Local Government Energy Audit Report

Alexander Hamilton Elementary

August 8, 2024

Prepared for:
Morris School District BOE
24 Mills Street
Morristown, New Jersey 07950

Prepared by:
TRC
317 George Street
New Brunswick, New Jersey 08901

Disclaimer

The goal of this audit report is to identify potential energy efficiency opportunities and help prioritize specific measures for implementation. Most energy conservation measures have received preliminary analysis of feasibility that identifies expected ranges of savings and costs. This level of analysis is usually considered sufficient to establish a basis for further discussion and to help prioritize energy measures.

TRC reviewed the energy conservation measures and estimates of energy savings for technical accuracy. Actual, achieved energy savings depend on behavioral factors and other uncontrollable variables and, therefore, estimates of final energy savings are not guaranteed. TRC and the New Jersey Board of Public Utilities (NJBPU) shall in no event be liable should the actual energy savings vary.

TRC bases estimated material and labor costs primarily on RS Means cost manuals as well as on our experience at similar facilities. This approach is based on standard cost estimating manuals and is vendor neutral. Cost estimates include material and labor pricing associated with one for one equipment replacements. Cost estimates do not include demolition or removal of hazardous waste. The actual implementation costs for energy savings projects are anticipated to be significantly higher based on the specific conditions at your site(s). We strongly recommend that you work with your design engineer or contractor to develop actual project costs for your specific scope of work for the installation of high efficiency equipment. We encourage you to obtain multiple estimates when considering measure installations. Actual installation costs can vary widely based on selected products and installers. TRC and NJBPU do not guarantee cost estimates and shall in no event be held liable should actual installed costs vary from these material and labor estimates.

Incentive values provided in this report are estimated based on previously run state efficiency programs. Incentive levels are not guaranteed. The NJBPU reserves the right to extend, modify, or terminate programs without prior notice. Please review all available utility program incentives and eligibility requirements prior to selecting and installing any energy conservation measures.

The customer and their respective contractor(s) are responsible to implement energy conservation measures in complete conformance with all applicable local, state, and federal requirements.

TRC

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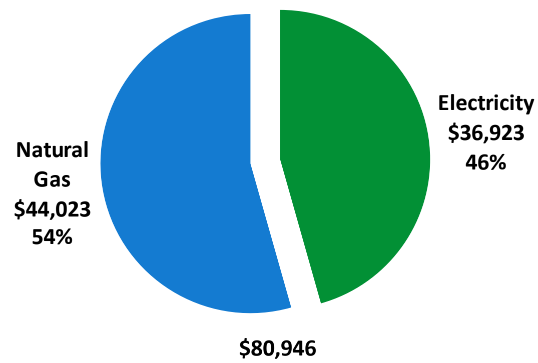
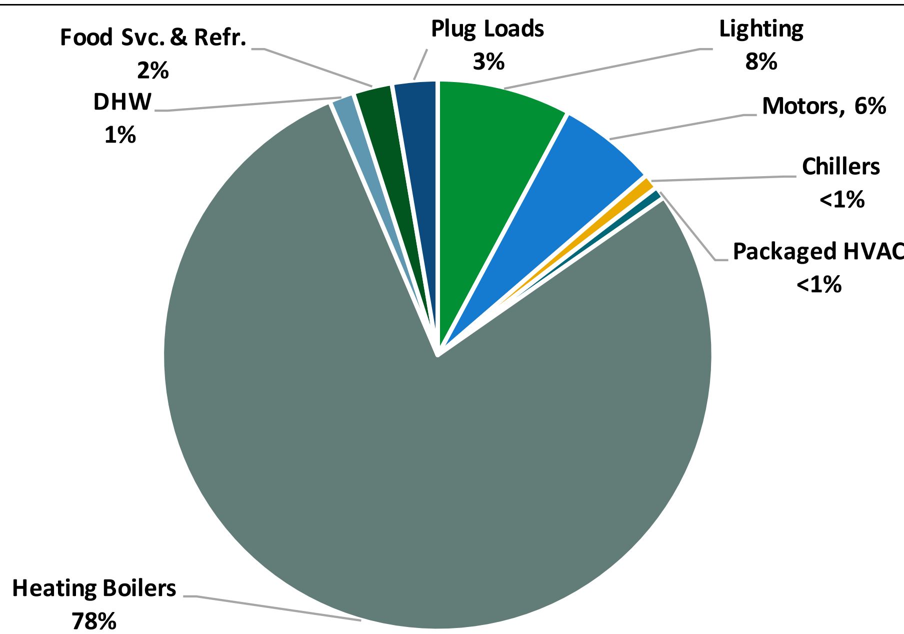
1 Executive Summary

The New Jersey Board of Public Utilities (NJBPU) has sponsored this Local Government Energy Audit (LGEA) report for Alexander Hamilton Elementary School. This report provides you with information about your facility's energy use, identifies energy conservation measures (ECMs) that can reduce your energy use, and provides information and assistance to help make changes in your facility. TRC conducted this study as part of a comprehensive effort to assist New Jersey school districts and local governments in controlling their energy costs and to help protect our environment by reducing statewide energy consumption.

BUILDING PERFORMANCE REPORT

Annual Energy Utilities	Costs: $80,946 Electricity: 261,172 kWh Natural Gas: 34,792 Therms Water: 729,351 Gallons	
ENERGY STAR® Benchmarking Score	31 *(1-100 scale)*	This building performs at or below the national average. This report contains suggestions about how to improve building performance and reduce energy costs.





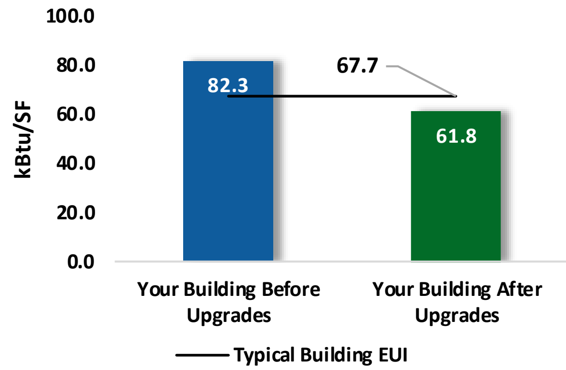
Energy Use by System

POTENTIAL IMPROVEMENTS

This energy audit considered a range of potential energy improvements in your building. Costs and savings will vary between improvements. Presented below are two potential scopes of work for your consideration.

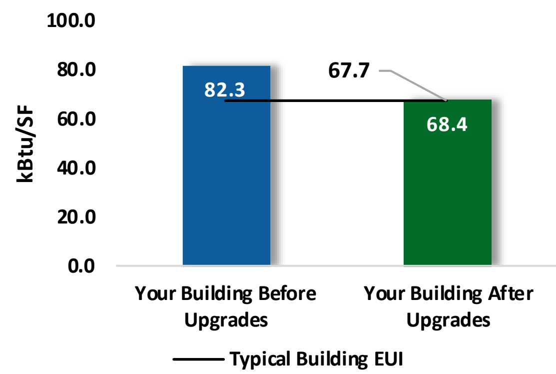
Scenario 1: Full Package (All Evaluated Measures)

Installation Cost	$379,880
Potential Rebates & Incentives[1]	$27,470
Annual Cost Savings	$23,541
Annual Energy Savings	Electricity: 99,727 kWh Natural Gas: 7,463 Therms
Greenhouse Gas Emission Savings	94 Tons
Simple Payback	15.0 Years
Site Energy Savings (All Utilities)	25%



Scenario 2: Cost Effective Package[2]

Installation Cost	$121,080
Potential Rebates & Incentives	$16,370
Annual Cost Savings	$16,818
Annual Energy Savings	Electricity: 76,463 kWh Natural Gas: 4,748 Therms
Greenhouse Gas Emission Savings	66 Tons
Simple Payback	6.2 Years
Site Energy Savings (all utilities)	17%



On-site Generation Potential

Photovoltaic	High
Combined Heat and Power	None

[1] Incentives are based on previously run state rebate programs. Contact your utility provider for current program incentives that may apply.

[2] A cost-effective measure is defined as one where the simple payback does not exceed two-thirds of the expected proposed equipment useful life. Simple payback is based on the net measure cost after potential incentives.

#	Energy Conservation Measure	Cost Effective?	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades			**49,211**	**15.0**	**-10**	**$6,825**	**$45,690**	**$8,220**	**$37,470**	**5.5**	**48,333**
ECM 1	Install LED Fixtures	No	3,750	3.8	0	$528	$10,200	$900	$9,300	17.6	3,756
ECM 2	Retrofit Fixtures with LED Lamps	Yes	45,461	11.2	-10	$6,297	$35,490	$7,320	$28,170	4.5	44,576
Lighting Control Measures			**14,207**	**3.5**	**-3**	**$1,967**	**$24,470**	**$6,940**	**$17,530**	**8.9**	**13,924**
ECM 3	Install Occupancy Sensor Lighting Controls	Yes	11,145	2.9	-3	$1,543	$17,160	$2,050	$15,110	9.8	10,923
ECM 4	Install High/Low Lighting Controls	Yes	3,062	0.5	-1	$424	$7,310	$4,890	$2,420	5.7	3,001
Variable Frequency Drive (VFD) Measures			**15,664**	**7.0**	**12**	**$2,369**	**$27,600**	**$3,800**	**$23,800**	**10.0**	**17,208**
ECM 5	Install VFDs on Constant Volume (CV) Fans	Yes	8,951	3.9	0	$1,265	$12,300	$1,900	$10,400	8.2	9,014
ECM 6	Install Boiler Draft Fan VFDs	No	5,820	3.1	0	$823	$11,800	$1,800	$10,000	12.2	5,860
ECM 7	Install VFDs on Kitchen Hood Fan Motors	No	893	0.0	12	$281	$3,500	$100	$3,400	12.1	2,334
Unitary HVAC Measures			**929**	**1.2**	**0**	**$131**	**$6,100**	**$0**	**$6,100**	**46.5**	**935**
ECM 8	Install High Efficiency Air Conditioning Units	No	929	1.2	0	$131	$6,100	$0	$6,100	46.5	935
Electric Chiller Replacement			**4,252**	**-1.0**	**0**	**$601**	**$56,900**	**$2,300**	**$54,600**	**90.8**	**4,282**
ECM 9	Install High Efficiency Chillers	No	4,252	-1.0	0	$601	$56,900	$2,300	$54,600	90.8	4,282
Gas Heating (HVAC/Process) Replacement			**0**	**0.0**	**166**	**$2,102**	**$137,200**	**$5,100**	**$132,100**	**62.8**	**19,450**
ECM 10	Install High Efficiency Steam Boilers	No	0	0.0	166	$2,102	$137,200	$5,100	$132,100	62.8	19,450
HVAC System Improvements			**1,622**	**0.0**	**280**	**$3,775**	**$23,470**	**$100**	**$23,370**	**6.2**	**34,440**
ECM 11	Install Programmable Thermostats	Yes	1,043	0.0	232	$3,080	$16,990	$0	$16,990	5.5	28,185
ECM 12	Implement Demand Control Ventilation (DCV)	No	579	0.0	37	$553	$5,800	$0	$5,800	10.5	4,943
ECM 13	Install Pipe Insulation	Yes	0	0.0	11	$142	$680	$100	$580	4.1	1,311
Domestic Water Heating Upgrade			**432**	**0.0**	**7**	**$147**	**$250**	**$110**	**$140**	**0.9**	**1,235**
ECM 14	Install Low-Flow DHW Devices	Yes	432	0.0	7	$147	$250	$110	$140	0.9	1,235
Food Service & Refrigeration Measures			**11,061**	**1.3**	**0**	**$1,564**	**$18,000**	**$900**	**$17,100**	**10.9**	**11,139**
ECM 15	Replace Refrigeration Equipment	No	11,061	1.3	0	$1,564	$18,000	$900	$17,100	10.9	11,139
Custom Measures			**2,349**	**0.0**	**295**	**$4,059**	**$40,200**	**$0**	**$40,200**	**9.9**	**36,856**
ECM 16	Retro-Commissioning Study	Yes	6,370	0.0	239	$3,919	$30,900	$0	$30,900	7.9	34,348
ECM 17	Replace Electric Water Heater with Heat Pump Water Heater	No	1,231	0.0	0	$174	$4,000	$0	$4,000	23.0	1,240
ECM 18	Replace Gas Fired Water Heater with Heat Pump Water Heater***	No	-5,252	0.0	56	-$34	$5,300	$0	$5,300	-155.9	1,268
TOTALS (COST EFFECTIVE MEASURES)			**76,463**	**18.6**	**475**	**$16,818**	**$121,080**	**$16,370**	**$104,710**	**6.2**	**132,594**
TOTALS (ALL MEASURES)			**99,727**	**26.9**	**746**	**$23,541**	**$379,880**	**$27,470**	**$352,410**	**15.0**	**187,801**

* - All incentives presented in this table are included as placeholders for planning purposes and are based on previously run state rebate programs. Contact your utility provider for details on current programs.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

*** - Negative payback explained in section 4.10

All Evaluated Energy Improvements[3]

For more detail on each evaluated energy improvement and a break out of cost-effective improvements, see **Section 4: Energy Conservation Measures.**

[3] TRC bases estimated material and labor costs primarily on RS Means cost manuals as well as on our experience at similar facilities. This approach is based on standard cost estimating manuals and is vendor neutral. Cost estimates include material and labor pricing associated with one for one equipment replacements. Cost estimates do not include demolition or removal of hazardous waste. The actual implementation costs for energy savings projects are anticipated to be significantly higher based on the specific conditions at your site(s). We strongly recommend that you work with your design engineer or contractor to develop actual project costs for your specific scope of work for the installation of high efficiency equipment. We encourage you to obtain multiple estimates when considering measure installations.

1.1 Planning Your Project

Careful planning makes for a successful energy project. When considering this scope of work, you will have some decision to make, such as:

- How will the project be funded/and or financed?
- Is it best to pursue individual ECMs, groups of ECMs, or use a comprehensive approach where all ECMs are installed together?
- Are there other facility improvements that should happen at the same time?

Pick Your Installation Approach

Utility-run energy efficiency programs and New Jersey's Clean Energy Programs, give you the flexibility to do a little or a lot. Rebates, incentives, and financing are available to help reduce both your installation costs and your energy bills. If you are planning to take advantage of these programs, make sure to review incentive program guidelines before proceeding. This is important because in most cases you will need to submit applications for the incentives *before* purchasing materials or starting installation.

Options from Your Utility Company

Prescriptive and Custom Rebates

For facilities wishing to pursue only selected individual measures (or planning to phase implementation of selected measures over multiple years), incentives are available through the Prescriptive and Custom Rebates program. To participate, you can use internal resources or an outside firm or contractor to perform the final design of the ECM(s) and install the equipment. Program pre-approval may be required for some incentives. Contact your utility company for more details prior to project installation.

Direct Install

The Direct Install program provides turnkey installation of multiple measures through an authorized contractor. This program can provide incentives up to 70% or 80% of the cost of selected measures. A Direct Install contractor will assess and verify individual measure eligibility and perform the installation work. The Direct Install program is available to sites with an average peak demand of less than 200 kW.

Engineered Solutions

The Engineered Solutions program provides tailored energy-efficiency assistance and turnkey engineering services to municipalities, universities, schools, hospitals, and healthcare facilities (MUSH), non-profit entities, and multifamily buildings. The program provides all professional services from audit, design, construction administration, to commissioning and measurement and verification for custom whole-building energy-efficiency projects. Engineered Solutions allows you to install as many measures as possible under a single project as well as address measures that may not qualify for other programs.

For more details on these programs please contact your utility provider.

Options from New Jersey's Clean Energy Program

Financing and Planning Support with the Energy Savings Improvement Program (ESIP)

For larger facilities with limited capital availability to implement ECMs, project financing may be available through the ESIP. Supported directly by the NJBPU, ESIP provides government agencies with project development, design, and implementation support services, as well as attractive financing for implementing ECMs. You have already taken the first step as an LGEA customer, because this report is *required to participate in ESIP.*

Resiliency with Return on Investment through Combined Heat and Power (CHP)

The CHP program provides incentives for combined heat and power (i.e., cogeneration) and waste heat to power projects. Combined heat and power systems generate power on-site and recover heat from the generation system to meet on-site thermal loads. Waste heat to power systems use waste heat to generate power. You will work with a qualified developer who will design a system that meets your building's heating and cooling needs.

Successor Solar Incentive Program (SuSI)

New Jersey is committed to supporting solar energy. Solar projects help the state reach the renewable goals outlined in the state's Energy Master Plan. The SuSI program is used to register and certify solar projects in New Jersey. Rebates are not available, but certified solar projects are able to earn one SREC II (Solar Renewable Energy Certificates II) for each megawatt-hour of solar electricity produced from a qualifying solar facility.

Ongoing Electric Savings with Demand Response

The Demand Response Energy Aggregator program reduces electric loads at commercial facilities when wholesale electricity prices are high or when the reliability of the electric grid is threatened due to peak power demand. By enabling commercial facilities to reduce electric demand during times of peak demand, the grid is made more reliable, and overall transmission costs are reduced for all ratepayers. Curtailment service providers provide regular payments to medium and large consumers of electric power for their participation in demand response (DR) programs. Program participation is voluntary, and facilities receive payments regardless of whether they are called upon to curtail their load during times of peak demand.

Large Energy User Program (LEUP)

LEUP is designed to promote self-investment in energy efficiency for the largest energy consumers in the state. Customers in this category spend about $5 million a year on energy bills. This program incentivizes owners/users of buildings to upgrade or install energy conserving measures in existing buildings to help offset the capital costs associated with the project. The efficiency upgrades are customized to meet the requirements of the customers' existing facilities, while advancing the State's energy efficiency, conservation, and greenhouse gas reduction goals.

For more details on these programs please visit New Jersey's Clean Energy Program website.

2 Existing Conditions

The New Jersey Board of Public Utilities (NJBPU) has sponsored this Local Government Energy Audit (LGEA) report for the Alexander Hamilton Elementary School. This report provides information on how your facility uses energy, identifies energy conservation measures (ECMs) that can reduce your energy use, and provides information and assistance to help you implement the ECMs.

TRC conducted this study as part of a comprehensive effort to assist New Jersey educational and local government facilities in controlling energy costs and protecting our environment by offering a wide range of energy management options and advice.

2.1 Site Overview

On February 21, 2024, TRC performed an energy audit at the Alexander Hamilton Elementary School located in Morristown, New Jersey. TRC met with Alfred Rapa to review the facility operations and help focus our investigation on specific energy-using systems.

Alexander Hamilton Elementary School is a three-story, 53,108 square foot building built in 1933. Spaces include classrooms, gymnasium, multipurpose room, offices, corridors, stairwells, kitchen, and mechanical space.

Lighting for the facility is primarily provided by linear fluorescent T8 fixtures. Some offices and classrooms use window air conditioners for cooling, while steam boilers supply heating. An air-cooled chiller cools the auditorium space. The site wants to upgrade the controls for its mostly pneumatically controlled HVAC system. The main concerns are steam trap failures and hidden steam traps. Steam systems use steam traps to remove condensation from pipes, protecting plant equipment, and ensuring efficient operation. Best practice involves conducting a steam trap study using ultrasonic detection and thermal imaging.

2.2 Building Occupancy

The facility is occupied Monday through Friday during regular school hours. The facility is occupied intermittently on weekends, as needed for maintenance and operations.

The school is fully occupied from September through June. Typical weekday occupancy is 80 staff and 300 students. During the summer, occupancy primarily involves ongoing maintenance tasks and limited use of office space, with a few summer classes being held.

Building Name	Weekday/Weekend	Operating Schedule
Alexander Hamilton Elementary Staff	Weekday	6:30 AM - 10:00 PM
	Weekend	No
Alexander Hamilton Elementary Classes	Weekday	8:30 AM - 3:15 PM
	Weekend	No

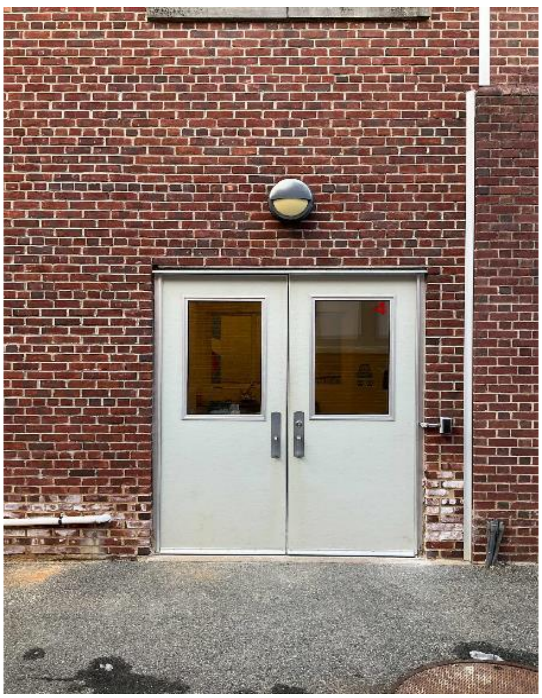
Building Occupancy Schedule

2.3 Building Envelope

The walls are made of brick over structural steel with a painted CMU interior finish. The roof has two parts. The flat roof is supported by steel trusses and a wood deck, with a built-up aggregate roof with a gravel pebble finish. Wood trusses support a pitched roof with a wood deck covered with asphalt shingles. The pitched roof was recently renovated. The roof encloses a plenum area with conditioned space below a drop ceiling. Most windows are double paned with aluminum frames with a thermal break. The seals between the glass and frames are in fair condition. The operable window weather seals are also in fair condition and show no signs of excessive wear. Exterior doors are made from fiberglass reinforced polymer (FRP) composite material with aluminum frames. They are in fair condition with undamaged door seals. Degraded window and door seals can lead to increased drafts and outside air infiltration.

Typical Building Envelope

Building Envelope with Windows



Typical Door

Typical Door

Flat Roof Section *Attic Area*

Typical Roof Section

2.4 Lighting Systems

The primary interior lighting system utilizes 32-Watt linear fluorescent T8 lamps. Additionally, some compact fluorescent lamps (CFL) and LED lamps are installed in some offices and storage rooms. Fixture types include 1-lamp, 2-lamp, 3-lamp, and 4-lamp, 4-foot-long recessed troffer fixtures with U-bend and linear tube lamps. Typically, T8 fluorescent lamps use electronic ballasts.

Some of the linear fixtures in the mechanical and storage rooms have been converted to operate LED tube lamps. Auditorium fixtures have high-bay LED lamps that are manually controlled, along with HID spotlights for the stage area. All exit signs are LED.

Most fixtures are in fair condition. Interior lighting levels were generally sufficient. Lighting fixtures in most spaces are controlled by wall switches, while there are few occupancy sensor switches in the restrooms.

Incandescent Lamps

Linear Fluorescent T8 Lamps

Linear Fluorescent T8 Lamps

LED Tube T8 Equivalent Lamps

LED Lamps *U Bend Fluorescent T8 Lamps*

Exterior light fixtures like wall packs and floodlights use a combination of high-intensity discharge (HID) and incandescent lamps, along with HID flood lamps. There are also a few wall-mounted LED fixtures.

Most of the exterior light fixtures are controlled by photocell.

Exterior LED Fixture

Exterior LED Fixture

Exterior HID Fixture

Exterior HID Fixture

2.5 Air Handling Systems

Unit Ventilators and Heating Equipment

Unit ventilators are equipped with supply fan motors and pneumatically controlled outside air dampers and connected to the steam distribution system. They provide heating and ventilation to classrooms. This system is original to the building and appears to be in fair operating condition.

In addition, there are also a few radiant heaters connected to the steam distribution system. These heaters are controlled via manual or thermostatic valves and are located in some of the classrooms and offices. This system is also the original one installed in the building and appears to be in fair operating condition.

Typical Classroom Unit Ventilator

Typical Classroom Unit Ventilator

Radiant Heater with Thermostatic Valve

Unitary Electric HVAC Equipment

Some classrooms, library, main office, and staff office are cooled by window air conditioning (AC) units. These units have capacities ranging from 6,000 Btu to 24,000 Btu and are in good condition. Most units are still within their useful lifespan, in fair condition, and are of standard efficiency. The newer systems are operated using remote control units located within the space, while the older window air conditioners have manual control type with rotary knobs to control the temperature and fan speed of the air conditioner.

Window Air Conditioners

Air Handling Units (AHUs)

In the school, there are two air handling units primarily used for heating and exchanging air: one for the gymnasium and one for the auditorium. The auditorium air handling unit is connected to a chilled water coil for cooling. Each unit has a supply fan motor and a steam heating coil. The size of the supply fan motors for different Air Handling Units (AHUs) are 7.5 hp and 5 hp. All units operate at a constant speed and have standard efficiency. According to facility personnel, these fan motors run continuously to bring in outdoor air as per the design conditions.

For the air exchange of the building, there are ten ventilation fans located in the attic area which supply fresh air to the building. There are also a few fractional horsepower exhaust fans used for the same purpose. These fresh air ventilation fans are estimated to be 1 hp, and all units operate at a constant speed and have standard efficiency.

The HVAC systems are pneumatically controlled, with a 1.5 hp air compressor located in the mechanical room with a 60-gallon storage tank set at 40 PSI serving the pneumatic system. No air leaks were observed during the inspection.

The heating coil is supplied by a steam boiler, and the chilled water coil is supplied by the chiller, which will be discussed in Sections 2.6 and 2.7, respectively.

Gymnasium Air Handling Unit

Attic Exhaust Fan

Air Handling Unit- Storage Room

Attic – Exhaust Fan

2.6 Heating Steam Systems

Two Superior steam boilers, each with a capacity of 2,135 MBh, serve the building's heating load. The boilers' burners are modulating, and they are configured in a lead-lag control scheme. Both boilers are required under high-load conditions and are well-maintained and in good condition. The facility regularly tests the air-fuel ratio with the combustion test and tunes the boilers for maximum efficiency.

The building's heating terminals are served by a steam distribution system that includes radiant heaters and unit ventilators. The mechanical room contains two boiler feed pumps, one with a 1 hp capacity and the other with a 0.5 hp capacity. There are three condensate return pumps: two with a 1 hp capacity and one with a 1.5 hp capacity. Most of the insulation for the steam supply and condensate return is in good condition, and the steam traps are changed and repaired as needed. The controls for heating the classrooms and other areas are pneumatically controlled. During the audit, it was found that the steam pressure set was 5 PSI.

Energy for America is the energy management company that remotely manages the HVAC system, which controls the boilers and the set point temperature for occupied and unoccupied times.

Steam Boilers

Feed Water Pump

Steam Boiler

Condensate Return Pump

2.7 Chilled Water Systems

The chiller plant at the school consists of a 25-ton Trane scroll air-cooled chiller, which provides cooling to the auditorium and stage area.

The temperature of the chilled water supply is adjusted based on the outside air temperature. The chilled water is then distributed to air handlers located in the storage room of the auditorium.

The chiller plant is old, but it is well-maintained. It has been evaluated for replacement. Energy for America is the energy management company that remotely manages the HVAC system, which controls the chiller and the set point temperature for occupied and unoccupied times.

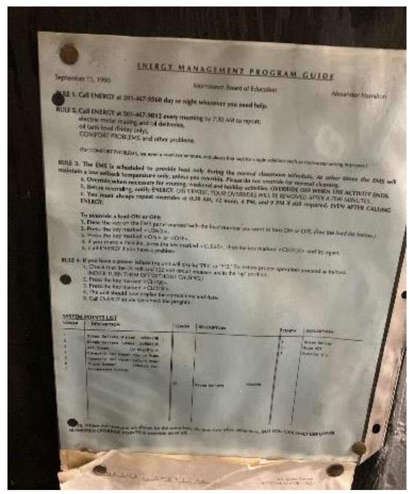
Air Cooled Chiller

2.8 Building Automation System (BAS)

The HVAC system is remotely managed by a third party, Energy for America. Energy for America controls occupied and unoccupied temperature setpoints, as well as equipment operating times (including boilers and air handlers). Classrooms and similar spaces are scheduled based on occupancy, while areas like the office, auditorium, and gymnasium are scheduled based on both typical occupancy and events. According to staff, Energy for America's control functions are not accessible to local staff.

The mechanical room has a 1.5 hp compressor set at around 50 PSI, dedicated to the pneumatic system with a 60-gallon air receiver tank. No leaks were observed, and the equipment was in fair condition. The site staff are interested in expanding the control provided by the BAS. Retro-commissioning of the BAS system has been evaluated and is recommended because the facility's EUI is higher than the national average. Whether or not to replace the remaining pneumatic controls with solid-state systems should be considered. System upgrade planning and retro-commissioning activities should be coordinated among the various stakeholder parties.

Pneumatic System



BAS Program Guide-EFA

Air Compressor- pneumatic system

Boiler Control System

2.9 Domestic Hot Water

Hot water is generated by a 116-gallon, gas-fired AO Smith brand storage water heater with a capacity of 120 MBh. The water is then stored in two, 119-gallon tanks. In the kitchen, hot water is produced by an 80-gallon electric Rheem brand storage water heater, with a capacity of 4.5 kW.

Two fractional horsepower circulation pumps recirculate the water to the end uses, and they operate continuously. The domestic water pipes are insulated in the heater section and are in fair condition. However, the pipes for the storage tank sections are not insulated.

Electric Storage Tank Heater

Natural Gas Storage Tank Heater

DHW Storage Tank

DHW Circulating Pumps

2.10 Food Service Equipment

The kitchen is equipped with a combination of gas and electric equipment used for preparing breakfast and lunch for students. Most of the cooking is done using a gas-fired oven and an electric oven. Electric holding cabinets of Vulcan and BevLes brands are used for storing bulk prepared foods. The equipment's used is in fair condition and not high efficiency.

Visit https://www.energystar.gov/products/commercial_food_service_equipment for the latest information on high efficiency food service equipment.

Cooktop/Oven

Food Holding Cabinet

Convection Oven

Food Holding Cabinet

2.11 Refrigeration

The kitchen has several stand-up refrigerators with solid doors. There is a freezer chest as well as a refrigerator chest. All equipment is of standard efficiency and in fair condition. This report makes additional suggestions for ECMs in this area as well as energy efficient best practices.

Visit https://www.energystar.gov/products/commercial_food_service_equipment for the latest information on high efficiency food service equipment.

Refrigerator Chest

Freezer

Stand-Up Solid Door Freezer

Stand-Up Solid Door Refrigerator

2.12 Plug Load and Vending Machines

The location is doing a great job managing the electrical plug loads. This report makes additional suggestions for ECMs in this area as well as energy efficient best practices.

There are 302 Chromebooks being used by the students and staff, along with few computer workstations spread throughout the facility. Plug loads include general cafe, office, and classroom equipment. Typical loads include printer/copiers, microwaves, and projectors. All the classrooms are equipped with Promethean smartboards and Medify brand air purifiers.

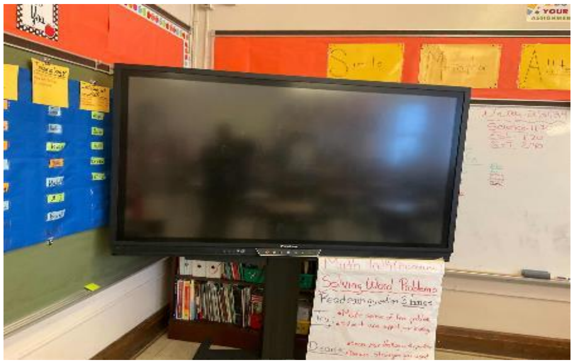
There are also a few residential-style refrigerators throughout the building that are used to store food. These vary in condition and efficiency.

Air Purifier and Dehumidifier

Printer/Copier

Residential-style Refrigerator

Typical Plug Loads



Smartboard

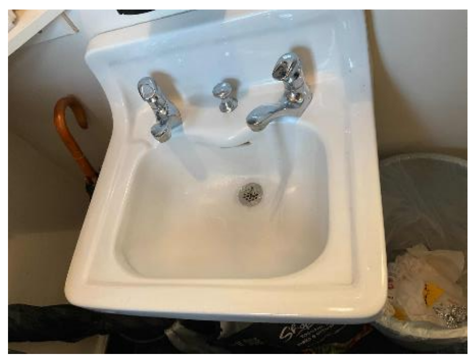
Serving Table

2.13 Water-Using Systems

Water is provided by the Southeast Morris County Municipal Utilities Authority. Water is mainly used for drinking, cleaning, cooking, landscaping, space conditioning, and sanitary fixtures. Water leaks were not observed.

EPA WaterSense® has set maximum flow rates for sanitary fixtures. They are: 1.28 gallons per flush (gpf) for toilets, 0.5 gpf for urinals, 1.5 gallons per minute (gpm) for lavatory faucets, and 2.0 gpm for showerheads. There are few restrooms with toilets, urinals, and sinks. Faucet flow rates are 2.2 gpm or higher.

Kitchen Faucet



Restroom Faucet

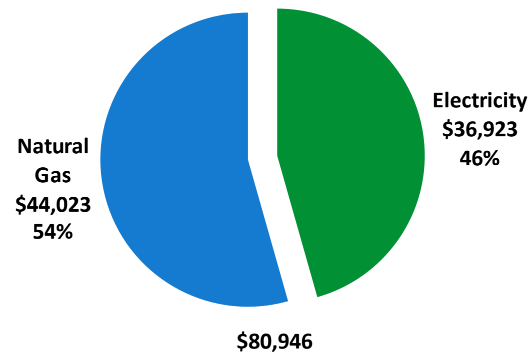
Classroom Faucets

Restroom Faucets

3 Energy and Water Use and Costs

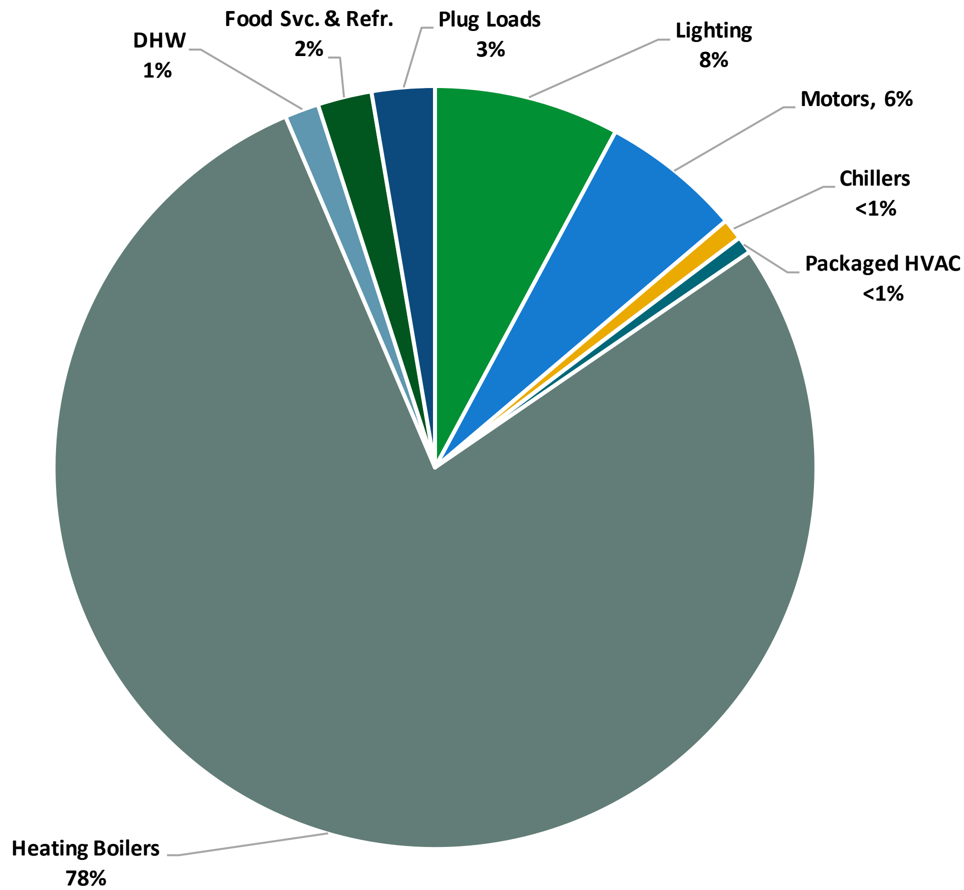
Twelve months of utility billing data are used to develop annual energy consumption and cost data. This information creates a profile of the annual energy consumption and energy costs.

Utility Summary		
Fuel	**Usage**	**Cost**
Electricity	261,172 kWh	$36,923
Natural Gas	34,792 Therms	$44,023
Total		**$80,946**



An energy balance identifies and quantifies energy use in your various building systems. This can highlight areas with the most potential for improvement. This energy balance was developed using calculated energy use for each of the end uses noted in the figure.

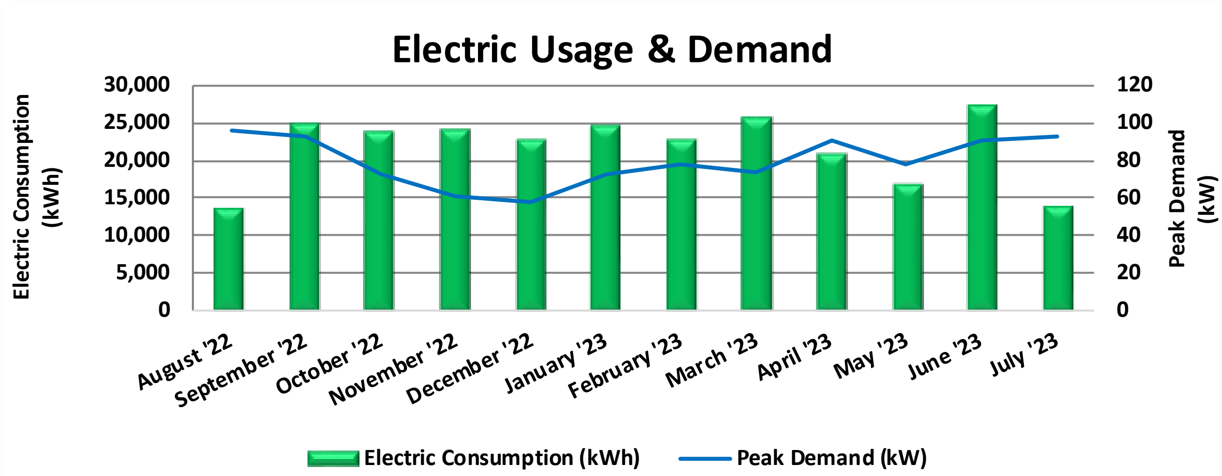
The energy auditor collects information regarding equipment operating hours, capacity, efficiency, and other operational parameters from facility staff, drawings, and on-site observations. This information is used as the inputs to calculate the existing conditions energy use for the site. The calculated energy use is then compared to the historical energy use and the initial inputs are revised, as necessary, to balance the calculated energy use to the historical energy use.



Energy Balance by System

3.1 Electricity

JCP&L delivers electricity under rate class General Service Secondary 3 Phase JC_GS3_01D, with electric production provided by Direct Energy Business LLC, a third-party supplier.



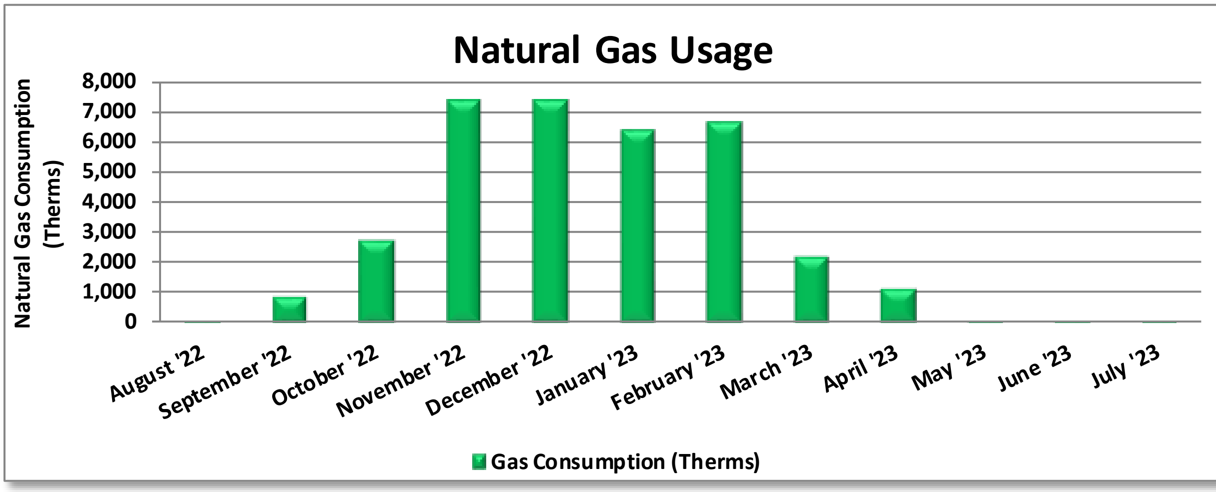
Electric Billing Data					
Period Ending	Days in Period	Electric Usage (kWh)	Demand (kW)	Demand Cost	Total Electric Cost
8/26/22	29	13,598	97	$347	$1,855
9/28/22	33	24,798	93	$736	$3,584
10/27/22	29	23,758	73	$540	$3,308
11/28/22	32	24,158	61	$453	$3,265
12/28/22	30	22,718	58	$427	$3,060
1/27/23	30	24,558	73	$537	$3,368
2/24/23	28	22,638	78	$576	$3,208
3/28/23	32	25,518	74	$545	$3,520
4/26/23	29	20,798	91	$675	$3,150
5/25/23	29	16,798	78	$574	$2,611
6/27/23	33	27,198	91	$642	$3,810
7/27/23	30	13,918	93	$334	$2,081
Totals	**364**	**260,456**	**97**	**$6,384**	**$36,821**
Annual	**365**	**261,172**	**97**	**$6,401**	**$36,923**

Notes:

- Peak demand of 97 kW occurred in August '22.
- Average demand over the past 12 months was 80 kW.
- The average electric cost over the past 12 months was $0.141/kWh, which is the blended rate that includes energy supply, distribution, demand, and other charges. This report uses this blended rate to estimate energy cost savings.

3.2 Natural Gas

PSE&G delivers natural gas under rate class Large Volume Gas (LVG), with natural gas supply provided by Direct Energy, a third-party supplier.



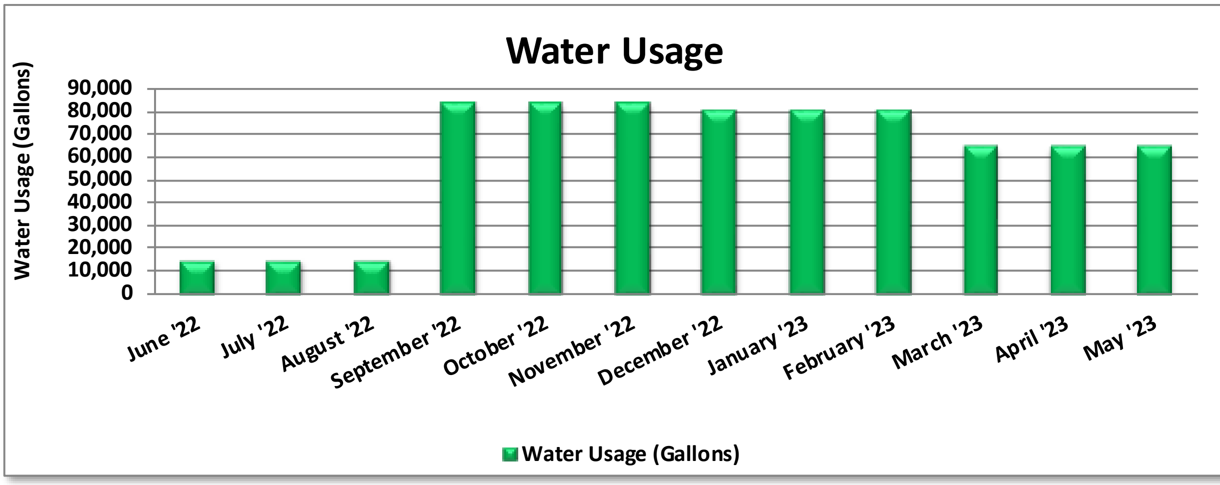
Gas Billing Data			
Period Ending	Days in Period	Natural Gas Usage (Therms)	Natural Gas Cost
9/19/22	32	21	$221
10/18/22	29	875	$1,227
11/16/22	29	2,696	$4,451
12/19/22	33	7,367	$9,584
1/20/23	32	7,381	$9,626
2/17/23	28	6,375	$7,531
3/21/23	32	6,675	$7,450
4/20/23	30	2,201	$1,997
5/19/23	29	1,139	$1,277
6/21/23	33	23	$222
7/20/23	29	19	$219
8/18/23	29	19	$219
Totals	**365**	**34,792**	**$44,023**
Annual	**365**	**34,792**	**$44,023**

Notes:

- The average gas cost for the past 12 months is $1.265/therm, which is the blended rate used throughout the analysis.

3.3 Water

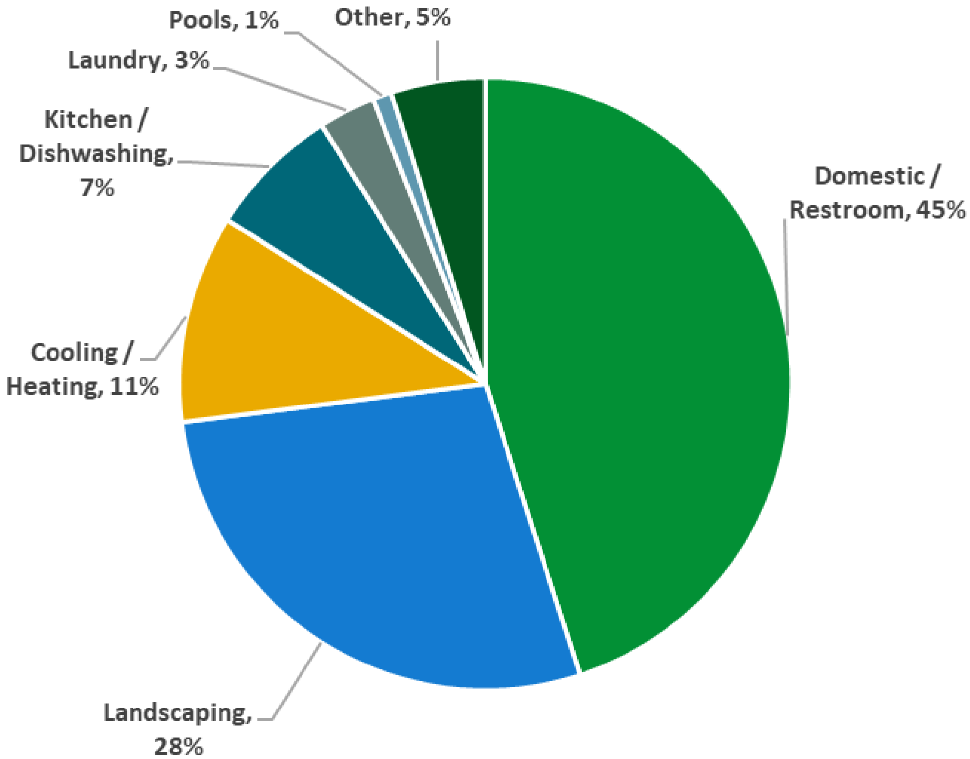
Southeast Morris County Municipal Utilities Authority delivers water to the project site.



Water Billing Data			
Period Ending	Days in Period	Water Usage (gallons)	Water Cost
7/1/22	30	14,462	$149
8/1/22	31	14,462	$149
9/1/22	31	14,462	$149
10/1/22	30	83,782	$775
11/1/22	31	83,782	$775
12/1/22	30	83,782	$775
1/1/23	31	80,291	$822
2/1/23	31	80,291	$822
3/1/23	28	80,291	$822
4/1/23	31	64,582	$692
5/1/23	30	64,582	$692
6/1/23	31	64,582	$692
Totals	**365**	**729,351**	**$7,313**
Annual	**365**	**729,351**	**$7,313**

Notes:

- The average cost of water for the past 12 months is $0.0100/gal.



Typical Education Water End Use[4]

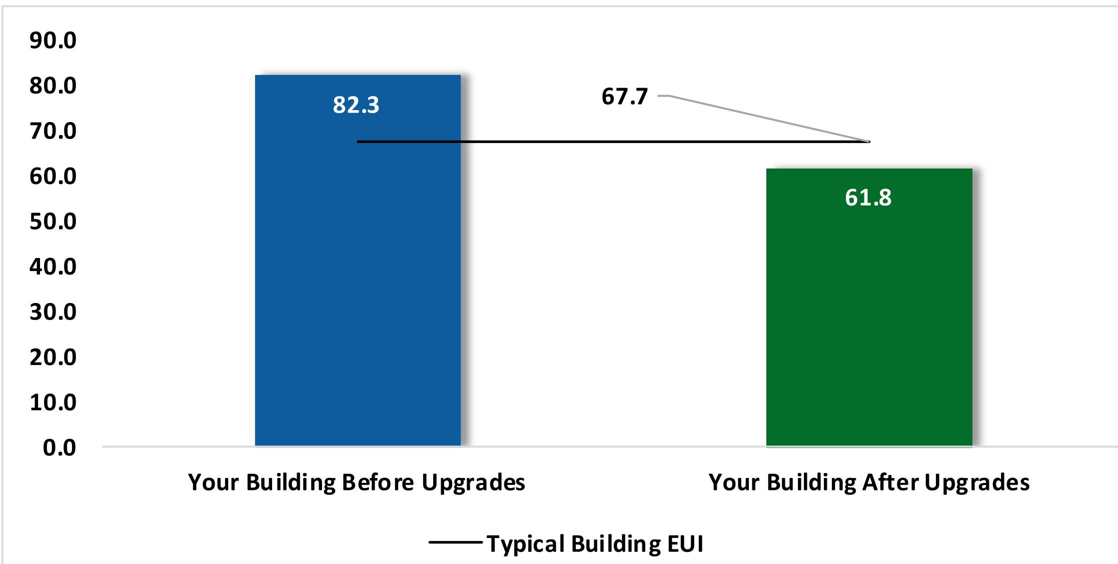
[4] Chart is of typical water end use and not specific to the facility

3.4 Benchmarking

Your building was benchmarked using the United States Environmental Protection Agency's (EPA) Portfolio Manager® software. Benchmarking compares your building's energy use to that of similar buildings across the country, while neutralizing variations due to location, occupancy, and operating hours. Some building types can be scored with a 1-100 ranking of a building's energy performance relative to the national building market. A score of 50 represents the national average and a score of 100 is best.

This ENERGY STAR benchmarking score provides a comprehensive snapshot of your building's energy performance. It assesses the building's physical assets, operations, and occupant behavior, which is compiled into a quick and easy-to-understand score.

Benchmarking Score	31



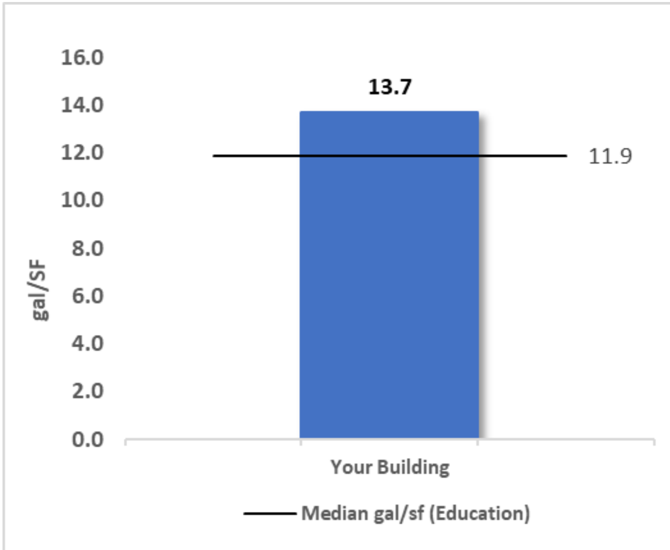
Energy Use Intensity Comparison[5]

This building performs at, or below the national average. This report contains suggestions about how to improve building performance and reduce energy costs.

Energy use intensity (EUI) measures energy consumption per square foot and is the standard metric for comparing buildings' energy performance. A lower EUI means better performance and less energy consumed. Several factors can cause a building to vary from typical energy usage. Local weather conditions, building age and insulation levels, equipment efficiency, daily occupancy hours, changes in occupancy throughout the year, equipment operating hours, and occupant behavior all contribute to a building's energy use and the benchmarking score.

[5] Based on all evaluated ECMs

Water Benchmarking



A benchmark is provided for your building's water use based on the annual water use in gallons per square foot of building area (gal/sf-yr.). Your building is compared to other similar buildings based on average water usage as available from the 2012 Commercial Buildings Energy Consumption Survey (CBECS) and from the EPA ENERGY STAR DataTrends Water Use Tracking database.

Steam boilers are significant water users. Kitchens and sanitary fixtures may use varying amounts of water.

Tracking your Energy Performance

Keeping track of your energy and water use on a monthly basis is one of the best ways to keep utility costs in check and keep your facility operating efficiently. Update your utility information in Portfolio Manager regularly, so that you can keep track of your building's performance.

We have created a Portfolio Manager account for your facility and have already entered the monthly utility data shown above for you. Account login information for your account will be sent via email.

Free online training is available to help you use ENERGY STAR Portfolio Manager to track your building's performance at: https://www.energystar.gov/buildings/training.

For more information on ENERGY STAR and Portfolio Manager, visit their website.

3.5 Understanding Your Utility Bills

The State of New Jersey Department of the Public Advocate provides detailed information on how to read natural gas and electric bills. Your bills contain important information including account numbers, meter numbers, rate schedules, meter readings, and the supply and delivery charges. Gas and electric bills both provide comparisons of current energy consumption with prior usage.

Sample bills, with annotation, may be viewed at:
https://www.nj.gov/rpa/docs/Understanding_Electric_Bill.pdf
https://www.nj.gov/rpa/docs/Understanding_Gas_Bill.pdf

Why Utility Bills Vary

Utility bills vary from one month to another for many reasons. For this reason, assessing the effects of your energy savings efforts can be difficult.

Billing periods vary, typically ranging between 28 and 33 days. Electric bills provide the kilowatt-hours (kWh) used per month while gas bills provide therms (or hundreds of cubic feet - CCF) per month consumption information. Monthly consumption information can be helpful as a tool to assess your efforts to reduce energy, particularly when compared to monthly usage from a similar calendar period in a prior year.

Bills typically vary seasonally, often with more gas consumed in the winter for heating, and more electricity used in the summer when air conditioning is used. Facilities with electric heating may experience higher electricity use in the winter. Seasonal variance will be impacted by the type of heating and cooling systems used. Normal seasonal fluctuations are further impacted by the weather. Extremely cold or hot weathers causes HVAC equipment to run longer, increasing usage. Other monthly fluctuations in usage can be caused by changes in building occupancy. Utility bills provide a comparison of usage between the current period and comparable billing month period of the prior year. Year-to-year monthly use comparisons can point to trends with energy savings for measures/projects that were implemented within the timeframe, but these comparisons do not account for changing weather of occupancy patterns.

The price of fuel and purchased power used to produce and delivery electricity and gas fluctuates. Any increase or decrease in these costs will be reflected in your monthly bill. Additionally, billing rates occasionally change after justification and approval of the NJBPU. For this reason, it is more useful to review energy use rather than cost when assessing energy use trends or the impact of energy conservation measures implemented.

4 Energy Conservation Measures

The goal of this audit report is to identify and evaluate potential energy efficiency improvements and provide information about the cost effectiveness of those improvements. Most energy conservation measures have received preliminary analysis of feasibility, which identifies expected ranges of savings. This level of analysis is typically sufficient to demonstrate project cost-effectiveness and help prioritize energy measures.

Calculations of energy use and savings are based on the current version of the *New Jersey's Clean Energy Program Protocols to Measure Resource Savings*, which is approved by the NJBPU. Further analysis or investigation may be required to calculate more precise savings based on specific circumstances.

Operation and maintenance costs for the proposed new equipment will generally be lower than the current costs for the existing equipment—especially if the existing equipment is at or past its normal useful life. We have conservatively assumed there to be no impact on overall maintenance costs over the life of the equipment.

Financial incentives in this report are based on the previously run state rebate program SmartStart, which has been retired. Now, all investor-owned gas and electric utility companies are offering complementary energy efficiency programs directly to their customers. Some measures and proposed upgrades may be eligible for higher incentives than those shown below. The incentives in the summary tables should be used for high-level planning purposes. To verify incentives, reach out to your utility provider or visit the NJCEP website for more information.

For a detailed list of the locations and recommended energy conservation measures for all inventoried equipment, see Appendix A: Equipment Inventory & Recommendations.

#	Energy Conservation Measure	Cost Effective?	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades			**49,211**	**15.0**	**-10**	**$6,825**	**$45,690**	**$8,220**	**$37,470**	**5.5**	**48,333**
ECM 1	Install LED Fixtures	No	3,750	3.8	0	$528	$10,200	$900	$9,300	17.6	3,756
ECM 2	Retrofit Fixtures with LED Lamps	Yes	45,461	11.2	-10	$6,297	$35,490	$7,320	$28,170	4.5	44,576
Lighting Control Measures			**14,207**	**3.5**	**-3**	**$1,967**	**$24,470**	**$6,940**	**$17,530**	**8.9**	**13,924**
ECM 3	Install Occupancy Sensor Lighting Controls	Yes	11,145	2.9	-3	$1,543	$17,160	$2,050	$15,110	9.8	10,923
ECM 4	Install High/Low Lighting Controls	Yes	3,062	0.5	-1	$424	$7,310	$4,890	$2,420	5.7	3,001
Variable Frequency Drive (VFD) Measures			**15,664**	**7.0**	**12**	**$2,369**	**$27,600**	**$3,800**	**$23,800**	**10.0**	**17,208**
ECM 5	Install VFDs on Constant Volume (CV) Fans	Yes	8,951	3.9	0	$1,265	$12,300	$1,900	$10,400	8.2	9,014
ECM 6	Install Boiler Draft Fan VFDs	No	5,820	3.1	0	$823	$11,800	$1,800	$10,000	12.2	5,860
ECM 7	Install VFDs on Kitchen Hood Fan Motors	No	893	0.0	12	$281	$3,500	$100	$3,400	12.1	2,334
Unitary HVAC Measures			**929**	**1.2**	**0**	**$131**	**$6,100**	**$0**	**$6,100**	**46.5**	**935**
ECM 8	Install High Efficiency Air Conditioning Units	No	929	1.2	0	$131	$6,100	$0	$6,100	46.5	935
Electric Chiller Replacement			**4,252**	**-1.0**	**0**	**$601**	**$56,900**	**$2,300**	**$54,600**	**90.8**	**4,282**
ECM 9	Install High Efficiency Chillers	No	4,252	-1.0	0	$601	$56,900	$2,300	$54,600	90.8	4,282
Gas Heating (HVAC/Process) Replacement			**0**	**0.0**	**166**	**$2,102**	**$137,200**	**$5,100**	**$132,100**	**62.8**	**19,450**
ECM 10	Install High Efficiency Steam Boilers	No	0	0.0	166	$2,102	$137,200	$5,100	$132,100	62.8	19,450
HVAC System Improvements			**1,622**	**0.0**	**280**	**$3,775**	**$23,470**	**$100**	**$23,370**	**6.2**	**34,440**
ECM 11	Install Programmable Thermostats	Yes	1,043	0.0	232	$3,080	$16,990	$0	$16,990	5.5	28,185
ECM 12	Implement Demand Control Ventilation (DCV)	No	579	0.0	37	$553	$5,800	$0	$5,800	10.5	4,943
ECM 13	Install Pipe Insulation	Yes	0	0.0	11	$142	$680	$100	$580	4.1	1,311
Domestic Water Heating Upgrade			**432**	**0.0**	**7**	**$147**	**$250**	**$110**	**$140**	**0.9**	**1,235**
ECM 14	Install Low-Flow DHW Devices	Yes	432	0.0	7	$147	$250	$110	$140	0.9	1,235
Food Service & Refrigeration Measures			**11,061**	**1.3**	**0**	**$1,564**	**$18,000**	**$900**	**$17,100**	**10.9**	**11,139**
ECM 15	Replace Refrigeration Equipment	No	11,061	1.3	0	$1,564	$18,000	$900	$17,100	10.9	11,139
Custom Measures			**2,349**	**0.0**	**295**	**$4,059**	**$40,200**	**$0**	**$40,200**	**9.9**	**36,856**
ECM 16	Retro-Commissioning Study	Yes	6,370	0.0	239	$3,919	$30,900	$0	$30,900	7.9	34,348
ECM 17	Replace Electric Water Heater with Heat Pump Water Heater	No	1,231	0.0	0	$174	$4,000	$0	$4,000	23.0	1,240
ECM 18	Replace Gas Fired Water Heater with Heat Pump Water Heater***	No	-5,252	0.0	56	-$34	$5,300	$0	$5,300	-155.9	1,268
TOTALS			**99,727**	**26.9**	**746**	**$23,541**	**$379,880**	**$27,470**	**$352,410**	**15.0**	**187,801**

* - All incentives presented in this table are included as placeholders for planning purposes and are based on previously run state rebate programs. Contact your utility provider for details on current programs.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

*** - Negative payback explained in section 4.10

All Evaluated ECMs

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**45,461**	**11.2**	**-10**	**$6,297**	**$35,490**	**$7,320**	**$28,170**	**4.5**	**44,576**
ECM 2	Retrofit Fixtures with LED Lamps	45,461	11.2	-10	$6,297	$35,490	$7,320	$28,170	4.5	44,576
Lighting Control Measures		**14,207**	**3.5**	**-3**	**$1,967**	**$24,470**	**$6,940**	**$17,530**	**8.9**	**13,924**
ECM 3	Install Occupancy Sensor Lighting Controls	11,145	2.9	-3	$1,543	$17,160	$2,050	$15,110	9.8	10,923
ECM 4	Install High/Low Lighting Controls	3,062	0.5	-1	$424	$7,310	$4,890	$2,420	5.7	3,001
Variable Frequency Drive (VFD) Measures		**8,951**	**3.9**	**0**	**$1,265**	**$12,300**	**$1,900**	**$10,400**	**8.2**	**9,014**
ECM 5	Install VFDs on Constant Volume (CV) Fans	8,951	3.9	0	$1,265	$12,300	$1,900	$10,400	8.2	9,014
HVAC System Improvements		**1,043**	**0.0**	**243**	**$3,222**	**$17,670**	**$100**	**$17,570**	**5.5**	**29,497**
ECM 11	Install Programmable Thermostats	1,043	0.0	232	$3,080	$16,990	$0	$16,990	5.5	28,185
ECM 13	Install Pipe Insulation	0	0.0	11	$142	$680	$100	$580	4.1	1,311
Domestic Water Heating Upgrade		**432**	**0.0**	**7**	**$147**	**$250**	**$110**	**$140**	**0.9**	**1,235**
ECM 14	Install Low-Flow DHW Devices	432	0.0	7	$147	$250	$110	$140	0.9	1,235
Custom Measures		**6,370**	**0.0**	**239**	**$3,919**	**$30,900**	**$0**	**$30,900**	**7.9**	**34,348**
ECM 16	Retro-Commissioning Study	6,370	0.0	239	$3,919	$30,900	$0	$30,900	7.9	34,348
TOTALS		**76,463**	**18.6**	**475**	**$16,818**	**$121,080**	**$16,370**	**$104,710**	**6.2**	**132,594**

* - All incentives presented in this table are included as placeholders for planning purposes and are based on previously run state rebate programs. Contact your utility provider for details on current programs.

** - Simple Payback Period is based on net measure costs (i.e. after incentives).

Cost Effective ECMs

4.1 Lighting

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**49,211**	**15.0**	**-10**	**$6,825**	**$45,690**	**$8,220**	**$37,470**	**5.5**	**48,333**
ECM 1	Install LED Fixtures	3,750	3.8	0	$528	$10,200	$900	$9,300	17.6	3,756
ECM 2	Retrofit Fixtures with LED Lamps	45,461	11.2	-10	$6,297	$35,490	$7,320	$28,170	4.5	44,576

When considering lighting upgrades, we suggest using a comprehensive design approach that simultaneously upgrades lighting fixtures and controls to maximize energy savings and improve occupant lighting. Comprehensive design will also consider appropriate lighting levels for different space types to make sure that the right amount of light is delivered where needed. If conversion to LED light sources is proposed, we suggest converting all of a specific lighting type (e.g., linear fluorescent) to LED lamps to minimize the number of lamp types in use at the facility, which should help reduce future maintenance costs.

ECM 1: Install LED Fixtures

We evaluated replacing existing fixtures containing HID lamps with new LED light fixtures. This measure saves energy by installing LEDs, which use less power than other technologies with a comparable light output.

In some cases, HID fixtures can be retrofit with screw-based LED lamps. Replacing an existing HID fixture with a new LED fixture will generally provide better overall lighting optics; however, replacing the HID lamp with a LED screw-in lamp is typically a less expensive retrofit. We recommend you work with your lighting contractor to determine which retrofit solution is best suited to your needs and will be compatible with the existing fixture(s).

Maintenance savings may also be achieved since LED lamps last longer than other light sources and therefore do not need to be replaced as often.

Affected Building Areas: auditorium and exterior fixtures

ECM 2: Retrofit Fixtures with LED Lamps

Replace fluorescent, or incandescent lamps with LED lamps. Many LED tubes are direct replacements for existing fluorescent tubes and can be installed while leaving the fluorescent fixture ballast in place. LED lamps can be used in existing fixtures as a direct replacement for most other lighting technologies. Be sure to specify replacement lamps that are compatible with existing dimming controls, where applicable. In some circumstances, you may need to upgrade your dimming system for optimum performance.

This measure saves energy by installing LEDs, which use less power than other lighting technologies yet provide equivalent lighting output for the space. Maintenance savings may also be available, as longer-lasting LEDs lamps will not need to be replaced as often as the existing lamps.

Affected Building Areas: all areas with fluorescent fixtures with T8 tubes, classrooms, storage rooms, and exterior CFL and incandescent lamps

4.2 Lighting Controls

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Control Measures		**14,207**	**3.5**	**-3**	**$1,967**	**$24,470**	**$6,940**	**$17,530**	**8.9**	**13,924**
ECM 3	Install Occupancy Sensor Lighting Controls	11,145	2.9	-3	$1,543	$17,160	$2,050	$15,110	9.8	10,923
ECM 4	Install High/Low Lighting Controls	3,062	0.5	-1	$424	$7,310	$4,890	$2,420	5.7	3,001

Lighting controls reduce energy use by turning off or lowering lighting fixture power levels when not in use. A comprehensive approach to lighting design should upgrade the lighting fixtures and the controls together for maximum energy savings and improved lighting for occupants.

ECM 3: Install Occupancy Sensor Lighting Controls

Install occupancy sensors to control lighting fixtures in areas that are frequently unoccupied, even for short periods. For most spaces, we recommend that lighting controls use dual technology sensors, which reduce the possibility of lights turning off unexpectedly.

Occupancy sensors detect occupancy using ultrasonic and/or infrared sensors. When an occupant enters the space, the lighting fixtures switch to full lighting levels. Most occupancy sensor lighting controls allow users to manually turn fixtures on/off, as needed. Some controls can also provide dimming options.

Occupancy sensors can be mounted on the wall at existing switch locations, mounted on the ceiling, or in remote locations. In general, wall switch replacement sensors are best suited to single occupant offices and other small rooms. Ceiling-mounted or remote mounted sensors are used in large spaces, locations without local switching, and where wall switches are not in the line-of-sight of the main work area.

This measure provides energy savings by reducing the lighting operating hours.

Affected Building Areas: offices, classrooms, gymnasium, library, restrooms, and storage rooms

ECM 4: Install High/Low Lighting Controls

Install occupancy sensors to provide dual level lighting control for lighting fixtures in spaces that are infrequently occupied but may require some level of continuous lighting for safety or security reasons.

Lighting fixtures with these controls operate at default low levels when the area is unoccupied to provide minimal lighting to meet security or safety code requirements for egress. Sensors detect occupancy using ultrasonic and/or infrared sensors. When an occupant enters the space, the lighting fixtures switch to full lighting levels. Fixtures automatically switch back to low level after a predefined period of vacancy. In parking lots and parking garages with significant ambient lighting, this control can sometimes be combined with photocell controls to turn the lights off when there is sufficient daylight.

The controller lowers the light level by dimming the fixture output. Therefore, the controlled fixtures need to have a dimmable ballast or driver. This will need to be considered when selecting retrofit lamps and bulbs for the areas proposed for high/low control.

For this type of measure the occupancy sensors will generally be ceiling or fixture mounted. Sufficient sensor coverage must be provided to ensure that lights turn on in each area as occupants approach the area.

This measure provides energy savings by reducing the light fixture power draw when reduced light output is appropriate.

Affected Building Areas: hallways and stairwells

4.3 Variable Frequency Drives (VFD)

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Variable Frequency Drive (VFD) Measures		**15,664**	**7.0**	**12**	**$2,369**	**$27,600**	**$3,800**	**$23,800**	**10.0**	**17,208**
ECM 5	Install VFDs on Constant Volume (CV) Fans	8,951	3.9	0	$1,265	$12,300	$1,900	$10,400	8.2	9,014
ECM 6	Install Boiler Draft Fan VFDs	5,820	3.1	0	$823	$11,800	$1,800	$10,000	12.2	5,860
ECM 7	Install VFDs on Kitchen Hood Fan Motors	893	0.0	12	$281	$3,500	$100	$3,400	12.1	2,334

Variable frequency drives control motors for fans, pumps, and process equipment based on the actual output required of the driven equipment. Energy savings result from more efficient control of motor energy usage when equipment operates at partial load. The magnitude of energy savings depends on the estimated amount of time that the motor would operate at partial load. For equipment with proposed VFDs, we have included replacing the controlled motor with a new inverter duty rated motor to conservatively account for the cost of an inverter duty rated motor.

ECM 5: Install VFDs on Constant Volume (CV) Fans

Install VFDs to control constant volume fan motor speeds. This converts a constant-volume, single-zone air handling system into a variable-air-volume (VAV) system. A separate VFD is usually required to control the return fan motor or dedicated exhaust fan motor if the air handler has one.

Zone thermostats signal the VFD to adjust fan speed to maintain the appropriate temperature in the zone, while maintaining a constant supply air temperature.

Energy savings result from reducing the fan speed (and power) when conditions allow for reduced air flow.

Affected Air Handlers: air handlers located in storage room and gymnasium

ECM 6: Install Boiler Draft Fan VFDs

We evaluated replacing existing volume control devices on boiler draft fans, such as inlet vanes or dampers, with VFDs. Inlet vanes or dampers are an inefficient means of controlling the air volume compared to VFDs. The existing volume control device will be removed or permanently disabled, and the control signal will be redirected to the VFD to determine proper fan motor speed.

Energy savings result from reducing the draft fan speed (and power) when conditions allow for reduced combustion air flow.

Additional maintenance savings may result from this measure. VFDs are solid state electronic devices, which generally require less maintenance than mechanical air volume control devices.

ECM 7: Install VFDs on Kitchen Hood Fan Motors

We evaluated installing VFDs and sensors to control the kitchen hood fan motor(s). The air flow of the hood is varied based on two key inputs: temperature and smoke/cooking fumes. The VFD controls the amount of exhaust (and kitchen make-up air) based on temperature—the lower the temperature the lower the flow. If the optic sensor is triggered by smoke or cooking fumes, the speed of the fan ramps up to 100%.

Energy savings result from reducing the hood fan speed (and power) when conditions allow for reduced air flow.

4.4 Unitary HVAC

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Unitary HVAC Measures		**929**	**1.2**	**0**	**$131**	**$6,100**	**$0**	**$6,100**	**46.5**	**935**
ECM 8	Install High Efficiency Air Conditioning Units	929	1.2	0	$131	$6,100	$0	$6,100	46.5	935

Replacing the unitary HVAC units has a long payback period and may not be justifiable based simply on energy considerations. However, most of the units are nearing or have reached the end of their normal useful life. Typically, the marginal cost of purchasing a high efficiency unit can be justified by the marginal savings from the improved efficiency. When the window air conditioner is eventually replaced, consider purchasing equipment that exceeds the minimum efficiency required by building codes.

ECM 8: Install High Efficiency Air Conditioning Units

We evaluated replacing old standard efficiency window air conditioning units with high efficiency window air conditioning units. The magnitude of energy savings for this measure depends on the relative efficiency of the older unit versus the new high efficiency unit, the average cooling and heating load, and the estimated annual operating hours.

Affected Units: main office, child study room, and library window air conditioner

4.5 Electric Chillers

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Electric Chiller Replacement		**4,252**	**-1.0**	**0**	**$601**	**$56,900**	**$2,300**	**$54,600**	**90.8**	**4,282**
ECM 9	Install High Efficiency Chillers	4,252	-1.0	0	$601	$56,900	$2,300	$54,600	90.8	4,282

ECM 9: Install High Efficiency Chillers

We evaluated replacing older inefficient electric chillers with new high efficiency chillers. The type of chiller to be installed depends on the magnitude of the cooling load and variability of the cooling load profile, for example:

- Positive displacement chillers are usually under 600 tons of cooling capacity, and centrifugal chillers generally start at 150 tons of cooling capacity.
- Constant speed chillers should be used to meet cooling loads with little or no variation, while variable speed chillers are more efficient for variable cooling load profiles.
- Water cooled chillers are more efficient than air cooled chillers but require cooling towers and additional pumps to circulate the cooling water.
- In any given size range, variable speed chillers tend to have better partial load efficiency, but worse full load efficiency, than constant speed chillers.

Energy savings result from the improvement in chiller efficiency and matching the right type of chiller to the cooling load. The energy savings are calculated based on the cooling capacity of the new chiller, the improvement in efficiency compared with the base case equipment, the cooling load profile, and the estimated annual operating hours of the chiller before and after the upgrade.

For the purposes of this analysis, we evaluated the replacement of chillers on a one-for-one basis with equipment of the same capacity. We recommend that you work with your design team to select chillers that are sized appropriately for the cooling load. In some cases, the plant energy use can be reduced by selecting multiple chillers that match the facility load profile, rather than one or two large chillers. This can also improve the chiller plant reliability through increased redundancy. Energy savings are maximized by proper selection of new equipment based on the cooling load profile.

Replacing the chiller has a long payback based on energy savings and may not be justifiable based simply on energy considerations. However, the chiller has reached the end of its normal useful life. Typically, the marginal cost of purchasing a high-efficiency chiller can be justified by the marginal savings from the improved efficiency. When the chiller is eventually replaced, consider purchasing equipment that exceed the minimum efficiency required by building codes.

4.6 Gas-Fired Heating

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Gas Heating (HVAC/Process) Replacement		**0**	**0.0**	**166**	**$2,102**	**$137,200**	**$5,100**	**$132,100**	**62.8**	**19,450**
ECM 10	Install High Efficiency Steam Boilers	0	0.0	166	$2,102	$137,200	$5,100	$132,100	62.8	19,450

ECM 10: Install High Efficiency Steam Boilers

We evaluated replacing older inefficient steam boilers with high-efficiency steam boilers. Energy savings results from improved combustion efficiency and reduced standby losses at low loads.

For the purpose of this analysis, we evaluated the replacement of boilers on a one-for-one basis with equipment of the same capacity. We recommend that you work with your mechanical design team to select boilers that are sized appropriately for the heating load. In many cases installing multiple modular boilers, rather than one or two large boilers, will result in higher overall plant efficiency while providing additional system redundancy.

Replacing the boilers has a long payback based on energy savings and may not be justifiable based simply on energy considerations. However, the boilers have reached the end of their normal useful life. Typically, the marginal cost of purchasing high-efficiency boilers can be justified by the marginal savings from the improved efficiency. When the boiler is eventually replaced, consider purchasing boilers that exceed the minimum efficiency required by building codes.

4.7 HVAC Improvements

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
HVAC System Improvements		**1,622**	**0.0**	**280**	**$3,775**	**$23,470**	**$100**	**$23,370**	**6.2**	**34,440**
ECM 11	Install Programmable Thermostats	1,043	0.0	232	$3,080	$16,990	$0	$16,990	5.5	28,185
ECM 12	Implement Demand Control Ventilation (DCV)	579	0.0	37	$553	$5,800	$0	$5,800	10.5	4,943
ECM 13	Install Pipe Insulation	0	0.0	11	$142	$680	$100	$580	4.1	1,311

ECM 11: Install Programmable Thermostats

Replace manual thermostats with programmable thermostats, which provide energy savings by reducing heating and cooling energy usage when a room is unoccupied. Manual thermostats are generally adjusted to a single heating and cooling setpoint and left at that setting regardless of occupancy, and they provide the same level of heating and cooling regardless of whether the space is being used. Programmable thermostats can maintain different temperature settings for different times of day and for different days of the week. By reducing heating temperature setpoints and raising cooling temperature setpoints when spaces are unoccupied, the operation of the HVAC equipment is reduced while maintaining comfortable space temperatures for building usage.

ECM 12: Implement Demand Control Ventilation (DCV)

Demand control ventilation (DCV) is a control strategy that monitors the indoor air's carbon dioxide (CO2) content to measure room occupancy. This data is used to regulate the amount of outdoor air provided to the space for ventilation.

Standard ventilation systems often provide outside air based on a space's estimated maximum occupancy but not actual occupancy. During low occupancy periods, the space may then be over ventilated. This wastes energy through heating and cooling the excess outside air flow. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual occupancy levels. DCV is most suited for facilities where occupancy levels vary significantly from hour to hour and day to day.

Energy savings associated with DCV are based on hours of operation, space occupancy, outside air reduction, and other factors. Energy savings results from eliminating unnecessary ventilation and space conditioning. Implementation of this measure is dependent upon having a building automation system (BAS) or other smart building control system connected to the space conditioning equipment serving the noted areas.

Affected Building Areas: evaluated DCV for the gymnasium and auditorium room

ECM 13: Install Pipe Insulation

Install insulation on domestic hot water system piping. Distribution system thermal losses are dependent on system fluid temperature, the size of the distribution system, and the extent and condition of piping insulation. When the insulation has been damaged due to exposure to water, when the insulation has been removed from some areas of the pipe, or when valves have not been properly insulated, system thermal efficiency can be significantly reduced. This measure saves energy by reducing heat transfer in the distribution system.

Affected Systems: domestic hot water piping

4.8 Domestic Water Heating

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Domestic Water Heating Upgrade		**432**	**0.0**	**7**	**$147**	**$250**	**$110**	**$140**	**0.9**	**1,235**
ECM 14	Install Low-Flow DHW Devices	432	0.0	7	$147	$250	$110	$140	0.9	1,235

ECM 14: Install Low-Flow DHW Devices

Install low-flow devices to reduce overall hot water demand. The following low-flow devices are recommended to reduce hot water usage:

Device	Flow Rate
Faucet aerators (lavatory)	0.5 gpm
Faucet aerator (kitchen)	1.5 gpm
Showerhead	2.0 gpm
Pre-rinse spray valve (kitchen)	1.28 gpm

Low-flow devices reduce the overall water flow from the fixture, while still providing adequate pressure for washing.

4.9 Food Service and Refrigeration Measures

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Food Service & Refrigeration Measures		**11,061**	**1.3**	**0**	**$1,564**	**$18,000**	**$900**	**$17,100**	**10.9**	**11,139**
ECM 15	Replace Refrigeration Equipment	11,061	1.3	0	$1,564	$18,000	$900	$17,100	10.9	11,139

ECM 15: Replace Refrigeration Equipment

We evaluated replacing existing commercial refrigerators, and freezers with new ENERGY STAR-rated equipment. The energy savings associated with this measure come from reduced energy usage, due to more efficient technology, and reduced run times.

4.10 Custom Measures

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Custom Measures		**2,349**	**0.0**	**295**	**$4,059**	**$40,200**	**$0**	**$40,200**	**9.9**	**36,856**
ECM 16	Retro-Commissioning Study	6,370	0.0	239	$3,919	$30,900	$0	$30,900	7.9	34,348
ECM 17	Replace Electric Water Heater with Heat Pump Water Heater	1,231	0.0	0	$174	$4,000	$0	$4,000	23.0	1,240
ECM 18	Replace Gas Fired Water Heater with Heat Pump Water Heater***	-5,252	0.0	56	-$34	$5,300	$0	$5,300	-155.9	1,268

ECM 16: Retro-Commissioning Study

Due to the complexity of today's HVAC systems and controls a thorough analysis and rebalance of heating, ventilation, and cooling systems should periodically be conducted. There are indications at this site that systems may not be operating correctly or as efficiently as they could be. One important tool available to building operators to ensure proper system operation is retro-commissioning.

Retro-commissioning is a common practice recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) to be implemented every few years. We recommend that you contact a reputable engineering firm that specializes in energy control systems and retro-commissioning. Ask them to propose a scope of work and an outline of the procedures and processes to be implemented, including a schedule and the roles of all responsible parties.

Note that this process may involve identifying additional control opportunities that require further investment, such as replacing dedicated pneumatic controls, installing a local BAS system at the facility, and adding more control points to the BAS system. Additional control or monitoring points will likely increase the cost beyond the amount estimated for retro-commissioning. Retro-commissioning is especially important for your facility because it has a low energy benchmarking score. Adjustments to setpoints and schedules for air handling units, boilers, ventilation fans, and pumps will likely be necessary to optimize your building operations.

Once goals and responsibilities are established, the objective of the investigation process is to understand how the building is currently operating, identify the issues, and determine the most cost-effective way to improve performance. The retro-commissioning agent will review building documentation, interview building occupants, and inspect and test the equipment. Information is then compiled into a report and shared with facility staff, who will select which recommendations to implement after reviewing the findings.

The implementation phase puts the selected processes into place. Typical measures may include sensor calibration, equipment schedule changes, damper linkage repair and similar relatively low-cost adjustments—although more expensive sophisticated programming and building control system upgrades may be warranted. Approved measures may be implemented by the agent, the building staff, or by subcontractors. Typically, a combination of these individuals makes up the retro-commissioning team.

After the approved measures are implemented, the team will verify that the changes are working as expected. Baseline and post-case measurements will allow building staff to monitor equipment and ensure that the benefits are maintained.

A high-level evaluation of potential savings and costs is provided for demonstration purposes only. It is a screening evaluation for the potential in HVAC control improvements. Based on industry standards and previous project experience, the potential energy savings may be up to 15% of existing HVAC energy use. We estimate the cost of retro-commissioning studies and control improvements of $0.50 per square foot. Actual savings and costs will need to be outlined by the specific contractor engaged to perform the study. For the purposes of this report, we have conservatively estimated savings to be 7.0% of the HVAC energy consumption baseline.

ECM 17: Replace Electric Water Heater with Heat Pump Water Heater

We evaluated replacing the existing electric water heater with a heat pump water heater (HPWH).

A typical electric water heater uses electric resistance coils to heat water at a coefficient of performance (COP) of 1. Air source heat pump water heaters use a refrigeration cycle to transfer heat from the surrounding air to the domestic water. The typical average COP for a HPWH is about 2.5, so they require significantly less electricity to produce the same amount of hot water as a traditional electric water heater. There are two types of HPWH, those integrated with the heat pump and storage tank in the same unit, and those that are split into two sections (with the storage tank separate from the heat pump). The following addresses integrated HPWH.

HPWH reject cold air. As such, they need to be installed in an unconditioned space of about 750 cubic feet with good ventilation. Ideal locations are garages, large enclosed, unconditioned storage areas, or areas with excess heat such as a furnace or boiler room.[6] The HPWH will also produce condensate so accommodations for draining the condensate need to be provided.

Most HPWH operate effectively down to an air temperature of 40 °F. Below that temperature, an electric resistance booster heater is typically required to achieve full heating capacity. It is critical that the HPWH controls are set up so that the electric resistance heat only engages when the air temperature is too cold for the HPWH to extract heat from it. HPWHs have a slow recovery. During periods of high demand, the electric resistance heating element, if enabled, may be energized to maintain set point, thus reducing the overall efficiency of the unit. It is recommended that a careful analysis of the hot water demand be conducted to determine if the application makes economic sense, and the HPWH heating capacity and storage are properly sized.

HPWH operate most effectively when the temperature difference between the incoming and outgoing water is high. Generally, this means that cold make-up water should be piped to the bottom of the tank and return water should be piped to the top of the tank to maintain stratification within the storage tank. Water should be drawn from the bottom of the tank to be heated. If there is a DHW recirculation pump, it should only be operated during high hot water demand periods.

Affected Units: storage tank water heater- kitchen area

ECM 18: Replace Gas Fired Water Heater with Heat Pump Water Heater

We evaluated replacing existing the gas water heater with a heat pump water heater (HPWH).

A gas fired water heater uses a burner to heat water. Air source heat pump water heaters use a refrigeration cycle to transfer heat from the surrounding air to the domestic water. Water heater efficiency is rated by the uniform energy factor (UEF). For a relative comparison of water heater UEFs, the criteria for certifying a water heater in the ENERGY STAR program are provided below. These values indicate that HPWH heaters are significantly more efficient than gas fired water heaters.

[6] https://basc.pnnl.gov/code-compliance/heat-pump-water-heaters-code-compliance-brief#:~:text=HPWH%20must%20have%20unrestricted%20airflow,depending%20on%20size%20of%20system

There are two types of HPWH: those integrated with the heat pump and storage tank in the same unit, and those that are split into two sections (with the storage tank separate from the heat pump). The measure considers an integrated HPWH.

ENERGY STAR Uniform Energy Factor (UEF) Criteria for Certified Water Heaters *

Water Heater Type	*Minimum UEF*	*Other*
Integrated HPWH	3.3	
Integrated HPWH	2.2	120 Volt, 15 Amp circuit
Split System HPWH	2.2	
Gas Fired Storage	0.64	< 55-gal, Medium Draw Pattern
Gas Fired Storage	0.68	< 55-gal, High Draw Pattern
Gas Fired Storage	0.78	> 55-gal, Medium Draw Pattern
Gas Fired Storage	0.80	> 55-gal, High Draw Pattern
Gas Fired Storage	0.80	Residential Duty
Gas Fired Instantaneous	0.87	

** Note: Uniform Energy Factor (UEF): The newest measure of water heater overall efficiency. The higher the UEF value is, the more efficient the water heater. UEF is determined by the Department of Energy's test method outlined in 10 CFR Part 430, Subpart B, Appendix E.*[7]

HPWH reject cold air. As such, they need to be installed in an unconditioned space of about 750 cubic feet with good ventilation[8]. Ideal locations are garages, large enclosed, unconditioned storage areas, or areas with excess heat such as a furnace or boiler room. The HPWH will also produce condensate so accommodations for draining the condensate need to be provided.

Most HPWH operate effectively down to an air temperature of 40 °F. Below that temperature, an electric resistance booster heater is typically required to achieve full heating capacity. It is critical that the HPWH controls are set up so that the electric resistance heat only engages when the air temperature is too cold for the HPWH to extract heat from it. HPWHs have a slow recovery. During periods of high demand, the electric resistance heating element, if enabled, may be energized to maintain set point, thus reducing the overall efficiency of the unit. It is recommended that a careful analysis of the hot water demand be conducted to determine if the application makes economic sense, and the HPWH heating capacity and storage are properly sized.

HPWH operate most effectively when the temperature difference between the incoming and outgoing water is high. Generally, this means that cold make-up water should be piped to the bottom of the tank and return water should be piped to the top of the tank to maintain stratification within the storage tank. Water should be drawn from the bottom of the tank to be heated. If there is a DHW recirculation pump, it should only be operated during high hot water demand periods.

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[7] https://www.energy.gov/sites/prod/files/2014/06/f17/rwh_tp_final_rule.pdf

[8] https://basc.pnnl.gov/code-compliance/heat-pump-water-heaters-code-compliance-brief#:~:text=HPWH%20must%20have%20unrestricted%20airflow,depending%20on%20size%20of%20system

Switching from a gas fired water heater to a HPWH has the potential to reduce the sites overall greenhouse gas emissions. If the electricity for the HPWH is provided by an on-site photovoltaic (PV) system then there are essentially no greenhouse gas (GHG) emissions. A 2016 study conducted at Cornell[9] calculated the kg of methane (CH_4) and carbon dioxide (CO_2) produced per GJ of water heated. The study compared HPWH to gas and electric fired, storage and tankless water heaters. The study also considered electricity produced from natural gas and coal fired electric plants. In all cases the study found that HPWHs produced less methane than all of the other water heaters. The study also found that HPWH produced less carbon dioxide than electric resistance water heaters but more carbon dioxide than tankless gas water heaters and about the same amount of carbon dioxide as storage gas water heaters. The summary tables provide the reduction in CO2 equivalent emissions based on the typical New Jersey electric utility.

This measure has a negative simple payback due to the relative cost of electricity to natural gas. At this site the cost per Btu for natural gas is significantly lower than for electricity. Therefore, even though this measure will result in a net energy savings in terms of Btu at this site it will increase the overall cost for providing domestic hot water.

Affected Units: gas fired storage water tank heater

4.11 Measures for Future Consideration

There are additional opportunities for improvement that Morris School District BOE may wish to consider. These potential upgrades typically require further analysis, involve substantial capital investment, and/or include significant system reconfiguration. These measure(s) are therefore beyond the scope of this energy audit. These measure(s) are described here to support a whole building approach to energy efficiency and sustainability.

Morris School District BOE may wish to consider the Energy Savings Improvement Program (ESIP) or other whole building approach. With interest in implementing comprehensive, largescale and/or complex system wide projects, these measures may be pursued during development of a future energy savings plan. We recommend that you work with your energy service company (ESCO) and/or design team to:

- Evaluate these measures further.
- Develop firm costs.
- Determine measure savings.
- Prepare detailed implementation plans.

Other modernization or capital improvement funds may be leveraged for these types of refurbishments. As you plan for capital upgrades, be sure to consider the energy impact of the building systems and controls being specified.

Heating System Conversion from Steam to Hot Water

This type of system upgrade/conversion has significant up-front capital costs. However, there are benefits with modular hot water boiler system designs with advanced control strategies. Advantages associated with configuring a boiler plant around several modular boilers include the better system performance at low load conditions, and the modular boilers will often take less space than multiple old large boilers.

[9] Greenhouse gas emissions from domestic hot water: Heat pumps compared to most commonly used systems. Bongghi Hong, Robert W. Howarth. Department of Ecology and Evolutionary Biology, Cornell University. Energy Science and Engineering 2016.

Steam and condensate return piping will need to be capped off, removed, or replaced in most cases. If distribution systems are mainly hydronic, replacing a steam boiler will likely be more cost effective than for situations where steam is supplied to the end uses, for instance, where steam coils or fin tube radiators are used. In such cases, end use distribution points will need to be modified to accommodate the circulation of hot water.

As the existing boilers are approaching the end of their useful life, it is recommended that reconfiguring the boiler plant be further evaluated. We recommend that you work with your mechanical design team to select boilers that are sized appropriately for the heating load.

Replacing the boilers has a long payback, and it may not be justifiable based simply on energy considerations. We also recommend working with your mechanical design team to determine whether a hot water heating system can operate with return water temperatures below 130°F, which would allow for operating condensing boilers at efficiencies above 90%. Energy savings resulted from improved combustion efficiency and reduced standby losses at low loads. Further analysis should be conducted for the feasibility of this measure. This measure is a capital improvement measure for future consideration.

Upgrade to a Heat Pump System

Electric resistance heating units work by passing an electric current through wires to heat them. The system is 100% efficient since for every unit of electricity consumed, one unit of heat is produced.

But there is a way to convert electricity to create heat at better than a 1:1 ratio. Heat pumps operate on a more efficient principle, the refrigeration cycle. Instead of directly converting electricity to heat, electricity does the work, via a compressor, of moving refrigerant through a system that transfers heat from a cooler place to a warmer place. That system can move three to five as much energy as is available using electric resistance heating methods. Heat pumps work in a similar manner to an air conditioner, except they reverse the cooling process to circulate warm air instead of cold air. Also, heat pumps are generally capable of dispensing refrigerated air as they can typically be operated in air conditioning mode.

An electric furnace or boiler has no flue loss through a chimney. The AFUE rating for an all-electric furnace or boiler is between 95% and 100%. The lower values are for units installed outdoors because they have greater jacket heat loss. However, despite their high efficiency, the higher cost of electricity in most parts of the country makes all-electric furnaces or boilers an uneconomic choice. If you are interested in electric heating, consider installing a heat pump system.

Electric resistance heat, including electric furnaces and baseboard heaters, can be inexpensive to install but often expensive to run. Facilities with these systems can save substantial energy at a moderate cost by installing a heat pump when they replace a central air conditioner.

Even in buildings without central air-conditioning, there are opportunities to save energy when an existing electric furnace needs to be replaced, as well as opportunities to install ductless electric heat pumps in buildings with baseboard electric heaters and electric fan coils. Unit ventilators with built-in electric resistance heaters can be replaced with unit ventilators with integrated heat pumps.

Electric heat pumps have high coefficient of performance (COP) ratings and are substantially more efficient than traditional electric heating systems. Further investigation is required to determine whether installing a heat pump system is a cost-effective solution when replacing existing electrical heating systems.

Replace Smooth V-Belts with Notched or Synchronous Belts

This measure is for the replacement of smooth V-belts in non-residential package and split HVAC systems with notched V-belts or for the installation of new equipment with synchronous belts instead of smooth V-belts. Typically, there is a V-belt between the motor and the supply air fan and/or return air fan in larger package and split HVAC systems.

In general, there are two styles of grooved V-belts: notched and synchronous. The U.S. Department of Energy (DOE) compares these two types as follows:[10]

Characteristic	Notched V-Belts	Synchronous Belts
Description	A notched belt has grooves or notches that run perpendicular to the belt's length, which reduces the bending resistance of the belt.	They are also called cogged, timing, positive-drive, or high-torque drive belts, and are "toothed".
Pulleys/Sprockets	Can use the same pulleys as cross-section standard V-belts	Require the installation of mating grooved sprockets.
Typical Efficiency	Run cooler, last longer, and are about 2% more efficient than standard V-belts.	Operate with a consistent efficiency of 98% and maintain their efficiency over a wide load range.
Constraints	Have a sharp reduction in efficiency at high torque due to increased slippage.	Noisier than V-belts, less suited for use on shock-loaded applications, and transfer more vibration due to their stiffness.
Other Benefits	Lower cost than synchronous belts, overall.	Require minimal maintenance and re-tensioning. Operate in wet and oily environments, and run slip-free

The DOE offers the following suggested actions with respect to investigating the applicability of notched or synchronous V belts:

- Conducted a survey of belt-driven equipment. Gather application and operating-hour data. Then determine the cost effectiveness of replacing existing V-belts with notched belts or synchronous belts and sprockets.
- Consider synchronous belts for all new installations; the price premium is minimal due to the avoidance of conventional pulley costs.
- Consider having a power transmission specialist determine the energy and cost savings potential from retrofitting all V-belt drives with synchronous belts. Synchronous belts rely on tooth grip instead of friction to efficiently transfer power and provide a constant speed ratio.
- Install notched belts where the retrofit of a synchronous belt is not cost effective.

[10] https://www.nrel.gov/docs/fy13osti/56012.pdf US DOE Motor Systems Tip Sheet #5

5 Energy Efficient Best Practices

A whole building maintenance plan will extend equipment life; improve occupant comfort, health, and safety; and reduce energy and maintenance costs.

Operation and maintenance (O&M) plans enhance the operational efficiency of HVAC and other energy intensive systems and could save 5% –20% of the energy usage in your building without substantial capital investment. A successful plan includes your records of energy usage trends and costs, building equipment lists, current maintenance practices, and planned capital upgrades, and it incorporates your ideas for improved building operation. Your plan will address goals for energy-efficient operation, provide detail on how to reach the goals, and outline procedures for measuring and reporting whether goals have been achieved.

You may already be doing some of these things—see our list below for potential additions to your maintenance plan. Be sure to consult with qualified equipment specialists for details on proper maintenance and system operation.

Energy Tracking with ENERGY STAR Portfolio Manager

You've heard it before—you cannot manage what you do not measure. ENERGY STAR Portfolio Manager is an online tool that you can use to measure and track energy and water consumption, as well as greenhouse gas emissions[11] . Your account has already been established. Now you can continue to keep tabs on your energy performance every month.

Weatherization

Caulk or weather strip leaky doors and windows to reduce drafts and loss of heated or cooled air. Sealing cracks and openings can reduce heating and cooling costs, improve building durability, and create a healthier indoor environment. Materials used may include caulk, polyurethane foam, and other weather-stripping materials. There is an energy savings opportunity by reducing the uncontrolled air exchange between the outside and inside of the building. Blower door assisted comprehensive building air sealing will reduce the amount of air exchange, which will in turn reduce the load on the buildings heating and cooling equipment, providing energy savings and increased occupant comfort.

Doors and Windows

Close exterior doors and windows in heated and cooled areas. Leaving doors and windows open leads to a loss of heat during the winter and chilled air during the summer. Reducing air changes per hour can lead to increased occupant comfort as well as heating and cooling savings, especially when combined with proper HVAC controls and adequate ventilation.

Window Treatments/Coverings

Use high-reflectivity films or cover windows with shades or shutters to reduce solar heat gain and reduce the load on cooling and heating systems. Older, single-pane windows and east- or west-facing windows are especially prone to solar heat gain. In addition, use shades or shutters at night during cold weather to reduce heat loss.

[11] https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

Lighting Maintenance

Clean lamps, reflectors and lenses of dirt, dust, oil, and smoke buildup every six to twelve months. Light levels decrease over time due to lamp aging, lamp and ballast failure, and buildup of dirt and dust. Together, this can reduce total light output by up to 60% while still drawing full power.

In addition to routine cleaning, developing a maintenance schedule can ensure that maintenance is performed regularly, and it can reduce the overall cost of fixture re-lamping and re-ballasting. Group re-lamping and re-ballasting maintains lighting levels and minimizes the number of site visits by a lighting technician or contractor, decreasing the overall cost of maintenance.

Motor Controls

Electric motors often run unnecessarily, and this is an overlooked opportunity to save energy. These motors should be identified and turned off when appropriate. For example, exhaust fans often run unnecessarily when ventilation requirements are already met. Whenever possible, use automatic devices such as twist timers or occupancy sensors to turn off motors when they are not needed.

Motor Maintenance

Motors have many moving parts. As these parts degrade over time, the efficiency of the motor is reduced. Routine maintenance prevents damage to motor components. Routine maintenance should include cleaning surfaces and ventilation openings on motors to prevent overheating, lubricating moving parts to reduce friction, inspecting belts and pulleys for wear and to ensure they are at proper alignment and tension, and cleaning and lubricating bearings. Consult a licensed technician to assess these and other motor maintenance strategies.

Thermostat Schedules and Temperature Resets

Use thermostat setback temperatures and schedules to reduce heating and cooling energy use during periods of low or no occupancy. Thermostats should be programmed for a setback of 5-10°F during low occupancy hours (reduce heating setpoints and increase cooling setpoints). Cooling load can be reduced by increasing the facility's occupied setpoint temperature. In general, during the cooling season, thermostats should be set as high as possible without sacrificing occupant comfort.

Chiller Maintenance

Service chillers regularly to keep them operating properly. Chillers are responsible for a substantial portion of a commercial building's overall energy usage, and when they do not work well, there is usually a noticeable increase in energy bills and increased occupant complaints. Regular diagnostics and service can save five to ten percent of the cost of operating your chiller. If you already have a maintenance contract in place, your existing service company should be able to provide these services.

AC System Evaporator/Condenser Coil Cleaning

Dirty evaporator and condenser coils restrict air flow and restrict heat transfer. This increases the loads on the evaporator and condenser fan and decreases overall cooling system performance. Keeping the coils clean allows the fans and cooling system to operate more efficiently.

HVAC Filter Cleaning and Replacement

Air filters should be checked regularly (often monthly) and cleaned or replaced when appropriate. Air filters reduce indoor air pollution, increase occupant comfort, and help keep equipment operating efficiently. If the building has a building management system, consider installing a differential pressure switch across filters to send an alarm about premature fouling or overdue filter replacement. Over time, filters become less and less effective as particulate buildup increases. Dirty filters also restrict air flow through the air conditioning or heat pump system, which increases the load on the distribution fans.

Steam Trap Repair and Replacement

Steam traps are a crucial part of delivering heat from the boiler to the space heating units. Steam traps are automatic valves that remove condensate from the system. If the traps fail closed, condensate can build up in the steam supply side of the trap, which reduces the flow in the steam lines and thermal capacity of the radiators. Or they may fail open, allowing steam into the condensate return lines resulting in wasted energy, water, and hammering. Losses can be significantly reduced by testing and replacing equipment as they start to fail. Repair or replace traps that are blocked or allowing steam to pass. Inspect steam traps as part of a regular steam system maintenance plan.

Boiler Maintenance

Many boiler problems develop slowly over time, so regular inspection and maintenance is essential to keeping the heating system running efficiently and preventing expensive repairs. Annual tune-ups should include a combustion analysis to analyze the exhaust from the boilers and to ensure the boiler is operating safely and efficiently. Boilers should be cleaned according to the manufacturer's instructions to remove soot and scale from the boiler tubes to improve heat transfer.

Optimize HVAC Equipment Schedules

Energy management systems (BAS) typically provide advanced controls for building HVAC systems, including chillers, boilers, air handling units, rooftop units and exhaust fans. The BAS monitors and reports operational status, schedules equipment start and stop times, locks out equipment operation based on outside air or space temperature, and often optimizes damper and valve operation based on complex algorithms. These BAS features, when in proper adjustment, can improve comfort for building occupants and save substantial energy.

Know your BAS scheduling capabilities. Regularly monitor HVAC equipment operating schedules and match them to building operating hours to eliminate unnecessary equipment operation and save energy. Monitoring should be performed often at sites with frequently changing usage patterns – daily in some cases. We recommend using the optimal start feature of the BAS (if available) to optimize the building warmup sequence. Most BAS scheduling programs provide for holiday schedules, which can be used during reduced use or shutdown periods. Finally, many systems are equipped with a one-time override function, which can be used to provide additional space conditioning due to a one-time, special event. When available this override feature should be used rather than changing the base operating schedule.

Water Heater Maintenance

The lower the supply water temperature that is used for hand washing sinks, the less energy is needed to heat the water. Reducing the temperature results in energy savings and the change is often unnoticeable to users. Be sure to review the domestic water temperature requirements for sterilizers and dishwashers as you investigate reducing the supply water temperature.

Also, preventative maintenance can extend the life of the system, maintain energy efficiency, and ensure safe operation. At least once a year, follow manufacturer instructions to drain a few gallons out of the water heater using the drain valve. If there is a lot of sediment or debris, then a full flush is recommended. Turn the temperature down and then completely drain the tank. Annual checks should include checks for:

- Leaks or heavy corrosion on the pipes and valves.
- Corrosion or wear on the gas line and on the piping. If you noticed any black residue, soot, or charred metal, this is a sign you may be having combustion issues, and you should have the unit serviced by a professional.
- For electric water heaters, look for signs of leaking such as rust streaks or residue around the upper and lower panels covering the electrical components on the tank.
- For water heaters more than three years old, have a technician inspect the sacrificial anode annually.

Compressed Air System Maintenance

Compressed air systems require periodic maintenance to operate at peak efficiency. A maintenance plan for compressed air systems should include:

- Inspection, cleaning, and replacement of inlet filter cartridges.
- Cleaning of drain traps.
- Daily inspection of lubricant levels to reduce unwanted friction.
- Inspection of belt condition and tension.
- Check for leaks and adjust loose connections.
- Overall system cleaning.
- Reduce pressure setting to minimum needed for air operated equipment.
- Turn off compressor if not routinely needed.
- Use low pressure blower air rather than high pressure compressed air.

Contact a qualified technician for help with setting up periodic maintenance schedule.

Refrigeration Equipment Maintenance

Preventative maintenance keeps commercial refrigeration equipment running reliably and efficiently. Commercial refrigerators and freezers are mission-critical equipment that can cost a fortune when they go down. Even when they appear to be working properly, refrigeration units can be consuming too much energy. Have walk-in refrigeration and freezer and other commercial systems serviced at least annually. This practice will allow systems to perform to their highest capabilities and will help identify system issues if they exist.

Maintaining your commercial refrigeration equipment can save between five and ten percent on energy costs. When condenser coils are dirty, your commercial refrigerators and freezers work harder to maintain the temperature inside. Worn gaskets, hinges, door handles or faulty seals cause cold air to leak from the unit, forcing the unit to run longer and use more electricity.

Regular cleaning and maintenance also help your commercial refrigeration equipment to last longer.

Procurement Strategies

Purchasing efficient products reduces energy costs without compromising quality. Consider modifying your procurement policies and language to require ENERGY STAR products where available.

6 WATER BEST PRACTICES

Getting Started

The commercial and institutional sector is the second largest consumer of publicly supplied water in the United States, accounting for 17% of the withdrawals from public water supplies[12]. In New Jersey, excluding water used for power generation, approximately 80% of total water use was attributed to potable supply during the period of 2009 to 2018. Water withdrawals for potable supply have not changed noticeably during the period from 1990 to 2018[13].

Water management planning serves as the foundation for any successful water reduction effort. It is the first step a commercial or institutional facility owner or manager should take to achieve and sustain long-term water savings. Understanding how water is used within a facility is critical for the water management planning process. A water assessment provides a comprehensive account of all known water uses at the facility. It allows the water management team to establish a baseline from which progress and program success can be measured. It also enables the water management team to set achievable goals and identify and prioritize specific projects based on the relative savings opportunities and project cost-effectiveness.

Water conservation devices may significantly reduce your water and sewer usage costs. Any reduction in water use reduces grid-level electricity use since a significant amount of electricity is used to treat and deliver water from reservoirs to end users.

For more information regarding water conservation or additional details regarding the practices shown below go to the EPA's WaterSense website[14] or download a copy of EPA's "WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities"[15] to get ideas for creating a water management plan and best practices for a wide range of water using systems.

Leak Detection and Repair

Identifying and repairing leaks and other water use anomalies within a facility's water distribution system or from processes or equipment can keep a facility from wasting significant quantities of water. Examples of common leaks include leaking toilets and faucets, drip irrigation malfunctions, stuck float valves, and broken distribution lines. Reading meters, installing failure abatement technologies, and conducting visual and auditory inspections are important best practices to detect leaks. Train building occupants, employees, and visitors to report any leaks that they detect. To reduce unnecessary water loss, detected leaks should be repaired quickly. Repairing leaks in water distribution that is pressurized by on-site pumps or in heated or chilled water piping will also reduce energy use.

Toilets and Urinals

Toilets and urinals are considered sanitary fixtures and are found in most facilities. High efficiency fixtures are at least 20% more efficient than available standard products. Leaking or damaged equipment is a substantial source of water waste. Train users to report continuously flushing, leaking, or otherwise improperly operating equipment to the appropriate personnel. Depending on the age of the equipment

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[12] Estimated from analyzing data in: Solley, Wayne B,. et al, "Estimated Use of Water in the United States in 1995", U.S Geological Survey Circular 1200, (1998)

[13] https://dep.nj.gov/wp-content/uploads/dsr/trends-water-supply.pdf

[14] https://www.epa.gov/watersense

[15] https://www.epa.gov/watersense/watersense-work-0

and the frequency of use, it may be cost effective to replace older inefficient fixtures with current generation WaterSense labeled equipment.

Commercial facilities typically use tank toilets or wall-mount flushometers. Educate and inform users with restroom signage and other means to avoid flushing inappropriate objects. For tank toilets, periodically check to ensure fill valves are working properly and that water level is set correctly. Annually test toilets to ensure the flappers are not worn or allowing water to seep from the tank into the bowl and down the sewer. Control stops and piston valves on flushometer toilets should be checked at least annually.

Most urinals use water to flush liquid. These standard single-user fixtures are present in most facilities. Non-water urinals use a specially designed trap that allows liquid waste to drain out of the fixture through a trap seal, and into the drainage system. Flushing urinals should be inspected at least annually for proper valve and sensor operation. For non-water urinals, follow maintenance practices as directed by the manufacturer to ensure products perform as expected. Non-water urinals can be considered during urinal replacement, however, review the condition and design of the existing plumbing system and the expected usage patterns to ensure that these products will provide the anticipated performance.

Faucets and Showerheads

Faucets and showerheads are sanitary fixtures that generally dispense heated water. Reducing water use by these fixtures translates into a reduction of site fuel or electric use depending on how water is heated. High efficiency fixtures are at least 20% more efficient than available standard products. Leaking or damaged equipment is a substantial source of water waste. Train users to report continuously dripping, leaking, or otherwise improperly operating equipment to the appropriate personnel. Depending on the age of the equipment and the frequency of use, it may be cost effective to replace older fixtures with current generation WaterSense labeled equipment.

Faucets are used for a variety of purposes, and standard flow rates are dictated by the intended use. Public use lavatory faucets and kitchen faucets are subject to maximum flow rates while service sinks are not. Periodically inspect faucet aerators for scale buildup to ensure flow is not being restricted. Clean or replace the aerator or other spout end device as needed. Check and adjust automatic sensors (where installed) to ensure they are operating properly to avoid faucets running longer than necessary. Post materials in restrooms and kitchens to ensure user awareness of the facility's water-efficiency goals. Remind users to turn off the tap when they are done and to consider turning the tap off during sanitation activities when it is not being used. Consider installing lavatory and kitchen faucet fixtures with reduced flow. Federal standards limit kitchen and restroom faucet flows to 2.2 gpm. To qualify for a WaterSense label a faucet cannot exceed 1.5 gpm.

Effective in 1992, the maximum allowable flow rate for all showerheads sold in the United States is 2.5 gpm. Since this standard was enacted, many showerheads have been designed to use even less water. WaterSense labeled equipment is designed to use 2.0 gpm, or less. For optimum showerhead efficiency, the system pressure should be tested to make sure that it is between 20 and 80 pounds per square inch (PSI). Verify that plumbing lines are routed through a shower valve to prevent water pressure fluctuations. Periodically inspect showerheads for scale buildup to ensure flow is not being restricted. In general, replace showerheads with 2.5 gpm flow rates or higher with WaterSense labeled models. Note: Use of poor performing replacement reduced flow showerheads may result in increased use if the duration of use is increased to compensate for reduced performance. WaterSense labeled showerheads are independently certified to meet or exceed minimum performance requirements for spray coverage and force.

Steam Boiler System

Typically, boilers that produce hot water are closed loop systems and do not have significant water losses as long as there are no leaks in the boiler or distribution piping. Therefore, this section focuses on boilers that produce steam. Steam is typically used for space heating, indirectly to heat domestic water and for process heating.

As steam is distributed, its heat is transferred to the process or the ambient environment and, as a result, the steam condenses to water. This condensate is then either discharged to the sewer or captured and returned to the boiler for reuse.

As water is converted to steam within the boiler, dissolved solids, such as calcium, magnesium, chloride, and silica, are left behind. With evaporation, the total dissolved solids (TDS) concentration increases. If the concentration gets too high, the TDS can cause scale to form within the system or can lead to corrosion. The concentration of TDS is controlled by removing (i.e., blowing down) a portion of the water that has a high concentration of TDS and replacing that water with make-up water, which has a lower concentration of TDS. Some boiler operators practice continuous blowdown by leaving the blowdown valve partially open, requiring a continuous feed of make-up water.

Proper control of boiler blowdown water is critical to ensure efficient boiler operation and minimize make-up water use. Insufficient blowdown can lead to scaling and corrosion, while excessive blowdown wastes water, energy, and chemicals. The optimum blowdown rate is influenced by several factors, including boiler type, operating pressure, water treatment, and quality of make-up water. Generally, blowdown rates range from 4% to 8% of the make-up water flow rate, although they can be as high as 10% if the make-up water is poor quality with high concentrations of solids.

Blowdown is typically assessed and controlled by measuring the conductivity of the boiler make-up water compared to that in the boiler blowdown water. Conductivity provides an indication of the overall TDS concentration in the boiler. The blowdown percentage can be calculated as indicated below. The boiler water quality is often expressed in terms of cycles of concentration, which is the inverse of the blowdown percentage. See figure below.

Blowdown Percentage = Make-up Water Conductivity / Blowdown Conductivity

Blowdown Percentage

Controlling the blowdown percentage and maximizing the cycles of concentration will reduce make-up water use; however, this can only be done within the constraints of the make-up and boiler water chemistry. As the TDS concentration in the blowdown water increases, scaling and corrosion problems can occur, unless carefully controlled.

For optimum steam boiler water efficiency, there are several operations, maintenance, and user education strategies to consider.

- Check steam, hot water, and condensate lines for leaks regularly and make repairs promptly.
- Regularly clean and inspect boiler water and fire tubes.
- Develop and implement an annual boiler tune-up program.
- Provide proper insulation on piping and the central storage tank to conserve heat.
- Implement a steam trap inspection program for boiler systems with condensate recovery. Repair leaking traps as soon as possible.

- Choose a water treatment vendor that will work with you to minimize water use, chemical use, and cost, while maintaining appropriate water chemistry for efficient scale and corrosion control.
- Have the water treatment vendor produce a report every time they evaluate the water chemistry in the boiler. Review the reports to ensure that characteristics, such as conductivity and cycles of concentration, are within the target range.
- To minimize blowdown, calculate and understand the boiler's cycles of concentration.
- Consider pre-treating boiler make-up water to remove impurities, which can increase the cycles of concentration the boiler can achieve.

There are also retrofits to consider if the steam system is not already equipped with these items.

- Install and maintain a condensate recovery system to return condensate to the boiler for reuse. If there already is a condensate recovery system inspect and maintain it regularly to maintain the maximum level of condensate return possible. Maximizing condensate return to the boiler is the most effective way to reduce water use. Recovering condensate:
  - Reduces the amount of make-up water required,
  - Reduces the frequency of blowdown,
  - Reduces boiler fuel use since the temperature of the condensate is considerably higher than the temperature of the make-up water.
- Where condensate cannot be returned to the boiler and must be discharged to the sanitary sewer, consider one of the following options:
  - Installing a heat exchanger to recover heat from the condensate to preheat the make-up water,
  - Install an expansion tank to temper hot condensate rather than adding water to cool it.
- Install an automatic blowdown control system, particularly on boilers that are more than 200 horsepower (6,700 kBtu/hr.), to control the amount and frequency of blowdown rather than relying on continuous blowdown. Control systems with a conductivity controller will initiate blowdown only when the TDS concentrations in the boiler have built up to a specified concentration.
- Install flow meters on the make-up water line and the condensate return line to monitor the amount of make-up water added to the boiler.
- Install automated chemical feed systems to monitor conductivity, control blowdown, and add chemicals based on make-up water flow. These systems minimize water and chemical use while protecting against scale buildup and corrosion.

7 On-Site Generation

You don't have to look far in New Jersey to see one of the thousands of solar electric systems providing clean power to homes, businesses, schools, and government buildings. On-site generation includes both renewable (e.g., solar, wind) and non-renewable (e.g., fuel cells) technologies that generate power to meet all or a portion of the facility's electric energy needs. Also referred to as distributed generation, these systems contribute to greenhouse gas (GHG) emission reductions, demand reductions, and reduced customer electricity purchases, which results in improved electric grid reliability through better use of transmission and distribution systems.

Preliminary screenings were performed to determine if an on-site generation measure could be a cost-effective solution for your facility. Before deciding to install an on-site generation system, we recommend conducting a feasibility study to analyze existing energy profiles, siting, interconnection, and the costs associated with the generation project including interconnection costs, departing load charges, and any additional special facilities charges.

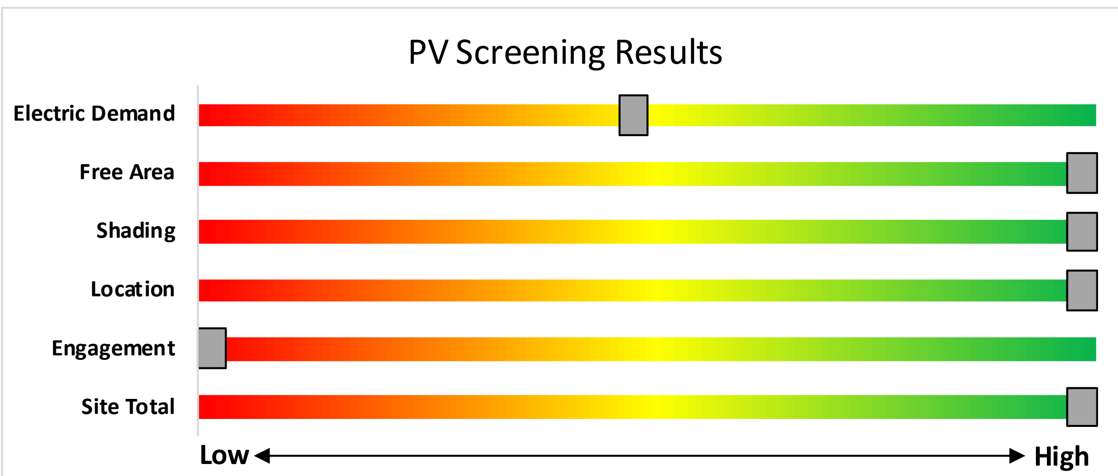
7.1 Solar Photovoltaic

Photovoltaic (PV) panels convert sunlight into electricity. Individual panels are combined into an array that produces direct current (DC) electricity. The DC current is converted to alternating current (AC) through an inverter. The inverter is then connected to the building's electrical distribution system.

A preliminary screening based on the facility's electric demand, size and location of free area, and shading elements shows that the facility has high potential for installing a PV array.

The amount of free area, ease of installation (location), and the lack of shading elements contribute to the high potential. A PV array located on the roof may be feasible. If you are interested in pursuing the installation of PV, we recommend conducting a full feasibility study.

The graphic below displays the results of the PV potential screening conducted as a part of this audit. The position of each slider indicates the potential (potential increases to the right) that each factor contributes to the overall site potential.



Potential	High	
System Potential	80	kW DC STC
Electric Generation	95,310	kWh/yr
Displaced Cost	$13,470	/yr
Installed Cost	$208,000	

Photovoltaic Screening

Successor Solar Incentive Program (SuSI)

The SuSI program replaces the SREC Registration Program (SRP) and the Transition Incentive (TI) program. The SuSI program is used to register and certify solar projects in New Jersey. Rebates are not available for solar projects. Solar projects may qualify to earn SREC- IIs (Solar Renewable Energy Certificates-II), however, the project owners must register their solar projects prior to the start of construction to establish the project's eligibility.

Get more information about solar power in New Jersey or find a qualified solar installer who can help you decide if solar is right for your building:

- **Successor Solar Incentive Program (SuSI):** https://www.njcleanenergy.com/renewable-energy/programs/susi-program
- **Basic Info on Solar PV in NJ**: http://www.njcleanenergy.com/whysolar
- **NJ Solar Market FAQs**: ww.njcleanenergy.com/renewable-energy/program-updates-and-background-information/solar-transition/solar-market-faqs
- **Approved Solar Installers in the NJ Market**: http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/tools-and-resources/tradeally/approved_vendorsearch/?id=60&start=1

7.2 Combined Heat and Power

Combined heat and power (CHP) generates electricity at the facility and puts waste heat energy to good use. Common types of CHP systems are reciprocating engines, microturbines, fuel cells, backpressure steam turbines, and (at large facilities) gas turbines.

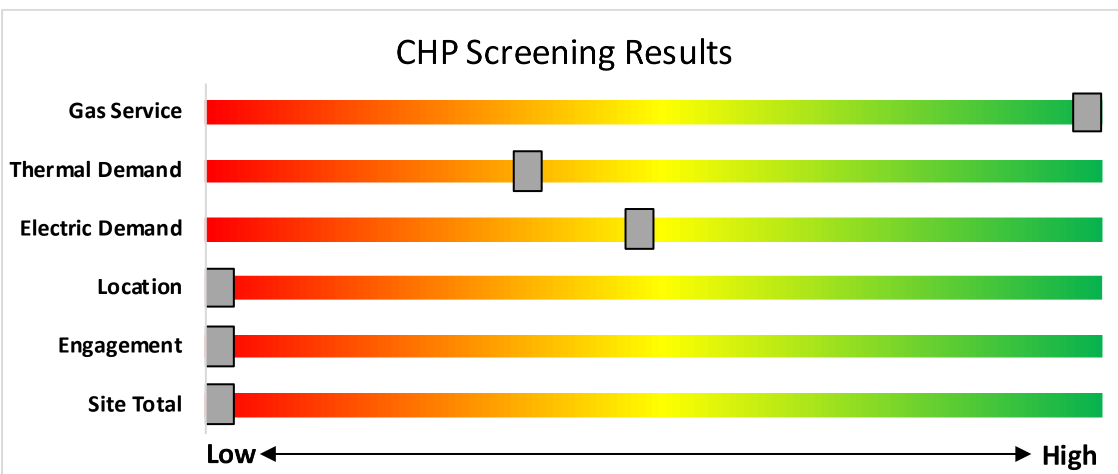
CHP systems typically produce a portion of the electric power used on-site, with the balance of electric power needs supplied by the local utility company. The heat is used to supplement (or replace) existing boilers and provide space heating and/or domestic hot water heating. Waste heat can also be routed through absorption chillers for space cooling.

The key criteria used for screening is the amount of time that the CHP system would operate at full load and the facility's ability to use the recovered heat. Facilities with a continuous need for large quantities of waste heat are the best candidates for CHP.

A preliminary screening based on heating and electrical demand, siting, and interconnection shows that the facility has no potential for installing a cost-effective CHP system.

Based on a preliminary analysis, the facility does not appear to meet the minimum requirements for a cost-effective CHP installation. The lack of gas service, low or infrequent thermal load, and lack of space for siting the equipment are the most significant factors contributing to the lack of CHP potential.

The graphic below displays the results of the CHP potential screening conducted as a part of this audit. The position of each slider indicates the potential (potential increases to the right) that each factor contributes to the overall site potential.



Combined Heat and Power Screening

Find a qualified firm that specializes in commercial CHP cost assessment and installation: http://www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/tools-and-resources/tradeally/approved_vendorsearch/

8 Electric Vehicles

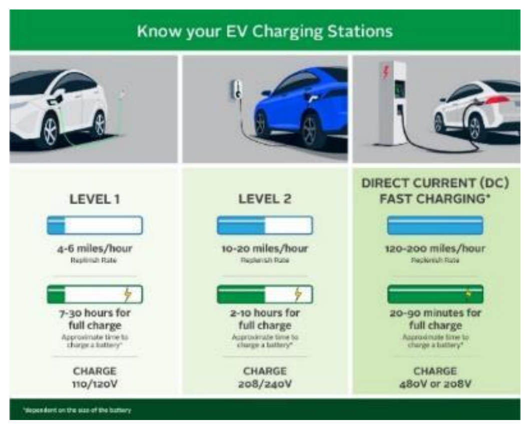
All electric vehicles (EVs) have an electric motor instead of an internal combustion engine. EVs function by plugging into a charge point, taking electricity from the grid, and then storing it in rechargeable batteries. Although electricity production may contribute to air pollution, the U.S. EPA categorizes all-electric vehicles as zero-emission vehicles because they produce no direct exhaust or tailpipe emissions.

EVs are typically more expensive than similar conventional and hybrid vehicles, although some cost can be recovered through fuel savings, federal tax credit, or state incentives.

8.1 EV Charging

EV charging stations provide a means for electric vehicle operators to recharge their batteries at a facility. While many EV drivers charge at home, others do not have access to regular home charging, and the ability to charge at work or in public locations is critical to making EVs practical for more drivers. Charging can also be used for electric fleet vehicles, which can reduce fuel and maintenance costs for fleets that replace gas or diesel vehicles with EVs.

EV charging comes in three main types. For this assessment, the screening considers addition of Level 2 charging, which is most common at workplaces and other public locations. Depending on the site type and usage, other levels of charging power may be more appropriate.



The preliminary assessment of EV charging at the facility shows that there is medium potential for adding EV chargers to the facility's parking, based on potential costs of installation and other site factors.

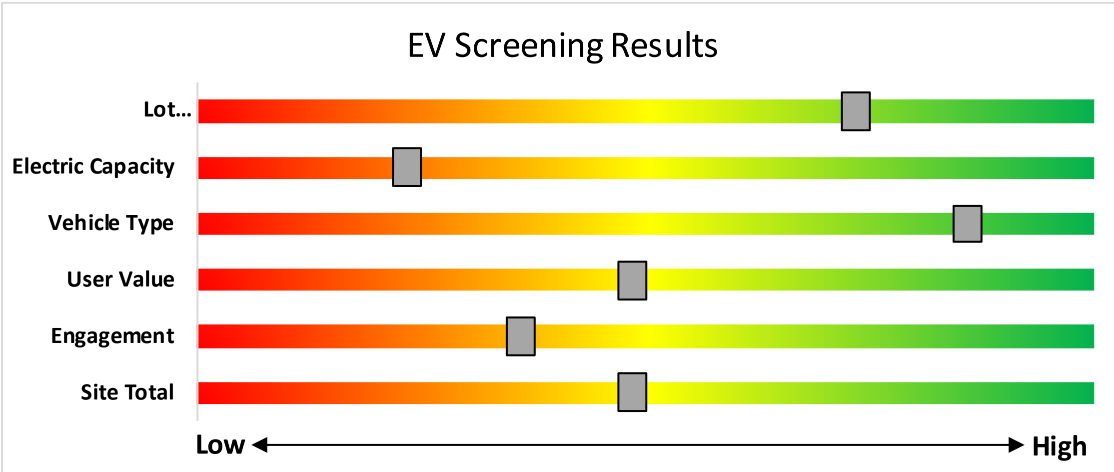
The primary costs associated with installing EV charging are the charger hardware and the cost to extend power from the facility to parking spaces. This may include upgrades to electric panels to serve increased loads.

The type and size of the parking area impact the costs and feasibility of adding EV charging. Parking structure installations can be less costly than surface lot installations as power may be readily available, and equipment and wiring can be surface mounted. Parking lot installations often require trenching through concrete or asphalt surface. Large parking areas provide greater flexibility in charger siting than smaller lots.

The location and capacity of facility electric panels also impact charger installation costs. A Level 2 charger generally requires a dedicated 208-240V, 40 Amp circuit. The electric panel nearest the planned installation may not have available capacity and may need to be upgraded to serve new EV charging loads. Alternatively, chargers could be powered from a more distant panel. The distance from the panel to the location of charging stations ties directly to costs, as conduits, cables, and potential trenching costs all increase on a per-foot basis. The more charging stations planned, the more likely it is that additional electrical capacity will be needed.

Other factors to consider when planning for EV charging at a facility include who the intended users are, how long they park vehicles at the site, and whether they will need to pay for the electricity they use.

The graphic below displays the results of the EV charging assessment conducted as part of this audit. The position of each slider indicates the impact each factor has on the feasibility of installing EV charging at the site.



EV Charger Screening

Electric Vehicle Programs Available

New Jersey is leading the way on electric vehicle (EV) adoption on the East Coast. There are several programs designed to encourage EV adoption in New Jersey, which is crucial to reaching a 100% clean energy future.

NJCEP offers a variety of EV programs for vehicles, charging stations, and fleets. Certain EV charging stations that receive electric utility service from Atlantic City Electric Company (ACE), Public Service Electric and Gas Company (PSE&G) or Jersey Central Power and Light (JCP&L), may be eligible for additional electric vehicle charging incentives directly from the utility. Projects may be eligible for both the incentives offered by this BPU program and incentives offered by ACE, PSE&G or JCP&L, up to 90% of the combined charger purchase and installation costs. Please check ACE, PSE&G or JCP&L program eligibility requirements before purchasing EV charging equipment, as additional conditions on types of eligible chargers may apply for utility incentives.

EV Charging incentive information is available from Atlantic City Electric, PSE&G and JCP&L.For more information and to keep up to date on all EV programs please visit https://www.njcleanenergy.com/commercial-industrial/programs/electric-vehicle-programs

9 Project Funding and Incentives

Ready to improve your building's performance? New Jersey's Clean Energy Programs and Utility Energy Efficiency Programs can help. Pick the program that works best for you. This section provides an overview of currently available incentive programs in New Jersey.

NJBPU and NJCEP Administered Programs

New Jersey's cleanenergy program™

- New Construction (residential, commercial, industrial, government)
- Large Energy Users
- Energy Savings Improvement Program (financing)
- State Facilities Initiative*
- Local Government Energy Audits
- Combined Heat & Power & Fuel Cells

*State facilities are also eligible for utility programs

Utility Administered Programs

atlantic city electric – An Exelon Company; Jersey Central Power & Light – A FirstEnergy Company; PSEG; Rockland Electric Company; Elizabethtown Gas; South Jersey Gas; New Jersey Natural Gas

- Existing buildings (residential, commercial, industrial, government)
- Efficient Products
  - Lighting & Marketplace
  - HVAC
  - Appliance Rebates
  - Appliance Recycling

9.1 New Jersey's Clean Energy Program

Save money while saving the planet! New Jersey's Clean Energy Program is a statewide program that offers incentives, programs, and services that benefit New Jersey residents, businesses, educational, non-profit, and government entities to help them save energy, money, and the environment.

Large Energy Users

The Large Energy Users Program (LEUP) is designed to foster self-directed investment in energy projects. This program is offered to New Jersey's largest energy customers. To qualify entities must have incurred at least $5 million in total energy costs in the prior fiscal year.

Incentives

Incentives are based on the specifications below. The maximum incentive per entity is the lesser of:

- $4 million
- 75% of the total project(s) cost
- 90% of total NJCEP fund contribution in previous year
- $0.33 per projected kWh saved; $3.75 per projected Therm saved annually

How to Participate

To participate in LEUP, you will first need submit an enrollment application. This program requires all qualified and approved applicants to submit an energy plan that outlines the proposed energy efficiency work for review and approval. Applicants may submit a Draft Energy Efficiency Plan (DEEP), or a Final Energy Efficiency Plan (FEEP). Once the FEEP is approved, the proposed work can begin.

Detailed program descriptions, instructions for applying, and applications can be found at http://www.njcleanenergy.com/LEUP.

Combined Heat and Power

The Combined Heat & Power (CHP) program provides incentives for eligible CHP or waste heat to power (WHP) projects. Eligible CHP or WHP projects must achieve an annual system efficiency of at least 65% (lower heating value, or LHV), based on total energy input and total utilized energy output. Mechanical energy may be included in the efficiency evaluation. ≤

Incentives[16]

Eligible Technology	Size (Installed Rated Capacity)	Incentive ($/Watt)[5]	% of Total Cost Cap per Project	$ Cap per Project
CHPs powered by non-renewable or renewable fuel source, or a combination:[4] - Gas Internal Combustion Engine - Gas Combustion Turbine - Microturbine Fuel Cells ≥60%	≤500 kW[1]	$2.00	30-40%[2]	$2 million
	>500 kW - 1 MW[1]	$1.00		
	> 1 MW - 3 MW[1]	$0.55	30%	$3 million
	>3 MW[1]	$0.35		
Fuel Cells ≥40%	Same as above[1]	Applicable amount above	30%	$1 million
Waste Heat to Power (WHP)[3] Powered by non-renewable fuel source. Heat recovery or other mechanical recovery from existing equipment utilizing new electric generation equipment (e.g. steam turbine)	≤1MW[1]	$1.00	30%	$2 million
	> 1MW[1]	$.50	30%	$3 million

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[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 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-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.

How to Participate

You will work with a qualified developer or consulting firm to complete the CHP application. Once the application is approved the project can be installed. Information about the CHP program can be found at http://www.njcleanenergy.com/CHP.

Successor Solar Incentive Program (SuSI)

The SuSI program replaces the SREC Registration Program (SRP) and the Transition Incentive (TI) program. The program is used to register and certify solar projects in New Jersey. Rebates are not available for solar projects, but owners of solar projects must register their projects prior to the start of construction to establish the project's eligibility to earn SREC-IIs (Solar Renewable Energy Certificates-II). SuSI consists of two sub-programs. The Administratively Determined Incentive (ADI) Program and the Competitive Solar Incentive (CSI) Program.

Administratively Determined Incentive (ADI) Program

The ADI Program provides administratively set incentives for net metered residential projects, net metered non-residential projects 5 MW or less, and all community solar projects.

After the registration is accepted, construction is complete, and a complete final as-built packet has been submitted, the project is issued a New Jersey certification number, which enables it to generate New Jersey SREC- IIs.

Market Segments	Size MW dc	Incentive Value ($/SREC II)	Public Entities Incentive Value - $20 Adder ($/SRECII)
Net Metered Residential	All types and sizes	$90	N/A
Small Net Metered Non-Residential located on Rooftop, Carport, Canopy and Floating Solar	Projects smaller than 1 MW	$100	$120
Large Net Metered Non-Residential located on Rooftop, Carport, Canopy and Floating Solar	Projects 1 MW to 5 MW	$90	$110
Small Net Metered Non-Residential Ground Mount	Projects smaller than 1 MW	$85	$105
Large Net Metered Non-Residential Ground Mount	Projects 1 MW to 5 MW	$80	$100
LMI Community Solar	Up to 5 MW	$90	N/A
Non-LMI Community Solar	Up to 5 MW	$70	N/A
Interim Subsection (t)	All types and sizes	$100	N/A

Eligible projects may generate SREC-IIs for 15 years following the commencement of commercial operations which is defined as permission to operate (PTO) from the Electric Distribution Company. After 15 years, projects may be eligible for a NJ Class I REC.

SREC-IIs will be purchased monthly by the SREC-II Program Administrator who will allocate the SREC-IIs to the Load Serving Entities (BGS Providers and Third-Party Suppliers) annually based on their market share of retail electricity sold during the relevant Energy Year.

The ADI Program online portal is now open to new registrations.

Competitive Solar Incentive (CSI) Program

The CSI Program opened on April 15, 2023, and will serve as the permanent program within the SuSI Program providing incentives to larger solar facilities. The CSI Program is open to qualifying grid supply solar facilities, non-residential net metered solar installations with a capacity greater than five (5) megawatts ("MW"), and to eligible grid supply solar facilities installed in combination with energy storage.

CSI eligible facilities will only be allowed to register in the CSI program upon award of a bid pursuant to N.J.A.C. 14:8-11.10.

The CSI program structure has separate categories, or tranches, to ensure that a range of solar project types, including those on preferred sites, are able to participate despite potentially different project cost profiles. The Board has approved four tranches for grid supply and large net metered solar and an additional fifth tranche for storage in combination with grid supply solar. The following table lists procurement targets for the first solicitation:

Tranche	Project Type	MW (dc) Targets
Tranche 1.	Basic Grid Supply	140
Tranche 2.	Grid Supply on the Built Environment	80
Tranche 3.	Grid Supply on Contaminated Sites and Landfills	40
Tranche 4.	Net Metered Non- Residential	40
Tranche 5.	*Storage Paired with Grid	160 MWh

*The storage tranche of 160 MWh corresponds to a 4-hour storage pairing of 40 MW of solar

Solar projects help the State of New Jersey reach renewable energy goals outlined in the state's Energy Master Plan.

If you are considering installing solar on your building, visit the following link for more information: https://njcleanenergy.com/renewable-energy/programs/susi-program

Energy Savings Improvement Program

The Energy Savings Improvement Program (ESIP) serves New Jersey's government agencies by financing energy projects. An ESIP is a type of performance contract, whereby school districts, counties, municipalities, housing authorities, and other public and state entities enter contracts to help finance building energy upgrades. Annual payments are lower than the savings projected from the energy conservation measures (ECMs), ensuring that ESIP projects are cash flow positive for the life of the contract.

ESIP provides government agencies in New Jersey with a flexible tool to improve and reduce energy usage with minimal expenditure of new financial resources. NJCEP incentive programs described above can also be used to help further reduce the total project cost of eligible measures.

How to Participate

This LGEA report is the first step to participating in ESIP. Next, you will need to select an approach for implementing the desired ECMs:

(1) Use an energy services company or "ESCO."
(2) Use independent engineers and other specialists, or your own qualified staff, to provide and manage the requirements of the program through bonds or lease obligations.
(3) Use a hybrid approach of the two options described above where the ESCO is used for some services and independent engineers, or other specialists or qualified staff, are used to deliver other requirements of the program.

After adopting a resolution with a chosen implementation approach, the development of the energy savings plan can begin. The ESP demonstrates that the total project costs of the ECMs are offset by the energy savings over the financing term, not to exceed 15 years. The verified savings will then be used to pay for the financing.

The ESIP approach may not be appropriate for all energy conservation and energy efficiency improvements. Carefully consider all alternatives to develop an approach that best meets your needs. A detailed program descriptions and application can be found at www.njcleanenergy.com/ESIP.

ESIP is a program delivered directly by the NJBPU and is not an NJCEP incentive program. As mentioned above, you can use NJCEP incentive programs to help further reduce costs when developing the energy savings plan. Refer to the ESIP guidelines at the link above for further information and guidance on next steps.

Demand Response (DR) Energy Aggregator

Demand Response Energy Aggregator is a program designed to reduce the electric load when electric wholesale prices are high or when the reliability of the electric grid is threatened due to peak demand. Grid operators call upon curtailment service providers and commercial facilities to reduce electric usage during times of peak demand, making the grid more reliable and reducing transmission costs for all ratepayers. Curtailment service providers provide regular payments to medium and large consumers of electric power for their participation in DR programs. Program participation is voluntary and participants receive payments whether or not their facility is called upon to curtail its electric usage.

Typically, an electric customer must be capable of reducing their electric demand, within minutes, by at least 100 kW or more in order to participate in a DR program. Customers with greater capability to quickly curtail their demand during peak hours receive higher payments. Customers with back-up generators on site may also receive additional DR payments for their generating capacity if they agree to run the generators for grid support when called upon. Eligible customers who have chosen to participate in DR programs often find it to be a valuable source of revenue for their facility, because the payments can significantly offset annual electric costs.

Participating customers can often quickly reduce their peak load through simple measures, such as temporarily raising temperature setpoints on thermostats (so that air conditioning units run less frequently) or agreeing to dim or shut off less critical lighting. This usually requires some level of building automation and controls capability to ensure rapid load reduction during a DR curtailment event. DR program participants may need to install smart meters or may need to also sub-meter larger energy-using equipment, such as chillers, to demonstrate compliance with DR program requirements.

DR does not include the reduction of electricity consumption based on normal operating practice or behavior. For example, if a company's normal schedule is to close for a holiday, the reduction of electricity due to this closure or scaled-back operation is not considered a DR activity in most situations.

The first step toward participation in a DR program is to contact a curtailment service provider. A list of these providers is available on the website of the independent system operator, PJM, and it includes contact information for each company, as well as the states where they have active business[17]. PJM also posts training materials for program members interested in specific rules and requirements regarding DR activity along with a variety of other DR program information[18].

Curtailment service providers typically offer free assessments to determine a facility's eligibility to participate in a DR program. They will provide details regarding program rules and requirements for metering and controls, assess a facility's ability to temporarily reduce electric load, and provide details on payments to be expected for participation in the program. Providers usually offer multiple options for DR to larger facilities, and they may also install controls or remote monitoring equipment of their own to help ensure compliance with all terms and conditions of a DR contract.

[17] http://www.pjm.com/markets-and-operations/demand-response.aspx.

[18] http://www.pjm.com/training/training-events.aspx.

9.2 Utility Energy Efficiency Programs

The Clean Energy Act, signed into law by Governor Murphy in 2018, requires New Jersey's investor-owned gas and electric utilities to reduce their customers' use by set percentages over time. To help reach these targets the New Jersey Board of Public Utilities approved a comprehensive suite of energy efficiency programs to be run by the utility companies.

Prescriptive and Custom

The Prescriptive and Custom rebate program through your utility provider offers incentives for installing prescriptive and custom energy efficiency measures at your facility. This program provides an effective mechanism for securing incentives for energy efficiency measures installed individually or as part of a package of energy upgrades. This program serves most common equipment types and sizes.

Equipment Examples

Lighting
Lighting Controls
HVAC Equipment
Refrigeration
Gas Heating
Gas Cooling
Commercial Kitchen Equipment
Food Service Equipment
Variable Frequency Drives
Electronically Commutate Motors
Variable Frequency Drives
Plug Loads Controls
Washers and Dryers
Agricultural
Water Heating

The Prescriptive program provides fixed incentives for specific energy efficiency measures. Prescriptive incentives vary by equipment type. The Custom program provides incentives for more unique or specialized technologies or systems that are not addressed through prescriptive incentives.

Direct Install

Direct Install is a turnkey program available to existing small to medium-sized facilities with an average peak electric demand that does not exceed 200 kW or less over the recent 12-month period. You work directly with a pre-approved contractor who will perform a free energy assessment at your facility, identify specific eligible measures, and provide a clear scope of work for installation of selected measures. Energy efficiency measures may include lighting and lighting controls, refrigeration, HVAC, motors, variable speed drives, and controls.

Incentives

The program pays up to 70% of the total installed cost of eligible measures.

How to Participate

To participate in Direct Install, you will work with a participating contractor. The contractor will be paid the measure incentives directly by the program, which will pass on to you in the form of reduced material and implementation costs. This means up to 70% of eligible costs are covered by the Direct Install program, subject to program rules and eligibility, while the remaining percent of the cost is paid to the contractor by the customer.

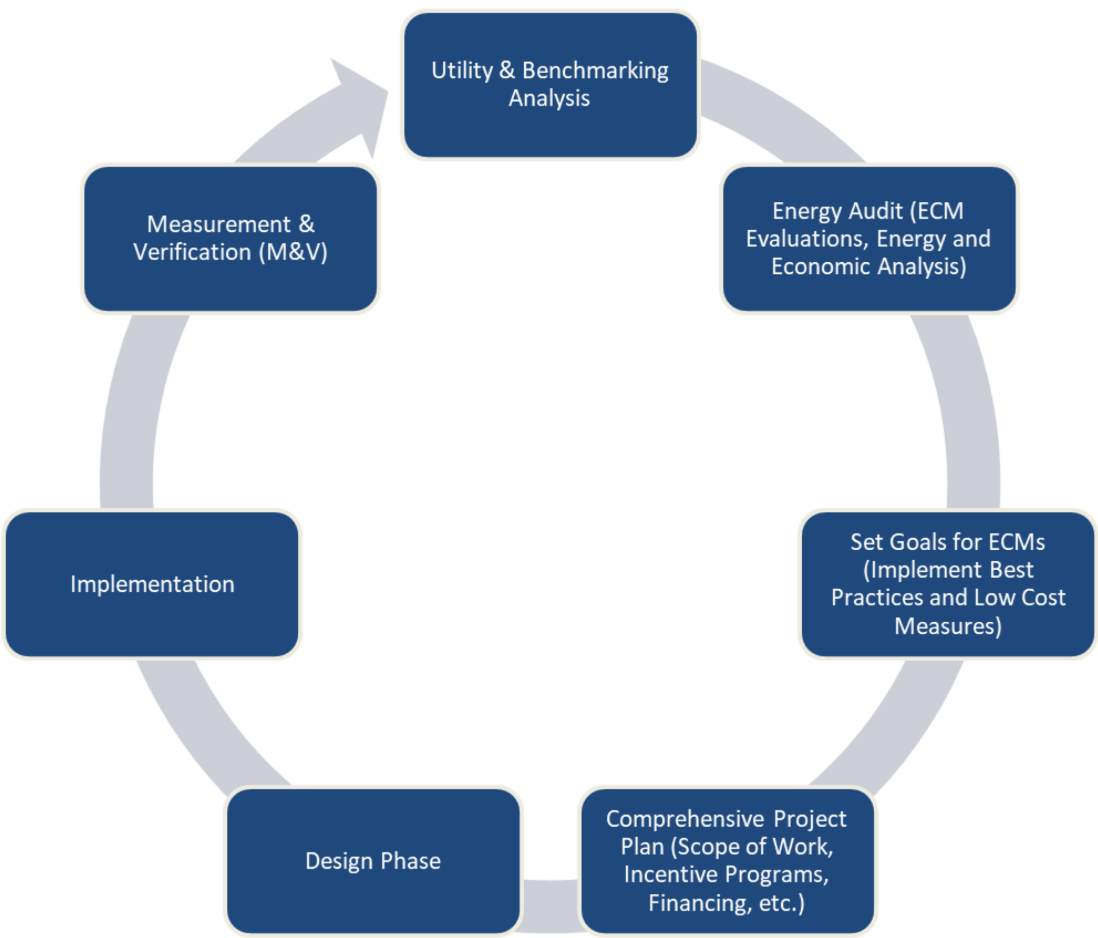
Engineered Solutions

The Engineered Solutions Program provides tailored energy-efficiency assistance and services to municipalities, universities, schools, hospitals, and healthcare facilities (MUSH), non-profit entities, and multifamily buildings. Customers receive expert guided services, including investment-grade energy auditing, engineering design, installation assistance, construction administration, commissioning, and measurement and verification (M&V) services to support the implementation of cost-effective and comprehensive efficiency projects. Engineered Solutions is generally a good option for medium to large sized facilities with a peak demand over 200 kW looking to implement as many measures as possible under a single project to achieve deep energy savings. Engineered Solutions has an added benefit of addressing measures that may not qualify for other programs. Many facilities pursuing an Energy Savings Improvement Program loan also use this program. Incentives for this program are based on project scope and energy savings achieved.

For more information on any of these programs, contact your local utility provider or visit https://www.njcleanenergy.com/transition.

10 Project Development

Energy conservation measures (ECMs) have been identified for your site, and their energy and economic analyses are provided within this LGEA report. Note that some of the identified projects may be mutually exclusive, such as replacing equipment versus upgrading motors or controls. The next steps with project development are to set goals and create a comprehensive project plan. The graphic below provides an overview of the process flow for a typical energy efficiency or renewable energy project. We recommend implementing as many ECMs as possible prior to undertaking a feasibility study for a renewable project. The cyclical nature of this process flow demonstrates the ongoing work required to continually improve building energy efficiency over time. If your building(s) scope of work is relatively simple to implement or small in scope, the measurement and verification (M&V) step may not be required. It should be noted through a typical project cycle, there will be changes in costs based on specific scopes of work, contractor selections, design considerations, construction, etc. The estimated costs provided throughout this LGEA report demonstrate the unburdened turn-key material and labor cost only. There will be contingencies and additional costs at the time of implementation. We recommend comprehensive project planning that includes the review of multiple bids for project work, incorporates potential operations and maintenance (O&M) cost savings, and maximizes your incentive potential.



Project Development Cycle

11 Energy Purchasing and Procurement Strategies

11.1 Retail Electric Supply Options

Energy deregulation in New Jersey has increased energy buyers' options by separating the function of electricity distribution from that of electricity supply. Though you may choose a different company from which to buy your electric power, responsibility for your facility's interconnection to the grid and repair to local power distribution will still reside with the traditional utility company serving your region.

If your facility is not purchasing electricity from a third-party supplier, consider shopping for a reduced rate from third-party electric suppliers. If your facility already buys electricity from a third-party supplier, review and compare prices at the end of each contract year.

A list of licensed third-party electric suppliers is available at the NJBPU website[19].

11.2 Retail Natural Gas Supply Options

The natural gas market in New Jersey is also deregulated. Most customers that remain with the utility for natural gas service pay rates that are market based and fluctuate monthly. The utility provides basic gas supply service to customers who choose not to buy from a third-party supplier for natural gas commodity.

A customer's decision about whether to buy natural gas from a retail supplier typically depends on whether a customer prefers budget certainty and/or longer-term rate stability. Customers can secure longer-term fixed prices by signing up for service through a third-party retail natural gas supplier. Many larger natural gas customers may seek the assistance of a professional consultant to assist in their procurement process.

If your facility does not already purchase natural gas from a third-party supplier, consider shopping for a reduced rate from third-party natural gas suppliers. If your facility already purchases natural gas from a third-party supplier, review and compare prices at the end of each contract year.

A list of licensed third-party natural gas suppliers is available at the NJBPU website[20].

[19] www.state.nj.us/bpu/commercial/shopping.html

[20] www.state.nj.us/bpu/commercial/shopping.html

Appendix A: Equipment Inventory & Recommendations

Lighting Inventory & Recommendations

	Existing Conditions						Proposed Conditions								Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Light Level	Watts per Fixture	Annual Operating Hours	ECM #	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Auditorium	7	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	7	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Auditorium	8	LED Lamps: (2) 13W A19 Screw-In Lamps	Wall Switch	S	26	2,250	3	None	Yes	8	LED Lamps: (2) 13W A19 Screw-In Lamps	Occupancy Sensor	26	1,553	0.0	145	0	$20	$0	$0	0.0
Auditorium	9	LED - Fixtures: High-Bay	Wall Switch	S	125	2,250	3	None	Yes	9	LED - Fixtures: High-Bay	Occupancy Sensor	125	1,553	0.2	785	0	$109	$660	$70	5.4
Auditorium	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,250	2, 3	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,553	0.1	283	0	$39	$480	$70	10.4
Auditorium	12	Metal Halide: (1) 750W Lamp	Wall Switch	S	850	100	1	Fixture Replacement	No	12	LED - Fixtures: Architectural Flood/Spot Luminaire	Wall Switch	225	100	3.8	750	0	$104	$7,890	$600	70.2
Child study team	2	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.1	266	0	$37	$510	$80	11.7
Classroom 1	2	LED Lamps: (1) 13W A19 Screw-In Lamp	Wall Switch	S	13	1,800	3	None	Yes	2	LED Lamps: (1) 13W A19 Screw-In Lamp	Occupancy Sensor	13	1,242	0.0	15	0	$2	$0	$0	0.0
Classroom 1	12	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	S	93	1,800	2, 3	Relamp	Yes	12	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,242	0.4	1,360	0	$188	$1,090	$220	4.6
Classroom 10	8	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.3	1,065	0	$148	$1,040	$200	5.7
Classroom 11	6	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	6	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.2	799	0	$111	$860	$160	6.3
Classroom 12	14	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	14	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.3	1,058	0	$147	$1,040	$180	5.9
Classroom 15	11	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	11	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.4	1,465	0	$203	$1,300	$260	5.1
Classroom 16	9	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	9	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.3	1,198	0	$166	$1,130	$220	5.5
Classroom 17	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.0	151	0	$21	$100	$20	3.8
Classroom 17	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	S	93	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,242	0.3	907	0	$126	$840	$160	5.4
Classroom 18	16	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	16	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.3	1,209	0	$167	$1,470	$230	7.4
Classroom 18	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	S	93	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,242	0.3	907	0	$126	$510	$120	3.1
Classroom 19	16	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	16	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.3	1,209	0	$167	$1,470	$230	7.4
Classroom 19 a	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.1	302	0	$42	$530	$80	10.7
Classroom 2	1	Incandescent: (1) 40W A19 Screw-In Lamp	Wall Switch	S	40	1,800	2, 3	Relamp	Yes	1	LED Lamps: (1) 5.5W Plug-In Lamp	Occupancy Sensor	6	1,242	0.0	65	0	$9	$30	$0	3.4
Classroom 2	8	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.3	1,065	0	$148	$1,040	$200	5.7
Classroom 20	6	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	6	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.2	799	0	$111	$860	$160	6.3
Classroom 21	8	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.3	1,065	0	$148	$1,040	$200	5.7
Classroom 22	8	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.3	1,065	0	$148	$1,040	$200	5.7
Classroom 22a	1	Incandescent: (1) 65W A19 Screw-In Lamp	Wall Switch	S	65	1,800	2, 3	Relamp	Yes	1	LED Lamps: (1) 10.5W Plug-In Lamp	Occupancy Sensor	10	1,242	0.0	105	0	$14	$30	$0	2.1

	Existing Conditions						Proposed Conditions								Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Light Level	Watts per Fixture	Annual Operating Hours	ECM #	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Classroom 22a	3	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	3	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.1	399	0	$55	$600	$100	9.0
Classroom 23	8	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.3	1,065	0	$148	$1,040	$200	5.7
Classroom 24	8	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.3	1,065	0	$148	$1,040	$200	5.7
Classroom 25	8	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	S	93	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,242	0.3	907	0	$126	$840	$160	5.4
Classroom 25	2	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.1	266	0	$37	$180	$40	3.8
Classroom 25a	4	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	S	93	1,800	2, 3	Relamp	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,242	0.1	453	0	$63	$580	$100	7.6
Classroom 25a	1	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	1	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.0	133	0	$18	$90	$20	3.8
Classroom 26	14	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	14	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.5	1,864	0	$258	$1,570	$320	4.8
Classroom 27	14	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	14	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.5	1,864	0	$258	$1,570	$320	4.8
Classroom 28	8	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.3	1,065	0	$148	$1,040	$200	5.7
Classroom 29	14	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	14	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.3	1,058	0	$147	$1,040	$180	5.9
Classroom 2a	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.1	302	0	$42	$530	$80	10.7
Classroom 3	8	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.3	1,065	0	$148	$1,040	$200	5.7
Classroom 30	14	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	14	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.3	1,058	0	$147	$1,040	$180	5.9
Classroom 30a	4	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.1	302	0	$42	$530	$80	10.7
Classroom 4	1	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	S	93	1,800	2, 3	Relamp	Yes	1	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,242	0.0	113	0	$16	$60	$20	2.5
Classroom 4	8	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	8	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.3	1,065	0	$148	$1,040	$200	5.7
Classroom 5	12	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	12	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.3	907	0	$126	$940	$160	6.2
Classroom 9	1	LED Lamps: (1) 13W A19 Screw-In Lamp	Wall Switch	S	13	1,800	3	None	Yes	1	LED Lamps: (1) 13W A19 Screw-In Lamp	Occupancy Sensor	13	1,242	0.0	7	0	$1	$0	$0	0.0
Classroom 9	10	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	10	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.4	1,332	0	$184	$1,210	$240	5.3
Classroom 9a	10	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	10	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.2	756	0	$105	$840	$140	6.7
Classroom staff	2	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.1	266	0	$37	$510	$80	11.7
Corridor 1st floor	48	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	S	32	2,520	2, 4	Relamp	Yes	48	LED - Linear Tubes: (1) 4' Lamp	High/Low Control	15	1,739	0.5	2,661	-1	$368	$3,460	$1,920	4.2
Corridor 1st floor	11	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Wall Switch	S	62	2,520	2, 4	Relamp	Yes	11	LED - Linear Tubes: (2) U-Lamp	High/Low Control	33	1,739	0.2	1,087	0	$151	$1,530	$500	6.8
Corridor 2nd floor	6	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	6	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0

	Existing Conditions							Proposed Conditions								Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Light Level	Watts per Fixture	Annual Operating Hours	ECM #	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Corridor 2nd floor	32	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,520	2, 4	Relamp	Yes	32	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,739	0.7	3,386	-1	$469	$3,310	$1,440	4.0
Corridor 3rd floor	8	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	8	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Corridor 3rd floor	35	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,520	2, 4	Relamp	Yes	35	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	1,739	0.7	3,704	-1	$513	$3,460	$1,580	3.7
Corridor 3rd floor	3	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	2,520	2, 4	Relamp	Yes	3	LED - Linear Tubes: (4) 4' Lamps	High/Low Control	58	1,739	0.1	559	0	$77	$550	$170	4.9
Elevator Room	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	200	2	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	200	0.0	7	0	$1	$50	$10	43.8
Exterior	1	Incandescent: (1) 75W A19 Screw-In Lamp	Photocell		75	4,380	2	Relamp	No	1	LED Lamps: (1) 12W Plug-In Lamp	Photocell	12	4,380	0.0	276	0	$39	$30	$0	0.8
Exterior	2	Incandescent: (1) 75W A19 Screw-In Lamp	Photocell		75	4,380	2	Relamp	No	2	LED Lamps: (1) 12W Plug-In Lamp	Photocell	12	4,380	0.0	552	0	$78	$50	$0	0.6
Exterior	2	LED - Fixtures: Downlight Surface Mount	Photocell		150	4,380		None	No	2	LED - Fixtures: Downlight Surface Mount	Photocell	150	4,380	0.0	0	0	$0	$0	$0	0.0
Exterior	3	LED - Fixtures: Downlight Surface Mount	Photocell		75	4,380		None	No	3	LED - Fixtures: Downlight Surface Mount	Photocell	75	4,380	0.0	0	0	$0	$0	$0	0.0
Exterior	5	Metal Halide: (1) 100W Lamp	Photocell		128	4,380	1	Fixture Replacement	No	5	LED - Fixtures: Outdoor Wall-Mounted Area Fixture	Photocell	30	4,380	0.0	2,146	0	$303	$1,640	$250	4.6
Exterior	1	Metal Halide: (1) 250W Lamp	Photocell		295	4,380	1	Fixture Replacement	No	1	LED - Fixtures: Outdoor Wall-Mounted Area Fixture	Photocell	100	4,380	0.0	854	0	$121	$670	$50	5.1
Gymnasium 1	4	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	S	32	2,250	2, 3	Relamp	Yes	4	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,553	0.0	198	0	$27	$430	$60	13.5
Gymnasium 1	15	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	2,250	2, 3	Relamp	Yes	15	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,553	0.6	2,497	-1	$346	$1,660	$340	3.8
Kitchen 1	13	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,250	2, 3	Relamp	Yes	13	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,553	0.3	1,228	0	$170	$990	$170	4.8
Kitchen 1	6	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	S	93	2,250	2, 3	Relamp	Yes	6	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,553	0.2	850	0	$118	$710	$130	4.9
Library	1	Incandescent: (1) 40W A19 Screw-In Lamp	Wall Switch	S	40	1,800	2, 3	Relamp	Yes	1	LED Lamps: (1) 5.5W Plug-In Lamp	Occupancy Sensor	6	1,242	0.0	65	0	$9	$360	$40	35.8
Library	9	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	S	93	1,800	2, 3	Relamp	Yes	9	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,242	0.3	1,020	0	$141	$900	$180	5.1
Library	14	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2, 3	Relamp	Yes	14	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,242	0.5	1,864	0	$258	$1,570	$320	4.8
Lobby	1	LED Lamps: Corn Bulb	Wall Switch	S	60	2,520	4	None	Yes	1	LED Lamps: Corn Bulb	High/Low Control	60	1,739	0.0	47	0	$6	$280	$40	37.0
Lobby	4	LED Lamps: (1) 13W A19 Screw-In Lamp	Wall Switch	S	13	2,520	4	None	Yes	4	LED Lamps: (1) 13W A19 Screw-In Lamp	High/Low Control	13	1,739	0.0	41	0	$6	$280	$140	24.9
Lobby	1	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	2,520	2, 4	Relamp	Yes	1	LED - Linear Tubes: (4) 4' Lamps	High/Low Control	58	1,739	0.0	186	0	$26	$90	$20	2.7
Mechanical	5	LED Lamps: (1) 9W A19 Screw-In Lamp	Wall Switch	S	9	2,520	3	None	Yes	5	LED Lamps: (1) 9W A19 Screw-In Lamp	Occupancy Sensor	9	1,739	0.0	35	0	$5	$330	$40	59.6
Mechanical	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	S	29	2,520	3	None	Yes	1	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,739	0.0	23	0	$3	$330	$40	92.4
Mechanical	1	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	S	32	2,520	2, 3	Relamp	Yes	1	LED - Linear Tubes: (1) 4' Lamp	Occupancy Sensor	15	1,739	0.0	55	0	$8	$30	$10	2.6
Mechanical	7	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,520	2, 3	Relamp	Yes	7	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,739	0.1	741	0	$103	$680	$110	5.6

	Existing Conditions						Proposed Conditions								Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Light Level	Watts per Fixture	Annual Operating Hours	ECM #	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Office - Main	1	LED Lamps: (1) 13W A19 Screw-In Lamp	Wall Switch	S	13	2,250	3	None	Yes	1	LED Lamps: (1) 13W A19 Screw-In Lamp	Occupancy Sensor	13	1,553	0.0	9	0	$1	$0	$0	0.0
Office - Main	10	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	S	93	2,250	2, 3	Relamp	Yes	10	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	1,553	0.3	1,417	0	$196	$960	$190	3.9
Restroom - feMale 2nd floor	2	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	2	LED - Linear Tubes: (2) U-Lamp	Occupancy Sensor	33	1,242	0.0	141	0	$20	$510	$60	23.0
Restroom - female 3rd	2	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Occupancy Sensor	S	62	1,242	2	Relamp	No	2	LED - Linear Tubes: (2) U-Lamp	Occupancy Sensor	33	1,242	0.0	72	0	$10	$180	$20	16.0
Restroom - Male 1	2	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Occupancy Sensor	S	62	1,242	2	Relamp	No	2	LED - Linear Tubes: (2) U-Lamp	Occupancy Sensor	33	1,242	0.0	72	0	$10	$180	$20	16.0
Restroom - Male 1st floor	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,242	0.1	227	0	$31	$480	$70	13.1
Restroom - Male 2nd floor	2	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Wall Switch	S	62	1,800	2, 3	Relamp	Yes	2	LED - Linear Tubes: (2) U-Lamp	Occupancy Sensor	33	1,242	0.0	141	0	$20	$510	$60	23.0
Server Room 1	1	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	1,800	2	Relamp	No	1	LED - Linear Tubes: (4) 4' Lamps	Wall Switch	58	1,800	0.0	101	0	$14	$90	$20	5.0
Stairs 1	5	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Wall Switch		62	8,760	2, 4	Relamp	Yes	5	LED - Linear Tubes: (2) U-Lamp	High/Low Control	33	6,044	0.1	1,718	0	$238	$720	$230	2.1
Storage	1	Compact Fluorescent: (1) 13W Plug-In Lamp	Wall Switch	S	13	200	2	Relamp	No	1	LED Lamps: (1) 10.5W Plug-In Lamp	Wall Switch	11	200	0.0	1	0	$0	$30	$0	433.3
Storage 3	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	200	2	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	200	0.0	7	0	$1	$50	$10	43.8
Storage 4	1	Incandescent: (1) 65W A19 Screw-In Lamp	Wall Switch	S	65	200	2	Relamp	No	1	LED Lamps: (1) 12W Plug-In Lamp	Wall Switch	10	200	0.0	11	0	$2	$30	$0	19.7
Storage 5	1	Compact Fluorescent: (1) 13W Plug-In Lamp	Wall Switch	S	13	200	2	Relamp	No	1	LED Lamps: (1) 10.5W Plug-In Lamp	Wall Switch	11	200	0.0	1	0	$0	$30	$0	433.3
Storage 5	1	Incandescent: (1) 40W A19 Screw-In Lamp	Wall Switch	S	40	200	2	Relamp	No	1	LED Lamps: (1) 5.5W Plug-In Lamp	Wall Switch	6	200	0.0	7	0	$1	$30	$0	31.9
Storage 5	4	LED Lamps: (1) 13W A19 Screw-In Lamp	Wall Switch	S	13	200		None	No	4	LED Lamps: (1) 13W A19 Screw-In Lamp	Wall Switch	13	200	0.0	0	0	$0	$0	$0	0.0
Storage 5	1	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	S	15	200		None	No	1	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	200	0.0	0	0	$0	$0	$0	0.0
Storage roof door-Attic	25	Compact Fluorescent: (1) 18W Plug-In Lamp	Wall Switch	S	18	300	2	Relamp	No	25	LED Lamps: (1) 12W Plug-In Lamp	Wall Switch	12	300	0.1	45	0	$6	$630	$30	96.3
Storage roof door-Attic	1	LED Lamps: (1) 13W A19 Screw-In Lamp	Wall Switch	S	13	300		None	No	1	LED Lamps: (1) 13W A19 Screw-In Lamp	Wall Switch	13	300	0.0	0	0	$0	$0	$0	0.0
Storage roof door-Attic	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	300	2	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	300	0.0	10	0	$1	$50	$10	29.2

Motor Inventory & Recommendations

		Existing Conditions									Proposed Conditions					Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Motor Quantity	Motor Application	HP Per Motor	Full Load Efficiency	VFD Control?	Manufacturer	Model	Remaining Useful Life	Annual Operating Hours	ECM #	Install High Efficiency Motors?	Full Load Efficiency	Install VFDs?	Number of VFDs	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Mechanical room	Steam Boiler	1	Combustion Air Fan	5.00	82.5%	No	Marathon		B	1,647	6	No	86.5%	Yes	1	1.6	3,025	0	$428	$5,900	$900	11.7
Mechanical room	Steam Boiler	1	Combustion Air Fan	5.00	85.0%	No	Marathon		B	1,647	6	No	86.5%	Yes	1	1.5	2,795	0	$395	$5,900	$900	12.7
Various Classrooms	Unit Ventilator	30	Supply Fan	0.20	65.0%	No			W	2,000		No	65.0%	No		0.0	0	0	$0	$0	$0	0.0
Gymnasium	Air Handling Unit	1	Supply Fan	5.00	85.0%	No	Marathon	WVC184TTDH7627AD	W	2,000	5	No	89.5%	Yes	1	1.5	3,589	0	$507	$5,600	$900	9.3
Storage room	Air Handling Unit	1	Supply Fan	7.50	86.0%	No	Marathon	WVD213TTDR7359BP	W	2,000	5	No	91.0%	Yes	1	2.3	5,362	0	$758	$6,700	$1,000	7.5
Mechanical room	Pneumatic system	1	Air Compressor	1.50	80.0%	No	Ingersoll Rand		B	728		No	80.0%	No		0.0	0	0	$0	$0	$0	0.0
Exterior Rooftop	Exhaust System	2	Exhaust Fan	0.33	65.0%	No	Greenheck		W	1,784		No	65.0%	No		0.0	0	0	$0	$0	$0	0.0
Storage roof door	Exhaust System	1	Exhaust Fan	0.03	60.0%	No	Fantech	FR100 (5C516)	W	1,784		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Storage roof door	Attic Exhaust System	8	Exhaust Fan	0.27	65.0%	No			W	1,784		No	65.0%	No		0.0	0	0	$0	$0	$0	0.0
Mechanical room	Domestic Water Circulation	2	DHW Circulation Pump	0.20	65.0%	No			W	8,760		No	65.0%	No		0.0	0	0	$0	$0	$0	0.0
Mechanical room	Condensate return pumps	2	Condensate Pump	1.00	75.0%	No	Baldor	35J302Y474G1	W	1,784		No	75.0%	No		0.0	0	0	$0	$0	$0	0.0
Mechanical room	Condensate return pumps	1	Condensate Pump	1.50	82.0%	No	Century	P48N2EB7	W	1,784		No	82.0%	No		0.0	0	0	$0	$0	$0	0.0
Mechanical room	Feed Water Pump	1	Boiler Feed Water Pump	0.50	70.0%	No	Century	P48J2EB7A1	W	1,784		No	70.0%	No		0.0	0	0	$0	$0	$0	0.0
Mechanical room	Feed Water Pump	1	Boiler Feed Water Pump	1.00	75.0%	No	Century	P48L2EB7A1	W	1,784		No	75.0%	No		0.0	0	0	$0	$0	$0	0.0
Exterior	Kitchen Hood Exhaust	1	Kitchen Hood Exhaust Fan	0.50	75.0%	No			B	2,700	7	No	78.2%	Yes	1	0.0	893	12	$281	$3,500	$100	12.1
Elevator Room	Elevator Motor	1	Other	25.00	75.5%	No	Submersible hydraulic	FR160ZBS	W	100		No	75.5%	No		0.0	0	0	$0	$0	$0	0.0
Mechanical Room	Sewer Pumps	1	Other	1.50	82.0%	No	Worldwide Electic	ATL5-18-56CB	W	1,647		No	82.0%	No		0.0	0	0	$0	$0	$0	0.0
Attic Area	Fresh Air Circulation Fans	10	Ventilation Fan	1.00	80.0%	No				2,745		No	80.0%	No		0.0	0	0	$0	$0	$0	0.0

Packaged HVAC Inventory & Recommendations

		Existing Conditions									Proposed Conditions								Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (MBh)	Cooling Mode Efficiency (SEER/IEER/EER)	Heating Mode Efficiency	Manufacturer	Model	Remaining Useful Life	ECM #	Install High Efficiency System?	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (MBh)	Cooling Mode Efficiency (SEER/IEER/EER)	Heating Mode Efficiency	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Child study team	Child study team-Cooling Load	1	Window AC	0.59		9.55		Friedrich	SQ07J10A-1	B	9	Yes	1	Window AC	0.59		12.00		0.1	61	0	$9	$900	$0	105.1
Classroom 1	Classroom 1-Cooling Load	1	Window AC	2.00		10.40		Friedrich		W		No							0.0	0	0	$0	$0	$0	0.0
Classroom 12	Classroom 12-Cooling Load	1	Window AC	2.00		10.40		Friedrich	KCL24A30B-A	W		No							0.0	0	0	$0	$0	$0	0.0
Classroom 19 a	Classroom 19 a-Cooling Load	1	Window AC	0.50		12.20		Friedrich		W		No							0.0	0	0	$0	$0	$0	0.0
Classroom 2	Classroom 2-Cooling Load	1	Window AC	2.00		10.40		Friedrich	KCL24A30B-A	W		No							0.0	0	0	$0	$0	$0	0.0
Classroom 22	Classroom 22-Cooling Load	1	Window AC	2.00		10.40		Friedrich	KCL24A30B-A	W		No							0.0	0	0	$0	$0	$0	0.0
Classroom 22a	Classroom 22a-Cooling Load	1	Window AC	1.00		11.30		Friedrich	CP12G10A	W		No							0.0	0	0	$0	$0	$0	0.0
Classroom 30a	Classroom 30a-Cooling Load	1	Window AC	0.67		12.10		Friedrich	KCQ08A10A	W		No							0.0	0	0	$0	$0	$0	0.0
Classroom staff	Classroom staff-Cooling Load	1	Window AC	1.50		10.40		Friedrich		W		No							0.0	0	0	$0	$0	$0	0.0
Library	Library- Cooling Load	2	Window AC	2.00		8.81		Friedrich	SL24J30A-3	B	9	Yes	2	Window AC	2.00		12.00		0.7	579	0	$82	$3,500	$0	42.8
Office - Main	Office - Main-Cooling Load	1	Window AC	2.00		8.81		Friedrich	SL24J30A-4	B	9	Yes	1	Window AC	2.00		12.00		0.4	289	0	$41	$1,700	$0	41.5
Office - Main	Office - Main-Cooling Load	1	Window AC	1.00		10.80		Heat controller	CGRADS-121H	W		No							0.0	0	0	$0	$0	$0	0.0

Electric Chiller Inventory & Recommendations

		Existing Conditions						Proposed Conditions								Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Chiller Quantity	System Type	Cooling Capacity per Unit (Tons)	Manufacturer	Model	Remaining Useful Life	ECM #	Install High Efficiency Chillers?	Chiller Quantity	System Type	Constant/ Variable Speed	Cooling Capacity (Tons)	Full Load Efficiency (kW/Ton)	IPLV Efficiency (kW/Ton)	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Rooftop	Auditorium Cooling Load	1	Air-Cooled Scroll Chiller	25.00	Trane	RAUCC25GGBB0 0ADF1	B	10	Yes	1	Air-Cooled Scroll Chiller	Variable	25.00	1.24	0.74	-1.0	4,252	0	$601	$56,900	$2,300	90.8

Space Heating Boiler Inventory & Recommendations

		Existing Conditions						Proposed Conditions							Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Output Capacity per Unit (MBh)	Manufacturer	Model	Remaining Useful Life	ECM #	Install High Efficiency System?	System Quantity	System Type	Output Capacity per Unit (MBh)	Heating Efficiency	Heating Efficiency Units	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Mechanical room	Building Heating Load	2	Forced Draft Steam Boiler	2,135	Superior		B	11	Yes	2	Forced Draft Steam Boiler	2,135	81.00%	Et	0.0	0	166	$2,102	$137,200	$5,100	62.8

Programmable Thermostat Recommendations

		Recommendation Inputs					Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Affected	ECM #	Thermostat Quantity	Cooling Capacity of Controlled System (Tons)	Electric Heating Capacity of Controlled System (kBtu/hr)	Output Heating Capacity of Controlled System (MBh)	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Whole Building Area	Heating and Cooling System	12	45.00	25.00	0.00	4,270.00	0.0	1,043	232	$3,080	$16,990	$0	5.5

Demand Control Ventilation Recommendations

		Recommendation Inputs					Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Affected	ECM #	Number of Zones	Cooling Capacity of Controlled System (Tons)	Electric Heating Capacity of Controlled System (kBtu/hr)	Output Heating Capacity of Controlled System (MBh)	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Gymnasium	Gymnasium Heating load	13	2.00	0.00	0.00	426.00	0.0	0	17	$215	$2,900	$0	13.5
Auditorium and stage	Auditorium Cooling and Heating Load	13	2.00	25.00	0.00	507.00	0.0	579	20	$338	$2,900	$0	8.6

Pipe Insulation Recommendations

		Recommendation Inputs			Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Affected	ECM #	Length of Uninsulated Pipe (ft)	Pipe Diameter (in)	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Mechanical room	Storage Tank-DHW	14	30	1.00	0.0	0	6	$71	$410	$60	4.9
Mechanical room	Storage Tank-DHW	14	20	1.50	0.0	0	6	$71	$270	$40	3.2

DHW Inventory & Recommendations

		Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Manufacturer	Model	Remaining Useful Life	ECM #	Replace?	System Quantity	System Type	Fuel Type	System Efficiency	Efficiency Units	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Kitchen	Domestic Hot Water System	1	Storage Tank Water Heater (> 50 Gal)	Rheem	82V80-2	W		No						0.0	0	0	$0	$0	$0	0.0
Mechanical room	Domestic Hot Water System	1	Storage Tank Water Heater (> 50 Gal)	AO smith	BTR-120 118	W		No						0.0	0	0	$0	$0	$0	0.0

Low-Flow Device Recommendations

	Recommedation Inputs					Energy Impact & Financial Analysis						
Location	ECM #	Device Quantity	Device Type	Existing Flow Rate (gpm)	Proposed Flow Rate (gpm)	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Kitchen	15	2	Faucet Aerator (Kitchen)	2.50	1.50	0.0	98	0	$14	$20	$0	1.4
Various Restrooms	15	4	Faucet Aerator (Lavatory)	2.20	0.50	0.0	334	0	$47	$30	$20	0.2
Various Classrooms	15	18	Faucet Aerator (Lavatory)	2.20	0.50	0.0	0	5	$65	$150	$70	1.2
Various Restrooms	15	6	Faucet Aerator (Lavatory)	2.20	0.50	0.0	0	2	$22	$50	$20	1.4

Commercial Refrigerator/Freezer Inventory & Recommendations

	Existing Conditions					Proposed Conditions		Energy Impact & Financial Analysis						
Location	Quantity	Refrigerator/ Freezer Type	Manufacturer	Model	ENERGY STAR Qualified?	ECM #	Install ENERGY STAR Equipment?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Kitchen	2	Refrigerator Chest	Welsh Farms		No	16	Yes	0.2	2,011	0	$284	$5,300	$0	18.6
Kitchen	1	Freezer Chest			No	16	Yes	0.3	2,675	0	$378	$2,200	$0	5.8
Kitchen	1	Stand-Up Freezer, Solid Door (>50 cu. ft.)	Beverage Air		No	16	Yes	0.5	4,296	0	$607	$4,500	$600	6.4
Kitchen	1	Stand-Up Refrigerator, Solid Door (>50 cu. ft.)	Beverage Air		No	16	Yes	0.1	1,237	0	$175	$3,500	$200	18.9
Kitchen	1	Stand-Up Refrigerator, Solid Door (31 - 50 cu. ft.)	Delfield		No	16	Yes	0.1	842	0	$119	$2,500	$100	20.2

Cooking Equipment Inventory & Recommendations

	Existing Conditions					Proposed Conditions		Energy Impact & Financial Analysis						
Location	Quantity	Equipment Type	Manufacturer	Model	High Efficiency Equipement?	ECM #	Install High Efficiency Equipment?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Kitchen	1	Oven/Cooktop	Vulcan		No		No	0.0	0	0	$0	$0	$0	0.0
Kitchen	1	Non- Insulated Food Holding Cabinet (Full Size)	Vulcan	VHFA18-1	No		No	0.0	0	0	$0	$0	$0	0.0
Kitchen	1	Non- Insulated Food Holding Cabinet (Full Size)	Belves		No		No	0.0	0	0	$0	$0	$0	0.0
Kitchen	1	Electric Convection Oven (Half Size)	Blodgett	ZEPHAIRE-100-G	Yes		No	0.0	0	0	$0	$0	$0	0.0

Plug Load Inventory

	Existing Conditions					
Location	Quantity	Equipment Description	Energy Rate (W)	ENERGY STAR Qualified?	Manufacturer	Model
Mechanical	1	Coffee Machine	800	No		
Office - Main	1	Coffee Machine	800	No		
Classroom 5	1	Dehumidifier	615	No	Heat Controller	BHD-501-G
Office - Main	2	Desktop	150	No		
Classroom 9	1	Microwave	1,000	No		
Classroom staff	2	Microwave	1,000	No		
Mechanical	1	Microwave	1,000	No		
Office - Main	1	Microwave	1,000	No		
Auditorium	6	Air Purifier	95	No	Medify Air	MA-112
Child study team	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 1	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 10	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 11	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 12	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 15	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 16	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 17	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 18	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 19	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 19 a	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 2	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 20	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 21	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 22	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 24	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 24	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 25	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 25a	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 26	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 27	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 28	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 29	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 2a	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 3	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 30	1	Air Purifier	95	No	Medify Air	MA-112

	Existing Conditions					
Location	Quantity	Equipment Description	Energy Rate (W)	ENERGY STAR Qualified?	Manufacturer	Model
Classroom 30a	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 4	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 5	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 9	1	Air Purifier	95	No	Medify Air	MA-112
Classroom 9a	2	Dehumidifier	615	No	Heat Controller	BHD-501-G
Classroom 9a	1	Air Purifier	95	No	Medify Air	MA-112
Gymnasium 1	2	Air Purifier	95	No	Medify Air	MA-112
Kitchen 1	1	Air Purifier	95	No	Medify Air	MA-112
Library	1	Air Purifier	95	No	Medify Air	MA-112
Office - Main	2	Air Purifier	95	No	Medify Air	MA-112
Office - Main	1	Paper Shredder	150	No		
Child study team	1	Printer (Medium/Small)	200	No		
Classroom 1	1	Printer (Medium/Small)	200	No		
Classroom 2	1	Printer (Medium/Small)	200	No		
Classroom 25	1	Printer (Medium/Small)	200	No		
Classroom 25a	1	Printer (Medium/Small)	200	No		
Classroom 3	1	Printer (Medium/Small)	200	No		
Classroom 4	1	Printer (Medium/Small)	200	No		
Classroom 9a	1	Printer (Medium/Small)	200	No		
Library	1	Printer (Medium/Small)	200	No		
Office - Main	1	Printer (Medium/Small)	200	No		
Corridor 3rd floor	1	Printer/Copier (Large)	600	Yes		
Office - Main	1	Printer/Copier (Large)	600	Yes		
Classroom 20	1	Projector	200	No		
Classroom 21	1	Projector	200	No		
Classroom 22	1	Projector	200	No		
Classroom 24	1	Projector	200	No		
Classroom 24	1	Projector	200	No		
Office - Main	1	Refrigerator (Mini)	153	No		
Classroom 22a	1	Refrigerator (Residential)	218	No		
Classroom 9	1	Refrigerator (Residential)	218	No		
Classroom staff	1	Refrigerator (Residential)	218	No		
Mechanical	1	Refrigerator (Residential)	218	No		
Kitchen 1	1	Serving Table (Chilled/Heated)	1,920	No		
Classroom 1	1	Smart Board	235	No	Promethean	

	Existing Conditions					
Location	Quantity	Equipment Description	Energy Rate (W)	ENERGY STAR Qualified?	Manufacturer	Model
Classroom 10	1	Smart Board	235	No	Promethean	
Classroom 11	1	Smart Board	235	No	Promethean	
Classroom 12	1	Smart Board	235	No	Promethean	
Classroom 15	1	Smart Board	235	No	Promethean	
Classroom 16	1	Smart Board	235	No	Promethean	
Classroom 17	1	Smart Board	235	No	Promethean	
Classroom 18	1	Smart Board	235	No	Promethean	
Classroom 19	1	Smart Board	235	No	Promethean	
Classroom 2	1	Smart Board	235	No	Promethean	
Classroom 20	1	Smart Board	235	No	Promethean	
Classroom 21	1	Smart Board	235	No	Promethean	
Classroom 22	1	Smart Board	235	No	Promethean	
Classroom 24	1	Smart Board	235	No	Promethean	
Classroom 24	1	Smart Board	235	No	Promethean	
Classroom 26	1	Smart Board	235	No	Promethean	
Classroom 27	1	Smart Board	235	No	Promethean	
Classroom 28	1	Smart Board	235	No	Promethean	
Classroom 29	1	Smart Board	235	No	Promethean	
Classroom 3	1	Smart Board	235	No	Promethean	
Classroom 30	1	Smart Board	235	No	Promethean	
Classroom 4	1	Smart Board	235	No	Promethean	
Classroom 5	1	Smart Board	235	No	Promethean	
Classroom 9	1	Smart Board	235	No	Promethean	
Classroom 9a	1	Smart Board	235	No	Promethean	
Library	1	Smart Board	235	No	Promethean	
Classroom staff	1	Toaster Oven	1,200	No		
Various	302	Chromebook	45	No		

Custom (High Level) Measure Analysis

Retro-Commissioning Study

Building Square Footage	53,108	**Fuel Utility Rate**	$12.653 MMBtu
Percent of Conditioned Area Impacted	100%	**Blended Electric Utility Rate**	$0.141 kWh

Existing Conditions						Proposed Conditions					Energy Impact & Financial Analysis										
Description	Area(s)/System(s) Served	Remaining Useful Life	Total HVAC Motor Usage kWh	Total HVAC Electric Usage kWh	Total HVAC Fuel Usage MMBtu	Description	% Savings HVAC Motor Usage kWh	% Savings HVAC Electric Usage kWh	% Savings HVAC Fuel Usage MMBtu	Estimated Cost per Sqft	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Base Incentives	Enhanced Incentives	Total Incentives	Total Net Cost	Payback w/o Incentives in Years	Simple Payback w/ Incentives in Years
HVAC Controls Not Currently Optimized	HVAC Equipment & Systems	3	76,098	20,865	3,408	Retro-Commissioning Study	7%	5%	7%	$0.50	0.00	6,370	239	$3,919	$30,900	$0	$0	$0	$30,900	7.88	7.88

Electric Tank Water Heater to HPWH

NOTE: HPWH calculation should not be used for existing water heaters with a storage capacity greater than 120 gal or less than 30 gal.

Existing Conditions						Proposed Conditions				Energy Impact & Financial Analysis										
Description	Area(s)/System(s) Served	SF of Area Served	Fuel Type	Input Capacity per Unit (kW)	Tank Capacity per Unit (Gal)	Description	COP	Tank Capacity per Unit (Gal)	Estimated Unit Cost	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Base Incentives	Enhanced Incentives	Total Incentives	Total Net Cost	Payback w/o Incentives in Years	Payback w/ Incentives in Years
Storage Tank Water Heater (>50 Gal)	Domestic Hot Water System	1,000	Electric	4.5	80	Heat Pump Water Heater	2.5	80	$3,322.98	0.00	1,231	0	$174	$4,000	$0	$0	$0	$4,000	22.99	22.99
			Electric																	
			Electric																	

APPENDIX B: ENERGY STAR STATEMENT OF ENERGY PERFORMANCE

Energy use intensity (EUI) is presented in terms of site energy and source energy. Site energy is the amount of fuel and electricity consumed by a building as reflected in utility bills. Source energy includes fuel consumed to generate electricity consumed at the site, factoring in electric production and distribution losses for the region. NJCEP uses the EPA's ENERGY STAR Portfolio Manager system to generate baseline energy usage results and comparable building EUIs. Portfolio Manager is specifically designed for benchmarking energy consumption within a building.

LEARN MORE AT energystar.gov

ENERGY STAR® Statement of Energy Performance

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ENERGY STAR® Score[1]

Alexander Hamilton Elementary

Primary Property Type: K-12 School
Gross Floor Area (ft²): 53,108
Built: 1933

For Year Ending: June 30, 2023
Date Generated: March 06, 2024

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
Alexander Hamilton Elementary 24 Mills Street Morristown, New Jersey 07960	Morris School District 31 Hazel Street Morristown, NJ 07960 (973) 292-2300	Anthony Lo Franco 31 Hazel Street Morristown, NJ 07960 (973) 292-2300 x2021 Anthony.LoFranco@msdk12.net

Property ID: 32587373

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
81.8 kBtu/ft²

Source EUI
114.5 kBtu/ft²

Annual Energy by Fuel	
Natural Gas (kBtu)	3,479,219 (80%)
Electric - Grid (kBtu)	867,349 (20%)

National Median Comparison	
National Median Site EUI (kBtu/ft²)	67.7
National Median Source EUI (kBtu/ft²)	94.7
% Diff from National Median Source EUI	21%
Annual Emissions	
Total (Location-Based) GHG Emissions (Metric Tons CO2e/year)	263

Signature & Stamp of Verifying Professional

I _________________ (Name) verify that the above information is true and correct to the best of my knowledge.

LP Signature: ______________________ Date: ___________

Licensed Professional

____ ________
,
(____)____-______
____

Professional Engineer or Registered Architect Stamp
(if applicable)

APPENDIX C: GLOSSARY

TERM	DEFINITION
Blended Rate	Used to calculate fiscal savings associated with measures. The blended rate is calculated by dividing the amount of your bill by the total energy use. For example, if your bill is $22,217.22, and you used 266,400 kilowatt-hours, your blended rate is 8.3 cents per kilowatt-hour.
Btu	*British thermal unit*: a unit of energy equal to the amount of heat required to increase the temperature of one pound of water by one-degree Fahrenheit.
CHP	*Combined heat and power*. Also referred to as cogeneration.
COP	*Coefficient of performance*: a measure of efficiency in terms of useful energy delivered divided by total energy input.
Demand Response	Demand response reduces or shifts electricity usage at or among participating buildings/sites during peak energy use periods in response to time-based rates or other forms of financial incentives.
DCV	*Demand control ventilation*: a control strategy to limit the amount of outside air introduced to the conditioned space based on actual occupancy need.
US DOE	*United States Department of Energy*
EC Motor	*Electronically commutated motor*
ECM	*Energy conservation measure*
EER	*Energy efficiency ratio*: a measure of efficiency in terms of cooling energy provided divided by electric input.
EUI	*Energy Use Intensity:* measures energy consumption per square foot and is a standard metric for comparing buildings' energy performance.
Energy Efficiency	Reducing the amount of energy necessary to provide comfort and service to a building/area. Achieved through the installation of new equipment and/or optimizing the operation of energy use systems. Unlike conservation, which involves some reduction of service, energy efficiency provides energy reductions without sacrifice of service.
ENERGY STAR	ENERGY STAR is the government-backed symbol for energy efficiency. The ENERGY STAR program is managed by the EPA.
EPA	*United States Environmental Protection Agency*
Generation	The process of generating electric power from sources of primary energy (e.g., natural gas, the sun, oil).
GHG	*Greenhouse gas* gases that are transparent to solar (short-wave) radiation but opaque to long-wave (infrared) radiation, thus preventing long-wave radiant energy from leaving Earth's atmosphere. The net effect is a trapping of absorbed radiation and a tendency to warm the planet's surface.
gpf	*Gallons per flush*

gpm	*Gallon per minute*
HID	*High intensity discharge:* high-output lighting lamps such as high-pressure sodium, metal halide, and mercury vapor.
hp	*Horsepower*
HPS	*High-pressure sodium*: a type of HID lamp.
HSPF	*Heating seasonal performance factor:* a measure of efficiency typically applied to heat pumps. Heating energy provided divided by seasonal energy input.
HVAC	*Heating, ventilating, and air conditioning*
IHP 2014	US DOE Integral Horsepower rule. The current ruling regarding required electric motor efficiency.
IPLV	*Integrated part load value:* a measure of the part load efficiency usually applied to chillers.
kBtu	One thousand British thermal units
kW	*Kilowatt*: equal to 1,000 Watts.
kWh	*Kilowatt-hour*: 1,000 Watts of power expended over one hour.
LED	*Light emitting diode*: a high-efficiency source of light with a long lamp life.
LGEA	*Local Government Energy Audit*
Load	The total power a building or system is using at any given time.
Measure	A single activity, or installation of a single type of equipment, that is implemented in a building system to reduce total energy consumption.
MH	*Metal halide*: a type of HID lamp.
MBh	*Thousand Btu per hour*
MBtu	*One thousand British thermal units*
MMBtu	*One million British thermal units*
MV	*Mercury Vapor:* a type of HID lamp.
NJBPU	*New Jersey Board of Public Utilities*
NJCEP	*New Jersey's Clean Energy Program:* NJCEP is a statewide program that offers financial incentives, programs and services for New Jersey residents, business owners and local governments to help them save energy, money, and the environment.
psig	Pounds per square inch gauge
Plug Load	Refers to the amount of power used in a space by products that are powered by means of an ordinary AC plug.
PV	*Photovoltaic:* refers to an electronic device capable of converting incident light directly into electricity (direct current).

SEER	*Seasonal energy efficiency ratio:* a measure of efficiency in terms of annual cooling energy provided divided by total electric input.
SEP	*Statement of energy performance:* a summary document from the ENERGY STAR Portfolio Manager.
Simple Payback	The amount of time needed to recoup the funds expended in an investment or to reach the break-even point between investment and savings.
SREC (II)	*Solar renewable energy credit*: a credit you can earn from the state for energy produced from a photovoltaic array.
T5, T8, T12	A reference to a linear lamp diameter. The number represents increments of 1/8th of an inch.
Temperature Setpoint	The temperature at which a temperature regulating device (thermostat, for example) has been set.
therm	100,000 Btu. Typically used as a measure of natural gas consumption.
tons	A unit of cooling capacity equal to 12,000 Btu/hr.
Turnkey	Provision of a complete product or service that is ready for immediate use.
VAV	*Variable air volume*
VFD	*Variable frequency drive*: a controller used to vary the speed of an electric motor.
WaterSense®	The symbol for water efficiency. The WaterSense® program is managed by the EPA.
Watt (W)	Unit of power commonly used to measure electricity use.