhood Dev	90 Degree Elbow	DHW	1 1/4	1.66	6	10.8	85	125	100	8,760	0.83	Cellular Glass	PVC	1.0	0.31	113.94
J. Cresswell Stuart Early Childhood Dev	90 Degree Elbow	DHW	1	1.315	9	16.2	85	125	82	8,760	0.83	Cellular Glass	PVC	1.0	0.31	140.15
J. Cresswell Stuart Early Childhood Dev	45 Degree Elbow	DHW	1 1/2	1.9	3	3	85	125	120	8,760	0.83	Cellular Glass	PVC	1.5	0.31	37.98
J. Cresswell Stuart Early Childhood Dev	45 Degree Elbow	DHW	1 1/4	1.66	3	3	85	125	100	8,760	0.83	Cellular Glass	PVC	1.0	0.31	31.65
J. Cresswell Stuart Early Childhood Dev	Ball valve	DHW	1 1/2	1.9	4	16.4	85	125	120	8,760	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.31	207.62
J. Cresswell Stuart Early Childhood Dev	Ball valve	DHW	1 1/4	1.66	3	12.3	85	125	107	8,760	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.31	138.85
J. Cresswell Stuart Early Childhood Dev	Ball valve	DHW	1	1.315	2	8.2	85	125	85	8,760	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.31	73.53
J. Cresswell Stuart Early Childhood Dev	End Cap	MTHW	4	4.5	1	1.8	85	185	281	5,110	0.83	Cellular Glass	ASJ	2.0	0.77	31.13
J. Cresswell Stuart Early Childhood Dev	Air Seperator Tank	MTHW	11 2/7	#N/A	1	1	85	185	281	5,110	0.83	Cellular Glass	ASJ	2.0	0.77	17.29
J. Cresswell Stuart Early Childhood Dev	Suction Diffuser	MTHW	4	4.5	2	8.8	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	148.39
J. Cresswell Stuart Early Childhood Dev	Strainer	MTHW	4	4.5	2	10	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	168.62
J. Cresswell Stuart Early Childhood Dev	Strainer	MTHW	3	3.5	3	15	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	212.32
J. Cresswell Stuart Early Childhood Dev	In-Line Pump	MTHW	3	3.5	3	15	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	212.32
J. Cresswell Stuart Early Childhood Dev	Flex Fitting	MTHW	4	4.5	4	6	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	101.17
J. Cresswell Stuart Early Childhood Dev	Flange	MTHW	4	4.5	12	21.6	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	364.23
J. Cresswell Stuart Early Childhood Dev	Flange	MTHW	3	3.5	12	21.6	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	305.74
J. Cresswell Stuart Early Childhood Dev	Check Valve	MTHW	4	4.5	2	8.2	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	138.27
J. Cresswell Stuart Early Childhood Dev	Centrifugal Pump	MTHW	3	3.5	2	10	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	141.55
J. Cresswell Stuart Early Childhood Dev	Butterfly Valve	MTHW	4	4.5	4	16.4	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	276.54
J. Cresswell Stuart Early Childhood Dev	Butterfly Valve	MTHW	3	3.5	6	24.6	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	348.20
J. Cresswell Stuart Early Childhood Dev	Balance Valve	MTHW	3	3.5	3	12.3	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	174.10

Pipe and Valve Insulation Savings

BUILDING	Component	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	PIPE OD ""	Total Quantity or Length	Total Eq Length(LF) or Total Area(SF)*	AMBIENT TEMP	Fluid Temperature	Savings Factor	OPERATION HOURS/YEAR	Heating / Cooling Efficiency	Proposed Insulation Type	Proposed Jacket Type	Proposed Insulation Thickness	Scaling Factor	Fuel Savings Therms
James A. Cotten Intermediate School	Condensate Tank	Cond	21 1/4	#N/A	1	1	85	165	281	5,110	0.83	Cellular Glass	ASJ	2.0	0.62	17.25
James A. Cotten Intermediate School	90 Degree Elbow	Cond	3	3.5	2	3.6	85	165	236	5,110	0.83	Cellular Glass	PVC	2.0	0.62	52.14
James A. Cotten Intermediate School	In-Line Pump	Cond	1 1/2	1.9	2	10	85	165	120	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.62	73.65
James A. Cotten Intermediate School	Flange	Cond	3	3.5	1	1.8	85	165	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.62	25.41
James A. Cotten Intermediate School	Check Valve	Cond	3	3.5	1	4.1	85	165	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.62	57.88
James A. Cotten Intermediate School	Strainer	LPS	1	1.315	1	5	85	205	85	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.92	26.08
James A. Cotten Intermediate School	Steam Trap	LPS	1	1.315	3	13.2	85	205	85	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.92	68.86
James A. Cotten Intermediate School	Flange	LPS	3	3.5	4	7.2	85	205	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.92	101.63
James A. Cotten Intermediate School	Bonnet	LPS	4	4	2	3.6	85	205	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.92	60.54
James A. Cotten Intermediate School	Bonnet	LPS	3	3.5	1	1.8	85	205	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.92	25.41
James A. Cotten Intermediate School	Air Seperator Tank	MTHW	31 2/5	#N/A	1	1	85	185	281	5,110	0.83	Cellular Glass	ASJ	2.0	0.77	17.25
James A. Cotten Intermediate School	90 Degree Elbow	MTHW	4	4.5	8	14.4	85	185	281	5,110	0.83	Cellular Glass	PVC	2.0	0.77	248.34
James A. Cotten Intermediate School	45 Degree Elbow	MTHW	4	4.5	4	4	85	185	281	5,110	0.83	Cellular Glass	PVC	2.0	0.77	68.98
James A. Cotten Intermediate School	Triple Duty Valve	MTHW	6	6.625	2	8.8	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	151.76
James A. Cotten Intermediate School	Suction Diffuser	MTHW	6	6.625	2	8.8	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	151.76
James A. Cotten Intermediate School	Flex Fitting	MTHW	6	6.625	4	6	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	103.48
James A. Cotten Intermediate School	Flex Fitting	MTHW	4	4.5	8	12	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	201.80
James A. Cotten Intermediate School	Flange	MTHW	6	6.625	16	28.8	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	496.68
James A. Cotten Intermediate School	Flange	MTHW	4	4.5	24	43.2	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	726.47
James A. Cotten Intermediate School	Check Valve	MTHW	4	4.5	4	16.4	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	275.79
James A. Cotten Intermediate School	Centrifugal Pump	MTHW	4	4.5	2	10	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	168.16
James A. Cotten Intermediate School	Butterfly Valve	MTHW	4	4.5	8	32.8	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	551.58
Memorial Middle School	Straight Pipe	MTHW	4	4.5	4	4	85	185	281	5,110	0.83	Cellular Glass	ASJ	2.0	0.77	69.40
Memorial Middle School	Air Seperator Tank	MTHW	15.441892	#N/A	1	1	85	185	281	5,110	0.83	Cellular Glass	ASJ	2.0	0.77	17.35
Memorial Middle School	90 Degree Elbow	MTHW	4	4.5	8	14.4	85	185	281	5,110	0.83	Cellular Glass	PVC	2.0	0.77	249.84
Memorial Middle School	Triple Duty Valve	MTHW	6	6.625	2	8.8	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	152.68
Memorial Middle School	Suction Diffuser	MTHW	6	6.625	2	8.8	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	152.68
Memorial Middle School	Flex Fitting	MTHW	6	6.625	4	6	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	104.10
Memorial Middle School	Flex Fitting	MTHW	4	4.5	8	12	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	203.01
Memorial Middle School	Flange	MTHW	6	6.625	10	18	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	312.30
Memorial Middle School	Flange	MTHW	5	5.563	2	3.6	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	62.46
Memorial Middle School	Flange	MTHW	4	4.5	9	16.2	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	274.07
Memorial Middle School	Check Valve	MTHW	4	4.5	3	12.3	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	208.09
Memorial Middle School	Centrifugal Pump	MTHW	4	4.5	2	10	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	169.18
Memorial Middle School	Butterfly Valve	MTHW	6	6.625	2	8.2	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	142.27
Memorial Middle School	Butterfly Valve	MTHW	5	5.563	3	12.3	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	213.40
Memorial Middle School	Butterfly Valve	MTHW	4	4.5	13	53.3	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	901.72

Pipe and Valve Insulation Savings

BUILDING	Component	Fluid Type	Pipe Dia (") or Tank Surface Area(SF)*	PIPE OD ""	Total Quantity or Length	Total Eq Length(LF) or Total Area(SF)*	AMBIENT TEMP	Fluid Temperature	Savings Factor	OPERATION HOURS/YEAR	Heating / Cooling Efficiency	Proposed Insulation Type	Proposed Jacket Type	Proposed Insulation Thickness	Scaling Factor	Fuel Savings Therms
Twin Hills Elementary School	Air Seperator Tank	MTHW	11.2952778	#N/A	1	1	85	185	281	5,110	0.83	Cellular Glass	ASJ	2.0	0.77	17.29
Twin Hills Elementary School	90 Degree Elbow	MTHW	4	4.5	1	1.8	85	185	281	5,110	0.83	Cellular Glass	PVC	2.0	0.77	31.13
Twin Hills Elementary School	Triple Duty Valve	MTHW	4	4.5	2	8.8	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	148.39
Twin Hills Elementary School	Triple Duty Valve	MTHW	3	3.5	2	8.8	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	124.56
Twin Hills Elementary School	Suction Diffuser	MTHW	4	4.5	2	8.8	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	148.39
Twin Hills Elementary School	Strainer	MTHW	4	4.5	4	20	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	337.25
Twin Hills Elementary School	Strainer	MTHW	1.5	1.9	1	5	85	185	120	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	36.93
Twin Hills Elementary School	In-Line Pump	MTHW	4	4.5	2	10	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.77	168.62
Twin Hills Elementary School	Flex Fitting	MTHW	4	4.5	8	12	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	202.3497167
Twin Hills Elementary School	Flange	MTHW	4	4.5	20	36	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	607.04915
Twin Hills Elementary School	Flange	MTHW	3	3.5	4	7.2	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	101.9133609
Twin Hills Elementary School	Flange	MTHW	2	2.375	2	3.6	85	185	148	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	32.78951613
Twin Hills Elementary School	Check Valve	MTHW	1.5	1.9	1	4.1	85	185	120	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	30.27860724
Twin Hills Elementary School	Centrifugal Pump	MTHW	3	3.5	2	10	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	141.5463347
Twin Hills Elementary School	Butterfly Valve	MTHW	4	4.5	8	32.8	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	553.0892256
Twin Hills Elementary School	Butterfly Valve	MTHW	3	3.5	4	16.4	85	185	230	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	232.1359888
Twin Hills Elementary School	Ball valve	MTHW	2	2.375	2	8.2	85	185	148	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	74.68723119
Twin Hills Elementary School	Ball valve	MTHW	1.5		1		85	185	#N/A	5,110	0.83	Removable Blanket	Fiberglass Fabric		0.769231	
W.R. James Elementary School	T Intersection	DHW	1.5	1.9	6	7.2	85	125	120	8,760	0.84	Cellular Glass	PVC	1.5	0.307692	90.60622927
W.R. James Elementary School	Straight Pipe	DHW	2	2.375	3	3	85	125	148	8,760	0.84	Cellular Glass	ASJ	1.5	0.307692	46.56153449
W.R. James Elementary School	Straight Pipe	DHW	1.5	1.9	12	12	85	125	120	8,760	0.84	Cellular Glass	ASJ	1.5	0.307692	151.0103821
W.R. James Elementary School	90 Degree Elbow	DHW	2	2.375	1	1.8	85	125	148	8,760	0.84	Cellular Glass	PVC	1.5	0.307692	27.93692069
W.R. James Elementary School	90 Degree Elbow	DHW	1.5	1.9	4	7.2	85	125	120	8,760	0.84	Cellular Glass	PVC	1.5	0.307692	90.60622927
W.R. James Elementary School	Ball valve	DHW	2	2.375	1	4.1	85	125	148	8,760	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.307692	63.63409713
W.R. James Elementary School	Ball valve	DHW	1.5	1.9	6	24.6	85	125	120	8,760	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.307692	309.5712833
W.R. James Elementary School	Straight Pipe	MTHW	1	1.315	12	12	85	185	85	5,110	0.84	Cellular Glass	ASJ	1.5	0.769231	62.39665094
W.R. James Elementary School	90 Degree Elbow	MTHW	1	1.315	11	19.8	85	185	85	5,110	0.84	Cellular Glass	PVC	1.5	0.769231	102.9544741
W.R. James Elementary School	Suction Diffuser	MTHW	4		2		85	185	#N/A	5,110	0.84	Removable Blanket	Fiberglass Fabric		0.769231	
W.R. James Elementary School	Strainer	MTHW	4	4.5	2	10	85	185	274	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.769231	167.6145329
W.R. James Elementary School	In-Line Pump	MTHW	3	3.5	3	15	85	185	230	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.769231	211.0474958
W.R. James Elementary School	Flex Fitting	MTHW	4	4.5	4	6	85	185	274	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.769231	100.5687198
W.R. James Elementary School	Flex Fitting	MTHW	3	3.5	6	9	85	185	230	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.769231	126.6284975
W.R. James Elementary School	Flange	MTHW	5	5.563	1	1.8	85	185	281	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.769231	30.94139809
W.R. James Elementary School	Flange	MTHW	4	4.5	10	18	85	185	274	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.769231	301.7061593
W.R. James Elementary School	Flange	MTHW	3	3.5	6	10.8	85	185	230	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.769231	151.954197
W.R. James Elementary School	Flange	MTHW	2	2.375	2	3.6	85	185	148	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.769231	32.59307414
W.R. James Elementary School	Centrifugal Pump	MTHW	2	2.375	2	10	85	185	148	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.769231	90.53631706
W.R. James Elementary School	Ball valve	MTHW	1	1.315	6	24.6	85	185	85	5,110	0.84	Removable Blanket	Fiberglass Fabric	1.5	0.769231	127.9131344
Warehouse	T Intersection	MTHW	2	2.375	4	4.8	85	185	153	5,110	0.83	Cellular Glass	PVC	2.0	0.769231	45.39589935
Warehouse	Straight Pipe	MTHW	2	2.375	35	35	85	185	153	5,110	0.83	Cellular Glass	ASJ	2.0	0.769231	331.0117661
Warehouse	90 Degree Elbow	MTHW	2	2.375	11	19.8	85	185	153	5,110	0.83	Cellular Glass	PVC	2.0	0.769231	187.2580848
Warehouse	45 Degree Elbow	MTHW	2	2.375	2	2	85	185	153	5,110	0.83	Cellular Glass	PVC	2.0	0.769231	18.91495806
Warehouse	In-Line Pump	MTHW	2	2.375	3	15	85	185	148	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	137.2261663
Warehouse	Flo-Check	MTHW	2	2.375	1	4.1	85	185	148	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	37.50848546
Warehouse	Ball valve	MTHW	2	2.375	8	32.8	85	185	148	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	300.0678837
Warehouse	Air Scoop	MTHW	2	2.375	1	4.4	85	185	148	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	40.25300879
Willingboro High School	Air Seperator Tank	MTHW	37.68	#N/A	1	1	85	185	281	5,110	0.83	Cellular Glass	ASJ	2.0	0.769231	17.34994221
Willingboro High School	Triple Duty Valve	MTHW	6	6.625	2	8.8	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	152.6794914
Willingboro High School	Suction Diffuser	MTHW	6	6.625	2	8.8	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	152.6794914
Willingboro High School	Flex Fitting	MTHW	6	6.625	2	3	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	52.04982662
Willingboro High School	Flange	MTHW	6	6.625	8	14.4	85	185	281	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	249.8391678
Willingboro High School	Flange	MTHW	4	4.5	12	21.6	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	365.4231244
Willingboro High School	Check Valve	MTHW	4	4.5	6	24.6	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	416.1763361
Willingboro High School	Centrifugal Pump	MTHW	4	4.5	2	10	85	185	274	5,110	0.83	Removable Blanket	Fiberglass Fabric	1.5	0.769231	169.1773724

Algorithms

Fossil Fuel Source:

Fuel Savings (MMBtu/yr) = SF * L * Oper Hrs / EFF

Electric Source:

Energy Savings (kWh/yr) = SF * L * Oper Hrs / EFF / C

Scaling: Only applicable if differential between the fluid temperature and space temperature is significantly different than 130°F. If this is the case, the fuel or electric savings calculated with the above formulas should be multiplied by the resulting scaling factor deroived as:

Scaling Factor (unitless) = (FT – ST)/130

Fuel or electric savinsg calculated using the derived savings factors should be multiplied by the acaling factor.

Scaled Savings (MMBtu/year or kWh/yr) = Calculated Savings * Savings Factor

Definition of Variables

SF = Savings factor derived from #E Plus Version 4.1 tool, Btu/hr-ft see table below

L = Length of pipe from water heating source to hot water application, ft

Oper Hrs = hours per year fluid flows in pipe, hours

EFF = Efficiency of equipment providing heat to the fluid

C = Conversion factor from Btu to kWh = 3,413 for electric water heating (kWh)

FT = Fluid Temperature (°F)

ST = Space temperature (°F)

Summary of Inputs

Pipe Insulation

Component	Type	Value	Source
SF	Fixed	See Table Below	1
L	Variable		Application
Oper Hrs	Fixed	4,282 hrs/year (default value reflects average heating season hours)	2
EFF	Fixed	98% electric 80% natural gas	3
FT	Variable		Application
ST	Variable		Application

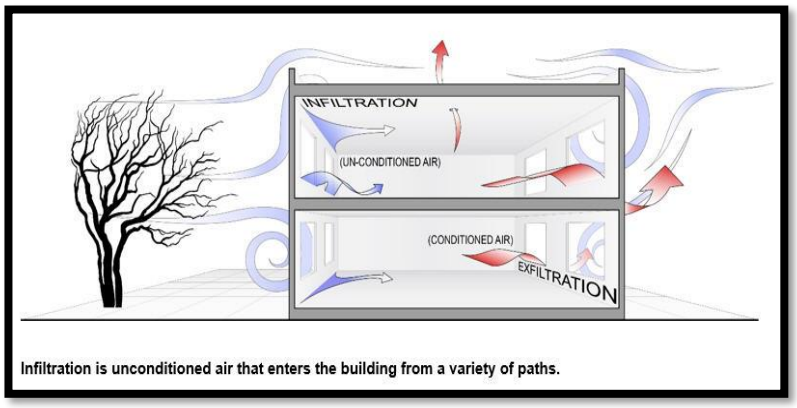
Savings Factor

	Savings, Btu/hr-ft			
Nominal Pipe Size, Inches	0.5" Insulation	1.0" Insulation	1.5" Insulation	2.0" Insulation
0.50	47	53	56	57
0.75	58	64	68	70
1.00	72	82	85	87
1.25	89	100	107	108
1.50	100	115	120	125
2.00	128	143	148	153
2.50	153	171	182	185
3.00	195	221	230	236
3.50	224	241	248	253
4.00	232	263	274	281

ECM 7 – Building Envelope Improvements

Willingboro Township Public Schools ECM Matrix		Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
✔	ECM was evaluated												
✔	ECM included in the project												
ECM #	ECM DESCRIPTION												
7	Building Envelope Weatherization	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

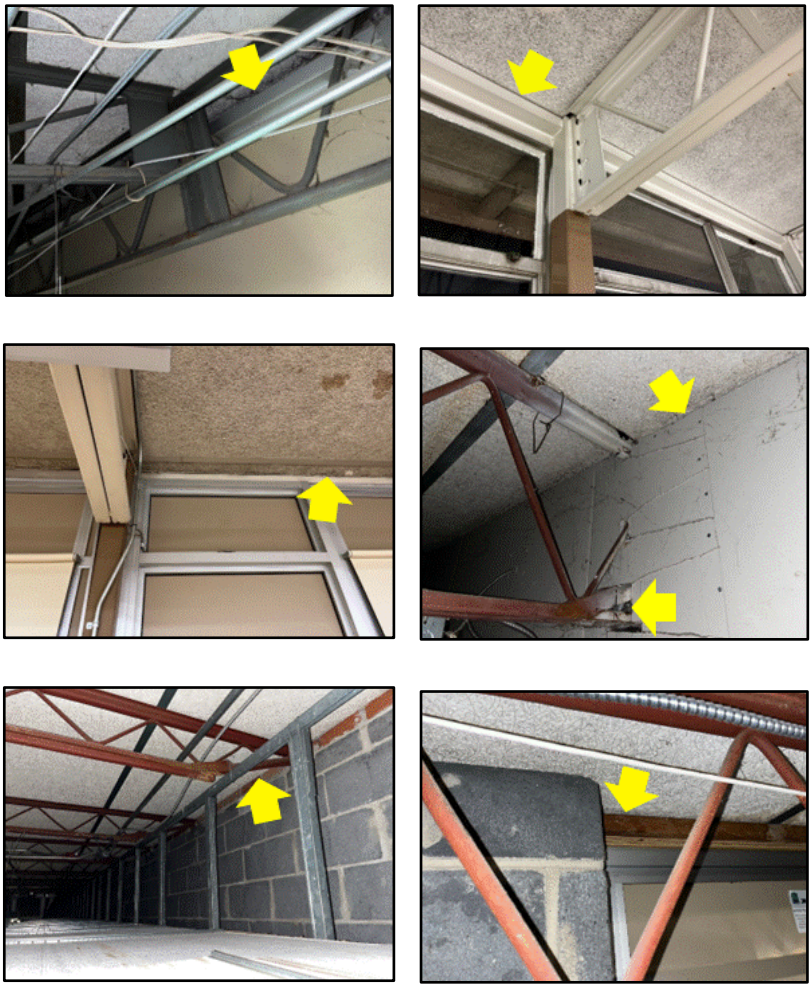
An on-site survey of the existing air barrier continuity was conducted at all twelve (12) Willingboro Township School's buildings. During the on-site inspection, several areas of the facilities were inspected for effective air barriers at the building envelope. Temperature, relative humidity, CO2 levels, smoke pencil testing and Infrared imaging was used to determine areas of uncontrolled air leakage into and out of the buildings.



Infiltration is unconditioned air that enters the building from a variety of paths.

Each of these facilities had varying degrees of uncontrolled air leakage into and out of the buildings. Typically, the exterior doors were found to have failed, missing or worn weather-seals and in some cases the exterior caulking had failed. Many of the facilities had insulation materials installed at the exterior roof/wall intersections. This can increase thermal values, however, the air leakage around the insulation and through the roof/wall joint was significant and results in increased energy costs.

Existing Conditions



Scope of Work

Building Envelope improvements to the district include:

- Door weather Stripping
- Roof-Wall Intersection Air Sealing
- Overhand Air Sealing
- Caulking
- Buck Frame Air Sealing
- Attic Insulation
- Attic Bypass Air Sealing
    - Weather strip and insulate the attic hatch to provide an airtight seal with permanently fixed insulation to prevent thermal heat gain and loss consistent with the surrounding attic recommendations.
- Garage Door Weather Stripping

ECM Calculations

Energy Savings from the installation of building envelope improvements are calculated on the following pages:

*Note: Building Envelope Improvements for Joseph A. McGinley School were evaluated but due to existing building conditions and poor financial payback, installation is not included in the ESIP Project. Savings are not shown below but can be reviewed on Form II in Section 4 of the Energy Savings Plan.

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Building Envelope - Heating Savings

Building	TYPE	SUBTYPE	BE RETROFIT INFILTRATION REDUCTION (CFM)	HEATING FUEL	HEATING EFFICIENCY (%)	SENSIABLE HEAT CONSTANT	HOURS (HR/DAY)	HEAT EFFICIENCY FACTOR	HDD	TOTAL HEATING SAVINGS (THERM)
Bookbinder School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	785	Natural Gas	80.00%	1.08	24	3086	5363	1,364
Bookbinder School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	653	Natural Gas	80.00%	1.08	24	3086	5363	1,134
Bookbinder School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	323	Natural Gas	80.00%	1.08	24	3086	5363	561
Bookbinder School	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	29	Natural Gas	80.00%	1.08	24	3086	5363	51
Country Club Administration Building	Overhang Air Sealing	Block, Seal (LF)	72	Natural Gas	87.00%	1.08	24	3356	5363	115
Country Club Administration Building	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	322	Natural Gas	87.00%	1.08	24	3356	5363	515
Country Club Administration Building	Door Weather Stripping	Install Door Jamb Spacer (UT)	0	Natural Gas	87.00%	1.08	24	3356	5363	0
Country Club Administration Building	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	131	Natural Gas	87.00%	1.08	24	3356	5363	209
Country Club Administration Building	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	215	Natural Gas	87.00%	1.08	24	3356	5363	344
Garfield East Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	452	Natural Gas	86.60%	1.08	24	3341	5363	726
Garfield East Elementary School	Overhang Air Sealing	Block, Seal (LF)	17	Natural Gas	86.60%	1.08	24	3341	5363	28
Garfield East Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	109	Natural Gas	86.60%	1.08	24	3341	5363	175
Garfield East Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	323	Natural Gas	86.60%	1.08	24	3341	5363	519
Hawthorne Elementary School	Roof-Wall Intersection Air Sealing	Seal (LF)	287	Natural Gas	86.60%	1.08	24	3341	5363	461
Hawthorne Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	592	Natural Gas	86.60%	1.08	24	3341	5363	951
Hawthorne Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	674	Natural Gas	86.60%	1.08	24	3341	5363	1,083
Hawthorne Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	323	Natural Gas	86.60%	1.08	24	3341	5363	519
James A. Cotten Intermediate School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	92	Natural Gas	85.80%	1.08	24	3310	5363	150
James A. Cotten Intermediate School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	307	Natural Gas	85.80%	1.08	24	3310	5363	498
James A. Cotten Intermediate School	Roof-Wall Intersection Air Sealing	Seal (LF)	10	Natural Gas	85.80%	1.08	24	3310	5363	16
James A. Cotten Intermediate School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	218	Natural Gas	85.80%	1.08	24	3310	5363	352
James A. Cotten Intermediate School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	1005	Natural Gas	85.80%	1.08	24	3310	5363	1,628
J. Cresswell Stuart Early Childhood Development Center	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	761	Natural Gas	86.60%	1.08	24	3341	5363	1,222
J. Cresswell Stuart Early Childhood Development Center	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	503	Natural Gas	86.60%	1.08	24	3341	5363	807
J. Cresswell Stuart Early Childhood Development Center	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	390	Natural Gas	86.60%	1.08	24	3341	5363	626
J. Cresswell Stuart Early Childhood Development Center	Roof-Wall Intersection Air Sealing	Seal (LF)	9	Natural Gas	86.60%	1.08	24	3341	5363	14
Memorial Middle School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	529	Natural Gas	85.80%	1.08	24	3310	5363	858
Memorial Middle School	Roof-Wall Intersection Air Sealing	Seal (LF)	141	Natural Gas	85.80%	1.08	24	3310	5363	229
Memorial Middle School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	522	Natural Gas	85.80%	1.08	24	3310	5363	846
Memorial Middle School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	610	Natural Gas	85.80%	1.08	24	3310	5363	989
Twin Hills Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	131	Natural Gas	86.60%	1.08	24	3341	5363	210
Twin Hills Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	287	Natural Gas	86.60%	1.08	24	3341	5363	461
Twin Hills Elementary School	Roof-Wall Intersection Air Sealing	Seal Paint (LF)	62	Natural Gas	86.60%	1.08	24	3341	5363	100
Twin Hills Elementary School	Roof-Wall Intersection Air Sealing	Block, Seal Paint (LF)	202	Natural Gas	86.60%	1.08	24	3341	5363	325
Twin Hills Elementary School	Overhang Air Sealing	Block, Seal (LF)	14	Natural Gas	86.60%	1.08	24	3341	5363	23
Twin Hills Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	486	Natural Gas	86.60%	1.08	24	3341	5363	780
Warehouse	Garage Door Weather Stripping	Overhead Door Weather Strip - Sides, Top	359	Natural Gas	87.00%	1.08	24	3356	5363	574
Warehouse	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	87	Natural Gas	87.00%	1.08	24	3356	5363	139
Warehouse	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	72	Natural Gas	87.00%	1.08	24	3356	5363	115
W.R. James Elementary School	Buck Frame Air Sealing	Block, Seal Exposed (LF)	8	Natural Gas	86.60%	1.08	24	3341	5363	12
W.R. James Elementary School	Roof-Wall Intersection Air Sealing	Seal (LF)	312	Natural Gas	86.60%	1.08	24	3341	5363	500
W.R. James Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	523	Natural Gas	86.60%	1.08	24	3341	5363	839
W.R. James Elementary School	Door Weather Stripping	Install Door Jamb Spacer (UT)	0	Natural Gas	86.60%	1.08	24	3341	5363	0
W.R. James Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	696.14	Natural Gas	86.60%	1.08	24	3341	5363	1117
W.R. James Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	287.16	Natural Gas	86.60%	1.08	24	3341	5363	461
Willingboro High School	Door Weather Stripping	Install Door Jamb Spacer (UT)	0.00	Natural Gas	85.80%	1.08	24	3310	5363	0
Willingboro High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	304.56	Natural Gas	85.80%	1.08	24	3310	5363	493
Willingboro High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	1,292.22	Natural Gas	85.80%	1.08	24	3310	5363	2094
Willingboro High School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	474.25	Natural Gas	85.80%	1.08	24	3310	5363	768
Willingboro High School	Overhang Air Sealing	Block, Seal (SF)	344	Natural Gas	85.80%	1.08	24	3310	5363	557
Willingboro High School	Roof-Wall Intersection Air Sealing	Seal (LF)	22	Natural Gas	85.80%	1.08	24	3310	5363	35
Willingboro High School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	529	Natural Gas	85.80%	1.08	24	3310	5363	856

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Building Envelope Savings - Cooling Savings

BUILDING	TYPE	SUBTYPE	% of Building Cooled	INFILTRATION REDUCTION (CFM)	TOTAL HEAT CONSTANT	INTERIOR DRY BULB TEMP (F)	EXTERIOR DRY BULB TEMP (F)	INTERIOR DRY RELATIVE HUMIDITY (%)	EXTERIOR RELATIVE HUMIDITY (%)
Bookbinder School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	100%	785	4.5	72.0	75.0	40.0	75.0
Bookbinder School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	100%	653	4.5	72.0	75.0	40.0	75.0
Bookbinder School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	100%	323	4.5	72.0	75.0	40.0	75.0
Bookbinder School	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	100%	29	4.5	72.0	75.0	40.0	75.0
Country Club Administration Building	Overhang Air Sealing	Block, Seal (LF)	75%	54	4.5	72.0	75.0	40.0	75.0
Country Club Administration Building	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	75%	242	4.5	72.0	75.0	40.0	75.0
Country Club Administration Building	Door Weather Stripping	Install Door Jamb Spacer (UT)	75%	0	4.5	72.0	75.0	40.0	75.0
Country Club Administration Building	Door Weather Stripping		75%	98	4.5	72.0	75.0	40.0	75.0
Country Club Administration Building	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	75%	162	4.5	72.0	75.0	40.0	75.0
Garfield East Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	85%	385	4.5	72.0	75.0	40.0	75.0
Garfield East Elementary School	Overhang Air Sealing	Block, Seal (LF)	85%	15	4.5	72.0	75.0	40.0	75.0
Garfield East Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	85%	92	4.5	72.0	75.0	40.0	75.0
Garfield East Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	85%	275	4.5	72.0	75.0	40.0	75.0
Hawthorne Elementary School	Roof-Wall Intersection Air Sealing	Seal (LF)	85%	244	4.5	72.0	75.0	40.0	75.0
Hawthorne Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	85%	504	4.5	72.0	75.0	40.0	75.0
Hawthorne Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	85%	573	4.5	72.0	75.0	40.0	75.0
Hawthorne Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	85%	274.60	4.5	72.0	75.0	40.0	75.0
James A. Cotten Intermediate School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	85%	78.59	4.5	72.0	75.0	40.0	75.0
James A. Cotten Intermediate School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	85%	261.04	4.5	72.0	75.0	40.0	75.0
James A. Cotten Intermediate School	Roof-Wall Intersection Air Sealing	Seal (LF)	85%	8.63	4.5	72.0	75.0	40.0	75.0
James A. Cotten Intermediate School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	85%	184.91	4.5	72.0	75.0	40.0	75.0
James A. Cotten Intermediate School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	85%	854.30	4.5	72.0	75.0	40.0	75.0
J. Cresswell Stuart Early Childhood Development Center	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	85%	647.20	4.5	72.0	75.0	40.0	75.0
J. Cresswell Stuart Early Childhood Development Center	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	85%	427.15	4.5	72.0	75.0	40.0	75.0
J. Cresswell Stuart Early Childhood Development Center	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	85%	331.61	4.5	72.0	75.0	40.0	75.0
J. Cresswell Stuart Early Childhood Development Center	Roof-Wall Intersection Air Sealing	Seal (LF)	85%	7.40	4.5	72.0	75.0	40.0	75.0
Memorial Middle School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	100%	529.36	4.5	72.0	75.0	40.0	75.0
Memorial Middle School	Roof-Wall Intersection Air Sealing	Seal (LF)	100%	141.40	4.5	72.0	75.0	40.0	75.0
Memorial Middle School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	100%	522.11	4.5	72.0	75.0	40.0	75.0
Memorial Middle School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	100%	610.21	4.5	72.0	75.0	40.0	75.0
Twin Hills Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	85%	110.95	4.5	72.0	75.0	40.0	75.0
Twin Hills Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	85%	244.09	4.5	72.0	75.0	40.0	75.0
Twin Hills Elementary School	Roof-Wall Intersection Air Sealing	Seal Paint (LF)	85%	53.01	4.5	72.0	75.0	40.0	75.0
Twin Hills Elementary School	Roof-Wall Intersection Air Sealing	Block, Seal Paint (LF)	85%	171.97	4.5	72.0	75.0	40.0	75.0
Twin Hills Elementary School	Overhang Air Sealing	Block, Seal (LF)	85%	12.02	4.5	72.0	75.0	40.0	75.0
Twin Hills Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	85%	412.97	4.5	72.0	75.0	40.0	75.0
Warehouse	Garage Door Weather Stripping	Overhead Door Weather Strip - Sides, Top	10%	35.89	4.5	72.0	75.0	40.0	75.0
Warehouse	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	10%	8.70	4.5	72.0	75.0	40.0	75.0
Warehouse	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	10%	7.18	4.5	72.0	75.0	40.0	75.0
W.R. James Elementary School	Buck Frame Air Sealing	Block, Seal Exposed (LF)	85%	6.47	4.5	72.0	75.0	40.0	75.0
W.R. James Elementary School	Roof-Wall Intersection Air Sealing	Seal (LF)	85%	264.89	4.5	72.0	75.0	40.0	75.0
W.R. James Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	85%	444.41	4.5	72.0	75.0	40.0	75.0
W.R. James Elementary School	Door Weather Stripping	Install Door Jamb Spacer (UT)	85%	0.00	4.5	72.0	75.0	40.0	75.0
W.R. James Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	85%	591.72	4.5	72.0	75.0	40.0	75.0
W.R. James Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	85%	244.09	4.5	72.0	75.0	40.0	75.0
Willingboro High School	Door Weather Stripping	Install Door Jamb Spacer (UT)	100%	0.00	4.5	72.0	75.0	40.0	75.0
Willingboro High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	100%	304.56	4.5	72.0	75.0	40.0	75.0
Willingboro High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	100%	1292.22	4.5	72.0	75.0	40.0	75.0
Willingboro High School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	100%	474.25	4.5	72.0	75.0	40.0	75.0
Willingboro High School	Overhang Air Sealing	Block, Seal (SF)	100%	343.72	4.5	72.0	75.0	40.0	75.0
Willingboro High School	Roof-Wall Intersection Air Sealing	Seal (LF)	100%	21.75	4.5	72.0	75.0	40.0	75.0
Willingboro High School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	100%	528.63	4.5	72.0	75.0	40.0	75.0

Building Envelope Savings - Cooling Savings										
BUILDING	TYPE	SUBTYPE	INTERIOR ENTHALPY (SUMMER)	EXTERIOR ENTHALPY (SUMMER)	ENTHALPY	TONS	EFFICIENCY (kW/TON)	Cooling Degree Days	INFILTRATION ELECTRIC SAVINGS (kW)	INFILTRATION ELECTRIC SAVINGS (kWh)
Bookbinder School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24.55	33.27	8.72	2.57	1.06	896	3	2,428
Bookbinder School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24.55	33.27	8.72	2.13	1.06	896	2	2,019
Bookbinder School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	1.06	1.06	896	1	999
Bookbinder School	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	24.55	33.27	8.72	0.10	1.06	896	0	91
Country Club Administration Building	Overhang Air Sealing	Block, Seal (LF)	24.55	33.27	8.72	0.18	1.10	896	0	173
Country Club Administration Building	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24.55	33.27	8.72	0.79	1.10	896	1	778
Country Club Administration Building	Door Weather Stripping	Install Door Jamb Spacer (UT)	24.55	33.27	8.72	0.00	1.10	896	0	0
Country Club Administration Building	Door Weather Stripping		24.55	33.27	8.72	0.32	1.10	896	0	315
Country Club Administration Building	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	0.53	1.10	896	1	520
Garfield East Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24.55	33.27	8.72	1.26	1.19	896	1	1,337
Garfield East Elementary School	Overhang Air Sealing	Block, Seal (LF)	24.55	33.27	8.72	0.05	1.19	896	0	51
Garfield East Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24.55	33.27	8.72	0.30	1.19	896	0	321
Garfield East Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	0.90	1.19	896	1	954
Hawthorne Elementary School	Roof-Wall Intersection Air Sealing	Seal (LF)	24.55	33.27	8.72	0.80	1.16	896	1	831
Hawthorne Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24.55	33.27	8.72	1.65	1.16	896	2	1,715
Hawthorne Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24.55	33.27	8.72	1.87	1.16	896	2	1,952
Hawthorne Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	0.90	1.16	896	1	935
James A. Cotten Intermediate School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	24.55	33.27	8.72	0.26	1.17	896	0	269
James A. Cotten Intermediate School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24.55	33.27	8.72	0.85	1.17	896	1	894
James A. Cotten Intermediate School	Roof-Wall Intersection Air Sealing	Seal (LF)	24.55	33.27	8.72	0.03	1.17	896	0	30
James A. Cotten Intermediate School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24.55	33.27	8.72	0.60	1.17	896	1	634
James A. Cotten Intermediate School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	2.79	1.17	896	3	2,927
J. Cresswell Stuart Early Childhood Development Center	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24.55	33.27	8.72	2.12	1.22	896	3	2,313
J. Cresswell Stuart Early Childhood Development Center	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	1.40	1.22	896	2	1,527
J. Cresswell Stuart Early Childhood Development Center	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24.55	33.27	8.72	1.08	1.22	896	1	1,185
J. Cresswell Stuart Early Childhood Development Center	Roof-Wall Intersection Air Sealing	Seal (LF)	24.55	33.27	8.72	0.02	1.22	896	0	26
Memorial Middle School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24.55	33.27	8.72	1.73	1.24	896	2	1,921
Memorial Middle School	Roof-Wall Intersection Air Sealing	Seal (LF)	24.55	33.27	8.72	0.46	1.24	896	1	513
Memorial Middle School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24.55	33.27	8.72	1.71	1.24	896	2	1,895
Memorial Middle School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	2.00	1.24	896	2	2,215
Twin Hills Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24.55	33.27	8.72	0.36	1.21	896	0	394
Twin Hills Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	0.80	1.21	896	1	866
Twin Hills Elementary School	Roof-Wall Intersection Air Sealing	Seal Paint (LF)	24.55	33.27	8.72	0.17	1.21	896	0	188
Twin Hills Elementary School	Roof-Wall Intersection Air Sealing	Block, Seal Paint (LF)	24.55	33.27	8.72	0.56	1.21	896	1	610
Twin Hills Elementary School	Overhang Air Sealing	Block, Seal (LF)	24.55	33.27	8.72	0.04	1.21	896	0	43
Twin Hills Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24.55	33.27	8.72	1.35	1.21	896	2	1,465
Warehouse	Garage Door Weather Stripping	Overhead Door Weather Strip - Sides, Top	24.55	33.27	8.72	0.12	1.31	896	0	138
Warehouse	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24.55	33.27	8.72	0.03	1.31	896	0	34
Warehouse	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	0.02	1.31	896	0	28
W.R. James Elementary School	Buck Frame Air Sealing	Block, Seal Exposed (LF)	24.55	33.27	8.72	0.02	1.17	896	0	22
W.R. James Elementary School	Roof-Wall Intersection Air Sealing	Seal (LF)	24.55	33.27	8.72	0.87	1.17	896	1	907
W.R. James Elementary School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24.55	33.27	8.72	1.45	1.17	896	2	1,522
W.R. James Elementary School	Door Weather Stripping	Install Door Jamb Spacer (UT)	24.55	33.27	8.72	0.00	1.17	896	0	0
W.R. James Elementary School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24.55	33.27	8.72	1.93	1.17	896	2	2,026
W.R. James Elementary School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	0.80	1.17	896	1	836
Willingboro High School	Door Weather Stripping	Install Door Jamb Spacer (UT)	24.55	33.27	8.72	0.00	0.66	896	0	0
Willingboro High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	24.55	33.27	8.72	1.00	0.66	896	1	586
Willingboro High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	24.55	33.27	8.72	4.22	0.66	896	3	2,487
Willingboro High School	Roof-Wall Intersection Air Sealing	Seal Exposed (LF)	24.55	33.27	8.72	1.55	0.66	896	1	913
Willingboro High School	Overhang Air Sealing	Block, Seal (SF)	24.55	33.27	8.72	1.12	0.66	896	1	662
Willingboro High School	Roof-Wall Intersection Air Sealing	Seal (LF)	24.55	33.27	8.72	0.07	0.66	896	0	42
Willingboro High School	Roof-Wall Intersection Air Sealing	Block, Seal (LF)	24.55	33.27	8.72	1.73	0.66	896	1	1,017

Enthalpy
Based on Interior Relative Humidity of 40% and temperature of 72 degrees F = 24.55 btu/lb. Exterior Enthalpy based on outside relative humidity estimate of 75% and the below NOAA summer temperature data.

Heat Efficiency Factor
The derivation of the Efficiency Factor is based on sensible heat constant (1.08 * 24 Hours per Day) and an assumed efficiency percentage for the heating plant in the building. The efficiency of the heating plant is captured as a percentage of the total energy output of the heating system.

Calculation is = 1.08 * 24 hours per day = 25.92; in order to get the Efficiency Factor in the denominator and account for system efficiency = 1/ (25.92 / (1,000,000 Btus * **Heating** Plant Efficiency Percent).

Infiltration Heating Savings (therm) = Infiltration Reduction (CFM) * Heating Degree Days (HDD) / Heat Efficiency Factor

Thermal Insulation Savings (therm) = Existing Heat Loss (therm) - Proposed Heat Loss (therm)

Existing Heat Loss (therm) = (Existing U-Value * (Hours/Day * Heating Degree Days (HDD)) * Surface Area (Sqft)) / Heating Efficiency (%) / 100,000 Btu/Therm

Proposed Heat Loss (therm) = (Proposed U-Value * (Hours/Day * Heating Degree Days (HDD)) * Surface Area (Sqft)) / Heating Efficiency (%) / 100,000 Btu/Therm

Infiltration Cooling Savings (kWh) = Tons * Efficiency (kW/ton) *Cooling Degree Days (CDD)*12000 btu/hr *0.000293071

Tons = Inflitration Reduction (CFM) * Total Heat Constant * Enthalpy / 12,0000 Btu/hr

Insulation Savings (kWh) = Existing Cooling Loss (kWh) - Proposed Cooling Loss (kWh)

Existing Cooling Loss (kWh) = (Existing U-Value) * (Hours/Day) * (Cooling Degree Days (CDD)) * (Surface Area (Sqft)) * (Cooling Efficiency (kWh/ton-hr)) * (1 Ton-hr/12,000 Btu)

Proposed Cooling Loss (kWh) = (Proposed U-Value) * (Hours/Day) * (Cooling Degree Days (CDD)) * (Surface Area (Sqft)) * (Cooling Efficiency (kWh/ton-hr)) * (1 Ton-hr/12,000 Btu)

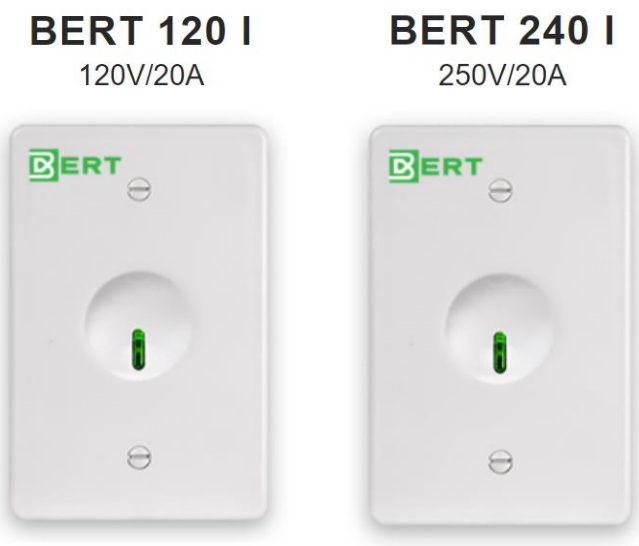
ECM 8 – Plug Load Controls

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
8	Plug Load Controls	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔	✔

Plug loads are often used for a small portion of the day. Left unmanaged, these loads can add a significant usage and cost to a building's electric load. Plug load controls utilize specialty sockets from BERT that have software to track real-time usage of your appliances. The software also allows the user to use a web browser to view this usage and automatically turn on/off all appliances plugged into these outlets.



Scope of Work

Existing wall plugs within the facilities will be retrofitted with specialty controllable wall plugs.

ECM Calculations

Energy savings are calculated by multiplying the equipment Standby Power Draw (W) by the number of hours the plug load will shut the equipment off completely:

Plug Load Controls Savings									
BUILDING NAME	Device Type	Plug Load Type	Quantity	Standby Power Draw (W)	Baseline Hours Scheduled ON per Year	Controller Hours Scheduled ON per Year	Controller Hours Scheduled OFF per Year	Annual Energy Savings (kWh)	Total Annual Energy Savings (kWh)
Bookbinder School	Projector	Bert 110X		8	8,760	3,500	5,260	0	
Bookbinder School	M Printer	Bert 110X		15	8,760	3,500	5,260	0	
Bookbinder School	Charging Cart/Station	Bert 110X		37	8,760	3,500	5,260	0	
Bookbinder School	Smartboard	Bert 110X		8	8,760	3,500	5,260	0	
Bookbinder School	AC-110 15A	Bert 110X		8	8,760	3,500	5,260	0	
Bookbinder School	AC-110 20A	Bert 120I Inline		8	8,760	3,500	5,260	0	7,390
Bookbinder School	AC-220 20A	Bert 240I Inline	15	8	8,760	3,500	5,260	631	
Bookbinder School	Copier- 110 15A	Bert 110X		40	8,760	3,500	5,260	0	
Bookbinder School	Air Scrubber	Bert 110X	18	68	8,760	3,500	5,260	6,438	
Bookbinder School	H/C Water	Bert 110X	1	61	8,760	3,500	5,260	321	
Bookbinder School	Soda Vend	Bert 110X		320	8,760	3,500	5,260	0	
Country Club Administration Building	Projector	Bert 110X		8	8,760	5,300	3,460	0	
Country Club Administration Building	M Printer	Bert 110X		15	8,760	5,300	3,460	0	
Country Club Administration Building	Charging Cart/Station	Bert 110X		37	8,760	5,300	3,460	0	
Country Club Administration Building	Smartboard	Bert 110X		8	8,760	5,300	3,460	0	
Country Club Administration Building	AC-110 15A	Bert 110X	8	8	8,760	5,300	3,460	221	
Country Club Administration Building	AC-110 20A	Bert 120I Inline	28	8	8,760	5,300	3,460	775	8,550
Country Club Administration Building	AC-220 20A	Bert 240I Inline	2	8	8,760	5,300	3,460	55	
Country Club Administration Building	Copier- 110 15A	Bert 110X		40	8,760	5,300	3,460	0	
Country Club Administration Building	Air Scrubber	Bert 110X	22	68	8,760	5,300	3,460	5,176	
Country Club Administration Building	H/C Water	Bert 110X	11	61	8,760	5,300	3,460	2,322	
Country Club Administration Building	Soda Vend	Bert 110X		320	8,760	5,300	3,460	0	
Garfield East Elementary School	Projector	Bert 110X		8	8,760	3,500	5,260	0	
Garfield East Elementary School	M Printer	Bert 110X		15	8,760	3,500	5,260	0	
Garfield East Elementary School	Charging Cart/Station	Bert 110X		37	8,760	3,500	5,260	0	
Garfield East Elementary School	Smartboard	Bert 110X		8	8,760	3,500	5,260	0	
Garfield East Elementary School	AC-110 15A	Bert 110X		8	8,760	3,500	5,260	0	
Garfield East Elementary School	AC-110 20A	Bert 120I Inline	1	8	8,760	3,500	5,260	42	12,251
Garfield East Elementary School	AC-220 20A	Bert 240I Inline	30	8	8,760	3,500	5,260	1,262	
Garfield East Elementary School	Copier- 110 15A	Bert 110X		40	8,760	3,500	5,260	0	
Garfield East Elementary School	Air Scrubber	Bert 110X	25	68	8,760	3,500	5,260	8,942	
Garfield East Elementary School	H/C Water	Bert 110X	1	61	8,760	3,500	5,260	321	
Garfield East Elementary School	Soda Vend	Bert 110X	1	320	8,760	3,500	5,260	1,683	
Hawthorne Elementary School	Projector	Bert 110X		8	8,760	3,500	5,260	0	
Hawthorne Elementary School	M Printer	Bert 110X		15	8,760	3,500	5,260	0	
Hawthorne Elementary School	Charging Cart/Station	Bert 110X		37	8,760	3,500	5,260	0	
Hawthorne Elementary School	Smartboard	Bert 110X		8	8,760	3,500	5,260	0	
Hawthorne Elementary School	AC-110 15A	Bert 110X		8	8,760	3,500	5,260	0	
Hawthorne Elementary School	AC-110 20A	Bert 120I Inline		8	8,760	3,500	5,260	0	8,206
Hawthorne Elementary School	AC-220 20A	Bert 240I Inline	25	8	8,760	3,500	5,260	1,052	
Hawthorne Elementary School	Copier- 110 15A	Bert 110X		40	8,760	3,500	5,260	0	
Hawthorne Elementary School	Air Scrubber	Bert 110X	20	68	8,760	3,500	5,260	7,154	
Hawthorne Elementary School	H/C Water	Bert 110X		61	8,760	3,500	5,260	0	
Hawthorne Elementary School	Soda Vend	Bert 110X		320	8,760	3,500	5,260	0	

Plug Load Controls Savings

BUILDING NAME	Device Type	Plug Load Type	Quantity	Standby Power Draw (W)	Baseline Hours Scheduled ON per Year	Controller Hours Scheduled ON per Year	Controller Hours Scheduled OFF per Year	Annual Energy Savings (kWh)	Total Annual Energy Savings (kWh)
J. Cresswell Stuart Early Childhood Development Center	Projector	Bert 110X		8	8,760	3,500	5,260	0	
J. Cresswell Stuart Early Childhood Development Center	M Printer	Bert 110X		15	8,760	3,500	5,260	0	
J. Cresswell Stuart Early Childhood Development Center	Charging Cart/Station	Bert 110X		37	8,760	3,500	5,260	0	
J. Cresswell Stuart Early Childhood Development Center	Smartboard	Bert 110X		8	8,760	3,500	5,260	0	
J. Cresswell Stuart Early Childhood Development Center	AC-110 15A	Bert 110X		8	8,760	3,500	5,260	0	
J. Cresswell Stuart Early Childhood Development Center	AC-110 20A	Bert 120I Inline		8	8,760	3,500	5,260	0	11,288
J. Cresswell Stuart Early Childhood Development Center	AC-220 20A	Bert 240I Inline	32	8	8,760	3,500	5,260	1,347	
J. Cresswell Stuart Early Childhood Development Center	Copier- 110 15A	Bert 110X		40	8,760	3,500	5,260	0	
J. Cresswell Stuart Early Childhood Development Center	Air Scrubber	Bert 110X	26	68	8,760	3,500	5,260	9,300	
J. Cresswell Stuart Early Childhood Development Center	H/C Water	Bert 110X	2	61	8,760	3,500	5,260	642	
J. Cresswell Stuart Early Childhood Development Center	Soda Vend	Bert 110X		320	8,760	3,500	5,260	0	
James A. Cotten Intermediate School	Projector	Bert 110X		8	8,760	3,500	5,260	0	
James A. Cotten Intermediate School	M Printer	Bert 110X		15	8,760	3,500	5,260	0	
James A. Cotten Intermediate School	Charging Cart/Station	Bert 110X		37	8,760	3,500	5,260	0	
James A. Cotten Intermediate School	Smartboard	Bert 110X		8	8,760	3,500	5,260	0	
James A. Cotten Intermediate School	AC-110 15A	Bert 110X		8	8,760	3,500	5,260	0	
James A. Cotten Intermediate School	AC-110 20A	Bert 120I Inline		8	8,760	3,500	5,260	0	16,096
James A. Cotten Intermediate School	AC-220 20A	Bert 240I Inline		8	8,760	3,500	5,260	0	
James A. Cotten Intermediate School	Copier- 110 15A	Bert 110X		40	8,760	3,500	5,260	0	
James A. Cotten Intermediate School	Air Scrubber	Bert 110X	45	68	8,760	3,500	5,260	16,096	
James A. Cotten Intermediate School	H/C Water	Bert 110X		61	8,760	3,500	5,260	0	
James A. Cotten Intermediate School	Soda Vend	Bert 110X		320	8,760	3,500	5,260	0	
Memorial Middle School	Projector	Bert 110X		8	8,760	3,500	5,260	0	
Memorial Middle School	M Printer	Bert 110X		15	8,760	3,500	5,260	0	
Memorial Middle School	Charging Cart/Station	Bert 110X		37	8,760	3,500	5,260	0	
Memorial Middle School	Smartboard	Bert 110X		8	8,760	3,500	5,260	0	
Memorial Middle School	AC-110 15A	Bert 110X		8	8,760	3,500	5,260	0	
Memorial Middle School	AC-110 20A	Bert 120I Inline	2	8	8,760	3,500	5,260	84	2,088
Memorial Middle School	AC-220 20A	Bert 240I Inline		8	8,760	3,500	5,260	0	
Memorial Middle School	Copier- 110 15A	Bert 110X		40	8,760	3,500	5,260	0	
Memorial Middle School	Air Scrubber	Bert 110X	0	68	8,760	3,500	5,260	0	
Memorial Middle School	H/C Water	Bert 110X	1	61	8,760	3,500	5,260	321	
Memorial Middle School	Soda Vend	Bert 110X	1	320	8,760	3,500	5,260	1,683	
Twin Hills Elementary School	Projector	Bert 110X		8	8,760	3,500	5,260	0	
Twin Hills Elementary School	M Printer	Bert 110X		15	8,760	3,500	5,260	0	
Twin Hills Elementary School	Charging Cart/Station	Bert 110X		37	8,760	3,500	5,260	0	
Twin Hills Elementary School	Smartboard	Bert 110X		8	8,760	3,500	5,260	0	
Twin Hills Elementary School	AC-110 15A	Bert 110X		8	8,760	3,500	5,260	0	
Twin Hills Elementary School	AC-110 20A	Bert 120I Inline	2	8	8,760	3,500	5,260	84	9,284
Twin Hills Elementary School	AC-220 20A	Bert 240I Inline	12	8	8,760	3,500	5,260	505	
Twin Hills Elementary School	Copier- 110 15A	Bert 110X		40	8,760	3,500	5,260	0	
Twin Hills Elementary School	Air Scrubber	Bert 110X	14	68	8,760	3,500	5,260	5,008	
Twin Hills Elementary School	H/C Water	Bert 110X	1	61	8,760	3,500	5,260	321	
Twin Hills Elementary School	Soda Vend	Bert 110X	2	320	8,760	3,500	5,260	3,366	
W.R. James Elementary School	Projector	Bert 110X		8	8,760	3,500	5,260	0	
W.R. James Elementary School	M Printer	Bert 110X		15	8,760	3,500	5,260	0	
W.R. James Elementary School	Charging Cart/Station	Bert 110X		37	8,760	3,500	5,260	0	
W.R. James Elementary School	Smartboard	Bert 110X		8	8,760	3,500	5,260	0	
W.R. James Elementary School	AC-110 15A	Bert 110X		8	8,760	3,500	5,260	0	
W.R. James Elementary School	AC-110 20A	Bert 120I Inline		8	8,760	3,500	5,260	0	13,429
W.R. James Elementary School	AC-220 20A	Bert 240I Inline	25	8	8,760	3,500	5,260	1,052	
W.R. James Elementary School	Copier- 110 15A	Bert 110X		40	8,760	3,500	5,260	0	
W.R. James Elementary School	Air Scrubber	Bert 110X	29	68	8,760	3,500	5,260	10,373	
W.R. James Elementary School	H/C Water	Bert 110X	1	61	8,760	3,500	5,260	321	
W.R. James Elementary School	Soda Vend	Bert 110X	1	320	8,760	3,500	5,260	1,683	
Warehouse	Projector	Bert 110X		8	8,760	3,500	5,260	0	
Warehouse	M Printer	Bert 110X		15	8,760	3,500	5,260	0	
Warehouse	Charging Cart/Station	Bert 110X		37	8,760	3,500	5,260	0	
Warehouse	Smartboard	Bert 110X		8	8,760	3,500	5,260	0	
Warehouse	AC-110 15A	Bert 110X	3	8	8,760	3,500	5,260	126	
Warehouse	AC-110 20A	Bert 120I Inline		8	8,760	3,500	5,260	0	2,130
Warehouse	AC-220 20A	Bert 240I Inline		8	8,760	3,500	5,260	0	
Warehouse	Copier- 110 15A	Bert 110X		40	8,760	3,500	5,260	0	
Warehouse	Air Scrubber	Bert 110X		68	8,760	3,500	5,260	0	
Warehouse	H/C Water	Bert 110X	1	61	8,760	3,500	5,260	321	
Warehouse	Soda Vend	Bert 110X	1	320	8,760	3,500	5,260	1,683	
Willingboro High School	Projector	Bert 110X		8	8,760	3,500	5,260	0	
Willingboro High School	M Printer	Bert 110X		15	8,760	3,500	5,260	0	
Willingboro High School	Charging Cart/Station	Bert 110X		37	8,760	3,500	5,260	0	
Willingboro High School	Smartboard	Bert 110X		8	8,760	3,500	5,260	0	
Willingboro High School	AC-110 15A	Bert 110X		8	8,760	3,500	5,260	0	
Willingboro High School	AC-110 20A	Bert 120I Inline		8	8,760	3,500	5,260	0	4,008
Willingboro High School	AC-220 20A	Bert 240I Inline		8	8,760	3,500	5,260	0	
Willingboro High School	Copier- 110 15A	Bert 110X		40	8,760	3,500	5,260	0	
Willingboro High School	Air Scrubber	Bert 110X		68	8,760	3,500	5,260	0	
Willingboro High School	H/C Water	Bert 110X	2	61	8,760	3,500	5,260	642	
Willingboro High School	Soda Vend	Bert 110X	2	320	8,760	3,500	5,260	3,366	

ECM 9 – eTemp

Willingboro Township Public Schools ECM Matrix

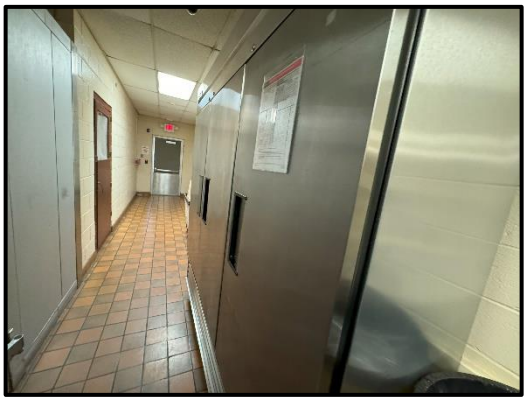
✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
9	eTemp Refrigeration Sensors	✔	✔	✔	✔	✔	✔		✔	✔	✔		✔

Commercial refrigerators waste 20% of their energy and run 50% or more cycles than necessary trying to keep temperature constant. This is because air temperature is measured instead of food temperature. eTemp is an energy saving device for commercial refrigerators (walk-in and reach-in coolers and freezers). It is a product temperature sensor that upgrades your existing cooler's air-temp thermostats into product-temp thermostats. Since a food product's temperature change is more gradual than the surrounding air temperature, conventional refrigeration units that control to maintain an air temperature at set point can waste energy and run more cycles than necessary by causing the compressor to overreact to air temperature changes. This product mimics actual food temp so the current thermostat is monitoring related food temperature rather than the surrounding air temperature.

This product covers a wide band of thermal properties, as specified by the National Sanitation Foundation, so no food and beverage products are excluded from the applicable lists of products that can use this device. In addition, NSF performed its own separate analysis which resulted in eTemp being Certified by the NSF for food safety as per their protocols.

Existing Conditions




ECM Calculations

Energy Savings from the installation of eTemp are shown below.

eTEMP Savings							
BUILDING NAME	Type	Est Qty of Devices	Baseline Energy Use (kWh)	% Energy Reduction	Savings per Unit (kWh)	Energy Savings (kWh)	Total Energy Savings (kWh)
Bookbinder School	Walk-in Cooler	0	21,000	23.0%	4,830	0	
Bookbinder School	Walk-in Freezer	0	25,000	23.0%	5,750	0	
Bookbinder School	Reach-in Cooler - 1 door	1	7,500	23.0%	1,725	1,725	
Bookbinder School	Reach-in Cooler - 2 door	0	9,000	23.0%	2,070	0	1,725
Bookbinder School	Reach-in Cooler - 3 door	0	11,000	23.0%	2,530	0	
Bookbinder School	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
Bookbinder School	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
Bookbinder School	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	
Country Club Administration Building	Walk-in Cooler	0	21,000	23.0%	4,830	0	
Country Club Administration Building	Walk-in Freezer	0	25,000	23.0%	5,750	0	
Country Club Administration Building	Reach-in Cooler - 1 door	1	7,500	23.0%	1,725	1,725	
Country Club Administration Building	Reach-in Cooler - 2 door	0	9,000	23.0%	2,070	0	1,725
Country Club Administration Building	Reach-in Cooler - 3 door	0	11,000	23.0%	2,530	0	
Country Club Administration Building	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
Country Club Administration Building	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
Country Club Administration Building	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	
Garfield East Elementary School	Walk-in Cooler	0	21,000	23.0%	4,830	0	
Garfield East Elementary School	Walk-in Freezer	0	25,000	23.0%	5,750	0	
Garfield East Elementary School	Reach-in Cooler - 1 door	2	7,500	23.0%	1,725	3,450	
Garfield East Elementary School	Reach-in Cooler - 2 door	0	9,000	23.0%	2,070	0	3,450
Garfield East Elementary School	Reach-in Cooler - 3 door	0	11,000	23.0%	2,530	0	
Garfield East Elementary School	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
Garfield East Elementary School	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
Garfield East Elementary School	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	
Hawthorne Elementary School	Walk-in Cooler	0	21,000	23.0%	4,830	0	
Hawthorne Elementary School	Walk-in Freezer	0	25,000	23.0%	5,750	0	
Hawthorne Elementary School	Reach-in Cooler - 1 door	3	7,500	23.0%	1,725	5,175	
Hawthorne Elementary School	Reach-in Cooler - 2 door	0	9,000	23.0%	2,070	0	5,175
Hawthorne Elementary School	Reach-in Cooler - 3 door	0	11,000	23.0%	2,530	0	
Hawthorne Elementary School	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
Hawthorne Elementary School	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
Hawthorne Elementary School	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	
J. Cresswell Stuart Early Childhood Dev	Walk-in Cooler	0	21,000	23.0%	4,830	0	
J. Cresswell Stuart Early Childhood Dev	Walk-in Freezer	0	25,000	23.0%	5,750	0	
J. Cresswell Stuart Early Childhood Dev	Reach-in Cooler - 1 door	3	7,500	23.0%	1,725	5,175	
J. Cresswell Stuart Early Childhood Dev	Reach-in Cooler - 2 door	0	9,000	23.0%	2,070	0	5,175
J. Cresswell Stuart Early Childhood Dev	Reach-in Cooler - 3 door	0	11,000	23.0%	2,530	0	
J. Cresswell Stuart Early Childhood Dev	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
J. Cresswell Stuart Early Childhood Dev	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
J. Cresswell Stuart Early Childhood Dev	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	
James A. Cotten Intermediate School	Walk-in Cooler	2	21,000	23.0%	4,830	9,660	
James A. Cotten Intermediate School	Walk-in Freezer	3	25,000	23.0%	5,750	17,250	
James A. Cotten Intermediate School	Reach-in Cooler - 1 door	0	7,500	23.0%	1,725	0	
James A. Cotten Intermediate School	Reach-in Cooler - 2 door	1	9,000	23.0%	2,070	2,070	28,980
James A. Cotten Intermediate School	Reach-in Cooler - 3 door	0	11,000	23.0%	2,530	0	
James A. Cotten Intermediate School	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
James A. Cotten Intermediate School	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
James A. Cotten Intermediate School	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	
Joseph A. McGinley School	Walk-in Cooler	0	21,000	23.0%	4,830	0	
Joseph A. McGinley School	Walk-in Freezer	0	25,000	23.0%	5,750	0	
Joseph A. McGinley School	Reach-in Cooler - 1 door	0	7,500	23.0%	1,725	0	
Joseph A. McGinley School	Reach-in Cooler - 2 door	0	9,000	23.0%	2,070	0	0
Joseph A. McGinley School	Reach-in Cooler - 3 door	0	11,000	23.0%	2,530	0	
Joseph A. McGinley School	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
Joseph A. McGinley School	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
Joseph A. McGinley School	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	

eTEMP Savings							
BUILDING NAME	Type	Est Qty of Devices	Baseline Energy Use (kWh)	% Energy Reduction	Savings per Unit (kWh)	Energy Savings (kWh)	Total Energy Savings (kWh)
Memorial Middle School	Walk-in Cooler	0	21,000	23.0%	4,830	0	15,410
Memorial Middle School	Walk-in Freezer	0	25,000	23.0%	5,750	0	
Memorial Middle School	Reach-in Cooler - 1 door	6	7,500	23.0%	1,725	10,350	
Memorial Middle School	Reach-in Cooler - 2 door	0	9,000	23.0%	2,070	0	
Memorial Middle School	Reach-in Cooler - 3 door	2	11,000	23.0%	2,530	5,060	
Memorial Middle School	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
Memorial Middle School	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
Memorial Middle School	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	
Twin Hills Elementary School	Walk-in Cooler	0	21,000	23.0%	4,830	0	5,175
Twin Hills Elementary School	Walk-in Freezer	0	25,000	23.0%	5,750	0	
Twin Hills Elementary School	Reach-in Cooler - 1 door	3	7,500	23.0%	1,725	5,175	
Twin Hills Elementary School	Reach-in Cooler - 2 door	0	9,000	23.0%	2,070	0	
Twin Hills Elementary School	Reach-in Cooler - 3 door	0	11,000	23.0%	2,530	0	
Twin Hills Elementary School	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
Twin Hills Elementary School	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
Twin Hills Elementary School	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	
W.R. James Elementary School	Walk-in Cooler	0	21,000	23.0%	4,830	0	5,175
W.R. James Elementary School	Walk-in Freezer	0	25,000	23.0%	5,750	0	
W.R. James Elementary School	Reach-in Cooler - 1 door	3	7,500	23.0%	1,725	5,175	
W.R. James Elementary School	Reach-in Cooler - 2 door	0	9,000	23.0%	2,070	0	
W.R. James Elementary School	Reach-in Cooler - 3 door	0	11,000	23.0%	2,530	0	
W.R. James Elementary School	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
W.R. James Elementary School	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
W.R. James Elementary School	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	
Warehouse	Walk-in Cooler	0	21,000	23.0%	4,830	0	0
Warehouse	Walk-in Freezer	0	25,000	23.0%	5,750	0	
Warehouse	Reach-in Cooler - 1 door	0	7,500	23.0%	1,725	0	
Warehouse	Reach-in Cooler - 2 door	0	9,000	23.0%	2,070	0	
Warehouse	Reach-in Cooler - 3 door	0	11,000	23.0%	2,530	0	
Warehouse	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
Warehouse	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
Warehouse	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	
Willingboro High School	Walk-in Cooler	0	21,000	23.0%	4,830	0	25,875
Willingboro High School	Walk-in Freezer	2	25,000	23.0%	5,750	11,500	
Willingboro High School	Reach-in Cooler - 1 door	3	7,500	23.0%	1,725	5,175	
Willingboro High School	Reach-in Cooler - 2 door	2	9,000	23.0%	2,070	4,140	
Willingboro High School	Reach-in Cooler - 3 door	2	11,000	23.0%	2,530	5,060	
Willingboro High School	Reach-in Freezer - 1 door	0	10,000	23.0%	2,300	0	
Willingboro High School	Reach-in Freezer - 2 door	0	12,000	23.0%	2,760	0	
Willingboro High School	Reach-in Freezer - 3 door	0	14,000	23.0%	3,220	0	

ECM 10 – Retro-commissioning

Willingboro Township Public Schools ECM Matrix		Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
✔	ECM was evaluated												
✔	ECM included in the project												
ECM #	ECM DESCRIPTION												
10	Retro-Commissioning	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

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

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

contacted to implement the remaining improvements. DCO Energy is budgeting $83,000 for on-site testing and to resolve district building system deficiencies.

Energy Savings Calculations

According to a Lawrence Berkeley National Laboratory study, *The Cost-Effectiveness of Commercial Buildings Commissioning*, "For existing buildings… whole-building energy savings of 15 percent, and payback times of 0.7 years." Savings are conservatively estimated to be 2.5% of existing site electric and 2.7% of the existing natural gas use:

*Note: Retro-Commissioning for Bookbinder School, Country Club Administration Building, Joseph A. McGinley School, and the Warehouse were evaluated but due to existing building conditions and poor financial payback, Retro-Commissioning is not included for these locations in the ESIP Project. Savings are not shown below but can be reviewed on Form II in Section 4 of the Energy Savings Plan.

Retro-Commissioning Savings		
BUILDING	**kWh SAVINGS**	**THERMS SAVINGS**
Garfield East Elementary School	3,771	267
Hawthorne Elementary School	4,478	467
J. Cresswell Stuart Early Childhood Development Center	5,499	408
James A. Cotten Intermediate School	18,001	1,573
Memorial Middle School	19,012	962
Twin Hills Elementary School	5,019	271
W.R. James Elementary School	4,459	384
Willingboro High School	44,511	1,354

kWh % SAVINGS	THERMS % SAVINGS
2.5%	2.7%

ECM 11 – Combined Heat & Power

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
11	Combined Heating & Power												✔

CHP offers energy and environmental benefits over electric-only and thermal-only systems in both central and distributed power generation applications. CHP systems have the potential for a wide range of applications and the higher efficiencies result in lower emissions than separate heat and power generation.

The simultaneous production of useful thermal and electrical energy in CHP systems leads to increased fuel efficiency. CHP units can be strategically located at the point of energy use. Such onsite generation avoids the transmission and distribution losses associated with electricity purchased via the grid from central stations. CHP is versatile and can be coupled with existing and planned technologies for many different applications in the industrial, commercial, and residential sectors.

4.4kW Axiom CHP

Scope of Work

- Provide engineered and stamped drawings including shop drawings, submittals and as-builts.
- File for City Permits
- Apply for the Interconnection application (if required).
- Furnish and install a new 4.4 KW CHP and 120-gallon buffer tank.
- Furnish and install HW supply piping, HW return piping, mixing valve, and circulation pump per manufacturer's installation manual.
- Connect CHP CW line to existing building CW line.
- Connect CHP HW line to existing building HWR.
- Furnish and install gas piping to the new CHP.
- Furnish and install exhaust venting pipe to exterior of building and terminate with a gooseneck.
- Furnish and install combustion air intake pipe and terminate with galvanized wire mesh screen.
- Insulate newly installed piping where applicable.
- Furnish and install all electrical power and control wiring.
- Provide startup of the CHP
- Provide certified balancing report.

ECM Calculations

The CHP will act as the first stage of heating for the domestic water heating re-circulation loop. The CHP is estimated to run at full load for over 5,000 hours per year. The remaining load is available for the CHP. The installed CHP will be available year-round and will operate when adequate heating load exists. If necessary, heat can be rejected through a radiator when the full heating load is not required.

CHP Input Data		
Number of units	1	
Electrical output	4.4	kW
Thermal output	42,000	BTU/hr
Gas input (HHV)	65,000	Btu/hr
Overall efficiency	87.7%	

Runtime Analysis	
Run hours	5,636
% DHW load displaced by CHP	55%

		Fuel Usage Without CHP				4.4 kW Cogen Plant Thermal Operation							
Month	Days	Total Gas Natural Use- Domestic Water System	Existing DHW Efficiency	Displaceable Gas Therms	Displaceable Heat Therms	Combined Cogen Run Hours	% Heat Load Displaced by CHP	Total Cogen Hours	Utilized Cogen Heat Therms	Max Cogen Heat Therms	Avoided DHW Gas Therms	Full Load Run Hours	System Operating Efficiency
Jan	31	414	90.0%	414	373	532	60%	532	223	223	248	532	88%
Feb	28	391	90.0%	391	352	480	57%	480	202	202	224	480	88%
Mar	31	440	90.0%	440	396	532	56%	532	223	223	248	532	88%
Apr	30	388	90.0%	388	349	514	62%	514	216	216	240	514	88%
May	31	386	90.0%	386	347	454	55%	454	191	191	212	454	88%
Jun	30	427	90.0%	427	384	358	39%	358	150	150	167	358	88%
Jul	31	351	90.0%	351	316	376	50%	376	158	158	175	376	88%
Aug	31	352	90.0%	352	317	376	50%	376	158	158	175	376	88%
Sep	30	396	90.0%	396	357	436	51%	436	183	183	203	436	88%
Oct	31	393	90.0%	393	354	532	63%	532	223	223	248	532	88%
Nov	30	385	90.0%	385	347	514	62%	514	216	216	240	514	88%
Dec	31	456	90.0%	456	410	532	54%	532	223	223	248	532	88%
Total:	365	4,780		4,780	4,302	5,636	55.0%	5,636	2,367	2,367	2,630	5,636	88%

		Fuel Usage With CHP			Electric Savings With CHP			
Month	Days	Supplemental DHW Gas Therms	Cogen Gas Therms	Total Gas	Run Hours	Avg Cogen Plant kW Output	kW Demand Savings	Cogen Electric Generation kWh
Jan	31	166	346	512	532	4	4	2,341
Feb	28	167	312	479	480	4	4	2,112
Mar	31	191	346	537	532	4	4	2,341
Apr	30	148	334	482	514	4	4	2,262
May	31	174	295	469	454	4	4	1,998
Jun	30	259	233	492	358	4	4	1,575
Jul	31	175	244	420	376	4	4	1,654
Aug	31	177	244	421	376	4	4	1,654
Sep	30	193	283	476	436	4	4	1,918
Oct	31	145	346	491	532	4	4	2,341
Nov	30	146	334	480	514	4	4	2,262
Dec	31	208	346	553	532	4	4	2,341
Total:	**365**	**2,150**	**3,663**	**5,813**	**5,636**		**4**	**24,798**

Combined Heat & Power Emission Reduction									
BUILDING	kW	Equivalent Full Load Electric Hours	NET GENERATION MWh	FUEL INPUT MMBTU	FOSSIL FUEL SAVINGS FROM HEAT RECOVERY MMBTU	CO2 EF ELECTRIC	CO2 EF CHP	CO2 EF GAS	CO2 EMISSION REDUCTION LBS
Willingboro High School	4.4	5,636	24.8	366.3	263.0	1,292.0	1,728.4	117.0	19,950.3

Combined Heat & Power Emission Reduction										
BUILDING	kW	NOx EF ELECTRIC	NOx EF CHP	NOx EF GAS	NOx EMISSION REDUCTION LBS	SO2 EF ELECTRIC	SO2 EF CHP	SO2 EMISSION REDUCTION LBS	Hg EF ELECTRIC	Hg EMISSION REDUCTION LBS
Willingboro High School	4.4	0.83	1.36	0.092	11.1	0.67	0.00	16.6	0.67	0.0

Combined Heat & Power Emission Reduction									
BUILDING	kW	CHP Gas Input (therms)	Pre-CHP DWH Gas Use (therms)	Post CHP DWH Gas Use (therms)	DWH Gas Savings (therms)	Net Building Gas Savings (therms)	DWH Efficiency	CHP Heat Recovered (MMBTU)	CHP Overall Efficiency
Willingboro High School	4.4	3,663	4,780	2,150	2,630	-1,033	90%	237	88%

The NJ Protocol is to follow the National Renewable Energy Laboratory's Combined Heat and Power, The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures [1]. The product should be all of the below outputs, as applicable:

a. Annual energy input to the generator, HHV basis (MMBtu/yr)
b. Annual electricity generated, net of all parasitic loads (kWh/yr)
c. Annual fossil fuel energy savings from heat recovery (MMBtu/yr)
d. Annual electric energy savings from heat recovery, including absorption chiller sourced savings if chiller installation is included as part of the system installation (kWh/yr)
e. Annual overall CHP fuel conversion efficiency, HHV basis (%)
f. Annual electric conversion efficiency, net of parasitics, HHV basis (%)

CHP Emissions Reduction Associated with PJM Grid

(Assuming that the useful thermal output will displace natural gas)

Algorithms

CO_2 ER (lbs) = (CO_2 EF_{elec} – CO_2 EF_{CHP}) * Net Electricity Generation (MWh) + CO_2 EF_{elec} * Electric Energy Savings (MWh) + CO_2 EF_{NG} * Gas Energy Savings (MMBtu) * 10

NO_x ER (tons) = (NO_x EF_{elec} – NO_x EF_{CHP}) * Net Electricity Generation (MWh) + NO_x EF_{elec} * Electric Energy Savings (MWh) + NO_x EF_{NG} * Gas Energy Savings (MMBtu) * 10

SO_2 ER (lbs) = (SO_2 EF_{elec} – SO_2 EF_{CHP}) * Net Electricity Generation (MWh) + SO_2 EF_{elec} * Electric Energy Savings (MWh)

Hg (grams) = (Electric Energy Savings (MWh) * Hg EF_{elec})/1,000

Definition of Variables

CO_2 EF_{elec} = CO_2 Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

NO_x EF_{elec} = NO_x Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

SO_2 EF_{elec} = SO_2 Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

Hg EF_{elec} = Hg Electric Emissions Factor – see emissions tables summarized in Introduction section of Protocols

CO_2 EF_{CHP} = CO_2 Emissions Factor of the CHP system (in lbs/MWh), which will vary with different projects based on the types of prime movers and emission control devices used

NO_x EF_{CHP} = NO_x Emissions Factor of the CHP system (in lbs/MWh), which will vary with different projects based on the types of prime movers and emission control devices used

SO_2 EF_{CHP} = SO_2 Emissions Factor of the CHP system (in lbs/MWh), which will vary with different projects based on the types of prime movers and emission control devices used

CO_2 EF_{NG} = CO_2 Natural Gas Emissions Factor associated with boiler fuel displacement – see emissions tables summarized in Introduction section of Protocols

NO_x EF_{NG} = NO_x Natural Gas Emissions Factor associated with boiler fuel displacement – see emissions tables summarized in Introduction section of Protocols

10 = Conversion from MMBtu to therms (1 MMBtu = 10 therms)

Calculation of Clean Air Impacts

The amount of air emission reductions resulting from the energy savings is calculated using the energy savings at the system level and multiplying them by factors provided by the New Jersey Department of Environmental Protection, Office of Air and Energy Advisor, on June 25, 2019.

Using Weighted Average of 2018 PJM On-Peak and Off-Peak annual data:

Electric Emission Factors

Emissions Product	Pounds per MWh[7]
CO_2	1,292
NOx	0.83
SO_2	0.67
Hg	1.1 mg/MWh[8]

Natural Gas Emission Factors

Emissions Product	Current
CO_2	11.7 lbs per therm saved
NOx	0.0092 lbs per therm saved

Note: CHP emission factors for CO2 and NOx were calculated using nameplate electric generation and natural gas input capacity as seen in the ECM calculation. Per BPU Protocols, natural gas does not require SO2 or Hg emission factors.

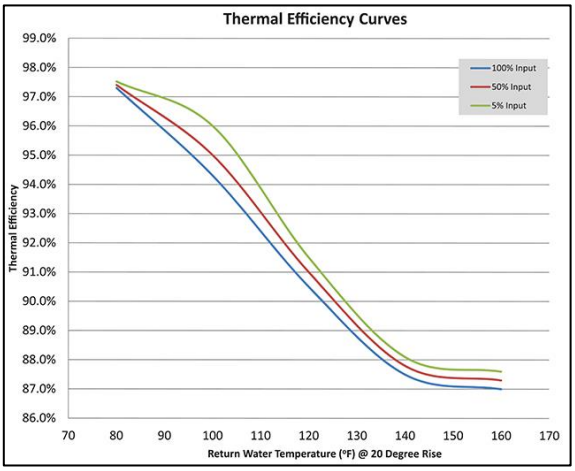
ECM 12 – Boiler Replacement

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
12	Boiler Plant Replacement	✔											

Old, oversized boiler systems have efficiencies in the range of 56%–75%. A condensing boiler hot water heating system can achieve efficiencies as high as 97%, converting nearly all the fuel to useful heat. The efficiency of the boiler increases at lower return water temperature. Lower return water temperatures allow more water vapor from the exiting flue gas to condense, allowing its latent heat of vaporization to be recovered.



Premium efficiency electric motors will help optimize fan and pump efficiency, reduce electrical power consumption and improve system reliability. These motors are designed to run cooler, last longer, and require less maintenance than the existing standard efficiency motors. Premium efficiency motors can be as high as 95% efficient (as opposed to standard efficiency motors of 78% to 88%) and are capable of operating at varying speeds allowing Variable Frequency Drive (VFD) installations where applicable.

Existing Conditions

Bookbinder School – Space heating is provided using two gas-fired non-condensing hot water York Shipley – Steam Pak boilers from 1959 and 1964. The boilers have an output capacity of 4,000MBH and 3,600 MBh and an efficiency of 75.3%. Hot water is distributed to the various air handlers and unit ventilators in the school using two constant speed pumps.

Scope of Work

Willingboro Township School District expressed to DCO Energy that improving the HVAC & air quality at the Bookbinder School was a top priority.

Bookbinder School

- Abatement of asbestos insulation wrapped around existing boilers.
- Demolition and removal of 2 existing hot water boilers
- Demolition and removal of 2 heating hot water pumps
- Demolition and removal of existing heating hot water supply and return piping required.
- Furnishing and installation of 3 Hydrotherm KN-20 2,000 MBH hot water boilers.
- Furnishing and installation of new heating hot water circulating pumps and VFDs.
- Furnishing and installation of new heating hot water and return piping required.
- Install new power wiring (incl. new conduit, wiring and circuit breakers) for new water condensing hot water boilers and re-circ pump from existing power panel(s). If adequate spare capacity is not available, provide a new sub-panel for electrical service to new equipment.
- Provide all valves, fittings, temperature/pressure sensors, meters and gauges required to complete the installation in accordance with the manufacturer's requirements and final design.

ECM Calculations

Boiler Plant Replacement Savings

BUILDING		Qty	Effective Operational Quantity	Input Capacity per Unit (mbh) [CAPin]	Total Input Capacity (mbh) [CAPin]	Equivalent Full Load Hours Per Boiler [EFLHh]	Boiler Nominal Efficiency	Boiler Year Built	Boiler Age
Bookbinder School	Existing, to be removed	1	1.0	4,000	4,000	840	75.3%	1959	65
Bookbinder School	Existing, to be removed	1	1.0	3,600	3,600	630	75.3%	1964	60
Bookbinder School	Proposed	3	3.0	2,000	6,000	775	87.0%	2024	0

Boiler Plant Replacement Savings

BUILDING		Boiler Maintenace Level	Boiler Maintenace Factor	Boiler Derated Efficiency [EFFb]	Plant Rated Output MBH	Existing Fuel Usage (THERMS)	Proposed Fuel Usage (THERMS)	Calculated Annual Fuel Savings (THERMS)
Bookbinder School	Existing, to be removed	Annual Professional Service	0.0025	71.7%	2,866	(33,600)		9,780
Bookbinder School	Existing, to be removed	Annual Professional Service	0.0025	71.7%	2,580	(22,680)		
Bookbinder School	Proposed			87.0%	5,220		46,500	

Boiler Plant Replacement Pump + VFD Savings

BUILDING	SYSTEM AND SERVICE	Heating Hot Water Pump Effective Operational Quantity	MOTOR HP	EXISTING MOTOR EFFICIENCY (Nbase)	REPLACEMENT MOTOR EFFICIENCY (Nprem)	LF	CF	IFvfd	HRS
Bookbinder School	Heating Hot Water Loop Pump 1-2	2	3.0	80.5%	85.5%	0.75	0.74	1.0	2,745.00

Boiler Plant Replacement Pump + VFD Savings												
BUILDING	SYSTEM AND SERVICE	ΔkW	PREM. MOTOR DEMAND SAVINGS (kW)	PREM. MOTOR ELECTRIC SAVINGS (kWh)	VFD ESF	VFD DSF	VFD DEMAND SAVINGS (kW)	VFD ELECTRIC SAVINGS (kWh)	TOTAL DEMAND SAVINGS (kW)	TOTAL DEMAND SAVINGS (kW)	TOTAL ELECTRIC SAVINGS (kWh)	TOTAL ELECTRIC SAVINGS (kWh)
Bookbinder School	Heating Hot Water Loop Pump 1-2	0.16	0.24	669	1,548.00	0.096	0.58	9,288.00	0.82	0.82	9,957	9,957

Algorithms

Fuel Savings (MMBtu/yr) = Cap_{in} * $EFLH_h$ * ((Eff_q/Eff_b)-1) / 1000 kBtu/MMBtu

Definition of Variables

Cap_{in} = Input capacity of qualifying unit in kBtu/hr

$EFLH_h$ = The Equivalent Full Load Hours of operation for the average unit during the heating season in hours

Eff_b = Boiler Baseline Efficiency

Eff_q = Boiler Proposed Efficiency

1000 = Conversion from kBtu to MMBtu

Summary of Inputs

Prescriptive Boilers

Component	Type	Value	Source
Cap_{in}	Variable		Application
$EFLH_h$	Fixed	See Table Below	1
Eff_b	Variable	See Table Below	2
Eff_q	Variable		Application

$EFLH_h$ Table

Facility Type	Heating EFLH
Assembly	603
Auto repair	1910
Dormitory	465
Hospital	3366
Light industrial	714
Lodging – Hotel	1077
Lodging – Motel	619
Office – large	2034
Office – small	431
Other	681
Religious worship	722

Facility Type	Heating EFLH
Restaurant – fast food	813
Restaurant – full service	821
Retail – big box	191
Retail – Grocery	191
Retail – small	545
Retail – large	2101
School – Community college	1431
School – postsecondary	1191
School – primary	840
School – secondary	901
Warehouse	452

Multi-family EFLH by Vintage

Facility Type	Prior to 1979	From 1979 to 2006	From 2007 through Present
Low-rise, Heating	757	723	503
High-rise, Heating	526	395	219

Baseline Boiler Efficiencies (Eff_b)

Boiler Type	Size Category (kBtu input)	Standard 90.1-2016
Hot Water – Gas fired	< 300 ≥ 300 and ≤ 2,500 > 2,500	82% AFUE 80% Et 82% Ec
Hot Water – Oil fired	< 300 ≥ 300 and ≤ 2,500 > 2,500	84% AFUE 82% Et 84% Ec
Steam – Gas fired	< 300	80% AFUE
Steam – Gas fired, all except natural draft	≥ 300 and ≤ 2,500	79% Et
Steam – Gas fired, all except	> 2,500	79% Ec

Boiler Type	Size Category (kBtu input)	Standard 90.1-2016
Steam – Gas fired, natural draft	≥ 300 and ≤ 2,500	79% Et
Steam – Gas fired, natural draft	> 2,500	79% Ec
Steam – Oil fired	< 300	82% AFUE
	≥ 300 and ≤ 2,500	81% Et
	> 2,500	81% Ec

Sources

1. New York State Joint Utilities, *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*, V7, April 2019. Appendix G – Equivalent Full-Load Hours (EFLH), For Heating and Cooling. P. 675-680. EFLH values for NYC due to proximity to NJ.
2. ASHRAE Standards 90.1-2016. *Energy Standard for Buildings Except Low Rise Residential Buildings*; available at: https://www.ashrae.org/standards-research--technology/standards--guidelines. Table 6.8.1-6

ECM 13 – RTU & Split System HVAC Replacement

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
13	RTU & Split System HVAC Replacement	✔											

Background

Willingboro Township School District expressed to DCO Energy that improving the HVAC & air quality at the Bookbinder School was a top priority. Currently the HVAC set up in the school has 11 hot water air-handling units in mechanical closet that have their supply air coming from subterranean ducts. These 11 AHUs serve classrooms 1-22. There are 4 existing hot water only horizontal unit ventilators serving the library, and there are 6 hot water only horizontal unit ventilators serving the brick-wing addition, classrooms 23-28. The multi-purpose room and stage are served by an AHU in the boiler room and a condensing unit outside the boiler room. The condensing unit to this AHU has been abandoned in place. Classrooms 29 & 30 have ductless split units to provide air conditioning and have ventilation coming from a 100% outdoor air unit, this setup is creating significant humdity issues in the summer. The kitchen and cafeteria are served by a hot water only air handling unit. Bathrooms in the core of the building have a ducted AHU exhausting and ventilating the space. Other bathrooms in the school are served by exhaust fans. This ECM is supplemental to ECM 17 – Unit Ventilator Replacement w/ Addition of Cooling. In ECM 17 – Unit Ventilator Replacement w/ Addition of Cooling, the classrooms of the original portion

Packaged RTU

of the building will be receiving improved ventilation and cooling. This ECM serves to provide improved air quality and cooling to the classrooms and spaces not served by unit ventilators.

Existing Conditions




- The main office wing is currently fin-tubed radiator heating only with operable windows.
- Classrooms 29 & 30 are served by a 100% OA unit and have a ductless split terminal unit in each classroom.
- The cafeteria and kitchen space are served by a hot water only AHU
- The multi-purpose room is served by an AHU located in the boiler room and the associated condensing unit has been abandoned in place.
- 8 bathrooms in the core of the building are served by AHUs with subterranean ducts

Willingboro Township Public Schools has expressed interest in adding cooling and improved ventilation to these spaces. DCO Energy has recommended the following scope of work to achieve this goal.

Scope of Work

Multi-Purpose Room AHU

- Demolition and removal of (1) existing AHU and associated piping
  - Asbestos abatement where required to complete demolition
- Demolition and removal of (1) existing split condensing unit out of boiler room
- Demolition and removal of existing ductwork from existing AHU to multi-purpose room
- Install new hot water & d/x coil air handling unit
- Install new split condensing unit on existing concrete pad
- Install new refrigerant piping from new split condensing unit to new AHU
- Extend existing heating hot water piping to connect to new AHU
- Install new insulated ductwork and ceiling-mounted supports the from the supply of the AHU extending the length of the multi-purpose room
- Install new return air ductwork from stage back to new AHU in boiler room
- All ductwork connections to be made with flexible connections
- Testing and balancing of system

Classrooms 29&30

- Demolition and removal of 100% OA hot water air handling unit in electrical closet near Room 30
- Install new roof curb
- Install new DOAS unit on roof curb
- Install new supply ductwork to connect to existing ductwork
- Extend existing heating hot water piping from mechanical closet to roof and connect to DOAS
- Extend existing electrical wiring to new DOAS and include all associated electrical panel upgrades for additional compressor load.
- All ductwork connections to be made with flexible connections
- Existing ductless split systems to remain
- Testing and balancing

Hallway between rooms 1-3

- Install 1 3-ton wall mounted indoor ductless split
- Install condensing unit on roof above hallway
- Install electrical wiring to the unit and any associated panel upgrade
- Install refrigerant line and drain line

Hallway between rooms 8-10

- Install 1 3-ton wall mounted indoor ductless split
- Install condensing unit on roof above hallway
- Install electrical wiring to the unit and any associated panel upgrade

- Install refrigerant line and drain line

Hallway between rooms 11-13

- Install 1 3-ton wall mounted indoor ductless split
- Install condensing unit on roof above hallway
- Install electrical wiring to the unit and any associated panel upgrade
- Install refrigerant line and drain line

Hallway between room 18-20

- Install 1 3-ton wall mounted indoor ductless split
- Install condensing unit on roof above hallway
- Install electrical wiring to the unit and any associated panel upgrade
- Install refrigerant line and drain line

Bathrooms between Classrooms 1&2, 9&10, 11&12, 19&20

- Demolition and removal of (4) existing hot water coil air handling unit in mechanical closet
- Cut and cap subterranean duct opening for existing air handling units
- Install new exhaust fans,1 in each bathroom (8 total)

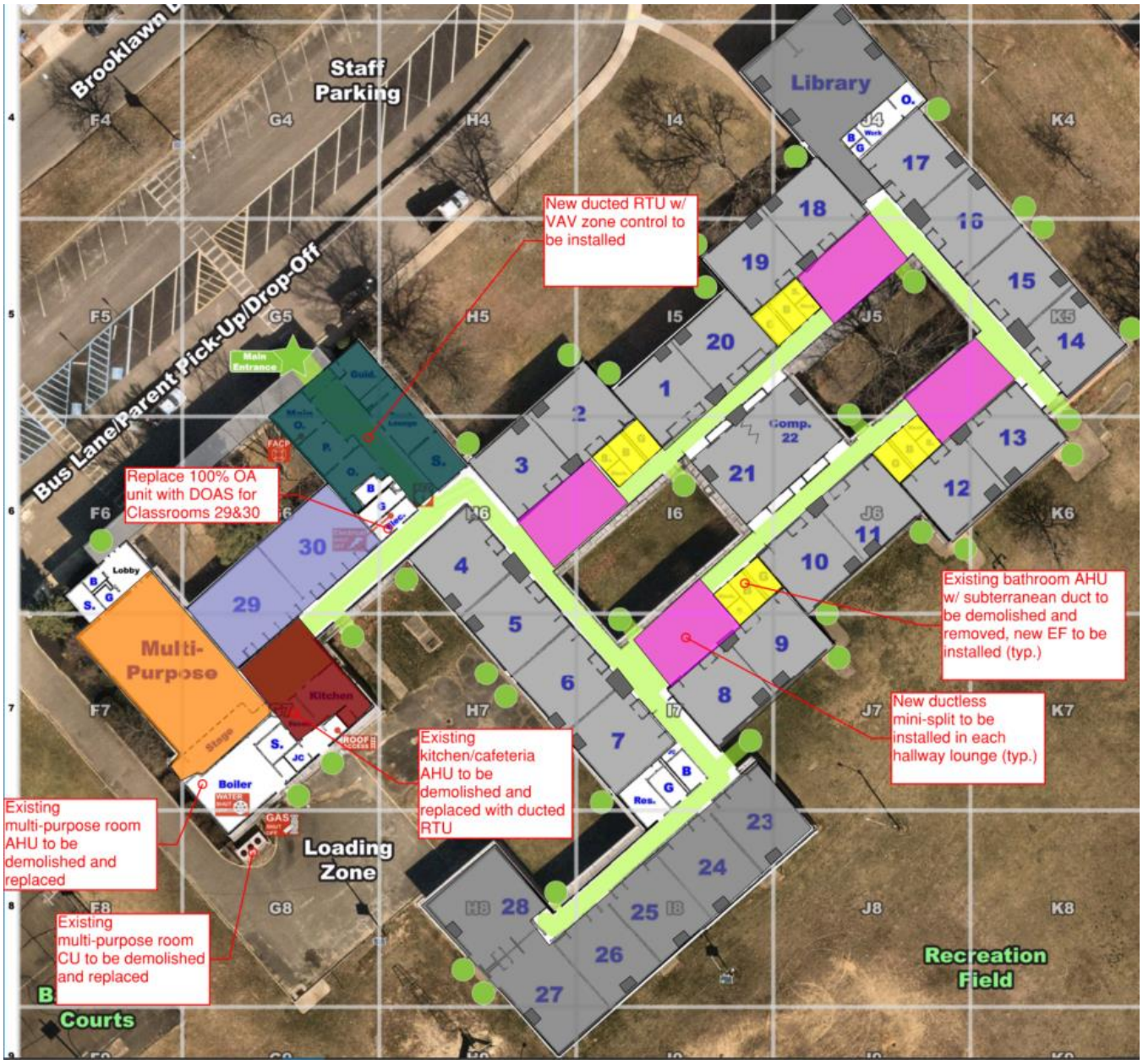
Kitchen

- Demolition and removal of hot water only air handling unit
- Install roof curb
- Install new packaged D/X RTU on roof curb
- Extend existing heating hot water piping to roof and connect to new packaged D/X and hot water coil RTU
- Extend existing electrical wiring to new packaged RTU and include all associated electrical panel upgrades for additional compressor load.
- Install ceiling-mounted supply and return ductwork serving kitchen and hallway space in front of kitchen (acting as cafeteria).
- Install 2 ceiling diffusers in the hallway and 1 ceiling diffuser in the kitchen
- Install 1 return grille in the hallway
- All ductwork connections to be made with flexible connections
- Testing and balancing of the system

Main Office Wing

- Install new roof curb
- Install new packaged RTU with D/X and hot water coil
- Install new insulated heating hot water supply and return piping to new RTU from branch off in nearby mechanical closet
- Install insulated ceiling-mounted ductwork from packaged RTU to connect to new VAV boxes and diffusers
- Install new VAV boxes, including associated hot water piping and electrical wiring.

- (1 VAV) Main Office
  - Install 1 diffuser
- (1 VAV) Principal's Office
  - Install 1 diffuser
- (1 VAV) Nurse {office next to Principal}
  - Install 1 diffuser
- (1 VAV) Guidance/ Teacher Lounge / Speech
  - Install 1 diffuser in Teacher lounge storage
  - Install 1 diffuser in Teacher Lounge
  - Install 1 diffuser Speech
- Install return grille
  - (1) Teacher lounge
  - (1) Principal office
  - (1) Main Office
  - (1) Nurse
- Install return ductwork from grille to roof curb return
- Install new electrical wiring and associated panel upgrades
- All ductwork connections to be made with flexible connections
- Testing and balancing


Brooklawn
Staff Parking
Library
Bus Lane/Parent Pick-Up/Drop-Off
Main Entrance
New ducted RTU w/ VAV zone control to be installed
Replace 100% OA unit with DOAS for Classrooms 29&30
Existing bathroom AHU w/ subterranean duct to be demolished and removed, new EF to be installed (typ.)
New ductless mini-split to be installed in each hallway lounge (typ.)
Existing kitchen/cafeteria AHU to be demolished and replaced with ducted RTU
Existing multi-purpose room AHU to be demolished and replaced
Existing multi-purpose room CU to be demolished and replaced
Multi-Purpose
Stage
Kitchen
Lobby
Boiler
Loading Zone
Courts
Recreation Field
Comp. 22

ECM Calculations

Willingboro Township Public Schools has made this ECM a top priority. DCO has worked with the district to approve a baseline adjustment necessary to carry some savings associated with addition of cooling related to RTU & Split System HVAC Replacement at Bookbinder School.

The Baseline Adjustment adds in the estimated electrical usage for cooling load from the packaged RTUs to the baseline period. At this time the current baseline data in Section 1 of the ESP does contain these values. The adjustment assumes standard efficiency units. DCO and Willingboro Township Public Schools have agreed to reflect these adjustments in our M&V Plan as well as future energy cost budgeting to be performed by the district so that future costs of electricity will be accounted for.

RTU & Split System HVAC Replacement -Baseline Adjustment

BUILDING	SYSTEM	Areas Served	Existing Qty	Tons Per Unit	Total Existing Tons	EERb / SEERb	Proposed Qty	Tons Per Unit	Total Proposed Tons	CF	EFLH Cooling	Demand Savings (kW)	Energy Savings (kWh)
Bookbinder School	New DOAS	Classroom 29 & 30 100% OA	1	10	10.0	14.0	1	10.0	10.0	0.5	394	4.3	3,377
Bookbinder School	New 25 ton RTU	Main Office Wing	1	25	25.0	10.0	1	25.0	25.0	0.5	394	15.0	11,820
Bookbinder School	New 15 ton RTU	Kitchen / Cafeteria	1	15	15.0	14.0	1	15.0	15.0	0.5	394	6.4	5,066
Bookbinder School	(4) New 3 ton ductless splits	Hallway Splits, (4) 3 ton units	4	3	12.0	14.0	4	3.0	12.0	0.5	394	5.1	4,053
Bookbinder School	Replace 25 ton CU	Multi-Purpose Room AHU	1	25	25.0	13.0	1	25.0	25.0	0.5	394	11.5	9,092

The savings calculations shown below and carried in the ESIP represent an efficiency improvement over the baseline adjustment calculation.

RTU & Split System HVAC Replacement - High Efficiency Savings

BUILDING	SYSTEM	Areas Served	Spaces to Get Cooling (Qty)	Tons Per Space	Total Tons	Standard Efficiency Unit EERb	Proposed Qty	Tons Per Unit	Total Proposed Tons	High Efficiency EERq	CF	EFLH Cooling	Demand Savings (kW)	Energy Savings (kWh)
Bookbinder School	New DOAS	Classroom 29 & 30 100% OA	1	10	10.0	14.00	1	10.0000	10.0	15.0	0.5	394	0.29	225.14
Bookbinder School	New 25 ton RTU	Main Office Wing	1	25	25.0	10.00	1	25.0000	25.0	12.3	0.5	394	2.80	2,210.24
Bookbinder School	New 15 ton RTU	Kitchen / Cafeteria	1	15	15.0	14.00	1	15.0000	15.0	15.0	0.5	394	0.43	337.71
Bookbinder School	(4) New 3 ton ductless splits	Hallway Splits, (4) 3 ton units	4	3	12.0	14.00	4	3.0000	12.0	15.0	0.5	394	0.34	270.17
Bookbinder School	Replace 25 ton CU	Multi-Purpose Room AHU	1	25	25.0	13.00	1	25.0000	25.0	14.7	0.5	394	1.33	1,051.49

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * CF$

(5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

cooling

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit.This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Water Source Heat Pumps (water to air, water loop) <=1.4 tons >1.4 to 5.4 tons >5.4 to 11.25 tons	 12.2 EER, 4.3 heating COP 13.0 EER, 4.3 heating COP 13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[27]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners <=5.4 tons >5.4 to 11.25 tons >11.25 to 20 tons	 10.0 EER 10.0 EER 10.0 EER
Single Package Vertical Heat Pumps <=5.4 tons >5.4 to 11.25 tons >11.25 to 20 tons	 10.0 EER, 3.0 heating COP 10.0 EER, 3.0 heating COP 10.0 EER, 3.0 heating COP

Facility Type	Heating EFLH$_h$	Cooling EFLH$_c$
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

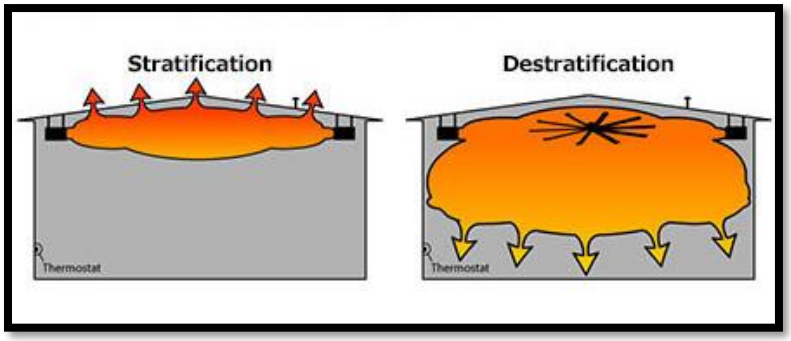
ECM 14 – Destratification Fans

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
14	Destratification Fans		✔	✔			✔		✔	✔		✔	✔

Large indoor spaces with high ceilings such as a gymnasium are prone to a condition called stratification. Stratification is a common property of air to separate due to temperature difference. Typically, a layer of warm air will sit on top of a layer of cold air. The lower cold air causes discomfort for occupants of the space as well as increased energy usage of air handling systems to overcome this condition. A destratification fan can efficiently heat large spaces by slowly moving large volumes of warm air off the ceiling without creating a draft. The steady mixing of air creates a uniform temperature throughout the space which helps the HVAC maintain the same thermostat setpoint with less effort, resulting in energy savings.



Scope of Work

Building	Area in Building	Fan Type	QTY
Country Club Administration Building	Gym	E-ONYX-P4-STD-120-X	2
Garfield East Elementary School	Gym	E-ONYX-P4-STD-120-X	2
James A. Cotten Intermediate School	Gym	E-ONYX-P4-STD-120-X	5
Memorial Middle School	Gym	E-ONYX-P4-STD-120-X	4
Twin Hills Elementary School	Gym	E-ONYX-P4-STD-120-X	2
Warehouse	Warehouse	E-ONYX-P4-STD-120-X	1
Warehouse	Warehouse	E-ONYX-P4-STD-120-X	2
Warehouse	Warehouse	E-ONYX-P4-STD-120-X	5
Willingboro High School	Large Gym	E-ONYX-P4-STD-120-X	8
Willingboro High School	Wrestling Room	E-ONYX-P4-STD-120-X	2
Willingboro High School	Small Gym	E-ONYX-P4-STD-120-X	2

ECM Calculations

Destratification Fans Savings											
Building	Area in Building	Ceiling Height (ft.)	Area (sq.ft.)	Gas Usage (therms)	Temp Differential (°F)	Total THERM Savings	Yearly Fan Operating Hours	Fan Type	QTY	kW Draw Per Fan	Total kWh Savings
Country Club Administration Building	Gym	28	3,200	3,840	12	799	4000	E-ONYX-P4-STD-120-X	2	0.076	(608.00)
Garfield East Elementary School	Gym	25	2,600	3,120	11	546	4000	E-ONYX-P4-STD-120-X	2	0.076	(608.00)
James A. Cotten Intermediate School	Gym	27	8,200	9,840	12	2,047	4000	E-ONYX-P4-STD-120-X	5	0.076	(1,520.00)
Memorial Middle School	Gym	25	6,536	7,843	11	1,373	4000	E-ONYX-P4-STD-120-X	4	0.076	(1,216.00)
Twin Hills Elementary School	Gym	21	3,200	3,840	10	622	4000	E-ONYX-P4-STD-120-X	2	0.076	(608.00)
Warehouse	Warehouse	20	1,300	975	10	158	4000	E-ONYX-P4-STD-120-X	1	0.076	(304.00)
Warehouse	Warehouse	21	2,500	1,875	10	304	4000	E-ONYX-P4-STD-120-X	2	0.076	(608.00)
Warehouse	Warehouse	21	9,600	7,200	10	1,166	4000	E-ONYX-P4-STD-120-X	5	0.076	(1,520.00)
Willingboro High School	Large Gym	29	14,960	17,952	13	3,967	4000	E-ONYX-P4-STD-120-X	8	0.076	(2,432.00)
Willingboro High School	Wrestling Room	21	3,744	4,493	10	728	4000	E-ONYX-P4-STD-120-X	2	0.076	(608.00)
Willingboro High School	Small Gym	21	3,744	4,493	10	728	4000	E-ONYX-P4-STD-120-X	2	0.076	(608.00)

Savings Table

Temp Differential (°F)

Celling Height (ft.)	5.4	7.2	9	10.8	16.2	18	19.8
20	12.7	14.7	16.2	17.5	21	22	23
26	15.8	17.6	19	20.8	24.4	26	27
33	18	20	21.8	23.2	27.6	28.8	30.5
40	20	22	23.6	25.6	30	31.8	33.2

% savings

Source: Building Scientific Research Information Association, UK, 1997. Computational Fluid Dynamics for a 100' x 165' x 26' building with a 100kW gas heater at 3,600cfm. Insulation and lighting remain constant.

ECM 17 – Unit Ventilator Replacement w/ Addition of Cooling

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
17	Unit Ventilator Replacement w/ Addition of Cooling	✔	✔										

Vertical Packaged Unit Ventilator

Willingboro Township School District expressed to DCO Energy that improving the HVAC & air quality at the Bookbinder School was a top priority. Currently the HVAC set up in the school has 11 hot water air-handling units in mechanical closet that have their supply air coming from subterranean ducts. These 11 AHUs serve classrooms 1-22. There are 4 existing hot water only horizontal unit ventilators serving the library, and there are 6 hot water only horizontal unit ventilators serving the brick-wing addition, classrooms 23-28. The multi-purpose room and stage are served by an AHU in the boiler room and a condensing unit outside the boiler room. The condensing unit to this AHU has been abandoned in place. Classrooms 29 & 30 have ductless split units to provide air conditioning and have ventilation coming from a 100% outdoor air unit, this setup is creating significant humdity issues in the summer. The kitchen and cafeteria are served by a hot water only air handling unit. Bathrooms in the core of the building have a ducted AHU exhausting and ventilating the space. Other bathrooms in the school are served by exhaust fans.

The high occupant densities of schools and classrooms often make it challenging for building designers to incorporate ventilation systems that provide adequate outdoor ventilation air (in compliance with the industry's ventilation standard, ASHRAE 62.1-2016), while providing buildings with good indoor air quality and minimized costs. With this in mind, and other construction constraints regarding the existing integrity of the subterranean ducts, the existing air-handling units will be demolished and removed. New vertical packaged unit ventilators will be installed to provide heating, venitlation, and air-conditioning to each classroom. This will create individual occupied comfort zones to meet ASHRAE 62.1-2016. To reduce the energy impact of this ventilation requirement, the recovery ventilator is used to recover a significant portion of the energy being exhausted with the stale indoor air.

For the existing hot water only horizontal unit ventilators in the library and the brickwing, new horizontal unit ventilators will be installed with hot water and direct expansion (DX) coils to serve both heating and cooling. New VRF systems will provide refrigerant to the DX coils and are like traditional D/X split systems except that a single VRF heat pump condensing unit serves multiple D/X coils. The VRF condensing unit modulates the compressor and flow of refrigerant based on the exact heating and cooling demand of the connected indoor units. Some additional benefits of VRF systems versus traditional D/X split systems are: Reduced installation costs, reduced operational costs (less electrical consumption), ability to provide simultaneous heating and cooling with a single VRF system, less maintenance costs due to fewer mechanical components (i.e. compressors) and lower outdoor unit sound levels. The system being proposed in this ECM will utilize a standard classroom unit ventilator style indoor unit that will fit in the same area as the existing classroom unit ventilators. Heating will be accomplished utilizing the new VRF heat pumps with secondary electric resistance heating coils. Cooling will be accomplished utilizing direct expansion, or D/X, coils served by remote VRF condensing units. The unit ventilator will also allow for economizer mode of operation, or free cooling, when the outdoor ambient conditions permit the use of 100% outside air.

Variable Refrigerant Flow (VRF) unit

New vertical packaged and horizontal unit ventilators will improve classroom indoor air quality. Superior indoor air quality can help ensure a healthier and higher performance learning environment for students and staff, and the choice of ventilation equipment plays a big role in

the quality of the indoor air. Proper ventilation with outdoor air is a key component for good indoor air quality in schools and classrooms since indoor air may be two to five times more polluted than outdoor air, and there are large populations of children who may be more susceptible to indoor pollutants than the general population.

Existing Conditions

- 22 Classrooms at Bookbinder School currently do not have cooling and are served by 11 hot-water air-handling units (heating only).
- 6 classrooms at Bookbinder School currently do not have cooling and are served by 6 hot-water horizontal unit ventilators (heating only).
- The library at Bookbinder School currently does not have cooling and is served by 4 hot-water horizontal unit ventilators (heating only).

Willingboro Township Public Schools has expressed interest in adding cooling to these 28 classrooms and the library at Bookbinder School (32 Unit Ventilators). DCO Energy has recommended the installation of variable refrigerant flow units equipped to the new horizontal unit ventilators. DCO Energy has recommended the installation of vertical packaged units for spaces currently served by the AHUs. These unit ventilators will be equipped with a D/X coil and will be able to provide cooling to classroom spaces and utilize energy recovery to reduce energy costs.

Scope of Work

Library

- Demolition and removal of (4) existing hot water coil only unit ventilators
- Careful removal of (4) existing window air conditioning units and return to owner
- Install 1 VRF Heat Pump Condensing Unit on roof above library. Provide all roof supports (equipment rails) and roof repairs required to maintain existing roof warranty.
- Install (4) new unit ventilators with hot water & d/x coil, ensure existing wall penetration is large enough to accommodate new louvre
- Install refrigerant piping to all (4) new unit ventilators routing on the exterior of the building and enclosed in aluminum u-shield pipe enclosure.
- Disconnect existing electrical power to classroom UVs being removed and re-use/reconnect to new classroom UVs.
- Provide new electrical power for outdoor condensing units. Contractor shall assume a new main breaker will be required at the primary electrical service.
- Provide new electrical distribution, including new electrical subpanels, breakers, conduit, and feeders to serve new outdoor condensing units.
- Install condensate dry-well for each new unit ventilator
- Testing and balancing of system.

Classrooms 23-28

- Demolition and removal of (6) existing hot water coil only unit ventilators
- Careful removal of (6) existing window air conditioning units and return to owner
- Install 2 VRF Heat Pump Condensing Units on roof. Provide all roof supports (equipment rails) and roof repairs required to maintain existing roof warranty.
- Install (6) new unit ventilators with hot water & d/x coil, ensure existing wall penetration is large enough to accommodate new louvre
- Install refrigerant piping to all (6) new unit ventilators routing on the exterior of the building and enclosed in aluminum u-shield pipe enclosure.
- Disconnect existing electrical power to classroom UVs being removed and re-use/reconnect to new classroom UVs.
- Provide new electrical power for outdoor condensing units. Contractor shall assume a new main breaker will be required at the primary electrical service.
- Provide new electrical distribution, including new electrical subpanels, breakers, conduit, and feeders to serve new outdoor condensing units.
- Install condensate dry-well for each new unit ventilator
- Testing and balancing of system

Classrooms 1-22

- Demolition and removal of (11) existing hot water air handling units in mechanical closets between classrooms
- Cut and cap subterranean duct opening for existing air handling units
- Careful removal of (22) existing window air conditioning units and return to owner
- Install 22 vertical packaged unit ventilators with energy recovery units in each classroom
    - Remove classroom window panel and install wall sleeve for ventilation air
- Install new electrical wiring from mechanical closet to new VPUV location in each classroom and install all associated electrical panel upgrades.
- Install new heating hot water piping from mechanical closet to each new VPUV location.
- Install condensate dry-well for each new VPUV
- Testing and balancing of system

Existing hot water only horizontal UV to be replaced with UV w/ DX coil and associated VCU

Existing hot water only air-handling unit serving adjacent classrooms to be demolished

Proposed vertical packaged unit ventilator w/ energy recovery

Area that will have cooling from VPUV

Area that will have cooling from horizontal UV w/ DX coil served by VCU

Area that is included as part of ECM #13 RTU & Split System Replacement

ECM Calculations

Willingboro Township Public Schools has made this ECM a top priority. DCO has worked with the district to approve a baseline adjustment necessary to carry some savings associated with addition of cooling related to the unit ventilator replacements. The ECM will include only the Bookbinder School. The Country Club Administration Building was also evaluated for this ECM but due to poor payback and WTPS priorities it is not included. Background, Scope of Work, and ECM Calculations for Country Club Administration Building are not provided. Cost and savings for Country Club Administration Building can be reviewed on Form II in Section 4 of the Energy Savings Plan.

The Baseline Adjustment adds in the estimated electrical usage for the new VRF & VPUV systems to the baseline period. The current baseline data in section 1 of the ESP does contain these values, The adjustment assumes 4-tons per classroom and standard efficiency units. The adjustment also accounts for the change from 11 AHU supply fan motors to 22 VPUV supply fan motors. DCO and Willingboro Township Public Schools have agreed to reflect these adjustments in our M&V Plan as well as future energy cost budgeting to be performed by the district so that future costs of electricity will be accounted for.

The savings calculations shown below and carried in the ESIP represent an efficiency improvement over the baseline adjustment calculation.

ADDED VRF & VPUV - BASELINE ADJUSTMENT

BUILDING	SYSTEM	Areas Served	Spaces to Get Cooling (Qty)	Tons Per Space	Total Tons	Standard Efficiency Unit EERb	CF	EFLH Cooling	Demand Savings (kW)	Energy Savings (kWh)
Bookbinder School	VRF	Unit Ventilators	4	4	16.0	11.00	0.5	394	8.73	6,877.09
Bookbinder School	VRF	Unit Ventilators	6	4	24.0	11.00	0.5	394	13.09	10,315.64
Bookbinder School	VPUV	Unit Ventilators	22	4	88.0	11.00	0.5	394	48.00	37,824.00

SUPPLY FAN MOTOR - BASELINE ADJUSTMENT

BUILDING	Existing AHU QTY	Existing AHU Supply Fan Motor HP	Replacement VPUV Quantity	Replacement VPUV HP	EXISTING AHU MOTOR EFFICIENCY (Nbase)	NEW VPUV MOTOR EFFICIENCY (Nprem)	LF	CF	IFvfd	HRS	Total Added ΔkW	DEMAND Addition (Kw)	ELECTRIC SAVINGS (kWh)
Bookbinder School	11	0.5	22	0.333333333	0.75	0.8	0.75	0.74	1.0	2745	1.37	1.01	2,816

Unit Ventilator Replacement Savings											
BUILDING	REPLACEMENT QTY	EXISTING FAN MOTOR HP	EXISTING FAN MOTOR EFFICIENCY (Nbase)	REPLACEMENT FAN MOTOR EFFICIENCY (Nprem)	LF	CF	IFvfd	HRS	Total ΔkW	DEMAND SAVINGS (Kw)	ELECTRIC SAVINGS (kWh)
Bookbinder School	4	0.167	0.8	0.855	0.75	0.74	1.0	2745	0.01	0.030	82
Bookbinder School	6	0.167	0.8	0.855	0.75	0.74	1.0	2745	0.01	0.044	123
Bookbinder School	22	0.167	0.8	0.855	0.75	0.74	1.0	2745	0.01	0.163	453

ADDED VRF & VPUV - High Efficiency Savings														
BUILDING	SYSTEM	Areas Served	Spaces to Get Cooling (Qty)	Tons Per Space	Total Tons	Standard Efficiency Unit EERb	Proposed Qty	Tons Per Unit	Total Proposed Tons	High Efficiency EERq	CF	EFLH Cooling	Demand Savings (kW)	Energy Savings (kWh)
Bookbinder School	VRF	Unit Ventilators	4	4	16.0	11	4	4.0000	16.0	12.0	0.5	394	0.73	573.09
Bookbinder School	VRF	Unit Ventilators	6	4	24.0	11.00	6	4.0000	24.0	12.0	0.5	394	1.09	859.64
Bookbinder School	VPUV	Unit Ventilators	22	4	88.0	11.00	22	4.0000	88.0	12.0	0.5	394	4.00	3,152.00

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
LF	Fixed	0.75	1
η_{base}	Fixed	ASHRAE 90.1-2016 Baseline Efficiency Table	ASHRAE
η_{prem}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
IF_{VFD}	Fixed	1.0 or 0.9	3
Efficiency - η_{ee}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
CF	Fixed	0.74	1
HRS	Fixed	Annual Operating Hours Table	1

Algorithms

Energy Savings (kWh/yr) = N * HP * ESF

Peak Demand Savings (kW) = N * HP * DSF

Definitions of Variables

N = Number of motors controlled by VFD(s) per application
HP = Nameplate motor horsepower or manufacturer specification sheet per application
ESF = Energy Savings Factor (kWh/year per HP)
DSF = Demand Savings Factor (kW per HP)

Summary of Inputs

Variable Frequency Drives

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
ESF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3
DSF	Variable	See Table Below	Derived value based on the following sources: 1, 2, 3

VFD Savings Factors

Application	ESF (kWh/Year-HP)	DSF (kW/HP)	Source
Supply Air Fan	2,033	0.286	1
Return Air Fan	1,788	0.297	1
CHW or CW Pump	1,633	0.185	1
HHW Pump	1,548	0.096	1
WSHP Pump	2,562	0.234	1
CT Fan	290	-0.025	2, 3
Boiler Feedwater Pump	1,588	0.498	2, 3

The ESF for the supply and return fans and circulating pumps are derived from a 2014 NEEP-funded study of 400 VFD installations in eight northeast states. The derived values are based on actual logged input power data and reflect average operating hours, load factors, and motor efficiencies for the sample. Savings factors representing cooling tower fans and boiler feed water pumps are not reflected in the NEEP report. Values representing these applications are taken from April 2018 New York TRM, Appendix K, and represent average values derived from DOE2.2 simulation of various building types

Component	Type	Value	Source
HP	Variable	Nameplate/Manufacturer Spec. Sheet	Application
LF	Fixed	0.75	1
η_{base}	Fixed	ASHRAE 90.1-2016 Baseline Efficiency Table	ASHRAE
η_{prem}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
IF_{VFD}	Fixed	1.0 or 0.9	3
Efficiency - η_{ee}	Variable	Nameplate/Manufacturer Spec. Sheet	Application
CF	Fixed	0.74	1
HRS	Fixed	Annual Operating Hours Table	1

NEMA ASHRAE 90.1-2016 Motor Efficiency Table – General Purpose Subtype I (Adapted from Table 10.8-1)

Motor	1200 RPM (6 pole)		1800 RPM (4 pole)		3600 RPM (2 pole)	
1	.825	.825	.855	.855	.77	.77
1.5	.865	.875	.865	.865	.84	.84
2	.875	.885	.865	.865	.855	.855
3	.885	.895	.895	.895	.855	.865
5	.895	.895	.895	.895	.865	.885
7.5	.902	.91	.91	.917	.885	.895
10	.917	.91	.917	.917	.895	.902
15	.917	.917	.93	.924	.902	.91
20	.924	.917	.93	.930	.91	.91
25	.93	.93	.936	.936	.917	.917
30	.936	.93	.941	.936	.917	.917
40	.941	.941	.941	.941	.924	.924
50	.941	.941	.945	.945	.93	.93
60	.945	.945	.95	.950	.936	.936
75	.945	.945	.95	.954	.936	.936
100	.95	.95	.954	.954	.936	.941
125	.95	.95	.954	.954	.941	.95
150	.954	.958	.958	.958	.941	.95
200	.954	.958	.958	.962	.95	.954

Annual Operating Hours Table

Motor Horsepower	Operating Hours, HRS
1 to 5 HP	2,745
6 to 20 HP	3,391
21 to 50 HP	4,067
51 to 100 HP	5,329
101 to 200 HP	5,200

Algorithms

Air Conditioning Algorithms:

Energy Savings (kWh/yr) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * EFLH_c$

Peak Demand Savings (kW) = N * Tons * 12 kBtuh/Ton * $(1/EER_b - 1/EER_q) * CF$

(5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

CF = Coincidence Factor – This value represents the percentage of the total load which is on during electric system's Peak Window. This value is based on existing measured usage and determined as the average number of operating hours during the peak window period.

$EFLH_{c\ or\ h}$ = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off-peak periods.

Summary of Inputs

HVAC and Heat Pumps

Component	Type	Value	Source
Tons	Variable	Rated Capacity, Tons	Application
EER_b	Variable	See Table below	1
EER_q	Variable	ARI/AHRI or AHAM Values	Application
CF	Fixed	50%	2
$EFLH_{(c\ or\ h)}$	Variable	See Tables below	3

Definition of Variables

N = Number of units

Tons = Rated cooling capacity of unit. This value comes from ARI/AHRI or AHAM rating or manufacturer data.

EER_b = Energy Efficiency Ratio of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER should be used in place of EER.

COP_b = Coefficient of Performance of the baseline unit. This data is found in the HVAC and Heat Pumps table below. For units < 65,000 BtuH (5.4 tons), SEER and HSPF/3.412 should be used in place of COP * 3.412 for cooling and heating savings, respectively.

EER_q = Energy Efficiency Ratio of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 (5.4 tons) BtuH, SEER should be used in place of EER.

COP_q = Coefficient of Performance of the high efficiency unit. This value comes from the ARI/AHRI or AHAM directories or manufacturer data. For units < 65,000 BtuH

EFLH Table

Facility Type	Heating $EFLH_h$	Cooling $EFLH_c$
Assembly	603	669
Auto repair	1910	426
Dormitory	465	800
Hospital	3366	1424
Light industrial	714	549
Lodging – Hotel	1077	2918
Lodging – Motel	619	1233
Office – large	2034	720
Office – small	431	955

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Water Source Heat Pumps (water to air, water loop)	
<=1.4 tons	12.2 EER, 4.3 heating COP
>1.4 to 5.4 tons	13.0 EER, 4.3 heating COP
>5.4 to 11.25 tons	13.0 EER, 4.3 heating COP
Ground Water Source Heat Pumps <=11.25 tons	18.0 EER, 3.7 heating COP
Ground Source Heat Pumps (brine to air, ground loop) <=11.25 tons	14.1 EER, 3.2 heating COP
Package Terminal Air Conditioners[27]	14.0 – (0.300 * Cap/1,000), EER
Package Terminal Heat Pumps	14.0 – (0.300 * Cap/1,000), EER 3.7 – (0.052 * Cap/1,000), heating COP
Single Package Vertical Air Conditioners	
<=5.4 tons	10.0 EER
>5.4 to 11.25 tons	10.0 EER
>11.25 to 20 tons	10.0 EER
Single Package Vertical Heat Pumps	
<=5.4 tons	10.0 EER, 3.0 heating COP
>5.4 to 11.25 tons	10.0 EER, 3.0 heating COP
>11.25 to 20 tons	10.0 EER, 3.0 heating COP

Facility Type	Heating EFLH$_h$	Cooling EFLH$_c$
Other	681	736
Religious worship	722	279
Restaurant – fast food	813	645
Restaurant – full service	821	574
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – small	545	882
Retail – large	2101	1068
School – Community college	1431	846
School – postsecondary	1191	1208
School – primary	840	394
School – secondary	901	466
Warehouse	452	400

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ECM 18 – Field Lighting Upgrade

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
18	Field Lighting Upgrade												✔

Outdoor field lighting are types of site light fixtures that are commonly used to illuminate large areas for sporting events or other large outdoor events and activities, such as concerts. Sports light fixtures are typically mounted on poles 40 to 100 feet tall, with between 1-12 fixtures mounted on each pole. This type of outdoor lighting is often used by schools, colleges and universities, municipalities, amateur sports clubs, and professional sports franchises.

Common (HID) lamp wattages used for conventional sports lighting fixtures range from 400 watts to 2,000 watts. The higher the wattage the higher the light output. The function of the area being illuminated, combined with the quantity, spacing, and mounting height of the field light fixtures plays a role in the existing wattages utilized. A few 1000w or 2000w metal halide sports light lamps (very common wattages for existing outdoor sports lighting) can cost up to $6,300 and $12,500, respectively, to operate per year, in electricity costs alone.

Maintenance costs are often a big concern for those managing lights. In addition to the potential lamp lifetime concerns, sports field fixtures can easily cause interference with the

day-to-day activities of teams or employees when changing out a lamp or a ballast. It can cost up to $2,000 in labor and material to maintain a single exterior HID sports field fixture over the course of three years.

Existing Conditions

Scope of Work

No scope of work is included for this ECM. The district is completing the scope outside of the ESIP and only the savings are being carried.

ECM Calculations

BPU Protocols for lighting replacement were used to calculate the savings associated with the Field Lighting Upgrades.

FIELD LIGHTING UPGRADE						
BUILDING	**SPACE**	**kW_b**	**kW_q**	**ΔkW**	**Hours per Year**	**Energy Savings (kWh)**
Willingboro High School	EXTERIOR	76.00	45.90	30.10	420	12,642

Algorithms

$$\text{DkW} = (\#\ of\ replaced\ fixtures) * (Watts_b) - (\#\ of\ fixtures\ installed) * (Watts_q) = (LPD_b - LPD_q) * (\text{SF})$$

$$\text{Energy Savings } \left(\frac{\text{kWh}}{\text{yr}}\right) = (\Delta\text{kW}) * (\text{Hrs}) * (1 + HVAC_e)$$

$$\text{Peak Demand Savings (kW)} = (\Delta\text{kW}) * (\text{CF}) * (1 + HVAC_d)$$

$$\text{Fuel Savings } \left(\frac{\text{MMBtu}}{\text{yr}}\right) = (\Delta\text{kW}) * (\text{Hrs}) * (\text{HVAC}_g)$$

Definition of Variables

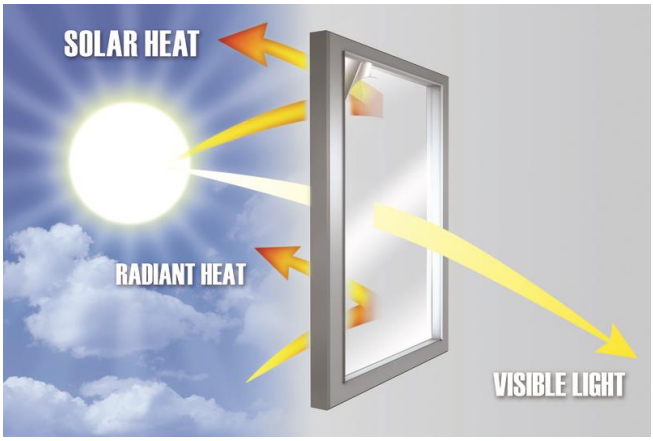
ΔkW	= Change in connected load from baseline to efficient lighting
$\text{Watts}_{b,q}$	= Wattage of existing baseline and qualifying equipment
LPD_b	= Baseline lighting power density in Watt per square foot of space floor area
LPD_q	= Lighting power density of qualified fixtures, equal to the sum of installed fixture wattage divided by floor area of the space where the fixtures are installed.
SF	= Space floor area, in square feet
CF	= Coincidence factor
Hrs	= Annual operating hours
HVAC_d	= HVAC Interactive Factor for peak demand savings
HVAC_e	= HVAC Interactive Factor for annual energy savings
HVAC_g	= HVAC Interactive Factor for annual energy savings

Summary of Inputs

ECM 19 – Window Film

Willingboro Township Public Schools ECM Matrix		Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
✔	ECM was evaluated												
✔	ECM included in the project												
ECM #	ECM DESCRIPTION												
19	Window Film			✔		✔	✔		✔	✔			✔

Window film adheres to existing windows to reflect radiant infrared energy, thus tending to keep radiant heat on the side of the glass where it originated. This results in more efficient windows because radiant heat originating from indoors in winter is reflected back inside, while infrared heat radiation from the sun during summer is reflected away, keeping it cooler inside. Window film stills allow the natural light to shine through but reduces the window glare to allow occupants to see clearly without straining their eyes.



Scope of Work

The schools list below were evalauted to have low efficiency glazing. 5 schools will have the 3M Affinity 15 solar window film installed. The high school has existing security film that will be removed and replaced with a combination security and solar film, Solargard Silver 20 8 mil.

BUILDING	Window Film Model
Garfield East Elementary School	Affinity 15
J. Cresswell Stuart Early Childhood Development Center	Affinity 15
James A. Cotten Intermediate School	Affinity 15
Memorial Middle School	Affinity 15
Twin Hills Elementary School	Affinity 15
Willingboro High School	Silver 20 8mil

3M™ AFFINITY 15 WINDOW FILM

Glass Type (All 1/4")	Film Type	Visible Light			Total Solar Energy Rejected	Solar Heat Gain Coefficient (G Value)	U Value		Solar Heat Reduction	UV Light Rejected	Glare Reduction	Visible Light to Solar Heat Gain Ratio
		Reflected (Interior)	Reflected (Exterior)	Transmitted			btu/ hft²F	w/ m²K				
 Clear	Affinity 15	25%	58%	9%	79%	0.21	1.00	5.7	74%	99%	90%	0.4
	Affinity 30	19%	29%	33%	61%	0.39	0.94	5.3	52%	99%	63%	0.8
 Tinted	Affinity 15	25%	24%	5%	73%	0.27	1.00	5.7	57%	99%	91%	0.2
	Affinity 30	19%	14%	20%	63%	0.37	0.94	5.3	41%	99%	62%	0.5
 Double Clear	Affinity 15	26%	57%	8%	68%	0.32	0.47	2.7	54%	99%	90%	0.3
	Affinity 30	20%	32%	30%	54%	0.46	0.45	2.6	34%	99%	62%	0.7
 Double Tinted	Affinity 15	25%	23%	5%	73%	0.27	0.47	2.7	47%	99%	89%	0.2
	Affinity 30	20%	15%	18%	64%	0.36	0.45	2.6	29%	99%	62%	0.5

SOLARGARD SILVER 20 8MIL

Specification	Armorcoat-Silver 4mil 20	Armorcoat-Silver 8mil 20	Armorcoat-Silver 8mil 35	Armorcoat-Stainless Steel 4mil 20	Armorcoat-Stainless Steel 4mil 35	Armorcoat-Stainless Steel 4mil 50	Armorcoat-Stainless Steel 8mil 20	Armorcoat-Stainless Steel 8mil 35	Armorcoat-Stainless Steel 8mil 50
Visible light transmittance %	15%	14%	35%	22%	37%	46%	21%	37%	43%
Visible light reflectance (exterior) %	57%	57%	35%	27%	17%	13%	26%	17%	13%
Visible light reflectance (interior) %	60%	59%	33%	25%	15%	11%	24%	16%	11%
Solar heat gain coefficient	.23	.23	.38	.38	.50	.55	.38	.50	.53
Total solar energy rejected %	77%	77%	62%	62%	50%	45%	62%	50%	47%
UV Tdw-ISO @ 300 to 700 nm %	13%	13%	28%	16%	26%	33%	15%	26%	30%
UV light blocked (300 to 380 nm) %	>99%	>99%	>99%	>99%	>99%	>99%	>99%	>99%	>99%
Fade Reduction %	84%	84%	66%	80%	68%	60%	82%	68%	63%

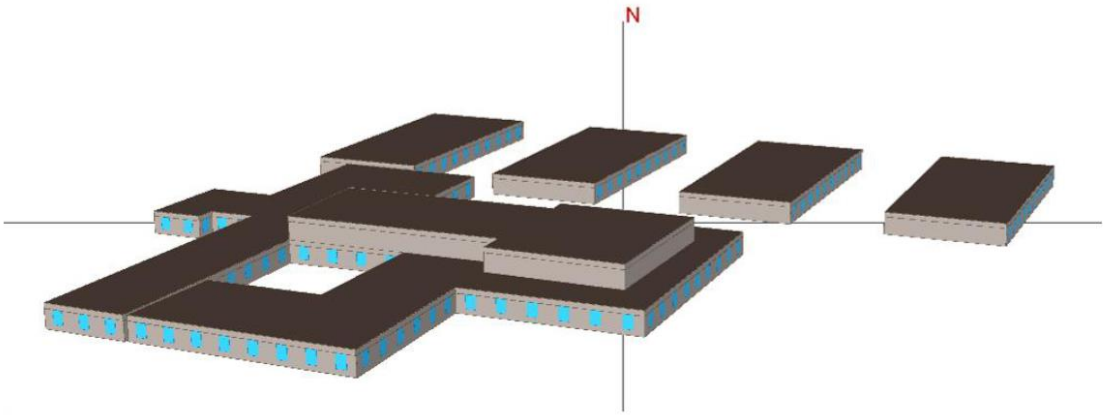
Existing Conditions

ECM Calculations

Energy Savings from the installation of Window Film was modeled in eQuest and the summary is shown below.

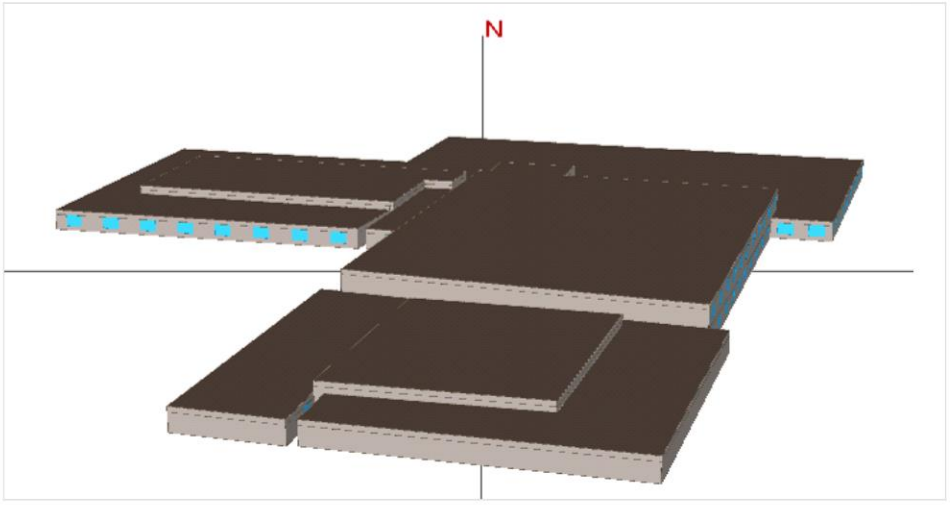
Window Film Savings				
BUILDING	**Window Film Model**	**kWh Savings**	**kW Savings**	**THERM Savings**
Garfield East Elementary School	Affinity 15	6,034	5	537
J. Cresswell Stuart Early Childhood Development Center	Affinity 15	12,987	11	783
James A. Cotten Intermediate School	Affinity 15	12,067	9	133
Memorial Middle School	Affinity 15	37,845	27	1,255
Twin Hills Elementary School	Affinity 15	16,671	13	894
Willingboro High School	Silver 20 8mil	61,275	10	3,757

JAMES A COTTEN INTERMEDIATE 50 DR. MARTIN LUTHER KING JR.BLVD. WILLINGBORO, NJ 08046



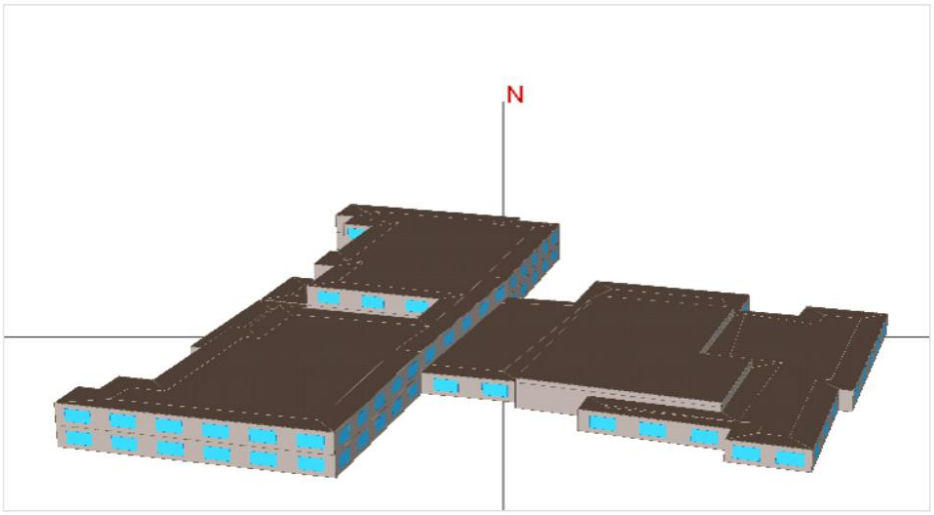
NGS

WILLINGBORO HIGH SCHOOL 20 JOHN F. KENNEDY WAY WILLINGBORO, NJ 08046



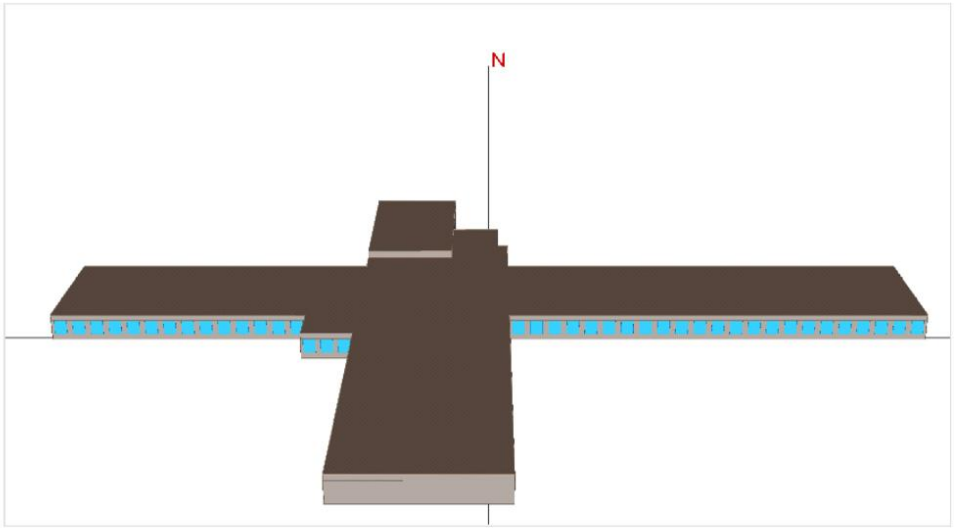
NGS

MEMORIAL MIDDLE SCHOOL 451 VAN SCIVER PKWY. WILLINGBORO, NJ 08046



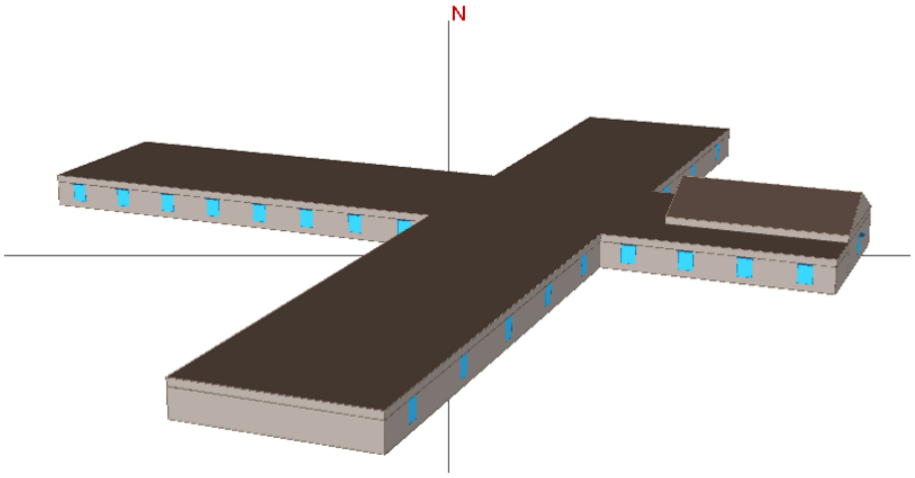
NGS

TWIN HILLS ELEMENTARY 110 TWIN HILL DR. WILLINGBORO, NJ 08046



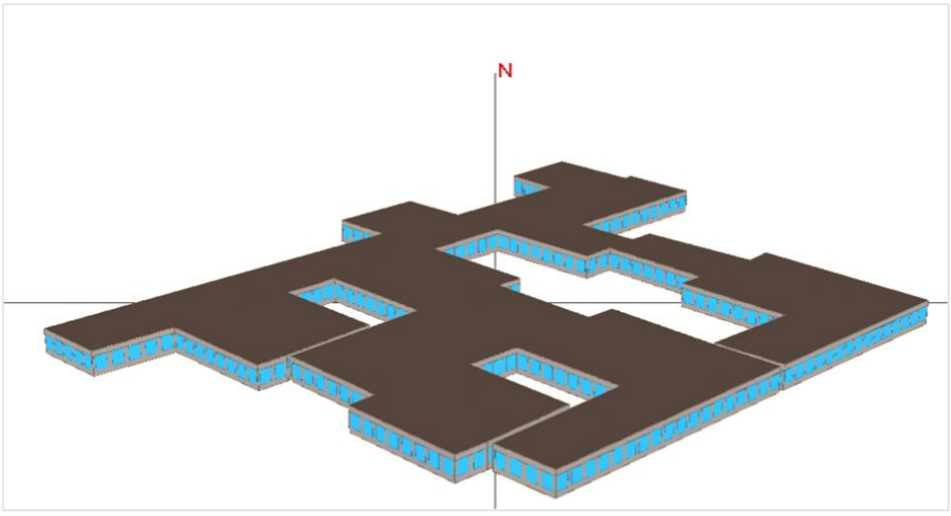
NGS

GARFIELD EAST EARLY CHILDHOOD CENTER 150 EVERGREEN DR. WILLINGBORO, NJ 08046



NGS

JC STUART EARLY CHILDHOOD CENTER 70 SUNSET RD. WILLINGBORO, NJ 08046



NGS

ECMs Evaluated but Not Included

The energy conservation measures highlighted in this section were each evaluated during the investment grade audit. Due to high capital costs compared to annual energy savings and district priorities, these measures have not been included in the Energy Savings Plan.

ECM 5 – Roof Renovations

Due to poor payback and WTPS priorities, this ECM is not included in the ESIP Project

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
5	Roof Renovations			✔			✔		✔				✔

Background, Scope of Work, and ECM Calculations not provided. Cost and savings can be reviewed on Form II in Section 4 of the Energy Savings Plan.

ECM 15 & 16 – Solar Ownership & Solar PPA

DCO Energy submitted interconnection applications for 9 schools. 7 Schools were approved for non-export, Memorial Middle School and James A. Cotten Intermediate School were denied. System sizes would be significantly reduced from sizes submitted on the interconnection application due to the non-export limitation. Required roofing upgrades would exceed the benefit of the solar generation. Due to poor payback and WTPS priorities, this ECM is not included in the ESIP Project

Willingboro Township Public Schools ECM Matrix

✔	ECM was evaluated
✔	ECM included in the project

ECM #	ECM DESCRIPTION	Bookbinder School	Country Club Administration Building	Garfield East Elementary School	Hawthorne Elementary School	J. Cresswell Stuart Early Childhood Development Center	James A. Cotten Intermediate School	Joseph A. McGinley School	Memorial Middle School	Twin Hills Elementary School	W.R. James Elementary School	Warehouse	Willingboro High School
15	Solar Ownership		✔	✔	✔	✔	✔		✔	✔	✔		✔
16	Solar PPA		✔	✔	✔	✔	✔		✔	✔	✔		✔

Background, Scope of Work, and ECM Calculations not provided. Cost and savings can be reviewed on Form II in Section 4 of the Energy Savings Plan.

ENERGY SAVINGS PLAN

SECTION 4 – FINANCIAL ANALYSIS

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Form II – Energy Conservation Measures Summary Form

FORM II - 20 Years @ 4% Interest

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ENERGY CONSERVATION MEASURES (ECMs) SUMMARY FORM
Willingboro Township Public Schools
ENERGY SAVINGS IMPROVEMENT PROGRAM

ESCO Name: DCO Energy

Proposed Preliminary Energy Savings Plan		Estimated Installed Hard Costs[1] $	Estimated Annual Savings $	Est. Simple Payback (Years)
ECM Numbe	Energy Conservation Measure			
1	LED Lighting Upgrades	$1,818,217	$235,516	7.7
2	Lighting Controls	$406,059	$19,693	20.6
3	District Wide Energy Management System Tier 1	$474,045	$41,702	11.4
4	District Wide Energy Management System Tier 2	$2,977,249	$103,028	28.9
6	Pipe and Valve Insulation	$120,195	$27,084	4.4
7	Building Envelope Weatherization	$344,200	$39,216	8.8
8	Plug Load Controls	$109,832	$12,379	8.9
9	eTemp Refrigeration Sensors	$47,292	$12,952	3.7
10	Retro-Commissioning	$83,000	$19,927	4.2
11	Combined Heating & Power	$187,830	$3,204	58.6
12	Boiler Plant Replacement	$931,753	$11,860	78.6
13	RTU & Split System HVAC Replacement	$1,826,688	$731	2500.6
14	Destratification Fans	$161,950	$10,886	14.9
17	Unit Ventilator Replacement w/ Addition of Cooling	$3,558,347	$905	3932.9
18	Field Lighting Upgrade	$0	$1,850	0.0
19	Window Film	$189,569	$32,644	5.8
*Add additional lines as needed**	**Project Summary:**	**$13,236,226**	**$573,576**	**23.1**

Optional ECMs *Considered, but not included with base project at this time*		Estimated Installed Hard Costs[1] $	Estimated Annual Savings $	Est. Simple Payback (Years)
ECM Number	Energy Conservation Measure			
4	District Wide Energy Management System Tier 2	$181,599	$0	-
5	Roof Renovations	$4,274,868	$1,441	2966.9
7	Building Envelope Weatherization	$33,600	$5,018	6.7
10	Retro-Commissioning	$19,000	$3,711	5.1
15	Solar Ownership	$577,295	$26,453	21.8
16	Solar PPA	$0	$0	-
17	Unit Ventilator Replacement w/ Addition of Cooling	$3,130,535	$920	3403.5
*Add additional lines as needed**	**Optional ECMs Summary:**	**$8,216,897**	**$37,543**	**218.9**

Proposed Energy Related Capital Improvements		Supporting ECM	Estimated Cost $	Percentage of Total Project Cost (Not to Exceed 15%)
ECM Number	Energy Conservation Measure			
*Add additional lines as needed**	**Optional ECMs Summary:**	**-**	**$0**	**0.0%**

(1) The total value of Hard Costs is defined in accordance with standard AIA definitions that include: Labor Costs, Subcontractor Costs, Cost of Materials and Equipment, Temporary Facilities and Related Items, and Miscellaneous Costs such as Permits, Bonds, Taxes, Insurance, Mark-ups, Overhead, Profit, etc.

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Form V – ESCO Construction and Service Fees

FORM V - 20 Years @ 4% Interest		
ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP): ESCOs PROPOSED FINAL PROJECT COST FORM FOR BASE CASE PROJECT Willingboro Township Public Schools ENERGY SAVING IMPROVEMENT PROGRAM		
ESCO Name: DCO Energy PROPOSED CONSTRUCTION FEES:		
Fee Category	**Fees (1) Dollar ($) Value**	**Percentage of Hard Costs**
Estimated Value of Hard Costs (2)	$ 13,236,226	N/A
Contingency	$ 476,504	
Estimated Value of Hard Costs (2)	$ 13,712,730	
Project Service Fees		
Investment Grade Energy Audit	$ 342,818	2.50%
Design Engineering Fees	$ 891,327	6.50%
Construction Management & Project Administration	$ 987,317	7.20%
System Commissioning	$ 89,133	0.65%
Equipment Initial Training Fees	$ 89,133	0.65%
ESCO Overhead	$ 411,382	3.00%
ESCO Profit	$ 548,509	4.00%
Project Service Fees Sub Total	$ 2,399,728	17.50%
TOTAL FINANCED PROJECT COSTS(4):	$ 17,072,348	24.50%
PROPOSED ANNUAL SERVICE FEES		
First Year Annual Service Fees	**Fees (1) Dollar ($) Value**	**Percentage of Hard Costs**
SAVINGS GUARANTEE *(OPTION)*	$0	0.00%
Measurement & Verification *(Associated w/ Savings Guarantee Option)*	$75,000	FLAT FEE
ENERGY STAR Services *(optional)*	$0	0.00%
Post Construction Services *(if applicable)*	$0	0.00%
Performance Monitoring	w/ M&V	0.00%
On-going Training Services	w/ M&V	0.00%
Verification Reports	w/ M&V	0.00%
TOTAL FIRST YEAR ANNUAL SERVICES	$0	0.00%

NOTES:
(1) Fees should include all mark-ups, overhead, and profit. Figures stated as a range will NOT be accepted.
(2) The total value of Hard Costs is defined in accordance with standard AIA definitions that include: Labor Costs, Subcontractor Costs, Cost of Materials and Equipment, Temporary Facilities and Related Items, and Miscellaneous Costs such as Permits, Bonds Taxes, Insurance, Mark-ups, Overhead and Profit, etc.

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Form VI – Project Cash Flow Analysis

FORM VI - 20 Years @ 4% Interest

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
Willingboro Township Public Schools - ENERGY SAVING IMPROVEMENT PROGRAM

ESCO Name: DCO Energy

Note: Respondents must use the following assumptions in all financial calculations:
(a) The cost of all types of energy should be assumed to inflate at **2.4% gas, 2.2%** electric per year and
1. Term of Agreement: **20 Years**
2. Construction Period (months): 24 Months
3. Cash Flow Analysis Format:

Miscellaneous Costs Financed:	
Cost of Issuance	$150,000
Total	$150,000

Project Cost[1]: **$17,072,348**
Capital Contribution: **$5,772,000**
Misc Costs Financed: **$150,000**
Financed Amount: **$11,450,348**

Interest Rate: **4.00%**

Year	Annual Energy Savings [2]	Annual Operational Savings	Energy Rebates / Incentives Value	Energy Rebates / Incentives Utility	Solar PPA Savings	Total Annual Savings	Annual Project Costs	Net Cash-Flow to Client	Cumulative Cash Flow
Installation (2 Years)	$ 652,737		$ 266,963	PSE&G Prescriptive		$ 919,701	$ (389,312)		
Year 1	$ 625,741	$ 147,166	$ 266,963			$ 1,039,871	$ (1,567,837)	$ 2,423	$ 2,423
Year 2	$ 639,871	$ 147,166				$ 787,037	$ (784,615)	$ 2,423	$ 4,846
Year 3	$ 654,321	$ 54,700				$ 709,021	$ (706,598)	$ 2,423	$ 7,268
Year 4	$ 669,098	$ 54,700				$ 723,798	$ (721,375)	$ 2,423	$ 9,691
Year 5	$ 684,209	$ 54,700				$ 738,909	$ (736,486)	$ 2,423	$ 12,114
Year 6	$ 699,662					$ 699,662	$ (697,239)	$ 2,423	$ 14,537
Year 7	$ 715,464					$ 715,464	$ (713,041)	$ 2,423	$ 16,959
Year 8	$ 731,624					$ 731,624	$ (729,201)	$ 2,423	$ 19,382
Year 9	$ 748,149					$ 748,149	$ (745,727)	$ 2,423	$ 21,805
Year 10	$ 765,049					$ 765,049	$ (762,626)	$ 2,423	$ 24,228
Year 11	$ 782,330					$ 782,330	$ (779,908)	$ 2,423	$ 26,651
Year 12	$ 800,003					$ 800,003	$ (797,580)	$ 2,423	$ 29,073
Year 13	$ 818,076					$ 818,076	$ (815,653)	$ 2,423	$ 31,496
Year 14	$ 836,557					$ 836,557	$ (834,134)	$ 2,423	$ 33,919
Year 15	$ 855,457					$ 855,457	$ (853,034)	$ 2,423	$ 36,342
Year 16	$ 874,784					$ 874,784	$ (872,362)	$ 2,423	$ 38,764
Year 17	$ 894,549					$ 894,549	$ (892,126)	$ 2,423	$ 41,187
Year 18	$ 914,761					$ 914,761	$ (912,338)	$ 2,423	$ 43,610
Year 19	$ 935,431					$ 935,431	$ (933,008)	$ 2,423	$ 46,033
Year 20	$ 956,568					$ 956,568	$ (954,145)	$ 2,423	$ 48,455
Totals	$ 16,254,442	$ 458,432	$ 533,927	$ -	$ -	$ 17,246,801	$ (17,198,345)	$ 48,455	

NOTES:
(1) Includes: Hard costs and project service fees defined in ESCO's PROPOSED "FORM V"
(2) As of 7/1/21. Board approved utility EE programs replaced certain NJ CEP offerings. Subsequently, the BPU is requiring that all ESIP projects consult with the DCA and follow all DCA guidance regarding the procurement of all subcontractors. Additionally utility incentives must be detailed on ESIP forms.

Utility Inflation Details

Per Form VI, the annual inflation rate is 2.2% for electric and 2.4% for natural gas.

Utility Inflation Worksheet		
Year	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS
1	$443,740.10	$182,000.82
2	$453,502.38	$186,368.84
3	$463,479.43	$190,841.69
4	$473,675.98	$195,421.89
5	$484,096.85	$200,112.02
6	$494,746.98	$204,914.70
7	$505,631.41	$209,832.66
8	$516,755.31	$214,868.64
9	$528,123.92	$220,025.49
10	$539,742.65	$225,306.10
11	$551,616.99	$230,713.45
12	$563,752.56	$236,250.57
13	$576,155.12	$241,920.58
14	$588,830.53	$247,726.68
15	$601,784.80	$253,672.12
16	$615,024.07	$259,760.25
17	$628,554.60	$265,994.49
18	$642,382.80	$272,378.36
19	$656,515.22	$278,915.44
20	$670,958.55	$285,609.41

ENERGY SAVINGS PLAN

SECTION 5 – RISK, DESIGN, & COMPLIANCE

Assessment of Risks, Design & Compliance Issues

Moving from a conceptual design to engineered documents, DCO has identified areas of the project that could change during the detailed design. The table below represents potential conceptual areas of concern that will need to be investigated further with a corresponding party responsible for the compliance of each item.

Issue	Category	Responsible Party
Alteration of expected Maintenance and Operational Savings	Risk	Willingboro Township Public Schools
Disposition of Abandoned Equipment (Steam Piping, Condensate Piping, Oil Tanks, etc.)	Risk	Willingboro Township Public Schools
New Natural Gas Distribution	Risk	Willingboro Township Public Schools
Integrity of re-used Infrastructure	Risk	Willingboro Township Public Schools
Life Safety System Coordination	Risk	Willingboro Township Public Schools
Coordination with Willingboro Township Public Schools Information Technology Department	Risk	Willingboro Township Public Schools
Ventilation Compliance with Code	Compliance	Consulting Engineer
Temperature, Humidity and Air Change Compliance with Code	Compliance	Consulting Engineer
Boiler Capacity and Turndown	Design	Consulting Engineer
Natural Gas Regulator Compliance with Code	Compliance	Consulting Engineer
Undocumented Underground Utilities	Risk	Consulting Engineer
Code Compliance of Existing Electrical Infrastructure	Compliance	Consulting Engineer
Lighting Levels	Compliance	Consulting Engineer
Design Light Consortium rating for bulbs	Compliance	Consulting Engineer

Underwriters Laboratory Testing for retrofitted LED Lighting Systems	Compliance	Consulting Engineer
Lighting Retrofits within hard ceilings for fixtures and occupancy sensors	Risk	Consulting Engineer
Street/Parking Lot Pole Structural Integrity	Risk	Consulting Engineer
Unrealized Energy Savings 1. Energy Modeling 2. Performance Monitoring 3. Capacity of Equipment 4. Efficiency of Equipment 5. Run Hours of Equipment	Risk	DCO/ Consulting Engineer 1. DCO 2. DCO 3. Consulting Engineer / Basis of Design Vendor 4. Consulting Engineer / Basis of Design Vendor 5. Willingboro Township Public Schools
Existing Plumbing Infrastructure with New Low Flow Devices	Design	Consulting Engineer
Adaptation to New RTUs (Curb, Electric, Ductwork, Condensate)	Design	Consulting Engineer / Basis of Design Manufacture
Structural Loads for Rooftop Equipment Replacement	Design	Consulting Engineer
Transformer Loading	Risk	Consulting Engineer
Site Work for Equipment	Design	Consulting Engineer
Condition of Roof Under Units	Risk	Consulting Engineer
Adequate Crane Lifts & Clearances	Design	Consulting Engineer / Rigger
Physical Space Constraints and Clearance for Equipment Replacement	Design	Consulting Engineer
Refrigerant Reclaim / Refrigerant Disposal	Compliance	Contractor

Existing Tie in Locations	Design	Consulting Engineer
Schedule Oversight	Risk	DCO Energy
Impact of Boiler Flue	Design	Consulting Engineer
Impact of Space Usage During Construction	Risk	Consulting Engineer & Willingboro Township Public Schools
Scope changes relating to requests by Authorities Having Jurisdiction.	Risk	Willingboro Township Public Schools (via contingency)
Department of Environmental Protection Permitting	Risk	Consulting Engineer
Modifications of Energy Saving Control Sequences and Setpoints impacting Energy Savings and Incentives	Risk	Willingboro Township Public Schools
Post Construction Calibration of Sensors, Meters, & Safety Devices	Risk	Willingboro Township Public Schools
Adequate time and access for bidding contractor site surveys	Risk	Willingboro Township Public Schools
Utility Interconnection approval for the CHP Unit	Risk	Contractor

Measurement & Verification (M&V) Plan

Our approach to M&V of energy savings aligns with the International Performance Measurement & Verification Protocol. More detailed information may be found below. It's most cost-effective to perform M&V using the least costly option that still adequately documents system performance and permits analysis of savings. This approach lowers the total cost of the program, leaving more dollars available to perform more facility improvements. Depending upon which ECMs are implemented by Willingboro Township Public Schools, the M&V plan proposed by DCO would incorporate one or more of the following options which outlines the four most common approaches for M&V:

Option A – Retrofit Isolation with Key Parameter Measurement	This option is based on a combination of measured and estimated factors when variations in factors are not expected. Measurements are spot or short-term and are taken at the component or system level, both in the baseline and post-installation cases. Measurements should include the key performance parameter(s) which define the energy use of the ECM. Estimated factors are supported by historical or manufacturer's data. Savings are determined by means of engineering calculations of baseline and post-installation energy use based on measured and estimated values.	Direct measurements and estimated values, engineering calculations and/or component or system models often developed through regression analysis. Adjustments to models are not typically required.
Option B – Retrofit Isolation with Parameter Measurement	This option is based on periodic or continuous measurements of energy use taken at the component or system level when variations in factors are expected. Energy or proxies of energy use are measured continuously. Periodic spot or short-term measurements may suffice when variations in factors are not expected. Savings are determined form analysis of baseline and reporting period energy use of proxies of energy use.	Direct measurements, engineering calculations, and/or component or system models often developed through regression analysis. Adjustments to models may be required.
Option C – Utility Data Analysis	This option is based on long-term, continuous, whole-building utility meter, facility level, or sub-meter energy (or water) data. Savings are determined from analysis of baseline and reporting period energy data. Typically, regression analysis is conducted to correlate with and adjust energy use to independent variables such as weather, but simple comparisons may also be used.	Based on regression analysis of utility meter data to account for factors that drive energy use. Adjustments to models are typically required.
Option D – Calibrated	Computer simulation software is used to model energy performance of a whole facility (or sub-facility). Models must be calibrated with actual hourly or monthly billing data from the facility. Implementation of simulation modeling requires	Based on computer simulation model calibrated with whole-building or end-use

Computer Simulation	engineering expertise. Inputs to the model include facility characteristics; performance specifications of new and existing equipment or systems; engineering estimates, spot-, short-term, or long-term measurements of system components; and long-term whole-building utility meter data. After the model has been calibrated, savings are determined by comparing a simulation of the baseline with either a simulation of the performance period or actual utility data	metered data or both. Adjustments to models are required.

Each of the options can be used for a wide array of energy efficiency upgrades and each has different costs and complexities associated with it. When selecting an M&V approach, the following general rule of thumb can be applied:

OPTION A

- When magnitude of savings is low for the entire project or a portion of the project
- The risk of not achieving savings is low.

OPTION B

- For simple equipment replacement projects
- When energy savings values per individual measure are desired
- When interactive effects are to be ignored or are estimated using estimating methods that do not involve long term measurements
- When sub-meters already exist that record the energy use of subsystems under consideration

OPTION C

- For complex equipment replacement and controls projects
- When predicted energy savings are in excess of 10 to 20 percent as compared with the record energy use
- When energy savings per individual measure are not desired
- When interactive effects are to be included
- When the independent variables that affect energy, use are complex and excessively difficult or expensive.

OPTION D

- When new construction projects are involved
- When energy savings values per measure are desired
- When Option C tools cannot cost effectively evaluate particular measures or their interactions with the building when complex baseline adjustments are anticipated

DCO will perform measurement and verification of the energy unit's savings at the conclusion of each month in the first year of the energy units guarantee. After the first year, M&V will be performed and presented within 30 days of the year end. Willingboro Township Public Schools will work with DCO to provide necessary information and provide access to any buildings to allow DCO to properly verify and measure energy savings. DCO's energy guarantee will be based on units of energy saved as determined from the baseline provided in the RFP, or adjusted baseline if original baseline is determined by both parties to be inaccurate.

Adjustments to the baseline and associated savings will be taken for weather, hours of operation, building usage, utility rate increases, code or statute changes, requirements listed in Table 1, and any other actions that adversely affect the savings beyond the control of DCO. Any savings discrepancies will be resolved to the satisfaction of both Willingboro Township Public Schools and DCO in a timely manner.

As part of the optional energy guarantee, DCO uses weather normalization procedures to correct the effect of weather variance on energy savings in subsequent years. Baseline energy and weather data are used to establish an algorithm to predict how the baseline building uses energy as a function of weather. The algorithm is then applied to subsequent years to correct for the impact weather may have on future building energy use. The weather normalization procedure and algorithms will be covered in detail as part of the optional energy guarantee contract provided to Willingboro Township Public Schools.

Maintenance Plan

Owner Tasks and Responsibilities:

As a general statement, Willingboro Township Public Schools or its 3rd party service providers shall be responsible for providing ongoing maintenance through the duration of the M&V period. DCO will review operational procedures and schedules associated with such things as the building automation/control upgrades as well as the manufacturers' published requirements for all installed equipment be it: quarterly, semi-annually or annually. In most cases, Willingboro Township Public Schools is already aware of or self-implementing similar maintenance practices on campus or has contracted a 3rd party for such services. Failure to properly maintain the equipment may cause energy savings goals to fall short.

Specific Areas of Consideration:

In order to sustain energy savings Willingboro Township School's Staff will be required to implement new maintenance tasks and even modify existing policies and practices. Outlined are two examples of specific instances.

Example 1. Advanced Building Operations Programming:

Willingboro Township Public Schools will be given specific training on the changes and advancements in environmental operations and energy savings strategies. Willingboro Township Public Schools will be responsible for following the agreed upon guidelines associated with programmed schedules and any use of override functions.

Example 2. Verification of Proper Operations: Mechanical Equipment

Willingboro Township Public Schools will be required to assure that proper mechanical maintenance continues to be implemented on their mechanical equipment. Example: outside air dampers will require proper operation with the appropriate seals in order to maintain ECM(s) such as demand ventilation. DCO will periodically spot check system operations to verify the Owner or its 3rd party representative is implementing proper maintenance. Any deficiencies that may be identified will be brought to Willingboro Township Public Schools' attention for correction.

ENERGY SAVINGS PLAN

SECTION 6 – OPERATION & MAINTENANCE

It is critical to the success of achieving continued energy savings that Willingboro Township Public Schools develop and implement an Operation and Maintenance Plan. In this section are some recommendations for Willingboro Township Public Schools and/or 3rd party maintenance contractors.

Air Handling Units

Comprehensive Annual Inspection

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Inspect the unit for cleanliness.
   b) Inspect the fan wheel and shaft for wear and clearance.
   c) Check the sheaves and pulleys for wear and alignment.
   d) Check the belts for tension, wear, cracks, and glazing.
   e) Verify tight bolts, set screws, and locking collars.
   f) Check dampers for wear, security and linkage adjustment.
   g) Verify clean condensate pan.
   h) Verify proper operation of the condensate drain.
   i) Verify clean air filters.
   j) Verify clean coils.
   k) Verify proper operation of the spray pump, if applicable.
   l) Verify smooth fan operation.
   m) Log operating conditions after system has stabilized.
   n) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.
4. Lubrication
   a) Lubricate the fan shaft bearings, if applicable.
   b) Lubricate the motor bearings, if applicable.
5. Controls and Safeties
   a) Test the operation of the low temperature safety device, if applicable.
   b) Test the operation of the high static pressure safety device, if applicable.
   c) Test the operation of the low static pressure safety device, if applicable.
   d) Check the thermal cutout on electric heaters, if applicable.
   e) Check the step controller, if applicable.

f) Check and record supply air and control air pressure, if applicable.
g) Verify the operation of the control system and dampers while the fan is operating.

6. Motor and Starter
   a) Clean the starter and cabinet.
   b) Inspect the wiring and connections for tightness and signs of overheating and discoloration. This includes wiring to the electric heat, if applicable.
   c) Check the condition of the contacts for wear and pitting.
   d) Check the contactors for free and smooth operation.
   e) Meg the motor and record readings.

Heating Inspection

1. Gas Heat Option
   a) Visually inspect the heat exchanger.
   b) Inspect the combustion air blower fan, and clean, if required.
   c) Lubricate the combustion air blower fan motor, if applicable.
   d) Verify the operation of the combustion air flow-proving device.
   e) Test the operation of the high gas pressure safety device, if applicable. Calibrate, if necessary.
   f) Test the operation of the low gas pressure safety device, if applicable. Calibrate, if necessary.
   g) Verify the operation of the flame detection device.
   h) Test the operation of the high temperature limit switch.
   i) Verify the integrity of the flue system.
   j) Verify the operation of the operating controls.
   k) Verify the burner sequence of operation.
   l) Verify proper gas pressure to the unit and/or at the manifold, if applicable.
   m) Perform combustion test. Make adjustments as necessary.
2. Electric Heat Option
   a) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   b) Check and calibrate operating and safety controls, if applicable.
   c) Verify the operation of the heating elements.
   d) Check voltage and amperage and compare readings with the watt rating on the heater.
3. Hot Water / Steam Heat Option
   a) Inspect control valves and traps.
   b) Check and calibrate all operating and safety controls.
   c) Verify the operation of the heating coils.
   d) Verify the operation of the unit low temperature safety device.

Scheduled Running Inspection

1. Check the general condition of the fan.
2. Verify smooth fan operation.
3. Check and record supply and control air pressure, if applicable.
4. Verify the operation of the control system.
5. Log the operating conditions after the system has stabilized.
6. Review operating procedures with operating personnel.
7. Provide a written report of completed work, operating log, and indicate uncorrected deficiencies detected.

Oil Sample/Spectrographic Analysis

1. Pull oil sample for spectrographic analysis.

Refrigerant Sample/Analysis

1. Pull refrigerant sample for spectrographic analysis for contaminants (oil, water, and acid), using approved containers

Boilers

Comprehensive Annual Inspection

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Secure and drain the boiler.
   b) Open the fire and water side for cleaning and inspection.
   c) Check heating surfaces and water side for corrosion, pitting, scale, blisters, bulges, and soot.
   d) Inspect refractory.
   e) Clean fire inspection glass.
   f) Check blow-down valve packing, and lubricate.
   g) Check and test boiler blow-down valve.

h) Perform hydrostatic test, if required.
i) Verify proper operation of the level float.
j) Gas Train Burner Assembly
    1. Check the gas train isolation valves for leaks.
    2. Check the gas supply piping for leaks.
    3. Check the gas pilot solenoid valve for wear and leaks.
    4. Check the main gas and the pilot gas regulators for wear and leaks.
    5. Test the low gas pressure switch. Calibrate and record setting.
    6. Test the high gas pressure switch. Calibrate and record setting.
    7. Verify the operation of the burner fan air flow switch.
    8. Inspect and clean the burner assembly.
    9. Inspect and clean the pilot igniter assembly.
    10. Inspect and clean the burner fan.
    11. Run the fan and check for vibration.
    12. Inspect the flue and flue damper.
    13. Burner Control Panel:
        a) Inspect the panel for cleanliness.
        b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
k) Clean burner fan wheel and air dampers. Check fan for vibration.
l) Verify tightness on linkage set screws.
m) Check gas valves for leakage (where test cocks are provided).
n) Verify proper operation of the feed water pump.
o) Verify proper operation of the feed water treating equipment.

4. Controls and Safeties
    a) Disassemble and inspect low water cutoff safety device.
    b) Reassemble boiler low water cutoff safety device with new gaskets.
    c) Clean contacts in program timer, if applicable.
    d) Check the operation of the low water cutoff safety device and feed controls.
    e) Verify the setting and test the operation of the operating and limit controls.
    f) Verify the operation of the water level control.

Startup/Checkout Procedure

1. Verify proper water level in the boiler
2. Test the safety/relief valve after startup (full pressure test).
3. Clean or replace fuel filters.

4. Clean fuel nozzles.
5. Inspect clean, and functionally test the flame scanner and flame safeguard relay.
6. Clean and adjust the ignition electrode.
7. Replace the vacuum tube in the flame safeguard control, if applicable.
8. Perform pilot turn down test.
9. Verify proper steam pressure.
10. Perform combustion test and adjust the burner for maximum efficiency.
11. Test the following items:
    a) Firing rate
    b) Fuel/air ratio
    c) CO2
    d) CO
    e) NOX
    f) Perform smoke test.
12. Review operating procedures
13. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Mid-Season Running Inspection

1. Check the general condition of the unit.
2. Inspect the burner.
3. Adjust the burner controls to obtain proper combustion.
4. Check the operation of the pressure relief valve.
5. Check the operation of the low water cutoff and feed controls.
6. Check the setting and test the operation of the operating and limit controls.
7. Check the operation of the modulating motor.
8. Lift the safety/relief valves with at least 70% of rated pressure.
9. Blow down and try gauge cocks to confirm glass water level.
10. Check and test boiler blow down valve.
11. Log operating conditions after the system has stabilized.
12. Review operating procedures
13. Provide a written report of completed work, operating log, and indicate uncorrected deficiencies detected.

Seasonal Shut-down Procedure

1. Shut down boiler at boiler controls.
2. Shut off fuel lines at main valves.
3. Review operating procedures
4. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Burners

Gas Train

1. Check the gas train isolation valves for leaks.
2. Check the gas supply piping for leaks.
3. Check the gas pilot solenoid valve for wear and leaks.
4. Check the main gas and the pilot gas regulators for wear and leaks.
5. Test the low gas pressure switch. Calibrate and record setting.
6. Test the high gas pressure switch. Calibrate and record setting.
7. Verify the operation of the burner fan air flow switch.
8. Inspect and clean the burner assembly.
9. Inspect and clean the pilot ignitor assembly.
10. Inspect and clean the burner fan.
11. Run the fan and check for vibration.
12. Inspect the flue and flue damper.
13. Burner Control Panel:
    a) Inspect the panel for cleanliness.
    b) Inspect wiring and connections for tightness and signs of overheating.
14. Clean burner fan wheel and air dampers. Check the fan for vibration.
15. Verify tightness of the linkage set screws.
16. Check the gas valves against leakage (where test cocks are provided

Oil Train

1. Check the gas train isolation valves for leaks.
2. Check the gas supply piping for leaks.

3. Check the gas pilot solenoid valve for wear and leaks.
4. Check the main gas and the pilot gas regulators for wear and leaks.
5. Test the low gas pressure switch. Calibrate and record setting.
6. Test the high gas pressure switch. Calibrate and record setting.
7. Verify the operation of the burner fan air flow switch.
8. Inspect and clean the burner assembly.
9. Inspect and clean the pilot ignitor assembly.
10. Inspect and clean the burner fan.
11. Run the fan and check for vibration.
12. Inspect the flue and flue damper.
13. Burner Control Panel:
    a) Inspect the panel for cleanliness.
    b) Inspect wiring and connections for tightness and signs of overheating.
14. Clean burner fan wheel and air dampers. Check the fan for vibration.
15. Verify tightness of the linkage set screws.
16. Check the gas valves against leakage (where test cocks are provided).

Dual Fuel Train

1. Check the gas train isolation valves for leaks.
2. Check the gas supply piping for leaks.
3. Check the gas pilot solenoid valve for wear and leaks.
4. Check the main gas and the pilot gas regulators for wear and leaks.
5. Test the low gas pressure switch. Calibrate and record setting.
6. Test the high gas pressure switch. Calibrate and record setting.
7. Verify the operation of the burner fan air flow switch.
8. Inspect and clean the burner assembly.
9. Inspect and clean the pilot ignitor assembly.
10. Inspect and clean the burner fan.
11. Run the fan and check for vibration.
12. Inspect the flue and flue damper.
13. Burner Control Panel:
    a) Inspect the panel for cleanliness.
    b) Inspect wiring and connections for tightness and signs of overheating.
14. Clean burner fan wheel and air dampers. Check the fan for vibration.
15. Verify tightness of the linkage set screws.
16. Check the gas valves against leakage (where test cocks are provided)

Cooling Towers

Startup/Checkout Procedure

1. Fill the basin and verify the float level.
2. Verify the operation of the basin heaters
3. Verify the operation, setpoint, and sensitivity of the basin heater temperature control device.
4. Start the condenser water pumps.
5. Verify the balance of the return water through the distribution boxes.
6. Verify proper operation of the bypass valve(s), if applicable.
7. Operate fan and verify smooth operation.
8. Log operation after system has stabilized.
9. Review operating procedures
10. Provide a written report of completed work, operating log, and indicate uncorrected deficiencies detected.

Comprehensive Bi-Annual Inspection

1. Perform following inspection and cleaning before starting the tower for the cooling season and during shutdown at end of season.
2. Record and report abnormal conditions, measurements taken, etc.
3. Review logs for operational problems and trends.
4. General Assembly
   a) Structure
      1. Disassemble all screens and access panels for inspection.
      2. Inspect the conditions of the slats, if applicable.
      3. Inspect the condition of the tower fill.
      4. Inspect the condition of the support structure.
      5. Inspect the condition of the basins (upper and lower) and/or spray nozzles.
      6. Verify clean basins and strainer(s).
      7. Verify the condition and operation of the basin fill valve system.
   b) Mechanical
      1. Inspect belts for wear, cracks, and glazing.
      2. Verify correct belt tension. Adjust the tension as necessary.
      3. Inspect sheaves and pulleys for wear, condition, and alignment.

4. Inspect fan shaft and bearings for condition.
5. Inspect fan assembly for condition, security, and clearances. (e.g. blade tip clearance).

4. Lubrication System
   a) Lubricate motor bearings.
   b) Lubricate fan shaft bearings.
5. Motor And Starter
   a) Clean the starter and cabinet.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Check the condition of the contacts for wear and pitting.
   d) Check the contactor(s) for free and smooth operation.
   e) Meg the motor(s) and record readings.
   f) Check disconnect terminal block for wear, tightness and signs of overheating and discoloration.
   g) Check the condition and operation of the basin heater contactor(s).

Shut-Down Procedure

1. Check the general condition of the tower.
2. Turn off electrical power to basin heaters, tower fans, and pipe heaters as necessary.
3. Drain tower and condenser water piping.
4. Review operating procedures
5. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Energy Management System

Maintenance Inspection

1. Review reports for operational problems and trends.
2. Make a back-up copy of the BAS program.
3. Check for loose or damaged parts or wiring.
4. Check for any accumulation of dirt or moisture. Clean if required.
5. Verify proper electrical grounding.

6. Verify control panel power supplies for proper output voltages.
7. Inspect interconnecting cables and electrical connections.
8. Verify that manual override switches are in the desired positions.
9. Check the operation of all binary and analog outputs, if applicable.
10. Calibrate control devices, if applicable.
11. Verify the correct time and date.
12. Check and update the holiday schedules and daylight savings time.
13. Via terminal mode, view the event log and input/output points for any unusual status or override conditions.
14. Clean the external surfaces of the panel enclosure.
15. Review operating program and parameters.
16. Check cable connections for security.
17. Review operating procedures
18. Provide a written report of completed work, and indicate any uncorrected deficiencies detected.

Maintenance Inspection (Control Panels)

1. Control Panel
   a) Verify secure connections on all internal wiring, LAN, and communication links.
   b) Check for loose or damaged parts or wiring.
   c) Check for any accumulation of dirt or moisture. Clean if required.
   d) Remove excessive dust from heat sink surfaces
   e) Verify proper system electrical grounding.
   f) Verify proper output voltages on control panel power supplies.
   g) Check LED Indications to verify proper operation
   h) Verify LAN communications
   i) Verify that cards are seated and secured.
   j) Check wiring trunks and check for possible Error Code Indications
   k) Check voltage level of
   l) Verify the proper operation of critical control processes and points associated with this unit an make adjustments if necessary.
   m) Check Volatile memory available
   n) Cheek Non volatile memory available
   o) Check Processor idle time
   p) Clean external surfaces of the panel enclosure.
   q) Check modem operation, if applicable.

r) View the event log and input/output points for any unusual status or override conditions.
s) Verify correct time and date.
t) Check and update holiday schedules, if applicable, and daylight savings time.
u) Review operating procedures with operating personnel.
v) Provide a written report of completed work, and indicate any uncorrected deficiencies detected.

Maintenance Inspection (EMS - Sequence of Operations)

Central Plant

In order to assure effective environmental conditioning while minimizing the cost to operate the equipment, technicians will review operating sequences and practices for the chiller plant. An initial survey of current equipment operating parameters will be conducted within the first 60 days of the contract term during cooling season. This survey will include:

1. Chiller(s) operation
2. Cooling tower(s) operation
3. Pump(s) operation
4. Economizer operation (where applicable)
5. Environmental safety

A detailed report of findings and recommendations for changes, if any, will be made. Agreed upon operational changes which require only adjustment of controls or programming will be made during regularly scheduled maintenance visits as part of this agreement at no additional cost. Any recommended alterations that require addition of devices or equipment will be accompanied by a guaranteed cost proposal reflecting the applicable discounts determined by this agreement.

Building Systems

In order to assure effective environmental conditioning while minimizing the cost to operate the equipment, technicians will review operating sequences and practices for covered airside systems. An initial survey of current systems operating parameters will be conducted within the first 60 days of the contract term, except seasonally operated systems, which will be surveyed during the appropriate operating season. This survey will include:

1. Time schedule(s)
2. Reset schedule(s)
3. Economizer changeover (where applicable)
4. Setpoints
5. Energy Management routines

A detailed report of findings and recommendations for changes, if any, will be made. Agreed upon operational changes which require only adjustment of controls or programming will be made during regularly scheduled maintenance visits as part of this agreement at no additional cost. Any recommended alterations that require addition of devices or equipment will be accompanied by a guaranteed cost proposal reflecting the applicable discounts determined by this agreement.

Fans

Maintenance Procedure

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Check the general condition of the unit.
   b) Verify tightness of the fan, fan guards, louvers, etc.
   c) Verify clean burner assembly.
   d) Check sheaves and pulleys for wear and alignment, if applicable.
   e) Check belts for tension, wear, cracks, and/or glazing.
4. Lubrication
   a) Lubricate the fan motor, if applicable.
   b) Lubricate the fan bearings as necessary.
5. Controls and Safeties
   a) Verify proper operation of the temperature control device.
   b) Verify proper operation of the high temperature control device.
   c) Verify proper operation of the fan switch.
   d) Verify proper operation of the pilot safety device, if applicable.
6. Electrical
   a) Inspect wiring and connections for tightness and signs of overheating and discoloration.

7. Startup and Checkout
   a) Start the unit.
   b) Verify proper combustion air to the burner.
   c) Verify proper gas pressure to the burner.
   d) Check the flame for proper combustion.

Comprehensive Annual Inspection

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Disassemble all screens and panels necessary to gain access to the fan mechanism.
   b) Disassemble the control mechanism (AVPB only).
   c) Clean all accessible rotor components to include control pitch mechanism (AVPB only).
   d) Inspect blades for wear.
   e) Inspect blade arms for wear (AVPB only).
   f) Check blade tip clearance.
   g) Check for oil leak on the blade bearing housing (AVPB only).
   h) Clean motor and fan housing.
   i) Reassemble all removed screens and plates.
4. Lubrication
   a) Lubricate the motor bearings.
   b) Lubricate the shaft bearings (AVPA only).
5. Controls and Safeties
   a) Test the operation of the high static safety device. Calibrate and record setting.
   b) Test the operation of the low static safety device. Calibrate and record setting.
   c) Test the operation of the vibration safety device. Calibrate and record setting.
   d) Verify the operation of the phase monitor, if applicable.
   e) Inspect pneumatic and electrical controls for condition and calibration.
   f) Verify proper operation.
6. Motor and Starter
   a) Clean the starter and cabinet.
   b) Clean the disconnect switch and cabinet at the fan, if applicable.
   c) Inspect the wiring and connections for tightness and signs of overheating and discoloration.
   d) Check the condition of the contacts for wear and pitting.
   e) Check the contactors for free and smooth operation.

f) Meg the motor and record readings.

7. Startup / Checkout Procedure
   a) Start the fan.
   b) Verify the operation of the starter.
   c) Check and record supply and control air pressure.
   d) Verify the operation of the control system while the fan is operating.
   e) Log the operating conditions after the system has stabilized.
   f) Review operating procedures with operating personnel.
   g) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Scheduled Running Inspection (fans)

1. Check the general operation of the fan.
2. Check and record supply and control air pressure.
3. Verify the operation of the control system.
4. Log the operating conditions after the system has stabilized.
5. Review operating procedures with operating personnel.
6. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Comprehensive Annual Inspection (fans)

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Verify tight bolts, set screws, and locking collars.
   b) Inspect sheaves and pulleys for wear and alignment.
   c) Inspect belts for tension, wear, cracks, and glazing.
   d) Inspect dampers for wear, security, and clearances, if applicable.
   e) Verify clean air filters.
   f) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.
4. Lubrication
   a) Lubricate fan bearings.
   b) Lubricate motor bearings, if applicable.
5. Controls and Safeties

a) Verify the operation of the control system while the fan is operating.
b) Verify the setting of the low temperature safety device, if applicable.
c) Verify the operation of the pre-heat control device, if applicable.
d) Verify the operation of the cooling control device, if applicable.
e) Verify the operation of the re-heat control device, if applicable.
f) Verify the operation of the humidity control device, if applicable.

6. Motor and Starter
   a) Clean the starter and cabinet.
   b) Inspect the wiring and connections for tightness and signs of overheating and discoloration.
   c) Check the condition of the contacts for wear and pitting.
   d) Check the contactors for free and smooth operation.
   e) Meg the motor and record readings.
   f) Check volts and amps of the motor.

Lubricate/Grease Bearings

1. Lubricate and/or grease bearings according to manufacturer's specifications

MEG Motor

1. Check the integrity of the insulation on the motor windings and the motor leads, using a megohm meter.

Coils

Maintenance Procedure

1. Record and report abnormal conditions.
2. Visually inspect the coil for leaks.
3. Inspect the coil for cleanliness.

Pumps

Annual Inspection

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Check motor shaft and pump shaft for alignment, if applicable.
   b) Inspect the coupling for wear.
   c) Verify that the shaft guard is in place and tight, if applicable.
   d) Verify water flow through the pump.
   e) Check for leaks on the mechanical pump seals, if applicable.
   f) Verify proper drip rate on the pump seal packing, if applicable.
   g) Verify smooth operation of the pump.
   h) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.
4. Lubrication
   a) Lubricate the motor bearings as necessary.
   b) Lubricate the pump bearings as necessary.
5. Motor and Starter
   a) Clean the starter and cabinet.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Meg the motor.
   d) Verify tight connections on the motor terminals.
   e) Check the condition of the contacts for wear and pitting, if applicable.
   f) Check the contactors for free and smooth operation.
   g) Verify proper volts and amps.

Pump Run Inspection

1. Verify smooth operation of the pump.
2. Check for leaks on the mechanical pump seals, if applicable.
3. Verify proper drip rate on the pump seal packing, if applicable.
4. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Mechanical Starters with Electronic Controls

Comprehensive Annual Maintenance

1. Clean the starter and cabinet.
2. Inspect wiring and connections for tightness and signs of overheating and discoloration.
3. Check condition of the contacts for wear and pitting.
4. Check contactors for free and smooth operation.
5. Check the mechanical linkages for wear, security, and clearances.
6. Verify the overload settings.

VFD Starters

Comprehensive Annual Maintenance

1. Clean the starter and cabinet.
2. Inspect wiring and connections for tightness and signs of overheating and discoloration.
3. Check the tightness of the motor terminal connections.
4. Verify the operation of the cooling loop.
5. Verify proper operation of the frequency drive.

Rooftop Units

Comprehensive Annual Maintenance

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.
3. General Assembly
   a) Inspect for leaks and report results.
   b) Calculate refrigerant loss rate and report to the customer.
   c) Repair minor leaks as required (e.g. valve packing, flare nuts).
   d) Visually inspect condenser tubes for cleanliness.

4. Controls and Safeties
   a) Inspect the control panel for cleanliness.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Verify the working condition of all indicator/alarm lights, if applicable.
   d) Test the low water temperature control device. Calibrate and record setting.
   e) Test the low evaporator pressure safety device. Calibrate and record setting.
   f) Test the oil pressure safety device. Calibrate and record setting, if applicable.
   g) Check programmed parameters of RCM control, if applicable.
5. Lubrication System
   a) Check oil level in the compressor.
   b) Test oil for acid content and discoloration. Make recommendations to the customer based on the results of the test.
   c) Verify the operation of the oil heater. Measure amps and compare reading with the watt rating of the heater.

6. Motor and Starter
   a) Clean the starter and cabinet.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Check condition of the contacts for wear and pitting.
   d) Check the contactors for free and smooth operation.
   e) Check the tightness of the motor terminal connections.
   f) Meg the motor and record readings.
   g) Verify the operation of the electrical interlocks.
   h) Measure voltage and record. Voltage should be nominal voltage ± 10%.

Comprehensive Maintenance Inspection (RTU Heating Cycle)

1. Perform heating inspection/maintenance applicable to the unit (steam/hot water, gas, electric).
2. Verify smooth operation of the fans.
3. Check the belts for tension, wear, cracks, and glazing.
4. Verify clean air filters.
5. Gas Heat Option
   a) Visually inspect the heat exchanger.
   b) Inspect the combustion air blower fan, and clean, if required.
   c) Lubricate the combustion air blower fan motor, if applicable.
   d) Verify the operation of the combustion air flow-proving device.

e) Test the operation of the high gas pressure safety device, if applicable. Calibrate, if necessary.
f) Test the operation of the low gas pressure safety device, if applicable. Calibrate, if necessary.
g) Verify the operation of the flame detection device.
h) Test the operation of the high temperature limit switch. i.. Verify the integrity of the flue system.
i) Verify the operation of the operating controls.
j) Verify the burner sequence of operation.
k) Verify proper gas pressure to the unit and/or at the manifold, if applicable.
l) Perform combustion test. Make adjustments as necessary.

6. Electric Heat Option
   a) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   b) Check and calibrate operating and safety controls, if applicable.
   c) Verify the operation of the heating elements.
   d) Check voltage and amperage and compare readings with the watt rating on the heater.

7. Hot Water / Steam Heat Option
   a) Inspect control valves and traps.
   b) Check and calibrate all operating and safety controls.
   c) Verify the operation of the heating coils.
   d) Verify the operation of the unit low temperature safety device.

Mid-Season Cooling Inspection (RTU)

1. Check the general condition of the unit.
2. Log the operating condition after system has stabilized.
3. Verify the operation of the control circuits.
4. Analyze the recorded data. Compare the data to the original design conditions.
5. Review operating procedures with operating personnel.
6. Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

Comprehensive Maintenance Inspection (RTU - Cooling Cycle)

1. Record and report abnormal conditions, measurements taken, etc.
2. Review logs for operational problems and trends.

3. General Assembly
   a) Inspect for leaks and report results.
   b) Calculate refrigerant loss rate and report to the customer.
   c) Repair minor leaks as required (e.g. valve packing, flare nuts).
   d) Check pulleys and sheaves for wear and alignment.
   e) Check belts for tension, wear, cracks, and glazing.
   f) Verify clean evaporator coil, blower wheel, and condensate pan.
   g) Verify clean air filters.
   h) Verify proper operation of the condensate drain.
   i) Verify proper operation of the dampers and/or inlet guide vanes, if applicable.
4. Controls and Safeties
   a) Inspect the control panel for cleanliness.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Verify the working condition of all indicator/alarm lights, if applicable.
   d) Test the low evaporator pressure safety device. Calibrate and record setting, if applicable.
   e) Test the high condenser pressure safety device. Calibrate and record setting, applicable.
   f) Test the oil pressure safety device, if applicable. Calibrate and record setting.
   g) Test the high static pressure safety device, if applicable. Calibrate and record setting.
   h) Verify the operation of the static pressure control device, if applicable.
5. Lubrication
   a) Verify the operation of the oil heater, if applicable.
   b) Lubricate the fan bearings as required.
   c) Lubricate the fan motor bearings as required.
   d) Lubricate the damper bearings, if applicable.
6. Motor and Starter
   a) Clean the starter and cabinet.
   b) Inspect wiring and connections for tightness and signs of overheating and discoloration.
   c) Check the condition of the contacts for wear and pitting.
   d) Check the contactors for free and smooth operation.
7. Startup /Checkout Procedure
   a) Verify the operation of the oil heater.
   b) Verify full water system, including the cooling tower and the condenser.
   c) Verify clean cooling tower and strainers.
   d) Test all flow-proving devices on the condenser water circuit.
   e) Start the condenser water pump and the cooling tower fan(s).

f) Verify flow rate through the condenser.
g) Start the unit.
h) Verify smooth operation of the compressor(s) and fan(s).
i) Check the setpoint and sensitivity of the temperature control device.
j) Verify the operation of the condenser water temperature control device.
k) Verify clean condenser using pressure and temperature.
l) Check operation and setup of the Unit Control Module.
m) Check the superheat and subcooling on the refrigeration circuit(s).
n) Log the operating conditions after the system has stabilized.
o) Review operating procedures with operating personnel.
p) Provide a written report of completed work, operating log, and indicate any uncorrected deficiencies detected.

ENERGY SAVINGS PLAN

SECTION 7 – OPTIONAL ENERGY GUARANTEE

OPTIONAL ENERGY GUARANTEE OVERVIEW

NOTE: *The following is meant only to serve as a description of an optional energy guarantee and does not constitute any contractual obligations between the Willingboro Township Public Schools and DCO. If Willingboro Township Public Schools chooses to implement an energy guarantee contract, a separate document will be used based on mutual agreement and acceptance of all parties of its terms and conditions.*

A successful energy project consists of a partnership between an ESCO and Owner. Both parties have defined roles and accept their individual responsibilities as well as support any joint initiatives of the program as defined in this document. Both DCO and the Willingboro Township Public Schools will have a role in ongoing maintenance and operations as defined in the agreed-upon energy guarantee contractual documents. Both parties will be required to meet their obligations for the guaranteed energy units savings (referred to as “guarantee or savings”) to be achieved and to ensure the guarantee stays intact.

DCO will guarantee Willingboro Township Public Schools will achieve the energy unit savings per the provisions of the agreed-upon energy guarantee contractual documents based on the final selection of ECMs and their associated energy savings as measured and verified by the Owner’s third-party, independent firm. The energy savings will be in energy units, not dollars as DCO has no control over the costs of utilities. The energy units guarantee contract shall commence thirty (30) days after the start-up and commissioning of the last Energy Conservation Measure (ECM) and be enforced for a period of one (1) year or until terminated by Willingboro Township Public Schools.

SAVINGS VERIFICATION

There are events that cause energy savings to change. Willingboro Township Public Schools and DCO will agree to baseline energy consumption that represents the facility’s energy use and cost prior to the date of any Agreement (the “Base Year”) and parameters, which affect the energy usage and cost of the facility, including but not limited to, utility rates, local weather profile, facility square footage, environmental conditions, schedules (e.g., lighting, HVAC) and an inventory of equipment in the facility. Energy savings are determined by comparing measured energy use or demand before and after implementation of an energy savings program.

ECM ENERGY SAVINGS = BASELINE ENERGY USE – POST INSTALLATION ENERGY USE +/- ADJUSTMENTS

Changes in estimated energy savings fall into two categories. These categories are Routine Adjustments and Non-Routine Adjustments. Routine Adjustments are expected changes during the savings reporting period to energy governing factors (e.g. weather). DCO uses IPMVP approved mathematical techniques to determine adjustments. Non-Routine Adjustments include energy-governing factors which are not usually expected to change, such as the facility size, the design and operation of installed equipment, occupancy and the type of occupants or any physical changes to the building or equipment that impact the facilities' utility use. These factors will be monitored for change throughout the reporting period.

DCO will perform monthly utility bill analysis and audit reports which compare the current year with base year energy consumption and costs. DCO will perform periodic on-site analysis to determine whether mechanical and electrical systems are operating at optimal efficiency and to assess the occupancy and operational schedules of the buildings.

As part of the optional energy guarantee, DCO uses weather normalization procedures to correct the effect of weather variance on energy savings in subsequent years. Baseline energy and weather data are used to establish an algorithm to predict how the baseline building uses energy as a function of weather. The algorithm is then applied to subsequent years to correct for the impact weather may have on future building energy use. The weather normalization procedure and algorithms will be covered in detail as part of the optional energy guarantee contract provided to Willingboro Township Public Schools.

ENERGY SAVINGS PLAN

APPENDICIES

APPENDIX LIST	
APPENDIX A	Construction Contingency Allowance
APPENDIX B	Design Bid Build Procedures
APPENDIX C	Operations & Maintenance Savings
APPENDIX D	Project Changes in Financing
APPENDIX E	Incentives in Debt Service
APPENDIX F	ECM Breakdown by Building
APPENDIX G	Energy Savings Supplemental Information
APPENDIX H	Local Government Energy Audits

ENERGY SAVINGS PLAN

APPENDIX A – CONSTRUCTION CONTINGENCY ALLOWANCE

Appendix A – Construction Contingency Allowance

Experience shows that during the construction phase there are four major categories of potential change of scope issues that benefit from having an appropriate Construction Contingency Allowance (CCA).

- Unknown conditions
- Building inspector's modifications
- Project owner requested changes.
- Design clarifications or modifications

Unknown Conditions

Renovations to older facilities have greater potential for revealing the unknown. Missing or inaccurate Blueprints, deviations from the original blueprints by the original builder and unknown or undocumented modifications during the life of the facility.

Areas such as behind a wall/roof/equipment or under the slab can bring unforeseen conditions which can delay the new construction and change the anticipated scope of the work. Therefore, it is advisable to dedicate a CCA that is higher than that for new construction.

Building Inspection Modifications

A plan review for the local building jurisdiction reviews the construction documents prior to issuing a building permit. However, there remains the likelihood that the building inspector will request modifications to the plans based upon experience and their interpretation of the applicable building code.

While we can ask for code review and documentation, if you hope to get a Certificate of Occupancy under a tight schedule from this same inspector requested modifications will need to be implemented as successfully appeals take time.

Whether it is adding an extra exit sign, smoke detector or fire extinguisher, or whether it is something more significant, it may require more work from the contractor, thus adding expense. The CCA is intended to be the source of funds necessary for these requested modifications.

Project Owner Requested Changes

It is nearly impossible to express your every desire during the design phase. You will always see something during construction that you would like to change.

There is nothing necessarily wrong with that.

The CCA is intended to be the source of funds necessary for these requested changes.

Design Clarifications or Modifications

No designer has ever developed the perfect set of construction documents.

There are always items that can be detailed better or more clearly. The design intent should be adequately reflected in the drawings and specifications so that the contractor can bid and build the ECM to meet the design intent.

However, there will be times during construction when the builder will not be readily able to identify the exact intent of particular details or systems. At that time the builder will submit a Request for Information (RFI) to the designer for clarification or more information. The designer will issue clarifications or directives so that the builder can continue to meet the design intent.

On occasion, the RFI will reveal that something more than was shown in the construction documents is necessary to fulfill the design intent. The clarification or modification may impact the scope of the work to a degree that additional construction costs become necessary.

As long as the design omission is not negligent, the CCA is intended to be the source of funds necessary for these design clarifications or modifications.

Allowance Method

Detailed plans, schematics and specifications for Willingboro Township Public Schools were not available to deliver a cost estimate for each ECM. The budgetary costs carried out in the project are based on good faith estimates, contractor supplied budgets for similar ECMs on other recent projects and a database of actual installed costs for various ECMs.

a. Allowance Amount (3.6% of Hard Costs)

BID PACKAGE ALLOWANCE	
ENERGY CONSERVATION MEASURE	CONTINGENCY AMOUNT (3.6%)
LED Lighting Upgrades	$65,456
Lighting Controls	$14,618
District Wide Energy Management System Tier 1	$17,066
District Wide Energy Management System Tier 2	$107,181
Pipe and Valve Insulation	$4,327
Building Envelope Weatherization	$12,391
Plug Load Controls	$3,954
eTemp Refrigeration Sensors	$1,702
Retro-Commissioning	$2,988
Combined Heating & Power	$6,762
Boiler Plant Replacement	$33,543
RTU & Split System HVAC Replacement	$65,761
Destratification Fans	$5,830
Unit Ventilator Replacement w/ Addition of Cooling	$128,100
Field Lighting Upgrade	$0
Window Film	$6,824

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ENERGY SAVINGS PLAN

APPENDIX B – DESIGN BID BUILD

Appendix B – Design Bid Build Procedures

Design–bid–build (or **design/bid/build**, and abbreviated **D–B–B** or **D/B/B** accordingly), also known as **Design–tender** (or "design/tender") **traditional method** or **hard bid** is the method of delivery for this project.

Design–bid–build is the traditional method for project delivery and differs in several substantial aspects from design–build.

There are three main sequential phases to the design–bid–build delivery method:

- The design phase.
- The bidding (or tender) phase
- The construction phase.

Design Phase

In this phase DCO will design and produce bid documents, including construction drawings and technical specifications, on which various contractors will in turn bid to construct the project.

The Energy Savings Plan (ESP) is intended to document the owner's project requirements and provide a conceptual and/or schematic design and good faith estimates.

With the ESP DCO will bring in other design professionals including mechanical, electrical, and plumbing engineers (MEP specifications engineers), a fire protection engineer, structural engineer, sometimes a civil engineer and a landscape architect to help complete the construction drawings and technical.

The design document should reflect the intent of the energy savings plan for scope, price, savings, operations & maintenance savings, incentive and schedule.

The finished bid documents are coordinated by the DCO and owner for issuance to contractors during the bid phase.

Bid (or tender) phase

Bidding is according to NJ Public Bid Law and is "open", in which any qualified bidder may participate.

The various contractors bidding obtains bid documents, and then put them out to multiple subcontractors for bids on sub-components of the project.

Questions may arise during the bid period, and DCO will issue clarifications or corrections to the bid documents in the form of addenda.

From these elements, the contractor compiles a complete bid for submission by the established closing date and time bid date.

Bids are to be based on a base bid lump sum plus alternates, bid requirements and alternates are elucidated within the bid documents.

Once bids are received, DCO reviews the bids, seeks any clarifications required of the bidders, investigates contractor qualifications, ensures all documentation is in order (including bonding if required), and advises the owner as to the ranking of the bids.

If the bids fall in a range acceptable to the owner, the project is awarded to the contractor with the lowest reasonable bid.

In the event that all of the bids do not satisfy the needs of the owner the following options become available to DCO:

- Rebid the construction of the project in the future when monies become available and/or construction costs go down.
- Revise the design of that ECM (at no cost to the client) so as to make the project smaller or reduce features or elements of the project to bring the cost down. The revised bid documents can then be issued again for bid.
    - DCO will provide guidance on energy savings, operation and maintenance savings and incentives to ensure the project is self-funding.
- Revise the design of future ECM(s) (at no cost to the client) so as to make the project smaller or reduce features or elements of the project to bring the cost down. The current bid package can then be contracted.
    - DCO will provide guidance on energy savings, operation and maintenance savings and incentives to ensure the project is self-funding.

Construction phase

Once the construction of the project has been awarded to the contractor, the bid documents (e.g., approved construction drawings and technical specifications) may not be altered.

The necessary permits (for example, a building permit) must be achieved from all jurisdictional authorities in order for the construction process to begin.

Should design changes be necessary during construction, whether initiated by the contractor, owner, or as discovered by the architect, DCO will issue sketches or written clarifications and handle the project through allowance (See Appendix A).

The contractor may be required to document "as built" conditions to the owner.

Bidding Method

1. To achieve energy savings and fund debt service payments as rapidly as possible the bid packages will be bid in the following order:

BID METHOD SCHEDULE		
ENERGY CONSERVATION MEASURE	Cost + Allowance	SAVINGS
LED Lighting Upgrades	$1,883,673	$235,516
Lighting Controls	$420,677	$19,693
District Wide Energy Management System Tier 1	$491,111	$41,702
District Wide Energy Management System Tier 2	$3,084,430	$103,028
Combined Heating & Power	$194,592	$3,204
Field Lighting Upgrade	$0	$1,850
Building Envelope Weatherization	$356,591	$39,216
Destratification Fans	$167,780	$10,886
Window Film	$196,394	$32,644
Plug Load Controls	$113,786	$12,379
eTemp Refrigeration Sensors	$48,994	$12,952
Boiler Plant Replacement	$965,296	$11,860
RTU & Split System HVAC Replacement	$1,892,449	$731
Unit Ventilator Replacement w/ Addition of Cooling	$3,686,447	$905

2. Bids in group 1 (Green) are within 15% of the budget value they will be awarded.
3. Bids in group 2 (Yellow) may be value engineered from the project to meet budget.
    a. DCO will provide the impact of ECMs value engineered:
        i. Energy Savings
        ii. Operations and Maintenance Savings
        iii. Incentive
4. Bids in group 3 (Red) may be value engineered **or removed** from the project to meet budget.
    a. DCO will provide the impact of ECMs value engineered or removed:
        i. Energy Savings
        ii. Operations and Maintenance Savings
        iii. Incentive
5. As per ESIP law DCO fee will be applied to the ECM hard cost.
    a. DCO will receive no compensation for bids that are under budget.
    b. DCO will receive no penalty for bids that are over budget.
6. If the budget overruns make savings unachievable at the current budget, DCO will provide additional ECMs above the budget to meet the required energy savings.

ENERGY SAVINGS PLAN

APPENDIX C – OPERATIONS AND MAINTENANCE SAVINGS

Appendix C – Operation & Maintenance Savings

Operations and Maintenance and other non-energy-related cost savings are allowable in NJ ESIPs, and are defined as reduction in expenses (other than energy cost savings) related to energy and water consuming equipment:

Energy-related cost savings can result from avoided expenditures for operations, maintenance, equipment repair, or equipment replacement due to the ESIP project.

Sources of O&M savings include:

- Termination of service personnel
- Lower maintenance service contract costs
- Decrease in repair costs.
    - Avoided repair and replacement costs as a result of replacing old and unreliable equipment.
    - Material savings due to new equipment warranties
    - Material savings due to the longer life items not needing replacement.
        - In particular, reduction in florescent bulbs due to LED

Termination of service personnel

As a result of the ESIP, a number of the client's maintenance staff members may no longer be required. If there is a reduction in the government's maintenance staff, O&M savings can be claimed.

A problem could arise if the maintenance staff is not reduced. Then it would be necessary to determine what new O&M responsibilities the facility has taken on, or savings should not be claimed. For example, it could be that a new building was constructed. During the performance period, it is important to establish that any increased maintenance was not due to the equipment installed under the ESIP.

Lower maintenance service contract costs

Prior to the implementation of the ESIP mechanical and electrical equipment was maintained by a third party under a maintenance contract. The ESIP replaces the aging equipment with newer, more efficient equipment, which can reduce the service costs to the client.

Decrease in repair costs.

The client is responsible for maintenance both before and after the equipment installation. Although there is no reduction in staff for which to claim labor savings, there will be cost savings on replacement materials.

Material-related savings frequently result from lighting and lighting controls projects.

For this project, lighting maintenance savings will result from the following:

1. Reduced material requirements (e.g., lamps)
2. Reduced operating time — Control measures increase equipment life by reducing the burn time of lamps and ballasts.
3. Warranty-related savings — newly installed lamps, and fixtures come with a manufacturer warranty of 10 years.

Year 1 O&M Savings

Willingboro Public School District ESIP		ANNUAL O&M COST SAVINGS
ECM #	ENERGY CONSERVATION MEASURE	$
1	LED Lighting Upgrades	$54,700
3	District Wide Energy Management System Tier 1	$37,298
6	Pipe and Valve Insulation	$11,993
10	Retro-Commissioning	$12,653
12	Boiler Plant Replacement	$6,500
13	RTU & Split System HVAC Replacement	$12,732
17	Unit Ventilator Replacement w/ Addition of Cooling	$11,289
	TOTALS	$147,166

ENERGY SAVINGS PLAN

APPENDIX D – PROJECT CHANGES IN FINANCING

Appendix D – Project Changes in Financing

The Energy savings plan has been approved using:

Interest rate of 4.00%
Term: ..... 20 Years
Construction Term ..... 24 Months
Construction Interest Only Payment of ..... TBD by Willingboro Township Public Schools financial advisor
Annual Surplus of no less than $2,400

During financing DCO will provide assistance but does not guarantee the timing of savings or incentives.

While beneficial to the client financing changes are the responsibility of the client, bond counsel and/or financial advisor. DCO represents in no way advice on these financial items

Financial items may include but are not limited to:

- Timing of payments
- Splitting payments into bi-annual, tri-annual, etc.
- Coordination with the client's fiscal year
- Local finance board material, forms and presentations
- Multiple tiered interest rates

ENERGY SAVINGS PLAN

APPENDIX E – INCENTIVES IN DEBT SERVICE

Appendix E – Incentives in Debt Service

As part of the Energy Savings Plan for Willingboro Township Public Schools, prescriptive rebates through PSE&G were investigated. The estimated incentive amount is listed below. Upon final selection of the project scope and award of subcontractor bids, the incentive applications will be filed.

BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	Estimated Incentive $
Bookbinder School	Boiler Plant Replacement	$16,740
Bookbinder School	LED Lighting Upgrades	$9,464
Country Club Administration Building	LED Lighting Upgrades	$8,444
Garfield East Elementary School	LED Lighting Upgrades	$9,205
Hawthorne Elementary School	LED Lighting Upgrades	$9,147
J. Cresswell Stuart Early Childhood Development Center	LED Lighting Upgrades	$12,561
James A. Cotten Intermediate School	LED Lighting Upgrades	$15,832
Joseph A. McGinley School	LED Lighting Upgrades	$8,383
Memorial Middle School	LED Lighting Upgrades	$27,818
Twin Hills Elementary School	LED Lighting Upgrades	$9,782
W.R. James Elementary School	LED Lighting Upgrades	$10,100
Warehouse	LED Lighting Upgrades	$2,991
Willingboro High School	LED Lighting Upgrades	$42,566
Bookbinder School	Lighting Controls	$19,367
Country Club Administration Building	Lighting Controls	$19,205
Garfield East Elementary School	Lighting Controls	$22,785
Hawthorne Elementary School	Lighting Controls	$18,298
J. Cresswell Stuart Early Childhood Development Center	Lighting Controls	$26,389
James A. Cotten Intermediate School	Lighting Controls	$38,711
Joseph A. McGinley School	Lighting Controls	$17,856
Memorial Middle School	Lighting Controls	$56,637
Twin Hills Elementary School	Lighting Controls	$19,995
W.R. James Elementary School	Lighting Controls	$18,647
Warehouse	Lighting Controls	$837
Willingboro High School	Lighting Controls	$79,934
Bookbinder School	Plug Load Controls	$474
Country Club Administration Building	Plug Load Controls	$990
Garfield East Elementary School	Plug Load Controls	$809
Hawthorne Elementary School	Plug Load Controls	$628
J. Cresswell Stuart Early Childhood Development Center	Plug Load Controls	$837
James A. Cotten Intermediate School	Plug Load Controls	$628
Memorial Middle School	Plug Load Controls	$56
Twin Hills Elementary School	Plug Load Controls	$432
W.R. James Elementary School	Plug Load Controls	$781
Warehouse	Plug Load Controls	$70
Willingboro High School	Plug Load Controls	$56
Bookbinder School	RTU & Split System HVAC Replacement	$6,473
	Total Incentive:	$533,927

All estimated incentive values for Willingboro Township Public Schools ESIP project were calculated using JCP&L prescriptive rebates. The total incentive amount was calculated to be $533,927

No implied and/or written guarantee is being made with respective to the receipt of incentives. All incentives estimates carry inherent risks that may jeopardize the receipt of them. Therefore, Willingboro Township Public Schools acknowledges and accepts that any project proposed should not rely on the receipt of incentives as a reason to implement it.

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ENERGY SAVINGS PLAN

APPENDIX F – ECM BREAKDOWN BY BUILDING

Willingboro Township Public Schools % SAVINGS BY BUILDING (T.O.R.)

Willingboro Township Public Schools BUILDINGS/FACILITIES		UTILITY ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	ONSITE ELECTRIC SAVINGS	NATURAL GAS SAVINGS
BUILDING/FACILITY NAME	SQFT	kWh	kW	kWh	Therms
Bookbinder School	58,745	50.1%	20.7%	50.1%	67.0%
Country Club Administration Building	38,585	45.6%	10.3%	45.6%	21.2%
Garfield East Elementary School	51,493	43.7%	24.8%	43.7%	44.1%
Hawthorne Elementary School	58,745	41.6%	39.6%	41.6%	43.7%
J. Cresswell Stuart Early Childhood Development Center	61,459	43.7%	31.6%	43.7%	43.6%
James A. Cotten Intermediate School	125,000	28.5%	14.6%	28.5%	23.6%
Joseph A. McGinley School	58,745	29.4%	6.4%	29.4%	9.4%
Memorial Middle School	159,000	43.0%	18.6%	43.0%	41.2%
Twin Hills Elementary School	51,305	43.1%	30.6%	43.1%	46.5%
W.R. James Elementary School	58,745	42.5%	28.8%	42.5%	41.2%
Warehouse	24,500	24.6%	17.7%	24.6%	48.8%
Willingboro High School	227,623	30.2%	22.6%	30.2%	43.7%
TOTALS	**973,945**	**36.2%**	**40.0%**	**36.2%**	**37.4%**

Willingboro Township Public Schools SAVINGS BY BUILDING BY UTILITY FROM SMART SELECT

Willingboro Township Public Schools BUILDINGS/FACILITIES		ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	ONSITE ELECTRIC SAVINGS	NATURAL GAS SAVINGS
BUILDING/FACILITY NAME	SQFT	kWh	kW	kWh	Therms
Bookbinder School	58,745	139,376	58	139,376	21,372
Country Club Administration Building	38,585	90,319	20	90,319	4,091
Garfield East Elementary School	51,493	113,990	33	113,990	7,588
Hawthorne Elementary School	58,745	124,247	43	124,247	13,038
J. Cresswell Stuart Early Childhood Development Center	61,459	166,713	56	166,713	11,364
James A. Cotten Intermediate School	125,000	279,511	81	279,511	17,485
Joseph A. McGinley School	58,745	37,245	19	37,245	3,847
Memorial Middle School	159,000	559,295	144	559,295	24,283
Twin Hills Elementary School	51,305	148,096	55	148,096	8,495
W.R. James Elementary School	58,745	128,506	43	128,506	9,678
Warehouse	24,500	43,397	9	43,397	3,404
Willingboro High School	227,623	749,939	172	749,939	37,828
TOTALS	**973,945**	**2,580,634**	**734**	**2,580,634**	**162,473**

ECMs evaluated and included in the ESIP

Willingboro Township Public Schools			INSTALLED COST	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS	ANNUAL ENERGY COST SAVINGS	ANNUAL O&M COST SAVINGS	TOTAL ANNUAL COST SAVINGS	SIMPLE PAYBACK WITHOUT INCENTIVES	ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	NATURAL GAS SAVINGS	TOTAL SITE ENERGY SAVINGS	TOTAL SOURCE ENERGY SAVINGS	Reduction of CO_2	Reduction of No_x	Reduction of SO_2	Reduction of Hg
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	$	$	$	$	$	$	YEARS	kWh	kW	THERMS	MMBTU	MMBTU	LBS	LBS	LBS	mg
1	Bookbinder School	LED Lighting Upgrades	$133,517	$8,979	($162)	$8,817	$4,017	$12,834	10.4	71,055	18	(147)	228	663	95,904	78	70	78.16
2	Bookbinder School	Lighting Controls	$30,754	$972	($18)	$954	$0	$954	32.2	7,683	2	(16)	25	72	10,369	8	8	8.45
3	Bookbinder School	District Wide Energy Management System Tier 1	$40,885	$0	$4,725	$4,725	$3,217	$7,942	5.1	0	0	4,293	429	451	50,229	39	0	0.00
4	Bookbinder School	District Wide Energy Management System Tier 2	$200,384	$4,103	$4,790	$8,893	$0	$8,893	22.5	27,360	20	4,352	529	718	88,513.96	70.41	26.81	30.10
7	Bookbinder School	Building Envelope Weatherization	$34,200	$944	$3,423	$4,368	$0	$4,368	7.8	5,537	6	3,110	330	379	43,999	35	5	6.09
8	Bookbinder School	Plug Load Controls	$9,240	$839	$0	$839	$0	$839	11.0	7,390	0	0	25	71	10,154	8	7	8.13
9	Bookbinder School	eTemp Refrigeration Sensors	$1,278	$196	$0	$196	$0	$196	6.5	1,725	0	0	6	16	2,370	2	2	1.90
12	Bookbinder School	Boiler Plant Replacement	$931,753	$1,096	$10,764	$11,860	$6,500	$18,360	50.8	9,288	1	9,780	1,010	1,116	127,188	100	9	10.22
13	Bookbinder School	RTU & Split System HVAC Replacement	$1,826,688	$731	$0	$731	$12,732	$13,463	135.7	4,095	5	0	14	39	5,626	5	4	4.50
17	Bookbinder School	Unit Ventilator Replacement w/ Addition of Cooling	$3,558,347	$905	$0	$905	$11,289	$12,194	291.8	5,243	6	0	18	50	7,204.39	5.82	5.14	5.77
1	Country Club Administration Building	LED Lighting Upgrades	$71,076	$12,030	($779)	$11,251	$2,138	$13,389	5.3	69,793	17	(679)	170	595	87,951	71	68	76.77
2	Country Club Administration Building	Lighting Controls	$17,024	$1,313	($85)	$1,227	$0	$1,227	13.9	7,613	2	(74)	19	65	9,590	8	7	8.37
3	Country Club Administration Building	District Wide Energy Management System Tier 1	$40,885	$0	$1,852	$1,852	$3,217	$5,069	8.1	0	0	1,615	161	170	18,893	15	0	0.00
4	Country Club Administration Building	District Wide Energy Management System Tier 2	$23,205	$228	$0	$228	$0	$228	101.6	1,460	0	0	5	14	2,005.92	1.62	1.43	1.61
6	Country Club Administration Building	Pipe and Valve Insulation	$6,771	$0	$1,433	$1,433	$676	$2,108	3.2	0	0	1,249	125	131	14,612	11	0	0.00
7	Country Club Administration Building	Building Envelope Weatherization	$15,900	$413	$1,356	$1,770	$0	$1,770	9.0	1,786	2	1,182	124	141	16,288	13	2	1.96
8	Country Club Administration Building	Plug Load Controls	$18,907	$1,338	$0	$1,338	$0	$1,338	14.1	8,550	0	0	29	82	11,747	9	8	9.40
9	Country Club Administration Building	eTemp Refrigeration Sensors	$1,278	$270	$0	$270	$0	$270	4.7	1,725	0	0	6	16	2,370	2	2	1.90
14	Country Club Administration Building	Destratification Fans	$9,225	($95)	$916	$821	$0	$821	11.2	(608)	0	799	78	78	8,510	7	-1	-0.67
1	Garfield East Elementary School	LED Lighting Upgrades	$85,637	$9,635	($880)	$8,754	$2,576	$11,331	7.6	70,303	18	(687)	171	600	88,557	72	69	77.33
2	Garfield East Elementary School	Lighting Controls	$31,535	$1,238	($113)	$1,125	$0	$1,125	28.0	9,035	2	(88)	22	77	11,382	9	9	9.94
3	Garfield East Elementary School	District Wide Energy Management System Tier 1	$40,885	$0	$1,921	$1,921	$3,217	$5,138	8.0	0	0	1,499	150	157	17,543	14	0	0.00
4	Garfield East Elementary School	District Wide Energy Management System Tier 2	$230,945	$1,379	$1,656	$3,035	$0	$3,035	76.1	7,091	6	1,293	153	203	24,867.38	19.76	6.95	7.80
6	Garfield East Elementary School	Pipe and Valve Insulation	$12,433	$0	$3,553	$3,553	$1,241	$4,794	2.6	0	0	2,773	277	291	32,445	26	0	0.00
7	Garfield East Elementary School	Building Envelope Weatherization	$18,100	$599	$1,854	$2,454	$0	$2,454	7.4	2,663	3	1,447	154	177	20,595	16	3	2.93
8	Garfield East Elementary School	Plug Load Controls	$17,353	$1,361	$0	$1,361	$0	$1,361	12.7	12,251	0	0	42	117	16,832	14	12	13.48
9	Garfield East Elementary School	eTemp Refrigeration Sensors	$2,555	$383	$0	$383	$0	$383	6.7	3,450	0	0	12	33	4,740.30	3.83	3.38	3.80
10	Garfield East Elementary School	Retro-Commissioning	$6,000	$419	$342	$761	$915	$1,676	3.6	3,771	0	267	40	64	8,307	7	4	4.15
14	Garfield East Elementary School	Destratification Fans	$9,046	($68)	$700	$632	$0	$632	14.3	(608)	0	546	53	52	5,553	4	-1	-0.67
19	Garfield East Elementary School	Window Film	$13,083	$1,134	$688	$1,823	$0	$1,823	7.2	6,034	5	537	74	114	14,576.31	11.64	5.91	6.64
1	Hawthorne Elementary School	LED Lighting Upgrades	$116,429	$12,364	($864)	$11,500	$3,503	$15,003	7.8	78,759	20	(765)	192	672	99,270	80	77	86.64
2	Hawthorne Elementary School	Lighting Controls	$30,633	$1,140	($80)	$1,060	$0	$1,060	28.9	7,253	2	(71)	18	62	9,136	7	7	7.98
3	Hawthorne Elementary School	District Wide Energy Management System Tier 1	$40,885	$0	$2,948	$2,948	$3,217	$6,165	6.6	0	0	2,608	261	274	30,516	24	0	0.00
4	Hawthorne Elementary School	District Wide Energy Management System Tier 2	$408,850	$3,573	$3,934	$7,506	$0	$7,506	54.5	14,944	16	3,481	399	508	61,257.65	48.61	14.64	16.44
6	Hawthorne Elementary School	Pipe and Valve Insulation	$14,407	$0	$4,864	$4,864	$1,438	$6,302	2.3	0	0	4,304	430	452	50,358	40	0	0.00
7	Hawthorne Elementary School	Building Envelope Weatherization	$37,600	$1,339	$3,405	$4,745	$0	$4,745	7.9	5,433	6	3,013	320	368	42,717	34	5	5.98
8	Hawthorne Elementary School	Plug Load Controls	$13,742	$1,073	$0	$1,073	$0	$1,073	12.8	8,206	0	0	28	78	11,274	9	8	9.03
9	Hawthorne Elementary School	eTemp Refrigeration Sensors	$3,616	$677	$0	$677	$0	$677	5.3	5,175	0	0	18	49	7,110.45	5.74	5.07	5.69
10	Hawthorne Elementary School	Retro-Commissioning	$6,000	$586	$528	$1,113	$915	$2,028	3.0	4,478	0	467	62	92	11,614	9	4	4.93

ECMs evaluated and included in the ESIP

Willingboro Township Public Schools			INSTALLED COST	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS	ANNUAL ENERGY COST SAVINGS	ANNUAL O&M COST SAVINGS	TOTAL ANNUAL COST SAVINGS	SIMPLE PAYBACK WITHOUT INCENTIVES	ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	NATURAL GAS SAVINGS	TOTAL SITE ENERGY SAVINGS	TOTAL SOURCE ENERGY SAVINGS	Reduction of CO_2	Reduction of No_x	Reduction of SO_2	Reduction of Hg
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	$	$	$	$	$	$	YEARS	kWh	kW	THERMS	MMBTU	MMBTU	LBS	LBS	LBS	mg
1	J. Cresswell Stuart Early Childhood Development Center	LED Lighting Upgrades	$133,166	$14,581	($1,014)	$13,567	$4,006	$17,573	7.6	102,570	25	(964)	254	879	129,654	105	101	112.83
2	J. Cresswell Stuart Early Childhood Development Center	Lighting Controls	$31,069	$1,498	($108)	$1,391	$0	$1,391	22.3	10,467	3	(102)	25	89	13,184	11	10	11.51
3	J. Cresswell Stuart Early Childhood Development Center	District Wide Energy Management System Tier 1	$40,885	$0	$2,366	$2,366	$3,217	$5,583	7.3	0	0	2,249	225	236	26,315	21	0	0.00
4	J. Cresswell Stuart Early Childhood Development Center	District Wide Energy Management System Tier 2	$558,025	$2,825	$2,817	$5,642	$0	$5,642	98.9	13,676	12	2,678	314	412	50,122.03	39.82	13.40	15.04
6	J. Cresswell Stuart Early Childhood Development Center	Pipe and Valve Insulation	$15,943	$0	$3,833	$3,833	$1,591	$5,424	2.9	0	0	3,644	364	383	42,630.54	33.52	0.00	0.00
7	J. Cresswell Stuart Early Childhood Development Center	Building Envelope Weatherization	$31,400	$1,166	$2,808	$3,973	$0	$3,973	7.9	5,052	6	2,669	284	329	38,169	30	5	5.56
8	J. Cresswell Stuart Early Childhood Development Center	Plug Load Controls	$17,931	$1,324	$0	$1,324	$0	$1,324	13.5	11,288	0	0	39	108	15,510	13	11	12.42
9	J. Cresswell Stuart Early Childhood Development Center	eTemp Refrigeration Sensors	$3,616	$607	$0	$607	$0	$607	6.0	5,175	0	0	18	49	7,110.45	5.74	5.07	5.69
10	J. Cresswell Stuart Early Childhood Development Center	Retro-Commissioning	$7,000	$645	$429	$1,074	$1,067	$2,141	3.3	5,499	0	408	60	95	12,324	10	5	6.05
19	J. Cresswell Stuart Early Childhood Development Center	Window Film	$22,545	$2,625	$824	$3,449	$0	$3,449	6.5	12,987	11	783	123	206	27,008.68	21.62	12.73	14.29
1	James A. Cotten Intermediate School	LED Lighting Upgrades	$145,022	$20,760	($331)	$20,429	$4,363	$24,792	5.8	150,817	37	(307)	484	1,409	203,627	165	148	165.90
2	James A. Cotten Intermediate School	Lighting Controls	$36,837	$2,118	($35)	$2,084	$0	$2,084	17.7	15,349	4	(32)	49	143	20,714	17	15	16.88
3	James A. Cotten Intermediate School	District Wide Energy Management System Tier 1	$40,885	$0	$5,823	$5,823	$3,217	$9,040	4.5	0	0	5,413	541	568	63,334	50	0	0.00
4	James A. Cotten Intermediate School	District Wide Energy Management System Tier 2	$487,305	$5,749	$3,178	$8,927	$0	$8,927	54.6	34,967	26	2,955	415	644	82,614.39	66.00	34.27	38.46
6	James A. Cotten Intermediate School	Pipe and Valve Insulation	$21,453	$0	$3,291	$3,291	$2,141	$5,431	3.9	0	0	3,059	306	321	35,791	28	0	0.00
7	James A. Cotten Intermediate School	Building Envelope Weatherization	$33,200	$882	$2,845	$3,727	$0	$3,727	8.9	4,754	5	2,645	281	323	37,474	30	5	5.23
8	James A. Cotten Intermediate School	Plug Load Controls	$6,398	$1,995	$0	$1,995	$0	$1,995	3.2	16,096	0	0	55	154	22,115	18	16	17.71
9	James A. Cotten Intermediate School	eTemp Refrigeration Sensors	$7,231	$3,592	$0	$3,592	$0	$3,592	2.0	28,980	0	0	99	277	39,818.52	32.17	28.40	31.88
10	James A. Cotten Intermediate School	Retro-Commissioning	$13,000	$2,231	$1,692	$3,924	$1,982	$5,906	2.2	18,001	0	1,573	219	337	43,140	34	18	19.80
14	James A. Cotten Intermediate School	Destratification Fans	$22,986	($188)	$2,202	$2,013	$0	$2,013	11.4	(1,520)	0	2,047	199	200	21,858	17	-1	-1.67
19	James A. Cotten Intermediate School	Window Film	$30,126	$1,998	$143	$2,141	$0	$2,141	14.1	12,067	9	133	54	129	18,133.34	14.62	11.83	13.27
1	Joseph A. McGinley School	LED Lighting Upgrades	$115,210	$6,797	($82)	$6,715	$3,466	$10,181	11.3	33,707	17	(70)	108	315	45,488	37	33	37.08
2	Joseph A. McGinley School	Lighting Controls	$30,807	$714	($9)	$705	$0	$705	43.7	3,539	2	(7)	11	33	4,776	4	3	3.89
3	Joseph A. McGinley School	District Wide Energy Management System Tier 1	$40,885	$0	$4,540	$4,540	$3,217	$7,757	5.3	0	0	3,925	393	412	45,923	36	0	0.00
1	Memorial Middle School	LED Lighting Upgrades	$271,835	$48,103	($487)	$47,616	$8,178	$55,794	4.9	346,722	60	(496)	1,133	3,260	470,592.55	380.30	339.79	381.39
2	Memorial Middle School	Lighting Controls	$75,504	$3,227	($46)	$3,181	$0	$3,181	23.7	22,461	6	(47)	72	210	30,312.15	24.50	22.01	24.71
3	Memorial Middle School	District Wide Energy Management System Tier 1	$34,255	$0	$4,754	$4,754	$2,695	$7,450	4.6	0	0	4,841	484	508	56,636.03	44.53	0.00	0.00
4	Memorial Middle School	District Wide Energy Management System Tier 2	$162,435	$16,836	$10,058	$26,894	$0	$26,894	6.0	110,428	44	10,241	1,401	2,130	271,545.86	216.79	108.22	121.47
6	Memorial Middle School	Pipe and Valve Insulation	$13,706	$0	$3,175	$3,175	$1,368	$4,542	3.0	0	0	3,233	323	339	37,820.73	29.74	0.00	0.00
7	Memorial Middle School	Building Envelope Weatherization	$36,000	$1,286	$2,869	$4,156	$0	$4,156	8.7	6,544	7	2,921	314	369	43,170.79	34.14	6.41	7.20
8	Memorial Middle School	Plug Load Controls	$1,156	$267	$0	$267	$0	$267	4.3	2,088	0	0	7	20	2,869.21	2.32	2.05	2.30
9	Memorial Middle School	eTemp Refrigeration Sensors	$9,642	$1,973	$0	$1,973	$0	$1,973	4.9	15,410	0	0	53	147	21,173.34	17.11	15.10	16.95
10	Memorial Middle School	Retro-Commissioning	$16,000	$2,435	$945	$3,380	$2,439	$5,819	2.7	19,012	0	962	161	283	37,380.11	29.96	18.63	20.91
14	Memorial Middle School	Destratification Fans	$18,399	($156)	$1,348	$1,192	$0	$1,192	15.4	(1,216)	0	1,373	133	133	14,388.17	11.28	-1.19	-1.34
19	Memorial Middle School	Window Film	$58,532	$6,521	$1,233	$7,754	$0	$7,754	7.5	37,845	27	1,255	255	493	66,688.47	53.56	37.09	41.63

ECMs evaluated and included in the ESIP

Willingboro Township Public Schools			INSTALLED COST	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS	ANNUAL ENERGY COST SAVINGS	ANNUAL O&M COST SAVINGS	TOTAL ANNUAL COST SAVINGS	SIMPLE PAYBACK WITHOUT INCENTIVES	ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	NATURAL GAS SAVINGS	TOTAL SITE ENERGY SAVINGS	TOTAL SOURCE ENERGY SAVINGS	Reduction of CO_2	Reduction of No_x	Reduction of SO_2	Reduction of Hg
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	$	$	$	$	$	$	YEARS	kWh	kW	THERMS	MMBTU	MMBTU	LBS	LBS	LBS	mg
1	J. Cresswell Stuart Early Childhood Development Center	LED Lighting Upgrades	$133,166	$14,581	($1,014)	$13,567	$4,006	$17,573	7.6	102,570	25	(964)	254	879	129,654	105	101	112.83
2	J. Cresswell Stuart Early Childhood Development Center	Lighting Controls	$31,069	$1,498	($108)	$1,391	$0	$1,391	22.3	10,467	3	(102)	25	89	13,184	11	10	11.51
3	J. Cresswell Stuart Early Childhood Development Center	District Wide Energy Management System Tier 1	$40,885	$0	$2,366	$2,366	$3,217	$5,583	7.3	0	0	2,249	225	236	26,315	21	0	0.00
4	J. Cresswell Stuart Early Childhood Development Center	District Wide Energy Management System Tier 2	$558,025	$2,825	$2,817	$5,642	$0	$5,642	98.9	13,676	12	2,678	314	412	50,122.03	39.82	13.40	15.04
6	J. Cresswell Stuart Early Childhood Development Center	Pipe and Valve Insulation	$15,943	$0	$3,833	$3,833	$1,591	$5,424	2.9	0	0	3,644	364	383	42,630.54	33.52	0.00	0.00
7	J. Cresswell Stuart Early Childhood Development Center	Building Envelope Weatherization	$31,400	$1,166	$2,808	$3,973	$0	$3,973	7.9	5,052	6	2,669	284	329	38,169	30	5	5.56
8	J. Cresswell Stuart Early Childhood Development Center	Plug Load Controls	$17,931	$1,324	$0	$1,324	$0	$1,324	13.5	11,288	0	0	39	108	15,510	13	11	12.42
9	J. Cresswell Stuart Early Childhood Development Center	eTemp Refrigeration Sensors	$3,616	$607	$0	$607	$0	$607	6.0	5,175	0	0	18	49	7,110.45	5.74	5.07	5.69
10	J. Cresswell Stuart Early Childhood Development Center	Retro-Commissioning	$7,000	$645	$429	$1,074	$1,067	$2,141	3.3	5,499	0	408	60	95	12,324	10	5	6.05
19	J. Cresswell Stuart Early Childhood Development Center	Window Film	$22,545	$2,625	$824	$3,449	$0	$3,449	6.5	12,987	11	783	123	206	27,008.68	21.62	12.73	14.29
1	Twin Hills Elementary School	LED Lighting Upgrades	$105,450	$13,026	($870)	$12,157	$3,172	$15,329	6.9	85,441	22	(831)	208	729	107,677.02	87.20	83.73	93.99
2	Twin Hills Elementary School	Lighting Controls	$25,355	$1,210	($81)	$1,129	$0	$1,129	22.5	7,929	2	(77)	19	68	9,987.86	8.09	7.77	8.72
3	Twin Hills Elementary School	District Wide Energy Management System Tier 1	$40,885	$0	$1,569	$1,569	$3,217	$4,786	8.5	0	0	1,499	150	157	17,543.05	13.79	0.00	0.00
4	Twin Hills Elementary School	District Wide Energy Management System Tier 2	$369,070	$3,553	$1,809	$5,362	$0	$5,362	68.8	15,619	15	1,729	226	331	41,686.70	33.24	15.31	17.18
6	Twin Hills Elementary School	Pipe and Valve Insulation	$11,608	$0	$2,607	$2,607	$1,158	$3,765	3.1	0	0	2,490	249	261	29,136.90	22.91	0.00	0.00
7	Twin Hills Elementary School	Building Envelope Weatherization	$27,200	$870	$1,987	$2,857	$0	$2,857	9.5	3,564	4	1,898	202	233	27,102.99	21.42	3.49	3.92
8	Twin Hills Elementary School	Plug Load Controls	$8,520	$1,166	$0	$1,166	$0	$1,166	7.3	9,284	0	0	32	89	12,756.08	10.31	9.10	10.21
9	Twin Hills Elementary School	eTemp Refrigeration Sensors	$3,616	$650	$0	$650	$0	$650	5.6	5,175	0	0	18	49	7,110.45	5.74	5.07	5.69
10	Twin Hills Elementary School	Retro-Commissioning	$6,000	$630	$284	$914	$915	$1,829	3.3	5,019	0	271	44	76	10,068.62	8.07	4.92	5.52
14	Twin Hills Elementary School	Destratification Fans	$9,225	($76)	$651	$575	$0	$575	16.0	(608)	0	622	60	60	6,442.94	5.05	-0.60	-0.67
19	Twin Hills Elementary School	Window Film	$21,481	$3,445	$935	$4,381	$0	$4,381	4.9	16,671	13	894	146	253	33,361.37	26.73	16.34	18.34
1	W.R. James Elementary School	LED Lighting Upgrades	$128,004	$14,071	($793)	$13,279	$3,851	$17,130	7.5	76,452	19	(737)	187	653	96,424.09	78.08	74.92	84.10
2	W.R. James Elementary School	Lighting Controls	$30,867	$1,364	($78)	$1,286	$0	$1,286	24.0	7,393	2	(72)	18	63	9,313.15	7.54	7.25	8.13
3	W.R. James Elementary School	District Wide Energy Management System Tier 1	$40,885	$0	$2,004	$2,004	$3,217	$5,221	7.8	0	0	1,863	186	196	21,797.44	17.14	0.00	0.00
4	W.R. James Elementary School	District Wide Energy Management System Tier 2	$369,070	$4,210	$3,745	$7,955	$0	$7,955	46.4	16,284	16	3,481	404	521	63,099.46	50.10	15.96	17.91
6	W.R. James Elementary School	Pipe and Valve Insulation	$9,850	$0	$1,968	$1,968	$983	$2,951	3.3	0	0	1,829	183	192	21,404.27	16.83	0.00	0.00
7	W.R. James Elementary School	Building Envelope Weatherization	$36,800	$1,462	$3,153	$4,614	$0	$4,614	8.0	5,313	6	2,930	311	358	41,582.26	32.85	5.21	5.84
8	W.R. James Elementary School	Plug Load Controls	$15,306	$2,117	$0	$2,117	$0	$2,117	7.2	13,429	0	0	46	128	18,451.14	14.91	13.16	14.77
9	W.R. James Elementary School	eTemp Refrigeration Sensors	$3,616	$816	$0	$816	$0	$816	4.4	5,175	0	0	18	49	7,110.45	5.74	5.07	5.69
10	W.R. James Elementary School	Retro-Commissioning	$6,000	$703	$413	$1,116	$915	$2,031	3.0	4,459	0	384	54	83	10,619.32	8.48	4.37	4.90
1	Warehouse	LED Lighting Upgrades	$40,107	$7,146	($397)	$6,749	$1,207	$7,956	5.0	43,165	8	(321)	115	379	55,555.70	44.96	42.30	47.48
2	Warehouse	Lighting Controls	$694	$57	($4)	$53	$0	$53	13.0	334	0	(3)	1	3	420.31	0.34	0.33	0.37
3	Warehouse	District Wide Energy Management System Tier 1	$37,570	$0	$531	$531	$2,956	$3,487	10.8	0	0	429	43	45	5,015.47	3.94	0.00	0.00
6	Warehouse	Pipe and Valve Insulation	$5,164	$0	$1,046	$1,046	$515	$1,561	3.3	0	0	844	84	89	9,878.73	7.77	0.00	0.00
7	Warehouse	Building Envelope Weatherization	$9,400	$51	$1,025	$1,076	$0	$1,076	8.7	199	0	827	83	89	9,953.03	7.83	0.20	0.22
8	Warehouse	Plug Load Controls	$711	$312	$0	$312	$0	$312	2.3	2,130	0	0	7	20	2,927.03	2.36	2.09	2.34
14	Warehouse	Destratification Fans	$36,977	($356)	$2,016	$1,660	$0	$1,660	22.3	(2,432)	0	1,628	155	148	15,707.20	12.28	-2.38	-2.68
1	Willingboro High School	LED Lighting Upgrades	$472,764	$75,421	($739)	$74,682	$14,223	$88,905	5.3	442,281	108	(885)	1,421	4,132	597,335.61	482.79	433.44	486.51
2	Willingboro High School	Lighting Controls	$64,980	$5,556	($56)	$5,499	$0	$5,499	11.8	32,375	8	(68)	104	302	43,690.73	35.31	31.73	35.61
3	Willingboro High School	District Wide Energy Management System Tier 1	$34,255	$3,618	$5,050	$8,668	$2,695	$11,363	3.0	24,720	0	6,051	689	872	104,759.90	83.11	24.23	27.19
4	Willingboro High School	District Wide Energy Management System Tier 2	$167,960	$14,521	$14,064	$28,585	$0	$28,585	5.9	75,395	35	16,850	1,942	2,490	300,736.88	238.71	73.89	82.93
6	Willingboro High School	Pipe and Valve Insulation	$8,859	$0	$1,315	$1,315	$884	$2,199	4.0	0	0	1,575	158	165	18,431.88	14.49	0.00	0.00
7	Willingboro High School	Building Envelope Weatherization	$64,400	$1,468	$4,010	$5,477	$0	$5,477	11.8	5,707	6	4,804	500	559	64,047.38	50.53	5.59	6.28
8	Willingboro High School	Plug Load Controls	$569	$587	$0	$587	$0	$587	1.0	4,008	0	0	14	38	5,507.16	4.45	3.93	4.41
9	Willingboro High School	eTemp Refrigeration Sensors	$10,847	$3,787	$0	$3,787	$0	$3,787	2.9	25,875	0	0	88	247	35,552.25	28.72	25.36	28.46
10	Willingboro High School	Retro-Commissioning	$23,000	$6,514	$1,130	$7,645	$3,506	$11,151	2.1	44,511	0	1,354	287	567	77,001.72	61.87	43.62	48.96
11	Willingboro High School	Combined Heating & Power	$187,830	$4,066	($862)	$3,204	$0	$3,204	58.6	24,798	4	(1,033)	(19)	128	19,950.31	11.08	16.61	0.00
14	Willingboro High School	Destratification Fans	$56,093	($534)	$4,526	$3,992	$0	$3,992	14.0	(3,648)	0	5,423	530	535	58,437.44	45.84	-3.58	-4.01
18	Willingboro High School	Field Lighting Upgrade	$0	$1,850	$0	$1,850	$0	$1,850	0.0	12,642	0	0	43	121	17,370.11	14.03	12.39	13.91
19	Willingboro High School	Window Film	$43,803	$9,961	$3,136	$13,097	$0	$13,097	3.3	61,275	10	3,757	585	980	128,151.32	102.58	60.05	67.40

ECMs evaluated but NOT included in the ESIP

Willingboro Township Public Schools			INSTALLED COST	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS	ANNUAL ENERGY COST SAVINGS	ANNUAL O&M COST SAVINGS	TOTAL ANNUAL COST SAVINGS	SIMPLE PAYBACK WITHOUT INCENTIVES	ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	NATURAL GAS SAVINGS	TOTAL SITE ENERGY SAVINGS	TOTAL SOURCE ENERGY SAVINGS	Reduction of CO_2	Reduction of No_x	Reduction of SO_2	Reduction of Hg
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	$	$	$	$	$	$	YEARS	kWh	kW	THERMS	MMBTU	MMBTU	LBS	LBS	LBS	mg
10	Bookbinder School	Retro-Commissioning	$6,000	$394	$312	$706	$915	$1,621	3.7	3,476	0	284	40	63	8,094	6	3	3.82
10	Country Club Administration Building	Retro-Commissioning	$4,000	$422	$470	$892	$610	$1,502	2.7	2,698	0	410	50	69	8,499	7	3	2.97
15	Country Club Administration Building	Solar Ownership	$89,921	$4,220	$0	$4,220	$0	$4,220	21.3	0	0	0	92	258	37,065	30	26	30
16	Country Club Administration Building	Solar PPA	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
17	Country Club Administration Building	Unit Ventilator Replacement w/ Addition of Cooling	$3,130,535	$920	$0	$920	$9,932	$10,852	288.5	3,933	5	0	13	38	5,403.29	4.37	3.85	4.33
5	Garfield East Elementary School	Roof Renovations	$493,942	$25	$179	$204	$0	$204	2421.6	229	0	139	15	17	1,944.98	1.54	0.22	0.25
15	Garfield East Elementary School	Solar Ownership	$0	$4,086	$0	$4,086	$0	$4,086	0.0	0	0	0	125	351	50,525	41	36	40
16	Garfield East Elementary School	Solar PPA	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
15	Hawthorne Elementary School	Solar Ownership	$145,522	$5,711	$0	$5,711	$0	$5,711	25.5	0	0	0	149	417	59,984	48	43	48
16	Hawthorne Elementary School	Solar PPA	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
15	J. Cresswell Stuart Early Childhood Development Center	Solar Ownership	$178,718	$6,289	$0	$6,289	$0	$6,289	28.4	0	0	0	183	512	73,668	60	53	59
16	J. Cresswell Stuart Early Childhood Development Center	Solar PPA	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
5	James A. Cotten Intermediate School	Roof Renovations	$1,210,029	$69	$374	$443	$0	$443	2733.7	558	0	347	37	42	4,828.54	3.81	0.55	0.61
15	James A. Cotten Intermediate School	Solar Ownership	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
16	James A. Cotten Intermediate School	Solar PPA	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
4	Joseph A. McGinley School	District Wide Energy Management System Tier 2	$181,599	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0.00	0.00	0.00	0.00
7	Joseph A. McGinley School	Building Envelope Weatherization	$33,600	$1,492	$3,526	$5,018	$0	$5,018	6.7	5,742	6	3,049	324	375	43,559	34	6	6.32
10	Joseph A. McGinley School	Retro-Commissioning	$6,000	$342	$1,164	$1,506	$915	$2,420	2.5	2,234	0	1,006	108	127	14,843	12	2	2.46
5	Memorial Middle School	Roof Renovations	$951,316	$60	$271	$332	$0	$332	2868.6	470	0	276	29	34	3,879.36	3.06	0.46	0.52
15	Memorial Middle School	Solar Ownership	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
16	Memorial Middle School	Solar PPA	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
15	Twin Hills Elementary School	Solar Ownership	$163,134	$6,147	$0	$6,147	$0	$6,147	26.5	0	0	0	167	468	67,244	54	48	54
16	Twin Hills Elementary School	Solar PPA	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
15	W.R. James Elementary School	Solar Ownership	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
16	W.R. James Elementary School	Solar PPA	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
10	Warehouse	Retro-Commissioning	$3,000	$487	$119	$607	$457	$1,064	2.8	3,331	0	96	21	42	5,704.26	4.58	3.26	3.66
5	Willingboro High School	Roof Renovations	$1,619,581	$63	$399	$463	$0	$463	3500.8	432	0	479	49	54	6,192.60	4.88	0.42	0.47
15	Willingboro High School	Solar Ownership	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0
16	Willingboro High School	Solar PPA	$0	$0	$0	$0	$0	$0	0.0	0	0	0	0	0	0	0	0	0

Note:

- **Factors used to calculate Greenhouse Gas Reductions are as follows:**
  - ***CO2 = (1.292*kWh Savings) + (11.7*Therm Savings)***
  - ***NOx = (0.0083*kWh Savings) + (0.0092*Therm Savings)***
  - ***SO2 = (0.0067*kWh Savings)***
  - ***Hg = (0.0000000243* kWh Savings)***

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ENERGY SAVINGS PLAN

APPENDIX G – ENERGY SAVINGS SUPPLEMENTAL INFORMATION

*Refer to submission folder

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ENERGY SAVINGS PLAN

APPENDIX H – LOCAL GOVERNMENT ENERGY AUDITS