ENERGY SAVINGS PLAN

SUBMITTED BY:
DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648
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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 Gloucester City School District's 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 Gloucester City School District with the necessary information to decide which proposed ECMs to implement as part of your (ESIP) project. Gloucester City School District has decided to utilize the standard ESIP model, with DCO Energy as the ESCO, Phoenix Advisors, LLC acting as the financial advisor and Wilentz, Goldman & Spitzer, P.A. as the bond counsel. Working with the School District's staff, your selected ESIP project would:

1. Self-fund a $7,076,609 project, with a capital contribution of $500,000
2. Generate $392,529 in annual energy savings – 39% of current utility spend
3. Eligible for $262,344 in rebates and incentives
4. Reduce utility related annual CO2 emissions by 1,401 metric tons – a 57% reduction

NOTE: This submitted ESP doesn't constitute any contractual obligation between the Gloucester City School District and DCO Energy (DCO). Any contractual obligations will be performed under separate legal documents per mutual 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.*

DCO Energy looks forward to the third-party review of our energy calculations and the Gloucester City School District's approval of the Energy Savings Plan to implement via the requirements of the ESIP legislation. Your time, effort, and support are appreciated.

Gloucester High School

Gloucester High School is a one-story, 172,000 square foot building built in 1960. Spaces include classrooms, conference rooms, fitness rooms, a gymnasium, a kitchen, a library, dining areas, prep rooms, corridors, offices, mechanical spaces, and storage areas. The facility also has an 880-kW solar array located in the parking lot. The building is occupied year-round, with weekend occupancy limited to events. Typical weekday occupancy includes 122 staff and 560 students until 3:00 PM. A summer day camp and maintenance activities continue throughout the summer.

Description of Building HVAC

Most of the hallways in the building are conditioned by dedicated packaged air-handling units which are equipped with a supply fan and hot water coils. The units include four (4) 0.5 HP rooftop units serving the B wing exit, C wing hallway, E wing hallway, and B wing hallway. Six (6) 1.5 HP rooftop units serve the D wing hallway, A wing hallway, C wing hallway exit, and the C wing hallway. Most offices, classrooms, and other small areas are served by fan-coil units equipped with chilled water coils for cooling and hot water coils for heating. These units are located above the ceiling. The supply fan motors for all these units are fractional horsepower fan motors. The cooling is provided by the chiller plant and the heating source is provided by the hot water boilers. There are approximately eighty-one (81) fan coil units and twelve (12) cabinet unit heaters throughout the building. There are various areas throughout the building that are conditioned by unitary electric HVAC equipment. These include split air conditioning (AC) systems in the ROTC office, prep lab, and server room. Cooling capacities range between 1 ton and 5 tons with. These systems are mainly controlled by remote control units located within the space. The kitchen is served by a make-up air unit with a built-in natural gas furnace to serve its heating load. There are sixteen (16) packaged direct expansion / natural gas fired furnace rooftop units which serve various spaces including the auditorium, old gym, old gym locker rooms, new gym, new gym locker rooms, library, cafeteria and kitchen. These units range from 3 to 50 tons in cooling capacity and equate to 310.5 tons total for the building.

The building's heating system consists of two (2) Smith gas-fired hot water boilers each with an input capacity of 9,667 MBh. The boilers serve a hot water loop with two (2), 20 HP constant speed hot water pumps (HWLP-1 and HWLP-2) operating with a lead-lag control scheme. The hot water loop serves existing fan coil units, air handling units and cabinet unit heaters. The building's cooling system consists of two (2) Trane 250 Ton Air Cooled Chillers. These chillers serve chilled water through the existing chilled water loop by two (2) constant speed, 60 hp pumps to existing unit ventilators, air handlers, fan coil units. Gloucester High School has three (3) domestic water heaters. One (1) water heater uses natural gas and has a capacity of 400 MBh. The other two (2) water heaters are also natural gas fired and each have a capacity of 200 MBh

Description of Building Lighting

The primary interior lighting system uses fluorescent fixtures, including 32-Watt 4-foot linear T8, 17-Watt 2-foot linear T8, 30-Watt 3-foot linear T12, 59-Watt 8-foot linear T8, U-Bend T12, and U-Bend T8 fluorescent lamps. Several fixtures throughout use LED, compact fluorescent lamps (CFL), or incandescent lamps, typically ranging between 10-Watts and 100-Watts. The theatre has many halogen incandescent spotlights that range between 300-Watts and 500 Watts. The gym in the new wing has several 400-Watt metal halide (MH) lamp fixtures. Most exit signs use LED sources. Fixtures are configured with a variety of lamp types in different lengths as needed to suit area lighting requirements. Fixtures are accordingly recessed, ceiling mount, wall mount, or suspended. Most interior lighting fixtures are controlled manually while a few fixtures in some of the classrooms and offices are controlled by occupancy sensors. The lighting in the hallways is controlled by a timeclock. Exterior fixtures include wall mounted and pole mounted area lights with incandescent and high-pressure sodium (HPS), and canopy mounted LED fixtures of varying wattages. Most exterior light fixtures are all controlled by timeclocks and a few wall mounted fixtures being controlled by photocells. The lighting fixtures in the baseball and football fields are controlled by individual breakers.

Cold Springs Elementary School & Early Childhood Center

Cold Springs ES & ECC is a two-story, 161,000 square foot building. The facility is comprised of two sections, Cold Springs Elementary School built in 1994 and Early Childhood Center built in 2004 as an expansion. Spaces include classrooms, a gymnasium, commercial kitchens, a library, locker rooms, teacher's lounges, offices, dining areas, corridors, stairwells, conference rooms, mechanical and electrical rooms, storage spaces, and a multipurpose room. The facility is occupied year-round, including 250 staff and 845 students until 3:00 PM on weekdays. In the summer, a day camp operates for 20 days until 5:00 PM, and maintenance activities continue throughout. There are no weekend activities.

Description of Building HVAC

Most of the classrooms in the CSS section of the building are served by unit ventilators. There are forty-three (43) unit ventilators each equipped with a supply fan motor ranging in size from .25 to 1HP and an outside air damper. These units have chilled water and heating hot water coils. These units are controlled by the building energy management system (EMS). There also six (6) dedicated outside air handling units (DOAS) which are each configured with a hot water and a chilled water coil. All units include an air-to-air heat exchanger. These units serve the gym, locker rooms, office spaces, cafeteria, stage and kitchen. The DOAS air handling units have supply fan motors which range from 5 to 17.5 HP. There are also sixteen (16) variable air volume boxes each with a hot water coil serving office spaces. The CSS kitchen's makeup air unit (MAU) has a 2.0 hp makeup air fan motor and a 2.0 hp kitchen hood exhaust fan. This unit provides ventilation only and does not have features to provide heating or cooling.

Most of the ECC rooms, a few sections of hallways, and mechanical spaces are served by fan coil units of varying sizes. There are thirty-four (34) fan coil units each equipped with a .25 HP supply fan motor and outside air damper. These units have chilled water and heating hot water coils. These units are controlled by the building energy management system (EMS). There are also six (6) cabinet unit heaters with hot water coils located in stairwells and hallway spaces.

There are three (3) air handling units each equipped with a hot water and chilled water coil located in a second-floor mechanical space. These constant volume air handling units serve the kitchen, main office and cafeteria of ECC. There supply fan motors range in HP from 1.5 to 7.5. Various office areas, server rooms, and electrical rooms throughout the building are conditioned by unitary HVAC equipment. These include split system air conditioning (AC) systems in tech room, IDF rooms, and the elevator room. Their cooling capacity ranges between 1 and 2 tons. These systems are controlled by remote control thermostats located within the space. There are also split air-source heat pump (HP) systems in security and computer rooms that each have a cooling capacity of 1.5 ton, with heating capacities of 18.0Mbh to 20.0 Mbh. A phone room is served by a 1.0-ton ductless mini-split AC unit that is currently not being used. The ECC kitchen's makeup air unit (MAU) is equipped with a 2.0 hp makeup air fan motor, 2.0 hp kitchen hood exhaust fan, gas-fired furnace, and DX coils served by an outdoor condensing unit. The split system AC serving the MAU has a cooling capacity of 10.0 tons, and the gas-fired furnace has a heating capacity of 280.0 MBh. Most of the HVAC systems are controlled by the facility EMS.

The CSS section of the building's heating system consists of three (3) Aerco gas-fired condensing hot water boilers each with an input capacity of 2000 MBh. The boilers serve the CSS hot water loop with two (2), 15 hp hot water pumps with variable frequency drives operating with a lead-lag control scheme. The hot water loop serves existing CSS unit ventilators, DOAS air handling units and fan coil units. The CSS section of the building's cooling system consists of one (1) Smardt 370 Ton Water Cooled Chiller. This chiller serves chilled water through the existing chilled water loop to existing unit ventilators, DOAS air handling units and variable air volume boxes. The ECC section of the building's heating system consists of three (3) Lochnivar gas-fired hot water boilers each with an input capacity of 990 MBh. The boilers serve a hot water loop with two (2), 5 hp constant speed hot water pumps operating with a lead lag control scheme. The hot water loop serves air handling units, fan coil units and cabinet unit heaters. The ECC section of the building's cooling system consists of one (1) Trane 225 Ton Air Cooled Chiller. This chiller serves chilled water through the existing chilled water loop by two (2), 15 hp pumps with variable frequency drives to existing fan coil units and air handling units. CSS has two (2) domestic natural gas-fired water heaters each with a capacity of 800 MBh. ECC has one (1) domestic natural gas-fied water heater with capacity of 199 MBh.

Description of Building Lighting

The primary interior lighting system uses 32-Watt 4-foot linear T8 and 17-Watt 2-foot linear T8 fluorescent lamps. Several fixtures throughout use LED, compact fluorescent lamps (CFL), or incandescent lamps, typically ranging between 9-Watts and 100-Watts. The gym has several 250-Watt metal halide (MH) lamp fixtures, and some classroom areas contain 250-Watt mercury vapor lamps. The dining area contains some high wattage halogen incandescent lamps. Typically, T8 fluorescent lamps use electronic ballasts. Most exit signs use LED sources. Fixtures are configured with a variety of lamp types in different lengths as needed to suit area lighting requirements. Fixtures are accordingly recessed, ceiling mount, wall mount, or suspended. Interior lighting levels were generally sufficient. A majority of interior lighting fixtures are controlled manually. The remaining lighting fixtures, mostly in classrooms, restrooms, and a few storage spaces; are controlled by occupancy sensors. Hallway lighting is controlled by a timeclock. Exterior fixtures include wall mounted recessed ceiling mounted and pole mounted area lights with compact fluorescent lamps (CFL), metal halide (MH), high-pressure sodium (HPS), and LED fixtures of varying wattages. Most exterior light fixtures are controlled by timeclocks, and a few pole mounted MH fixtures are controlled by photocells.

Gloucester Middle School

Gloucester Middle School is a three story, 122,000 square foot building built in 2017. Spaces include classrooms, offices, conference rooms, computer labs, a cafeteria, electrical rooms, hallways, a garage, gymnasiums, closets, a commercial kitchen, locker rooms, lounges, a media center, rest rooms, server rooms, stairwells, storage rooms, and mechanical rooms. The facility is occupied year-round, with summer use for administrative offices, summer camp, and continuing maintenance activities. The building has varying use on the weekends, and the facility closes at 3:00 PM on weekdays. During a typical day, the facility is occupied by 250 staff and 800 students.

Description of Building HVAC

Fan coil units equipped with fractional hp constant speed supply fan motors, hot water coils, and chilled water coils are located in the ceiling of many classrooms. There are forty-seven (47) fan coil units each with 1/3 HP supply fan motors and outside air dampers. These units are controlled through the EMS. Stairwells and vestibules are heated by cabinet unit heaters each equipped with a fractional hp supply fan motors and hot water coil. There are thirteen (13) cabinet unit heaters. Most of the building areas are heated, cooled, and ventilated by ten (10) packaged rooftop units. These units are equipped with supply fan motors, exhaust fan motors, outdoor air dampers, direct expansion (DX) coils, and gas-fired furnaces. Four of the units (RTU 1-4) are tied to heat recovery units and equipped with enthalpy wheels. These ten (10) rooftop units range in cooling capacity from 6 to 40 tons equating to 131 total tons. A 20-ton make-up air unit (MAU) serves the kitchen, equipped with a supply fan motor, exhaust fan motor, outdoor air damper, direct expansion (DX) coils, and gas-fired furnace. All rooftop units are controlled through the EMS. Several areas of the building are served by ductless mini-split system heat pumps. These units were all installed in 2016 and are in good condition. These units are controlled by individual programmable thermostats. There thirty (30) variable air volume boxes each with a hot water heating coil. Heating, cooling, and ventilation is also provided to classroom and office areas by two dedicated outdoor air units (DOAS-1 & DOAS-2). DOAS-1 serves the first floor and half of the second floor, while DOAS-2 serves the third floor and half of the second floor. Each of these units is equipped with a 10 HP VFD controlled supply fan motor, a 10 HP VFD controlled exhaust fan motor, hot water coils served by the boiler, chilled water coils served by the chillers, an outdoor air damper, and an energy wheel. Both these units are controlled through the EMS.

The building's heating system consists of three (3) Lochnivar gas-fired hot water boilers each with an input capacity of 1,500 MBh. The boilers serve a hot water loop with two (2), 10 HP hot water pumps configured with variable frequency drives and operating with a lead-lag control scheme. The hot water loop serves existing fan coil units, variable air volume boxes and cabinet unit heaters. The building's cooling system consists of two (2) Trane 90 Ton Air Cooled Chillers. These chillers serve chilled water through the existing chilled water loop by two (2) constant speed, 3 HP pumps and two (2) 10 HP pumps with variable frequency drives to existing fan coil units. Gloucester Middle School has two (2) domestic water heaters which are natural gas fired and each have a capacity of 500 MBh.

Description of Building Lighting

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps. There are also several LED wall mounted fixtures in the stairwells, as well as several other general-purpose LED fixtures throughout the building. Additionally, there are some compact fluorescent lamps (CFL), halogen incandescent, and linear fluorescent T5 lamps. Fixture types include 1-lamp, 2-lamp, 3-lamp, or 6-lamp, 2-foot or 4-foot-long troffer, recessed, surface mounted, and pendent mounted fixtures. There are also spotlights, recessed can fixtures, LED panels, track lighting, and wall mounted fixtures. The main gymnasium is equipped with high bay fixtures with linear fluorescent lamps. The auxiliary gymnasium has high bay 2-foot by 4-foot LED panels. Lighting in both gyms is controlled through a digital lighting control system. The cafeteria has high bay, pendent mounted fixtures with linear fluorescent lamps. Fixtures are controlled through a digital lighting control system. Most fixtures are in good condition. Interior lighting levels were generally sufficient. All exit signs are LED. Most lighting fixtures are controlled by occupancy sensors, some rooms by daylight dimming controls, and the remainder by wall switches.Exterior fixtures include recessed can fixtures, under canopy fixtures, wall packs, and in-ground flag lighting that use a combination of CFL and LED sources. Pole mounted fixtures use LED lamps. Exterior light fixtures are controlled by a time clock.

ENERGY SAVINGS PLAN

SECTION 2 – ENERGY BASELINE

Total Utility Consumption and Site EUI

The Gloucester City School District Energy Savings Plan includes 3 buildings. One elementary school, one middle school, and one high school. To develop the ESP, DCO Energy was provided with all available utility data (electric, natural gas, existing solar, water/sewer). DCO Energy tracked and documented this utility data from May of 2023 through April of 2024. A listing of the buildings, the total utility consumption, and Energy Usage Index for the 3 sites are detailed below.

GLOUCESTER CITY SCHOOL DISTRICT BUILDINGS/FACILITIES	
BUILDING/FACILITY NAME	SQFT
Gloucester High School	172,243
Cold Springs ES & ECC	161,294
Gloucester Middle School	122,000
TOTALS	**455,537**

Gloucester City School District - Energy Use Summary

GLOUCESTER CITY SCHOOL DISTRICT BUILDINGS/FACILITIES		ELECTRIC				
BUILDING/FACILITY NAME	SQFT	CONSUMPTION kWh	DEMAND kW	USAGE BTU / SQFT	TOTAL COST $$	BLENDED COST $$ / kWh
Gloucester High School	172,243	1,271,409	723	25,186	$256,181	$0.201
Cold Springs ES & ECC	161,294	1,246,257	617	26,363	$188,452	$0.151
Gloucester Middle School	122,000	388,317	299	10,860	$67,697	$0.174
TOTALS	**455,537**	**2,905,983**	**723**	**21,766**	**$512,329**	**$0.176**

GLOUCESTER CITY SCHOOL DISTRICT BUILDINGS/FACILITIES		NATURAL GAS			
BUILDING/FACILITY NAME	SQFT	USAGE THERMS	USAGE BTU / SQFT	TOTAL COST $$	BLENDED COST $$ / THERM
Gloucester High School	172,243	82,745	48,039	$80,173	$0.97
Cold Springs ES & ECC	161,294	72,696	45,071	$67,796	$0.93
Gloucester Middle School	122,000	32,543	26,674	$31,008	$0.95
TOTALS	**455,537**	**187,984**	**41,266**	**$178,977**	**$0.95**

GLOUCESTER CITY SCHOOL DISTRICT BUILDINGS/FACILITIES		Solar PPA (kWh)			
BUILDING/FACILITY NAME	SQFT	USAGE	USAGE BTU / SQFT	TOTAL COST $$	UNIT COST $$ /
Gloucester High School	172,243	1,252,892	24,819	$115,444	$0.092
Cold Springs ES & ECC	161,294	1,242,796	26,290	$114,273	$0.092
Gloucester Middle School	122,000	751,897	21,028	$69,117	$0.092
TOTALS	**455,537**	**3,247,585**	**24,325**	**$298,834**	**$0.092**

GLOUCESTER CITY SCHOOL DISTRICT BUILDINGS/FACILITIES		Water & Sewer (kGal)			
BUILDING/FACILITY NAME	SQFT	USAGE kGallons	USAGE kGAL / SQFT	TOTAL COST $$	UNIT COST $$ / kGallons
Gloucester High School	172,243	1,099	6.38	$18,531	$16.86
Cold Springs ES & ECC	161,294	1,488	9.23	$23,029	$15.48
Gloucester Middle School	122,000	983	8.06	$12,532	$12.74
TOTALS	**455,537**	**3,571**	**7.84**	**$54,092**	**$15.15**

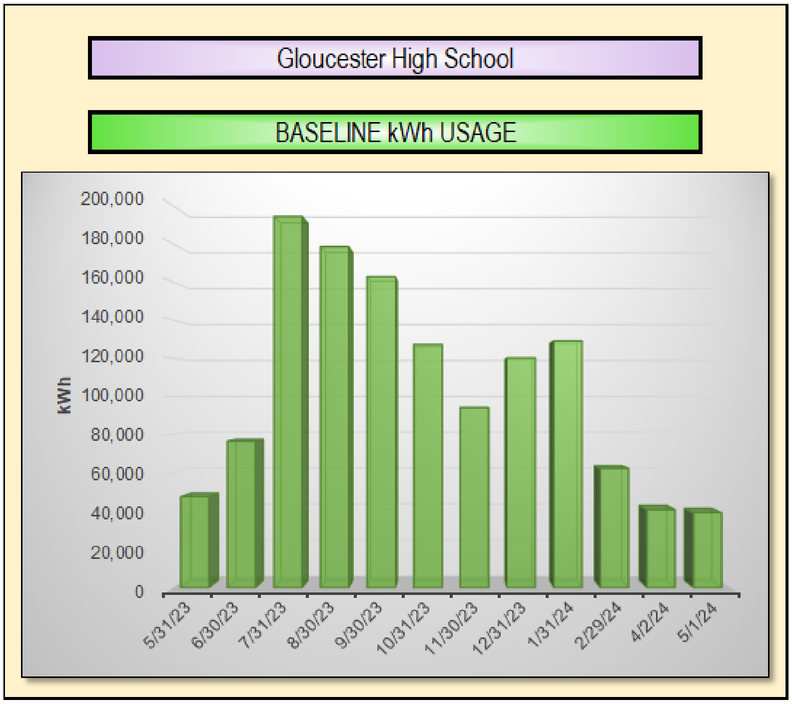
GLOUCESTER CITY SCHOOL DISTRICT BUILDINGS/FACILITIES		TOTAL ENERGY	TOTAL COST
BUILDING/FACILITY NAME	SQFT	USAGE BTUs	$$
Gloucester High School	172,243	16,887,375,496	$470,328
Cold Springs ES & ECC	161,294	15,762,282,122	$393,550
Gloucester Middle School	122,000	7,144,685,342	$180,353
TOTALS	**455,537**	**39,794,342,959**	**$1,044,232**

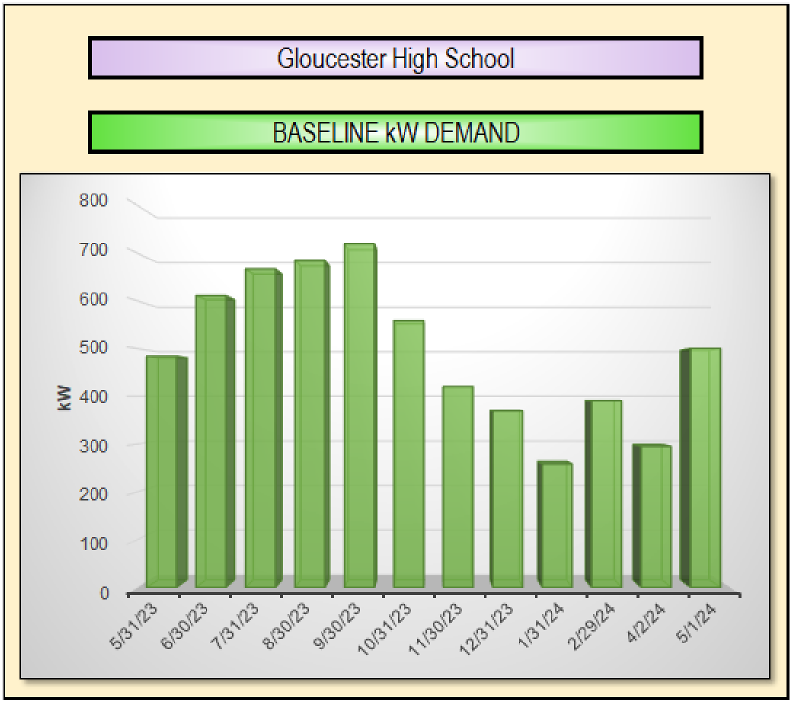
Gloucester City School District – Energy Use & Cost Index

GLOUCESTER CITY SCHOOL DISTRICT BUILDINGS/FACILITIES		SITE EUI		
BUILDING/FACILITY NAME	SQFT	USAGE BTU / SQFT	NATIONAL MEDIAN BTU / SQFT	NATIONAL MEDIAN +/- %
Gloucester High School	172,243	98,044	62,700	-56%
Cold Springs ES & ECC	161,294	97,724	62,700	-56%
Gloucester Middle School	122,000	58,563	62,700	7%
TOTALS	**455,537**	**87,357**	**62,700**	**-39%**

GLOUCESTER CITY SCHOOL DISTRICT BUILDINGS/FACILITIES		SITE ECI		
BUILDING/FACILITY NAME	SQFT	COST $$ / SQFT	NATIONAL MEDIAN $$ / SQFT	NATIONAL MEDIAN +/- %
Gloucester High School	172,243	$2.73	$1.55	-76%
Cold Springs ES & ECC	161,294	$2.44	$1.55	-57%
Gloucester Middle School	122,000	$1.48	$1.55	5%
TOTALS	**455,537**	**$2.29**	**$1.55**	**-48%**

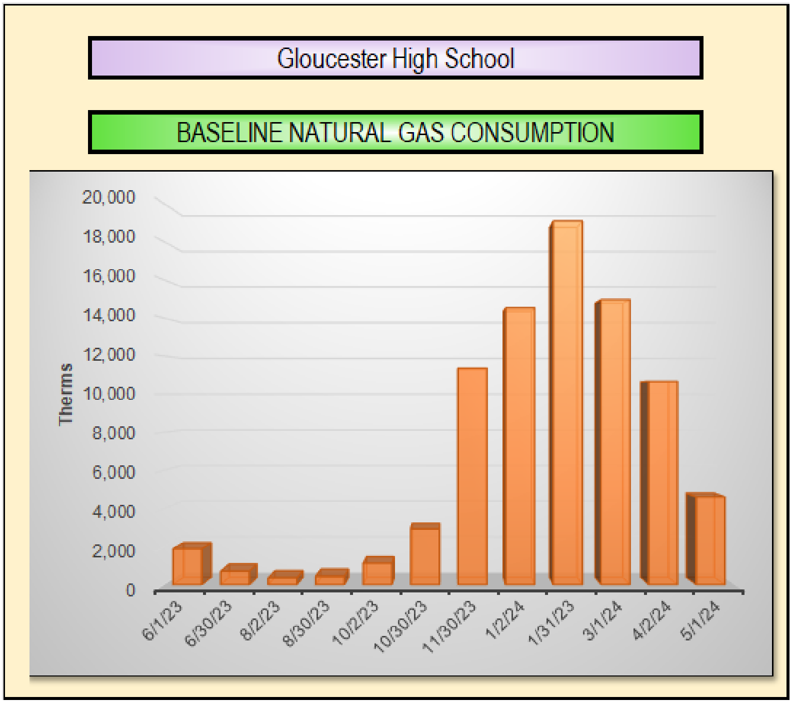
Gloucester High School Baseline Energy Use





Gloucester High School						ELECTRIC METER #1						
Provider:	PSE&G			Account #	4200381001				Meter #	9217778		
Commodity:				Account #	7392644106				Meter #			
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
5/1/23	5/31/23	47,338	482	$778	$9,277	$2,168	$371	$12,594	$0.212	31	13%	161,517,256
6/1/23	6/30/23	76,561	610	$1,440	$5,337	$8,590	$371	$15,738	$0.089	30	17%	261,226,132
7/1/23	7/31/23	193,869	666	$3,647	$22,364	$9,389	$371	$35,771	$0.134	31	39%	661,481,028
8/1/23	8/30/23	176,012	680	$3,349	$21,390	$9,583	$371	$34,692	$0.141	30	36%	600,552,944
8/31/23	9/30/23	162,378	718	$3,089	$19,984	$10,124	$371	$33,569	$0.142	31	30%	554,033,736
10/1/23	10/31/23	126,719	554	$2,141	$17,064	$2,739	$371	$22,314	$0.152	31	31%	432,365,228
11/1/23	11/30/23	93,699	420	$1,583	$13,957	$2,081	$371	$17,991	$0.166	30	31%	319,700,988
12/1/23	12/31/23	119,724	368	$2,023	$16,449	$1,826	$371	$20,668	$0.154	31	44%	408,498,288
1/1/24	1/31/24	128,495	257	$2,076	$17,753	$1,773	$371	$21,973	$0.154	31	67%	438,424,940
2/1/24	2/29/24	61,563	388	$1,040	$11,522	$1,925	$371	$14,859	$0.204	29	23%	210,052,956
3/1/24	4/2/24	40,820	292	$715	$9,302	$1,447	$371	$11,834	$0.245	33	18%	139,277,840
4/3/24	5/1/24	38,939	497	$710	$9,661	$2,465	$371	$13,207	$0.266	29	11%	132,859,868
TOTALS		1266117	718	$22,591	$174,059	$54,109	$4,450	$255,209	$0.155	367	20%	4,319,991,204

Gloucester High School							ELECTRIC METER #2					
Provider:	PSEG&G				Account #	7392643908				Meter #	16440869	
Commodity:					Account #					Meter #		
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
5/3/23	6/1/23	231	2	$6	$28	$11	$5	$49	0.145	30	14%	788,172
6/2/23	6/30/23	118	1	$3	$20	$17	$5	$44	0.188	29	15%	402,616
7/1/23	8/1/23	97	1	$2	$18	$9	$5	$34	0.209	32	21%	330,964
8/2/23	8/30/23	2,143	4	$46	$168	$66	$5	$285	0.100	29	72%	7,311,916
8/31/23	9/29/23	79	1	$2	$16	$14	$5	$37	0.227	30	12%	269,548
9/30/23	10/30/23	401	4	$10	$37	$23	$5	$75	0.117	31	13%	1,368,212
10/31/23	11/30/23	347	1	$9	$33	$6	$5	$53	0.121	31	39%	1,183,964
12/1/23	1/2/24	383	1	$9	$38	$6	$5	$59	0.124	33	40%	1,306,796
1/3/24	1/31/24	379	1	$9	$54	$6	$5	$75	0.166	29	45%	1,293,148
2/1/24	3/1/24	759	3	$19	$80	$14	$5	$117	0.130	30	41%	2,589,708
3/2/24	4/2/24	32	4	$1	$31	$19	$5	$55	0.987	32	1%	109,184
4/3/24	5/1/24	323	3	$9	$56	$18	$5	$87	0.200	29	14%	1,102,076
TOTALS		5292	4	$123	$579	$209	$61	$971	$0.133	365	14%	18,056,304



Gloucester High School						Natural Gas Meter #1		
Provider	PSE&G		Account #	73 926 441 06			Meter #	3164366
Commodity	Direct Energy		Account #				Meter #	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
5/3/23	6/1/23	808	$76	$484	$177	$737	$0.69	80,785,800
6/2/23	6/30/23	201	$14	$121	$180	$315	$0.67	20,063,400
7/1/23	8/2/23	91	$6	$58	$180	$244	$0.71	9,140,900
8/3/23	8/30/23	118	$7	$74	$180	$261	$0.69	11,772,600
8/31/23	10/2/23	488	$30	$310	$180	$520	$0.70	48,788,200
10/3/23	10/30/23	1,347	$204	$877	$180	$1,261	$0.80	134,690,700
10/31/23	11/30/23	4,309	$1,845	$2,940	$180	$4,965	$1.11	430,897,500
12/1/23	1/2/24	5,754	$1,903	$3,440	$180	$5,523	$0.93	575,449,500
1/3/24	1/31/23	8,105	$2,463	$4,811	$180	$7,454	$0.90	810,516,400
2/1/23	3/1/24	5,595	$2,012	$3,274	$180	$5,465	$0.94	559,537,600
3/2/24	4/2/24	4,083	$1,772	$2,187	$180	$4,139	$0.97	408,293,300
4/3/24	5/1/24	1,034	$168	$487	$180	$835	$0.63	103,372,400
TOTALS		31,933	$10,502	$19,065	$2,153	$29,566	$0.93	3,193,308,300

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Gloucester High School						Natural Gas Meter #2		
Provider	PSE&G		Account #	73 926 441 06			Meter #	3275105
Commodity	Direct Energy		Account #				Meter #	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
5/3/23	5/2/23	1086	$140	$651	$177	$969	$0.73	108,562,900
5/3/23	6/30/23	521	$37	$315	$180	$532	$0.67	52,142,700
7/1/23	8/2/23	276	$19	$176	$180	$375	$0.71	27,643,000
8/3/23	8/30/23	340	$21	$214	$180	$415	$0.69	33,997,600
8/31/23	10/2/23	654	$41	$415	$180	$636	$0.70	65,418,100
10/3/23	10/30/23	1601	$230	$1,043	$180	$1,453	$0.80	160,131,100
10/31/23	11/30/23	7043	$2,900	$4,806	$180	$7,885	$1.09	704,332,500
12/1/23	1/2/24	8768	$2,991	$5,242	$180	$8,413	$0.94	876,801,800
1/3/24	1/31/24	10980	$3,403	$6,516	$180	$10,099	$0.90	1,097,958,400
2/1/24	3/1/24	9365	$3,113	$5,479	$180	$8,772	$0.92	936,542,700
3/2/24	4/2/24	6593	$2,666	$3,531	$180	$6,377	$0.94	659,261,500
4/3/24	5/1/24	3573	$656	$1,683	$180	$2,518	$0.65	357,325,700
TOTALS		50801	$16,216	$30,073	$2,153	$48,443	$0.91	5,080,118,000

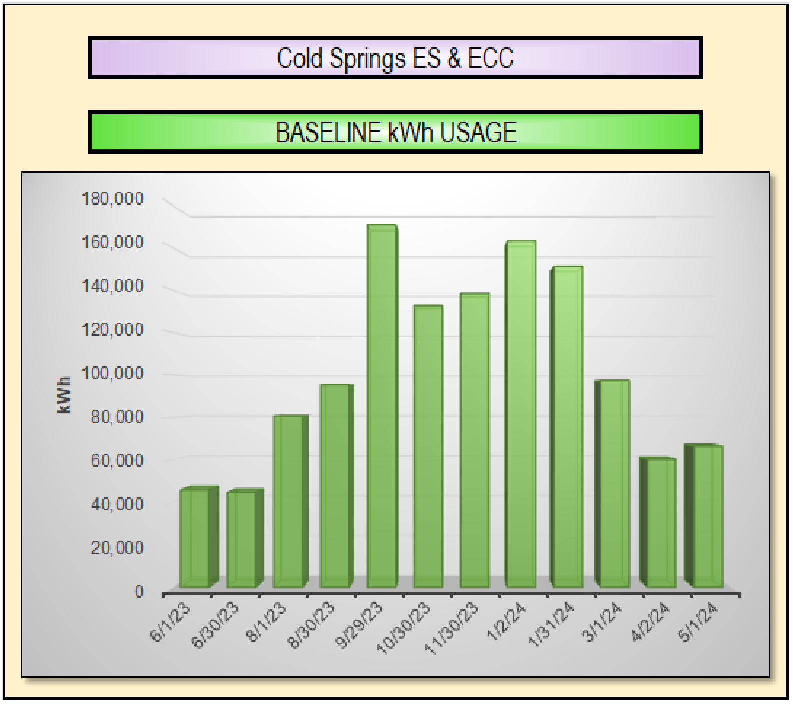
Gloucester High School								
Provider	PSE&G		Account #	73 926 439 08			Meter #	2472397
Commodity	Direct Energy		Account #				Meter #	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
5/3/23	6/1/23	1	$0	$1	$20	$1	$1.00	100,000
6/2/23	6/30/23	1	$0	$1	$20	$1	$1.00	100,000
7/1/23	8/1/23	1	$0	$1	$20	$1	$0.98	104,300
8/2/23	8/30/23	1	$0	$1	$20	$1	$0.98	104,300
8/31/23	9/29/23	1	$0	$1	$20	$1	$0.98	104,300
9/30/23	10/30/23	1	$0	$1	$20	$1	$1.00	104,300
10/31/23	11/30/23	1	$0	$1	$20	$1	$1.00	104,500
12/1/23	1/2/24	1	$0	$1	$20	$1	$1.00	104,500
1/3/24	1/30/24	1	$0	$1	$20	$1	$1.01	104,700
1/31/24	2/29/24	1	$0	$1	$20	$1	$0.95	104,700
3/1/24	4/1/24	0	$0	$0	$20	$0	$0.00	0
4/2/24	4/30/24	0	$0	$0	$20	$0	$0.00	0
TOTALS		10	$4	$6	$242	$10	$0.99	1,035,600

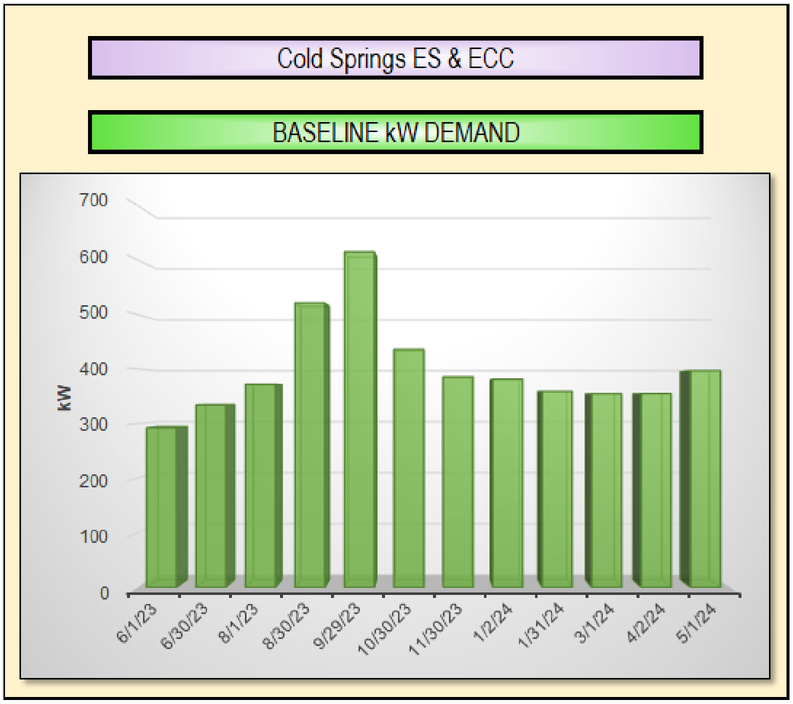
Gloucester High School					
Provider	Gloucester City Solar		Solar PPA (kWh)		
Meter/Acct #	38 2707 815				
Billing Period Start Date	Actual Reading	kWh	$$	Cost / Unit Checksum	BTU
5/1/23	5/31/23	158,668	$14,277	$0.090	541,374,287
6/1/23	6/30/23	132,898	$11,961	$0.090	453,447,843
7/1/23	7/31/23	148,613	$13,375	$0.090	507,069,039
8/1/23	8/31/23	129,593	$11,663	$0.090	442,171,346
9/1/23	9/30/23	108,111	$9,730	$0.090	368,873,347
10/1/23	10/31/23	94,938	$8,544	$0.090	323,926,919
11/1/23	11/30/23	73,141	$6,583	$0.090	249,556,984
12/1/23	12/31/23	44,878	$4,039	$0.090	153,124,491
1/1/24	1/31/24	32,761	$3,192	$0.097	111,782,070
2/1/24	2/29/24	82,177	$8,006	$0.097	280,386,794
3/1/24	3/31/24	117,528	$11,450	$0.097	401,003,830
4/1/24	4/30/204	129,587	$12,624	$0.097	442,149,138
TOTALS		1,252,892	$115,444	$0.0921	4,274,866,088

Gloucester High School							
Provider	Gloucester City				Water & Sewer (kGal)		
Acct #	32098-0 / 1910-0						
Billing Period Start Date	Actual Reading	kGal	Water/Sewer Usage Charges	Fixed Charges	$$	Cost / Unit Checksum	BTU
4/5/23	6/20/23	250	$2,217	$1,310	$3,527	$14.12	0
6/21/23	10/19/23	340	$3,525	$1,310	$4,835	$14.24	0
10/20/23	1/11/24	285	$2,660	$1,310	$3,970	$13.93	0
1/12/24	4/3/24	176	$1,281	$1,310	$2,591	$14.73	0
TOTALS		1,050	$9,683	$5,240	$14,923	$14.21	0

Gloucester High School							
Provider	Gloucester City				Water & Sewer (kGal)		
Acct #	160-0 / 42716-0						
Billing Period Start Date	Actual Reading	kGal	Water/Sewer Usage Charges	Fixed Charges	$$	Cost / Unit Checksum	BTU
4/5/23	6/20/23	11	$0.00	$902	$902	$79.12	0
6/21/23	10/19/23	11	$0.00	$902	$902	$79.12	0
10/20/23	1/11/24	12	$0.00	$902	$902	$75.17	0
1/12/24	4/3/24	14	$0.00	$902	$902	$63.08	0
TOTALS		49	$0	$3,608	$3,608	$73.48	0

Cold Springs ES & ECC Baseline Energy Use

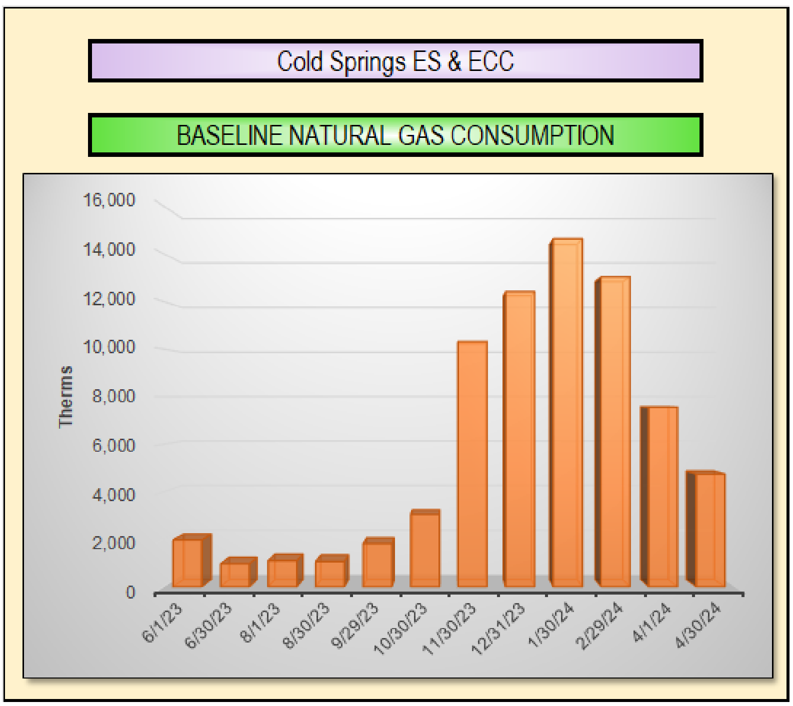




Cold Springs ES & ECC							ELECTRIC METER #1					
Provider:	PSE&G			Account #	4200480018				Meter #	9219951		
Commodity:				Rate					Meter #			
Billing Period Start Date	Actual Reading	Usage kWh	Demand kW	Electric Delivery Charges	Electric Commodity Charges	Electric Demand Charges	Fixed Customer Charges	Total Electric Charges	Cost / kWh Checksum	Days	Load Factor	BTU
5/3/23	6/1/23	44,627	293	$738	$2,628	$1,320	$371	$5,057	$0.075	30	21%	152,267,324
6/2/23	6/30/23	43,538	334	$818	$3,732	$4,707	$371	$9,628	$0.105	29	19%	148,551,656
7/1/23	8/1/23	79,283	372	$1,492	$6,502	$5,238	$371	$13,603	$0.101	32	28%	270,513,596
8/2/23	8/30/23	94,030	521	$1,789	$10,767	$7,341	$371	$20,268	$0.134	29	26%	320,830,360
8/31/23	9/29/23	168,876	615	$3,213	$14,818	$8,664	$371	$27,066	$0.107	30	38%	576,204,912
9/30/23	10/30/23	130,890	436	$2,221	$11,484	$2,157	$371	$16,233	$0.105	31	40%	446,596,680
10/31/23	11/30/23	136,059	386	$2,299	$11,938	$1,913	$371	$16,520	$0.105	31	47%	464,233,308
12/1/23	1/2/24	160,906	382	$2,719	$14,370	$1,893	$371	$19,352	$0.106	33	53%	549,011,272
1/3/24	1/31/24	148,965	359	$2,517	$13,427	$1,781	$371	$18,096	$0.107	29	60%	508,268,580
2/1/24	3/1/24	95,407	355	$1,613	$9,596	$1,760	$371	$13,339	$0.117	30	37%	325,528,684
3/2/24	4/2/24	58,607	355	$1,420	$9,473	$1,556	$371	$12,819	$0.186	32	22%	199,967,084
4/3/24	5/1/24	65,029	395	$1,186	$8,781	$1,960	$371	$12,299	$0.153	29	24%	221,878,948
TOTALS		1226217	615	$22,024	$117,517	$40,290	$4,450	$184,281	$0.114	365	23%	4,183,852,404

Cold Springs ES & ECC							ELECTRIC METER #2					
Provider:	PSE&G				Account #	7392644408			Meter #	ST Lighting		
Commodity:					Account #				Meter #			
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
5/5/23	6/5/23	1,390	0	$35	$90	$0	$189	$315	0.090	32	$0.00	4,742,680
6/6/23	7/5/23	1,233	0	$34	$82	$0	$189	$305	0.094	30	$0.00	4,206,996
7/6/23	8/3/23	1,240	0	$34	$83	$0	$189	$306	0.094	29	$0.00	4,230,880
8/4/23	9/1/23	1,366	0	$37	$91	$0	$189	$317	0.094	29	$0.00	4,660,792
9/2/23	10/3/23	1,723	0	$47	$100	$0	$189	$336	0.085	32	$0.00	5,878,876
10/4/23	11/1/23	1,737	0	$44	$101	$0	$189	$334	0.083	29	$0.00	5,926,644
11/2/23	12/4/23	2,170	0	$55	$127	$0	$189	$371	0.084	33	$0.00	7,404,040
12/5/23	1/4/24	2,119	0	$53	$130	$0	$189	$373	0.086	31	$0.00	7,230,028
1/5/24	2/2/24	1,940	0	$49	$119	$0	$189	$357	0.086	29	$0.00	6,619,280
2/3/24	3/5/24	1,958	0	$49	$123	$0	$189	$361	0.088	32	$0.00	6,680,696
3/6/24	4/4/24	1,651	0	$42	$120	$0	$189	$351	0.098	30	$0.00	5,633,212
4/5/24	5/3/24	1,412	0	$37	$110	$0	$189	$335	0.104	29	$0.00	4,817,744
TOTALS		19939	0	$515	$1,275	$0	$2,271	$4,061	0.090	365	$0.00	68,031,868

Cold Springs ES & ECC						ELECTRIC METER #3						
Provider:				Account #	7392644009				Meter #	Sign		
Commodity:				Account #					Meter #			
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
5/3/23	5/31/23	10	0	$0	$2	$3	$5	$11	$0.28	29	7%	32,414
6/1/23	6/30/23	14	0	$0	$3	$3	$5	$11	$0.21	30	10%	47,768
7/1/23	8/2/23	16	0	$0	$3	$0	$5	$8	$0.20	33	$0.00	54,592
8/3/23	8/31/23	14	0	$0	$3	$3	$5	$11	$0.22	29	10%	47,768
9/1/23	10/2/23	16	0	$0	$3	$0	$5	$8	$0.19	32	$0.00	54,592
10/3/23	10/30/23	14	0	$0	$3	$0	$5	$8	$0.21	28	$0.00	47,768
10/31/23	11/30/23	2	0	$0	$2	$0	$5	$7	$0.93	31	$0.00	6,824
12/1/23	1/2/24	2	0	$0	$2	$0	$5	$7	$0.93	33	$0.00	6,824
1/3/24	1/31/24	2	0	$0	$2	$0	$5	$7	$0.95	29	$0.00	6,824
2/1/24	3/1/24	3	0	$0	$2	$0	$5	$7	$0.67	30	$0.00	10,236
3/2/24	4/2/24	3	0	$0	$2	$1	$5	$8	$0.71	32	2%	10,236
4/3/24	5/1/24	5	2	$0	$2	$9	$5	$17	$0.48	29	0%	17,060
TOTALS		101	2	$2	$28	$19	$61	$110	$0.30	365	1%	342,906



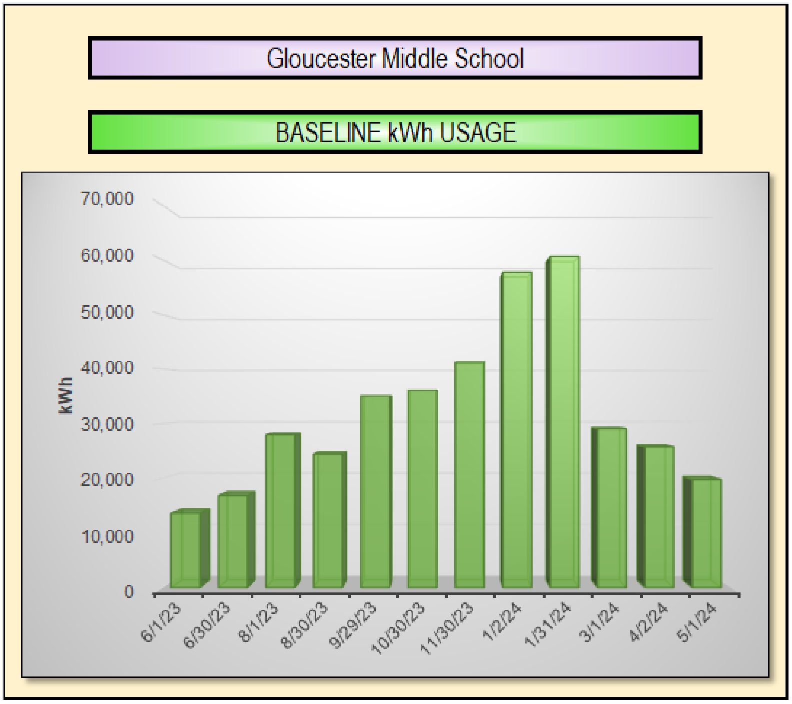
Cold Springs ES & ECC						Natural Gas Meter #1		
Provider		Account #	4200480018				Meter #	3861863
Commodity		Account #					Meter #	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
5/3/23	6/1/23	1,981	$296	$1,188	$177	$1,661	$0.75	198,091,300
6/2/23	6/30/23	981	$69	$593	$180	$842	$0.67	98,112,000
7/1/23	8/1/23	1,112	$80	$710	$180	$969	$0.71	111,232,700
8/2/23	8/30/23	1,078	$68	$679	$180	$926	$0.69	107,824,100
8/31/23	9/29/23	1,828	$128	$1,159	$180	$1,467	$0.70	182,818,200
9/30/23	10/30/23	3,051	$405	$1,985	$180	$2,570	$0.78	305,064,000
10/31/23	11/30/23	10,306	$3,267	$7,032	$180	$10,479	$1.00	1,030,622,900
12/1/23	12/31/23	12,403	$3,833	$7,415	$180	$11,428	$0.91	1,240,278,500
1/1/24	1/30/24	14,638	$4,942	$8,688	$180	$13,809	$0.93	1,463,797,200
1/31/24	2/29/24	13,024	$4,642	$7,643	$180	$12,465	$0.94	1,302,381,500
3/1/24	4/1/24	7,551	$3,712	$4,061	$180	$7,953	$1.03	755,115,900
4/2/24	4/30/24	4,743	$813	$2,234	$180	$3,226	$0.64	474,296,800
TOTALS		72,696	$22,256	$43,387	$2,153	$65,643	$0.90	7,269,635,100

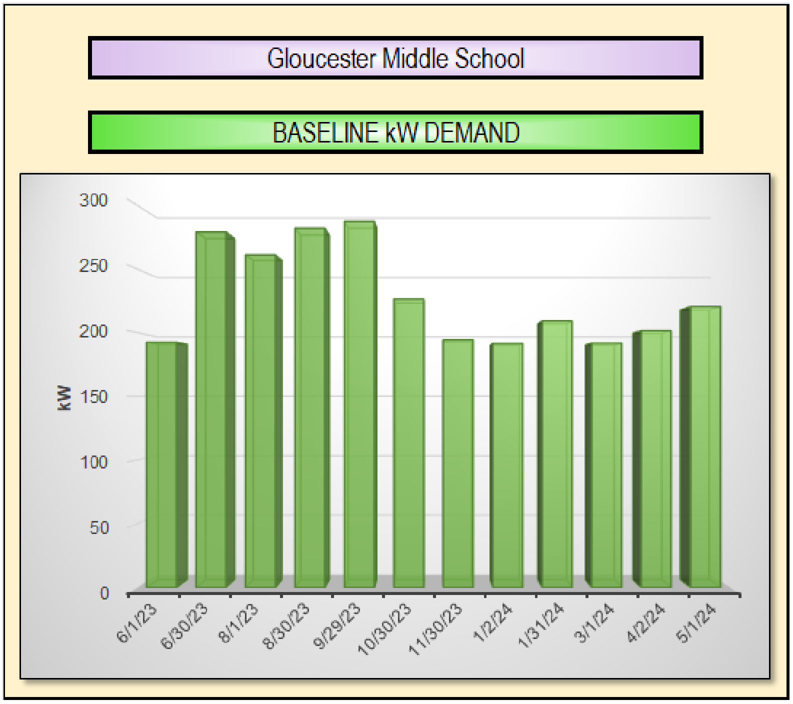
Cold Springs ES & ECC					
Provider	Gloucester City Solar		Solar PPA (kWh)		
Meter/Acct #	38 2707 815				
Billing Period Start Date	Actual Reading	kWh	$$	Cost / Unit Checksum	BTU
5/1/23	5/31/23	163,146	$14,680	$0.0900	556,655,013
6/1/23	6/30/23	136,649	$12,298	$0.0900	466,246,774
7/1/23	7/31/23	152,808	$13,753	$0.0900	521,381,472
8/1/23	8/31/23	133,251	$11,993	$0.0900	454,651,989
9/1/23	9/30/23	111,162	$10,005	$0.0900	379,285,095
10/1/23	10/31/23	97,617	$8,786	$0.0900	333,070,017
11/1/23	11/30/23	75,205	$6,768	$0.0900	256,600,931
12/1/23	12/31/23	46,145	$4,153	$0.0900	157,446,553
1/1/24	1/31/24	33,686	$3,282	$0.0974	114,937,210
2/1/24	2/29/24	84,496	$8,232	$0.0974	288,300,937
3/1/24	3/31/24	96,817	$9,432	$0.0974	330,339,604
4/1/24	4/30/24	111,813	$10,893	$0.0974	381,504,250
TOTALS		1,242,796	$114,273	$0.0919	4,240,419,844

Cold Springs ES & ECC							
Provider	Gloucester City				Water & Sewer (kGal)		
Acct #	32115-0 / 42233-0						
Billing Period Start Date	Actual Reading	kGal	Water/Sewer Usage Charges	Fixed Charges	$$	Cost / Unit Checksum	BTU
4/5/23	6/20/23	30	$0	$1,010	$1,010	$33.67	0
6/21/23	10/19/23	30	$0	$1,010	$1,010	$33.67	0
10/20/23	1/11/24	30	$0	$1,010	$1,010	$33.67	0
1/12/24	4/3/24	30	$0	$1,010	$1,010	$33.67	0
TOTALS		120	$0	$4,040	$4,040	$33.67	0

Cold Springs ES & ECC							
Provider	Gloucester City				Water & Sewer (kGal)		
Acct #	32108-0						
Billing Period Start Date	Actual Reading	0	Water/Sewer Usage Charges	Fixed Charges	$$	Cost / Unit Checksum	BTU
4/5/23	6/20/23	574	$6,316	$1,130	$7,446	$12.97	0
6/21/23	10/19/23	529	$5,746	$1,130	$6,876	$13.00	0
10/20/23	1/11/24	0	$0	$1,130	$1,130	$0.00	0
1/12/24	4/3/24	265	$2,407	$1,130	$3,537	$13.35	0
TOTALS		1,368	14,469	4,520	$18,989	$13.88	0

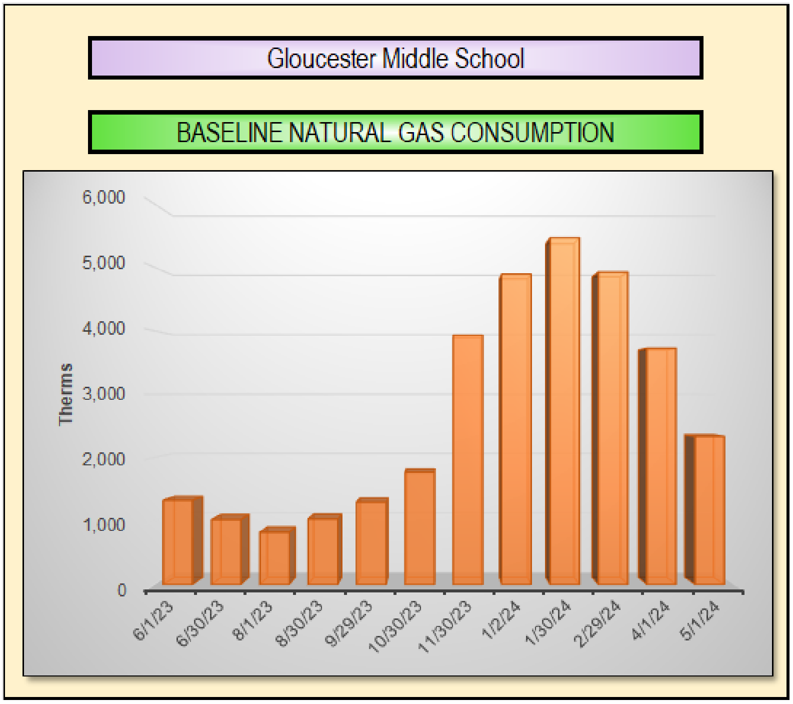
Gloucester MS Baseline Energy Use





Gloucester Middle School						ELECTRIC METER #1						
Provider:	PSE&G			Account #	4244300007				Meter #	9221117		
Commodity:				Account #					Meter #			
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
5/3/23	6/1/23	13,612	192	$226	$1,162	$868	$371	$2,626	$0.102	30	10%	46,444,144
6/2/23	6/30/23	16,900	279	$318	$1,162	$3,931	$371	$5,781	$0.088	29	9%	57,662,800
7/1/23	8/1/23	27,985	261	$527	$1,878	$3,746	$371	$6,521	$0.086	32	14%	95,484,820
8/2/23	8/30/23	24,374	273	$464	$1,644	$3,699	$371	$6,178	$0.086	29	13%	83,164,088
8/31/23	9/29/23	35,100	267	$668	$2,193	$3,761	$371	$6,993	$0.081	30	18%	119,761,200
9/30/23	10/30/23	36,090	219	$611	$2,286	$1,081	$371	$4,348	$0.080	31	22%	123,139,080
10/31/23	11/30/23	41,289	187	$698	$2,687	$929	$371	$4,685	$0.082	31	30%	140,878,068
12/1/23	1/2/24	57,654	185	$974	$3,999	$916	$371	$6,260	$0.086	33	39%	196,715,448
1/3/24	1/31/24	60,558	204	$1,023	$5,449	$1,012	$371	$7,855	$0.107	29	43%	206,623,896
2/1/24	3/1/24	29,107	185	$492	$3,172	$917	$371	$4,952	$0.126	30	22%	99,313,084
3/2/24	4/2/24	25,801	197	$455	$3,232	$979	$371	$5,036	$0.143	32	17%	88,033,012
4/3/24	5/1/24	19,807	214	$361	$2,983	$1,062	$371	$4,777	$0.169	29	13%	67,581,484
TOTALS		388277	279	$6,816	$31,847	$22,901	$4,450	$66,013	$0.100	365	16%	1,324,801,124

Gloucester Middle School							ELECTRIC METER #2					
Provider:	PSE&G				Account #	7320781905			Meter #	Fire Pump		
Commodity:					Account #				Meter #			
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
5/3/23	6/1/23	0	0	$0	$56	$0	$5	$61	$0.00	30	$0.00	0
6/2/23	6/30/23	0	0	$0	$56	$0	$5	$61	$0.00	29	$0.00	0
7/1/23	8/1/23	0	0	$0	$56	$0	$5	$61	$0.00	32	$0.00	0
8/2/23	8/30/23	40	8	$1	$59	$129	$5	$193	1.49	29	1%	136,480
8/31/23	9/29/23	0	20	$0	$56	$313	$5	$374	$0.00	30	0%	0
9/30/23	10/30/23	0	8	$0	$56	$40	$5	$101	$0.00	31	0%	0
10/31/23	11/30/23	0	7	$4	$59	$36	$5	$105	$0.00	31	0%	0
12/1/23	1/2/24	0	7	$4	$59	$36	$5	$105	$0.00	33	0%	0
1/3/24	1/31/24	0	5	$0	$117	$28	$5	$150	$0.00	29	0%	0
2/1/24	3/1/24	0	7	$0	$117	$36	$5	$158	$0.00	30	0%	0
3/2/24	4/2/24	0	4	$0	$118	$21	$5	$144	$0.00	32	0%	0
4/3/24	5/1/24	0	6	$1	$131	$34	$5	$171	$0.00	29	0%	0
TOTALS		40	20	$10	$940	$674	$61	$1,684	$42.1	365	0%	136,480



Gloucester Middle School						Natural Gas Meter #1		
Provider			Account #	4244300007			Meter #	3882453
Commodity			Account #				Meter #	
Billing Period Start Date	Actual Reading	Therms	Gas Delivery Charges	Gas Commodity Charges	Fixed Customer Charge	Gas Total Charges	Cost/Therm Checksum	BTU
5/3/23	6/1/23	1,328	$98	$797	$177	$1,071	$0.67	132,798,600
6/2/23	6/30/23	1,025	$72	$620	$180	$872	$0.68	102,521,600
7/1/23	8/1/23	826	$58	$527	$180	$764	$0.71	82,598,600
8/2/23	8/30/23	1,034	$65	$651	$180	$895	$0.69	103,423,100
8/31/23	9/29/23	1,300	$86	$824	$180	$1,090	$0.70	129,955,100
9/30/23	10/30/23	1,773	$195	$1,154	$180	$1,529	$0.76	177,311,600
10/31/23	11/30/23	3,928	$1,893	$2,680	$180	$4,753	$1.16	392,828,400
12/1/23	1/2/24	4,888	$1,678	$2,923	$180	$4,780	$0.94	488,828,600
1/3/24	1/30/24	5,462	$1,795	$3,242	$180	$5,217	$0.92	546,160,000
1/31/24	2/29/24	4,920	$1,675	$2,887	$180	$4,742	$0.93	491,986,200
3/1/24	4/1/24	3,726	$1,484	$2,004	$180	$3,667	$0.94	372,582,800
4/2/24	5/1/24	2,333	$350	$1,099	$180	$1,628	$0.62	233,278,900
TOTALS		32,543	$9,448	$19,407	$2,153	$28,854	$0.89	3,254,273,500

Gloucester Middle School					
Provider	Gloucester City Solar		Solar PPA (kWh)		
Meter/Acct #	38 2707 815				
Billing Period Start Date	Actual Reading	0	$$	Cost / Unit Checksum	BTU
5/1/23	5/31/23	99,167	$8,923	$0.0900	338,358,929
6/1/23	6/30/23	83,061	$7,475	$0.0900	283,404,902
7/1/23	7/31/23	92,883	$8,360	$0.0900	316,918,149
8/1/23	8/31/23	80,996	$7,290	$0.0900	276,357,091
9/1/23	9/30/23	67,569	$6,081	$0.0900	230,545,842
10/1/23	10/31/23	59,336	$5,340	$0.0900	202,454,324
11/1/23	11/30/23	45,713	$4,114	$0.0900	155,973,115
12/1/23	12/31/23	28,049	$2,524	$0.0900	95,702,807
1/1/24	1/31/24	20,476	$1,995	$0.0974	69,863,794
2/1/24	2/29/24	51,360	$5,004	$0.0974	175,241,746
3/1/24	3/31/24	62,600	$6,098	$0.0974	213,590,347
4/1/24	4/30/204	60,687	$5,912	$0.0974	207,063,191
TOTALS		751,897	$69,117	$0.0919	2,565,474,238

Gloucester Middle School							
Provider	Gloucester City				Water & Sewer (kGal)		
Acct #	6725-0						
Billing Period Start Date	Actual Reading	kGal	Water/Sewer Usage Charges	Fixed Charges	$$	Cost / Unit Checksum	BTU
4/5/23	6/20/23	184	$982	$1,130	$2,112	$11.51	0
6/21/23	10/19/23	225	$1,648	$1,130	$2,778	$12.34	0
10/20/23	1/11/24	177	$1,294	$1,130	$2,424	$13.72	0
1/12/24	4/3/24	398	$4,089	$1,130	$5,219	$13.11	0
TOTALS		983	$8,012	$4,520	$12,532	$12.74	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	OTHER ENERGY #2	OTHER ENERGY #3
	$$ / kW	$$ / kWh	Blended $$ / kWh	Therms	Solar PPA (kWh)	Water & Sewer (kGal)
Gloucester High School	$9.12	$0.155	$0.201	$0.92	$0.092	$8.81
Cold Springs ES & ECC	$8.39	$0.113	$0.151	$0.90	$0.092	$9.72
Gloucester Middle School	$8.62	$0.102	$0.174	$0.89	$0.092	$8.15

ENERGY SAVINGS PLAN

SECTION 3 – ENERGY CONSERVATION MEASURES

Energy Conservation Measure Breakdown by Building

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

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
1	LED Lighting Upgrades	✔ (included)	✔ (included)	✔ (included)
2	Lighting Controls	✔ (included)	✔ (included)	
3	Energy Management System Upgrades	✔ (included)	✔ (included)	✔ (included)
4	Boiler Replacement	✔		
5	Chiller Replacement	✔	✔ (included)	
6	Premium Efficiency Pump Motors and VFDs	✔ (included)		
7	Rooftop Unit Replacement	✔ (included)		
8	Split System Replacement	✔		
9	Pipe and Valve Insulation	✔ (included)	✔ (included)	✔ (included)
10	Ductwork Insulation			✔
11	Water Conservation	✔ (included)	✔ (included)	✔ (included)
12	Building Envelope Weatherization	✔ (included)	✔ (included)	✔ (included)
13	Plug Load Controls	✔ (included)	✔ (included)	✔ (included)
14	eTemp Refrigeration Sensors	✔ (included)	✔ (included)	✔ (included)
15	Retro-Commissioning	✔ (included)	✔ (included)	✔ (included)
16	Combined Heating & Power	✔ (included)		
17	Destratifcation Fans	✔	✔	✔
18	Window Film	✔ (included)		✔ (included)
19	Softball Field Lighting	✔		

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ECM Breakdown by Cost & Savings

GLOUCESTER CITY SCHOOL DISTRICT		INSTALLED COST	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS	ANNUAL kGallons COST SAVINGS	ANNUAL ENERGY COST SAVINGS	ANNUAL O&M COST SAVINGS	TOTAL ANNUAL COST SAVINGS
ECM #	ENERGY CONSERVATION MEASURE	$	$	$	$	$	$	$
1	LED Lighting Upgrades	$1,402,746	$157,994	($1,789)	$0	$156,205	$26,927	$183,133
2	Lighting Controls	$47,067	$3,494	($39)	$0	$3,455	$0	$3,455
3	Energy Management System Upgrades	$432,500	$36,519	$13,133	$0	$49,651	$7,868	$57,519
5	Chiller Replacement	$675,195	$13,827	$0	$0	$13,827	$4,984	$18,811
6	Premium Efficiency Pump Motors and VFDs	$191,061	$16,787	$0	$0	$16,787	$0	$16,787
7	Rooftop Unit Replacement	$2,184,975	$32,443	$4,320	$0	$36,763	$8,749	$45,511
9	Pipe and Valve Insulation	$44,179	$0	$4,740	$0	$4,740	$0	$4,740
11	Water Conservation	$33,912	$0	$4,962	$2,103	$7,065	$0	$7,065
12	Building Envelope Weatherization	$229,103	$6,561	$10,304	$0	$16,866	$0	$16,866
13	Plug Load Controls	$37,493	$3,087	$0	$0	$3,087	$0	$3,087
14	eTemp Refrigeration Sensors	$29,500	$5,306	$0	$0	$5,306	$0	$5,306
15	Retro-Commissioning	$129,000	$12,296	$8,092	$0	$20,388	$0	$20,388
16	Combined Heating & Power	$210,600	$3,846	($1,039)	$0	$2,807	$0	$2,807
18	Window Film	$122,074	$25,519	($2,797)	$0	$22,722	$0	$22,722
TOTALS		$5,769,405	$317,678	$39,887	$2,103	$359,668	$48,528	$408,196

GLOUCESTER CITY SCHOOL DISTRICT		SIMPLE PAYBACK WITHOUT INCENTIVES	ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	NATURAL GAS SAVINGS	kGallons SAVINGS	TOTAL SITE ENERGY SAVINGS	TOTAL SOURCE ENERGY SAVINGS
ECM #	ENERGY CONSERVATION MEASURE	YEARS	kWh	kW	THERMS	kGallons	MMBTU	MMBTU
1	LED Lighting Upgrades	7.7	1,059,277	241	(1,982)	0	3,416	9,912
2	Lighting Controls	13.6	20,417	5	(43)	0	65	191
3	Energy Management System Upgrades	7.5	227,128	52	14,419	0	2,217	3,684
5	Chiller Replacement	35.9	48,574	83	0	0	166	464
6	Premium Efficiency Pump Motors and VFDs	11.4	99,923	12	0	0	341	955
7	Rooftop Unit Replacement	48.0	175,051	48	4,711	0	1,068	2,167
9	Pipe and Valve Insulation	9.3	0	0	5,239	0	524	550
11	Water Conservation	4.8	0	0	5,474	233	547	575
12	Building Envelope Weatherization	13.6	27,151	25	11,327	0	1,225	1,449
13	Plug Load Controls	12.1	26,721	0	0	0	91	255
14	eTemp Refrigeration Sensors	5.6	43,953	0	0	0	150	420
15	Retro-Commissioning	6.3	94,444	0	8,929	0	1,215	1,840
16	Combined Heating & Power	75.0	21,676	4	(1,133)	0	-39	88
18	Window Film	5.4	149,112	44	(3,072)	0	202	1,102
TOTALS		14.1	1,993,427	514	43,870	233	11,189	23,651

ECM Breakdown by Greenhouse Gas Reduction

GLOUCESTER CITY SCHOOL DISTRICT		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	1,345,397	861	710	0.0
2	Lighting Controls	25,879	17	14	0.0
3	Energy Management System Upgrades	462,146	321	152	0.0
5	Chiller Replacement	62,758	40	33	0.0
6	Premium Efficiency Pump Motors and VFDs	129,100	83	67	0.0
7	Rooftop Unit Replacement	281,287	189	117	0.0
9	Pipe and Valve Insulation	61,299	48	0	0.0
11	Water Conservation	64,048	50	0	0.0
12	Building Envelope Weatherization	167,607	127	18	0.0
13	Plug Load Controls	34,523	22	18	0.0
14	eTemp Refrigeration Sensors	56,787	36	29	0.0
15	Retro-Commissioning	226,494	161	63	0.0
16	Combined Heating & Power	14,748	8	15	0.0
18	Window Film	156,710	96	100	0.0
TOTALS		3,088,784	2,058	1,336	0

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

- ***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)***

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 Gloucester City School District were not available to deliver a cost estimate for each ECM. The budgetary costs carried 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.

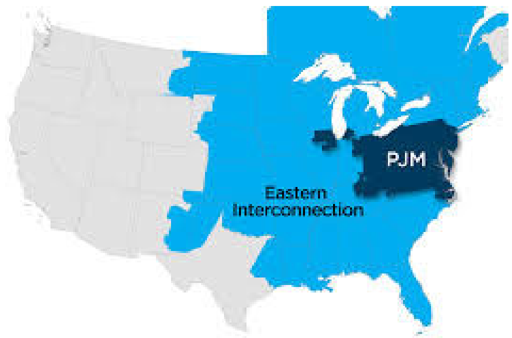
GLOUCESTER CITY SCHOOL DISTRICT		INSTALLED COST
ECM #	ENERGY CONSERVATION MEASURE	$
1	LED Lighting Upgrades	$1,402,746
2	Lighting Controls	$47,067
3	Energy Management System Upgrades	$432,500
5	Chiller Replacement	$675,195
6	Premium Efficiency Pump Motors and VFDs	$191,061
7	Rooftop Unit Replacement	$2,184,975
9	Pipe and Valve Insulation	$44,179
11	Water Conservation	$33,912
12	Building Envelope Weatherization	$229,103
13	Plug Load Controls	$37,493
14	eTemp Refrigeration Sensors	$29,500
15	Retro-Commissioning	$129,000
16	Combined Heating & Power	$210,600
18	Window Film	$122,074
TOTALS		$5,769,405

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Demand Response & Project Incentives Analysis

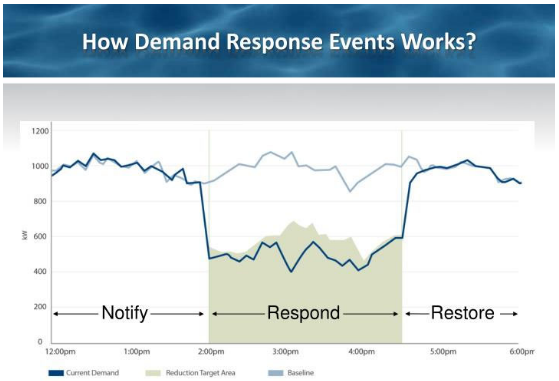
Demand Response

Demand Response (DR) is a voluntary Pennsylvania-Jersey-Maryland (PJM) Interconnection program that allows end use customers to reduce their electricity usage during periods of higher power prices. In exchange, end-use customers are compensated through PJM members known as Curtailment Service Providers (CSPs) for decreasing their electricity use when requested by PJM.



Common reduction strategies used in Demand Response include:

- Manual or automatic load drop
- Energy management systems
- Load shedding strategies
- Lighting control strategies
- Backup generation
- Ice storage systems



Benefits of the program include:

- Significant source of new revenue
- Helps to ensure local grid reliability
- Reduces the need for new environmentally taxing energy generation

In the base product, customers commit to reducing their load at the direction of PJM during emergency conditions during the summer months. In the Capacity Performance product, the customer will need to be able to reduce load when directed during the entire year.

Note: Chapter 55 of the applicable law states the ESCO must investigate all Demand Response programs. ESIP projects will only be allowed to bid into the Demand Response program for measures that did not receive utility program incentives. Demand Response is not included because of associated utility incentives for proposed measures.

Commercial & Industrial Prescriptive Rebate Program

Commercial and industrial facilities with a peak electric demand exceeding 200 kW, the Commercial & Industrial Prescriptive Rebate Program is the best option for maximum rebates and incentives. This program is offered through public utilities and provides the technical and financial means to help improve the energy efficiency of your buildings. The program is designed to take a comprehensive approach to energy savings while allowing you to earn incentives that are directly linked to equipment type and size. This Prescriptive rebate program is your best option for lighting and controls, heating, cooling and ventilation (HVAC), refrigeration, kitchen equipment, Electronically Commutated Motors (ECM), electric water heaters, plug load controls, or variable speed drive (VSD) upgrades and installations.

Prescriptive rebates are designed to cover up to 50 percent of the incremental measure cost for installing high-efficiency equipment. Applications for this rebate are filed through your electric and natural gas provider.

Commercial & Industrial Custom Rebate Program

Commercial and industrial facilities with a peak electric demand exceeding 200 kW which have energy conservation measures that are not covered by the Prescriptive Rebate Program, the Custom Rebate Program is the best option to maximize rebates and incentives. This program is offered through public utilities and is designed to cover energy conservation measures or projects which are more unique in nature. All custom projects required for pre-approval, engineering analyses demonstrating savings, and a pre-inspection to determine eligibility.

The Custom Rebate Program Incentive structure breaks down as:

Electric – $.16/kwh saved for the first year
Natural Gas – $1.60/therm saved for the first year, and buydown to 1 year payback

*As of July 1, 2021, Board-approved utility EE programs replaced certain NJCEP offerings. Subsequently, the BPU is requiring that all ESIP projects consult with the DCA and follow all DCA guidance regarding the utilization of any utility incentive program in an ESIP project.

Direct Install

Created specifically for existing small to mid-sized facilities, Direct Install is a turnkey project solution that makes it easy and affordable to upgrade to high-efficiency equipment. The program provides a free energy assessment, and a participating contractor will work with you to cut your facility's energy costs by replacing lighting, HVAC and other outdated operational equipment with energy efficient alternatives.

The DI Program is open to all eligible commercial and industrial customers whose *average* demand did not exceed 200 kW in any of the preceding twelve months, have their gas or electricity provided by one of New Jersey's Investor-Owned Utilities (IOUs), and pay into the Societal Benefits Charge (SBC).

To dramatically improve your payback on the project, the program pays up to 80% of retrofit costs to facilities within an Urban Enterprise Zone, Opportunity Zone, owned or operated by a local government, K-12 public school, or designated as affordable housing. Other types of facilities receive an incentive up to 70% of retrofit costs.

In 2019 the Direct Install program surpassed $200 million in incentives provided since its inception.

Systems and Equipment Addressed by the Program:

- Lighting & Lighting Controls
- Heating, Cooling & Ventilation (HVAC) and HVAC Controls
- Refrigeration
- Motors
- Variable Frequency Drives
- Hot Water Conservation Measures

*As of July 1, 2021, Board-approved utility EE programs replaced certain NJCEP offerings. Subsequently, the BPU is requiring that all ESIP projects consult with the DCA and follow all DCA guidance regarding the utilization of any utility incentive program in an ESIP project.

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 these 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 Gas Combustion Turbine Microturbine Fuel Cells with Heat Recovery (FCHR)	≤500 kW	$2,000	30-40%[2]	$2 million
	>500 kW - 1 MW	$1,000		
	> 1 MW - 3 MW	$550	30%	$3 million
	>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)

Incentive Calculations

Estimated incentive values were calculated in accordance with the PSEG Rebate Program Guidelines. The total incentive amount was calculated to be $262,344 in rebates and incentives. The Prescriptive Rebate program, offered by PSEG, covers a large majority of the project incentives. Special energy conservation measures, such as chiller replacements (if included), will utilize the PSEG's Custom Rebate Program. Please see below, Appendix E and Appendix F for building-by-building details. Installation incentives are carried within Form VI of the Gloucester City School District Energy Savings Plan.

Incentive Totals							
BUILDING	INCENTIVE TYPE	SOURCE	NOTES	YEAR 1 INCENTIVE	YEAR 2 INCENTIVE	SUBTOTAL	TOTAL
GLOUCESTER CITY SCHOOL DISTRICT	PRESCIPTIVE	ACE	Various Measures	$127,286	$127,286	$254,572	$262,344
	CUSTOM	ACE	Chiller Replacement	$3,886	$3,886	$7,772	

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, Gloucester City School District acknowledges and accepts that any project proposed should not rely on the receipt of incentives as a reason to implement it.

ECM 1 – LED Lighting Upgrades

GLOUCESTER CITY SCHOOL DISTRICT
ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
1	LED Lighting Upgrades	✔	✔	✔

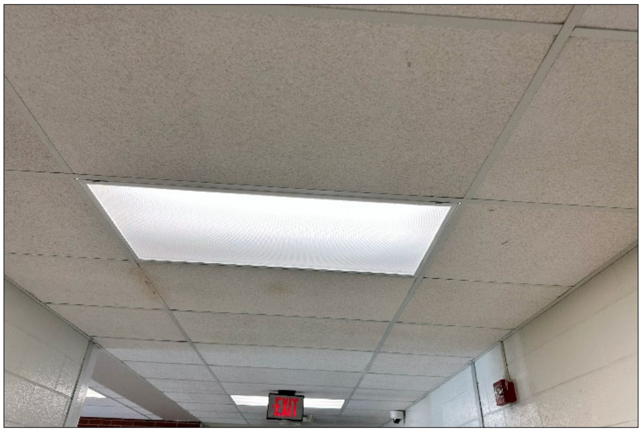
Lighting retrofits and fixture replacements can greatly reduce energy consumption and lower energy bills, while maintaining lighting levels and quality by upgrading lighting components to more efficient and advanced technologies. Upgrading technologies can also offer employees greater control over lighting,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

Retrofitting is typically the least expensive way to transform and upgrade the lighting in a facility. Many offices, government and school facilities utilize 2-to-4-foot tubes as primary lighting type. In these situations, specifying Type B LED Tubes may be most optimal because they have an internal LED driver which allows them to bypass the existing fluorescent ballast in a fixture and wire directly to line voltage. This results in added energy savings as LED T8 tubes that run on a ballast are less efficient. Initial installation takes more time as the ballast wiring needs to be cut out, but long-term, this will also result in maintenance savings as there is no need to replace ballasts.

Fixture Replacements are often the most expensive option, but are also typically the most efficient choice, making them the most cost-effective choice over the lifespan of all products. From simple dimming installations, all the way to sophisticated sensing that can provide real-time feedback on energy usage, occupancy rates, and even operational status, LED fixtures may be able to provide the solution. Fixture Replacements allow for variety and increased customization of specific light color, output, and other features.

Existing Conditions



Existing interior lighting at Gloucester MS and Gloucester HS

Existing interior lighting at Cold Springs ES & ECC

Scope of Work

Retrofit or replace existing interior and exterior fixtures with LED bulbs/fixtures as proposed in the line-by-lines in Appendix G. 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. All Gloucester City School District sites will claim rebates through PSEG's prescriptive rebate program.

ECM Calculations

BPU Protocols were used to calculate LED lighting 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.

BPU CALCULATIONS														
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)
Gloucester High School	INTERIOR	160.98	0.93	54.46	0.32	106.5	0.50	2575	0.44	0.10	-0.00023	76.7	301710.8	-630.8
	EXTERIOR	27.54	0.16	9.31	0.05	18.2	1.00	4380	0	0	0	18.2	79856.2	0.0
	SPECIAL		0.00		0.00	0.0						0.0	0	0.0
Cold Springs ES & ECC	INTERIOR	194.98	1.21	65.13	0.40	129.9	0.50	2575	0.44	0.10	-0.00023	93.5	367813	-769.1
	EXTERIOR	9.56	0.06	3.30	0.02	6.3	1.00	4380	0	0	0	6.3	27401	0.0
	SPECIAL		0.00		0.00	0.0						0.0	0	0.0
Gloucester Middle School	INTERIOR	146.63	1.20	48.35	0.40	98.3	0.50	2575	0.44	0.10	-0.00023	70.8	278396.5	-582.1
	EXTERIOR	1.44	0.01	0.50	0.00	0.9	1.00	4380	0	0	0	0.9	4099.7	0.0
	SPECIAL		0.00		0.00	0.0						0.0	0.0	0.0

BPU CALCULATIONS			
LED Lighting Upgrades	Total (Fixture) Savings		
BUILDING	Total Demand Savings (kW)	Total Energy Savings (kWh)	Total Fuel Savings (Therms)
Gloucester High School	77	381567	-631
Cold Springs ES & ECC	93	395214	-769
Gloucester Middle School	71	282496	-582

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

ECM 2 – Lighting Controls

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

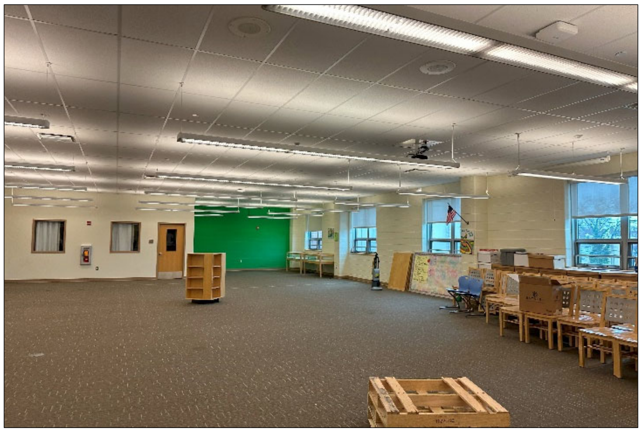
✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
2	Lighting Controls	✔	✔	

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




Existing interior lighting at Gloucester MS

Scope of Work

Add occupancy 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 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.

BPU CALCULATIONS											
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)
Gloucester High School	INTERIOR	0.50	2575	0.44	0.10	-0.00023	16.96	31%	3.8	14894.8	-31.1
	EXTERIOR	1.00	4380	0	0.00	0			0.0	0.0	0.0
	SPECIAL								0.0	0.0	0.0
Cold Springs ES & ECC	INTERIOR	0.50	2575	0.44	0.10	-0.00023	6.29	31%	1.4	5522.2	-11.5
	EXTERIOR	1.00	4380	0	0.00	0			0.0	0.0	0.0
	SPECIAL								0.0	0.0	0.0

BPU CALCULATIONS			
Lighting Control Savings	Total Savings		
BUILDING	Total Demand Savings (kW)	Total Energy Savings (kWh)	Total Fuel Savings (Therms)
Gloucester High School	3.8	14894.8	-31.1
Cold Springs ES & ECC	1.4	5522.2	-11.5

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

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

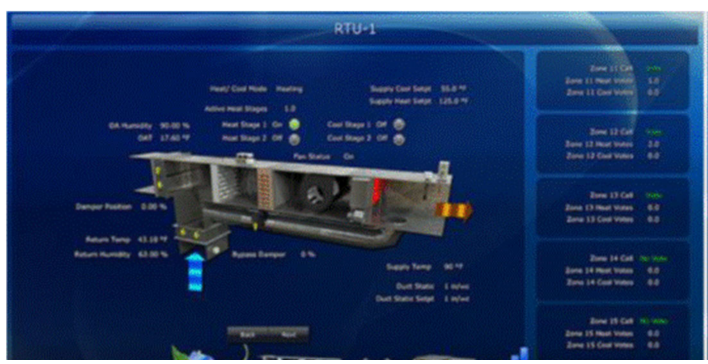
ECM 3 – Energy Management System Upgrades

GLOUCESTER CITY SCHOOL DISTRICT
ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
3	Energy Management System Upgrades	✔	✔	✔

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 Gloucester City School District with continuous monitoring & reporting.

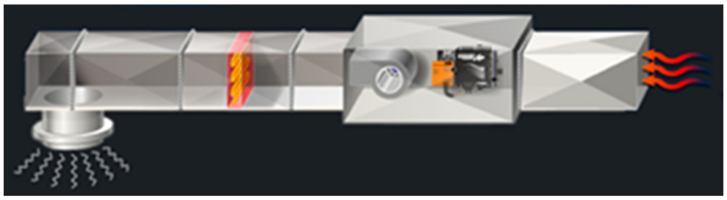


Web Based Building Automation Interface

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 these 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.

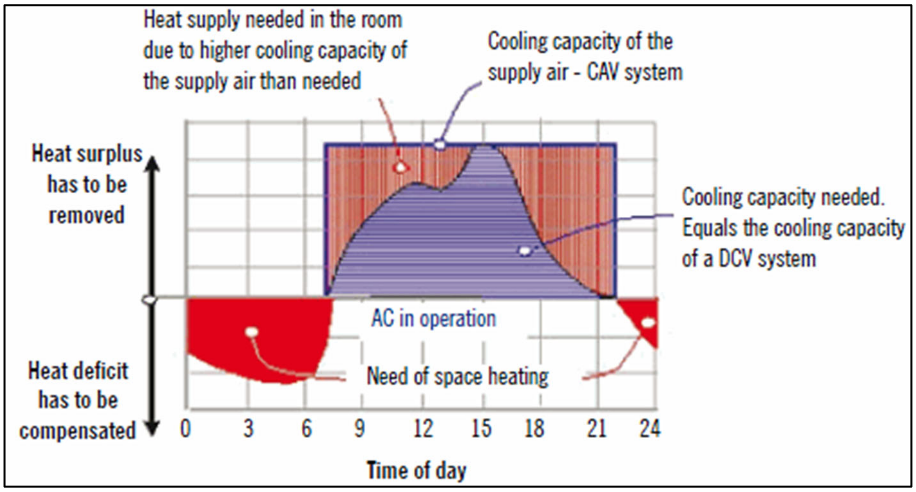
The upgraded District Wide EMS will integrate existing proprietary systems with new Open Protocol DDC Controls. Control strategies will be designed and programmed into the system to maintain building comfort while operating the building mechanical system in the most efficient manner possible. Strategies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

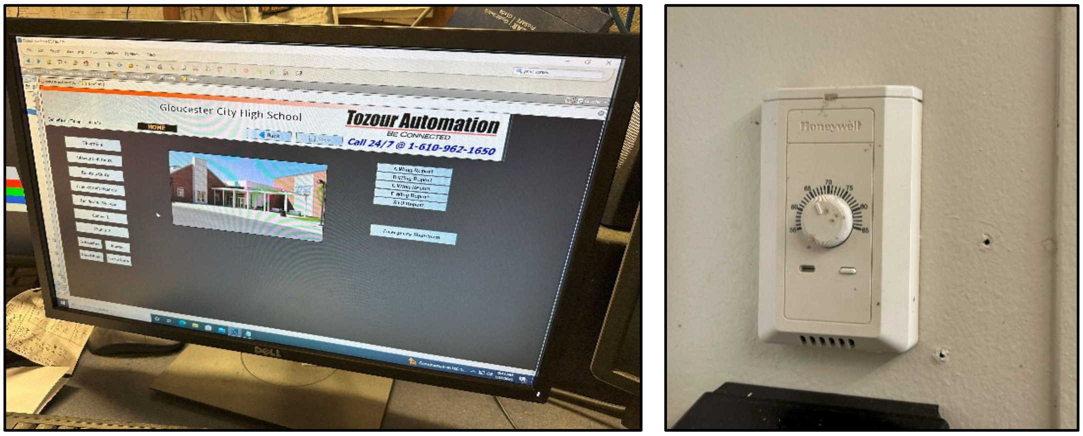
Demand Control Ventilation Operation
The objective of a CO2 control strategy is to modulate ventilation to maintain target cfm/person ventilation rates based on actual occupancy. The strategy should allow for reduced overall ventilation during periods of less than full occupancy which will save energy. 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


Existing controllers at Cold Springs ES & ECC and Gloucester MS



Existing control system and thermostat at Gloucester HS

Gloucester City School District's existing energy management system is direct digital and includes a combination of open protocol and proprietary equipment which varies depending on the location. Gloucester High School includes a Trane Tracer Summit system that operates through LonTalk. This system is desktop based with no remote login capabilities. Many equipment controllers are LonTalk. The Early Childhood Center also includes a Summit system similar to the high school operating on LonTalk. Cold Springs Elementary School includes a CM3 front end operating through Niagara. All system controllers have been upgraded to BACnet. Gloucester Middle School includes a Trane Trace SC+ system operating fully through BACnet and is web-based. All system controllers at this location are BACnet as well. These existing energy management systems can control the entire district's (all buildings) large air-side equipment (RTU's, H&V's, AHU's etc), hydronic equipment (hot water boilers) and all terminal equipment (UV's, FCU's) except for a few split units. GCSD does have the capability to develop unoccupied/occupied schedules, set space temperature set points, and view any alarms or specific unit issues. The users of the system can view trend information, as well as print, save & e-mail trend information.

Scope of Work

This measure involves upgrading and expanding the existing control system through the installation of new BACnet controllers, communication wiring, decommissioning of LonTalk and upgrading the system database, graphics, trends and alarms as needed.

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. This will include zone scheduling, temperature setback and unoccupied outdoor air shut off.

A more specific scope of work includes:

- Building Automation Systems shall be accessible via the Internet.
- User 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.
- Demand Control Ventilation (DCV) will be utilized in the following spaces:

Demand Control Scope of Work			
BUILDING	**Occupancy Category**	**Unit Type with DCV**	**Ventilation SQFT**
Gloucester High School	Auditorium	RTU-10	8000
Gloucester High School	Gym	RTU-12	3400
Gloucester High School	Gym	RTU-13	3400
Gloucester High School	Spectator Area	RTU-12-13	1700
Gloucester High School	Locker Room	RTU-18	2740
Gloucester High School	Locker Room	RTU-19	3130
Gloucester High School	Cafeteria	RTU-21A	2300
Gloucester High School	Cafeteria	RTU-21B	2300
Gloucester High School	Cafeteria	RTU-21C	2300
Gloucester High School	Kitchen	RTU-22	1600
Gloucester High School	Cafeteria	RTU-23	1000
Gloucester High School	Media Center	RTU-8	1020
Gloucester High School	Media Center	RTU-7	1665
Gloucester High School	Media Center	RTU-9	5527
Cold Springs ES & ECC	Classrooms	AHU-1	2500
Cold Springs ES & ECC	Cafeteria	AHU-2	4000
Cold Springs ES & ECC	Kitchen	AHU-3	750
Gloucester Middle School	Gym	RTU-7	3400
Gloucester Middle School	Gym	RTU-8	3400
Gloucester Middle School	Classrooms	RTU-10	5100

District Management Detailed Controls Upgrade

District Building Management System Infrastructure

- Install supervisor software (Trane Ensemble) to connect various building controllers

- Options for cloud-hosted (by Trane through Amazon Web services) or on-premise (server to be provided by the district and reside on the district network)
- All items listed under Group 1 above are included (graphics, setpoint controller, scheduling, alarming, trending, etc.)
    - HS – 8 floor plans, 2 plants
    - MS – 6 floor plans, 2 plants
    - CS – 6 floor plans, 2 plants
    - ECC – 4 floor plans, 2 plants
- Integration of the following devices:
    - (4) SC+ & JACE building controllers (EC-BOS-9, N4) at the High School
        - Existing building controllers to be upgraded
    - Trane SC+ building controller at the Middle School
        - Existing building controller to be re-used
    - Trane SC+ building controller at Cold Springs Elementary
        - Existing building controller to be re-used
    - JACE building controller (EC-BOS-9, N4) at the Early Childhood Center
        - Existing building controller to be upgraded

Gloucester High School

Hot Water Plant (existing)

- Replace existing controller with Trane BACnet controller
- Re-use all sensors, end devices, and wiring
- Communication wiring to nearby building controller

Chilled Water Plant (existing)

- Replace existing controller with Trane BACnet controller
- Re-use all sensors, end devices, and wiring
- Communication wiring to nearby building controller

(3) New Rooftop Units – Group A

- BAS integration via factory-provided BACnet communication interface
- Install space temperature, humidity, and CO2 sensors
- Wiring
- Factory and field-provided sensors
- Smoke detector interlock (as needed)

- Communication wiring to nearby building controller

<u>(2) New Rooftop Units – Group B</u>

- BAS integration via factory-provided BACnet communication interface
- Install space temperature, humidity, and CO2 sensors
- Wiring
- Factory and field-provided sensors
- Smoke detector interlock (as needed)
- Communication wiring to nearby building controller

<u>(5) New Rooftop Units – Group C</u>

- BAS integration via factory-provided BACnet communication interface
- Install space temperature, humidity, and CO2 sensors
- Wiring
- Factory and field-provided sensors
- Smoke detector interlock (as needed)
- Communication wiring to nearby building controller

<u>(3) New Rooftop Units – Group D</u>

- BAS integration via factory-provided BACnet communication interface
- Install space temperature, humidity, and CO2 sensors
- Wiring
- Factory and field-provided sensors
- Smoke detector interlock (as needed)
- Communication wiring to nearby building controller

<u>New Combined Heat and Power Unit – Group L</u>

- Integrate the points below using the new hot water plant controller
- Start/stop/status
- Water supply/return temperature
- Alarming
- Wiring
- Controller to dry contact
- Field-provided sensors

Early Childhood Center (section of CSS/ECC Conjoined Building)

Hot Water Plant (existing)

- Replace existing controller with Trane BACnet controller
- Re-use all sensors, end devices, and wiring
- Communication wiring to nearby building controller

Chilled Water Plant (new)

- Replace existing controller with Trane BACnet controller
- Supply new sensors, end devices, and wiring
- Start/stop/status/speed for (2) existing pumps w/ VFDs
    - Start/stop/status for (2) pumps
    - (3) Isolation valves
    - (4) Temperature sensors
    - (2) Differential pressure sensors
    - (2) Flow meters
- BAS integration of (1) chiller and (2) pump VFDs via factory-provided BACnet interfaces
- Wiring
    - Field-provided sensors and end devices
    - Communication wiring to nearby building controller

(3) Existing Air Handling Units

- Replace existing controller with Trane BACnet controller
- Re-use all sensors, end devices, and wiring
- Replace space sensor with temperature, humidity, and CO2 space sensor
- Communication wiring to nearby building controller

Gloucester Middle School

(3) Existing Rooftop Units (already integrated via BACnet)

(3) Install space or return CO2 sensor
(1) Install BACnet controller and connect to OA damper on existing RTU
(1) Communication wiring to nearby building controller

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 maintain the heating setpoint of 70F during occupied hours and 65F setpoint during unoccupied hours and cooling setpoint of 72F during occupied hours and 77F setpoint 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 based off and ASHRAE STANDARD 62.1 -2016 calculated outdoor air rates. The proposed upgraded Energy Management Systems will utilize Night Shutdown for connected airside systems (rooftop units, air handlers, unit ventilators, etc.). The calculations are shown below.

CALCULATED SAVINGS				
EMS Savings				
BUILDING	Existing Weekly Occupied Heat Hours [H]	Proposed Weekly Occupied Heat Hours [H]	Existing Weekly Occupied Cool Hours [H]	Proposed Weekly Occupied Cool Hours [H]
Gloucester High School	118	84	118	84
Gloucester High School	118	84	118	84
Gloucester High School	118	84	118	84
Gloucester High School	118	84	118	84
Gloucester High School				
Cold Springs ES & ECC	126	80	126	80
Cold Springs ES & ECC	126	80	126	80
Cold Springs ES & ECC	126	80	126	80
Cold Springs ES & ECC	126	80	126	80
Cold Springs ES & ECC				
Gloucester Middle School	90	80	90	80
Gloucester Middle School	90	80	90	80
Gloucester Middle School	90	80	90	80
Gloucester Middle School	90	80	90	80
Gloucester Middle School				

CALCULATED SAVINGS

EMS Savings

BUILDING	Split System AC/Heat Pump Cooling (tons) [CAPhp]	Split System AC/ Heat Pump Cooling Efficiency (EER) [EERhp]	RTU Cooling (tons) [CAPrtu]	RTU Cooling Efficiency (EER) [EERrtu]	Chiller Cooling (tons) [CAP]	Chiller Cooling Efficiency (EER) [EERchiller]	RTU Heating (Btu/hr) [CAPrtu]	RTU Heating Efficiency (%) [AFUEh]	Boiler Heating (Btu/hr) [CAPboiler]	Boiler Heating Efficiency (%) [AFUEh]
Gloucester High School					250	9.7			9,667,470	75.8%
Gloucester High School			311	10.0			5,890,000	79.0%		
Gloucester High School	23	8.6								
Gloucester High School										
Gloucester High School										
Cold Springs ES & ECC					595	19.7			5,980,000	83.2%
Cold Springs ES & ECC										
Cold Springs ES & ECC										
Cold Springs ES & ECC										
Cold Springs ES & ECC										
Gloucester Middle School					90	13.2			3,000,000	83.8%
Gloucester Middle School			151	11.1			3,180,000	77.3%		
Gloucester Middle School										
Gloucester Middle School										
Gloucester Middle School										

CALCULATED SAVINGS

EMS Savings

BUILDING	ELFHc	ELFHh	Supply/Return Fan Savings	DCV Savings (kWh)	DCV Demand Savings (kW)	DCV Heating Savings (therms)	Split System Cooling Energy Savings (kWh)	RTU Cooling Energy Savings (kWh)	Chiller Cooling Energy Savings (kWh)	RTU Heating Energy Savings (therms)	Boiler Heating Energy Savings (therms)
Gloucester High School	466	901					0	0	12,598	0	5,000
Gloucester High School	466	901		61,142	39	1,727	0	15,100	0	2,925	0
Gloucester High School	466	901	38,065				1,274	0	0	0	0
Gloucester High School	466	901					0	0	0	0	0
Gloucester High School	466	901					0	0	0	0	0
Cold Springs ES & ECC	394	840					0	0	15,769	0	3,325
Cold Springs ES & ECC	394	840		5,870	7	158	0	0	0	0	0
Cold Springs ES & ECC	394	840	59,352				0	0	0	0	0
Cold Springs ES & ECC	394	840					0	0	0	0	0
Cold Springs ES & ECC	394	840					0	0	0	0	0
Gloucester Middle School	394	840					0	0	1,075	0	501
Gloucester Middle School	394	840		7,706	6	208	0	2,141	0	576	0
Gloucester Middle School	394	840	7,036				0	0	0	0	0
Gloucester Middle School	394	840					0	0	0	0	0
Gloucester Middle School	394	840					0	0	0	0	0

CALCULATED SAVINGS

EMS Savings

BUILDING	Total Electric Savings (kWh)	Total Demand Savings	Total Gas Savings (therms)	Total Electric Savings (kWh)	Total Demand Savings	Total Gas Savings (therms)
Gloucester High School	12,598	0	5,000	128,179	39	9,651
Gloucester High School	76,242	39	4,651			
Gloucester High School	39,339	0	0			
Gloucester High School	0	0	0			
Gloucester High School						
Cold Springs ES & ECC	15,769	0	3,325	80,991	7	3,483
Cold Springs ES & ECC	5,870	7	158			
Cold Springs ES & ECC	59,352	0	0			
Cold Springs ES & ECC	0	0	0			
Cold Springs ES & ECC						
Gloucester Middle School	1,075	0	501	17,957	6	1,284
Gloucester Middle School	9,846	6	783			
Gloucester Middle School	7,036	0	0			
Gloucester Middle School	0	0	0			
Gloucester Middle School						

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

All Calculated Outdoor Air Rates refence ANSI ASHRAE STANDARD 62.1 -2016

NJ BPU FY 2020 Protocols – Demand Control Ventilation

CALCULATED SAVINGS

Demand Control Ventilation Savings

BUILDING	Occupancy Category	Unit Type with DCV	Ventilation SQFT	Space	People Outdoor Air Rate (cfm/person)	Area Outdoor Air Rate (cfm/sqft)	Occupant Density (#/1000 sqft)	Combined Outdoor Air Rate (cfm/person)	Total Occupants per Unit
Gloucester High School	Auditorium	RTU-10	8000	Auditorium	5.0	0.06	150.0	5.4	1,200
Gloucester High School	Gym	RTU-12	3400	Old Gym - Boys Side	20.0	0.18	7.0	45.7	24
Gloucester High School	Gym	RTU-13	3400	Old Gym - Girls Side	20.0	0.18	7.0	45.7	24
Gloucester High School	Spectator Area	RTU-12-13	1700	Spectator Area - Gym	7.5	0.06	150.0	7.9	255
Gloucester High School	Locker Room	RTU-18	2740	Old Gym Boys Locker Room	20.0	0.06	10.0	26.0	28
Gloucester High School	Locker Room	RTU-19	3130	Old Gym Girls Locker Room	20.0	0.06	10.0	26.0	32
Gloucester High School	Cafeteria	RTU-21A	2300	Cafeteria	7.5	0.06	100.0	8.1	230
Gloucester High School	Cafeteria	RTU-21B	2300	Cafeteria	7.5	0.06	100.0	8.1	230
Gloucester High School	Cafeteria	RTU-21C	2300	Cafeteria	7.5	0.06	100.0	8.1	230
Gloucester High School	Kitchen	RTU-22	1600	Kitchen	7.5	0.12	20.0	13.5	32
Gloucester High School	Cafeteria	RTU-23	1000	Teachers Lounge	7.5	0.06	100.0	8.1	100
Gloucester High School	Media Center	RTU-8	1020	Media Center Desk	10.0	0.12	25.0	14.8	26
Gloucester High School	Media Center	RTU-7	1665	Media Center	10.0	0.12	25.0	14.8	42
Gloucester High School	Media Center	RTU-9	5527	Media Center	10.0	0.12	25.0	14.8	139
Cold Springs ES & ECC	Classrooms	AHU-1	2500	Classrooms	10.0	0.12	35.0	13.4	88
Cold Springs ES & ECC	Cafeteria	AHU-2	4000	Cafeteria	7.5	0.06	100.0	8.1	400
Cold Springs ES & ECC	Kitchen	AHU-3	750	Kitchen	7.5	0.12	20.0	13.5	15
Gloucester Middle School	Gym	RTU-7	3400	Gym	20.0	0.18	7.0	45.7	24
Gloucester Middle School	Gym	RTU-8	3400	Gym	20.0	0.18	7.0	45.7	24
Gloucester Middle School	Classrooms	RTU-10	5100	Classrooms	10.0	0.12	35.0	13.4	179

CALCULATED SAVINGS

Demand Control Ventilation Savings

BUILDING	Occupancy Category	Calculated OA per Unit (cfm)	Existing Design OA per Unit (cfm)	OA per Unit (cfm)	CESF	CDSF	HSF	DCV Electric Savings (kWh)	DCV Demand Savings (kW)	DCV Gas Savings (Th)	Total Electric Savings (kWh)	Total Demand Savings (kW)	Total Gas Savings (Th)
Gloucester High School	Auditorium	6,480	N/A	6,480	1.500	0.0015	0.043	9,720	10	279	61,142	39	1,727
Gloucester High School	Gym	1,092	N/A	1,092	2.558	0.0013	0.069	2,793	1	75			
Gloucester High School	Gym	1,092	N/A	1,092	2.558	0.0013	0.069	2,793	1	75			
Gloucester High School	Spectator Area	2,015	N/A	2,015	2.558	0.0013	0.069	5,153	3	139			
Gloucester High School	Locker Room	724	3,100	3,100	2.529	0.0015	0.072	7,840	5	223			
Gloucester High School	Locker Room	828	3,100	3,100	2.529	0.0015	0.072	7,840	5	223			
Gloucester High School	Cafeteria	1,863	N/A	1,863	2.529	0.0015	0.072	4,712	3	134			
Gloucester High School	Cafeteria	1,863	N/A	1,863	2.529	0.0015	0.072	4,712	3	134			
Gloucester High School	Cafeteria	1,863	N/A	1,863	2.529	0.0015	0.072	4,712	3	134			
Gloucester High School	Kitchen	432	N/A	432	2.529	0.0015	0.072	1,093	1	31			
Gloucester High School	Cafeteria	810	N/A	810	2.529	0.0015	0.072	2,048	1	58			
Gloucester High School	Media Center	382	N/A	382	2.529	0.0015	0.072	967	1	28			
Gloucester High School	Media Center	620	N/A	620	2.529	0.0015	0.072	1,567	1	45			
Gloucester High School	Media Center	2,053	N/A	2,053	2.529	0.0015	0.072	5,193	3	148			
Cold Springs ES & ECC	Classrooms	1,180	1,000	1,000	1.079	0.0013	0.029	1,079	1	29	5,870	7	158
Cold Springs ES & ECC	Cafeteria	3,240	4,240	4,240	1.079	0.0013	0.029	4,575	6	123			
Cold Springs ES & ECC	Kitchen	203	200	200	1.079	0.0013	0.029	216	0	6			
Gloucester Middle School	Gym	1,092	1,000	1,000	2.558	0.0013	0.069	2,558	1	69	7,706	6	208
Gloucester Middle School	Gym	1,092	1,000	1,000	2.558	0.0013	0.069	2,558	1	69			
Gloucester Middle School	Classrooms	2,402	2,400	2,400	1.079	0.0013	0.029	2,590	3	70			

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

Night Shutdown - Fan (Air Handling Units, Rooftop Units, Unit Ventilators & Fan Coil Units)

Gloucester High School

Air Handling Units / Fan Coil Units

			CONSTANT VOLUME UNITS										
			SUPPLY FAN					RETURN FAN					TOTAL
Unit Tag	Make	Model	Total Fan HP	Motor Eff	VFD?	Est. Load Factor	Fan kW	Fan HP	Motor Eff	VFD?	Est. Load Factor	Fan kW	Fan kW
Group A-F	Trane	Various	21.5	86.5%	No	0.75	13.9	0	0.0%	No	0.75	0	13.91
Group G	Trane	Various	10.5	83.5%	No	0.75	7.0						7.04
FCU-1-81	Trane	Various	20.3	83.5%	No	0.75	13.6						13.57
CUH-1-12	Trane	Various	1.5	83.5%	No	0.75	1.0						1.01
Constant Volume Total Averages													35.5

RECPLACE

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Building Inputs

Building Balance Point	60 F
Blended Electric Rate	$ 0.20 / kWh
Blended Natural Gas Rate	$ 0.92 / Therm
Existing % Runtime during Unocc Periods	40%
Runtime Reduction during Unocc Periods [1]	0%
Proposed % Runtime during Unocc Period	40%

Note 1: Conservatively assumes new controls wil help reduce runtime but units may stil need to run for special events, etc

			EXISTING SCHEDULE		PROPOSED SCHEDULE		EXISTING LOADS						PROPOSED LOADS						SUMMARY	
							Occupied			Unoccupied			Occupied			Unoccupied				
Avg Outdoor Air Temp. Bins °F	Avg Outdoor Air Enthalpy	Existing Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Fan % Runtime	Fan Peak kW	Fan kWh	Fan % Runtime	Fan Peak kW	Fan kWh	Fan % Runtime	Fan Peak kW	Fan kWh	Fan % Runtime	Fan Peak kW	Fan kWh	Existing Total Fan kWh	Proposed Total Fan kWh
102.5	40.0	1	1	0	0	1	100%	36	25	40%	36	4	100%	36	18	40%	36	7	29	25
97.5	39.4	19	13	6	9	10	100%	36	474	40%	36	80	100%	36	337	40%	36	135	554	472
92.5	36.4	59	41	18	29	30	100%	36	1,472	40%	36	249	100%	36	1,045	40%	36	420	1,722	1,465
87.5	34.0	229	161	68	114	115	100%	36	5,715	40%	36	968	100%	36	4,056	40%	36	1,631	6,683	5,687
82.5	32.6	487	342	145	243	244	100%	36	12,153	40%	36	2,059	100%	36	8,626	40%	36	3,469	14,211	12,095
77.5	32.0	721	507	214	360	361	100%	36	17,992	40%	36	3,048	100%	36	12,770	40%	36	5,136	21,040	17,907
72.5	29.5	632	444	188	315	317	100%	36	15,771	40%	36	2,671	100%	36	11,194	40%	36	4,502	18,443	15,696
67.5	27.3	817	574	243	407	410	100%	36	20,388	40%	36	3,453	100%	36	14,471	40%	36	5,820	23,841	20,291
62.5	24.0	767	539	228	382	385	100%	36	19,140	40%	36	3,242	100%	36	13,585	40%	36	5,464	22,382	19,049
57.5	21.4	812	570	242	405	407	100%	36	20,263	40%	36	3,432	100%	36	14,382	40%	36	5,785	23,695	20,167
52.5	18.4	605	425	180	302	303	100%	36	15,097	40%	36	2,557	100%	36	10,716	40%	36	4,310	17,655	15,026
47.5	16.4	618	434	184	308	310	100%	36	15,422	40%	36	2,612	100%	36	10,946	40%	36	4,403	18,034	15,349
42.5	14.3	648	455	193	323	325	100%	36	16,170	40%	36	2,739	100%	36	11,477	40%	36	4,616	18,909	16,094
37.5	12.1	735	516	219	366	369	100%	36	18,341	40%	36	3,107	100%	36	13,018	40%	36	5,236	21,448	18,254
32.5	10.2	649	456	193	324	325	100%	36	16,195	40%	36	2,743	100%	36	11,495	40%	36	4,623	18,939	16,119
27.5	8.5	349	245	104	174	175	100%	36	8,709	40%	36	1,475	100%	36	6,182	40%	36	2,486	10,184	8,668
22.5	7.2	314	221	93	157	157	100%	36	7,836	40%	36	1,327	100%	36	5,562	40%	36	2,237	9,163	7,798
17.5	5.5	181	127	54	90	91	100%	36	4,517	40%	36	765	100%	36	3,206	40%	36	1,289	5,282	4,495
12.5	3.9	76	53	23	38	38	100%	36	1,897	40%	36	321	100%	36	1,346	40%	36	541	2,218	1,888
7.5	2.3	23	16	7	11	12	100%	36	574	40%	36	97	100%	36	407	40%	36	164	671	571
2.5	1.4	14	10	4	7	7	100%	36	349	40%	36	59	100%	36	248	40%	36	100	409	348
-2.5	0.3	4	3	1	2	2	100%	36	100	40%	36	17	100%	36	71	40%	36	28	117	99
-7.5	0.1	0	0	0	0	0	100%	36	0	40%	36	0	100%	36	0	40%	36	0	0	0
TOTALS		8,760	6,154	2,606	4,368	4,392			218,600			37,028			155,159			62,405	255,628	217,563

NIGHT SETBACK SAVINGS SUMMARY					
	Electric Demand (kW)	Electric Usage (kWh)	Gas Usage (Therms)	Maint. ($)	Total Cost ($)
Savings	0	38,065	0	$0	$7,670

Cold Springs ES & ECC

Air Handling Units / Unit Ventilators

CONSTANT VOLUME UNITS			SUPPLY FAN					RETURN FAN					TOTAL
Unit Tag	Make	Model	Total Fan HP	Motor Eff	VFD?	Est. Load Factor	Fan kW	Fan HP	Motor Eff	VFD?	Est. Load Factor	Fan kW	Fan kW
AHU-1			5.0	86.5%	No	0.75	3.2	3	86.5%	No	0.75	1.9	5.17
AHU-2			7.5	86.5%	No	0.75	4.9	5	89.5%	No	0.75	3.1	7.98
AHU-3			1.5	83.5%	No	0.75	1.0						1.01
FCU-1-20			5.0	83.5%	No	0.75	3.4						3.35
FCU-21-27			1.8	83.5%	No	0.75	1.2						1.17
FCU-28-29			0.5	83.5%	No	0.75	0.3						0.34
FCU-30-31			0.5	83.5%	No	0.75	0.3						0.34
FCU-32-33			0.5	83.5%	No	0.75	0.3						0.34
FCU-34			0.3	83.5%	No	0.75	0.2						0.17
CUH-1-6			0.8	83.5%	No	0.75	0.5						0.50
FCU-1-26			6.5	83.5%	No	0.75	4.4						4.36
AHU-1-22			20.5	83.5%	No	0.75	13.7						13.74
AHU-23-27			3.7	83.5%	No	0.75	2.5						2.50
Constant Volume Total Averages													40.9

Building Inputs

Building Balance Point	60	F
Blended Electric Rate	$ 0.15	/ kWh
Blended Natural Gas Rate	$ 0.90	/ Therm
Existing % Runtime during Unocc Periods	40%	
Runtime Reduction during Unocc Periods [Note 1]	0%	
Proposed % Runtime during Unocc Periods	40%	

Note 1: Conservatively assumes new controls will help reduce runtime but units may still need to run for special events, etc

			EXISTING SCHEDULE		PROPOSED SCHEDULE		EXISTING LOADS – Occupied			EXISTING LOADS – Unoccupied			PROPOSED LOADS – Occupied			PROPOSED LOADS – Unoccupied			SUMMARY	
Avg Outdoor Air Temp. Bins °F	Avg Outdoor Air Enthalpy	Existing Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Fan % Runtime	Fan Peak kW	Fan kWh	Fan % Runtime	Fan Peak kW	Fan kWh	Fan % Runtime	Fan Peak kW	Fan kWh	Fan % Runtime	Fan Peak kW	Fan kWh	Existing Total Fan kWh	Proposed Total Fan kWh
102.5	40.0	1	1	0	0	1	100%	41	31	40%	41	4	100%	41	19	40%	41	9	35	28
97.5	39.4	19	14	5	9	10	100%	41	584	40%	41	78	100%	41	369	40%	41	163	662	533
92.5	36.4	59	44	15	28	31	100%	41	1,813	40%	41	241	100%	41	1,147	40%	41	507	2,054	1,655
87.5	34.0	229	172	57	109	120	100%	41	7,038	40%	41	935	100%	41	4,453	40%	41	1,969	7,974	6,422
82.5	32.6	487	366	121	231	256	100%	41	14,968	40%	41	1,988	100%	41	9,469	40%	41	4,188	16,957	13,657
77.5	32.0	721	541	180	342	379	100%	41	22,161	40%	41	2,944	100%	41	14,019	40%	41	6,201	25,104	20,219
72.5	29.5	632	474	158	300	332	100%	41	19,425	40%	41	2,581	100%	41	12,288	40%	41	5,435	22,006	17,724
67.5	27.3	817	613	204	388	429	100%	41	25,111	40%	41	3,336	100%	41	15,885	40%	41	7,026	28,447	22,912
62.5	24.0	767	576	191	364	403	100%	41	23,574	40%	41	3,132	100%	41	14,913	40%	41	6,596	26,706	21,509
57.5	21.4	812	610	202	386	426	100%	41	24,957	40%	41	3,316	100%	41	15,788	40%	41	6,983	28,273	22,771
52.5	18.4	605	454	151	287	318	100%	41	18,595	40%	41	2,470	100%	41	11,763	40%	41	5,203	21,065	16,966
47.5	16.4	618	464	154	293	325	100%	41	18,995	40%	41	2,523	100%	41	12,016	40%	41	5,315	21,518	17,331
42.5	14.3	648	486	162	308	340	100%	41	19,917	40%	41	2,646	100%	41	12,599	40%	41	5,573	22,563	18,172
37.5	12.1	735	552	183	349	386	100%	41	22,591	40%	41	3,001	100%	41	14,291	40%	41	6,321	25,592	20,612
32.5	10.2	649	487	162	308	341	100%	41	19,948	40%	41	2,650	100%	41	12,619	40%	41	5,581	22,597	18,200
27.5	8.5	349	262	87	166	183	100%	41	10,727	40%	41	1,425	100%	41	6,786	40%	41	3,001	12,152	9,787
22.5	7.2	314	236	78	149	165	100%	41	9,651	40%	41	1,282	100%	41	6,105	40%	41	2,700	10,933	8,806
17.5	5.5	181	136	45	86	95	100%	41	5,563	40%	41	739	100%	41	3,519	40%	41	1,557	6,302	5,076
12.5	3.9	76	57	19	36	40	100%	41	2,336	40%	41	310	100%	41	1,478	40%	41	654	2,646	2,131
7.5	2.3	23	17	6	11	12	100%	41	707	40%	41	94	100%	41	447	40%	41	198	801	645
2.5	1.4	14	11	3	7	7	100%	41	430	40%	41	57	100%	41	272	40%	41	120	487	393
-2.5	0.3	4	3	1	2	2	100%	41	123	40%	41	16	100%	41	78	40%	41	34	139	112
-7.5	0.1	0	0	0	0	0	100%	41	0	40%	41	0	100%	41	0	40%	41	0	0	0
TOTALS		**8,760**	**6,576**	**2,184**	**4,160**	**4,600**			**269,246**			**35,768**			**170,326**			**75,336**	**305,014**	**245,662**
					36.7%															

NIGHT SETBACK SAVINGS SUMMARY	Electric Demand (kW)	Electric Usage (kWh)	Gas Usage (Therms)	Maint. ($)	Total Cost ($)
Savings	**0**	**59,352**	**0**	**$0**	**$8,975**

Gloucester Middle School

Air Handling Units / Fan Coil Units / RTUS

			CONSTANT VOLUME UNITS										
			SUPPLY FAN					RETURN FAN					TOTAL
Unit Tag	Make	Model	Fan HP	Motor Eff	VFD?	Est. Load Factor	Fan kW	Fan HP	Motor Eff	VFD?	Est. Load Factor	Fan kW	Fan kW
FCU-1-47	Trane	Various	12.3	83.5%	No	0.75	0.6						0.65
CUH-1-13	Trane	Various	0.7	83.5%	No	0.75	0.6						0.65
VAV-23-30	Trane	Various	0.0	83.5%	No	0.75	0.0						0.00
RTU-1	Trane	YHC072F4RM/	1.5	86.5%	No	0.75	1.0	0.75	86.5%	No	0.75	0.65	1.62
RTU-2	Trane	YHC102F4RH/	2.8	86.5%	No	0.75	1.8	0.75	86.5%	No	0.75	0.65	2.43
RTU-3	Trane	YHD180G4RH/	3.0	89.5%	No	0.75	1.9	1	86.5%	No	0.75	0.65	2.52
RTU-4	Trane	YHD180G4RH/	3.0	89.5%	No	0.75	1.9	1	86.5%	No	0.75	0.65	2.52
RTU-5	Trane	YHC120F4RM/	2.8	89.5%	No	0.75	1.7	0.75	86.5%	No	0.75	0.65	2.37
RTU-6	Trane	YHC048F4RL/	1.0	85.5%	No	0.75	0.7	1	86.5%	No	0.75	0.65	1.30
RTU-7	Trane	YHC120F4RM/	2.8	89.5%	No	0.75	1.7	0.75	86.5%	No	0.75	0.65	2.37
RTU-8	Trane	YHC120F4RM/	2.8	89.5%	No	0.75	1.7	0.75	86.5%	No	0.75	0.65	2.37
RTU-9	Trane	YHD150G4RV/	5.0	89.5%	No	0.75	3.1	1	86.5%	No	0.75	0.65	3.77
													0.00
Constant Volume Total Averages													22.6

Building Inputs

Building Balance Point	60	F
Blended Electric Rate	$ 0.17	/ kWh
Blended Natural Gas Rate	$ 0.89	/ Therm
Existing % Runtime during Unocc Periods	40%	
Runtime Reduction during Unocc Periods [1]	0%	
Proposed % Runtime during Unocc Period	40%	

Note 1: Conservatively assumes new controls wil help reduce runtime but units may stil need to run for special events, etc

			EXISTING SCHEDULE		PROPOSED SCHEDULE		EXISTING LOADS						PROPOSED LOADS						SUMMARY	
							Occupied			Unoccupied			Occupied			Unoccupied				
Avg Outdoor Air Temp. Bins °F	Avg Outdoor Air Enthalpy	Existing Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Occupied Equipment Bin Hours	Unoccupied Equipment Bin Hours	Fan % Runtime	Fan Peak kW	Fan kWh	Fan % Runtime	Fan Peak kW	Fan kWh	Fan % Runtime	Fan Peak kW	Fan kWh	Fan % Runtime	Fan Peak kW	Fan kWh	Existing Total Fan kWh	Proposed Total Fan kWh
102.5	40.0	1	1	0	0	1	100%	23	12	40%	23	4	100%	23	11	40%	23	5	16	15
97.5	39.4	19	10	9	9	10	100%	23	229	40%	23	80	100%	23	203	40%	23	90	309	293
92.5	36.4	59	32	27	28	31	100%	23	711	40%	23	248	100%	23	632	40%	23	279	959	911
87.5	34.0	229	122	107	109	120	100%	23	2,759	40%	23	962	100%	23	2,453	40%	23	1,085	3,721	3,537
82.5	32.6	487	260	227	231	256	100%	23	5,868	40%	23	2,046	100%	23	5,216	40%	23	2,307	7,914	7,523
77.5	32.0	721	385	336	342	379	100%	23	8,687	40%	23	3,029	100%	23	7,722	40%	23	3,415	11,716	11,137
72.5	29.5	632	338	294	300	332	100%	23	7,615	40%	23	2,655	100%	23	6,769	40%	23	2,994	10,270	9,762
67.5	27.3	817	436	381	388	429	100%	23	9,844	40%	23	3,433	100%	23	8,750	40%	23	3,870	13,276	12,620
62.5	24.0	767	410	357	364	403	100%	23	9,241	40%	23	3,223	100%	23	8,214	40%	23	3,633	12,464	11,848
57.5	21.4	812	434	378	386	426	100%	23	9,783	40%	23	3,412	100%	23	8,696	40%	23	3,846	13,195	12,543
52.5	18.4	605	323	282	287	318	100%	23	7,289	40%	23	2,542	100%	23	6,479	40%	23	2,866	9,831	9,345
47.5	16.4	618	330	288	293	325	100%	23	7,446	40%	23	2,597	100%	23	6,619	40%	23	2,927	10,043	9,546
42.5	14.3	648	346	302	308	340	100%	23	7,807	40%	23	2,723	100%	23	6,940	40%	23	3,070	10,530	10,010
37.5	12.1	735	393	342	349	386	100%	23	8,856	40%	23	3,088	100%	23	7,872	40%	23	3,482	11,944	11,353
32.5	10.2	649	347	302	308	341	100%	23	7,819	40%	23	2,727	100%	23	6,951	40%	23	3,074	10,546	10,025
27.5	8.5	349	186	163	166	183	100%	23	4,205	40%	23	1,466	100%	23	3,738	40%	23	1,653	5,671	5,391
22.5	7.2	314	168	146	149	165	100%	23	3,783	40%	23	1,319	100%	23	3,363	40%	23	1,487	5,103	4,850
17.5	5.5	181	97	84	86	95	100%	23	2,181	40%	23	760	100%	23	1,938	40%	23	857	2,941	2,796
12.5	3.9	76	41	35	36	40	100%	23	916	40%	23	319	100%	23	814	40%	23	360	1,235	1,174
7.5	2.3	23	12	11	11	12	100%	23	277	40%	23	97	100%	23	246	40%	23	109	374	355
2.5	1.4	14	7	7	7	7	100%	23	169	40%	23	59	100%	23	150	40%	23	66	228	216
-2.5	0.3	4	2	2	2	2	100%	23	48	40%	23	17	100%	23	43	40%	23	19	65	62
-7.5	0.1	0	0	0	0	0	100%	23	0	40%	23	0	100%	23	0	40%	23	0	0	0
TOTALS		**8,760**	**4,680**	**4,080**	**4,160**	**4,600**			**105,545**			**36,805**			**93,818**			**41,496**	**142,350**	**135,314**

NIGHT SETBACK SAVINGS SUMMARY					
	Electric Demand (kW)	Electric Usage (kWh)	Gas Usage (Therms)	Maint. ($)	Total Cost ($)
Savings	**0**	**7,036**	**0**	**$0**	**$1,227**

EMS Savings			
BUILDING	Total Electric Savings (kWh)	Total Demand Savings	Total Gas Savings (therms)
Gloucester High School	128,179	39	9,651
Cold Springs ES & ECC	80,991	7	3,483
Gloucester Middle School	17,957	6	1,284

ECM 5 – Chiller Replacement

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
5	Chiller Replacement	✔	✔	

Background

A chiller is one of the most energy-intensive units in any facility. Technology has made leaps and bounds in the past several years in making these machines more efficient. Chiller efficiency is rated by how much electrical energy is used to produce an amount of cooling. This is expressed in kilowatts per ton of cooling (kW/ton). An older machine may be as high as 1.5 kW/ton, whereas a new chiller may be as low as 1 kW/ton or even less. A new machine uses less electrical power to produce the same amount of cooling. The efficiency of the chiller can vary widely depending on whether the model is air-cooled, or water cooled.

Existing Conditions

Gloucester High School – Two (2) 250 Ton Trane Air-Cooled Screw Chillers serve the existing chilled water loop for cooling to a substantial portion of the building, including unit ventilators and fan coil units. Manufactured in 2005, these chillers were viewed to be in poor condition and will be past ASHARE useful life of 20 years.

Cold Springs ES & ECC – One (1) 225 Ton Trane Air-Cooled Screw Chiller serves the existing chilled water loop for cooling to a substantial portion of the building, including unit ventilators and fan coil units. Manufactured in 2003, this chiller was viewed to be in poor condition and is currently past ASHARE useful life of 20 years.


Existing air-cooled chiller at Gloucester HS and Cold Springs ES & ECC

Scope of Work

ONLY COLD SPRINGS ES & ECC INCLUDED IN ESIP PROJECT

Gloucester High School

- Demo & Removal of existing (2) 250-ton Air Cooled Screw Chillers
- Furnish & Install 2 new Trane Chillers
- Trane ATC
- Electrical
- Condensate & CHWS/R Piping
- Concrete/Dumpster/Land Restore
- Insulation
- Test & Balance

- Crane/Rigging - Demo & New
- Misc/Sketching/Other

Cold Springs ES & ECC

- Demo & Removal of existing (1) 225-ton Air Cooled Screw Chiller
- Furnish & Install 1 new Trane Chiller
- Trane ATC
- Electrical
- Condensate & CHWS/R Piping
- Concrete/Dumpster/Land Restore
- Insulation
- Test & Balance
- Crane/Rigging - Demo & New
- Misc/Sketching/Other

ECM Calculations

Energy Savings from the installation of a high efficiency air-cooled chiller were calculated using the BPU protocols. Only Cold Springs ES & ECC are included within the ESIP Project (GHS Chillers evaluated but **not** included). Existing chiller at CSES&ECC efficiency is derated to 1.242 kW/ton at part load.

CALCULATED SAVINGS

Chiller Replacement Savings

BUILDING	Qty	Qty Operational	Baseline Tons	Proposed Tons	Chiller Part Load Hours (EFLH)	IPLVb (kW/ton)	IPLVq (kW/ton)
Gloucester High School	2	1	250	250	466	1.242	0.701
Cold Springs ES & ECC	1	1	225	225	394	1.242	0.694

CALCULATED SAVINGS

Chiller Replacement Savings

BUILDING	Qty	Qty Operational	PDC	Peak Demand Savings (kW)	Total Energy Savings (kWh)
Gloucester High School	2	1	67%	91	62,984
Cold Springs ES & ECC	1	1	67%	83	48,574

ECM 6 – Premium Efficiency Pump Motors and VFDs

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

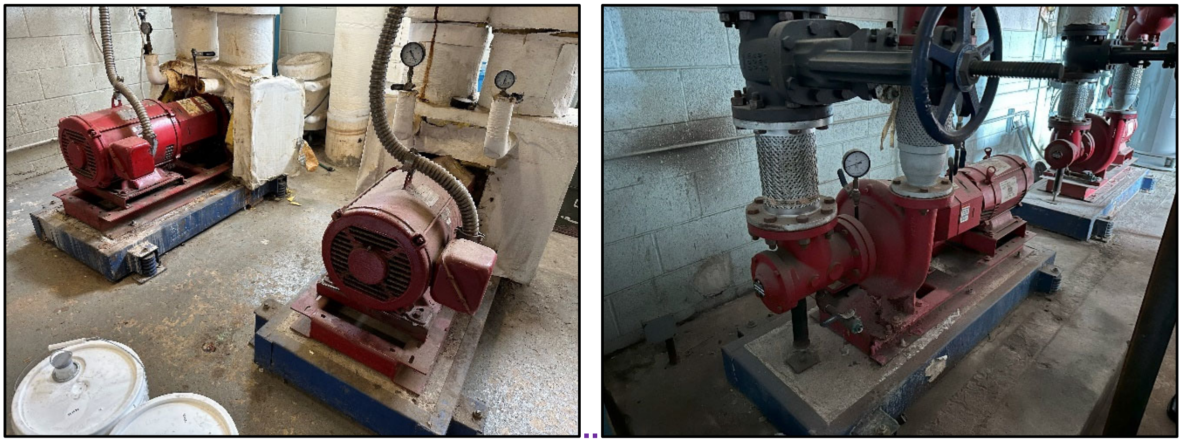
✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
6	Premium Efficiency Pump Motors and VFDs	✔		

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

Gloucester High School – Two (2) 20HP pumps serve the existing hot water loop and are located in the main mechanical room. Both pumps operate in lead/lag control and are configured to the existing Smith 9,667 mBH boilers. Both pumps do not have VFDs. Two (2) 60hp pumps serve the existing chilled water loop and are located in a mechanical room on the first floor. Both pumps operate in lead/lag control and are configured to the existing two (2) Trane 250-Ton Chillers. Both pumps do not have VFDs.



Existing Pumps at Gloucester HS

EXISTING EQUIPMENT							
BASIC				Motor			
Location	Type 1	Unit	# of Units	Motor Size (HP)	Motor Efficiency %	System Type	VFDs Installed?
Gloucester City HS	Hot Water Loop Pump	HWLP-1-2	2	20.00	92.4%	Heating Hot Water Pump	No
Gloucester City HS	Chilled Water Loop Pump	CHWLP-1-2	2	60.00	93.0%	Chilled Water Pump	No

Scope of Work

ONLY COLD GHS – CHILLED WATER LOOP PUMPS INCLUDED IN ESIP PROJECT

Gloucester High School

- Hot Water Loop Pump Replacement w/ VFDs
    - (2) 20 HP HW Loop Pumps & VFDs
    - Demo & Removal of 2 Pumps
    - Furnish & Install 2 Pumps (20 HP) with VFDs; Inertia Base
    - Electrical
    - HWS/R Piping
    - Concrete/Dumpster/GC
    - Insulation
    - Test & Balance
    - Misc/Sketching/Other
- Chilled Water Loop Pump Replacement w/ VFDs

- (2) 60 HP CHW Loop Pumps & VFDs
- Demo & Removal of 2 Pumps
- Furnish & Install 2 Pumps (60 HP) with VFDs
- Electrical
- CHWS/R Piping
- Concrete/Dumpster/GC
- Insulation
- Test & Balance
- Misc/Sketching/Other

ECM Calculations

Energy Savings from the installation of premium efficiency pump motors and VFDs were calculated using BPU protocols. The calculations are shown below. *The Gloucester High School chilled water loop pump/motor replacement with VFD installation is the only scope which is included in the ESP. The hot water loop pumps/motors will not be replaced.*

CALCULATED SAVINGS

Pump VFD Savings

BUILDING	SYSTEM AND SERVICE	QTY	OPERATIONAL QTY	MOTOR HP	EXISTING MOTOR EFFICIENCY (Nbase)	REPLACEMENT MOTOR EFFICIENCY (Nprem)
Gloucester High School	Chilled Water Loop Pump 1-2	2	1	60.0	93.0%	94.5%

Pump VFD Savings

BUILDING	SYSTEM AND SERVICE	OPERATIONAL QTY	LF	CF	IFvfd	HRS	ΔkW	PREM. MOTOR DEMAND SAVINGS (kW)	PREM. MOTOR ELECTRIC SAVINGS (kWh)
Gloucester High School	Chilled Water Loop Pump 1-2	1	0.75	0.74	1.0	3391	0.76	0.57	1,943

Pump VFD Savings

BUILDING	SYSTEM AND SERVICE	OPERATIONAL QTY	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)
Gloucester High School	Chilled Water Loop Pump 1-2	1	1,633.00	0.185	11.10	97,980	11.67	11.67	99,923	99,923

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 Horsepower	1200 RPM (6 pole)		1800 RPM (4 pole)		3600 RPM (2 pole)	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
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

From application form calculate ΔkW where:

$$\Delta kW = 0.746 * HP * IF_{VFD} * (1/\eta_{base} - 1/\eta_{prem})$$

Demand Savings = (ΔkW) * CF

Energy Savings = (ΔkW)*HRS * LF

Definition of Variables
ΔkW = kW Savings at full load
HP = Rated horsepower of qualifying motor, from nameplate/manufacturer specs.
LF = Load Factor, percent of full load at typical operating condition
IF_{VFD} = VFD Interaction Factor, 1.0 without VFD, 0.9 with VFD
η_{base} = Efficiency of the baseline motor
η_{prem} = Efficiency of the energy-efficient motor
HRS = Annual operating hours
CF = Coincidence Factor

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

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

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

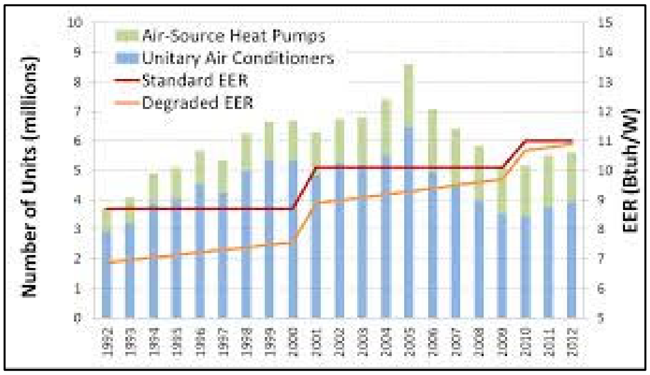
ECM 7 – Rooftop Unit Replacement

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
7	Rooftop Unit Replacement	✔		

Many commercial buildings are operating with older and inefficient HVAC systems. The average life expectancy of commercial HVAC RTU equipment is 10 to 15 years—which means that many commercial buildings are ready for new natural gas rooftop units. Technology improvements and demand have led to greater energy efficiency and more choices in systems. Installing new, higher efficiency units will provide energy savings as well as deliver enhanced technology and controls of the RTUs when compared to the existing units.



Existing Conditions

Gloucester High School – Thirty (30) total rooftop units currently serve various spaces within the school. Of the thirty units, sixteen (16) are packaged single zone units with direct expansion cooling and gas-fired furnace heating. These sixteen units equate to 310.5 tons of cooling. There are two (2) split condensing units which are configured to two (2) rooftop gas-fired furnace air handling units. This configuration represents 22.5 tons in total cooling and serves the new gym area corridors and bathroom. The other existing corridors within the school are served by ten (10) rooftop air handling units. Each unit is configured with a chilled water coil which is served by the existing chilled water plant. Also, within the duct work of each rooftop air handling unit, there is a hot water heating coil which is served by the existing boiler plant. All the units were identified to be in poor condition and past ASHRAE useful life of 15 years and were evaluated during the ESIP project development phase. Of all the units, thirteen (13) have been prioritized by the district and will be included within the project. These units are classified in Group A, B, C & D in the table shown in the scope of work section of this ECM.

Existing roof top units at Gloucester High School

Existing roof top units at Gloucester High School


Existing roof top units at Gloucester High School

Scope of Work

The following RTUs were evaluated during ESIP project development. All units in Group A, B, C & D will be replaced with high efficiency units – 13 units & 235.5 tons of cooling:

BUILDING	GROUP	INCLUDED IN ESIP	CATEGORY	AREA SERVED	TONS	QUANTITY
Gloucester High School	A	Y	RTU-10	Auditorium	50.0	1
			RTU-12	Old Gym - Boys Side	20.0	1
			RTU-13	Old Gym - Girls Side	20.0	1
	B	Y	RTU-18	Old Gym Boys Locker Room	25.0	1
			RTU-19	Old Gym Girls Locker Room	25.0	1
	C	Y	RTU-21A	Cafeteria	17.5	1
			RTU-21B	Cafeteria	17.5	1
			RTU-21C	Cafeteria	17.5	1
			RTU-22	Kitchen	7.5	1
			RTU-23	Teachers Lounge	3.0	1
	D	Y	RTU-8	Media Center Desk	7.5	1
			RTU-7	Media Center	7.5	1
			RTU-9	Media Center	17.5	1
	E	N	RTU-14	New Gym	25.0	1
			RTU-15	New Gym	25.0	1
			RTU-16	New Gym Locker Rooms	25.0	1
	F	N	RTU-17A	Gym Corridor	12.5	1
			RTU-20A	Gym Corridor	10.0	1
			RTU-17B	Gym Corridor	0.0	1
			RTU-20B	Gym Corridor	0.0	1
	G	N	RTU-1	B Wing Exit	0.0	1
			RTU-11	C Wing	0.0	1
			RTU-26	E Wing	0.0	1
			RTU-2	B Wing Hallway	0.0	1
			RTU-24	D Wing	0.0	1
			RTU-25	A Wing	0.0	1
			RTU-3	C Wing	0.0	1
			RTU-4	C Wing	0.0	1
			RTU-5	A Wing	0.0	1
			RTU-6	A Wing	0.0	1
				TOTAL EVALUATED	*333.0*	*30*
				INCLUDED IN ESIP	**235.5**	**13**

Gloucester High School

- Demo & Removal of existing Group A, B & C RTUs
- Furnish & Install new Trane RTUs matching capacity of Group A, B & C RTUs
- Electrical & Lightning Protection
- Condensate & Natural Gas Piping
- Ductwork and Insulation
- Roof Protection/Dumpster/General
- Test & Balance
- Crane/Rigging
- Misc/Sketching/Other

ECM Calculations

Energy Savings from the installation of high efficiency rooftop units were calculated using BPU protocols. The calculations are shown below.

CALCULATED SAVINGS

RTU Replacement - VFD Fan Savings

BUILDING	SYSTEM	Areas Served	Fan QTY	EXISTING FAN HP	PROPOSED FAN HP	EXISTING MOTOR EFFICIENCY (Nbase)	REPLACEMENT MOTOR EFFICIENCY (Nprem)	LF	CF	IFvfd	HRS	ΔkW
Gloucester High School	RTU-10	Auditorium	1	15.0	15.0	90.0%	93.0%	0.75	0.74	1.0	3,391	0.40
	RTU-12	Old Gym - Boys Side	1	7.5	7.5	88.0%	91.0%	0.75	0.74	1.0	3,391	0.21
	RTU-13	Old Gym - Girls Side	1	7.5	7.5	88.0%	91.0%	0.75	0.74	1.0	3,391	0.21
	RTU-18	Old Gym Boys Locker Room	1	2.0	2.0	83.5%	86.5%	0.75	0.74	1.0	2,745	0.06
	RTU-19	Old Gym Girls Locker Room	1	3.0	3.0	86.5%	89.5%	0.75	0.74	1.0	2,745	0.09
	RTU-21A	Cafeteria	1	7.5	7.5	88.0%	91.0%	0.75	0.74	1.0	3,391	0.21
	RTU-21B	Cafeteria	1	7.5	7.5	88.0%	91.0%	0.75	0.74	1.0	3,391	0.21
	RTU-21C	Cafeteria	1	7.5	7.5	88.0%	91.0%	0.75	0.74	1.0	3,391	0.21
	RTU-22	Kitchen	1	2.0	2.0	83.5%	86.5%	0.75	0.74	1.0	2,745	0.06
	RTU-23	Teachers Lounge	1	1.0	1.0	83.5%	86.5%	0.75	0.74	1.0	2,745	0.03
	RTU-8	Media Center Desk	1	2.0	2.0	83.5%	86.5%	0.75	0.74	1.0	2,745	0.06
	RTU-7	Media Center	1	2.0	2.0	83.5%	86.5%	0.75	0.74	1.0	2,745	0.06
	RTU-9	Media Center	1	7.5	7.5	88.0%	91.0%	0.75	0.74	1.0	3,391	0.21

RTU Replacement - VFD Fan Savings

BUILDING	SYSTEM	Areas Served	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 ELECTRIC SAVINGS (kWh)
Gloucester High School	RTU-10	Auditorium	0.30	1,020	2,033	0.286	4.3	30,495	4.6	31,515
	RTU-12	Old Gym - Boys Side	0.16	533	2,033	0.286	2.1	15,248	2.3	15,781
	RTU-13	Old Gym - Girls Side	0.16	533	2,033	0.286	2.1	15,248	2.3	15,781
	RTU-18	Old Gym Boys Locker Room	0.05	128	2,033	0.286	0.6	4,066	0.6	4,194
	RTU-19	Old Gym Girls Locker Room	0.06	179	2,033	0.286	0.9	6,099	0.9	6,278
	RTU-21A	Cafeteria	0.16	533	2,033	0.286	2.1	15,248	2.3	15,781
	RTU-21B	Cafeteria	0.16	533	2,033	0.286	2.1	15,248	2.3	15,781
	RTU-21C	Cafeteria	0.16	533	2,033	0.286	0.6	4,066	0.7	4,599
	RTU-22	Kitchen	0.05	128	2,033	0.286	0.0	0	0.0	128
	RTU-23	Teachers Lounge	0.02	64	2,033	0.286	0.3	2,033	0.3	2,097
	RTU-8	Media Center Desk	0.05	128	2,033	0.286	0.6	4,066	0.6	4,194
	RTU-7	Media Center	0.05	128	2,033	0.286	0.6	4,066	0.6	4,194
	RTU-9	Media Center	0.16	533	2,033	0.286	2.1	15,248	2.3	15,781

Algorithms

From application form calculate ΔkW where:

$$\Delta kW = 0.746 * HP * IF_{VFD} * (1/\eta_{base} - 1/\eta_{prem})$$

Demand Savings = (ΔkW) * CF

Energy Savings = (ΔkW)*HRS * LF

Definition of Variables

ΔkW = kW Savings at full load
HP = Rated horsepower of qualifying motor, from nameplate/manufacturer specs.
LF = Load Factor, percent of full load at typical operating condition
IF_{VFD} = VFD Interaction Factor, 1.0 without VFD, 0.9 with VFD
η_{base} = Efficiency of the baseline motor
η_{prem} = Efficiency of the energy-efficient motor
HRS = Annual operating hours
CF = Coincidence Factor

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

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

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

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

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

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

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

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

CALCULATED SAVINGS

RTU Replacement - Cooling Savings

BUILDING	SYSTEM	Areas Served	Existing Qty	Tons Per Unit	Total Existing Tons	EERb / SEERb	Proposed Qty	Tons Per Unit	Total Proposed Tons	EERq / SEERq	CF	EFLH Cooling	Demand Savings (kW)	Energy Savings (kWh)
Gloucester High School	RTU-10	Auditorium	1	50.0	50.0	7.8	1	50.0	50.0	10.0	0.5	466	8.2	7,680
	RTU-12	Old Gym - Boys Side	1	20.0	20.0	8.6	1	20.0	20.0	9.8	0.5	466	1.7	1,598
	RTU-13	Old Gym - Girls Side	1	20.0	20.0	8.6	1	20.0	20.0	9.8	0.5	466	1.7	1,598
	RTU-18	Old Gym Boys Locker Room	1	25.0	25.0	7.9	1	25.0	25.0	9.8	0.5	466	3.6	3,367
	RTU-19	Old Gym Girls Locker Room	1	25.0	25.0	7.9	1	25.0	25.0	9.8	0.5	466	3.6	3,367
	RTU-21A	Cafeteria	1	17.5	17.5	9.2	1	17.5	17.5	10.8	0.5	466	1.7	1,598
	RTU-21B	Cafeteria	1	17.5	17.5	9.2	1	17.5	17.5	10.8	0.5	466	1.7	1,598
	RTU-21C	Cafeteria	1	17.5	17.5	9.2	1	17.5	17.5	10.8	0.5	466	1.7	1,598
	RTU-22	Kitchen	1	7.5	7.5	9.5	1	7.5	7.5	11.0	0.5	466	0.6	595
	RTU-23	Teachers Lounge	1	3.0	3.0	9.2	1	3.0	3.0	12.9	0.5	466	0.6	527
	RTU-8	Media Center Desk	1	7.5	7.5	9.5	1	7.5	7.5	11.0	0.5	466	0.6	595
	RTU-7	Media Center	1	7.5	7.5	9.5	1	7.5	7.5	11.0	0.5	466	0.6	595
	RTU-9	Media Center	1	17.5	17.5	9.2	1	17.5	17.5	10.8	0.5	466	1.7	1,598

<u>Algorithms</u>

Air Conditioning Algorithms:

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

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

(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.

<u>Summary of Inputs</u>

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

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	14 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 12 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

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

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[37]	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

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
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

CALCULATED SAVINGS							
RTU Replacement - Economizer Savings							
BUILDING	**SYSTEM**	**Areas Served**	**QUANTITY**	**Cap (Tons)**	**D^kwh/ton**	**Demand Savings (kW)**	**Energy Savings (kWh)**
Gloucester High School	RTU-10	Auditorium	1	50	42	0	2,100
	RTU-12	Old Gym - Boys Side	1	20	42	0	840
	RTU-13	Old Gym - Girls Side	1	20	42	0	840
	RTU-18	Old Gym Boys Locker Room	1	25	42	0	1,050
	RTU-19	Old Gym Girls Locker Room	1	25	42	0	1,050
	RTU-21A	Cafeteria	1	17.5	42	0	735
	RTU-21B	Cafeteria	1	17.5	42	0	735
	RTU-21C	Cafeteria	1	17.5	42	0	735
	RTU-22	Kitchen	1	7.5	42	0	315
	RTU-23	Teachers Lounge	1	3	42	0	126
	RTU-8	Media Center Desk	1	7.5	42	0	315
	RTU-7	Media Center	1	7.5	42	0	315
	RTU-9	Media Center	1	17.5	42	0	735

Dual Enthalpy Economizers

The following algorithm details savings for dual enthalpy economizers. They are to be used to determine electric energy savings between baseline standard units and the high efficiency units promoted in the program. The baseline condition is assumed to be a rooftop unit with fixed outside air (no economizer). The high efficiency units are equipped with sensors that monitor the enthalpy of outside air and return air and modulate the outside air damper to optimize energy performance.

<u>Algorithms</u>

Electric energy savings (kWh/yr) = N * Tons * (ΔkWh/ton)

Peak Demand Savings (kW) = 0[38] kW

<u>Definition of Variables</u>

N = Number of units

Tons = Rated capacity of the cooling system retrofitted with an economizer

ΔkWh/ton = Stipulated per building type electricity energy savings per ton of cooling system retrofitted with an economizer

Summary of Inputs

Dual Enthalpy Economizers

Component	Type	Value	Source
N	Variable		Application
Tons	Variable	Rated Capacity, Tons	Application
ΔkWh/ton	Fixed	See Table Below	1

Savings per Ton of Cooling System

Building Type	Savings (ΔkWh/ton)
Assembly	27
Big Box Retail	152
Fast Food Restaurant	39
Full Service Restaurant	31
Light Industrial	25
Primary School	42
Small Office	186
Small Retail	95
Religious	6
Warehouse	2
Other	61

RTU Replacement - Heating Savings											
BUILDING NAME	SYSTEM	Areas Served	Qty	Estimated Existing Efficiency	Efficiency Units	Baseline RTU Rated Input MBH	Baseline Plant Rated Input MBH (CAPYbi)	Qualifying RTU Capacity MBH	Qualifying Plant Capacity (CAPYqi)	Qualifying RTU Efficiency	Efficiency Units
Gloucester High School	RTU-10	Auditorium	1	74.2%	%AFUE	850	850	850	850	81.0%	%AFUE
	RTU-12	Old Gym - Boys Side	1	74.2%	%AFUE	400	400	400	400	80.0%	%AFUE
	RTU-13	Old Gym - Girls Side	1	74.2%	%AFUE	400	400	400	400	80.0%	%AFUE
	RTU-18	Old Gym Boys Locker Room	1	74.2%	%AFUE	300	300	300	300	80.0%	%AFUE
	RTU-19	Old Gym Girls Locker Room	1	74.2%	%AFUE	350	350	350	350	80.0%	%AFUE
	RTU-21A	Cafeteria	1	74.2%	%AFUE	350	350	350	350	80.0%	%AFUE
	RTU-21B	Cafeteria	1	74.2%	%AFUE	350	350	350	350	80.0%	%AFUE
	RTU-21C	Cafeteria	1	74.2%	%AFUE	350	350	350	350	80.0%	%AFUE
	RTU-22	Kitchen	1	74.2%	%AFUE	150	150	150	150	81.0%	%AFUE
	RTU-23	Teachers Lounge	1	74.2%	%AFUE	120	120	120	120	81.0%	%AFUE
	RTU-8	Media Center Desk	1	74.2%	%AFUE	120	120	120	120	81.0%	%AFUE
	RTU-7	Media Center	1	74.2%	%AFUE	150	150	150	150	81.0%	%AFUE
	RTU-9	Media Center	1	74.2%	%AFUE	250	250	250	250	81.0%	%AFUE

RTU Replacement - Heating Savings									
BUILDING NAME	SYSTEM	Areas Served	EFLH	Conversion of BTU to kWh	Conversion of BTU to therms	Annual Electric Savings (kWh)	Baseline Gas Use (Therms)	Proposed Gas Use (Therms)	Annual Gas Savings (Therms)
Gloucester High School	RTU-10	Auditorium	901	3,412	100,000	-	10,320	9,455	865
	RTU-12	Old Gym - Boys Side	901	3,412	100,000	-	4,857	4,505	352
	RTU-13	Old Gym - Girls Side	901	3,412	100,000	-	4,857	4,505	352
	RTU-18	Old Gym Boys Locker Room	901	3,412	100,000	-	3,642	3,379	264
	RTU-19	Old Gym Girls Locker Room	901	3,412	100,000	-	4,249	3,942	308
	RTU-21A	Cafeteria	901	3,412	100,000	-	4,249	3,942	308
	RTU-21B	Cafeteria	901	3,412	100,000	-	4,249	3,942	308
	RTU-21C	Cafeteria	901	3,412	100,000	-	4,249	3,942	308
	RTU-22	Kitchen	901	3,412	100,000	-	1,821	1,669	153
	RTU-23	Teachers Lounge	901	3,412	100,000	-	1,457	1,335	122
	RTU-8	Media Center Desk	901	3,412	100,000	-	1,457	1,335	122
	RTU-7	Media Center	901	3,412	100,000	-	1,821	1,669	153
	RTU-9	Media Center	901	3,412	100,000	-	3,035	2,781	254

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 = Furnace Baseline Efficiency

Eff_q = Furnace Proposed Efficiency

1000 = Conversion from kBtu to MMBtu

Summary of Inputs

Prescriptive Furnaces

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

$EFLH_h$ 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 Furnace Efficiencies (Eff_b)

Furnace Type	Size Category (kBtu input)	Standard 90.1-2016
Gas Fired	< 225 ≥ 225	78% AFUE or 80% Et 80% Et
Oil Fired	< 225 ≥ 225	78% AFUE 81% Et

RTU Replacement - Total Savings								
BUILDING NAME	SYSTEM	Areas Served	Annual Electric Savings (kWh)	Total Electric Savings (kWh)	Annual Demand Savings (kW)	Total Demand Savings (kW)	Annual Gas Savings (Therms)	Total Gas Savings (Therms)
Gloucester High School	RTU-10	Auditorium	41,295	172,307	13	48	865	3,867
	RTU-12	Old Gym - Boys Side	18,219		4		352	
	RTU-13	Old Gym - Girls Side	18,219		4		352	
	RTU-18	Old Gym Boys Locker Room	8,611		4		264	
	RTU-19	Old Gym Girls Locker Room	10,695		5		308	
	RTU-21A	Cafeteria	18,114		4		308	
	RTU-21B	Cafeteria	18,114		4		308	
	RTU-21C	Cafeteria	6,933		2		308	
	RTU-22	Kitchen	1,038		1		153	
	RTU-23	Teachers Lounge	2,750		1		122	
	RTU-8	Media Center Desk	5,104		1		122	
	RTU-7	Media Center	5,104		1		153	
	RTU-9	Media Center	18,114		4		254	

HEAT RECOVERY SAVINGS

CALCULATED SAVINGS

Heat Recovery Installation Savings											
BUILDING	Occupancy Category	Ventilation SQFT	Space	HVAC Unit #	Supply Air CFM	Exaust Air CFM	OA % of Total SA	Density of Dry Supply Air (lb/cf)	Supply Air lb/min	Exaust Air lb/min	Moist-air specific heat at Constant Pressure (Btu/lb-F)
Gloucester High School	Locker Room	2740	Old Gym Boys Locker Room	RTU-18	3,100	3,100	100%	0.075	233	233	0.240
Gloucester High School	Locker Room	3130	Old Gym Girls Locker Room	RTU-19	3,100	3,100	100%	0.075	233	233	0.240

Heat Recovery Installation Savings								
BUILDING	Occupancy Category	Space	HVAC Unit #	Exhaust Air Entering Temp - Heating (F)	Exhaust Air Leaving Temp - Heating (F)	Sensible Heat-Transfer Rate (btu/hr)	EFLH Heating	Total Annaul Heating Savings (therms)
Gloucester High School	Locker Room	Old Gym Boys Locker Room	RTU-18	69	55	46,872	901	422
Gloucester High School	Locker Room	Old Gym Girls Locker Room	RTU-19	69	55	46,872	901	422

Heat Recovery Installation Savings											
BUILDING	Occupancy Category	Space	HVAC Unit #	Exhaust Air Entering Temp - Cooling (F)	Exhaust Air Leaving Temp - Cooling (F)	Maximum Sensible Heat-Transfer Rate (btu/hr)	Sensible Heat-Transfer Rate (btu/hr)	EFLH Cooling	Total Annual Cooling Savings (kWh)	Total Electric Savings (kWh)	Total Gas Savings (Th)
Gloucester High School	Locker Room	Old Gym Boys Locker Room	RTU-18	72	75	10,044	10,044	466	1,372	1,372	422
Gloucester High School	Locker Room	Old Gym Girls Locker Room	RTU-19	72	75	10,044	10,044	466	1,372	1,372	422

ECM 9 – Pipe and Valve Insulation

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✓	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
9	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 or cellular glass insulation.

Uninsulated hot water piping

Existing Conditions

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

Pipe and valve insulation at Gloucester High School

Pipe and valve insulation at Moore School and Woodruff School

Scope of Work

BUILDING	COMPONET	MEDIUM	TOTAL QTY OR LENGTH
Gloucester High School	End Cap	Hot Water	1
Gloucester High School	Flange	Hot Water	1
Gloucester High School	Butterfly Valve	Hot Water	1
Gloucester High School	Flange	Hot Water	15
Gloucester High School	Flex Fitting	Hot Water	4
Gloucester High School	Gate Valve	Hot Water	3
Gloucester High School	Pipe Reducer	Hot Water	2
Gloucester High School	T Intersection	Hot Water	1
Gloucester High School	Triple Duty Valve	Hot Water	2
Gloucester High School	90 Degree Elbow	Hot Water	1
Gloucester High School	Check Valve	Hot Water	2
Gloucester High School	End Cap	Hot Water	2
Gloucester High School	Flange	Hot Water	16
Gloucester High School	Gate Valve	Hot Water	5
Gloucester High School	Pipe Reducer	Hot Water	2
Gloucester High School	90 Degree Elbow	Hot Water	2
Gloucester High School	End Cap	Hot Water	1
Gloucester High School	Flange	Hot Water	22
Gloucester High School	Gate Valve	Hot Water	5
Gloucester High School	Strainer	Hot Water	1
Gloucester High School	T Intersection	Hot Water	2
Gloucester High School	Air Seperator Tank	Hot Water	1

BUILDING	COMPONET	MEDIUM	TOTAL QTY OR LENGTH
Cold Springs ES & ECC	Flange	Hot Water	6
Cold Springs ES & ECC	In-Line Pump	Hot Water	3
Cold Springs ES & ECC	Straight Pipe	Hot Water	1
Cold Springs ES & ECC	Flange	Hot Water	6
Cold Springs ES & ECC	In-Line Pump	Hot Water	3
Cold Springs ES & ECC	Flange	Hot Water	10
Cold Springs ES & ECC	In-Line Pump	Hot Water	1
Cold Springs ES & ECC	Strainer	Hot Water	3
Cold Springs ES & ECC	Triple Duty Valve	Hot Water	6
Cold Springs ES & ECC	Flange	Hot Water	12
Cold Springs ES & ECC	Flex Fitting	Hot Water	4
Cold Springs ES & ECC	Pipe Reducer	Hot Water	2
Cold Springs ES & ECC	Suction Diffuser	Hot Water	2
Cold Springs ES & ECC	90 Degree Elbow	Hot Water	1
Cold Springs ES & ECC	Butterfly Valve	Hot Water	6
Cold Springs ES & ECC	Flange	Hot Water	4
Cold Springs ES & ECC	Flex Fitting	Hot Water	4
Cold Springs ES & ECC	Pipe Reducer	Hot Water	2
Cold Springs ES & ECC	Straight Pipe	Hot Water	2
Cold Springs ES & ECC	Suction Diffuser	Hot Water	2
Cold Springs ES & ECC	Triple Duty Valve	Hot Water	2
Cold Springs ES & ECC	Flange	Hot Water	3
Cold Springs ES & ECC	Pipe Reducer	Hot Water	2
Cold Springs ES & ECC	Air Seperator Tank	Hot Water	1
Gloucester Middle School	90 Degree Elbow	Hot Water	22
Gloucester Middle School	Ball valve	Hot Water	14
Gloucester Middle School	Check Valve	Hot Water	3
Gloucester Middle School	Flange	Hot Water	4
Gloucester Middle School	In-Line Pump	Hot Water	2
Gloucester Middle School	Straight Pipe	Hot Water	33
Gloucester Middle School	Triple Duty Valve	Hot Water	2
Gloucester Middle School	90 Degree Elbow	Hot Water	4
Gloucester Middle School	Ball valve	Hot Water	4
Gloucester Middle School	Check Valve	Hot Water	2
Gloucester Middle School	Flange	Hot Water	4
Gloucester Middle School	In-Line Pump	Hot Water	2
Gloucester Middle School	Straight Pipe	Hot Water	5
Gloucester Middle School	Ball valve	Hot Water	1
Gloucester Middle School	90 Degree Elbow	Hot Water	2
Gloucester Middle School	Ball valve	Hot Water	2
Gloucester Middle School	Straight Pipe	Hot Water	6
Gloucester Middle School	Ball valve	Hot Water	3
Gloucester Middle School	90 Degree Elbow	Hot Water	2
Gloucester Middle School	Butterfly Valve	Hot Water	2
Gloucester Middle School	Flange	Hot Water	15
Gloucester Middle School	Gate Valve	Hot Water	2
Gloucester Middle School	In-Line Pump	Hot Water	2
Gloucester Middle School	Strainer	Hot Water	3
Gloucester Middle School	Suction Diffuser	Hot Water	2
Gloucester Middle School	Air Seperator Tank	Hot Water	1

Insulation will be installed on exposed pipes and valves. Failed insulation will be replaced. Poorly insulated pipes in the heating and cooling distribution system is 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
    - Foamglass
    - Styrofoam
    - Urethane
    - Closed cell rubber

ECM Calculations

Energy Savings from the installation of unit ventilators were calculated using BPU protocols. The calculations are shown below.

Pipe and Valve Insulation Savings										
BUILDING	COMPONET	MEDIUM	TOTAL QTY OR LENGTH	TOTAL LENGTH (LF) OR TOTAL AREA (SF)	PIPE DIA (IN) OR TANK SURFACE AREA (SF)	EQUIVALENT PIPE OD (IN)	INSULATION THICKNESS (IN)	SAVINGS FACTOR (BTU/HR-FT)	INSULATION THERMAL COND k (btu-in)/(hr-F-ft^2)	INSULATION VALUE (hr-F-ft^2)/btu)
Gloucester High School	End Cap	Hot Water	1	2	4.00	4.50	2.00	281.00	0.31	6.45
Gloucester High School	Flange	Hot Water	1	2	4.00	4.50	1.50	274.00	0.35	4.34
Gloucester High School	Butterfly Valve	Hot Water	1	4	5.00	5.56	1.50	274.00	0.35	4.34
Gloucester High School	Flange	Hot Water	15	27	5.00	5.56	1.50	274.00	0.35	4.34
Gloucester High School	Flex Fitting	Hot Water	4	6	5.00	5.56	1.50	274.00	0.35	4.34
Gloucester High School	Gate Valve	Hot Water	3	15	5.00	5.56	1.50	274.00	0.35	4.34
Gloucester High School	Pipe Reducer	Hot Water	2	2	5.00	5.56	1.50	274.00	0.35	4.34
Gloucester High School	T Intersection	Hot Water	1	1	5.00	5.56	2.00	281.00	0.31	6.45
Gloucester High School	Triple Duty Valve	Hot Water	2	9	5.00	5.56	1.50	274.00	0.35	4.34
Gloucester High School	90 Degree Elbow	Hot Water	1	2	6.00	6.63	2.00	281.00	0.31	6.45
Gloucester High School	Check Valve	Hot Water	2	8	6.00	6.63	1.50	274.00	0.35	4.34
Gloucester High School	End Cap	Hot Water	2	4	6.00	6.63	2.00	281.00	0.31	6.45
Gloucester High School	Flange	Hot Water	16	29	6.00	6.63	1.50	274.00	0.35	4.34
Gloucester High School	Gate Valve	Hot Water	5	25	6.00	6.63	1.50	274.00	0.35	4.34
Gloucester High School	Pipe Reducer	Hot Water	2	2	6.00	6.63	1.50	274.00	0.35	4.34
Gloucester High School	90 Degree Elbow	Hot Water	2	4	8.00	8.63	2.00	281.00	0.31	6.45
Gloucester High School	End Cap	Hot Water	1	2	8.00	8.63	2.00	281.00	0.31	6.45
Gloucester High School	Flange	Hot Water	22	40	8.00	8.63	1.50	274.00	0.35	4.34
Gloucester High School	Gate Valve	Hot Water	5	25	8.00	8.63	1.50	274.00	0.35	4.34
Gloucester High School	Strainer	Hot Water	1	5	8.00	8.63	1.50	274.00	0.35	4.34
Gloucester High School	T Intersection	Hot Water	2	2	8.00	8.63	2.00	281.00	0.31	6.45
Gloucester High School	Air Seperator Tank	Hot Water	1	31	31.40	0.00	2.00	281.00	0.31	6.45

Pipe and Valve Insulation Savings

BUILDING	PROPOSED INSULATION TYPE	HEATING EFFICIENCY (%)	COOLING EFFICIENCY (EER)	HOURS PER YEAR	SPACE TEMPERATURE (F)	FLUID TEMPERATURE (F)	SCALING FACTOR	Bare Convection h_c (BTU/hr-ft2-F)	Bare Convection h_c (BTU/hr-ft2-F)	BASELINE ENERGY CONSUMPTION (THERMS)	ENERGY SAVINGS (THERMS)
Gloucester High School	Cellular Glass	75.8%	N/A	4,282	74	170	0.738	0.877	1.089	23	16
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.877	1.089	23	16
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.830	1.089	62	43
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.830	1.089	409	286
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.830	1.089	91	64
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.830	1.089	227	159
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.830	1.089	30	21
Gloucester High School	Cellular Glass	75.8%	N/A	4,282	74	170	0.738	0.830	1.089	18	13
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.830	1.089	133	93
Gloucester High School	Cellular Glass	75.8%	N/A	4,282	74	170	0.738	0.793	1.089	32	21
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.793	1.089	145	94
Gloucester High School	Cellular Glass	75.8%	N/A	4,282	74	170	0.738	0.793	1.089	64	42
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.793	1.089	509	329
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.793	1.089	442	286
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.793	1.089	35	23
Gloucester High School	Cellular Glass	75.8%	N/A	4,282	74	170	0.738	0.738	1.089	80	42
Gloucester High School	Cellular Glass	75.8%	N/A	4,282	74	170	0.738	0.738	1.089	40	21
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.738	1.089	885	452
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.738	1.089	559	286
Gloucester High School	Removable Blanket	75.8%	N/A	4,282	74	170	0.738	0.738	1.089	112	57
Gloucester High School	Cellular Glass	75.8%	N/A	4,282	74	170	0.738	0.738	1.089	54	28
Gloucester High School	Cellular Glass	75.8%	N/A	4,282	74	170	0.738	0.524	1.089	0	0

Pipe and Valve Insulation Savings

BUILDING	COMPONET	MEDIUM	TOTAL QTY OR LENGTH	TOTAL LENGTH (LF) OR TOTAL AREA (SF)	PIPE DIA (IN) OR TANK SURFACE AREA (SF)	EQUIVALENT PIPE OD (IN)	INSULATION THICKNESS (IN)	SAVINGS FACTOR (BTU/HR-FT)	INSULATION THERMAL COND k (btu-in)/(hr-F-ft^2)	INSULATION VALUE (hr-F-ft^2)/btu)
Cold Springs ES & ECC	Flange	Hot Water	6	11	1.50	1.90	1.50	120.00	0.35	4.34
Cold Springs ES & ECC	In-Line Pump	Hot Water	3	15	1.50	1.90	1.50	120.00	0.35	4.34
Cold Springs ES & ECC	Straight Pipe	Hot Water	1	1	1.50	1.90	2.00	125.00	0.31	6.45
Cold Springs ES & ECC	Flange	Hot Water	6	11	2.00	2.38	1.50	148.00	0.35	4.34
Cold Springs ES & ECC	In-Line Pump	Hot Water	3	15	2.00	2.38	1.50	148.00	0.35	4.34
Cold Springs ES & ECC	Flange	Hot Water	10	18	2.50	2.88	1.50	182.00	0.35	4.34
Cold Springs ES & ECC	In-Line Pump	Hot Water	1	5	2.50	2.88	1.50	182.00	0.35	4.34
Cold Springs ES & ECC	Strainer	Hot Water	3	15	2.50	2.88	1.50	182.00	0.35	4.34
Cold Springs ES & ECC	Triple Duty Valve	Hot Water	6	26	2.50	2.88	1.50	182.00	0.35	4.34
Cold Springs ES & ECC	Flange	Hot Water	12	22	3.00	3.50	1.50	230.00	0.35	4.34
Cold Springs ES & ECC	Flex Fitting	Hot Water	4	6	3.00	3.50	1.50	230.00	0.35	4.34
Cold Springs ES & ECC	Pipe Reducer	Hot Water	2	2	3.00	3.50	1.50	230.00	0.35	4.34
Cold Springs ES & ECC	Suction Diffuser	Hot Water	2	9	3.00	3.50	1.50	230.00	0.35	4.34
Cold Springs ES & ECC	90 Degree Elbow	Hot Water	1	2	4.00	4.50	2.00	281.00	0.31	6.45
Cold Springs ES & ECC	Butterfly Valve	Hot Water	6	25	4.00	4.50	1.50	274.00	0.35	4.34
Cold Springs ES & ECC	Flange	Hot Water	4	7	4.00	4.50	1.50	274.00	0.35	4.34
Cold Springs ES & ECC	Flex Fitting	Hot Water	4	6	4.00	4.50	1.50	274.00	0.35	4.34
Cold Springs ES & ECC	Pipe Reducer	Hot Water	2	2	4.00	4.50	1.50	274.00	0.35	4.34
Cold Springs ES & ECC	Straight Pipe	Hot Water	2	2	4.00	4.50	2.00	281.00	0.31	6.45
Cold Springs ES & ECC	Suction Diffuser	Hot Water	2	9	4.00	4.50	1.50	274.00	0.35	4.34
Cold Springs ES & ECC	Triple Duty Valve	Hot Water	2	9	4.00	4.50	1.50	274.00	0.35	4.34
Cold Springs ES & ECC	Flange	Hot Water	3	5	6.00	6.63	1.50	274.00	0.35	4.34
Cold Springs ES & ECC	Pipe Reducer	Hot Water	2	2	6.00	6.63	1.50	274.00	0.35	4.34
Cold Springs ES & ECC	Air Seperator Tank	Hot Water	1	18	17.66	0.00	2.00	281.00	0.35	5.78

Pipe and Valve Insulation Savings

BUILDING	PROPOSED INSULATION TYPE	HEATING EFFICIENCY (%)	COOLING EFFICIENCY (EER)	HOURS PER YEAR	SPACE TEMPERATURE (F)	FLUID TEMPERATURE (F)	SCALING FACTOR	Bare Convection h_c (BTU/hr-ft2-F)	Bare Convection h_c (BTU/hr-ft2-F)	BASELINE ENERGY CONSUMPTION (THERMS)	ENERGY SAVINGS (THERMS)
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	1.121	1.089	59	41
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	1.121	1.089	81	57
Cold Springs ES & ECC	Cellular Glass	83.2%	N/A	4,282	74	170	0.738	1.121	1.089	5	4
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	1.043	1.089	71	49
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	1.043	1.089	98	69
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.987	1.089	139	97
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.987	1.089	39	27
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.987	1.089	116	81
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.987	1.089	204	143
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.943	1.089	199	139
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.943	1.089	55	39
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.943	1.089	18	13
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.943	1.089	81	57
Cold Springs ES & ECC	Cellular Glass	83.2%	N/A	4,282	74	170	0.738	0.877	1.089	21	14
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.877	1.089	281	197
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.877	1.089	82	58
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.877	1.089	69	48
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.877	1.089	23	16
Cold Springs ES & ECC	Cellular Glass	83.2%	N/A	4,282	74	170	0.738	0.877	1.089	23	16
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.877	1.089	101	70
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.877	1.089	101	70
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.793	1.089	87	56
Cold Springs ES & ECC	Removable Blanket	83.2%	N/A	4,282	74	170	0.738	0.793	1.089	32	21
Cold Springs ES & ECC	Cellular Glass	83.2%	N/A	4,282	74	170	0.738	0.605	1.089	0	0

Pipe and Valve Insulation Savings

BUILDING	COMPONET	MEDIUM	TOTAL QTY OR LENGTH	TOTAL LENGTH (LF) OR TOTAL AREA (SF)	PIPE DIA (IN) OR TANK SURFACE AREA (SF)	EQUIVALENT PIPE OD (IN)	INSULATION THICKNESS (IN)	SAVINGS FACTOR (BTU/HR-FT)	INSULATION THERMAL COND k (btu-in)/(hr-F-ft^2)	INSULATION VALUE (hr-F-ft^2)/btu)
Gloucester Middle School	90 Degree Elbow	Hot Water	22	40	1.00	1.32	1.50	85.00	0.31	4.84
Gloucester Middle School	Ball valve	Hot Water	14	57	1.00	1.32	1.50	85.00	0.35	4.34
Gloucester Middle School	Check Valve	Hot Water	3	12	1.00	1.32	1.50	85.00	0.35	4.34
Gloucester Middle School	Flange	Hot Water	4	7	1.00	1.32	1.50	85.00	0.35	4.34
Gloucester Middle School	In-Line Pump	Hot Water	2	10	1.00	1.32	1.50	85.00	0.35	4.34
Gloucester Middle School	Straight Pipe	Hot Water	33	33	1.00	1.32	1.50	85.00	0.31	4.84
Gloucester Middle School	Triple Duty Valve	Hot Water	2	9	1.00	1.32	1.50	85.00	0.35	4.34
Gloucester Middle School	90 Degree Elbow	Hot Water	4	7	1.25	1.66	1.50	107.00	0.31	4.84
Gloucester Middle School	Ball valve	Hot Water	4	16	1.25	1.66	1.50	107.00	0.35	4.34
Gloucester Middle School	Check Valve	Hot Water	2	8	1.25	1.66	1.50	107.00	0.35	4.34
Gloucester Middle School	Flange	Hot Water	4	7	1.25	1.66	1.50	107.00	0.35	4.34
Gloucester Middle School	In-Line Pump	Hot Water	2	10	1.25	1.66	1.50	107.00	0.35	4.34
Gloucester Middle School	Straight Pipe	Hot Water	5	5	1.25	1.66	1.50	107.00	0.31	4.84
Gloucester Middle School	Ball valve	Hot Water	1	4	1.50	1.90	1.50	120.00	0.35	4.34
Gloucester Middle School	90 Degree Elbow	Hot Water	2	4	2.00	2.38	2.00	153.00	0.31	6.45
Gloucester Middle School	Ball valve	Hot Water	2	8	2.00	2.38	1.50	148.00	0.35	4.34
Gloucester Middle School	Straight Pipe	Hot Water	6	6	2.00	2.38	2.00	153.00	0.31	6.45
Gloucester Middle School	Ball valve	Hot Water	3	12	2.50	2.88	1.50	182.00	0.35	4.34
Gloucester Middle School	90 Degree Elbow	Hot Water	2	4	4.00	4.50	2.00	281.00	0.31	6.45
Gloucester Middle School	Butterfly Valve	Hot Water	2	8	4.00	4.50	1.50	274.00	0.35	4.34
Gloucester Middle School	Flange	Hot Water	15	27	4.00	4.50	1.50	274.00	0.35	4.34
Gloucester Middle School	Gate Valve	Hot Water	2	10	4.00	4.50	1.50	274.00	0.35	4.34
Gloucester Middle School	In-Line Pump	Hot Water	2	10	4.00	4.50	1.50	274.00	0.35	4.34
Gloucester Middle School	Strainer	Hot Water	3	15	4.00	4.50	1.50	274.00	0.35	4.34
Gloucester Middle School	Suction Diffuser	Hot Water	2	9	4.00	4.50	1.50	274.00	0.35	4.34
Gloucester Middle School	Air Seperator Tank	Hot Water	1	9	9.42	0.00	2.00	281.00	0.35	5.78

Pipe and Valve Insulation Savings

BUILDING	PROPOSED INSULATION TYPE	HEATING EFFICIENCY (%)	HOURS PER YEAR	SPACE TEMPERATURE (F)	FLUID TEMPERATURE (F)	SCALING FACTOR	Bare Convection h_c (BTU/hr-ft2-F)	Bare Convection h_c (BTU/hr-ft2-F)	BASELINE ENERGY CONSUMPTION (THERMS)	ENERGY SAVINGS (THERMS)
Gloucester Middle School	Cellular Glass	83.8%	4,282	74	170	0.738	1.241	1.089	156	109
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.241	1.089	226	158
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.241	1.089	48	34
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.241	1.089	28	20
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.241	1.089	39	28
Gloucester Middle School	Cellular Glass	83.8%	4,282	74	170	0.738	1.241	1.089	130	91
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.241	1.089	35	24
Gloucester Middle School	Cellular Glass	83.8%	4,282	74	170	0.738	1.174	1.089	35	24
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.174	1.089	79	55
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.174	1.089	40	28
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.174	1.089	35	24
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.174	1.089	48	34
Gloucester Middle School	Cellular Glass	83.8%	4,282	74	170	0.738	1.174	1.089	24	17
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.121	1.089	22	15
Gloucester Middle School	Cellular Glass	83.8%	4,282	74	170	0.738	1.043	1.089	23	16
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	1.043	1.089	53	37
Gloucester Middle School	Cellular Glass	83.8%	4,282	74	170	0.738	1.043	1.089	39	27
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	0.987	1.089	94	66
Gloucester Middle School	Cellular Glass	83.8%	4,282	74	170	0.738	0.877	1.089	41	29
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	0.877	1.089	93	65
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	0.877	1.089	307	215
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	0.877	1.089	114	80
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	0.877	1.089	114	80
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	0.877	1.089	170	119
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	0.877	1.089	100	70
Gloucester Middle School	Removable Blanket	83.8%	4,282	74	170	0.738	0.708	1.089	0	0

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

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

Energy Use Density Look-up Table

Building Type	Energy Use Density (kBtu/SF/yr)
Education	7.0
Food sales	4.4
Food service	39.2
Health care	23.7
Inpatient	34.3
Outpatient	3.9
Lodging	26.5
Retail (other than mall)	2.5
Enclosed and strip malls	14.1
Office	4.8
Public assembly	2.1
Public order and safety	21.4
Religious worship	0.9
Service	15
Warehouse and storage	2.9
Other	2.3

Example: If a water heater of 150 kBtu/hr input capacity and 100 gallons storage capacity is installed in an existing building, the baseline standby losses would be calculated as SL = (150 kBtu/hr / 0.8 + 110 × √100) / 1000 = 1.29 kBtu/hr. If the proposed equipment's standby losses were rated for 1.0 kBtu/hr, the standby loss factor for savings would be SLF = (1.29 – 1.0) / 150 = 0.0019.

In the above example, if the unit was rated for 96% thermal efficiency, and installed in an office building space of 10,000 ft^2, the annual energy savings would be ((1 – 0.8/0.96) + 0.0019) × 4.8 × 10000 / 1000 = 8.1 MMBtus/yr

ECM 11 – Water Conservation

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
11	Water Conservation	✔	✔	✔

It takes a considerable amount of energy to deliver and treat the water you use every day. For example, letting your faucet run for five minutes uses about as much energy as letting a 60-watt light bulb run for 22 hours. Pump and water heating energy is required to deliver hot water to the end user. Installing new fixtures and aerators can conserve substantial energy while reducing water consumption as well.
New low flow fixtures are rated at 1.5 gallons per minute and can be fitted with time based automatic shutoffs.

Fixture with aerator

Existing Conditions

Existing urinals typically consist of 1.5 GPF and 1.0 GPF models. Existing urinals use older non-chloramine resistant diaphragm valves. These diaphragms and components deteriorate over time due to the flexing of the rubber and chloramines in the water treatment process. Urinal valves over 5 years in age have partially degraded diaphragms creating an average of 10% to 15% additional water per flush for those fixtures. The fixtures should be retrofit to low flow using high efficiency technology with newer chloramine resistant. Existing faucets evaluated for water conservation measures consist of models with an average flow of 2.2 GPM.

Existing equipment at Cold Springs ES & ECC and Gloucester HS

Scope of Work

192 existing faucets within the facilities will be retrofit with high efficiency .5 GPM aerators. 80 existing faucets within classroom spaces will be retrofit with high efficiency 1.5 GPM aerators (272 total). 24 existing urinals will be retrofit with .5 GPF (gallons per flush) urinal flush valves.

Water Conservation Scope of Work		
BUILDING	**CATEGORY**	**QUANTITY**
Gloucester High School	Urinal -Retrofit Valve Kit	18
	Faucets - Replace Aerators	85
Cold Springs ES & ECC	Urinal -Retrofit Valve Kit	6
	Faucets - Replace Aerators	166
Gloucester Middle School	Faucets - Replace Aerators	21

Type	Retrofit Description	Sum of QTY
FAUCET	0.5 GPM Faucet Aerator	191
URINAL	0.5 GPF Diaphragm Urinal Valve Kit	24
CLASSROOM FAUCET	1.5 GPM Classroom Aerator	80

ECM Calculations

Fuel savings associated with water conservation from faucet aerators is calculated using NJ BPU Protocols:

CALCULATED SAVINGS

Water Conservation Fuel Savings

BUILDING NAME				Faucets Aerators							
	DHW Type	Days/Wk	Wk/Yr	Number of Fixtures	Existing (GPM)	Proposed (GPM)	Duration (Min)	Days per year	dT (F)	EFF	Fuel Savings (Therms)
Gloucester High School	Natural Gas	5	38	85	2.09	0.68	30.0	190	27.40	80%	1,939
Cold Springs ES & ECC	Natural Gas	5	38	166	2.03	0.89	30.0	190	27.40	80%	3,071
Gloucester Middle School	Natural Gas	5	38	21	1.87	0.50	30.0	190	27.40	80%	464

Water Conservation Water Savings

BUILDING NAME	Population			Usage per Day				
	Students	Staff	Total	Urinal (flush)	Faucet (hr)	CF%	Urinal	Faucet
Gloucester High School	702	49	751	1.0	0.50	50%	376	188
Cold Springs ES & ECC	842	70	912	1.0	0.50	50%	456	228
Gloucester Middle School	779	58	837	1.0	0.50	50%	419	209

Water Conservation Water Savings

BUILDING NAME	Urinal Valve Replacement							
	Days Per Year	Fixture QTY	Avg Daily Usage	Existing Urinal Flow (GPM)	Pre Water Used Per Year (Gal)	Proposed Urinal Flow (GPM)	Proposed Water Used Per Year (Gal)	Water Saved Per Year (Gal)
Gloucester High School	190	18	20.9	1.0	71,345	0.5	35,673	35,673
Cold Springs ES & ECC	190	6	76.0	1.0	86,640	0.5	43,320	43,320
Gloucester Middle School	190	0	0.0	1.0	0	0.5	0	0

Water Conservation Water Savings

BUILDING NAME	Faucet Aerator Installation							
	Days Per Year	Fixture QTY	Avg Daily Usage	Existing Faucet Flow (GPM)	Pre Water Used Per Year (Gal)	Proposed Faucet Flow (GPM)	Proposed Water Used Per Year (Gal)	Water Saved Per Year (Gal)
Gloucester High School	190	85	2.2	2.09	74,409	0.68	24,131	50,277
Cold Springs ES & ECC	190	166	1.4	2.03	88,154	0.89	38,623	49,531
Gloucester Middle School	190	21	10.0	1.87	74,214	0.50	19,879	54,335

Gloucester City SD – Aerator Sum-Product Table

SCHOOL	AERATORS		COUNT	% of TOTAL	NAMEPLATE	
	PRE	POST			PRE	POST
Gloucester High School	2.2 GPM FA Male	0.5 GPM FA	16	18.8%	2.20	0.50
	2.2 GPM FA	0.5 GPM FA	18	21.2%	2.20	0.50
	2.2 GPM CF	1.5 GPM CA	15	17.6%	2.20	1.50
	1.5 GPM FA Male	0.5 GPM FA	4	4.7%	1.50	0.50
	1.5 GPM FA	0.5 GPM FA	1	1.2%	1.50	0.50
	2.0 GPM FA Male	0.5 GPM FA	27	31.8%	2.00	0.50
	2.0 GPM FA	0.5 GPM FA	4	4.7%	2.00	0.50
				100%	**2.09**	**0.68**
Cold Springs School	2.2 GPM FA Male	0.5 GPM FA	57	34.3%	2.20	0.50
	2.2 GPM FA	0.5 GPM FA	7	4.2%	2.20	0.50
	2.2 GPM CF	1.5 GPM CA	65	39.2%	2.20	1.50
	1.5 GPM FA Male	0.5 GPM FA	29	17.5%	1.50	0.50
	1.2 GPM FA Male	0.5 GPM FA	5	3.0%	1.20	0.50
	1.5 GPM FA Male	0.5 GPM FA	1	0.6%	1.50	0.50
	1.5 GPM FA	0.5 GPM FA	2	1.2%	1.50	0.50
				100%	**2.03**	**0.89**
Gloucester Middle School	2.2 GPM FA Male	0.5 GPM FA	6	28.6%	2.20	0.50
	2.2 GPM FA	0.5 GPM FA	2	9.5%	2.20	0.50
	2.2 GPM FA FS Male	0.5 GPM FA	3	14.3%	2.20	0.50
	1.5 GPM FA	0.5 GPM FA	10	47.6%	1.50	0.50
				100%	**1.87**	**0.50**

Water Conservation Fuel Savings

BUILDING NAME	Total Savings		
	Total Aerators	Total Electrtic Savings (kWh)	Total Fuel Savings (Therms)
Gloucester High School	85	0	1,939
Cold Springs ES & ECC	166	0	3,071
Gloucester Middle School	21	0	464

Water Conservation Water Savings

BUILDING NAME	Total Savings
	Total Water Savings (Gal)
Gloucester High School	85,950
Cold Springs ES & ECC	92,851
Gloucester Middle School	54,335

2021 NJ BPU Protocols:

Low Flow Faucet Aerators and Showerheads

Algorithm

Therm or kWh Fuel Savings/yr = N * M * D * (F_b – F_q) * (8.33 * DT / EFF)/ C

Definition of Variables

N = Number of fixtures

M = Minutes per day of device usage

D = Days per year of device usage

F_b = Baseline device flow rate (gal/m)

F_q = Low flow device flow rate (gal/m)

8.33 = Heat content of water (Btu/gal/°F)

DT = Difference in temperature (°F) between cold intake and output

EFF = Efficiency of water heating equipment

C = Conversion factor from Btu to therms or kWh = (100,000 for gas water heating (Therms), 3,413 for electric water heating (kWh)

Summary of Inputs

Low Flow Faucet Aerators and Showerheads

Component	Type	Value	Source
N	Variable		Application
M	Fixed	Aerators 30 minutes	1
		Shower heads 20 minutes	
D	Fixed	Aerators 260 days	1
		Shower heads 365 days	
F_b	Fixed	Aerators 2.2 gpm	
		Showerhead 2.5 gpm	
F_q	Fixed	Aerators <=1.5 gpm (kitchen) <=0.5 gpm (public restroom) <=1.5 gpm (private restroom)	2,3,4
		Showerheads <=2 gpm	4
DT	Fixed	Aerators 27.4°F	5
		Showerheads 44.4°F	6
EFF	Fixed	98% electric 80% natural gas	7,8

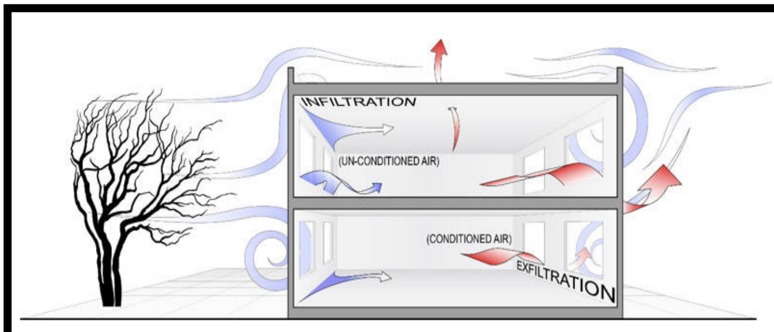
ECM 12 – Building Envelope Weatherization

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
12	Building Envelope Weatherization	✔	✔	✔

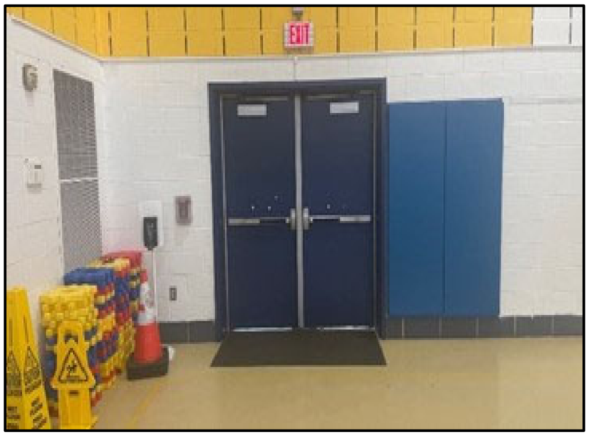
An on-site survey of the existing air barrier continuity was conducted at all three Gloucester City School District buildings. During the on-site inspection, several areas of the facilities were inspected for effective air barriers at the building envelope. Temperature, relative humidity, CO2 levels,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



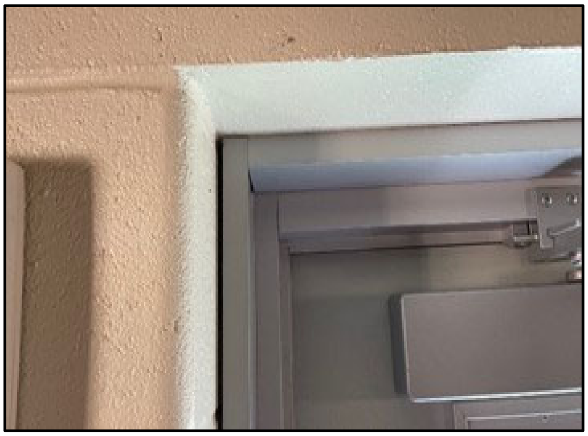
Infiltration is unconditioned air that enters the building from a variety of paths.

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

Existing Conditions at Cold Springs ES & ECC




Existing Conditions at Gloucester MS


Existing Conditions at Gloucester HS

Scope of Work

Building Envelope Scope of Work				
BUILDING	**TYPE**	**CATEGORY**	**NOTES**	**QUANTITY**
Gloucester High School	Buck Frame Air Sealing	Block, Seal (LF)	LF	1,874
	Caulking	Interior Seal (LF)	LF	702
	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	UT	27
	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	UT	21
	Garage Door Weather Stripping	Overhead Door Weather Strip - Sides, Top	UT	1
	Garage Door Weather Stripping	Roll-Up Door Weather Strip - Sides, Top, Bottom	UT	4
	Overhang Air Sealing	Block, Seal (SF)	SF	63
	Roof-Wall Intersection Air Sealing	Seal (LF)	LF	2426
Cold Springs ES & ECC	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	UT	1
	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	UT	27
	Door Weather Stripping	Install Door Jamb Spacer (UT)	UT	16
	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	UT	10
	Overhang Air Sealing	Block, Seal (LF)	LF	14
	ADDER - SKYLIGHT CAULKING	Caulking	LF	3217
Gloucester Middle School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	UT	18
	Door Weather Stripping	Install Door Jamb Spacer (UT)	UT	13
	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	UT	2
	Garage Door Weather Stripping	Roll-Up Door Weather Strip - Sides, Top	UT	2
	Roof-Wall Intersection Air Sealing	Seal (LF)	LF	681

Building Envelope improvements to the district will be included and not limited to:

- Door weather Stripping
- Roof-Wall Intersection Air Sealing
- Overhand Air Sealing
- Buck Frame Air Sealing
- Caulking

ECM Calculations

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

CALCULATED SAVINGS

Building Envelope - Heating Savings

BUILDING	TYPE	SUBTYPE	INFILTRATION REDUCTION (CFM)	HEATING FUEL	HEATING EFFICIENCY (%)	SENSIABLE HEAT CONSTANT	HOURS (HR/DAY)	HEAT EFFICIENCY FACTOR	HEATING DEGREE DAYS	INFILTRATION HEATING SAVINGS (THERM)	TOTAL HEATING SAVINGS (THERM)
Gloucester High School	Buck Frame Air Sealing	Block, Seal (LF)	1,359	Natural Gas	77.0%	1.08	24	2969	4644	2125	2,125
Gloucester High School	Caulking	Interior Seal (LF)	95	Natural Gas	77.0%	1.08	24	2969	4644	149	149
Gloucester High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	969	Natural Gas	77.0%	1.08	24	2969	4644	1516	1,516
Gloucester High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	457	Natural Gas	77.0%	1.08	24	2969	4644	715	715
Gloucester High School	Garage Door Weather Stripping	Overhead Door Weather Strip - Sides, Top	30	Natural Gas	77.0%	1.08	24	2969	4644	48	48
Gloucester High School	Garage Door Weather Stripping	Roll-Up Door Weather Strip - Sides, Top, Bottom	175	Natural Gas	77.0%	1.08	24	2969	4644	274	274
Gloucester High School	Overhang Air Sealing	Block, Seal (SF)	61	Natural Gas	77.0%	1.08	24	2969	4644	95	95
Gloucester High School	Roof-Wall Intersection Air Sealing	Seal (LF)	1,759	Natural Gas	77.0%	1.08	24	2969	4644	2751	2,751
Cold Springs ES & ECC	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	29	Natural Gas	83.0%	1.08	24	3201	4644	43	43
Cold Springs ES & ECC	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	969	Natural Gas	83.0%	1.08	24	3201	4644	1406	1,406
Cold Springs ES & ECC	Door Weather Stripping	Install Door Jamb Spacer (UT)	0	Natural Gas	83.0%	1.08	24	3201	4644	0	0
Cold Springs ES & ECC	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	218	Natural Gas	83.0%	1.08	24	3201	4644	316	316
Cold Springs ES & ECC	Overhang Air Sealing	Block, Seal (LF)	15	Natural Gas	83.0%	1.08	24	3201	4644	22	22
Cold Springs ES & ECC	ADDER - SKYLIGHT CAULKING	Caulking	0	Natural Gas	83.0%	1.08	24	3201	4644	0	0
Gloucester Middle School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	646	Natural Gas	80.5%	1.08	24	3105	4644	966	966
Gloucester Middle School	Door Weather Stripping	Install Door Jamb Spacer (UT)	0	Natural Gas	80.5%	1.08	24	3105	4644	0	0
Gloucester Middle School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	44	Natural Gas	80.5%	1.08	24	3105	4644	65	65
Gloucester Middle School	Garage Door Weather Stripping	Roll-Up Door Weather Strip - Sides, Top	65	Natural Gas	80.5%	1.08	24	3105	4644	98	98
Gloucester Middle School	Roof-Wall Intersection Air Sealing	Seal (LF)	494	Natural Gas	80.5%	1.08	24	3105	4644	739	739

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 (%)
Gloucester High School	Buck Frame Air Sealing	Block, Seal (LF)	95%	1,291	4.5	72.0	75.0	40.0
Gloucester High School	Caulking	Interior Seal (LF)	95%	91	4.5	72.0	75.0	40.0
Gloucester High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	95%	921	4.5	72.0	75.0	40.0
Gloucester High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	95%	434	4.5	72.0	75.0	40.0
Gloucester High School	Garage Door Weather Stripping	Overhead Door Weather Strip - Sides, Top	95%	29	4.5	72.0	75.0	40.0
Gloucester High School	Garage Door Weather Stripping	Roll-Up Door Weather Strip - Sides, Top, Bottom	95%	166	4.5	72.0	75.0	40.0
Gloucester High School	Overhang Air Sealing	Block, Seal (SF)	95%	58	4.5	72.0	75.0	40.0
Gloucester High School	Roof-Wall Intersection Air Sealing	Seal (LF)	95%	1,671	4.5	72.0	75.0	40.0
Cold Springs ES & ECC	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	95%	28	4.5	72.0	75.0	40.0
Cold Springs ES & ECC	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	95%	921	4.5	72.0	75.0	40.0
Cold Springs ES & ECC	Door Weather Stripping	Install Door Jamb Spacer (UT)	95%	0	4.5	72.0	75.0	40.0
Cold Springs ES & ECC	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	95%	207	4.5	72.0	75.0	40.0
Cold Springs ES & ECC	Overhang Air Sealing	Block, Seal (LF)	95%	14	4.5	72.0	75.0	40.0
Cold Springs ES & ECC	ADDER - SKYLIGHT CAULKING	Caulking	95%	0	4.5	72.0	75.0	40.0
Gloucester Middle School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	95%	614	4.5	72.0	75.0	40.0
Gloucester Middle School	Door Weather Stripping	Install Door Jamb Spacer (UT)	95%	0	4.5	72.0	75.0	40.0
Gloucester Middle School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	95%	41	4.5	72.0	75.0	40.0
Gloucester Middle School	Garage Door Weather Stripping	Roll-Up Door Weather Strip - Sides, Top	95%	62	4.5	72.0	75.0	40.0
Gloucester Middle School	Roof-Wall Intersection Air Sealing	Seal (LF)	95%	469	4.5	72.0	75.0	40.0

Building Envelope Savings - Cooling Savings

BUILDING	TYPE	SUBTYPE	EXTERIOR RELATIVE HUMIDITY (%)	INTERIOR ENTHALPY (SUMMER)	EXTERIOR ENTHALPY (SUMMER)	ENTHALPY	TONS	EFFICIENCY (kW/TON)	COOLING HOURS (HRS)	TOTAL COOLING SAVINGS (kWh)	TOTAL COOLING SAVINGS (kW)
Gloucester High School	Buck Frame Air Sealing	Block, Seal (LF)	75.0	24.55	33.27	8.72	4.22	1.23	1091	5,643	5.17
Gloucester High School	Caulking	Interior Seal (LF)	75.0	24.55	33.27	8.72	0.30	1.23	1091	396	0.36
Gloucester High School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	75.0	24.55	33.27	8.72	3.01	1.23	1091	4,024	3.69
Gloucester High School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	75.0	24.55	33.27	8.72	1.42	1.23	1091	1,897	1.74
Gloucester High School	Garage Door Weather Stripping	Overhead Door Weather Strip - Sides, Top	75.0	24.55	33.27	8.72	0.09	1.23	1091	126	0.12
Gloucester High School	Garage Door Weather Stripping	Roll-Up Door Weather Strip - Sides, Top, Bottom	75.0	24.55	33.27	8.72	0.54	1.23	1091	727	0.67
Gloucester High School	Overhang Air Sealing	Block, Seal (SF)	75.0	24.55	33.27	8.72	0.19	1.23	1091	253	0.23
Gloucester High School	Roof-Wall Intersection Air Sealing	Seal (LF)	75.0	24.55	33.27	8.72	5.46	1.23	1091	7,305	6.70
Cold Springs ES & ECC	Door Weather Stripping	Double Door - Sides, Sweep, Center (UT)	75.0	24.55	33.27	8.72	0.09	0.60	1091	60	0.05
Cold Springs ES & ECC	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	75.0	24.55	33.27	8.72	3.01	0.60	1091	1,969	1.81
Cold Springs ES & ECC	Door Weather Stripping	Install Door Jamb Spacer (UT)	75.0	24.55	33.27	8.72	0.00	0.60	1091	0	0.00
Cold Springs ES & ECC	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	75.0	24.55	33.27	8.72	0.68	0.60	1091	442	0.41
Cold Springs ES & ECC	Overhang Air Sealing	Block, Seal (LF)	75.0	24.55	33.27	8.72	0.05	0.60	1091	31	0.03
Cold Springs ES & ECC	ADDER - SKYLIGHT CAULKING	Caulking	75.0	24.55	33.27	8.72	0.00	0.60	1091	0	0.00
Gloucester Middle School	Door Weather Stripping	Double Door - Sides, Top, Sweep, Center (UT)	75.0	24.55	33.27	8.72	2.01	1.01	1091	2,213	2.03
Gloucester Middle School	Door Weather Stripping	Install Door Jamb Spacer (UT)	75.0	24.55	33.27	8.72	0.00	1.01	1091	0	0.00
Gloucester Middle School	Door Weather Stripping	Single Door - Sides, Top, Sweep (UT)	75.0	24.55	33.27	8.72	0.14	1.01	1091	149	0.14
Gloucester Middle School	Garage Door Weather Stripping	Roll-Up Door Weather Strip - Sides, Top	75.0	24.55	33.27	8.72	0.20	1.01	1091	223	0.20
Gloucester Middle School	Roof-Wall Intersection Air Sealing	Seal (LF)	75.0	24.55	33.27	8.72	1.53	1.01	1091	1,691	1.55

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 12 – Plug Load Controls

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
13	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.

BERT 120 I
120V/20A

BERT 240 I
250V/20A

Scope of Work

Existing wall plugs within the facilities will be retrofitted with specialty controllable wall plugs. 191 total district devices have been identified for the installation of BERT plug load controllers.

Plug Load Controller Scope of Work			
BUILDING	CATEGORY	NOTES	QUANTITY
Gloucester High School	Bert 110X	Network Verification Units	1
	Bert 110X		39
	Bert Harness	Bert Harness	3
	Install Bert Harness		0
	Set up	Preload SSID and Passphrase - plug in	39
	Set up	Preload SSID and Passphrase - inline	39
	Program	Programming & BacNet SW License	39
	Test	Verify Network Communication and Final Test	39
	M&V / Training	Remote Software Training/Customer Signoff/ M&V	39
	Installation	Install Berts and record MAC Address - plug in units only / M&V	39
	Travel	Travel expenses	1
	Shipping charges	FedEx Ground	1
Cold Springs ES & ECC	Bert 110X	Network Verification Units	1
	Bert 110X		89
	Bert Harness	Bert Harness	28
	Install Bert Harness		28
	Set up	Preload SSID and Passphrase - plug in	89
	Set up	Preload SSID and Passphrase - inline	89
	Program	Programming & BacNet SW License	89
	Test	Verify Network Communication and Final Test	89
	M&V / Training	Remote Software Training/Customer Signoff/ M&V	89
	Installation	Install Berts and record MAC Address - plug in units only / M&V	89
	Travel	Travel expenses	1
	Shipping charges	FedEx Ground	1
Gloucester Middle School	Bert 110X	Network Verification Units	1
	Bert 110X		63
	Bert Harness	Bert Harness	9
	Install Bert Harness		0
	Set up	Preload SSID and Passphrase - plug in	63
	Set up	Preload SSID and Passphrase - inline	63
	Program	Programming & BacNet SW License	63
	Test	Verify Network Communication and Final Test	63
	M&V / Training	Remote Software Training/Customer Signoff/ M&V	63
	Installation	Install Berts and record MAC Address - plug in units only / M&V	63
	Travel	Travel expenses	1
	Shipping charges	FedEx Ground	1

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:

CALCULATED SAVINGS

Plug Load Controller Savings

BUILDING NAME	Device Type	Plug Load Type	Quantity	Standby Power Draw (W)	Hours per Year	Baseline Hours Scheduled ON per Year	Baseline Equipment o... STANDBY Hours	Annual Energy Savings (kWh)	Total Annual Energy Savings (kWh)
Gloucester High School	Projector	Bert 110X	13	8	8,760	2,600	6,160	641	3,776
Gloucester High School	Smartboard TV	Bert 110X	17	8	8,760	2,600	6,160	838	
Gloucester High School	Projector/Smartboard	Bert 110X	0	10	8,760	2,600	6,160	0	
Gloucester High School	Amp	Bert 110X	0	6	8,760	2,600	6,160	0	
Gloucester High School	Charging Cart	Bert 110X	1	37	8,760	2,600	6,160	228	
Gloucester High School	Printer	Bert 110X	3	15	8,760	2,600	6,160	277	
Gloucester High School	Large Copy Machine	Bert 110X	0	40	8,760	2,600	6,160	0	
Gloucester High School	TV	Bert 110X	0	10	8,760	2,600	6,160	0	
Gloucester High School	Snack Vending	Bert 110X	1	40	8,760	2,600	6,160	246	
Gloucester High School	Soda Vending	Bert 110X	0	320	8,760	2,600	6,160	0	
Gloucester High School	Large Coffee	Bert 110X	0	56	8,760	2,600	6,160	0	
Gloucester High School	H/C Water Disp.	Bert 110X	3	61	8,760	2,600	6,160	1,127	
Gloucester High School	Other	Bert 110X	1	68	8,760	2,600	6,160	419	
Gloucester High School	AC - 110V (20A)	Bert 240I Inline	0	8	8,760	2,600	6,160	0	
Gloucester High School	AC - 220V (< 20A)	Bert 120I Inline	0	8	8,760	2,600	6,160	0	
Gloucester High School	Elec. Water Heater	Bert 240I Inline	0	80	8,760	2,600	6,160	0	
Gloucester High School	Exhaust Fan - 110V	Bert 110X	0	100	8,760	2,600	6,160	0	
Gloucester High School	Exhaust Fan - 220V	Bert 240I Inline	0	100	8,760	2,600	6,160	0	
Cold Springs ES & ECC	Projector	Bert 110X	30	8	8,760	2,420	6,340	1,522	14,024
Cold Springs ES & ECC	Smartboard TV	Bert 110X	19	8	8,760	2,420	6,340	964	
Cold Springs ES & ECC	Projector/Smartboard	Bert 110X	0	10	8,760	2,420	6,340	0	
Cold Springs ES & ECC	Amp	Bert 110X	0	6	8,760	2,420	6,340	0	
Cold Springs ES & ECC	Charging Cart	Bert 110X	30	37	8,760	2,420	6,340	7,037	
Cold Springs ES & ECC	Printer	Bert 110X	3	15	8,760	2,420	6,340	285	
Cold Springs ES & ECC	Large Copy Machine	Bert 110X	0	40	8,760	2,420	6,340	0	
Cold Springs ES & ECC	TV	Bert 110X	0	10	8,760	2,420	6,340	0	
Cold Springs ES & ECC	Snack Vending	Bert 110X	1	40	8,760	2,420	6,340	254	
Cold Springs ES & ECC	Soda Vending	Bert 110X	1	320	8,760	2,420	6,340	2,029	
Cold Springs ES & ECC	Large Coffee	Bert 110X	0	56	8,760	2,420	6,340	0	
Cold Springs ES & ECC	H/C Water Disp.	Bert 110X	5	61	8,760	2,420	6,340	1,934	
Cold Springs ES & ECC	Other	Bert 110X	0	68	8,760	2,420	6,340	0	
Cold Springs ES & ECC	AC - 110V (20A)	Bert 240I Inline	0	8	8,760	2,420	6,340	0	
Cold Springs ES & ECC	AC - 220V (< 20A)	Bert 120I Inline	0	8	8,760	2,420	6,340	0	
Cold Springs ES & ECC	Elec. Water Heater	Bert 240I Inline	0	80	8,760	2,420	6,340	0	
Cold Springs ES & ECC	Exhaust Fan - 110V	Bert 110X	0	100	8,760	2,420	6,340	0	
Cold Springs ES & ECC	Exhaust Fan - 220V	Bert 240I Inline	0	100	8,760	2,420	6,340	0	
Gloucester Middle School	Projector	Bert 110X	5	8	8,760	2,420	6,340	254	8,920
Gloucester Middle School	Smartboard TV	Bert 110X	40	8	8,760	2,420	6,340	2,029	
Gloucester Middle School	Projector/Smartboard	Bert 110X	0	10	8,760	2,420	6,340	0	
Gloucester Middle School	Amp	Bert 110X	0	6	8,760	2,420	6,340	0	
Gloucester Middle School	Charging Cart	Bert 110X	11	37	8,760	2,420	6,340	2,580	
Gloucester Middle School	Printer	Bert 110X	1	15	8,760	2,420	6,340	95	
Gloucester Middle School	Large Copy Machine	Bert 110X	0	40	8,760	2,420	6,340	0	
Gloucester Middle School	TV	Bert 110X	0	10	8,760	2,420	6,340	0	
Gloucester Middle School	Snack Vending	Bert 110X	0	40	8,760	2,420	6,340	0	
Gloucester Middle School	Soda Vending	Bert 110X	1	320	8,760	2,420	6,340	2,029	
Gloucester Middle School	Large Coffee	Bert 110X	0	56	8,760	2,420	6,340	0	
Gloucester Middle School	H/C Water Disp.	Bert 110X	5	61	8,760	2,420	6,340	1,934	
Gloucester Middle School	AC - 110V (15A)	Bert 110X	0	68	8,760	2,420	6,340	0	
Gloucester Middle School	AC - 110V (20A)	Bert 240I Inline	0	8	8,760	2,420	6,340	0	
Gloucester Middle School	AC - 220V (< 20A)	Bert 120I Inline	0	8	8,760	2,420	6,340	0	
Gloucester Middle School	Elec. Water Heater	Bert 240I Inline	0	80	8,760	2,420	6,340	0	
Gloucester Middle School	Exhaust Fan - 110V	Bert 110X	0	100	8,760	2,420	6,340	0	
Gloucester Middle School	Exhaust Fan - 220V	Bert 240I Inline	0	100	8,760	2,420	6,340	0	

4.6.3.11 Plug and Process Load Reduction Measures

- EEMs saving energy by eliminating or reducing idle or stand-by power consumption of connected plug loads through the use of the following eligible plug load controls. The percentages presented in the following tables represent the maximum energy reduction percentage that can be claimed for the plug load control.

  - *Load Sensing Controls:* Monitors a specific devices power state and de-energizes connected auxiliary units when the monitored devise enters a low power state.

Load Sensing Control	
Space Type	**Percent Energy Reduction from Baseline**
Workstation	4%
Print Rooms	32%

  - *Occupancy Sensing Controls:* Automatically de-energize devices when no user is present for a set period of time.

Occupancy Control	
Space Type	**Percent Energy Reduction from Baseline**
All	21%

  - *Scheduled Timer Control:* Allows users to set a schedule to energize and de-energize devices based on the devices usage pattern and space schedule.

Schedule Timer Control	
Space Type	**Percent Energy Reduction from Baseline**
Workstation	26%
Print Rooms	50%
Break Rooms	46%

ECM 14 – eTemp Refrigeration Sensors

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

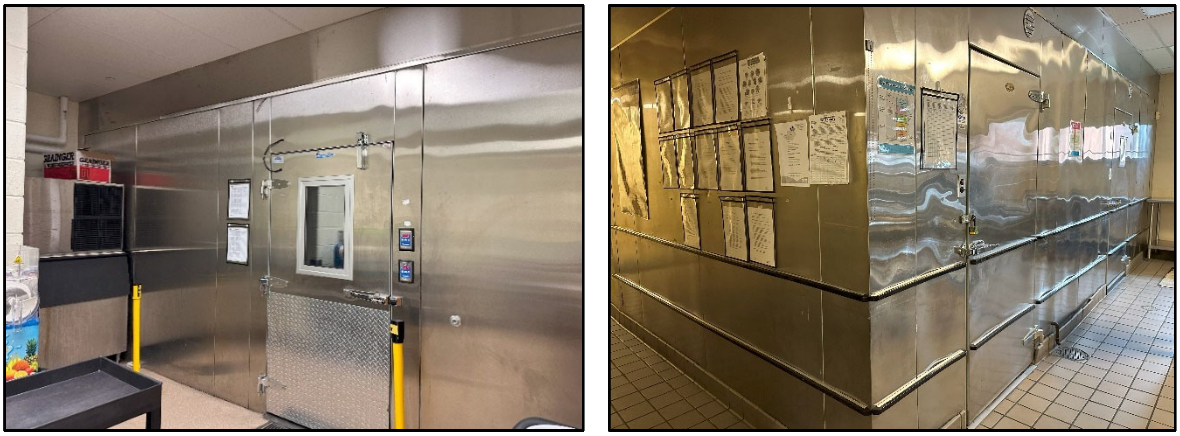
✓	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
14	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



Existing Walk-in Freezers at Gloucester MS and Cold Springs ES & ECC

Scope of Work

eTemp devices will be installed on the following Walk-In Freezers and Coolers, and Reach-In Coolers between both schools:

eTemp Scope of Work		
BUILDING	CATEGORY	QUANTITY
Gloucester High School	eTemp	5
Cold Springs ES & ECC	eTemp	7
Gloucester Middle School	eTemp	9

ECM Calculations

Energy Savings from the installation of eTemp are shown below.

CALCULATED SAVINGS								
					60%			
eTEMP Savings								
BUILDING NAME	Type	Qty	Baseline Energy Use (kWh)	% Energy Reduction (Vendor)	% Energy Reduction (Used for calculation)	Savings per Unit (kWh)	Energy Savings (kWh)	Total Energy Savings (kWh)
Gloucester High School	Walk-in Cooler	2	21,000	23%	13.8%	2,898	5,796	12,006
Gloucester High School	Walk-in Freezer	1	25,000	23%	13.8%	3,450	3,450	
Gloucester High School	Reach-in Cooler - 1 door	0	7,500	23%	13.8%	1,035	0	
Gloucester High School	Reach-in Cooler - 2 door	1	9,000	23%	13.8%	1,242	1,242	
Gloucester High School	Reach-in Cooler - 3 door	1	11,000	23%	13.8%	1,518	1,518	
Gloucester High School	Reach-in Freezer - 1 door	0	10,000	23%	13.8%	1,380	0	
Gloucester High School	Reach-in Freezer - 2 door	0	12,000	23%	13.8%	1,656	0	
Gloucester High School	Reach-in Freezer - 3 door	0	14,000	23%	13.8%	1,932	0	
Cold Springs ES & ECC	Walk-in Cooler	3	21,000	23%	13.8%	2,898	8,694	16,077
Cold Springs ES & ECC	Walk-in Freezer	1	25,000	23%	13.8%	3,450	3,450	
Cold Springs ES & ECC	Reach-in Cooler - 1 door	1	7,500	23%	13.8%	1,035	1,035	
Cold Springs ES & ECC	Reach-in Cooler - 2 door	1	9,000	23%	13.8%	1,242	1,242	
Cold Springs ES & ECC	Reach-in Cooler - 3 door	0	11,000	23%	13.8%	1,518	0	
Cold Springs ES & ECC	Reach-in Freezer - 1 door	0	10,000	23%	13.8%	1,380	0	
Cold Springs ES & ECC	Reach-in Freezer - 2 door	1	12,000	23%	13.8%	1,656	1,656	
Cold Springs ES & ECC	Reach-in Freezer - 3 door	0	14,000	23%	13.8%	1,932	0	
Gloucester Middle School	Walk-in Cooler	1	21,000	23%	13.8%	2,898	2,898	15,870
Gloucester Middle School	Walk-in Freezer	1	25,000	23%	13.8%	3,450	3,450	
Gloucester Middle School	Reach-in Cooler - 1 door	0	7,500	23%	13.8%	1,035	0	
Gloucester Middle School	Reach-in Cooler - 2 door	5	9,000	23%	13.8%	1,242	6,210	
Gloucester Middle School	Reach-in Cooler - 3 door	0	11,000	23%	13.8%	1,518	0	
Gloucester Middle School	Reach-in Freezer - 1 door	0	10,000	23%	13.8%	1,380	0	
Gloucester Middle School	Reach-in Freezer - 2 door	2	12,000	23%	13.8%	1,656	3,312	
Gloucester Middle School	Reach-in Freezer - 3 door	0	14,000	23%	13.8%	1,932	0	

ECM 15 – Retro-commissioning

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✓	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
15	Retro-Commissioning	✓	✓	✓

Background/Scope of Work

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 $129,000 for on-site testing, a retro-commissioning report, and contracting to resolve district building system issues.

Energy Savings Calculations

According to a Lawrence Berkeley National Laboratory study, *The Cost-Effectiveness of Commercial Buildings Commissioning*, "For existing buildings, we found median commissioning costs of $0.27/ft2, whole-building energy savings of 15 percent, and payback times of 0.7 years." Savings are conservatively estimated to be 3.25% of existing site electric and 4.75% of the existing natural gas use across the district:

Retro-Commissioning Savings					
BUILDING	SQFT	kWh SAVINGS	kWh % SAVINGS	THERMS SAVINGS	THERMS % SAVINGS
Gloucester High School	172,243	41,321	3.25%	3,930	4.75%
Cold Springs ES & ECC	161,294	40,503	3.25%	3,453	4.75%
Gloucester Middle School	122,000	12,620	3.25%	1,546	4.75%

ECM 16 – Combined Heat & Power

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX		Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
✔	ECM was evaluated			
(green)	ECM included in the project			
ECM #	ECM DESCRIPTION			
16	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.

4.4kW Micro-combined CHP

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.

Scope of Work

- Gloucester High School – Boiler Room
- CHP - 4.4 kW Axiom Unit Specified
- Demo & Removal of Area
- Furnish & Install 1 4.4kW CHP
- Trane ATC
- Electrical
- Nat Gas & Water Piping
- Concrete/Dumpster/GC
- Insulation
- Test & Balance
- Misc/Sketching/Other

The following will be installed at Gloucester High School

- One (1) 4.4kW micro CHP Including:
  - 4.4kW, 208 V, 60 Hz, Single Phase
  - Industrial Natural Gas Engine, EPA Certified
  - Open Protocol Interface

TECHNICAL DATA

Fuel	natural gas: minimum methane number 59 propane: minimum octane number MOZ 92 (EN 589)
Electrical Power	natural gas: 1.2 - 4.4 kW modulating propane: 1.2 - 4.4 kW modulating
Thermal Output	natural gas: 4.0 - 12.5 kW modulating propane: 4.5 - 13.8 kW modulating
Total Input Power	natural gas: 5.9 - 19.0 kW propane: 6.5 - 20.0 kW
Fuel Consumption	natural gas: .21 - .65 therms/hr propane: 0.26 - 0.78 gal/hr
Overall Efficiency	93%
Exhaust Gas Emissions	on-site settings: <250 ppm CO, <30 ppm NOx
Noise Pressure Level	approx. 55 dB (A), in 3.3 ft distance

ENGINE DATA

Engine	water-cooled, single cylinder, four stroke piston gas combustion engine, designed for long running time; displacement 16.6 in³ (272cm³)
Speed Range	1,200 - 3,600 RPM (factory max. setting: 3,400 RPM)
Coolant Temperature	operation: 167 - 176°F (75 - 80°C) short-term: 194°F (90°C)
Engine Electronics	control of the gas - air ratio (λ = 1 - control) and monitoring the engine operation, accomplished by microcontroller

GENERATOR AND INVERTER

Generator	brushless, permanent magnet generator directly flanged to the engine, with water cooling system
Inverter	three-phase inverter with integrated safety monitoring, microcontroller control (singe phase output for North America)

HEATING SYSTEM DATA

Heating Return Temperature	min. 95°F (35°C), max. 140°F (60°C)
Heating Supply Temp. Max.	167°F (75°C)
Pressure Drop at the Plate Heat Exchanger	1.0 psi (0.07 bar) at a flow rate of 211 gal/hour (800 L/h)
Temperature Sensor	standard NTC sensor outdoor, room, supply, return, and storage temperature, depending on the operating mode
Hot Water	adjustable: 41 - 158°F (5 - 70°C) (the factory setting of 140°F (60°C) is recommended

ELECTRICAL DATA

Voltage/Frequency/Power	230V nominal / 60 Hz / 0.98 - 1.00 power factor ecopower® adapts to the grid phase sequence
Phase Sequence	corresponds to the grid phase sequence

EXHAUST DATA

Exhaust Gas Temperature	operation: < 180°F (82°C)
Exhaust Gas Pipe	unit can be vented with 3 in. CPVC (schedule 80) pipe max. length: 65 ft. with max. of six 90 degree bends inner diam. 2.76 in (70 mm) outer diam. 2.85 in (75 mm) total drag 0.2 wci (0.5 mbar) max. high pressure (back pressure) 1.2 w.c.i. (3.0 mbar) with wind impact

ECM Calculations

The CHP will act as the first stage of heating for the domestic water heating loop. The CHP is estimated to run at full load for over 4,500 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%	

		Fuel Usage Without CHP				
Month	Days	Total Natural Gas Use - Domestic Water System	Existing Efficiency	Non-Displaceable Gas Therms	Displaceable Gas Therms	Displaceable Heat Therms
Jan	31	1,391	78.2%	0	1,391	1,088
Feb	28	1,090	78.2%	0	1,090	853
Mar	31	778	78.2%	0	778	608
Apr	30	336	78.2%	0	336	263
May	31	189	78.2%	0	189	148
Jun	30	145	78.2%	0	145	113
Jul	31	148	78.2%	0	148	115
Aug	31	183	78.2%	0	183	144
Sep	30	171	78.2%	0	171	134
Oct	31	295	78.2%	0	295	231
Nov	30	827	78.2%	0	827	647
Dec	31	1,058	78.2%	0	1,058	828
Total:	365	6,611		0	6,611	5,171

		4.4 kW Cogen Plant Thermal Operation								
Month	Days	Combined Cogen Run Hours	% Heat Load Displaced by CHP	Total Cogen Hours	Utilized Cogen Heat Therms	Net Natural Gas Use Therms	Max Cogen Heat Therms	Avoided Boiler Gas Therms	Full Load Run Hours	System Operating Efficiency
Jan	31	522	20.2%	522	219	120	219	280	522	87.7%
Feb	28	472	23.2%	472	198	109	198	253	472	87.7%
Mar	31	522	36.1%	522	219	120	219	280	522	87.7%
Apr	30	506	80.9%	506	212	116	212	271	506	87.7%
May	31	274	77.8%	274	115	63	115	147	274	87.7%
Jun	30	266	98.6%	266	112	61	112	143	266	87.7%
Jul	31	274	99.8%	274	115	63	115	147	274	87.7%
Aug	31	274	80.3%	274	115	63	115	147	274	87.7%
Sep	30	266	83.1%	266	112	61	112	143	266	87.7%
Oct	31	522	95.1%	522	219	120	219	280	522	87.7%
Nov	30	506	32.8%	506	212	116	212	271	506	87.7%
Dec	31	522	26.5%	522	219	120	219	280	522	87.7%
Total:	365	4,926	40.0%	4,926	2,069	1,133	2,069	2,645	4,926	87.7%

		Fuel Usage With CHP			Electric Savings With CHP			
Month	Days	Supplemental Boiler Gas Therms	Cogen Gas Therms	Total Gas	Run Hours	Avg Cogen Plant kW Output	kW Demand Savings	Cogen Electric Generation kWh
Jan	31	1,110	340	1,450	522	4.4	4.4	2,298
Feb	28	837	307	1,143	472	4.4	4.4	2,076
Mar	31	497	340	837	522	4.4	4.4	2,298
Apr	30	64	329	393	506	4.4	4.4	2,224
May	31	42	178	220	274	4.4	4.4	1,207
Jun	30	2	173	175	266	4.4	4.4	1,168
Jul	31	0	178	179	274	4.4	4.4	1,207
Aug	31	36	178	215	274	4.4	4.4	1,207
Sep	30	29	173	201	266	4.4	4.4	1,168
Oct	31	14	340	354	522	4.4	4.4	2,298
Nov	30	556	329	884	506	4.4	4.4	2,224
Dec	31	778	340	1,117	522	4.4	4.4	2,298
Total:	365	3,966	3,202	7,168	4,926		4.4	21,676

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

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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

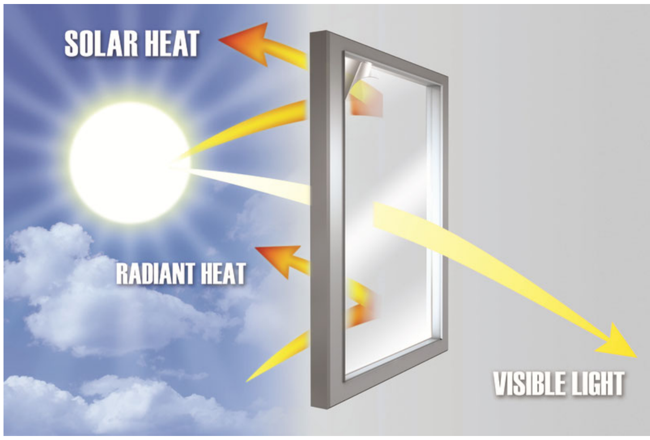
NO_x EF_{NG} = NO_x Natural Gas Emissions Factor associated with boiler fuel displacement – see emissions tables summarized in Introduction section of Protocols

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

ECM 18 – Window Film

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX		Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
✔ ECM was evaluated; (green) ECM included in the project				
ECM #	ECM DESCRIPTION			
18	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

Gloucester High School:
Furnish & Installation of 9,122 square feet of 3M Affinity 15 window film. The scope covers 944 windows encompassing all exterior windows and doors on the property except the 81 sf of glazing with existing film installed.

Gloucester Middle School:
Furnish & Installation of 5,751 square feet of 3M Affinity 15 window film. The scope covers 801 windows encompassing all exterior windows and doors on the property except the 45 sf of glazing with existing film installed.

Window Film Scope of Work		
BUILDING	**CATEGORY**	**NOTES**
Gloucester High School	Affinity 15	All
Gloucester Middle School	Affinity 15	All

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
Clear	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
Tinted	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
Double Clear	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
Double Tinted	Affinity 30	20%	15%	18%	64%	0.36	0.45	2.6	29%	99%	62%	0.5

Existing Conditions

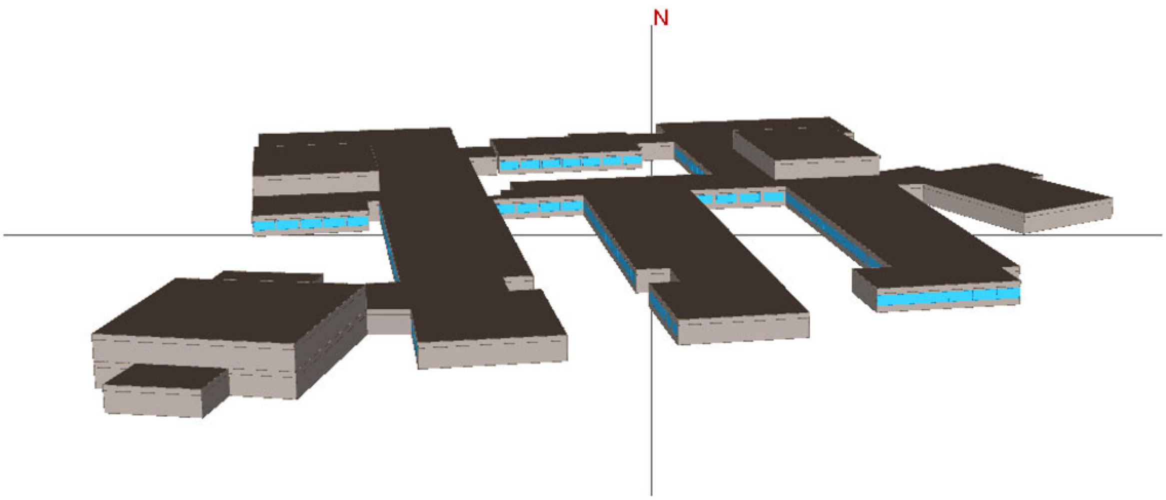
Existing windows at Gloucester High School and Gloucester Middle School

ECM Calculations

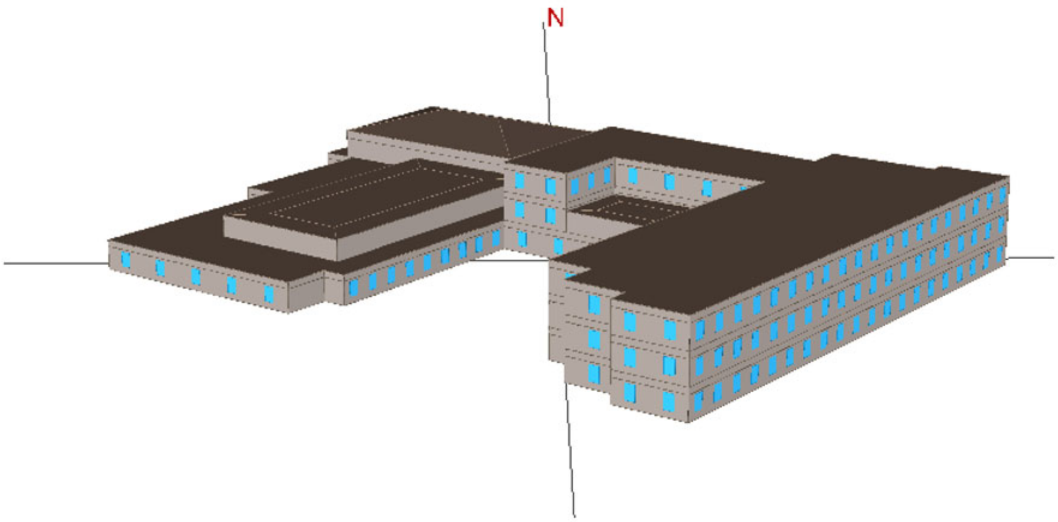
Energy Savings from the installation of Window Film was modeled in eQuest and the summary is shown below.

ENERGY MODELING OUTPUTS				
Window Film Savings				
BUILDING	NOTES	Affinity 15	Affinity 15	Affinity 15
		kWh Savings	kW Savings	THERM Savings
Gloucester High School	All	104387	34	-2428
Gloucester Middle School	All	44725	10	-644

GLOUCESTER HIGH SCHOOL



GLOUCESTER MIDDLE SCHOOL



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.

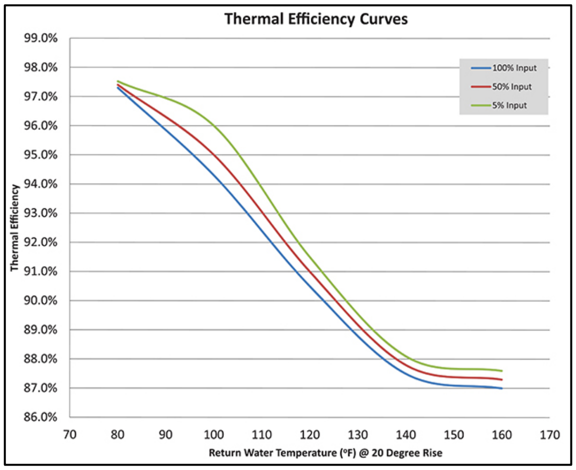
ECM 4 – Boiler Replacement

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
4	Boiler 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.



Existing Conditions

Gloucester High School – Two (2) Smith hot water boilers with a capacity of 9,667 MBh each serve the hot water loop of the building. These boilers are located in a mechanical room near the cafeteria and provide hot water to fan coil units and cabinet unit heaters. The district has identified these two boilers for eventual replacement stating new condensing models will save the district energy and maintenance costs. The boiler identified was estimated to be manufactured in 2002 and is coming up on useful life expectations. These boilers have been recommended for replacement within the energy savings plan but will not be included due to district priorities.

Non-condensing boilers at Gloucester HS

Scope of Work

Gloucester High School

- (2) 9,667 MBH HW Boilers
- Demo & Removal of 2 existing Boilers
- Furnish & Install (4) Aerco BMK 5000 Boilers
- Trane ATC
- Electrical
- HWS/R Piping
- Ductwork/Breeching
- Concrete/Dumpster/GC
- Roofing Mods for Breeching
- Asbestos Abatement/Remediation

- Insulation
- Test & Balance
- Crane/Rigging - Demo & New
- Misc/Sketching/Other

ECM Calculations

Energy Savings from the installation of high efficiency boilers were calculated using the BPU protocols. Existing boiler efficiency is derated to 75.8% at Gloucester High School based on age and condition. The proposed high efficiency hot water condensing boilers are 87% efficient. This ECM is not included in the project.

CALCULATED SAVINGS						
Boiler Replacement Savings						
BUILDING	Existing Qty	Exitsting Qty Used	Input Capacity (mbh) [CAPin]	Equivalent Full Load Hours [EFLHh]	Boiler Baseline Efficiency [EFFb]	Baseline Plant Rated Output MBH
Gloucester High School	2	1	9,667	901	75.8%	7,332

CALCULATED SAVINGS						
Boiler Replacement Savings						
BUILDING	Proposed Qty	Proposed Qty Used	Boiler Proposed Efficiency [EFFq]	Proposed Plant Rated Input MBH (CAPYbi)	Proposed Plant Rated Output MBH	Calculated Annual Fuel Savings (Th)
Gloucester High School	2	1	87.0%	9,667	8,411	12,813

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 ≥ 300 and ≤ 2,500 > 2,500	82% AFUE 81% Et 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

Electric Chillers

The measurement of energy and demand savings for C&I chillers is based on algorithms with key variables.

This measure applies to new construction, replacement of failed equipment, or end of useful life. The baseline unit is a code compliant unit with an efficiency as required by ASHRAE Std. 90.1 – 2016, which is the current code adopted by the state of New Jersey.

Algorithms

For IPLV:

Energy Savings (kWh/yr) = N * Tons * EFLH * ($IPLV_b$ – $IPLV_q$)

Peak Demand Savings (kW) = N * Tons * PDC * ($IPLV_b$ – $IPLV_q$)

For FLV:

Energy Savings (kWh/yr) = N * Tons * EFLH * (FLV_b – FLV_q)

Peak Demand Savings (kW) = N * Tons * PDC * (FLV_b – FLV_q)

Definition of Variables

N = Number of units

Tons = Rated capacity of coolling equipment.

EFLH = Equivalent Full Load Hours – This represents a measure of energy use by season during the on-peak and off peak periods.

PDC = Peak Duty Cycle: fraction of time the compressor runs during peak hours

$IPLV_b$ = Integrated Part Load Value of baseline equipment, kW/Ton. The efficiency of the chiller under partial-load conditions.

$IPLV_q$ = Integrated Part Load Value of qualifying equipment, kW/ efficiency of the chiller under partial-load conditions.

FLV_b = Full Load Value of baseline equipment, kW/Ton. The eff chiller under full-load conditions.

FLV_q = Full Load Value of qualifying equipment, kW/Ton. The the chiller under full-load conditions.

Electric Chillers – New Construction

Type	Capacity	ASHRAE 90.1 2016 Table 6.8.1-3) Path A Full Load kW/ton	Path A IPLV kW/ton	Path B Full Load kW/ton	Path B IPLV kW/ton
Air Cooled	tons < 150	*10.1* 1.188	*13.7* 0.876	*9.7* 1.237	*15.8* 0.759
	tons ≥ 150	*10.1* 1.188	*14.0* 0.857	*9.7* 1.237	*16.1* 0.745
Water Cooled Positive Displacement (rotary screw and scroll)	tons < 75	0.750	0.600	0.780	0.500
	75 ≤ tons < 150	0.720	0.560	0.750	0.490
	150 ≤ tons < 300	0.660	0.540	0.680	0.440
	300 ≤ tons < 600	0.610	0.520	0.625	0.410
	tons ≥ 600	0.560	0.500	0.585	0.380
Water Cooled Centrifugal	tons < 150	0.610	0.550	0.695	0.440
	150 ≤ tons < 300	0.610	0.550	0.635	0.400
	300 ≤ tons < 400	0.560	0.520	0.595	0.390
	400 ≤ tons < 600	0.560	0.500	0.585	0.380
	tons ≥ 600	0.560	0.500	0.585	0.380

a – Values in italics are EERs.

Summary of Inputs

Electric Chiller Assumptions

Electric Chillers Component	Type	Situation
Tons	Rated Capacity, Tons	All
$IPLV_b$ (kW/ton)	Variable	See table below

Electric Chillers Component	Type	Situation
$IPLV_q$ (kW/ton)	Variable	All
FLV_b (kW/ton)	Variable	See table below
FLV_q (kW/ton)	Variable	All
PDC	Fixed	All
EFLH	Variable	All

EFLH Table

Facility Type	Cooling EFLH
Assembly	669
Auto repair	426
Dormitory	800
Hospital	1424
Light industrial	549
Lodging – Hotel	2918
Lodging – Motel	1233
Office – large	720
Office – small	955
Other	736
Religious worship	279
Restaurant – fast food	645
Restaurant – full service	574
Retail – big box	1279
Retail – Grocery	1279
Retail – small	882
Retail – large	1068
School – Community college	846
School – postsecondary	1208
School – primary	394
School – secondary	466
Warehouse	400

ECM 8 –Split System Replacement

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
8	Split System Replacement	✔		

An air conditioning unit is one of the most energy-intensive units in any facility. Technology has made leaps and bounds in the past several years in making these machines more efficient. air conditioning unit efficiency is rated by how much electrical energy is used to produce an amount of cooling. This is expressed in kilowatts per ton of cooling (kW/ton). An older machine may be as high as 1.2 kW/ton, whereas a new air conditioning unit r may be as low as 0.9 kW/ton or even less. A new machine uses less electrical power to produce the same amount of cooling. In addition, installing new high efficient rooftop air conditioners will include:

- Condensing units that drain to the interior of the building
- Improved insulation
- Duct dampers which prevent off-cycle losses due to convection loops that lose heat
- More efficient modulating compressor and improved humidity control if the indoor blower or air handler is also variable speed

Existing Conditions

Gloucester High School – Two (2) .75-ton split system condensing units serve indoor air handling units located in the ROTC office and Room D8. These units are manufactured by EMI and were installed in 2002. These units were highlighted be replaced by the district due to their age being past ASHRAE useful life. Due to long economic payback and district priority, they are not included within the project

Existing split system AC units at Gloucester High School

Scope of Work

The following Split Systems will be replaced with high efficiency units:

Split System Scope of Work			
BUILDING	**CATEGORY**	**Tons**	**QUANTITY**
Elizabeth Moore School	SS-1-2	20	2
	SS-3	4	1

Gloucester High School

(2) Splits indoor/outdoor - 0.75 ton each
Demo & Removal of 2 Splits
Furnish & Install 2 New Splits
Electrical
Refrigerant & Condensate piping

Concrete/Dumpster/GC
Insulation
Test & Balance
Crane/Rigging - Demo & New

ECM Calculations

Energy Savings from the installation of high efficiency Split Systems were calculated using BPU protocols. The calculations are shown below.

CALCULATED SAVINGS															
Split System / Heat Pump Replacement Cooling Savings															
BUILDING	Model Number	Areas Served	Existing Qty	Tons Per Unit	Total Existing Tons	EERb	Proposed Qty	Tons Per Unit	Total Proposed Tons	EERq	CF	EFLH Cooling	Demand Savings (kW)	Energy Savings (kWh)
Gloucester High School	SS-1	ROTC office	1	0.75	0.75	7.9	1	0.75	0.75	15.4	0.5	466	0.3	257
Gloucester High School	SS-2	Prep lab D8	1	0.75	0.75	7.9	1	0.75	0.75	15.4	0.5	466	0.3	257

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

Algorithms

Air Conditioning Algorithms:

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

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

(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

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[57]	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

HVAC Baseline Efficiencies Table – New Construction/EUL/RoF

Equipment Type	Baseline = ASHRAE Std. 90.1 – 2016
Unitary HVAC/Split Systems and Single Package, Air Cooled	
<=5.4 tons, split	14 SEER
<=5.4 tons, single	14 SEER
>5.4 to 11.25 tons	11.0 EER, 12.7 IEER
>11.25 to 20 tons	10.8 EER, 12.2 IEER
> 21 to 63 tons	9.8 EER, 11.4 IEER
>63 Tons	9.5 EER, 11.0 IEER
Air Cooled Heat Pump Systems, Split System and Single Package	
<=5.4 tons, split	14 SEER, 8.2 HSPF
<=5.4 tons, single	14 SEER, 8.0 HSPF
>5.4 to 11.25 tons	10.8 EER, 12 IEER, 3.3 heating COP
>11.25 to 20 tons	10.4 EER, 11.4 IEER, 3.2 heating COP
>= 21	9.3 EER, 10.4 IEER, 3.2 heating COP

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

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 10 – Ductwork Insulation

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✔	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
10	Ductwork Insulation			✔

A ductwork system is a branching network of round or rectangular tubes which are generally constructed of sheet metal, fiberglass board, or a flexible plastic and-wire composite located within walls, floors, and ceilings. This system, depending on the season, distributes heated or cooled air (including ventilation air) from a rooftop unit or air handler to various rooms. This system can make a big difference in both the cost and the effectiveness of heating and cooling a large building. The ductwork system can also have an important effect on health of the occupants through the distribution of indoor air pollution. Ductwork repairs can be a very cost-effective energy conservation measure especially if ductwork is in penthouse or attic spaces.

Duct systems lose energy by conduction of heat from the warm surface, and air leakage through small cracks and seams. Ductwork located in attics or penthouse spaces that are nearly as cold as the temperature outside, heat loss through conduction will occur if insulation is in poor condition. Air leakage through supply and return ductwork can occur through accidental holes or poorly connected duct sections. In addition to increased efficiency of the system, sealing and insulating ducts can help with common comfort problems, such as rooms that are too hot in the summer or too cold in the winter.

Existing Conditions

Gloucester Middle School – RTU -3, 4, 7 and 8 do not have any exterior ductwork insulation. Uninsulated heating and cooling supply ductwork leading to the Gym and Cafeteria at the Middle School presents an opportunity for efficiency gains through duct insulation. The current setup is losing heat to the exterior instead of more efficiently distributing conditioned air to the building.

Existing exterior ductwork at Gloucester Middle School

Scope of Work

Duct Insulation – exterior duct insulation installed with 2 inch thick 3 lb. density fiberglass FSK board. Insulation will be weatherproofed with Ideal Seal Jacketing System and all tops pitched to prevent water ponding.

ECM Calculations

Energy Savings from ductwork sealing were calculated using BPU protocols. The calculations are shown below.

CALCULATED SAVINGS

Ductwork Insulation Savings

BUILDING	COMPONET	AIR TEMPERATURE	WIDTH (IN)	HIEGHT (IN)	LENGTH (FT)	TOTAL AREA (SQFT)	HEATING EFF	COOLING EFF	AMBIENT TEMPERATURE (F)	WIND VELOCITY (MPH)
Gloucester Middle School	Duct 1	55	24	24	7.95	63.60		80%	70.00	10.00
Gloucester Middle School	Duct 2	55	24	24	16.10	128.80		80%	70.00	10.00
Gloucester Middle School	Duct 3	55	24	24	9.68	77.40		80%	70.00	10.00
Gloucester Middle School	Duct 4	55	24	24	13.91	111.30		80%	70.00	10.00
Gloucester Middle School	Duct 5	55	24	24	7.96	63.70		80%	70.00	10.00
Gloucester Middle School	Duct 6	55	24	24	12.41	99.30		80%	70.00	10.00
Gloucester Middle School	Duct 7	55	24	24	12.41	99.30		80%	70.00	10.00
Gloucester Middle School	Duct 8	55	24	24	7.34	58.70		80%	70.00	10.00
Gloucester Middle School	Duct 8	55	24	24	6.58	52.60		80%	70.00	10.00
Gloucester Middle School	Duct 9	55	24	24	6.58	52.60		80%	70.00	10.00
Gloucester Middle School	Duct 1	105	24	24	7.95	63.60	74.2%		70.00	10.00
Gloucester Middle School	Duct 2	105	24	24	16.10	128.80	74.2%		70.00	10.00
Gloucester Middle School	Duct 3	105	24	24	9.68	77.40	74.2%		70.00	10.00
Gloucester Middle School	Duct 4	105	24	24	13.91	111.30	74.2%		70.00	10.00
Gloucester Middle School	Duct 5	105	24	24	7.96	63.70	74.2%		70.00	10.00
Gloucester Middle School	Duct 6	105	24	24	12.41	99.30	74.2%		70.00	10.00
Gloucester Middle School	Duct 7	105	24	24	12.41	99.30	74.2%		70.00	10.00
Gloucester Middle School	Duct 8	105	24	24	7.34	58.70	74.2%		70.00	10.00
Gloucester Middle School	Duct 8	105	24	24	6.58	52.60	74.2%		70.00	10.00
Gloucester Middle School	Duct 9	105	24	24	6.58	52.60	74.2%		70.00	10.00

Ductwork Insulation Savings

BUILDING	COMPONET	EXISTING MATERIAL	BARE EMITTANCE	BARE HEAT LOSS (Btu/sqft)	EXISTING HEAT LOSS (Btu/sqft)	HEATING OR COOLING HOURS	EXISTING FUEL LOSS (THERMS)	EXISTING ELECTRIC LOSS (kWh)
Gloucester Middle School	Duct 1	Alum - sheet	0.10	-19.7	(1,250)	4,015		335
Gloucester Middle School	Duct 2	Alum - sheet	0.10	-19.7	(2,531)	4,015		677
Gloucester Middle School	Duct 3	Alum - sheet	0.10	-19.7	(1,521)	4,015		407
Gloucester Middle School	Duct 4	Alum - sheet	0.10	-19.7	(2,187)	4,015		585
Gloucester Middle School	Duct 5	Alum - sheet	0.10	-19.7	(1,252)	4,015		335
Gloucester Middle School	Duct 6	Alum - sheet	0.10	-19.7	(1,951)	4,015		522
Gloucester Middle School	Duct 7	Alum - sheet	0.10	-19.7	(1,951)	4,015		522
Gloucester Middle School	Duct 8	Alum - sheet	0.10	-19.7	(1,153)	4,015		309
Gloucester Middle School	Duct 8	Alum - sheet	0.10	-19.7	(1,034)	4,015		277
Gloucester Middle School	Duct 9	Alum - sheet	0.10	-19.7	(1,034)	4,015		277
Gloucester Middle School	Duct 1	Alum - sheet	0.10	45.9	2,916	5,110	201	
Gloucester Middle School	Duct 2	Alum - sheet	0.10	45.9	5,905	5,110	407	
Gloucester Middle School	Duct 3	Alum - sheet	0.10	45.9	3,549	5,110	244	
Gloucester Middle School	Duct 4	Alum - sheet	0.10	45.9	5,103	5,110	351	
Gloucester Middle School	Duct 5	Alum - sheet	0.10	45.9	2,921	5,110	201	
Gloucester Middle School	Duct 6	Alum - sheet	0.10	45.9	4,553	5,110	314	
Gloucester Middle School	Duct 7	Alum - sheet	0.10	45.9	4,553	5,110	314	
Gloucester Middle School	Duct 8	Alum - sheet	0.10	45.9	2,691	5,110	185	
Gloucester Middle School	Duct 8	Alum - sheet	0.10	45.9	2,412	5,110	166	
Gloucester Middle School	Duct 9	Alum - sheet	0.10	45.9	2,412	5,110	166	

Ductwork Insulation Savings

BUILDING	COMPONET	PROPOSED MATERIAL	PROPOSED THICKNESS	INSULATED HEAT LOSS (Btu/sqft)	PROPOSED INSULATION %	PROPOSED HEAT LOSS (Btu/sqft)	PROPOSED FUEL LOSS (THERMS)	PROPOSED ELECTRIC LOSS (kWh)	SAVINGS ADJUSTMENT FACTOR	ELECTRIC SAVINGS (kWh)	NATURAL GAS SAVINGS (THERMS)
Gloucester Middle School	Duct 1	Mineral Fiber	2	(1.7)	100%	(109.7)		29	85%	259	0
Gloucester Middle School	Duct 2	Mineral Fiber	2	(1.7)	100%	(222.2)		59	85%	525	0
Gloucester Middle School	Duct 3	Mineral Fiber	2	(1.7)	100%	(133.5)		36	85%	316	0
Gloucester Middle School	Duct 4	Mineral Fiber	2	(1.7)	100%	(192.0)		51	85%	454	0
Gloucester Middle School	Duct 5	Mineral Fiber	2	(1.7)	100%	(109.9)		29	85%	260	0
Gloucester Middle School	Duct 6	Mineral Fiber	2	(1.7)	100%	(171.3)		46	85%	405	0
Gloucester Middle School	Duct 7	Mineral Fiber	2	(1.7)	100%	(171.3)		46	85%	405	0
Gloucester Middle School	Duct 8	Mineral Fiber	2	(1.7)	100%	(101.3)		27	85%	239	0
Gloucester Middle School	Duct 8	Mineral Fiber	2	(1.7)	100%	(90.7)		24	85%	215	0
Gloucester Middle School	Duct 9	Mineral Fiber	2	(1.7)	100%	(90.7)		24	85%	215	0
Gloucester Middle School	Duct 1	Mineral Fiber	2	4.0	100%	256.0	18		85%	0	156
Gloucester Middle School	Duct 2	Mineral Fiber	2	4.0	100%	518.4	36		85%	0	315
Gloucester Middle School	Duct 3	Mineral Fiber	2	4.0	100%	311.5	21		85%	0	189
Gloucester Middle School	Duct 4	Mineral Fiber	2	4.0	100%	448.0	31		85%	0	272
Gloucester Middle School	Duct 5	Mineral Fiber	2	4.0	100%	256.4	18		85%	0	156
Gloucester Middle School	Duct 6	Mineral Fiber	2	4.0	100%	399.7	28		85%	0	243
Gloucester Middle School	Duct 7	Mineral Fiber	2	4.0	100%	399.7	28		85%	0	243
Gloucester Middle School	Duct 8	Mineral Fiber	2	4.0	100%	236.3	16		85%	0	144
Gloucester Middle School	Duct 8	Mineral Fiber	2	4.0	100%	211.7	15		85%	0	129
Gloucester Middle School	Duct 9	Mineral Fiber	2	4.0	100%	211.7	15		85%	0	129

2. SAVINGS FROM REDUCED FAN MOTOR HEAT

Typically, thirty-five percent of the input to an HVAC fan motor is converted to heat in the airstream because of system inefficiency. Fan motor heat requires a significant cooling load.

The fan motor increases the supply air temperature, increasing the air volume required to meet a given space load in a draw-through fan configuration. The fan motor heat is absorbed directly by the coil in a blow through configuration.

The power reduction from reduced fan motor heat is calculated as:

$$\Delta kW_{fan\ heat} = \frac{\dot{V}_{fan-pre} - \dot{V}_{fan-post}}{\frac{EER}{3.41}}$$

EER (Energy Efficiency Ratio, in unit's Btu/h per W) is for the cooling system including compressor.

3.41 is a constant that converts BTUs to Watts.

3. SAVINGS FROM REDUCED OUTSIDE AIR IN COOLING

During the cooling season, duct leakage increases the amount of outdoor air being drawn into the building by the supply fan. The energy impact is the difference between the outdoor air and the return air enthalpy when the outdoor air has a higher enthalpy than the return air. It is assumed that the return air enthalpy = space temperature enthalpy.

The power reduction from reduced outside air during cooling is calculated as:

$$\Delta kW_{cool-OA} = \left(\sum \Delta h_{(OA-RA)} * F_{OA} * 0.0045 * \frac{\Delta \dot{V}_{fan\ (post-pre)}}{EER}\right)$$

$\sum \Delta h_{(OA-RA)}$ is the sum of the difference between the outdoor air and return air enthalpy during the occupied time

F_{OA} is the fraction of outside air to total fan design flow; it remains constant and is uncorrelated with outdoor air conditions

0.0045 is a constant to convert the units

$\Delta \dot{V}_{fan\ (post-pre)}$ is the reduction in fan flow

EER (Energy Efficiency Ratio, in unit's Btu/h per W) is for the cooling system, not just compressor.

4. SAVINGS FROM REDUCED OUTSIDE AIR IN HEATING

Similarly, during the heating season duct leakage increases the amount of outdoor air being drawn into the building by the supply fan. The energy impact is the difference between the outdoor air and the return air enthalpy when the outdoor air has a lower enthalpy than the return air. It is assumed that the return air enthalpy = space temperature enthalpy.

The annual natural gas energy reduction from reduced outside heating load is calculated as:

$$\Delta Therm\ NG_{heat-OA} = \frac{(Q_{heat-OA\ initial} - Q_{heat-OA\ post}) / \ \%\ Heating\ System\ steady\ state\ efficiency}{100{,}000 \frac{Btu}{Therm}}$$

$Q_{preheat-OA\ initial}$ = Total Annual OA heating load (in Btu) from initial duct leakage

$Q_{preheat-OA\ post}$ = Total Annual OA heating load (in Btu) from post sealing duct leakage

Note: The calculation above applies to natural gas fuel for heating, but other fuel sources may be substituted with the correct unit conversions.

For manual repairs of holes greater than 5/8" that will not be sealed using the Aeroseal system, the amount of CFM sealed will be used using Bernoulli's Equation. In fluid dynamics, Bernoulli's principle states that an increase in the speed of a fluid occurs simultaneously with a decrease in static pressure or a decrease in the fluid's potential energy. The formula is: $P + \frac{1}{2} \rho v^2 + \rho g h = constant$

All seal reports, documentation of holes and calculations will be provided during the installation process.

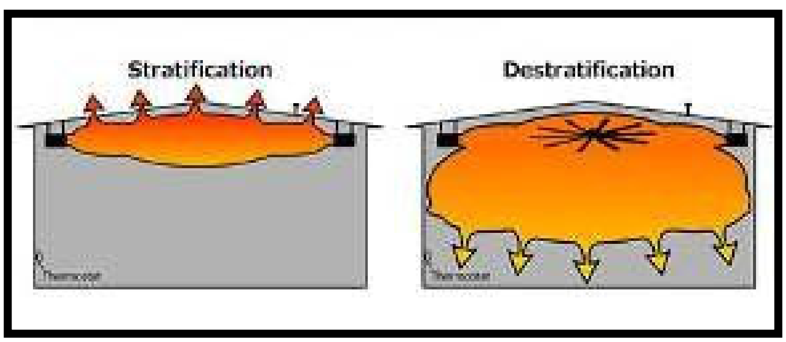
ECM 17 – Destratification Fans

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✓	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
17	Destratifcation 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

Destratification Fan Scope of Work			
BUILDING	**CATEGORY**	**NOTES**	**QUANTITY**
Gloucester High School	ARIUS-ONYX-P4-STD-120-X	Old Gym	4
	ARIUS-ONYX-P4-STD-120-X	New Gym	6
Cold Springs ES & ECC	ARIUS-ONYX-P4-STD-120-X	Gymnasium	4
Gloucester Middle School	ARIUS-ONYX-P4-STD-120-X	Gymnasium	4

ECM Calculations

CALCULATED SAVINGS

Destratification Fan Savings

BUILDING	Area	Space SQFT	HVAC % of Building Gas Use	Estimated Space Heating (Therm)	Ceiling Height (ft)	Floor to Ceiling deltaT (F)	HVAC Energy Savings (%)	Total DeStrat Fans (#)	DeStrat Fan Power (W)	DeStrat Fan Run Hours (hrs)	DeStrat Fan Energy (kWh)	Energy Savings (kWh)	Energy Savings (Therm)
Gloucester High School	Old Gym	8,500	95%	7,758	26	12.6	22.1%	4	76	4000	1216	(1,216)	1,715
Gloucester High School	New Gym	9,000	95%	8,215	33	14.4	26.3%	6	76	4000	1824	(1,824)	2,160
Gloucester High School													
Cold Springs ES & ECC	Gymnasium	7,200	95%	6,166	26	12.6	22.1%	4	76	4000	1216	(1,216)	1,363
Cold Springs ES & ECC													
Cold Springs ES & ECC													
Gloucester Middle School	Gymnasium	6,800	95%	5,169	26	12.6	22.1%	4	76	4000	1216	(1,216)	1,142
Gloucester Middle School													
Gloucester Middle School													

Savings Table

Temp Differential (°F) across; Ceiling Height (ft.) down; values are % savings.

Ceiling 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 19 – Softball Field Lighting

GLOUCESTER CITY SCHOOL DISTRICT ECM MATRIX

✓	ECM was evaluated
(green)	ECM included in the project

ECM #	ECM DESCRIPTION	Gloucester High School	Cold Springs ES & ECC	Gloucester Middle School
19	Softball Field Lighting	✓		

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 to $12,500 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

Existing Fields at Gloucester High School

Gloucester High School

- Existing Field Varsity and Junior Varsity Fields do not currently have a field lighting system.
- Both fields are evaluated by the district for the installation of field lighting systems as part of a potential upcoming field renovation project.

Scope of Work

Both district high schools are evaluated for LED Softball Field Lighting installations. The following work is being done at each school:

SOFTBALL FIELD LIGHTING SCOPE OF WORK					
BUILDING	ESTIMATE TYPE	POLE ID	FIXTURE QTY	SCOPE	ESTIMATE Count
Gloucester High School	JV Softball	A1-A2	8	Future Light Poles, 40' High with Concrete Base	4
	JV Softball	B1-B2	10	Field Lighting Fixtures (LED)	4
				Surge Protection Device, 480 V	1
				Lighting Control Cabinet	1
				Auxillary Lighting Interface Cabinet / Branch Circuit Wiring	1
	Varsity Softball	A3-A4	8	Future Light Poles, 40' High with Concrete Base	4
	Varsity Softball	B3-B4	10	Field Lighting Fixtures (LED)	4
				Surge Protection Device, 480 V	1
				Lighting Control Cabinet	1
				Auxillary Lighting Interface Cabinet	1

ECM Calculations

BPU Protocols were used to calculate Field Lighting Installation based on an adjusted baseline with existing metal halide lighting system. See calculations below.

BPU CALCULATIONS							
Softball Field Lighting Installation Savings							
BUILDING	QTY OF POLES	POLE ID	QTY OF FIXTURES	SPACE	kW_b	kW_q	ΔkW
Gloucester High School	2	A1-A2	8	SPECIAL	10.04	6.42	3.6
	2	B1-B2	10	SPECIAL	21.40	12.42	9.0
	2	A3-A4	8	SPECIAL	10.04	6.42	3.6
	2	B3-B4	10	SPECIAL	21.40	12.42	9.0

Softball Field Lighting Installation Savings						Total Savings (Retrofit)		
BUILDING	CF	Hours per Year	Peak Demand Savings (kW)	Replacement Energy Savings (kWh)	Replacement Fuel Savings (Therms)	Total Demand Savings (kW)	Total Energy Savings (kWh)	Total Fuel Savings (Therms)
Gloucester High School	0.50	180	1.8	651	0.0	4.5	4534	0
	0.50	180	4.5	1616	0.0			
	0.50	180	1.8	651	0.0			
	0.50	180	4.5	1616	0.0			

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

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

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

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ENERGY SAVINGS PLAN

SECTION 4 – FINANCIAL ANALYSIS

Form II – Energy Conservation Measures Summary Form

FORM II				
ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP): ENERGY CONSERVATION MEASURES (ECMs) SUMMARY FORM GLOUCESTER CITY SCHOOL DISTRICT ENERGY SAVINGS IMPROVEMENT PROGRAM				
ESCO Name: DCO Energy				
Proposed Preliminary Energy Savings Plan (Base)		Estimated Installed Hard Costs[(1)] $	Estimated Annual Savings $	Est. Simple Payback (Years)
ECM Number	Energy Conservation Measure			
1	LED Lighting Upgrades	$1,402,746	$156,205	9.0
2	Lighting Controls	$47,067	$3,455	13.6
3	Energy Management System Upgrades	$432,500	$49,651	8.7
5	Chiller Replacement	$675,195	$13,827	48.8
6	Premium Efficiency Pump Motors and VFDs	$191,061	$16,787	11.4
7	Rooftop Unit Replacement	$2,184,975	$36,763	59.4
9	Pipe and Valve Insulation	$44,179	$4,740	9.3
11	Water Conservation	$33,912	$7,065	4.8
12	Building Envelope Weatherization	$229,103	$16,866	13.6
13	Plug Load Controls	$37,493	$3,087	12.1
14	eTemp Refrigeration Sensors	$29,500	$5,306	5.6
15	Retro-Commissioning	$129,000	$20,388	6.3
16	Combined Heating & Power	$210,600	$2,807	75.0
18	Window Film	$122,074	$22,722	5.4
	ECM Contingency	$242,380	$0	-
*Add additional lines as needed**	**Project Summary:**	**$6,011,786**	**$359,668**	**16.7**
	Optional ECMs *(Considered, but not included)*	**Estimated Installed Hard Costs[(1)] $**	**Estimated Annual Savings $**	**Est. Simple Payback (Years)**
ECM Number	**Energy Conservation Measure**			
4	Boiler Replacement	$1,503,801	$11,748	128.0
5	Chiller Replacement	$1,162,629	$19,683	59.1
8	Split System Replacement	$47,189	$140	337.3
10	Ductwork Insulation	$37,800	$2,088	18.1
17	Destratifcation Fans	$75,850	$3,365	22.5
19	Softball Field Lighting	$694,370	$1,195	581.2
*Add additional lines as needed**	**Optional ECMs Summary:**	**$3,521,639**	**$38,219**	**92.1**
(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.				

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.				

Form V – ESCO Construction and Service Fees

FORM V

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCOs PROPOSED FINAL PROJECT COST FORM FOR BASE CASE PROJECT
GLOUCESTER CITY SCHOOL DISTRICT
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)	$ 5,769,405	
ECM Contingency	$ 242,380	
Estimated Value of Hard Costs (2)	$ 6,011,786	
Project Service Fees		
Investment Grade Energy Audit	$ 117,230	1.95%
Design Engineering Fees	$ 360,707	6.00%
Construction Management & Project Administration	$ 360,707	6.00%
System Commissioning	$ 90,177	1.50%
Equipment Initial Training Fees	$ 90,177	1.50%
ESCO Overhead	$ 180,354	3.00%
ESCO Profit	$ 240,471	4.00%
Project Service Fees Sub Total	$ 1,018,998	16.95%
TOTAL FINANCED PROJECT COSTS:	$ 7,451,609	23.95%

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)*	$37,500	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.

ESCO's proposed interest rate at the time of submission: 5% TO BE USED BY ALL RESPONDING ESCOs FOR PROPOSAL PURPOSES

Form VI – Project Cash Flow Analysis

FORM VI

ESCO's PRELIMINARY ENERGY SAVINGS PLAN (ESP):
ESCO's PRELIMINARY ANNUAL CASH FLOW ANALYSIS FORM
GLOUCESTER CITY SCHOOL DISTRICT - 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. No other escalators will be permitted.

1. Term of Agreement: **20 Years**
2. Construction Period [2] (months): 24 Months
3. Cash Flow Analysis Format:

Miscellaneous Costs Financed:	
Cost of Issuance	$125,000
Total	$125,000

Total Estimated Project Cost[1]:	**$7,451,609**
Alternative Funding Solutions	**-$500,000**
Misc Costs Financed:	**$125,000**
Financed Amount:	**$7,076,609**

3.90%

Year	Annual Energy Savings	Annual Operational Savings	Energy Rebates / Incentives	Total Annual Savings	Annual Project Costs	District Costs	Annual Service Costs[3]	Net Cash-Flow to Client	Cumulative Cash Flow
Installation (2 Years)	$ 551,500			$ 551,500	$ (336,664)				$ -
Year 1	$ 392,529	$ 48,528	$ 131,172	$ 572,229	$ (784,515)	$ -	$ -	$ 2,550	$ 2,550
Year 2	$ 401,206	$ 48,528	$ 131,172	$ 580,906	$ (578,356)	$ -	$ -	$ 2,550	$ 5,100
Year 3	$ 410,076	$ 26,927		$ 437,004	$ (434,454)	$ -	$ -	$ 2,550	$ 7,650
Year 4	$ 419,144	$ 26,927		$ 446,071	$ (443,521)	$ -	$ -	$ 2,550	$ 10,200
Year 5	$ 428,413	$ 26,927		$ 455,340	$ (452,790)	$ -	$ -	$ 2,550	$ 12,750
Year 6	$ 437,888			$ 437,888	$ (435,338)	$ -	$ -	$ 2,550	$ 15,300
Year 7	$ 447,574			$ 447,574	$ (445,024)	$ -	$ -	$ 2,550	$ 17,850
Year 8	$ 457,476			$ 457,476	$ (454,926)	$ -	$ -	$ 2,550	$ 20,400
Year 9	$ 467,597			$ 467,597	$ (465,047)	$ -	$ -	$ 2,550	$ 22,950
Year 10	$ 477,944			$ 477,944	$ (475,394)	$ -	$ -	$ 2,550	$ 25,500
Year 11	$ 488,521			$ 488,521	$ (485,971)	$ -	$ -	$ 2,550	$ 28,050
Year 12	$ 499,334			$ 499,334	$ (496,784)	$ -	$ -	$ 2,550	$ 30,600
Year 13	$ 510,387			$ 510,387	$ (507,837)	$ -	$ -	$ 2,550	$ 33,150
Year 14	$ 521,685			$ 521,685	$ (519,135)	$ -	$ -	$ 2,550	$ 35,700
Year 15	$ 533,236			$ 533,236	$ (530,686)	$ -	$ -	$ 2,550	$ 38,250
Year 16	$ 545,043			$ 545,043	$ (542,493)	$ -	$ -	$ 2,550	$ 40,800
Year 17	$ 557,113			$ 557,113	$ (554,563)	$ -	$ -	$ 2,550	$ 43,350
Year 18	$ 569,451			$ 569,451	$ (566,901)	$ -	$ -	$ 2,550	$ 45,900
Year 19	$ 582,064			$ 582,064	$ (579,514)	$ -	$ -	$ 2,550	$ 48,450
Year 20	$ 594,958			$ 594,958	$ (592,408)	$ -	$ -	$ 2,550	$ 51,000
Totals	$ 10,293,138	$ 177,838	$ 262,344	$ 10,733,320	$ (10,682,320)	$ -	$ -	$ 51,000	

NOTES:
(1) Includes: Hard costs and project service fees defined in ESCO's PROPOSED "FORM V"
(2) No payments are made by District during the construction period.
(3) This figure should equal the value indicated on the ESCO's PROPOSED "FORM V". DO NOT include in the Financed Project Cost.

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	ANNUAL Water & Sewer (kGal) COST SAVINGS	Total
1	$346,569.65	$43,856.76	$2,102.64	$392,529.04
2	$354,194.18	$44,909.32	$2,102.64	$401,206.14
3	$361,986.45	$45,987.15	$2,102.64	$410,076.23
4	$369,950.15	$47,090.84	$2,102.64	$419,143.63
5	$378,089.06	$48,221.02	$2,102.64	$428,412.71
6	$386,407.01	$49,378.32	$2,102.64	$437,887.97
7	$394,907.97	$50,563.40	$2,102.64	$447,574.01
8	$403,595.94	$51,776.92	$2,102.64	$457,475.51
9	$412,475.06	$53,019.57	$2,102.64	$467,597.26
10	$421,549.51	$54,292.04	$2,102.64	$477,944.18
11	$430,823.60	$55,595.05	$2,102.64	$488,521.28
12	$440,301.71	$56,929.33	$2,102.64	$499,333.68
13	$449,988.35	$58,295.63	$2,102.64	$510,386.62
14	$459,888.10	$59,694.73	$2,102.64	$521,685.46
15	$470,005.63	$61,127.40	$2,102.64	$533,235.67
16	$480,345.76	$62,594.46	$2,102.64	$545,042.85
17	$490,913.36	$64,096.73	$2,102.64	$557,112.73
18	$501,713.46	$65,635.05	$2,102.64	$569,451.14
19	$512,751.15	$67,210.29	$2,102.64	$582,064.08
20	$524,031.68	$68,823.33	$2,102.64	$594,957.65

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	Gloucester City School District
Disposition of Abandoned Equipment (Steam Piping, Condensate Piping, Oil Tanks, etc.)	Risk	Gloucester City School District
New Natural Gas Distribution	Risk	Gloucester City School District
Integrity of re-used Infrastructure	Risk	Gloucester City School District
Life Safety System Coordination	Risk	Gloucester City School District
Coordination with Gloucester City School District Information Technology Department	Risk	Gloucester City School District
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. Gloucester City School District
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 & Gloucester City School District
Scope changes relating to requests by Authorities Having Jurisdiction.	Risk	Gloucester City School District (via contingency)
Department of Environmental Protection Permitting	Risk	Consulting Engineer
Modifications of Energy Saving Control Sequences and Setpoints impacting Energy Savings and Incentives	Risk	Gloucester City School District
Post Construction Calibration of Sensors, Meters, & Safety Devices	Risk	Gloucester City School District
Adequate time and access for bidding contractor site surveys	Risk	Gloucester City School District
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 Gloucester City School District, 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 for 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 units 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 year end. Gloucester City School District 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 Gloucester City School District and DCO in a timely manner.

As part of the optional energy guarantee, DCO uses weather normalization procedures to correct for 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 Gloucester City School District.

Maintenance Plan

Owner Tasks and Responsibilities:

As a general statement, Gloucester City School District 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, Gloucester City School District 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 Gloucester City School District'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:

Gloucester City School District will be given specific training on the changes and advancements in the environmental operations and energy savings strategies. Gloucester City School District 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

Gloucester City School District will be required to assure that proper mechanical maintenance continues to be implemented on its 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 Gloucester City School District's attention for correction.

ENERGY SAVINGS PLAN

SECTION 6 – OPERATION & MAINTENANCE

It is critical to the success of achieving continued energy savings that Gloucester City School District develop and implement an Operation and Maintenance Plan. In this section are some recommendations for Gloucester City School District 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 Gloucester City School District and DCO. If Gloucester City School District 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 Gloucester City School District 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 Gloucester City School District will achieve 100% of the total energy units 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 Gloucester City School District.

SAVINGS VERIFICATION

There are events that cause energy savings to change. Gloucester City School District 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 for 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 Gloucester City School District.

DCO ENERGY

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

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	Lighting Line-by-Line
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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 added 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 Gloucester City School District were not available to deliver a cost estimate for each ECM. The budgetary costs carried 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 (4.2% of Hard Costs)

BID PACKAGE ALOWANCE SCHEDULE		CONTINGENCY
ECM #	ENERGY CONSERVATION MEASURE	$
1	LED Lighting Upgrades	$58,931
2	Lighting Controls	$1,977
3	Energy Management System Upgrades	$18,170
5	Chiller Replacement	$28,366
6	Premium Efficiency Pump Motors and VFDs	$8,027
7	Rooftop Unit Replacement	$91,794
9	Pipe and Valve Insulation	$1,856
11	Water Conservation	$1,425
12	Building Envelope Weatherization	$9,625
13	Plug Load Controls	$1,575
14	eTemp Refrigeration Sensors	$1,239
15	Retro-Commissioning	$5,419
16	Combined Heating & Power	$8,848
18	Window Film	$5,128

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 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 obtain 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:

- Re-bid the construction of the project on a 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	$1,461,677	$156,205
Lighting Controls	$49,045	$3,455
Energy Management System Upgrades	$450,670	$49,651
Retro-Commissioning	$134,419	$20,388
Building Envelope Weatherization	$238,728	$16,866
Pipe and Valve Insulation	$46,036	$4,740
Water Conservation	$35,337	$7,065
eTemp Refrigeration Sensors	$30,739	$5,306
Window Film	$127,202	$22,722
Combined Heating & Power	$219,448	$2,807
Premium Efficiency Pump Motors and VFDs	$199,088	$16,787
Plug Load Controls	$39,068	$3,087
Chiller Replacement	$703,561	$13,827
Rooftop Unit Replacement	$2,276,769	$36,763
TOTALS	$6,011,786	$359,668

2. Bids in group 1 (Green) are within 15% of 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 will be 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

GLOUCESTER CITY SCHOOL DISTRICT		ANNUAL O&M COST SAVINGS
ECM #	ENERGY CONSERVATION MEASURE	$
1	LED Lighting Upgrades	$26,927
3	Energy Management System Upgrades	$7,868
5	Chiller Replacement	$4,984
7	Rooftop Unit Replacement	$8,749
TOTALS		$48,528

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: 3.9%
Term: .... 20 Years (20 + 2 Construction Years)
Construction Term .... 24 Months
Construction Interest Only Payment of .... TBD by Gloucester City School District financial advisor
Annual Surplus of no less than $2,550

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

DCO Energy Efficiency Division
100 Lenox Drive
Lawrenceville, NJ 08648

ENERGY SAVINGS PLAN

APPENDIX E – INCENTIVES IN DEBT SERVICE

Appendix E – Incentives in Debt Service

Estimated incentive values were calculated in accordance with the PSE&G Rebate Program Guidelines. The total incentive amount was calculated to be $262,344 in rebates and incentives. The Prescriptive and Custom rebate program covers the entirety of the incentives carried within the project. Please see below for building-by-building details. Installation incentives are shown within Form VI of the Gloucester City School District Energy Savings Plan

Incentive Totals

BUILDING	INCENTIVE TYPE	SOURCE	NOTES	INCENTIVE $/UNIT	YEAR 1 INCENTIVE	YEAR 2 INCENTIVE	SUBTOTAL	TOTAL
GLOUCESTER CITY SCHOOL DISTRICT	PRESCIPTIVE	ACE	Various Measures		$127,286	$127,286	$254,572	$262,344
	CUSTOM	ACE	Chiller Replacement		$3,886	$3,886	$7,772	
				TOTALS	$131,172	$131,172	$262,344	

Incentive Data

BUILDING	INCENTIVE TYPE	SOURCE	ECM	INCLUDED IN ESIP	YEAR 1 INCENTIVE	YEAR 2 INCENTIVE	SUBTOTAL	TOTAL
Gloucester High School	PRESCIPTIVE	ACE	LED Lighting Upgrades	Y	$34,074	$34,074	$68,148	$121,088
	PRESCIPTIVE	ACE	Rooftop Unit Replacement	Y	$17,975	$17,975	$35,950	
	PRESCIPTIVE	ACE	Plug Load Controls	Y	$195	$195	$390	
	PRESCIPTIVE	ACE	Lighting Controls	Y	$6,050	$6,050	$12,100	
	PRESCIPTIVE	ACE	Premium Efficiency Pump Motors and VFDs	Y	$2,250	$2,250	$4,500	
							$0	
Cold Springs ES & ECC	PRESCIPTIVE	ACE	LED Lighting Upgrades	Y	$41,628	$41,628	$83,256	$96,818
	PRESCIPTIVE	ACE	Plug Load Controls	Y	$445	$445	$890	
	PRESCIPTIVE	ACE	Lighting Controls	Y	$2,450	$2,450	$4,900	
	CUSTOM	ACE	Chiller Replacement	Y	$3,886	$3,886	$7,772	
							$0	
Gloucester Middle School	PRESCIPTIVE	ACE	LED Lighting Upgrades	Y	$21,904	$21,904	$43,808	$44,438
	PRESCIPTIVE	ACE	Plug Load Controls	Y	$315	$315	$630	
							$0	

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, Gloucester City School District 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

GLOUCESTER CITY SCHOOL DISTRICT % SAVINGS BY BUILDING (T.O.R.)							
GLOUCESTER CITY SCHOOL DISTRICT BUILDINGS/FACILITIES		UTILITY ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	ONSITE ELECTRIC SAVINGS	NATURAL GAS SAVINGS	Water & Sewer (kGal) SAVINGS
BUILDING/FACILITY NAME	SQFT	kWh	kW	kWh	Therms	Water & Sewer (kGal)
Gloucester High School	172,243	78.9%	32.8%	39.7%	31.5%	7.8%
Cold Springs ES & ECC	161,294	48.4%	30.3%	24.2%	17.1%	6.2%
Gloucester Middle School	122,000	99.6%	30.2%	33.9%	16.6%	5.5%
TOTALS	**455,537**	**68.6%**	**32.8%**	**32.4%**	**23.3%**	**6.5%**

GLOUCESTER CITY SCHOOL DISTRICT SAVINGS BY BUILDING BY UTILITY						
GLOUCESTER CITY SCHOOL DISTRICT BUILDINGS/FACILITIES		ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	ONSITE ELECTRIC SAVINGS	NATURAL GAS SAVINGS	Water & Sewer (kGal) SAVINGS
BUILDING/FACILITY NAME	SQFT	kWh	kW	kWh	Therms	Water & Sewer (kGal)
Gloucester High School	172,243	1,003,153	237	1,003,153	26,073	86
Cold Springs ES & ECC	161,294	603,408	187	603,408	12,395	93
Gloucester Middle School	122,000	386,866	90	386,866	5,402	54
TOTALS	**455,537**	**1,993,427**	**237**	**1,993,427**	**43,870**	**233**

GLOUCESTER CITY SCHOOL DISTRICT			INCLUDED IN PROJECT	INSTALLED COST	ANNUAL ELECTRIC COST SAVINGS	ANNUAL NATURAL GAS COST SAVINGS	ANNUAL Water & Sewer (kGal) COST SAVINGS	ANNUAL ENERGY COST SAVINGS
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	"Y" OR "N"	$	$	$	$	$
1	Gloucester High School	LED Lighting Upgrades	Y	$526,740	$67,618	($578)	$0	$67,040
2	Gloucester High School	Lighting Controls	Y	$31,007	$2,726	($29)	$0	$2,698
3	Gloucester High School	Energy Management System Upgrades	Y	$197,000	$24,197	$8,849	$0	$33,045
6	Gloucester High School	Premium Efficiency Pump Motors and VFDs	Y	$191,061	$16,787	$0	$0	$16,787
7	Gloucester High School	Rooftop Unit Replacement	Y	$2,184,975	$32,443	$4,320	$0	$36,763
9	Gloucester High School	Pipe and Valve Insulation	Y	$18,163	$0	$2,193	$0	$2,193
11	Gloucester High School	Water Conservation	Y	$13,479	$0	$1,777	$757	$2,534
12	Gloucester High School	Building Envelope Weatherization	Y	$89,371	$5,205	$7,035	$0	$12,240
13	Gloucester High School	Plug Load Controls	Y	$7,614	$586	$0	$0	$586
14	Gloucester High School	eTemp Refrigeration Sensors	Y	$7,000	$1,864	$0	$0	$1,864
15	Gloucester High School	Retro-Commissioning	Y	$51,849	$6,414	$3,604	$0	$10,018
16	Gloucester High School	Combined Heating & Power	Y	$210,600	$3,846	($1,039)	$0	$2,807
18	Gloucester High School	Window Film	Y	$74,025	$19,923	($2,226)	$0	$17,697
1	Cold Springs ES & ECC	LED Lighting Upgrades	Y	$555,582	$54,242	($694)	$0	$53,548
2	Cold Springs ES & ECC	Lighting Controls	Y	$16,061	$768	($10)	$0	$757
3	Cold Springs ES & ECC	Energy Management System Upgrades	Y	$157,669	$9,899	$3,145	$0	$13,044
5	Cold Springs ES & ECC	Chiller Replacement	Y	$675,195	$13,827	$0	$0	$13,827
9	Cold Springs ES & ECC	Pipe and Valve Insulation	Y	$12,024	$0	$1,248	$0	$1,248
11	Cold Springs ES & ECC	Water Conservation	Y	$18,323	$0	$2,773	$903	$3,676
12	Cold Springs ES & ECC	Building Envelope Weatherization	Y	$110,127	$515	$1,613	$0	$2,128
13	Cold Springs ES & ECC	Plug Load Controls	Y	$17,545	$1,591	$0	$0	$1,591
14	Cold Springs ES & ECC	eTemp Refrigeration Sensors	Y	$10,000	$1,824	$0	$0	$1,824
15	Cold Springs ES & ECC	Retro-Commissioning	Y	$41,998	$4,594	$3,118	$0	$7,712
1	Gloucester Middle School	LED Lighting Upgrades	Y	$320,423	$36,134	($516)	$0	$35,618
3	Gloucester Middle School	Energy Management System Upgrades	Y	$77,831	$2,423	$1,139	$0	$3,562
9	Gloucester Middle School	Pipe and Valve Insulation	Y	$13,993	$0	$1,299	$0	$1,299
11	Gloucester Middle School	Water Conservation	Y	$2,110	$0	$412	$443	$854
12	Gloucester Middle School	Building Envelope Weatherization	Y	$29,605	$841	$1,656	$0	$2,498
13	Gloucester Middle School	Plug Load Controls	Y	$12,333	$910	$0	$0	$910
14	Gloucester Middle School	eTemp Refrigeration Sensors	Y	$12,500	$1,619	$0	$0	$1,619
15	Gloucester Middle School	Retro-Commissioning	Y	$35,153	$1,287	$1,371	$0	$2,658
18	Gloucester Middle School	Window Film	Y	$48,049	$5,596	($571)	$0	$5,025
		TOTALS		$5,769,405	$317,678	$39,887	$2,103	$359,668

GLOUCESTER CITY SCHOOL DISTRICT			INCLUDED IN PROJECT	ELECTRIC CONSUMPTION SAVINGS	ELECTRIC DEMAND SAVINGS	NATURAL GAS SAVINGS	WATER & SEWER SAVINGS
ECM #	BUILDING/FACILITY	ENERGY CONSERVATION MEASURE	"Y" OR "N"	kWh	kW	THERMS	kGallons
1	Gloucester High School	LED Lighting Upgrades	Y	381,567	77	(631)	0
2	Gloucester High School	Lighting Controls	Y	14,895	4	(31)	0
3	Gloucester High School	Energy Management System Upgrades	Y	128,179	39	9,651	0
6	Gloucester High School	Premium Efficiency Pump Motors and VFDs	Y	99,923	12	0	0
7	Gloucester High School	Rooftop Unit Replacement	Y	175,051	48	4,711	0
9	Gloucester High School	Pipe and Valve Insulation	Y	0	0	2,392	0
11	Gloucester High School	Water Conservation	Y	0	0	1,939	86
12	Gloucester High School	Building Envelope Weatherization	Y	20,373	19	7,673	0
13	Gloucester High School	Plug Load Controls	Y	3,776	0	0	0
14	Gloucester High School	eTemp Refrigeration Sensors	Y	12,006	0	0	0
15	Gloucester High School	Retro-Commissioning	Y	41,321	0	3,930	0
16	Gloucester High School	Combined Heating & Power	Y	21,676	4	(1,133)	0
18	Gloucester High School	Window Film	Y	104,387	34	(2,428)	0
1	Cold Springs ES & ECC	LED Lighting Upgrades	Y	395,214	93	(769)	0
2	Cold Springs ES & ECC	Lighting Controls	Y	5,522	1	(12)	0
3	Cold Springs ES & ECC	Energy Management System Upgrades	Y	80,991	7	3,483	0
5	Cold Springs ES & ECC	Chiller Replacement	Y	48,574	83	0	0
9	Cold Springs ES & ECC	Pipe and Valve Insulation	Y	0	0	1,382	0
11	Cold Springs ES & ECC	Water Conservation	Y	0	0	3,071	93
12	Cold Springs ES & ECC	Building Envelope Weatherization	Y	2,502	2	1,786	0
13	Cold Springs ES & ECC	Plug Load Controls	Y	14,024	0	0	0
14	Cold Springs ES & ECC	eTemp Refrigeration Sensors	Y	16,077	0	0	0
15	Cold Springs ES & ECC	Retro-Commissioning	Y	40,503	0	3,453	0
1	Gloucester Middle School	LED Lighting Upgrades	Y	282,496	71	(582)	0
3	Gloucester Middle School	Energy Management System Upgrades	Y	17,957	6	1,284	0
9	Gloucester Middle School	Pipe and Valve Insulation	Y	0	0	1,465	0
11	Gloucester Middle School	Water Conservation	Y	0	0	464	54
12	Gloucester Middle School	Building Envelope Weatherization	Y	4,276	4	1,868	0
13	Gloucester Middle School	Plug Load Controls	Y	8,920	0	0	0
14	Gloucester Middle School	eTemp Refrigeration Sensors	Y	15,870	0	0	0
15	Gloucester Middle School	Retro-Commissioning	Y	12,620	0	1,546	0
18	Gloucester Middle School	Window Film	Y	44,725	10	(644)	0
		TOTALS		1,993,427	93.5	43,870	233

ECM Breakdown by Building by Greenhouse Gas Reductions

GLOUCESTER CITY SCHOOL DISTRICT			INCLUDED IN PROJECT	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	"Y" OR "N"	MMBTU	MMBTU	LBS	LBS	LBS	LBS
1	Gloucester High School	LED Lighting Upgrades	Y	1,239	3,579	485,604	311	256	0.00
2	Gloucester High School	Lighting Controls	Y	48	139	18,880	12	10	0.00
3	Gloucester High School	Energy Management System Upgrades	Y	1,402	2,238	278,522	195	86	0.00
6	Gloucester High School	Premium Efficiency Pump Motors and VFDs	Y	341	955	129,100	83	67	0.00
7	Gloucester High School	Rooftop Unit Replacement	Y	1,068	2,167	281,287	189	117	0.00
9	Gloucester High School	Pipe and Valve Insulation	Y	239	251	27,986	22	0	0.00
11	Gloucester High School	Water Conservation	Y	194	204	22,681	18	0	0.00
12	Gloucester High School	Building Envelope Weatherization	Y	837	1,000	116,097	88	14	0.00
13	Gloucester High School	Plug Load Controls	Y	13	36	4,879	3	3	0.00
14	Gloucester High School	eTemp Refrigeration Sensors	Y	41	115	15,512	10	8	0.00
15	Gloucester High School	Retro-Commissioning	Y	534	807	99,372	70	28	0.00
16	Gloucester High School	Combined Heating & Power	Y	(39)	88	14,748	8	15	0.00
18	Gloucester High School	Window Film	Y	113	742	106,460	64	70	0.00
1	Cold Springs ES & ECC	LED Lighting Upgrades	Y	1,272	3,695	501,619	321	265	0.00
2	Cold Springs ES & ECC	Lighting Controls	Y	18	52	7,000	4	4	0.00
3	Cold Springs ES & ECC	Energy Management System Upgrades	Y	625	1,139	145,394	99	54	0.00
5	Cold Springs ES & ECC	Chiller Replacement	Y	166	464	62,758.09	40.32	32.54	0.00
9	Cold Springs ES & ECC	Pipe and Valve Insulation	Y	138	145	16,168	13	0	0.00
11	Cold Springs ES & ECC	Water Conservation	Y	307	322	35,933	28	0	0.00
12	Cold Springs ES & ECC	Building Envelope Weatherization	Y	187	211	24,131	19	2	0.00
13	Cold Springs ES & ECC	Plug Load Controls	Y	48	134	18,119	12	9	0.00
14	Cold Springs ES & ECC	eTemp Refrigeration Sensors	Y	55	154	20,771	13	11	0.00
15	Cold Springs ES & ECC	Retro-Commissioning	Y	484	750	92,731	65	27	0.00
1	Gloucester Middle School	LED Lighting Upgrades	Y	906	2,638	358,174	229	189	0.00
3	Gloucester Middle School	Energy Management System Upgrades	Y	190	306	38,229	27	12	0.00
9	Gloucester Middle School	Pipe and Valve Insulation	Y	147	154	17,144	13	0	0.00
11	Gloucester Middle School	Water Conservation	Y	46	49	5,434	4	0	0.00
12	Gloucester Middle School	Building Envelope Weatherization	Y	201	237	27,379	21	3	0.00
13	Gloucester Middle School	Plug Load Controls	Y	30	85	11,525	7	6	0.00
14	Gloucester Middle School	eTemp Refrigeration Sensors	Y	54	152	20,504.04	13.17	10.63	0.00
15	Gloucester Middle School	Retro-Commissioning	Y	198	283	34,391	25	8	0.00
18	Gloucester Middle School	Window Film	Y	88	360	50,250	31	30	0.00
		TOTALS		11,189	23,651	3,088,784	2,058	1,336	0.00

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)***

ENERGY SAVINGS PLAN

APPENDIX G – LIGHTING LINE BY LINE

ENERGY SAVINGS PLAN

APPENDIX H – LOCAL GOVERNMENT ENERGY AUDITS