Local Government Energy Audit Report

Mackin Hall

July 10, 2024

Prepared for:
Ramapo College of New Jersey
505 Ramapo Valley Road
Mahwah, New Jersey 07430

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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.

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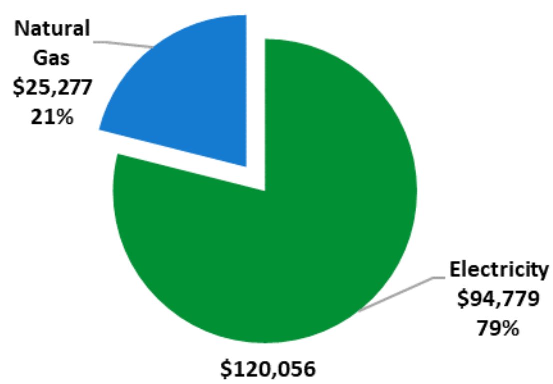
1 Executive Summary

The New Jersey Board of Public Utilities (NJBPU) has sponsored this Local Government Energy Audit (LGEA) report for Mackin Hall at the Ramapo College of New Jersey. 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 Utilities	Costs: $120,056 Electricity: 683,404 kWh Natural Gas: 26,199 Therms	
ENERGY STAR® Benchmarking Score	63 *(1-100 scale)*	Congratulations, your building performs better than the national average. This report has suggestions about how to keep your building running efficiently, further improve performance, and lower your energy bills even more.

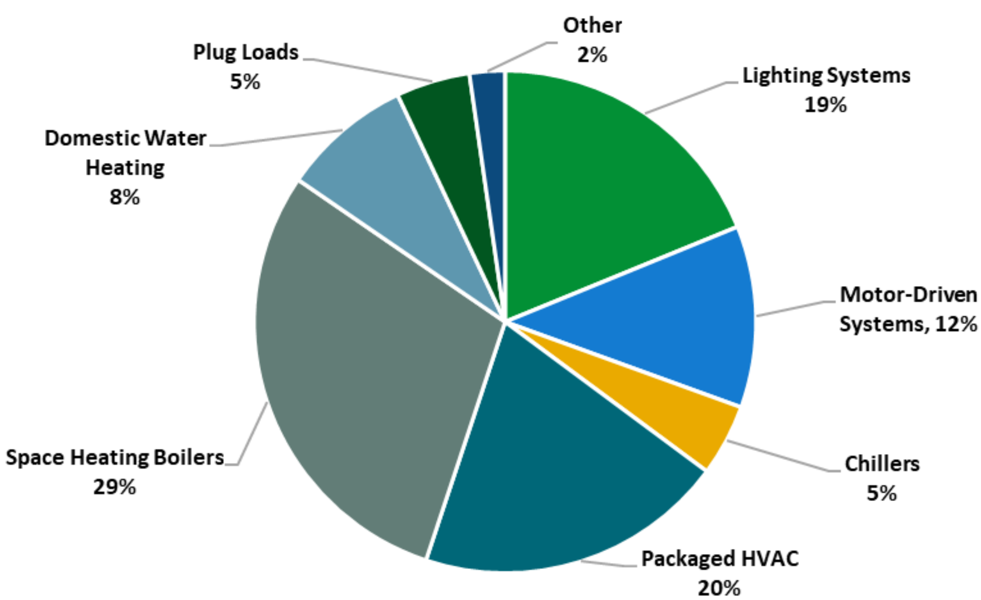


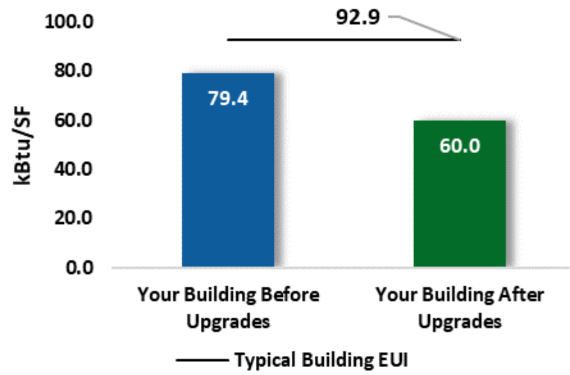
Figure 1 - Energy Use by System

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.

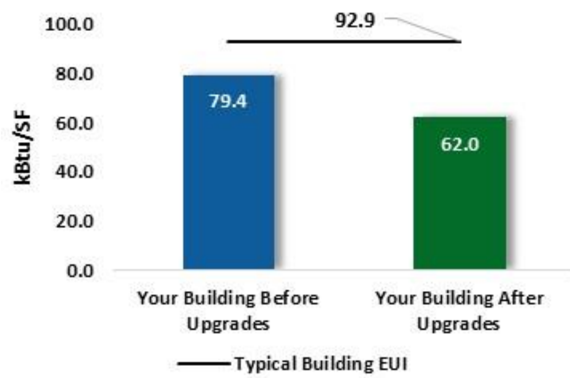
Scenario 1: Full Package (All Evaluated Measures)

Installation Cost	$321,865
Potential Rebates & Incentives[1]	$34,783
Annual Cost Savings	$32,493
Annual Energy Savings	Electricity: 197,092 kWh Natural Gas: 5,347 Therms
Greenhouse Gas Emission Savings	131 Tons
Simple Payback	8.8 Years
Site Energy Savings (All Utilities)	24%



Scenario 2: Cost Effective Package[2]

Installation Cost	$104,769
Potential Rebates & Incentives	$20,458
Annual Cost Savings	$29,179
Annual Energy Savings	Electricity: 202,429 kWh Natural Gas: 1,145 Therms
Greenhouse Gas Emission Savings	109 Tons
Simple Payback	2.9 Years
Site Energy Savings (all utilities)	16%



On-site Generation Potential

Photovoltaic	Medium
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			**147,799**	**33.7**	**-20**	**$20,307**	**$63,866**	**$9,643**	**$54,223**	**2.7**	**146,512**
ECM 1	Install LED Fixtures	Yes	54,435	0.0	0	$7,549	$14,954	$1,750	$13,204	1.7	54,815
ECM 2	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	Yes	27,188	12.6	-6	$3,715	$20,307	$2,010	$18,297	4.9	26,700
ECM 3	Retrofit Fixtures with LED Lamps	Yes	66,177	21.1	-14	$9,042	$28,605	$5,883	$22,722	2.5	64,997
Lighting Control Measures			**30,018**	**2.8**	**-5**	**$4,119**	**$14,324**	**$6,830**	**$7,494**	**1.8**	**29,698**
ECM 4	Install Occupancy Sensor Lighting Controls	Yes	2,027	1.0	0	$277	$3,974	$390	$3,584	12.9	1,991
ECM 5	Install Photocell Controls	Yes	8,751	0.0	0	$1,214	$1,800	$0	$1,800	1.5	8,812
ECM 6	Install High/Low Lighting Controls	Yes	19,239	1.8	-4	$2,629	$8,550	$6,440	$2,110	0.8	18,894
Variable Frequency Drive (VFD) Measures			**34,536**	**7.4**	**0**	**$4,790**	**$47,566**	**$4,000**	**$43,566**	**9.1**	**34,778**
ECM 7	Install VFDs on Constant Volume (CV) Fans	Yes	21,432	4.4	0	$2,972	$11,881	$2,000	$9,881	3.3	21,582
ECM 8	Install VFDs on Chilled Water Pumps	No	13,104	3.0	0	$1,817	$35,685	$2,000	$33,685	18.5	13,195
Unitary HVAC Measures			**8,613**	**7.3**	**7**	**$1,264**	**$51,427**	**$3,325**	**$48,102**	**38.0**	**9,519**
ECM 9	Install High Efficiency Air Conditioning Units	No	8,613	7.3	7	$1,264	$51,427	$3,325	$48,102	38.0	9,519
Electric Chiller Replacement			**11,717**	**0.0**	**0**	**$1,625**	**$126,034**	**$9,000**	**$117,034**	**72.0**	**11,799**
ECM 10	Install High Efficiency Chillers	No	11,717	0.0	0	$1,625	$126,034	$9,000	$117,034	72.0	11,799
HVAC System Improvements			**1,225**	**0.0**	**38**	**$534**	**$2,719**	**$0**	**$2,719**	**5.1**	**5,655**
ECM 11	Implement Demand Control Ventilation (DCV)	Yes	1,225	0.0	38	$534	$2,719	$0	$2,719	5.1	5,655
Domestic Water Heating Upgrade			**0**	**0.0**	**101**	**$975**	**$11,520**	**$1,935**	**$9,585**	**9.8**	**11,836**
ECM 12	Install Low-Flow DHW Devices	Yes	0	0.0	101	$975	$11,520	$1,935	$9,585	9.8	11,836
Food Service & Refrigeration Measures			**1,954**	**0.2**	**0**	**$271**	**$460**	**$50**	**$410**	**1.5**	**1,968**
ECM 13	Vending Machine Control	Yes	1,954	0.2	0	$271	$460	$50	$410	1.5	1,968
Custom Measures			**-38,771**	**0.0**	**413**	**-$1,392**	**$3,950**	**$0**	**$3,950**	**-2.8**	**9,315**
ECM 14	Replace Gas Fired Water Heater with Heat Pump Water Heater	No	-38,771	0.0	413	-$1,392	$3,950	$0	$3,950	-2.8	9,315
TOTALS (COST EFFECTIVE MEASURES)			**202,429**	**41.1**	**115**	**$29,179**	**$104,769**	**$20,458**	**$84,311**	**2.9**	**217,251**
TOTALS (ALL MEASURES)			**197,092**	**51.4**	**535**	**$32,493**	**$321,865**	**$34,783**	**$287,082**	**8.8**	**261,080**

* - 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).

Figure 2 – Evaluated Energy Improvements

For more detail on each evaluated energy improvement and a break out of cost-effective improvements, see **Section** Error! Reference source not found.: Error! Reference source not found..

1.1 Planning Your Project

Careful planning makes for a successful energy project. When considering this scope of work, you will have some decisions 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. It 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 Ramapo College of New Jersey – Mackin Hall. 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 July 12, 2023, TRC performed an energy audit at Mackin Hall located in Mahwah, New Jersey. TRC met with Eric to review the facility operations and help focus our investigation on specific energy-using systems.

Mackin Hall is a five-story, 62,400 square foot building built in 2000. Spaces include dormitories, restrooms, corridors, lounges, offices, storage room, and mechanical space.

2.2 Building Occupancy

The facility is occupied all week predominantly in the fall and spring seasons. The residential units are occupied after the university hours.

Building Name	Weekday/Weekend	Operating Schedule
Mackin Hall	Weekday	12:00 AM - 12:00 AM
	Weekend	12:00 AM - 12:00 AM

Figure 3 - Building Occupancy Schedule

2.3 Building Envelope

Building walls are concrete block over structural steel with a brick, glass, and stone facade. The roof is flat and covered with black membrane and in good condition.

Most of the windows are double pane and have aluminum frames. The glass-to-frame seals are in good condition. The operable window weather seals are in good condition. Exterior doors have aluminum frames and are in good condition.

Facade

Exterior Door

Windows

Roof

2.4 Lighting Systems

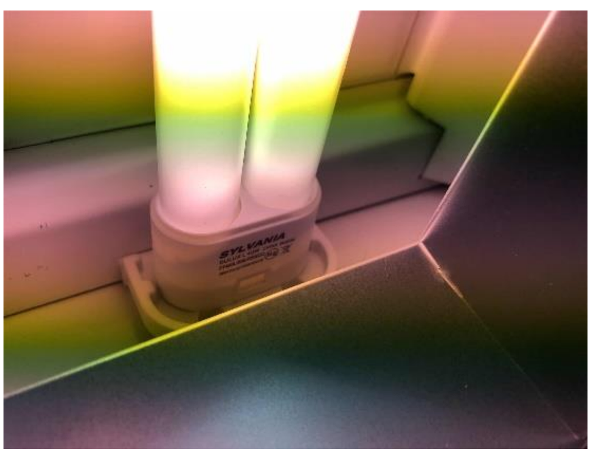
The primary interior lighting system uses 32-Watt linear fluorescent T8 and some 36-Watt T12 lamps. Fixture types include 1-lamp and 2- lamp, 2-foot, 3-foot, or 4-foot-long troffers and surface mounted fixtures. The lobby has a couple of 2-foot fixtures with U-bend tube lamps. Typically, T8 fluorescent lamps use electronic ballasts and T12 fluorescent lamps use magnetic ballasts.

Additionally, there are several 40-Watt and 42-Watt compact fluorescent lamps (CFL) for general purposes in the residential and restroom units.

All exit signs are 2-Watt LED units. The interior lighting is controlled using wall switches.

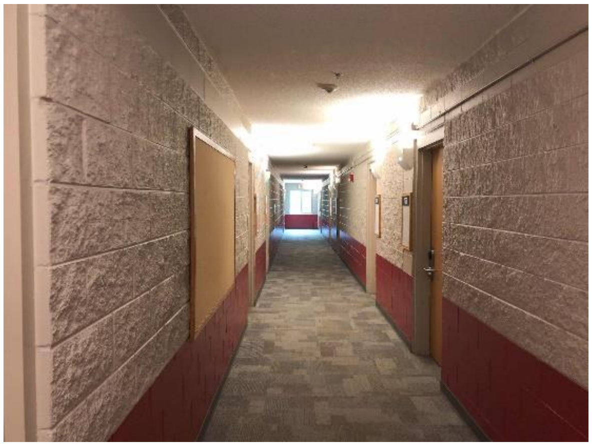
The fixtures are in good condition. Interior lighting levels were generally sufficient. The residential units are occupied sparsely; therefore, no occupancy sensors are being evaluated for these spaces.

The exterior lighting in the facility consists of 42-Watt plug in CFLs fixtures; 25-Watt LED corn bulb fixtures; wall mount LED fixtures; and 70-Watt to 250-Watt metal halide lamp fixtures. All the exterior lighting are controlled by a timeclock.



40-Watt CFL Fixtures

4-foot T8 Fixtures



Exterior Metal Halide Fixtures

CFL Fixtures

2.5 Air Handling Systems

Unit Ventilators

Unit ventilators are equipped with supply fan motors and pneumatically controlled outside air dampers and fan coil valves connected to the dual temperature water distribution system. They provide heating and cooling to the respective dorm rooms and some corridors. This system is original to the building and appears to be in fair operating condition.

Residential Fan Coil Unit – With Hot Water and Chilled Water Coils

Unitary Electric HVAC Equipment

The building has a Mitsubishi split AC unit of cooling capacity 2 tons. The unit has an EER of 10.3. The temperature control is provided using a programmable thermostat in the zone. This is beyond its useful life and has been evaluated for replacement.

Split AC Unit

Thermostat

Unitary Heating Equipment

All the restrooms in the building, lobby entrance, and some other smaller spaces are heated by electric resistance heaters. These vary in capacity between 1 kW to 2 kW. The units are in fair condition. Equipment is controlled by a manual dial thermostat within the units.

Security Office

Restroom Unit

Packaged Units

The building has two packaged units on the roof serving various sections of the building. The units both have DX cooling coils with a cooling capacity of 17.5 tons, and a gas fired furnace with an output of 203 MBh providing heating. These units also provide ventilation to the spaces and are equipped with economizers that are in fair condition.

The temperature control is provided using thermostats. The units are beyond their useful life and have been evaluated for replacement. Refer to Appendix A for detailed information about each unit.

Packaged Unit

Packaged Unit

2.6 Hydronic Systems

This building has a two-pipe hydronic system that can either provide heating in the winter or cooling in the summer. The system is switched seasonally between heating and cooling mode. Because the heating and cooling system share the same distribution piping, the entire building is switched between heating and cooling as a single system.

The distribution piping and pumping is referred to as the “dual temperature” system in the mechanical spaces.

2.7 Heating Hot Water Systems

There are four non-condensing hot water boilers serving the building’s heating load and domestic hot water needs. The boilers have an output capacity 320 MBH and an efficiency of 80 percent. The dual temperature circulation pumps to distribute hot water to the unit ventilators and domestic hot water uses.

The facility has a heat exchanger to recirculate the water to the dual temperature loop. The boilers are configured in automated lead-lag control scheme. Multiple boilers may be required under high load conditions. The boilers were installed in 2022 and are in good condition.

Non-condensing Hot Water Boilers

Dual Temperature Heat Exchanger

2.8 Chilled Water Systems

The building consists of a 100-ton, air-cooled screw Trane chiller providing cooling to the dorm rooms. The chilled water is circulated by two constant speed 7.5 hp pumps in the "dual temperature" system distributing the chilled water to the fan coil units.

The chiller was installed in 1999 and has been evaluated for a newer variable speed equipment based on the load profile of the building. The temperature control is provided using thermostats of the fan coil units in the respective zones.

Chiller

2.9 Plug Load and Vending Machines

You may wish to consider paying particular attention to minimizing your plug load usage. This report makes suggestions for ECMs in this area as well as energy efficient best practices.

There are 145 computer workstations throughout the facility. Each residential room has a laptop. Plug loads include general cafe equipment in the lounges and office and residential equipment in every dorm room.

There is one refrigerated beverage vending machine and one non-refrigerated vending machine. Vending machines are not equipped with occupancy-based controls.

Non-refrigerated Vending Machine

Refrigerated Vending Machine

2.10 Water-Using Systems

Every dorm room has a restroom. The faucet flow rates are at 1.6 gallons per minute (gpm) and showers are at 2.5 gpm. Toilets are rated at 1.6 gallons per flush (gpf).

2.11 On-Site Generation

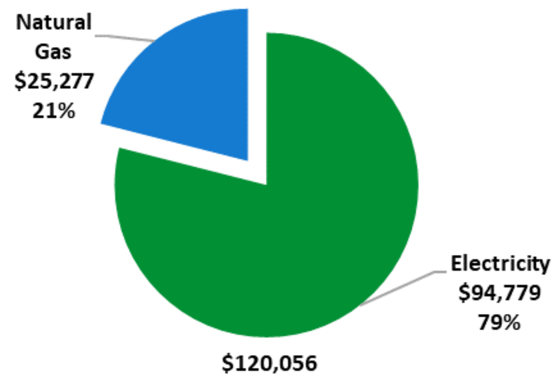
Mackin Hall has a 55-kW photovoltaic (PV) array with 210 panels. This system provides approximately 8 percent of the electricity used.

Solar PV

3 Energy 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	683,404 kWh	$94,779
Natural Gas	26,199 Therms	$25,277
Total		**$120,056**



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.

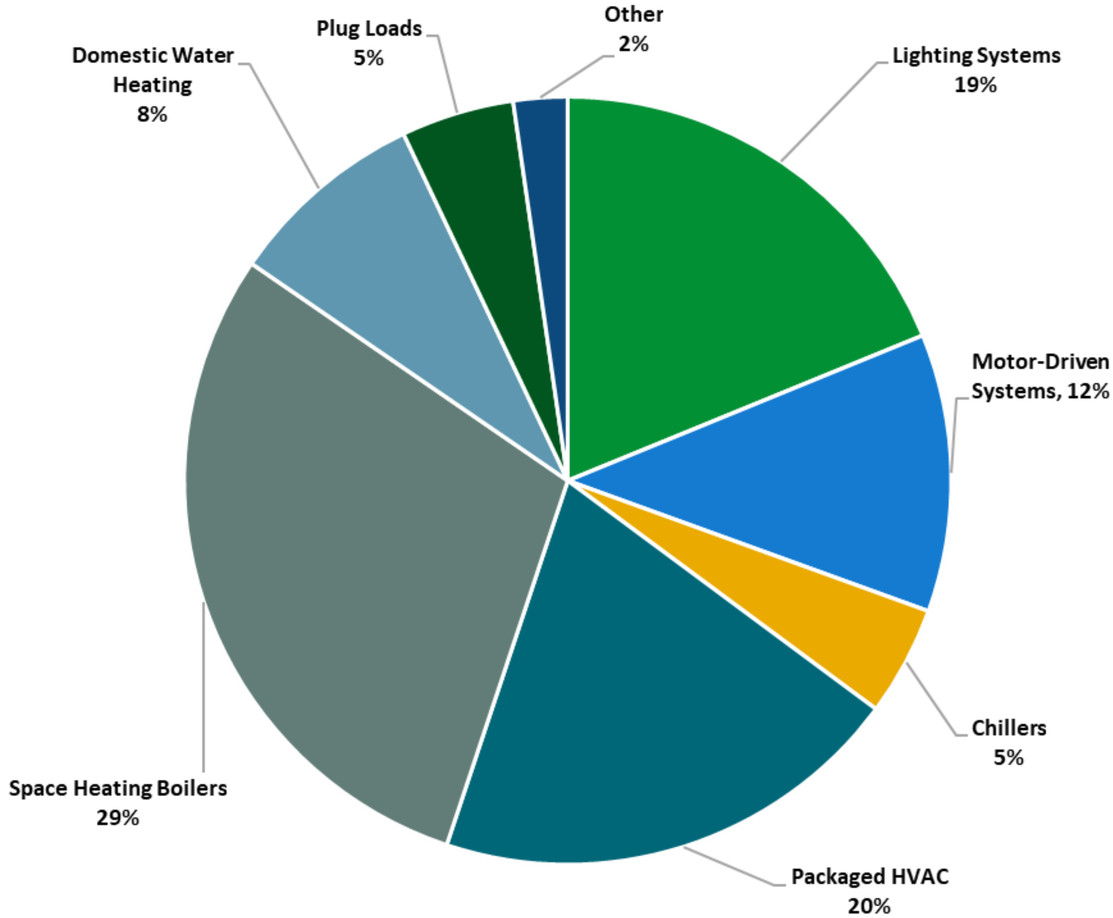
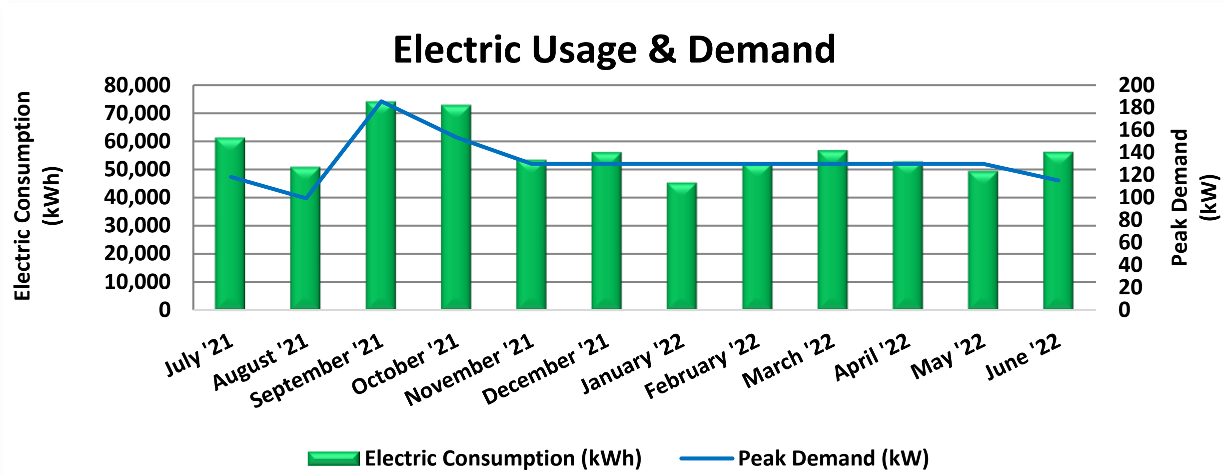


Figure 4 - Energy Balance

3.1 Electricity

Rockland Electric delivers electricity under rate class Electric Small C&I Gen Serv SEC-RE-DEL-PJM - Solar, with electric production provided by Direct Energy, a third-party supplier.



Electric Billing Data					
Period Ending	Days in Period	Electric Usage (kWh)	Demand (kW)	Demand Cost	Total Electric Cost
7/20/21	32	61,259	118	$706	$7,326
8/19/21	30	50,882	99	$590	$6,116
9/20/21	32	74,094	186	$1,114	$9,497
10/20/21	30	72,866	154	$823	$9,294
11/18/21	29	53,428	130	$653	$6,845
12/20/21	32	56,100	130	$653	$7,271
1/21/22	32	45,351	130	$780	$7,332
2/18/22	28	52,187	130	$878	$8,274
3/21/22	31	56,783	130	$878	$8,804
4/19/22	29	52,891	130	$878	$7,986
5/17/22	28	49,447	130	$878	$7,406
6/17/22	31	56,244	115	$859	$8,368
Totals	**364**	**681,532**	**186**	**$9,689**	**$94,519**
Annual	**365**	**683,404**	**186**	**$9,716**	**$94,779**

Notes:

- Peak demand of 186 kW occurred in September '21.
- Average demand over the past 12 months was 132 kW.
- Above billing data includes 52,412 kWh generated by the on-site solar PV system.
- The average electric cost over the past 12 months was $0.139/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.

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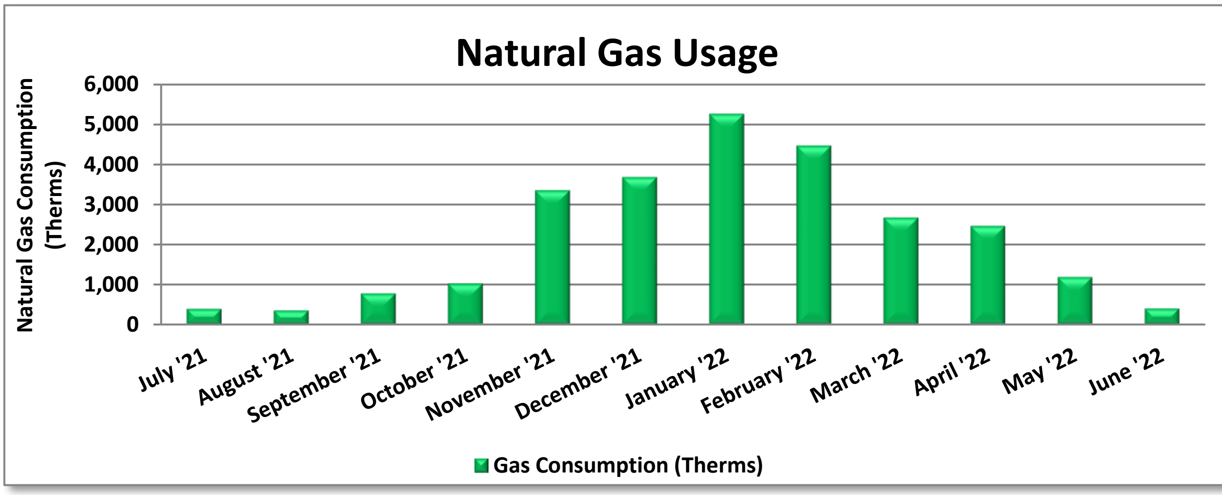
3.2 Natural Gas

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
8/2/21	31	398	$369
8/30/21	28	360	$347
9/28/21	29	786	$576
10/28/21	30	1,033	$760
11/30/21	33	3,348	$2,906
12/29/21	29	3,678	$3,171
1/28/22	30	5,255	$5,304
3/3/22	34	4,460	$4,696
3/31/22	28	2,675	$3,179
5/2/22	32	2,465	$2,218
5/31/22	29	1,190	$1,133
6/30/22	30	409	$480
Totals	**363**	**26,056**	**$25,139**
Annual	**365**	**26,199**	**$25,277**

Notes:

- The average gas cost for the past 12 months is $0.965/therm, which is the blended rate used throughout the analysis.

3.3 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	63

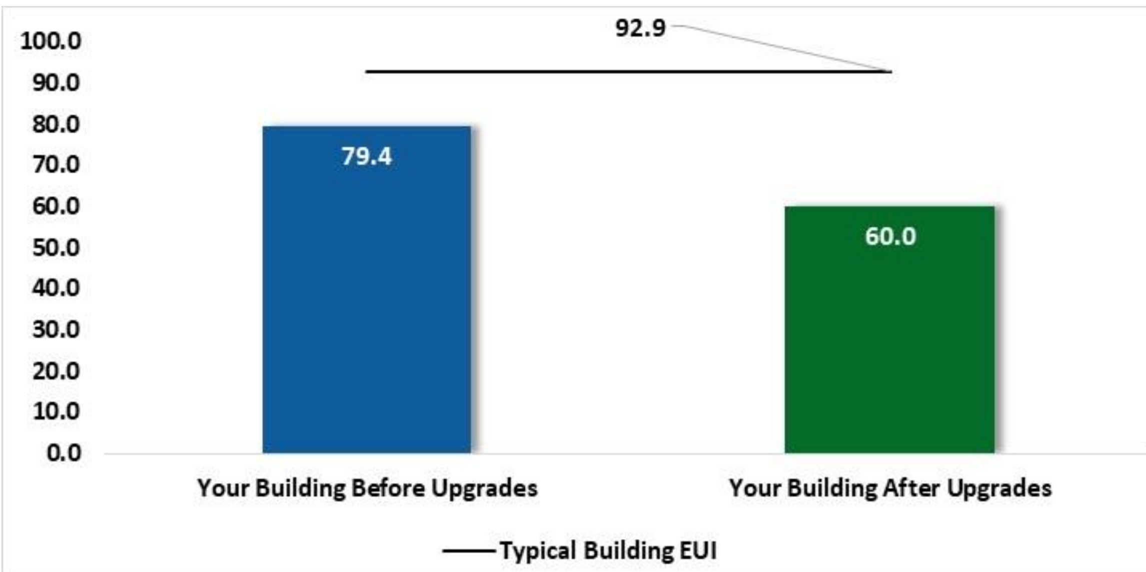


Figure 5 - Energy Use Intensity Comparison[3]

Congratulations, your building performs better than the national average. This report has suggestions about how to keep your building running efficiently, further improve performance, and lower your energy bills even more.

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.

[3] Based on all evaluated ECMs

Tracking Your Energy Performance

Keeping track of your energy use on a monthly basis is one of the best ways to keep energy costs in check. 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.

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			**147,799**	**33.7**	**-20**	**$20,307**	**$63,866**	**$9,643**	**$54,223**	**2.7**	**146,512**
ECM 1	Install LED Fixtures	Yes	54,435	0.0	0	$7,549	$14,954	$1,750	$13,204	1.7	54,815
ECM 2	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	Yes	27,188	12.6	-6	$3,715	$20,307	$2,010	$18,297	4.9	26,700
ECM 3	Retrofit Fixtures with LED Lamps	Yes	66,177	21.1	-14	$9,042	$28,605	$5,883	$22,722	2.5	64,997
Lighting Control Measures			**30,018**	**2.8**	**-5**	**$4,119**	**$14,324**	**$6,830**	**$7,494**	**1.8**	**29,698**
ECM 4	Install Occupancy Sensor Lighting Controls	Yes	2,027	1.0	0	$277	$3,974	$390	$3,584	12.9	1,991
ECM 5	Install Photocell Controls	Yes	8,751	0.0	0	$1,214	$1,800	$0	$1,800	1.5	8,812
ECM 6	Install High/Low Lighting Controls	Yes	19,239	1.8	-4	$2,629	$8,550	$6,440	$2,110	0.8	18,894
Variable Frequency Drive (VFD) Measures			**34,536**	**7.4**	**0**	**$4,790**	**$47,566**	**$4,000**	**$43,566**	**9.1**	**34,778**
ECM 7	Install VFDs on Constant Volume (CV) Fans	Yes	21,432	4.4	0	$2,972	$11,881	$2,000	$9,881	3.3	21,582
ECM 8	Install VFDs on Chilled Water Pumps	No	13,104	3.0	0	$1,817	$35,685	$2,000	$33,685	18.5	13,195
Unitary HVAC Measures			**8,613**	**7.3**	**7**	**$1,264**	**$51,427**	**$3,325**	**$48,102**	**38.0**	**9,519**
ECM 9	Install High Efficiency Air Conditioning Units	No	8,613	7.3	7	$1,264	$51,427	$3,325	$48,102	38.0	9,519
Electric Chiller Replacement			**11,717**	**0.0**	**0**	**$1,625**	**$126,034**	**$9,000**	**$117,034**	**72.0**	**11,799**
ECM 10	Install High Efficiency Chillers	No	11,717	0.0	0	$1,625	$126,034	$9,000	$117,034	72.0	11,799
HVAC System Improvements			**1,225**	**0.0**	**38**	**$534**	**$2,719**	**$0**	**$2,719**	**5.1**	**5,655**
ECM 11	Implement Demand Control Ventilation (DCV)	Yes	1,225	0.0	38	$534	$2,719	$0	$2,719	5.1	5,655
Domestic Water Heating Upgrade			**0**	**0.0**	**101**	**$975**	**$11,520**	**$1,935**	**$9,585**	**9.8**	**11,836**
ECM 12	Install Low-Flow DHW Devices	Yes	0	0.0	101	$975	$11,520	$1,935	$9,585	9.8	11,836
Food Service & Refrigeration Measures			**1,954**	**0.2**	**0**	**$271**	**$460**	**$50**	**$410**	**1.5**	**1,968**
ECM 13	Vending Machine Control	Yes	1,954	0.2	0	$271	$460	$50	$410	1.5	1,968
Custom Measures			**-38,771**	**0.0**	**413**	**-$1,392**	**$3,950**	**$0**	**$3,950**	**-2.8**	**9,315**
ECM 14	Replace Gas Fired Water Heater with Heat Pump Water Heater	No	-38,771	0.0	413	-$1,392	$3,950	$0	$3,950	-2.8	9,315
TOTALS			**197,092**	**51.4**	**535**	**$32,493**	**$321,865**	**$34,783**	**$287,082**	**8.8**	**261,080**

* - 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).

Figure 6 – 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		**147,799**	**33.7**	**-20**	**$20,307**	**$63,866**	**$9,643**	**$54,223**	**2.7**	**146,512**
ECM 1	Install LED Fixtures	54,435	0.0	0	$7,549	$14,954	$1,750	$13,204	1.7	54,815
ECM 2	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	27,188	12.6	-6	$3,715	$20,307	$2,010	$18,297	4.9	26,700
ECM 3	Retrofit Fixtures with LED Lamps	66,177	21.1	-14	$9,042	$28,605	$5,883	$22,722	2.5	64,997
Lighting Control Measures		**30,018**	**2.8**	**-5**	**$4,119**	**$14,324**	**$6,830**	**$7,494**	**1.8**	**29,698**
ECM 4	Install Occupancy Sensor Lighting Controls	2,027	1.0	0	$277	$3,974	$390	$3,584	12.9	1,991
ECM 5	Install Photocell Controls	8,751	0.0	0	$1,214	$1,800	$0	$1,800	1.5	8,812
ECM 6	Install High/Low Lighting Controls	19,239	1.8	-4	$2,629	$8,550	$6,440	$2,110	0.8	18,894
Variable Frequency Drive (VFD) Measures		**21,432**	**4.4**	**0**	**$2,972**	**$11,881**	**$2,000**	**$9,881**	**3.3**	**21,582**
ECM 7	Install VFDs on Constant Volume (CV) Fans	21,432	4.4	0	$2,972	$11,881	$2,000	$9,881	3.3	21,582
HVAC System Improvements		**1,225**	**0.0**	**38**	**$534**	**$2,719**	**$0**	**$2,719**	**5.1**	**5,655**
ECM 11	Implement Demand Control Ventilation (DCV)	1,225	0.0	38	$534	$2,719	$0	$2,719	5.1	5,655
Domestic Water Heating Upgrade		**0**	**0.0**	**101**	**$975**	**$11,520**	**$1,935**	**$9,585**	**9.8**	**11,836**
ECM 12	Install Low-Flow DHW Devices	0	0.0	101	$975	$11,520	$1,935	$9,585	9.8	11,836
Food Service & Refrigeration Measures		**1,954**	**0.2**	**0**	**$271**	**$460**	**$50**	**$410**	**1.5**	**1,968**
ECM 13	Vending Machine Control	1,954	0.2	0	$271	$460	$50	$410	1.5	1,968
TOTALS		**202,429**	**41.1**	**115**	**$29,179**	**$104,769**	**$20,458**	**$84,311**	**2.9**	**217,251**

* - 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).

Figure 7 – 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		**147,799**	**33.7**	**-20**	**$20,307**	**$63,866**	**$9,643**	**$54,223**	**2.7**	**146,512**
ECM 1	Install LED Fixtures	54,435	0.0	0	$7,549	$14,954	$1,750	$13,204	1.7	54,815
ECM 2	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	27,188	12.6	-6	$3,715	$20,307	$2,010	$18,297	4.9	26,700
ECM 3	Retrofit Fixtures with LED Lamps	66,177	21.1	-14	$9,042	$28,605	$5,883	$22,722	2.5	64,997

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

Replace existing fixtures containing HID, fluorescent, or incandescent 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: exterior fixtures

ECM 2: Retrofit Fluorescent Fixtures with LED Lamps and Drivers

Retrofit fluorescent fixtures by removing the fluorescent tubes and ballasts and replacing them with LED tubes and LED drivers (if necessary), which are designed to be used in retrofitted fluorescent fixtures.

The measure uses the existing fixture housing but replaces the electric components with more efficient lighting technology, which use less power than other lighting technologies but provides equivalent lighting output. Maintenance savings may also be achieved since LED tubes last longer than fluorescent tubes and, therefore, do not need to be replaced as often.

Affected Building Areas: all areas with fluorescent fixtures with T12 tubes

ECM 3: Retrofit Fixtures with LED Lamps

Replace fluorescent, HID, 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

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		**30,018**	**2.8**	**-5**	**$4,119**	**$14,324**	**$6,830**	**$7,494**	**1.8**	**29,698**
ECM 4	Install Occupancy Sensor Lighting Controls	2,027	1.0	0	$277	$3,974	$390	$3,584	12.9	1,991
ECM 5	Install Photocell Controls	8,751	0.0	0	$1,214	$1,800	$0	$1,800	1.5	8,812
ECM 6	Install High/Low Lighting Controls	19,239	1.8	-4	$2,629	$8,550	$6,440	$2,110	0.8	18,894

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 4: 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 and lounges

ECM 5: Install Photocell Controls

Install photocells to eliminate exterior lighting use during daytime periods.

Photocells or photocell sensors are lighting controls used for dusk to dawn applications to automatically turn the fixtures on or off. Photo controls detect the amount of light outside and once the light level reaches a low point, the fixture will switch on. During the day, the photocell will detect higher amounts of light and will turn the fixture off.

Photocells may be fixture mounted or wired externally and connected by line voltage to a single light fixture or to a series of fixtures.

This measure reduces energy use in exterior areas to restrict operation to non-daylight periods.

Affected Building Areas: exterior fixtures

ECM 6: 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

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		**34,536**	**7.4**	**0**	**$4,790**	**$47,566**	**$4,000**	**$43,566**	**9.1**	**34,778**
ECM 7	Install VFDs on Constant Volume (CV) Fans	21,432	4.4	0	$2,972	$11,881	$2,000	$9,881	3.3	21,582
ECM 8	Install VFDs on Chilled Water Pumps	13,104	3.0	0	$1,817	$35,685	$2,000	$33,685	18.5	13,195

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 7: 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.

For air handlers with direct expansion (DX) cooling systems, the minimum air flow across the cooling coil required to prevent the coil from freezing must be determined during the final project design. The control system programming should maintain the minimum air flow whenever the compressor is operating. Prior to implementation, verify minimum fan speed in cooling mode with the manufacturer. Note that savings will vary depending on the operating characteristics of each AHU.

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

Affected Air Handlers: supply fans for packaged units

ECM 8: Install VFDs on Chilled Water Pumps

Install VFDs to control chilled water pumps. Two-way valves must serve the chilled water coils being served and the chilled water loop must have a differential pressure sensor installed. If three-way valves or a bypass leg are used in the chilled water distribution, they will need to be modified when this measure is implemented. As the chilled water valves close, the differential pressure increases, and the VFD modulates the pump speed to maintain a differential pressure setpoint.

For systems with variable chilled water flow through the chiller, the minimum flow to prevent the chiller from tripping off will need to be determined during the final project design. The control system should be programmed to maintain the minimum flow through the chiller and to prevent pump cavitation.

Energy savings result from reducing the pump motor speed (and power) as chilled water valves close. The magnitude of energy savings is based on the estimated amount of time that the system operates at reduced loads.

Affected Pumps: two chilled water pumps ("dual temperature" pumps)

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		**8,613**	**7.3**	**7**	**$1,264**	**$51,427**	**$3,325**	**$48,102**	**38.0**	**9,519**
ECM 9	Install High Efficiency Air Conditioning Units	8,613	7.3	7	$1,264	$51,427	$3,325	$48,102	38.0	9,519

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 split AC unit and the packaged unit is eventually replaced, consider purchasing equipment that exceeds the minimum efficiency required by building codes.

ECM 9: Install High Efficiency Air Conditioning Units

Replace standard efficiency packaged air conditioning units with high efficiency packaged air conditioning units. The replacement of the packaged units will incorporate efficient gas furnaces. 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: packaged units and the 2-ton split AC unit

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		**11,717**	**0.0**	**0**	**$1,625**	**$126,034**	**$9,000**	**$117,034**	**72.0**	**11,799**
ECM 10	Install High Efficiency Chillers	11,717	0.0	0	$1,625	$126,034	$9,000	$117,034	72.0	11,799

ECM 10: Install High Efficiency Chillers

Replace 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 exceeds the minimum efficiency required by building codes.

4.6 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		**1,225**	**0.0**	**38**	**$534**	**$2,719**	**$0**	**$2,719**	**5.1**	**5,655**
ECM 11	Implement Demand Control Ventilation (DCV)	1,225	0.0	38	$534	$2,719	$0	$2,719	5.1	5,655

ECM 11: Implement Demand Control Ventilation (DCV)

Demand control ventilation (DCV) is a control strategy that monitors the indoor air's carbon dioxide (CO_2) 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: residential units

4.7 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		**0**	**0.0**	**101**	**$975**	**$11,520**	**$1,935**	**$9,585**	**9.8**	**11,836**
ECM 12	Install Low-Flow DHW Devices	0	0.0	101	$975	$11,520	$1,935	$9,585	9.8	11,836

ECM 12: 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.

Additional cost savings may result from reduced water usage.

4.8 Food Service & 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		**1,954**	**0.2**	**0**	**$271**	**$460**	**$50**	**$410**	**1.5**	**1,968**
ECM 13	Vending Machine Control	1,954	0.2	0	$271	$460	$50	$410	1.5	1,968

ECM 13: Vending Machine Control

Vending machines operate continuously, even during unoccupied hours. Install occupancy sensor controls to reduce energy use. These controls power down vending machines when the vending machine area has been vacant for some time, and then power up the machines at necessary regular intervals or when the surrounding area is occupied. Energy savings are dependent on the vending machine and activity level in the area surrounding the machines.

#	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		**-38,771**	**0.0**	**413**	**-$1,392**	**$3,950**	**$0**	**$3,950**	**-2.8**	**9,315**
ECM 14	Replace Gas Fired Water Heater with Heat Pump Water Heater	-38,771	0.0	413	-$1,392	$3,950	$0	$3,950	-2.8	9,315

ECM 14: Replace Gas Fired Water Heater with Heat Pump Water Heater

A gas fired water heater uses a burner to heat water. Air source heat pump water heaters (HPWH) 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.

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.*[4]

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

HPWH reject cold air. As such, they need to be installed in an unconditioned space of about 750 cubic feet with good ventilation[5]. 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 in order 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.

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 [6]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.

4.10 Measures for Future Consideration

There are additional opportunities for improvement that Ramapo College of New Jersey 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.

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

[6] 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.

Ramapo College of New Jersey 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.

Disaggregate Boiler System

A major consumer of energy in this building is the heating mechanical equipment. Due to the boiler plant serving the domestic water and space heating needs of the facility, a boiler must operate year-round at light load conditions, which results in an overall poor cycle efficiency. A potential solution includes the installation of a dedicated domestic hot water heater which would operate to meet the domestic water needs during the summer months, eliminating the need for the heating boiler during this period.

This action will increase the efficiency of the boiler plant operation and significantly reduce fuel consumption. We recommend that an HVAC contractor who specializes in boiler systems be contacted for a detailed evaluation and implementation costs.

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[7]. 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.

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

Lighting Controls

As part of a lighting maintenance schedule, test lighting controls to ensure proper functioning. For occupancy sensors, this requires triggering the sensor and verifying that the sensor's timer settings are correct. For daylight and photocell sensors, maintenance involves cleaning sensor lenses and confirming that setpoints and sensitivity are configured properly. Adjust exterior lighting time clock controls seasonally as needed to match your lighting requirements.

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.

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.

Ductwork Maintenance

Duct maintenance has two primary goals: keep the ducts clean to avoid air quality problems and seal leaks to save energy. Check for cleanliness, obstructions that block airflow, water damage, and leaks. Ducts should be inspected at least every two years.

The biggest symptoms of clogged air ducts are differing temperatures throughout the building and areas with limited airflow from supply registers. If a particular air duct is clogged, then air flow will only be cut off to some rooms in the building—not all of them. The reduced airflow will make it more difficult for those areas to reach the temperature setpoint, which will cause the HVAC system to run longer to cool or heat that area properly. If you suspect clogged air ducts, ensure that all areas in front of supply registers are clear of items that may block or restrict air flow, and you should check for fire dampers or balancing dampers that have failed closed.

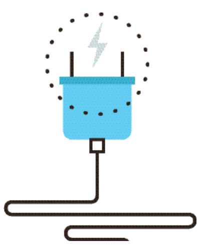
Duct leakage in commercial buildings can account for 5%–25% of the supply airflow. In the case of rooftop air handlers, duct leakage can occur to the outside of the building wasting conditioned air. Check ductwork for leakage. Eliminating duct leaks can improve ventilation system performance and reduce heating and cooling system operation.

Distribution system losses are dependent on-air system temperature, the size of the distribution system, and the level of insulation of the ductwork. Significant energy savings can be achieved when insulation has not been well maintained. When the insulation is missing or worn, the system efficiency can be significantly reduced. This measure saves energy by reducing heat transfer in the distribution system.

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.

Plug Load Controls



Reducing plug loads is a common way to decrease your electrical use. Limiting the energy use of plug loads can include increasing occupant awareness, removing under-used equipment, installing hardware controls, and using software controls. Consider enabling the most aggressive power settings on existing devices or install load sensing or occupancy sensing (advanced) power strips[8]. Your local utility may offer incentives or rebates for this equipment.

Water Conservation

Installing dual flush or low-flow toilets and low-flow/waterless urinals are ways to reduce water use. The EPA WaterSense® ratings for urinals is 0.5 gallons per flush (gpf) and for flush valve toilets is 1.28 gpf (this is lower than the current 1.6 gpf federal standard).

[8] For additional information refer to "Assessing and Reducing Plug and Process Loads in Office Buildings" http://www.nrel.gov/docs/fy13osti/54175.pdf, or "Plug Load Best Practices Guide" http://www.advancedbuildings.net/plug-load-best-practices-guide-offices.

For more information regarding water conservation go to the EPA's WaterSense website[9] or download a copy of EPA's "WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities"[10] to get ideas for creating a water management plan and best practices for a wide range of water using systems.

Water conservation devices that do not reduce hot water consumption will not provide energy savings at the site level, but they may significantly affect your water and sewer usage costs. Any reduction in water use does however ultimately reduce grid-level electricity use since a significant amount of electricity is used to deliver water from reservoirs to end users.

If the facility has detached buildings with a master water meter for the entire campus, check for unnatural wet areas in the lawn or water seeping in the foundation at water pipe penetrations through the foundation. Periodically check overnight meter readings when the facility is unoccupied, and there is no other scheduled water usage.

Manage irrigation systems to use water more effectively outside the building. Adjust spray patterns so that water lands on intended lawns and plantings and not on pavement and walls. Consider installing an evapotranspiration irrigation controller that will prevent over-watering.

Procurement Strategies

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

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

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

6 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.

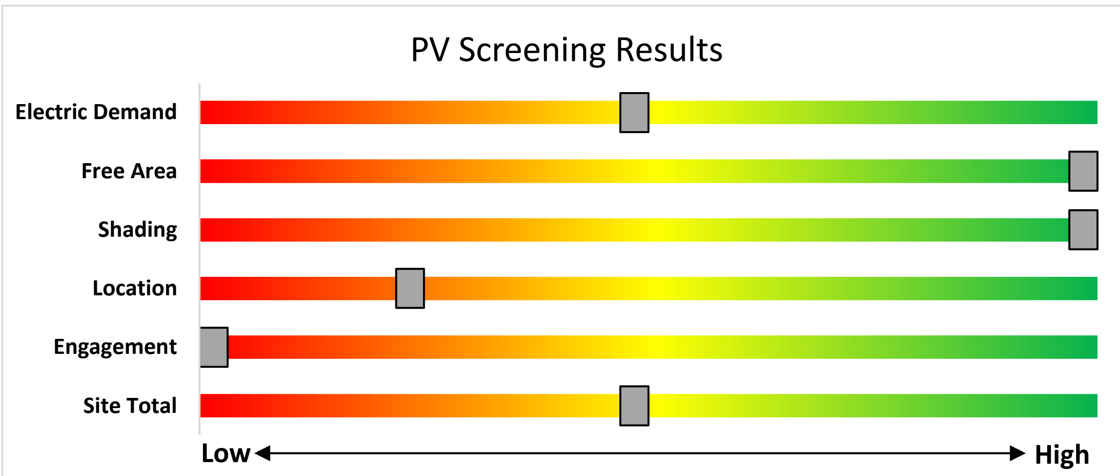
6.1 Solar Photovoltaic

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 medium potential for installing a PV array.

The amount of free area, ease of installation (location), and the lack of shading elements contribute to the medium potential. A PV array located in the parking lot 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	Medium	
System Potential	132	kW DC STC
Electric Generation	157,261	kWh/yr
Displaced Cost	$21,810	/yr
Installed Cost	$446,200	

Figure 8 - 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**: www.njcleanenergy.com/whysolar
- **NJ Solar Market FAQs**: www.njcleanenergy.com/renewable-energy/program-updates-and-background-information/solar-transition/solar-market-faqs.
- **Approved Solar Installers in the NJ Market**: www.njcleanenergy.com/commercial-industrial/programs/nj-smartstart-buildings/tools-and-resources/tradeally/approved_vendorsearch/?id=60&start=1

6.2 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. 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.

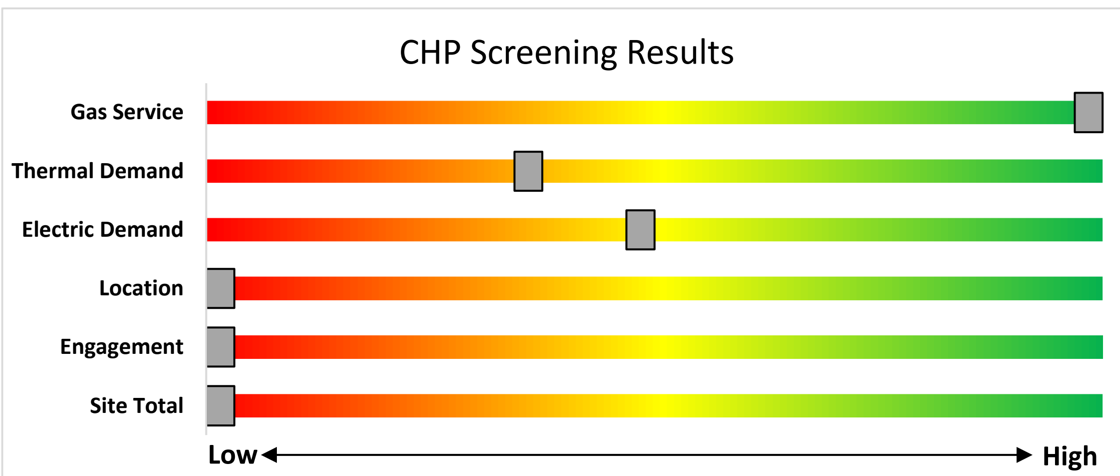


Figure 9 - Combined Heat and Power Screening

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/

7 Electric Vehicles (EV)

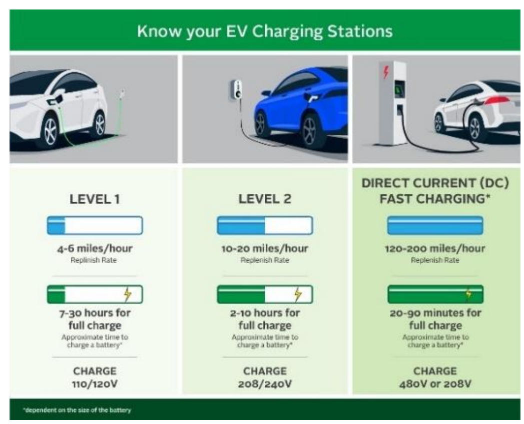
All electric vehicles (EVs) have an electric motor instead of an internal combustion engine. EVs function by plugging into a charge point, taking electricity from the grid, and then storing it in rechargeable batteries. Although electricity production may contribute to air pollution, the U.S. EPA categorizes 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.

7.1 Electric Vehicle 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.

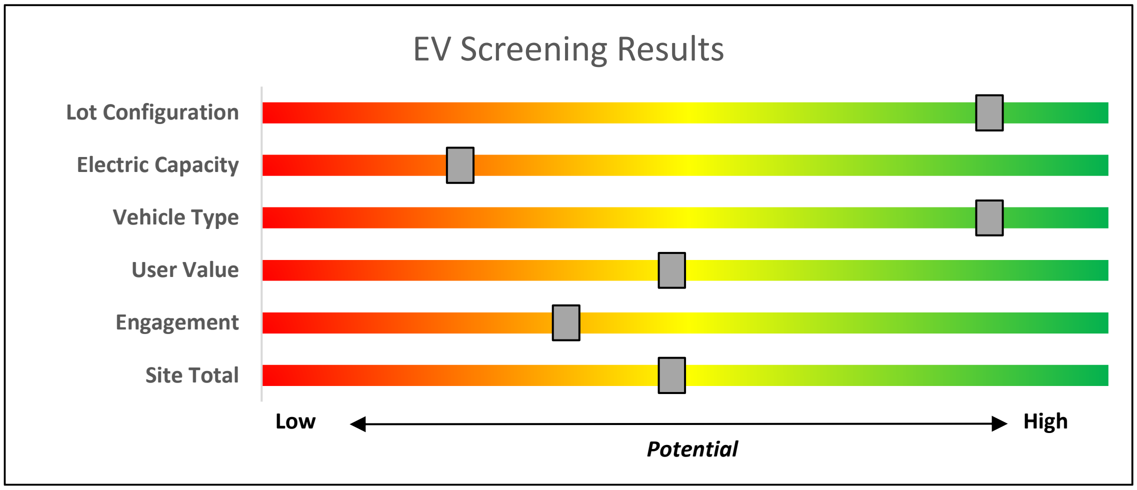


Figure 10 – EV Charger Screening

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) or Public Service Electric & Gas Company (PSE&G), 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 or PSE&G, up to 90% of the combined charger purchase and installation costs. Please check ACE or PSE&G program eligibility requirements before purchasing EV charging equipment, as additional conditions on types of eligible chargers may apply for utility incentives.

Both Jersey Central Power & Light (JCP&L) and Rockland Electric (RECO) have filed proposals for EV charging programs. BPU staff is currently reviewing those proposals.

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

8 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.

8.1 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.

8.2 New Jersey's Clean Energy Programs

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 that annually contribute at least $200,000 to the NJCEP aggregate of all buildings/sites. This equates to roughly $5 million in 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 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

Eligible Technologies	Size (Installed Rated Capacity)[1]	Incentive ($/kW)	% of Total Cost Cap per Project[3]	$ Cap per Project[3]
Powered by non-renewable or renewable fuel source[4]	≤500 kW	$2,000	30-40%[2]	$2 million
Gas Internal Combustion Engine	>500 kW - 1 MW	$1,000		
Gas Combustion Turbine	> 1 MW - 3 MW	$550	30%	$3 million
Microturbine	>3 MW	$350		
Fuel Cells with Heat Recovery				
Waste Heat to Power*	<1 MW	$1,000	30%	$2 million
	> 1MW	$500		$3 million

*Waste Heat to Power: Powered by non-renewable fuel source, heat recovery or other mechanical recovery from existing equipment utilizing new electric generation equipment (e.g. steam turbine).

Check the NJCEP website for details on program availability, current incentive levels, and requirements.

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 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 Program

The Competitive Solar Incentive (CSI) Program will provide competitively set incentives for grid supply projects and net metered non-residential projects greater than 5MW (dc). The program is currently under development. For updates, please continue to check the Solar Proceedings page on the New Jersey's Clean Energy Program website.

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 photovoltaics 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 into 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.

9 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.

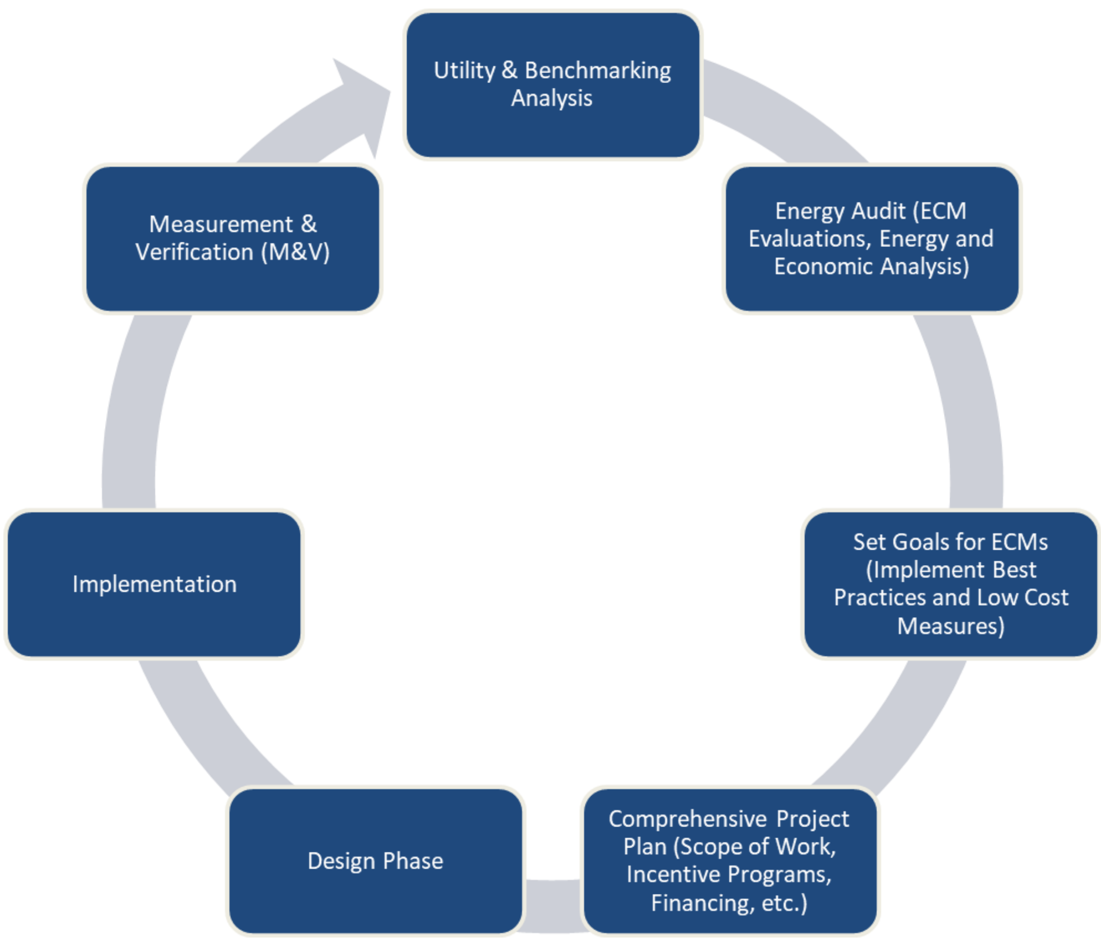


Figure 11 – Project Development Cycle

10 Energy Purchasing and Procurement Strategies

10.1 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[11].

10.2 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[12].

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

[12] 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
Corridor 2	4	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	None	S	42	8,760	3, 6	Relamp	Yes	4	LED Lamps: PL-L (Biax) Lamps	High/Low Control	30	6,044	0.1	806	0	$110	$279	$144	1.2
Corridor 2	2	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	None	S	42	8,760	3, 6	Relamp	Yes	2	LED Lamps: PL-L (Biax) Lamps	High/Low Control	30	6,044	0.0	403	0	$55	$252	$72	3.3
Corridor 2	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
Corridor 2	8	LED - Fixtures: Ambient 2x2 Fixture	None	S	35	8,760	6	None	Yes	8	LED - Fixtures: Ambient 2x2 Fixture	High/Low Control	35	6,044	0.1	821	0	$112	$450	$280	1.5
Electrical Room 2	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.0	63	0	$9	$37	$10	3.1
Elevator 1	2	LED - Fixtures: Ambient 1x4 Fixture	Wall Switch	S	30	8,760		None	No	2	LED - Fixtures: Ambient 1x4 Fixture	Wall Switch	30	8,760	0.0	0	0	$0	$0	$0	0.0
Exterior 2	3	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	None		42	8,760	3, 5	Relamp	Yes	3	LED Lamps: PL-L (Biax) Lamps	Photocell	30	4,380	0.0	710	0	$98	$241	$3	2.4
Exterior 2	1	Metal Halide: (1) 150W Lamp	None		190	8,760	1, 5	Fixture Replacement	Yes	1	LED - Fixtures: Outdoor Wall-Mounted Area Fixture	Photocell	45	4,380	0.0	1,467	0	$203	$546	$50	2.4
Exterior 2	4	Metal Halide: (1) 175W Lamp	Photocell		215	4,380	1	Fixture Replacement	No	4	LED - Fixtures: Outdoor Wall-Mounted Area Fixture	Photocell	53	4,380	0.0	2,838	0	$394	$1,538	$200	3.4
Exterior 2	3	Metal Halide: (1) 175W Lamp	Photocell		215	4,380	1	Fixture Replacement	No	3	LED - Fixtures: Outdoor Wall-Mounted Area Fixture	Photocell	53	4,380	0.0	2,129	0	$295	$1,154	$150	3.4
Exterior 2	24	Metal Halide: (1) 250W Lamp	None		295	8,760	1, 5	Fixture Replacement	Yes	24	LED - Fixtures: Outdoor Wall-Mounted Area Fixture	Photocell	75	4,380	0.0	54,137	0	$7,508	$12,498	$1,200	1.5
Exterior 2	3	Metal Halide: (1) 70W Lamp	None		95	8,760	1, 5	Fixture Replacement	Yes	3	LED - Fixtures: Outdoor Wall-Mounted Area Fixture	Photocell	21	4,380	0.0	2,221	0	$308	$818	$150	2.2
Lobby 1	2	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	None	S	42	4,380	3, 6	Relamp	Yes	2	LED Lamps: PL-L (Biax) Lamps	High/Low Control	30	3,022	0.0	202	0	$28	$252	$72	6.5
Lounge 5	6	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	Wall Switch	S	80	1,764	3, 4	Relamp	Yes	6	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	56	1,217	0.2	473	0	$65	$432	$47	6.0
Mechanical 1	5	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	880	3, 4	Relamp	Yes	5	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	607	0.2	200	0	$27	$453	$85	13.5
Office - Director	1	LED Lamps: (1) 9W A19 Screw-In Lamp	Wall Switch	S	9	1,764		None	No	1	LED Lamps: (1) 9W A19 Screw-In Lamp	Wall Switch	9	1,764	0.0	0	0	$0	$0	$0	0.0
Office - Director	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3, 4	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,217	0.1	240	0	$33	$380	$65	9.6
Office - Mail Rm	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3, 4	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,217	0.1	160	0	$22	$189	$40	6.8
Office - Security	2	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3, 4	Relamp	Yes	2	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	30	1,217	0.0	81	0	$11	$143	$22	10.9
Restroom - Unisex 3	2	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3, 4	Relamp	Yes	2	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	30	1,217	0.0	81	0	$11	$143	$2	12.7
Storage 1	6	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,320	3, 4	Relamp	Yes	6	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	911	0.2	359	0	$49	$489	$60	8.7
Storage 2	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,320	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,320	0.0	47	0	$6	$37	$10	4.1
Storage Laundry Rm	7	Linear Fluorescent - T8: 4' T8 (32W) - 2L	None	S	62	1,320	3, 4	Relamp	Yes	7	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	911	0.3	419	0	$57	$526	$70	8.0
Storage Trash Rm	3	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,320	3, 4	Relamp	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	911	0.1	180	0	$25	$380	$30	14.2
Storage Trash Rm	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,320	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,320	0.0	47	0	$6	$37	$10	4.1

	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
Lounge 4	6	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	Wall Switch	S	80	1,764	3, 4	Relamp	Yes	6	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	56	1,217	0.2	473	0	$65	$432	$47	6.0
Corridor 1	8	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	None	S	80	8,760	3, 6	Relamp	Yes	8	LED Lamps: PL-L (Biax) Lamps	High/Low Control	56	6,044	0.3	3,130	-1	$428	$666	$296	0.9
Corridor 1	29	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	None	S	42	8,760	3, 6	Relamp	Yes	29	LED Lamps: PL-L (Biax) Lamps	High/Low Control	30	6,044	0.5	5,844	-1	$798	$1,517	$1,044	0.6
Corridor 1	4	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	4	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Electrical Room 1	1	Linear Fluorescent - T8: 3' T8 (25W) - 2L	Wall Switch	S	48	880	3	Relamp	No	1	LED - Linear Tubes: (2) 3' Lamps	Wall Switch	21	880	0.0	26	0	$4	$37	$10	7.6
Janitorial 1	1	Linear Fluorescent - T8: 3' T8 (25W) - 2L	Wall Switch	S	48	880	3	Relamp	No	1	LED - Linear Tubes: (2) 3' Lamps	Wall Switch	21	880	0.0	26	0	$4	$37	$10	7.6
Lounge 1	6	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	Wall Switch	S	80	1,764	3, 4	Relamp	Yes	6	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	56	1,217	0.2	473	0	$65	$432	$47	6.0
Residential 314	1	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	1	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.0	23	0	$3	$14	$1	4.0
Residential 314	1	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	1	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.0	23	0	$3	$14	$1	4.0
Residential 314	3	Linear Fluorescent - T12: 3' T12 (30W) - 1L	None	S	46	1,764	2	Relamp & Reballast	No	3	LED - Linear Tubes: (1) 3' Lamp	None	11	1,764	0.1	203	0	$28	$152	$15	4.9
Residential 314	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.0	63	0	$9	$37	$10	3.1
Residential 314	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.0	63	0	$9	$37	$10	3.1
Restroom - Residence 314	1	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	S	33	1,764	3	Relamp	No	1	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	1,764	0.0	30	0	$4	$33	$6	6.4
Restroom - Residence 314	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.0	63	0	$9	$37	$10	3.1
Restroom - Unisex	2	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3, 4	Relamp	Yes	2	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	30	1,217	0.0	81	0	$11	$143	$2	12.7
Server Room 1	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.0	63	0	$9	$37	$10	3.1
Lounge 3	6	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	Wall Switch	S	80	1,764	3, 4	Relamp	Yes	6	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	56	1,217	0.2	473	0	$65	$432	$47	6.0
Corridor 3	8	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	None	S	80	8,760	3, 6	Relamp	Yes	8	LED Lamps: PL-L (Biax) Lamps	High/Low Control	56	6,044	0.3	3,130	-1	$428	$666	$296	0.9
Corridor 3	2	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	None	S	42	8,760	3, 6	Relamp	Yes	2	LED Lamps: PL-L (Biax) Lamps	High/Low Control	30	6,044	0.0	403	0	$55	$252	$72	3.3
Corridor 3	4	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	4	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Lounge 2	6	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	Wall Switch	S	80	1,764	3, 4	Relamp	Yes	6	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	56	1,217	0.2	473	0	$65	$432	$47	6.0
Stairs 1	5	Linear Fluorescent - T8: 4' T8 (32W) - 2L	None		62	8,760	3, 6	Relamp	Yes	5	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	6,044	0.2	1,986	0	$271	$408	$225	0.7
Stairs 2	5	Linear Fluorescent - T8: 4' T8 (32W) - 2L	None		62	8,760	3, 6	Relamp	Yes	5	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	6,044	0.2	1,986	0	$271	$408	$225	0.7
Residential - Third floor	26	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	26	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.3	594	0	$81	$351	$26	4.0
Residential - Third floor	26	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	26	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.3	594	0	$81	$351	$26	4.0

	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
Residential - Third floor	78	Linear Fluorescent - T12: 3' T12 (30W) - 1L	None	S	46	1,764	2	Relamp & Reballast	No	78	LED - Linear Tubes: (1) 3' Lamp	None	11	1,764	2.4	5,275	-1	$721	$3,940	$390	4.9
Residential - Third floor	26	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	26	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,635	0	$223	$949	$260	3.1
Residential - Third floor	26	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	26	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,635	0	$223	$949	$260	3.1
Residential - Third floor	26	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	S	33	1,764	3	Relamp	No	26	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	1,764	0.4	793	0	$108	$845	$156	6.4
Residential - Third floor	26	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	26	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,635	0	$223	$949	$260	3.1
Residential - First floor	26	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	26	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.3	594	0	$81	$351	$26	4.0
Residential - First floor	26	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	26	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.3	594	0	$81	$351	$26	4.0
Residential - First floor	78	Linear Fluorescent - T12: 3' T12 (30W) - 1L	None	S	46	1,764	2	Relamp & Reballast	No	78	LED - Linear Tubes: (1) 3' Lamp	None	11	1,764	2.4	5,275	-1	$721	$3,940	$390	4.9
Residential - First floor	26	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	26	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,635	0	$223	$949	$260	3.1
Residential - First floor	26	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	26	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,635	0	$223	$949	$260	3.1
Residential - First floor	26	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	S	33	1,764	3	Relamp	No	26	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	1,764	0.4	793	0	$108	$845	$156	6.4
Residential - First floor	26	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	26	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,635	0	$223	$949	$260	3.1
Residential - Fifth floor	27	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	27	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.3	617	0	$84	$365	$27	4.0
Residential - Fifth floor	27	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	27	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.3	617	0	$84	$365	$27	4.0
Residential - Fifth floor	81	Linear Fluorescent - T12: 3' T12 (30W) - 1L	None	S	46	1,764	2	Relamp & Reballast	No	81	LED - Linear Tubes: (1) 3' Lamp	None	11	1,764	2.5	5,478	-1	$748	$4,092	$405	4.9
Residential - Fifth floor	27	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,697	0	$232	$986	$270	3.1
Residential - Fifth floor	27	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,697	0	$232	$986	$270	3.1
Residential - Fifth floor	27	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	S	33	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	1,764	0.4	823	0	$112	$878	$162	6.4
Residential - Fifth floor	27	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,697	0	$232	$986	$270	3.1
Corridor - Fifth floor	8	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	None	S	80	8,760	3, 6	Relamp	Yes	8	LED Lamps: PL-L (Biax) Lamps	High/Low Control	56	6,044	0.3	3,130	-1	$428	$666	$296	0.9
Corridor - Fifth floor	29	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	None	S	42	8,760	3, 6	Relamp	Yes	29	LED Lamps: PL-L (Biax) Lamps	High/Low Control	30	6,044	0.5	5,844	-1	$798	$1,517	$1,044	0.6
Corridor - Fifth floor	4	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	4	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Electrical Room 5	1	Linear Fluorescent - T8: 3' T8 (25W) - 2L	Wall Switch	S	48	880	3	Relamp	No	1	LED - Linear Tubes: (2) 3' Lamps	Wall Switch	21	880	0.0	26	0	$4	$37	$10	7.6
Janitorial 5	1	Linear Fluorescent - T8: 3' T8 (25W) - 2L	Wall Switch	S	48	880	3	Relamp	No	1	LED - Linear Tubes: (2) 3' Lamps	Wall Switch	21	880	0.0	26	0	$4	$37	$10	7.6
Lounge 5	6	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	Wall Switch	S	80	1,764	3, 4	Relamp	Yes	6	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	56	1,217	0.2	473	0	$65	$432	$47	6.0

	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
Residential - Fourth floor	27	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	27	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.3	617	0	$84	$365	$27	4.0
Residential - Fourth floor	27	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	27	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.3	617	0	$84	$365	$27	4.0
Residential - Fourth floor	81	Linear Fluorescent - T12: 3' T12 (30W) - 1L	None	S	46	1,764	2	Relamp & Reballast	No	81	LED - Linear Tubes: (1) 3' Lamp	None	11	1,764	2.5	5,478	-1	$748	$4,092	$405	4.9
Residential - Fourth floor	27	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,697	0	$232	$986	$270	3.1
Residential - Fourth floor	27	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,697	0	$232	$986	$270	3.1
Residential - Fourth floor	27	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	S	33	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	1,764	0.4	823	0	$112	$878	$162	6.4
Residential - Fourth floor	27	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,697	0	$232	$986	$270	3.1
Corridor - Fourth floor	8	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	None	S	80	8,760	3, 6	Relamp	Yes	8	LED Lamps: PL-L (Biax) Lamps	High/Low Control	56	6,044	0.3	3,130	-1	$428	$666	$296	0.9
Corridor - Fourth floor	29	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	None	S	42	8,760	3, 6	Relamp	Yes	29	LED Lamps: PL-L (Biax) Lamps	High/Low Control	30	6,044	0.5	5,844	-1	$798	$1,517	$1,044	0.6
Corridor - Fourth floor	4	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	4	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Electrical Room 4	1	Linear Fluorescent - T8: 3' T8 (25W) - 2L	Wall Switch	S	48	880	3	Relamp	No	1	LED - Linear Tubes: (2) 3' Lamps	Wall Switch	21	880	0.0	26	0	$4	$37	$10	7.6
Janitorial 4	1	Linear Fluorescent - T8: 3' T8 (25W) - 2L	Wall Switch	S	48	880	3	Relamp	No	1	LED - Linear Tubes: (2) 3' Lamps	Wall Switch	21	880	0.0	26	0	$4	$37	$10	7.6
Lounge 4	6	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	Wall Switch	S	80	1,764	3, 4	Relamp	Yes	6	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	56	1,217	0.2	473	0	$65	$432	$47	6.0
Residential - Second floor	27	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	27	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.3	617	0	$84	$365	$27	4.0
Residential - Second floor	27	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	Wall Switch	S	42	1,764	3	Relamp	No	27	LED Lamps: PL-L (Biax) Lamps	Wall Switch	30	1,764	0.3	617	0	$84	$365	$27	4.0
Residential - Second floor	81	Linear Fluorescent - T12: 3' T12 (30W) - 1L	None	S	46	1,764	2	Relamp & Reballast	No	81	LED - Linear Tubes: (1) 3' Lamp	None	11	1,764	2.5	5,478	-1	$748	$4,092	$405	4.9
Residential - Second floor	27	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,697	0	$232	$986	$270	3.1
Residential - Second floor	27	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,697	0	$232	$986	$270	3.1
Residential - Second floor	27	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	S	33	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	1,764	0.4	823	0	$112	$878	$162	6.4
Residential - Second floor	27	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	1,764	3	Relamp	No	27	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	1,764	0.8	1,697	0	$232	$986	$270	3.1
Corridor - Second floor	8	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	None	S	80	8,760	3, 6	Relamp	Yes	8	LED Lamps: PL-L (Biax) Lamps	High/Low Control	56	6,044	0.3	3,130	-1	$428	$666	$296	0.9
Corridor - Second floor	29	Compact Fluorescent: (1) 42W Biaxial Plug-In Lamp	None	S	42	8,760	3, 6	Relamp	Yes	29	LED Lamps: PL-L (Biax) Lamps	High/Low Control	30	6,044	0.5	5,844	-1	$798	$1,517	$1,044	0.6
Corridor - Second floor	4	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	4	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Electrical Room 2	1	Linear Fluorescent - T8: 3' T8 (25W) - 2L	Wall Switch	S	48	880	3	Relamp	No	1	LED - Linear Tubes: (2) 3' Lamps	Wall Switch	21	880	0.0	26	0	$4	$37	$10	7.6
Janitorial 2	1	Linear Fluorescent - T8: 3' T8 (25W) - 2L	Wall Switch	S	48	880	3	Relamp	No	1	LED - Linear Tubes: (2) 3' Lamps	Wall Switch	21	880	0.0	26	0	$4	$37	$10	7.6

	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
Lounge 2	6	Compact Fluorescent: (2) 40W Biaxial Plug-In Lamps	Wall Switch	S	80	1,764	3, 4	Relamp	Yes	6	LED Lamps: PL-L (Biax) Lamps	Occupancy Sensor	56	1,217	0.2	473	0	$65	$432	$47	6.0

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**
Office - Director	Office - Director	1	Fan Coil Unit	0.3	60.0%	No			B	2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Storage 1	Storage 1	1	Fan Coil Unit	0.3	60.0%	No			B	2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Storage Laundry Rm	Storage Laundry Rm	1	Fan Coil Unit	0.3	60.0%	No			B	2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Residential 314	Residential 314	1	Fan Coil Unit	0.3	60.0%	No			B	2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Stairs 1	Stairs 1	1	Fan Coil Unit	0.3	60.0%	No			B	2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Stairs 2	Stairs 2	1	Fan Coil Unit	0.3	60.0%	No			B	2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Mechanical 1	Chiller	1	Chilled Water Pump	7.5	89.5%	No			B	2,560	8	No	91.7%	Yes	1	1.5	6,261	0	$868	$17,843	$1,000	19.4
Exterior 2	Various	1	Exhaust Fan	0.5	78.2%	No			B	2,745		No	78.2%	No		0.0	0	0	$0	$0	$0	0.0
Exterior 1	Various	8	Exhaust Fan	0.5	78.2%	No			B	2,745		No	78.2%	No		0.0	0	0	$0	$0	$0	0.0
Mechanical 1	DHW	1	DHW Circulation Pump	0.1	60.0%	No	Bell & Gosset		W	4,380		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Mechanical 1	DHW	1	DHW Circulation Pump	0.1	60.0%	No	Bell & Gosset		W	4,380		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Elevator 1	Elevator	2	Other	30.0	94.1%	No	Schindler		W	300		No	94.1%	No		0.0	0	0	$0	$0	$0	0.0
Various	Various	20	Fan Coil Unit	0.3	60.0%	No				2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
First floor residential units	First floor residential units	19	Fan Coil Unit	0.3	60.0%	No				2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Second floor residential units	Second floor residential units	27	Fan Coil Unit	0.3	60.0%	No				2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Third floor residential units	Third floor residential units	27	Fan Coil Unit	0.3	60.0%	No				2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Fourth floor residential units	Fourth floor residential units	27	Fan Coil Unit	0.3	60.0%	No				2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Fifth floor residential units	Fifth floor residential units	27	Fan Coil Unit	0.3	60.0%	No				2,300		No	60.0%	No		0.0	0	0	$0	$0	$0	0.0
Exterior 1	Various	2	Supply Fan	7.5	87.5%	No				4,380	7	No	88.5%	Yes	2	4.4	21,432	0	$2,972	$11,881	$2,000	3.3
Mechanical 1	Chiller	1	Chilled Water Pump	7.5	86.5%	No				2,560	8	No	91.7%	Yes	1	1.6	6,843	0	$949	$17,843	$1,000	17.7

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
Exterior 2	Various	1	Split-System	2.00		10.30		Mitsubishi	PUY-A24NHA7	W	9	Yes	1	Split-System	2.00		16.00		0.4	913	0	$127	$4,040	$210	30.2
Lobby 1	Lobby 1	1	Electric Resistance Heat		6.82		1 COP	Qmark		W		No							0.0	0	0	$0	$0	$0	0.0
Office - Security	Office - Security	1	Electric Resistance Heat		6.82		1 COP	Qmark		W		No							0.0	0	0	$0	$0	$0	0.0
Restroom - Unisex 3	Restroom - Unisex 3	1	Electric Resistance Heat		5.12		1 COP			W		No							0.0	0	0	$0	$0	$0	0.0
Restroom - Residence 314	Restroom - Residence 314	1	Electric Resistance Heat		6.80		1 COP			W		No							0.0	0	0	$0	$0	$0	0.0
Restroom - Unisex	Restroom - Unisex	1	Electric Resistance Heat		6.80		1 COP			W		No							0.0	0	0	$0	$0	$0	0.0
Exterior 1	Various	1	Package Unit	17.50	284.00	9.60	0.81 AFUE	Trane	Unknown	B	9	Yes	1	Package Unit	17.50	284.00	14.00	0.82 Et	3.4	3,850	4	$571	$23,694	$1,558	38.7
Exterior 1	Various	1	Package Unit	17.50	284.00	9.60	0.811428571428571 AFUE	Trane	YCH210C3LBBB	B	9	Yes	1	Package Unit	17.50	284.00	14.00	0.82 Et	3.4	3,850	3	$566	$23,694	$1,558	39.1
First floor residential units	First floor residential units	19	Electric Resistance Heat		3.41		1 COP			W		No							0.0	0	0	$0	$0	$0	0.0
Second floor residential units	Second floor residential units	27	Electric Resistance Heat		3.41		1 COP			W		No							0.0	0	0	$0	$0	$0	0.0
Third floor residential units	Third floor residential units	27	Electric Resistance Heat		3.41		1 COP			W		No							0.0	0	0	$0	$0	$0	0.0
Fourth floor residential units	Fourth floor residential units	27	Electric Resistance Heat		3.41		1 COP			W		No							0.0	0	0	$0	$0	$0	0.0
Fifth floor residential units	Fifth floor residential units	27	Electric Resistance Heat		3.41		1 COP			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
Exterior 1	Exterior 1	1	Air-Cooled Screw Chiller	100.00	Trane	RTAA100AYL01A3D0BDFM	B	10	Yes	1	Air-Cooled Screw Chiller	Variable	100.00	1.24	0.74	0.0	11,717	0	$1,625	$126,034	$9,000	72.0

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 1	All building	4	Non-Condensing Hot Water Boiler	320	Peerles Boiler	GM-08-SPRK	N		No						0.0	0	0	$0	$0	$0	0.0

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
Exterior 1	Various	11	1.00	17.50		284.00	0.0	613	19	$267	$1,359	$0	5.1
Exterior 1	Various	11	1.00	17.50		284.00	0.0	613	19	$267	$1,359	$0	5.1

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
Mechanical	Building	1	Indirect System			N		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
All fability	12	129	Showerhead	2.50	1.50	0.0	0	101	$975	$11,520	$1,935	9.8

Plug Load Inventory

	Existing Conditions					
Location	Quantity	Equipment Description	Energy Rate (W)	ENERGY STAR Qualified?	Manufacturer	Model
Storage Laundry Rm	6	Clothes Washer	900	No		
Office - Director	3	Desktop	145	No		
Office - Security	1	Desktop	145	No		
Lounge 4	1	Desktop	145	No		
Lounge 2	1	Desktop	145	No		
Office - Director	2	Electric Space Heater	1,500	No		
Office - Security	1	Electric Space Heater	1,500	No		
Lounge 2	1	Fan (Portable)	80	No		
Office - Director	1	Microwave	900	No		
Office - Security	1	Microwave	900	No		
Residential 314	1	Microwave	900	No		
Restroom - Unisex 3	1	Other	800	No		
Restroom - Unisex	1	Other	800	No		
Office - Director	1	Paper Shredder	200	No		
Office - Director	1	Printer (Medium/Small)	60	No		
Office - Security	1	Printer (Medium/Small)	60	No		
Office - Director	1	Printer/Copier (Large)	200	No		
Office - Director	1	Refrigerator (Mini)	60	No		
Office - Director	1	Refrigerator (Mini)	60	No		
Office - Security	1	Refrigerator (Mini)	60	No		
Residential 314	1	Refrigerator (Mini)	60	No		
Lounge 5	1	Television	100	No		
Lounge 4	1	Television	100	No		
Lounge 1	1	Television	100	No		
Lounge 3	1	Television	100	No		
Lounge 2	1	Television	100	No		
Corridor 2	1	Water Fountain	70	No		
Corridor 1	1	Water Fountain	70	No		
Corridor 3	1	Water Fountain	70	No		
Residences	1	Misc equipment	31,000	No		

Vending Machine Inventory & Recommendations

	Existing Conditions		Proposed Conditions		Energy Impact & Financial Analysis						
Location	Quantity	Vending Machine Type	ECM #	Install Controls?	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
Storage Laundry Rm	1	Non-Refrigerated	13	Yes	0.0	343	0	$48	$230	$0	4.8
Storage Laundry Rm	1	Refrigerated	13	Yes	0.2	1,612	0	$224	$230	$50	0.8

Miscellaneous Fuel Inventory

	Existing Conditions					
Location	Quantity	Equipment Description	Input Capacity per Unit (MBh)	ENERGY STAR Qualified?	Manufacturer	Model
Laundry Room	10	Dryer	25.0	No	Alliance	SSGNYAGS113TW01

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.

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ENERGY STAR® Statement of Energy Performance

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ENERGY STAR® Score[1]

Ramapo College - Mackin Hall

Primary Property Type: Residence Hall/Dormitory
Gross Floor Area (ft²): 62,400
Built: 2000

For Year Ending: May 31, 2022
Date Generated: February 07, 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
Ramapo College - Mackin Hall 505 Ramapo Valley Road Mahwah, New Jersey 07430	Ramapo College of New Jersey 505 Ramapo Valley Road Mahwah, NJ 07430 (201) 684-7666	Mike Cunningham 505 Ramapo Valley Road Mahwah, NJ 07430 (201) 684-7666 mcunning@ramapo.edu

Property ID: 26333882

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
79 kBtu/ft²

Source EUI
143.1 kBtu/ft²

Annual Energy by Fuel

Natural Gas (kBtu)	2,606,575 (53%)
Electric - Grid (kBtu)	2,147,067 (44%)
Electric - Solar (kBtu)	178,337 (4%)

National Median Comparison

National Median Site EUI (kBtu/ft²)	92.9
National Median Source EUI (kBtu/ft²)	168.1
% Diff from National Median Source EUI	-15%

Annual Emissions

Total (Location-Based) GHG Emissions (Metric Tons CO2e/year)	205

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, which 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.