Local Government Energy Audit:
Energy Audit Report

Calcia Hall

1 Normal Avenue

Montclair, New Jersey 07043

Montclair State University

July 9, 2018

Final Report by:

TRC Energy Services

Disclaimer

The intent of this energy analysis report is to identify energy savings opportunities and recommend upgrades to the facility's energy using equipment and systems. Approximate saving are included in this report to help make decisions about reducing energy use at the facility. This report, however, is not intended to serve as a detailed engineering design document. Further design and analysis may be necessary in order to implement some of the measures recommended in this report.

The energy conservation measures and estimates of energy savings have been reviewed for technical accuracy. However, estimates of final energy savings are not guaranteed, because final savings may depend on behavioral factors and other uncontrollable variables. TRC Energy Services (TRC) and New Jersey Board of Public Utilities (NJBPU) shall in no event be liable should the actual energy savings vary.

Estimated installation costs are based on TRC's experience at similar facilities, pricing from local contractors and vendors, and/or cost estimates from *RS Means*. The owner of the facility is encouraged to independently confirm these cost estimates and to obtain multiple estimates when considering measure installations. Since actual installed costs can vary widely for certain measures and conditions, TRC and NJBPU do not guarantee installed cost estimates and shall in no event be held liable should actual installed costs vary from estimates.

New Jersey's Clean Energy Program (NJCEP) incentive values provided in this report are estimates based on program information available at the time of the report. Incentive levels are not guaranteed. The NJBPU reserves the right to extend, modify, or terminate programs without prior notice. The owner of the facility should review available program incentives and eligibility requirements prior to selecting and installing any energy conservation measures.

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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 Calcia Hall.

The goal of an LGEA report is to provide you with information on how your facility uses energy, identify energy conservation measures (ECMs) that can reduce your energy use, and provide information and assistance to help facilities implement ECMs. The LGEA report also contains valuable information on financial incentives from New Jersey's Clean Energy Program (NJCEP) for implementing ECMs.

This study was conducted by TRC Energy Services (TRC), as part of a comprehensive effort to assist New Jersey higher education facilities in controlling energy costs and protecting our environment by offering a wide range of energy management options and advice.

1.1 Facility Summary

Calcia Hall is a 38,284 square foot facility. The two-story building includes offices, classrooms, labs, and mechanical spaces.

Lighting at Calcia Hall consists primarily of a mixture of T8 and T12 fluorescent sources, compact fluorescent lamps (CFLs), and some incandescent fixtures, all of which are inefficient as compared to currently available alternatives. Cooling is provided by chilled water (CHW) from the District Energy Plant to Calcia Hall's mechanical room, where it is distributed by pumps to the building's air handling equipment. There are two (2) main air handling units (AHUs) for the building. There are also three (3) packaged air-conditioning DX units and one (1) heat pump for cooling. Steam is provided from the District Energy Plant to Calcia Hall's mechanical room, where it is converted to heating and domestic hot water by steam to water heat exchangers. Heating hot water is distributed to the building's AHUs and terminal reheat coils. A thorough description of the facility and our observations are located in Section 2.

1.2 Your Cost Reduction Opportunities

Energy Conservation Measures

TRC evaluated nine (9) measures which together represent an opportunity for Calcia Hall to reduce annual energy costs by $44,206 and annual greenhouse gas emissions by 259,860 lbs CO_2e. We estimate that if all high priority measures are implemented as recommended, the project will pay for itself in 3.7 years. TRC has defined high priority measures as the evaluated measures that have a simple payback less than the typical equipment life of the proposed equipment. The breakdown of existing and potential utility costs after project implementation are illustrated in Figure 1 and Figure 2, respectively. Together these measures represent an opportunity to reduce Calcia Hall's annual energy use by 11%.

Figure 1 – Previous 12 Month Utility Costs

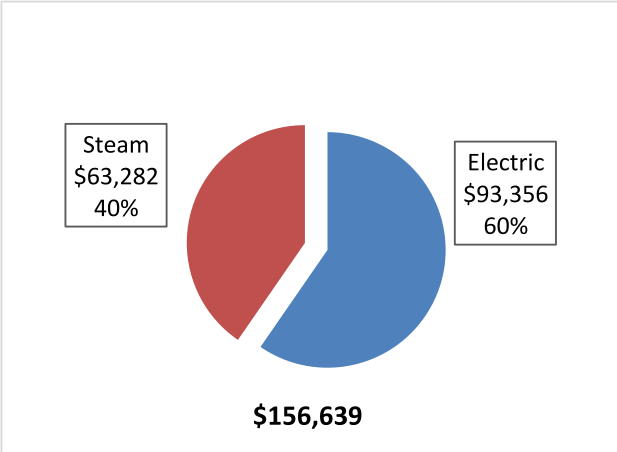
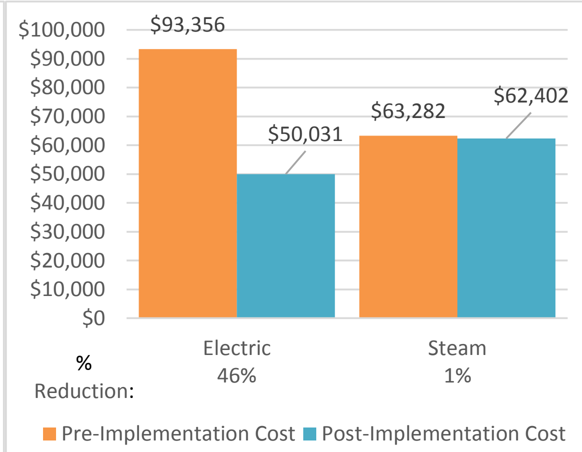


Figure 2 – Potential Post-Implementation Costs



A detailed description of Calcia Hall's existing energy use can be found in Section 3.

Estimates of the total cost, energy savings, and financial incentives for the evaluated energy efficient upgrades are summarized below in Figure 3. A brief description of each category can be found below and a description of savings opportunities can be found in Section 4.

Figure 3 – Summary of Energy Reduction Opportunities

Energy Conservation Measure		High Priority?	Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades			**118,339**	**0**	**27.0**	**0.0**	**$19,880.87**	**$85,326.89**	**$5,735.00**	**$79,591.89**	**4.0**	**119,166**
ECM 1	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	Yes	104,126	0	23.7	0.0	$17,493.21	$73,454.67	$5,020.00	$68,434.67	3.9	104,854
ECM 2	Retrofit Fixtures with LED Lamps	Yes	14,212	0	3.2	0.0	$2,387.66	$11,872.23	$715.00	$11,157.23	4.7	14,312
Lighting Control Measures			**19,397**	**0**	**4.4**	**0.0**	**$3,258.72**	**$9,950.00**	**$875.00**	**$9,075.00**	**2.8**	**19,533**
ECM 3	Install Occupancy Sensor Lighting Controls	Yes	16,768	0	3.8	0.0	$2,817.00	$6,750.00	$875.00	$5,875.00	2.1	16,885
ECM 4	Install High/Low Lighitng Controls	Yes	2,629	0	0.6	0.0	$441.72	$3,200.00	$0.00	$3,200.00	7.2	2,648
Motor Upgrades			**4,437**	**0**	**1.0**	**0.0**	**$745.45**	**$14,735.68**	**$0.00**	**$14,735.68**	**19.8**	**4,468**
ECM 5	Premium Efficiency Motors	Yes	4,437	0	1.0	0.0	$745.45	$14,735.68	$0.00	$14,735.68	19.8	4,468
Variable Frequency Drive (VFD) Measures			**107,502**	**0**	**25.3**	**0.0**	**$18,060.27**	**$47,660.40**	**$6,800.00**	**$40,860.40**	**2.3**	**108,253**
ECM 6	Install VFDs on Constant Volume (CV) HVAC	Yes	77,643	0	21.5	0.0	$13,044.03	$28,005.30	$6,800.00	$21,205.30	1.6	78,186
ECM 7	Install VFDs on Chilled Water Pumps	Yes	14,929	0	1.9	0.0	$2,508.12	$9,827.55	$0.00	$9,827.55	3.9	15,034
ECM 8	Install VFDs on Hot Water Pumps	Yes	14,929	0	1.9	0.0	$2,508.12	$9,827.55	$0.00	$9,827.55	3.9	15,034
HVAC System Improvements			**0**	**4,216**	**0.0**	**57.7**	**$2,260.23**	**$19,031.88**	**$0.00**	**$19,031.88**	**8.4**	**8,440**
ECM 9	Implement Demand Control Ventilation	Yes	0	4,216	0.0	57.7	$2,260.23	$19,031.88	$0.00	$19,031.88	8.4	8,440
TOTALS FOR HIGH PRIORITY MEASURES			**249,674**	**4,216**	**57.7**	**57.7**	**$44,205.54**	**$176,704.85**	**$13,410.00**	**$163,294.85**	**3.7**	**259,860**
TOTALS FOR ALL EVALUATED MEASURES			**249,674**	**4,216**	**57.7**	**57.7**	**$44,205.54**	**$176,704.85**	**$13,410.00**	**$163,294.85**	**3.7**	**259,860**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

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

Lighting Upgrades generally involve the replacement of existing lighting components such as lamps and ballasts (or the entire fixture) with higher efficiency lighting components. These measure save energy by reducing the power used by the lighting components due to improved electrical efficiency.

Lighting Controls measures generally involve the installation of automated controls to turn off lights or reduce light output when not needed. Automated control reduces reliance on occupant behavior for adjusting lights. These measures save energy by reducing the amount of time lights are on.

Motor Upgrades generally involve replacing older standard efficiency motors with high efficiency standard (IHP 2014). Motors replacements generally assume the same size motors, just higher efficiency. Although occasionally additional savings can be achieved by downsizing motors to better meet current load requirements. This measure saves energy by reducing the power used by the motors, due to improved electrical efficiency.

Variable Frequency Drives (VFDs) are motor control devices. These measures control the speed of a motor so that the motor spins at peak efficiency during partial load conditions. Sensors adapt the speed to flow, temperature, or pressure settings which is much more efficient than using a valve or damper to control flow rates, or running the motor at full speed when only partial power is needed. These measures save energy by controlling motor usage more efficiently.

Energy Efficient Practices

TRC also identified 14 low cost or no cost energy efficient practices. A facility's energy performance can be significantly improved by employing certain behavioral or operational adjustments and by performing better routine maintenance on building systems. These practices can extend equipment lifetime, improve occupant comfort, provide better health and safety, as well as reduce annual energy and O&M costs. Potential opportunities identified at Calcia Hall include:

- Reduce Air Leakage
- Close Doors and Windows
- Perform Proper Lighting Maintenance
- Develop a Lighting Maintenance Schedule
- Ensure Lighting Controls Are Operating Properly
- Turn Off Unneeded Motors
- Perform Routine Motor Maintenance
- Clean Evaporator/Condenser Coils on AC Systems
- Clean and/or Replace HVAC Filters
- Check for and Seal Duct Leakage
- Repair/Replace Steam Traps
- Perform Proper Water Heater Maintenance
- Perform Maintenance on Compressed Air Systems
- Water Conservation

For details on these Energy Efficient Practices, please refer to Section 5.

On-Site Generation Measures

TRC evaluated the potential for installing on-site generation for Calcia Hall. Based on the configuration of the site and its loads there is a low potential for installing any PV and combined heat and power self-generation measures.

For details on our evaluation and on-site generation potential, please refer to Section 6.

1.3 Implementation Planning

To realize the energy savings from the ECMs listed in this report, a project implementation plan must be developed. Available capital must be considered and decisions need to be made whether it is best to pursue individual ECMs separately, groups of ECMs, or a comprehensive approach where all ECMs are implemented together, possibly in conjunction with other facility upgrades or improvements.

Rebates, incentives, and financing are available from NJCEP, as well as other sources, to help reduce the costs associated with the implementation of energy efficiency projects. Prior to implementing any measure, please review the relevant incentive program guidelines before proceeding. This is important because in most cases you will need to submit applications for the incentives prior to purchasing materials or commencing with installation.

The ECMs outlined in this report may qualify under the following program(s):

- SmartStart
- Pay for Performance - Existing Building (P4P)
- Energy Savings Improvement Program (ESIP)

For facilities wanting to pursue only selected individual measures (or planning to phase implementation of selected measures over multiple years), incentives are available through the SmartStart program. To participate in this program you may utilize internal resources, or an outside firm or contractor, to do the final design of the ECM(s) and do the installation. Program pre-approval is required for some SmartStart incentives, so only after receiving pre-approval should you proceed with ECM installation. The incentive estimates listed above in Figure 3 are based on the SmartStart program. More details on this program and others are available in Section 8.

Larger facilities with an interest in a more comprehensive whole building approach to energy conservation should consider participating in the Pay for Performance (P4P) program. Projects eligible for this project program must meet minimum savings requirements. Final incentives are calculated based on actual measured performance achieved at the end of the project. The application process is more involved, and it requires working with a qualified P4P contractor, but the process may result in greater energy savings overall and more lucrative incentives, up to 50% of project's total cost.

For larger facilities with limited capital availability to implement ECMs, project financing may be available through the Energy Savings Improvement Program (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. An LGEA report (or other approved energy audit) is required for participation in ESIP. Please refer to Section 8.3 for additional information on the ESIP Program.

The Demand Response Energy Aggregator is a (non-NJCEP) program designed to reduce 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. Demand Response (DR) service providers (a.k.a. Curtailment Service Providers) are registered with PJM, the independent system operator (ISO) for mid-Atlantic state region that is charged with maintaining electric grid reliability. By enabling grid operators to call upon commercial facilities to reduce their electric usage 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 DR programs. Program participation is voluntary and facilities receive payments whether or not they are called upon to curtail their load during times of peak demand. Refer to Section 7 for additional information on this program.

Additional information on relevant incentive programs is located in Section 8. You may also check the following website for more details: www.njcleanenergy.com/ci.

2 Facility Information and Existing Conditions

2.1 Project Contacts

Figure 4 – Project Contacts

Name	Role	E-Mail	Phone #
Customer			
Ana Pinto	Director of Energy Management	pintoa@mail.montclair.edu	973-655-3244
TRC Energy Services			
Mike Smith	Auditor	mjsmith@trcsolutions.com	732-855-0033

2.2 General Site Information

On March 29, 2017, TRC performed an energy audit at Calcia Hall located in Montclair, New Jersey. TRC's team met with Ana Pinto to review the facility operations and help focus our investigation on specific energy-using systems.

Calcia Hall is a 38,284-square foot facility. The two-story building includes offices, classrooms, labs, and mechanical spaces.

Lighting at Calcia Hall consists primarily of a mixture of T8 and T12 fluorescent sources, compact fluorescent lamps (CFLs), and some incandescent fixtures, all of which are inefficient as compared to currently available alternatives. Cooling is provided by chilled water (CHW) from the District Energy Plant to Calcia Hall's mechanical room, where it is distributed by pumps to the building's air handling equipment. There are two (2) main air handling units (AHUs) for the building. There are also three (3) packaged air-conditioning DX units and one (1) heat pump for cooling. Steam is provided from the District Energy Plant to Calcia Hall's mechanical room, where it is converted to heating and domestic hot water by steam to water heat exchangers. Heating hot water is distributed to the building's AHUs and terminal reheat coils.

2.3 Building Occupancy

The facility is open on weekdays for 52 weeks a year. During a typical day, the facility is occupied by approximately 32 students and staff.

Figure 5 - Building Schedule

Building Name	Weekday/Weekend	Operating Schedule
Calcia Hall	Weekday	8 AM - 8 PM
Calcia Hall	Weekend	Closed

2.4 Building Envelope

Calcia Hall is a two-story building constructed of concrete and structural steel with a masonry facade. The building has a flat built-up roof that is in good condition. The building has double-pane windows that are in good condition and show little signs of infiltration. The exterior doors are constructed of metal and glass that are in good condition.

2.5 On-Site Generation

The campus has a central cogeneration plant. The cogeneration plant uses natural gas fired turbines to produce electricity. Waste heat from the turbines is used to produce steam. The steam is delivered to some of the buildings on campus and used to produce chilled water, which is delivered to some of the buildings on campus. See the campus summary report for additional information regarding the campus cogeneration plant.

Calcia Hall does not have any on-site electric generation capacity.

2.6 Energy-Using Systems

Please see **Appendix A: Equipment Inventory & Recommendations** for an inventory of the facility's equipment.

Lighting System

Interior lighting at the facility is provided mostly by fixtures which contain linear fluorescent T8 lamps with electronic ballasts, T12 lamps with magnetic ballasts, and fixtures with compact fluorescent or incandescent screw-in lamps. The linear fluorescent fixtures are located in all areas of the building. Most of the fixtures are 2-lamp or 4-lamp with 2-foot and 4-foot long troffers. Interior lighting fixtures are controlled by manually operated switches.

Chilled Water System

Chilled water (CHW) is provided from the District Energy Plant to Calcia Hall's mechanical room, where it is distributed to the building's air handling equipment. The water is distributed by three (3) 5-hp and two (2) 3-hp constant speed pumps.

Steam to Hot Water Heating System

The heating hot water (HHW) system consists of a steam to water heat exchanger in the mechanical room that receives steam from the District Energy Plant. From there, the HHW is distributed to the building's AHUs and terminal heating coils. The HHW is distributed by 5 hp constant speed pumps.

The equipment is well-maintained in good condition.

Air Distribution System

There are two (2) multi-zone air handling units (AHUs) for the building that provide space conditioning and ventilation. Each unit has a 20 hp supply fan. AHUs 1 & 2 are constant volume. There are no return fans for either unit. Labs are equipped with dedicated fume hood exhaust fan systems.

The equipment is well-maintained and in good condition.

Direct Expansion Air Conditioning System (DX)

There are two (2) 20-ton Trane packaged AC units and one (1) 3-ton McQuay unit that provides space cooling. The larger units are rated at 11 SEER efficiencies and the smaller unit at a 9.7 SEER efficiency. Additionally, there is one (1) Trane water source heat pump with a 3-ton cooling capacity and a 13.0 SEER rating.

Building Energy Management System (BEMS)

Facility operation at Calcia Hall is primarily controlled by an original pneumatic control system, which controls basic day/night space temperatures. Additionally, there is a central Alerton direct digital control (DDC) system, which controls air side HVAC operation and hot and chilled water pump scheduling and allows for setpoint monitoring and measures energy consumption.

Domestic Hot Water Heating System

DHW for the building is provided by an AERCO steam to water heat exchanger. The heat exchanger unit is approximately ten years old and is in good condition.

Building Plug Load

Plug load equipment includes multiple computers, printers, and displays. There are also nine (9) kilns that range in power from approximately 8,000 to 28,000 watts. Kiln usage is relatively low, however.

2.7 Water-Using Systems

There are approximately six (6) restrooms at Calcia Hall. A sampling of restrooms found that many faucets are rated for 2.2 gallons per minute (gpm).

3 SITE ENERGY USE AND COSTS

This building receives electricity through a master meter. It also receives electricity, steam and chilled water from the campus central cogeneration plant. These utilities were prorated for individual buildings based on building size and function.

Prorated utility data were evaluated to determine the annual energy performance metrics for the building in energy cost per square foot and energy usage per square foot. These metrics are an estimate of the relative energy efficiency of this building. There are a number of factors that could cause the energy use of this building to vary from the "typical" energy usage profile for facilities with similar characteristics. Local weather conditions, building age and insulation levels, equipment efficiency, daily occupancy hours, changes in occupancy throughout the year, equipment operating hours, and energy efficient behavior of occupants all contribute to benchmarking scores. Please refer to the Benchmarking section within Section 3.5 for additional information.

3.1 Total Cost of Energy

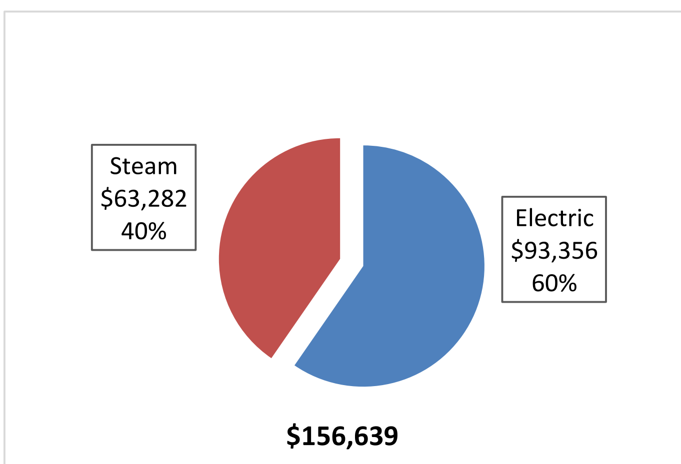
The following energy consumption and cost data is based on the last 12-month period of utility billing data that was provided for each utility. A profile of the annual energy consumption and energy cost of the facility was developed from this information.

Figure 6 - Utility Summary

Utility Summary for Calcia Hall		
Fuel	**Usage**	**Cost**
Electricity	1,108,061 kWh	$93,356
Steam	3,472 kLbs	$63,282
Total		**$156,639**

The current annual energy cost for this facility is $156,639 as shown in the chart below.

Figure 7 - Energy Cost Breakdown



3.2 Electricity Usage

Electricity is provided by PSE&G and the campus cogeneration plant. The average cost for electricity purchased from PSE&G was $0.168/kWh, which is the blended rate that includes energy supply, distribution, and other charges. This rate is used throughout the analyses in this report to assess energy costs and savings.

Demand data (kW) is absent from the table below because it was not provided for the electric cogeneration plant generation, therefore, kW totals would be incomplete for this facility. The monthly electricity consumption is shown in the chart below.

Figure 8 - Electric Usage & Demand

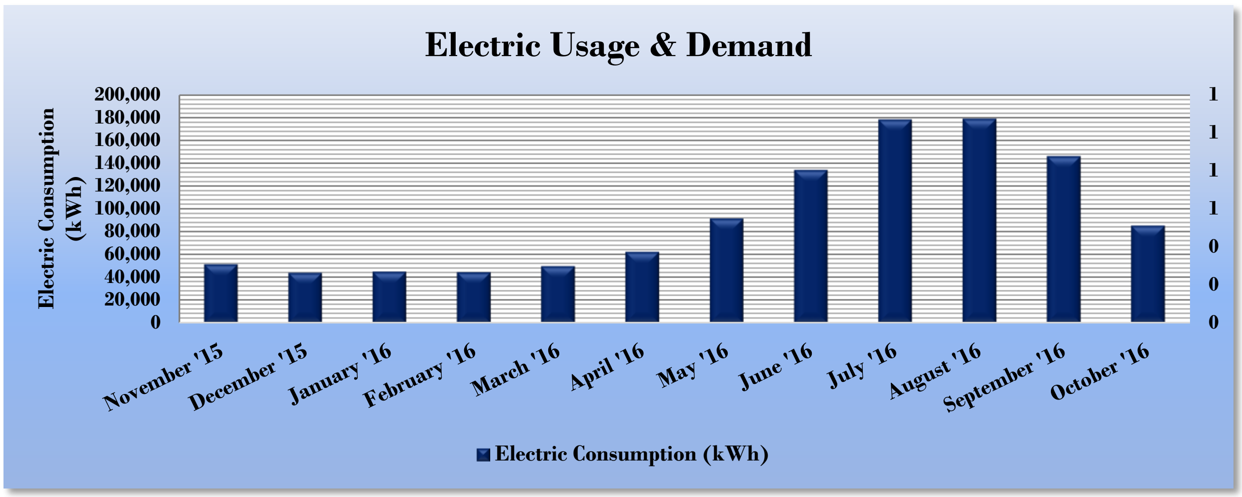


Figure 9 - Electric Usage & Demand

Electric Billing Data for Calcia Hall				
Period Ending	Days in Period	Electric Usage (kWh)	Total Electric Cost	TRC Estimated Usage?
11/30/15	30	51,400	$3,663	Yes
12/31/15	31	43,683	$3,485	Yes
1/31/16	31	44,651	$3,036	Yes
2/28/16	28	44,233	$6,038	Yes
3/31/16	31	49,707	$3,389	Yes
4/30/16	30	62,216	$4,559	Yes
5/31/16	31	91,212	$7,423	Yes
6/30/16	30	133,716	$11,571	Yes
7/31/16	31	177,834	$15,475	Yes
8/31/16	31	178,669	$15,615	Yes
9/30/16	30	145,759	$12,352	Yes
10/31/16	31	84,981	$6,750	Yes
Totals	**365**	**1,108,061**	**$93,356**	12
Annual	**365**	**1,108,061**	**$93,356**	

3.3 Steam Usage

Steam is provided by Campus CHP. The average steam cost for the past 12 months is $18.227/kLb, which is the blended rate used throughout the analyses in this report. The steam consumption is shown in the table below.

Figure 10 –Steam Usage

Steam Billing Data for Calcia Hall				
Period Ending	**Days in Period**	**Steam Usage (kLbs)**	**Fuel Cost**	**TRC Estimated Usage?**
11/30/15	30	230	$3,500	Yes
12/31/15	31	308	$4,730	Yes
1/31/16	31	438	$6,833	Yes
2/28/16	28	395	$16,367	Yes
3/31/16	31	330	$5,011	Yes
4/30/16	30	270	$4,056	Yes
5/31/16	31	205	$3,198	Yes
6/30/16	30	200	$3,036	Yes
7/31/16	31	257	$3,878	Yes
8/31/16	31	269	$4,053	Yes
9/30/16	30	264	$3,966	Yes
10/31/16	31	307	$4,652	Yes
Totals	**365**	**3,472**	**$63,282**	12
Annual	**365**	**3,472**	**$63,282**	

3.4 Chilled Water Usage

Chilled water is provided by the campus cogeneration plant. The average chilled water cost is $0.327/ton-hr, which is the blended rate used throughout the analyses in this report. The chilled water consumption is shown in the table below. Chilled water is produced by steam engine chillers at the cogeneration plant, however, for ease of analysis and reporting chilled water use and cost has been combined with electricity use and cost in this report in the summary graphics.

Figure 11 – Chilled Water Usage

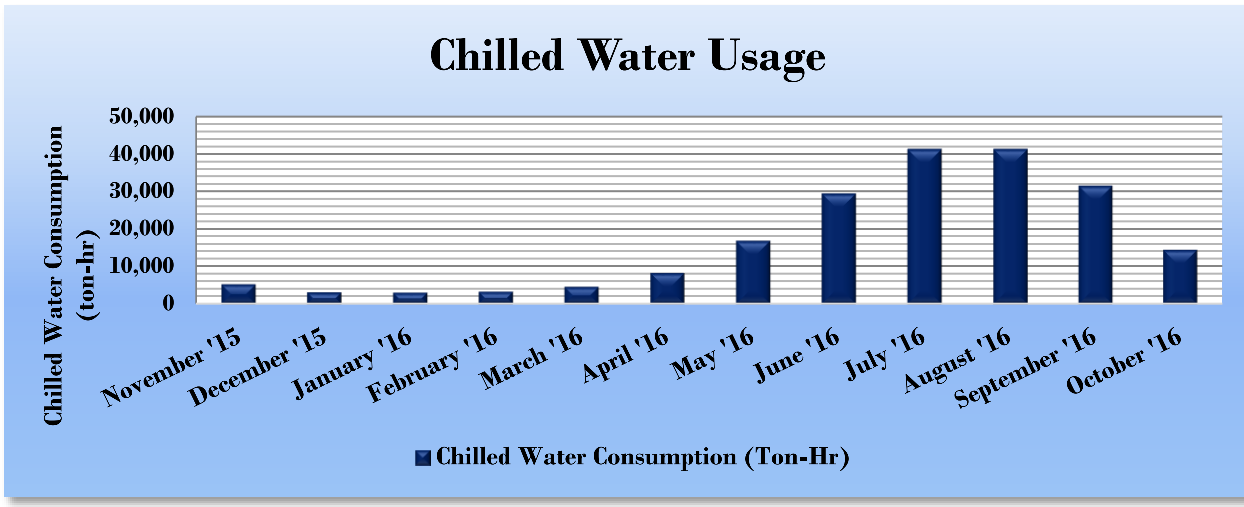


Figure 12 – Chilled Water Usage

Chilled Water Billing Data for Calcia Hall				
Period Ending	Days in Period	Chilled Water Usage (ton-hr)	Total Electric Cost	TRC Estimated Usage?
11/30/15	30	18,533	$1,725	Yes
12/31/15	31	11,020	$1,031	Yes
1/31/16	31	10,740	$1,017	Yes
2/28/16	28	11,604	$1,352	Yes
3/31/16	31	16,277	$1,511	Yes
4/30/16	30	29,141	$2,686	Yes
5/31/16	31	59,093	$5,589	Yes
6/30/16	30	103,387	$9,598	Yes
7/31/16	31	145,005	$13,388	Yes
8/31/16	31	145,005	$13,401	Yes
9/30/16	30	110,704	$10,192	Yes
10/31/16	31	50,817	$4,717	Yes
Totals	**365**	**711,326**	**$66,206**	12
Annual	**365**	**711,326**	**$66,206**	

3.5 Benchmarking

This facility was benchmarked using *Portfolio Manager*, an online tool created and managed by the United States Environmental Protection Agency (EPA) through the ENERGY STAR® program. Portfolio Manager analyzes your building's consumption data, cost information, and operational use details and then compares its performance against a national median for similar buildings of its type. Metrics provided by this analysis are Energy Use Intensity (EUI) and an ENERGY STAR® score for select building types.

Energy Use Intensity is a measure of a facility's energy consumption per square foot, and it is the standard metric for comparing buildings' energy performance. Comparing the EUI of a building with the national median EUI for that building type illustrates whether that building uses more or less energy than similar buildings of its type on a square foot basis. 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.

Figure 13 - Energy Use Intensity Comparison – Existing Conditions

Energy Use Intensity Comparison - Existing Conditions		
	Calcia Hall	National Median Building Type: Higher Education - Public
Source Energy Use Intensity (kBtu/ft^2)	440.0	262.6
Site Energy Use Intensity (kBtu/ft^2)	207.0	130.7

Implementation of all recommended measures in this report would improve the building's estimated EUI significantly, as shown in the table below:

Figure 14 - Energy Use Intensity Comparison – Following Installation of Recommended Measures

Energy Use Intensity Comparison - Following Installation of Recommended Measures		
	Calcia Hall	National Median Building Type: Higher Education - Public
Source Energy Use Intensity (kBtu/ft^2)	370.2	262.6
Site Energy Use Intensity (kBtu/ft^2)	184.8	130.7

Many types of commercial buildings are also eligible to receive an ENERGY STAR® score. This score is a percentile ranking from 1 to 100. It compares your building's energy performance to similar buildings nationwide. A score of 50 represents median energy performance, while a score of 75 means your building performs better than 75 percent of all similar buildings nationwide and may be eligible for ENERGY STAR® certification.

As the electric accounts were shared between various buildings, it was not possible to benchmark these buildings and provide a score individually. A campus wide Portfolio Manager Statement of Energy Performance (SEP) was generated.

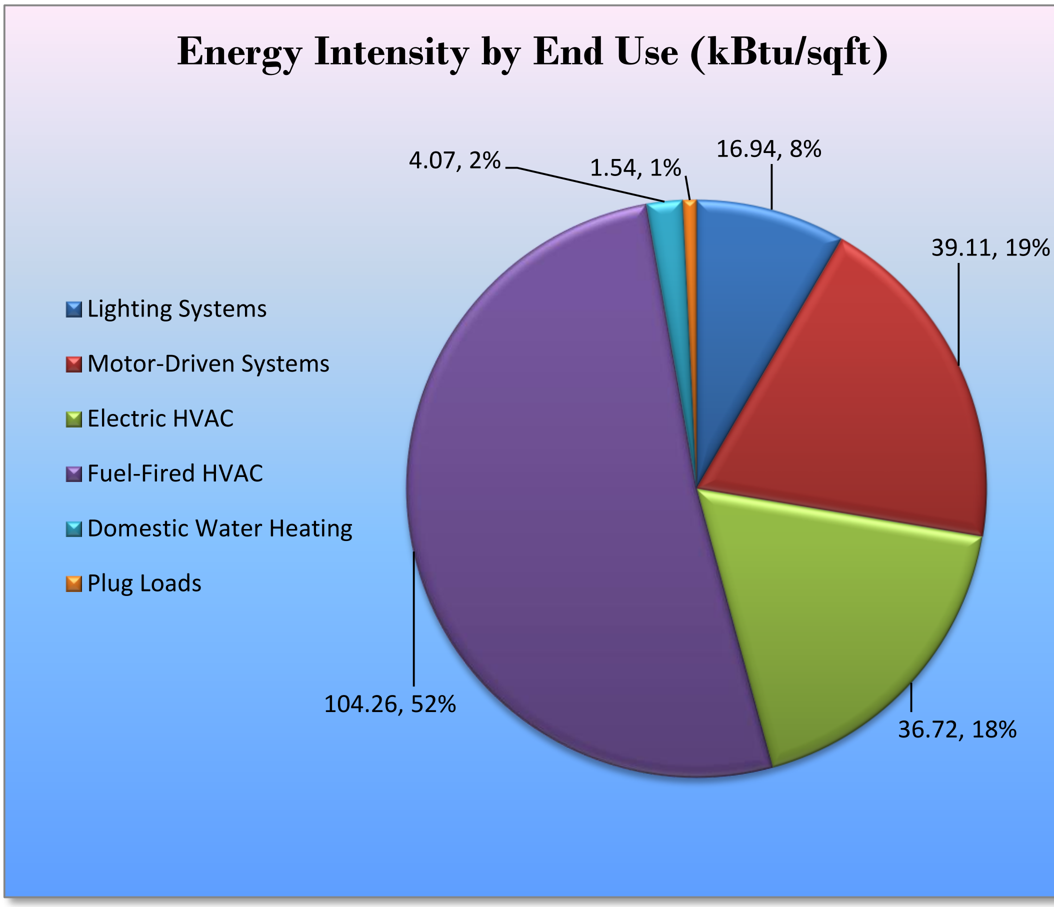
For more information on ENERGY STAR® certification go to: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/earn-recognition/energy-star-certification/how-app-1.

A Portfolio Manager account has been created online for your facility and you will be provided with the login information for the account. We encourage you to update your utility information in Portfolio Manager regularly, so that you can keep track of your building's performance. 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.

3.6 Energy End-Use Breakdown

In order to provide a complete overview of energy consumption across building systems, an energy balance was performed. An energy balance utilizes standard practice engineering methods to evaluate all components of the various electric and fuel-fired systems found in a building to determine their proportional contribution to overall building energy usage. This chart of energy end uses highlights the relative contribution of each equipment category to total energy usage. This can help determine where the greatest benefits might be found from energy efficiency measures.

Figure 15 - Energy Balance (% and kBtu/SF)



4 Energy Conservation Measures

The goal of this audit report is to identify potential energy efficiency opportunities, help prioritize specific measures for implementation, and provide information to the Calcia Hall regarding financial incentives for which they may qualify to implement the recommended measures. For this audit report, most measures have received only a preliminary analysis of feasibility which identifies expected ranges of savings and costs. This level of analysis is usually considered sufficient to demonstrate project cost-effectiveness and help prioritize energy measures. Savings are based on the New Jersey Clean Energy Program Protocols to Measure Resource Savings dated June 29, 2016, approved by the New Jersey Board of Public Utilities. Further analysis or investigation may be required to calculate more precise savings based on specific circumstances. A higher level of investigation may be necessary to support any custom SmartStart or Pay for Performance, or Direct Install incentive applications. Financial incentives for the ECMs identified in this report have been calculated based the NJCEP prescriptive SmartStart program. Some measures and proposed upgrade projects may be eligible for higher incentives than those shown below through other NJCEP programs as described in Section 8.

The following sections describe the evaluated measures.

4.1 High Priority ECMs

The measures below have been evaluated by the auditor and are recommended for implementation at the facility.

Figure 16 – Summary of High Priority ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**118,339**	**0**	**27.0**	**0.0**	**$19,880.87**	**$85,326.89**	**$5,735.00**	**$79,591.89**	**4.0**	**119,166**
ECM 1	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	104,126	0	23.7	0.0	$17,493.21	$73,454.67	$5,020.00	$68,434.67	3.9	104,854
ECM 2	Retrofit Fixtures with LED Lamps	14,212	0	3.2	0.0	$2,387.66	$11,872.23	$715.00	$11,157.23	4.7	14,312
Lighting Control Measures		**19,397**	**0**	**4.4**	**0.0**	**$3,258.72**	**$9,950.00**	**$875.00**	**$9,075.00**	**2.8**	**19,533**
ECM 3	Install Occupancy Sensor Lighting Controls	16,768	0	3.8	0.0	$2,817.00	$6,750.00	$875.00	$5,875.00	2.1	16,885
ECM 4	Install High/Low Lighitng Controls	2,629	0	0.6	0.0	$441.72	$3,200.00	$0.00	$3,200.00	7.2	2,648
Motor Upgrades		**4,437**	**0**	**1.0**	**0.0**	**$745.45**	**$14,735.68**	**$0.00**	**$14,735.68**	**19.8**	**4,468**
ECM 5	Premium Efficiency Motors	4,437	0	1.0	0.0	$745.45	$14,735.68	$0.00	$14,735.68	19.8	4,468
Variable Frequency Drive (VFD) Measures		**107,502**	**0**	**25.3**	**0.0**	**$18,060.27**	**$47,660.40**	**$6,800.00**	**$40,860.40**	**2.3**	**108,253**
ECM 6	Install VFDs on Constant Volume (CV) HVAC	77,643	0	21.5	0.0	$13,044.03	$28,005.30	$6,800.00	$21,205.30	1.6	78,186
ECM 7	Install VFDs on Chilled Water Pumps	14,929	0	1.9	0.0	$2,508.12	$9,827.55	$0.00	$9,827.55	3.9	15,034
ECM 8	Install VFDs on Hot Water Pumps	14,929	0	1.9	0.0	$2,508.12	$9,827.55	$0.00	$9,827.55	3.9	15,034
HVAC System Improvements		**0**	**4,216**	**0.0**	**57.7**	**$2,260.23**	**$19,031.88**	**$0.00**	**$19,031.88**	**8.4**	**8,440**
ECM 9	Implement Demand Control Ventilation	0	4,216	0.0	57.7	$2,260.23	$19,031.88	$0.00	$19,031.88	8.4	8,440
TOTALS		**249,674**	**4,216**	**57.7**	**57.7**	**$44,205.54**	**$176,704.85**	**$13,410.00**	**$163,294.85**	**3.7**	**259,860**

* - All incentives presented in this table are based on NJ Smart Start Building equipment incentives and assume proposed equipment meets minimum performance criteria for that program.

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

4.1.1 Lighting Upgrades

Our recommendations for upgrades to existing lighting fixtures are summarized in Figure 17 below.

Figure 17 – Summary of Lighting Upgrade ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**118,339**	**0**	**27.0**	**0.0**	**$19,880.87**	**$85,326.89**	**$5,735.00**	**$79,591.89**	**4.0**	**119,166**
ECM 1	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	104,126	0	23.7	0.0	$17,493.21	$73,454.67	$5,020.00	$68,434.67	3.9	104,854
ECM 2	Retrofit Fixtures with LED Lamps	14,212	0	3.2	0.0	$2,387.66	$11,872.23	$715.00	$11,157.23	4.7	14,312

During lighting upgrade planning and design, we recommend a comprehensive approach that considers both the efficiency of the lighting fixtures and how they are controlled.

ECM 1: Retrofit Fluorescent Fixtures with LED Lamps and Drivers

Summary of Measure Economics

Interior/ Exterior	Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Interior	104,126	0	23.7	0.0	$17,493.21	$73,454.67	$5,020.00	$68,434.67	3.9	104,854
Exterior	0	0	0.0	0.0	$0.00	$0.00	$0.00	$0.00	0.0	0

Measure Description

We recommend retrofitting existing fluorescent fixtures by removing T12 fluorescent tubes and ballasts and replacing them with LEDs and LED drivers (if necessary), which are designed to be used retrofitted fluorescent fixtures. The measure uses the existing fixture housing but replaces the rest of the components with more efficient lighting technology. This measure saves energy by installing LEDs which use less power than other lighting technologies yet provide equivalent lighting output for the space.

Additional savings from lighting maintenance can be anticipated since LEDs have lifetimes which are more than twice that of a fluorescent tubes.

ECM 2: Retrofit Fixtures with LED Lamps

Summary of Measure Economics

Interior/ Exterior	Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Interior	14,212	0	3.2	0.0	$2,387.66	$11,872.23	$715.00	$11,157.23	4.7	14,312
Exterior	0	0	0.0	0.0	$0.00	$0.00	$0.00	$0.00	0.0	0

Measure Description

We recommend retrofitting existing incandescent, fluorescent, or other lighting technologies with LED lamps. Many LED tube lamps are direct replacements for existing fluorescent lamps and can be installed while leaving the fluorescent fixture ballast in place. LED bulbs can be used in existing fixtures as a direct replacement for most other lighting technologies. This measure saves energy by installing LEDs which use less power than other lighting technologies yet provide equivalent lighting output for the space.

Additional savings from lighting maintenance can be anticipated since LEDs have lifetimes which are more than twice that of fluorescent tubes and more than 10 times longer than many incandescent lamps.

4.1.2 Lighting Control Measures

Our recommendations for lighting control measures are summarized in Figure 18 below.

Figure 18 – Summary of Lighting Control ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Lighting Control Measures		**19,397**	**0**	**4.4**	**0.0**	**$3,258.72**	**$9,950.00**	**$875.00**	**$9,075.00**	**2.8**	**19,533**
ECM 3	Install Occupancy Sensor Lighting Controls	16,768	0	3.8	0.0	$2,817.00	$6,750.00	$875.00	$5,875.00	2.1	16,885
ECM 4	Install High/Low Lighitng Controls	2,629	0	0.6	0.0	$441.72	$3,200.00	$0.00	$3,200.00	7.2	2,648

During lighting upgrade planning and design, we recommend a comprehensive approach that considers both the efficiency of the lighting fixtures and how they are controlled.

ECM 3: Install Occupancy Sensor Lighting Controls

Summary of Measure Economics

Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
16,768	0	3.8	0.0	$2,817.00	$6,750.00	$875.00	$5,875.00	2.1	16,885

Measure Description

We recommend installing occupancy sensors to control lighting fixtures that are currently controlled by manual switches in classrooms and offices areas. Lighting sensors detect occupancy using ultrasonic and/or infrared sensors. For most spaces, we recommend lighting controls use dual technology sensors, which can eliminate the possibility of any lights turning off unexpectedly. Lighting systems are enabled when an occupant is detected. Fixtures are automatically turned off after an area has been vacant for a preset period. Some controls also provide dimming options and all modern occupancy controls can be easily over-ridden by room occupants to allow them to manually turn fixtures on or off, as desired. Energy savings results from only operating lighting systems when they are required.

Occupancy sensors may be mounted on the wall at existing switch locations, mounted on the ceiling, or in remote locations. In general, wall switch replacement sensors are recommended for single occupant offices and other small rooms. Ceiling-mounted or remote mounted sensors are used in locations without local switching or where wall switches are not in the line-of-sight of the main work area and in large spaces. We recommend a comprehensive approach to lighting design that upgrades both the lighting fixtures and the controls together for maximum energy savings and improved lighting for occupants.

ECM 4: Install High/Low Lighting Controls

Summary of Measure Economics

Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
2,629	0	0.6	0.0	$441.72	$3,200.00	$0.00	$3,200.00	7.2	2,648

Measure Description

We recommend installing 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. Typical areas for such lighting control are interior corridors or hallways.

Lighting fixtures with these controls operate at default low levels when the area is not occupied to provide minimal lighting to meet security or safety requirements. Sensors detect occupancy using ultrasonic and/or infrared sensors. The lighting systems are switched to full lighting levels whenever an occupant is detected. Fixtures are automatically switched back to low level after an area has been vacant for a preset period of time. Energy savings results from only providing full lighting levels when it is required.

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

Additional savings from reduced lighting maintenance may also result from this measure, due to reduced lamp operation.

4.1.3 Motor Upgrades

Our recommendations for motor upgrades are summarized in Figure 19 below.

Figure 19 – Summary of Motor Upgrade ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	*Annual Natural Gas Savings (MMBtu)*	*Annual Steam Savings (MMBtu)*	*Annual N/A Savings (MMBtu)*	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)*	Estimated Net Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Motor Upgrades		**4,437**	**4,437**	**0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**$745.45**	**$14,735.68**	**$0.00**	**$14,735.68**	**19.8**	**4,468**
ECM 5	Premium Efficiency Motors	4,437	4,437	0	1.0	0.0	0.0	0.0	0.0	$745.45	$14,735.68	$0.00	$14,735.68	19.8	4,468

ECM 5: Premium Efficiency Motors

Summary of Measure Economics

Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
4,437	0	1.0	0.0	$745.45	$14,735.68	$0.00	$14,735.68	19.8	4,468

Measure Description

We recommend replacing standard efficiency motors with IHP 2014 efficiency motors. Our evaluation assumes that existing motors will be replaced with motors of equivalent size and type. Although occasionally additional savings can be achieved by downsizing motors to better meet the motor's current load requirements.

Although yielding a long payback as a standalone measure, premium efficiency motors have been recommended for all of the variable speed control measures to ensure there is sufficient budget to provide for inverter rated motors.

The base case motor efficiencies are estimated from nameplate information and our best estimates of motor run hours. Efficiencies of proposed motor upgrades are obtained from the *New Jersey's Clean Energy Program Protocols to Measure Resource Savings (2016)*. Savings are based on the difference between baseline and proposed efficiencies and the assumed annual operating hours.

4.1.4 Variable Frequency Drive Measures

Our recommendations for variable frequency drive (VFD) measures are summarized in Figure 20 below.

Figure 20 – Summary of Variable Frequency Drive ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
Variable Frequency Drive (VFD) Measures		107,502	0	25.3	0.0	$18,060.27	$47,660.40	$6,800.00	$40,860.40	2.3	108,253
ECM 6	Install VFDs on Constant Volume (CV) HVAC	77,643	0	21.5	0.0	$13,044.03	$28,005.30	$6,800.00	$21,205.30	1.6	78,186
ECM 7	Install VFDs on Chilled Water Pumps	14,929	0	1.9	0.0	$2,508.12	$9,827.55	$0.00	$9,827.55	3.9	15,034
ECM 8	Install VFDs on Hot Water Pumps	14,929	0	1.9	0.0	$2,508.12	$9,827.55	$0.00	$9,827.55	3.9	15,034

ECM 6: Install VFDs on Constant Volume (CV) HVAC

Summary of Measure Economics

Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
77,643	0	21.5	0.0	$13,044.03	$28,005.30	$6,800.00	$21,205.30	1.6	78,186

Measure Description

We recommend installing variable frequency drives (VFDs) to control supply fan motor speeds to convert 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 will cause the VFD to modulate fan speed to maintain the appropriate temperature in the zone, while maintaining a constant supply air temperature. Energy savings results from reducing fan speed (and power) when there is a reduced load required for the zone. The magnitude of energy savings is based on the estimated amount of time that fan motors operate at partial load. The replacement of existing motors with premium efficiency motors is recommended for this measure to ensure that the motors are inverter-rated and compatible with VFDs.

VAV systems should not be controlled such that the supply air temperature is raised at the expense of the fan power. A common mistake is to reset the supply air temperature to achieve chiller energy savings, which can lead to additional air flow requirements. Supply air temperature should be kept low, e.g. 55°F, until the minimum fan speed (typically about 50%) is met. At this point, it is efficient to raise the supply air temperature as the load decreases, but not such that additional air flow and thus fan energy is required.

For air handlers with direct expansion (DX) cooling systems, the minimum air flow across the cooling coil required to prevent the coil from freezing will have to be determined during the final project design. The control system should be programmed to maintain the minimum air flow whenever the compressor is operating.

ECM 7: Install VFDs on Chilled Water Pumps

Summary of Measure Economics

Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
14,929	0	1.9	0.0	$2,508.12	$9,827.55	$0.00	$9,827.55	3.9	15,034

Measure Description

We recommend installing a variable frequency drives (VFD) to control chilled water pumps. This measure requires that chilled water coils be served by 2-way valves and that a differential pressure sensor be installed in the chilled water loop. As the chilled water valves close, the differential pressure increases. The VFD modulates pump speed to maintain a differential pressure setpoint. Energy savings results from reducing 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. The replacement of existing motors with premium efficiency motors is recommended for this measure to ensure that the motors are inverter-rated and compatible with VFDs.

For systems with variable chilled water flow through the chiller, the minimum flow to prevent the chiller from tripping off will have 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.

ECM 8: Install VFDs on Hot Water Pumps

Summary of Measure Economics

Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
14,929	0	1.9	0.0	$2,508.12	$9,827.55	$0.00	$9,827.55	3.9	15,034

Measure Description

We recommend installing a variable frequency drives (VFD) to control a hot water pumps. This measure requires that a majority of the hot water coils be served by 2-way valves and that a differential pressure sensor is installed in the hot water loop. As the hot water valves close, the differential pressure increases. The VFD modulates pump speed to maintain a differential pressure setpoint. Energy savings results from reducing pump motor speed (and power) as hot water valves close. The magnitude of energy savings is based on the estimated amount of time that the system will operate at reduced load. The replacement of existing motors with premium efficiency motors is recommended for this measure to ensure that the motors are inverter-rated and compatible with VFDs.

4.1.5 HVAC System Upgrades

Our recommendation for HVAC system improvement are summarized in Figure 21 below.

Figure 21 - Summary of HVAC System Improvement ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
HVAC System Improvements		**0**	**4,216**	**0.0**	**57.7**	**$2,260.23**	**$19,031.88**	**$0.00**	**$19,031.88**	**8.4**	**8,440**
ECM 9	Implement Demand Control Ventilation	0	4,216	0.0	57.7	$2,260.23	$19,031.88	$0.00	$19,031.88	8.4	8,440

ECM 9: Implement Demand Control Ventilation (DCV)

Summary of Measure Economics

Annual Electric Savings (kWh)	Chilled Water Savings (Ton-Hr)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated Install Cost ($)	Estimated Incentive ($)	Estimated Net Cost ($)	Simple Payback Period (yrs)	CO_2e Emissions Reduction (lbs)
0	4,216	0.0	57.7	$2,260.23	$19,031.88	$0.00	$19,031.88	8.4	8,440

Measure Description

Demand control ventilation (DCV) monitors indoor air CO_2 content to measure room occupancy. This data is used to regulate the amount of outdoor air provided to the space for ventilation. In order to ensure adequate air quality, standard ventilation systems often provide outside air based on a space's estimated maximum occupancy. However, during low occupancy periods, the space may be over ventilated. This wastes energy through excessive fan usage and additional cost to heat and cool the excessive air flow. DCV reduces unnecessary outdoor air intake by regulating ventilation based on actual occupancy levels, saving significant amounts of energy. DCV is most suited for facilities where occupancy levels vary significantly hour to hour and day to day. For laboratory areas with fume hoods the DCV operation will need to be coordinated with the fume hood operation to make sure that adequate ventilation is provided to meet safety requirements.

Energy savings associated with DCV are based on hours of operation, space occupancy, system air flow, outside air reduction, and other factors. Energy savings results from eliminating unnecessary ventilation and space conditioning.

5 ENERGY EFFICIENT PRACTICES

In addition to the quantifiable savings estimated in Section 4, a facility's energy performance can also be improved through application of many low cost or no-cost energy efficiency strategies. By employing certain behavioral and operational changes and performing routine maintenance on building systems, equipment lifetime can be extended; occupant comfort, health and safety can be improved; and energy and O&M costs can be reduced. The recommendations below are provided as a framework for developing a whole building maintenance plan that is customized to your facility. Consult with qualified equipment specialists for details on proper maintenance and system operation.

Reduce Air Leakage

Air leakage, or infiltration, occurs when outside air enters a building uncontrollably through cracks and openings. Properly sealing such cracks and openings can significantly reduce heating and cooling costs, improve building durability, and create a healthier indoor environment. This includes caulking or installing weather stripping around leaky doors and windows allowing for better control of indoor air quality through controlled ventilation.

Close Doors and Windows

Ensure doors and windows are closed in conditioned spaces. Leaving doors and windows open leads to a significant increase in heat transfer between conditioned spaces and the outside air. Reducing a facility's air changes per hour (ACH) can lead to increased occupant comfort as well as significant heating and cooling savings, especially when combined with proper HVAC controls and adequate ventilation.

Perform Proper Lighting Maintenance

In order to sustain optimal lighting levels, lighting fixtures should undergo routine maintenance. Light levels decrease over time due to lamp aging, lamp and ballast failure, and buildup of dirt and dust on lamps, fixtures and reflective surfaces. Together, these factors can reduce total illumination by 20% - 60% or more, while operating fixtures continue drawing full power. To limit this reduction, lamps, reflectors and diffusers should be thoroughly cleaned of dirt, dust, oil, and smoke film buildup approximately every 6 – 12 months.

Develop a Lighting Maintenance Schedule

In addition to routine fixture cleaning, development of a maintenance schedule can both ensure maintenance is performed regularly and can reduce the overall cost of fixture re-lamping and re-ballasting. By re-lamping and re-ballasting fixtures in groups, lighting levels are better maintained and the number of site visits by a lighting technician or contractor can be minimized, decreasing the overall cost of maintenance.

Ensure Lighting Controls Are Operating Properly

Lighting controls are very cost effective energy efficient devices, when installed and operating correctly. As part of a lighting maintenance schedule, lighting controls should be tested annually to ensure proper functioning. For occupancy sensors, this requires triggering the sensor and verifying that the sensor's timer settings are correct. For daylight sensors, maintenance involves cleaning of sensor lenses and confirming setpoints and sensitivity are appropriately configured.

Turn Off Unneeded Motors

Electric motors often run unnecessarily, and this is an overlooked opportunity to save energy. These motors should be identified and turned off when appropriate. For example, exhaust fans often run unnecessarily when ventilation requirements are already met. Reducing run hours for these motors can result in significant energy savings. Whenever possible, use automatic devices such as twist timers or occupancy sensors to ensure that motors are turned off when not needed.

Perform Routine Motor Maintenance

Motors consist of many moving parts whose collective degradation can contribute to a significant loss of motor efficiency. In order to prevent damage to motor components, routine maintenance should be performed. This maintenance consists of 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.

Clean Evaporator/Condenser Coils on AC Systems

Dirty evaporators and condensers coils cause a restriction to air flow and restrict heat transfer. This results in increased evaporator and condenser fan load and a decrease in cooling system performance. Keeping the coils clean allows the fans and cooling system to operate more efficiently.

Clean and/or Replace HVAC Filters

Air filters work to reduce the amount of indoor air pollution and increase occupant comfort. Over time, filters become less and less effective as particulate buildup increases. In addition to health concerns related to clogged filters, filters that have reached saturation also restrict air flow through the facility's air conditioning or heat pump system, increasing the load on the distribution fans and decreasing occupant comfort levels. Filters should be checked monthly and cleaned or replaced when appropriate.

Check for and Seal Duct Leakage

Duct leakage in commercial buildings typically accounts for 5 to 25 percent of the supply airflow. In the case of rooftop air handlers, duct leakage can occur to the outside of the building, significantly increasing cooling and heating costs. By sealing sources of leakage, cooling, heating, and ventilation energy use can be reduced significantly, depending on the severity of air leakage.

Repair/Replace Steam Traps

Properly functioning steam traps ensure that all latent heat in the steam is delivered to the end use by preventing pressurized steam from leaking. Steam traps should be inspected as part of the regular steam system maintenance. Traps that are blocked, venting, or allowing steam to leak through should be repaired or replaced. Repairing or replacing existing steam traps will reduce steam losses.

Perform Proper Water Heater Maintenance

At least once a year, drain a few gallons out of the water heater using the drain valve. If there is a lot of sediment or debris, then a full flush is recommended. Turn the temperature down and then completely drain the tank. Once a year check for any leaks or heavy corrosion on the pipes and valves. For gas water heaters, check the draft hood and make sure it is placed properly, with a few inches of air space between the tank and where it connects to the vent. Look for any corrosion or wear on the gas line and on the piping. If you noticed any black residue, soot or charred metal, this is a sign you may be having combustion issues and you should have the unit serviced by a professional. For electric water heaters, look for any signs of leaking such as rust streaks or residue around the upper and lower panels covering the electrical components on the tank. For water heaters over three to four years old have a technician inspect the sacrificial anode annually.

Perform Maintenance on Compressed Air Systems

Like all electro-mechanical equipment, compressed air systems require periodic maintenance to operate at peak efficiency. A maintenance plan should be developed for process related compressed air systems to include inspection, cleaning, and replacement of inlet filter cartridges, cleaning of drain traps, daily inspection of lubricant levels to reduce unwanted friction, inspection of belt condition and tension, checking for system leaks and adjustment of loose connections, and overall system cleaning. Contact a qualified technician for help with setting up periodic maintenance schedule.

Water Conservation

Installing low-flow faucets or faucet aerators, low-flow showerheads, and kitchen sink pre-rinse spray valves saves both energy and water. These devices save energy by reducing the overall amount of hot water used hence reducing the energy used to heat the water. The flow ratings for EPA WaterSense™ (http://www3.epa.gov/watersense/products) labeled devices are 1.5 gpm for bathroom faucets, 2.0 gpm for showerheads, and 1.28 gpm for pre-rinse spray valves.

Installing dual flush or low-flow toilets and low-flow or waterless urinals are additional ways to reduce the sites water use, however, these devices do not provide energy savings at the site level. 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. The EPA WaterSense™ ratings for urinals is 0.5 gallons per flush (gpf) and toilets that use as little as 1.28 gpf (this is lower than the current 1.6 gpf federal standard).

6 On-Site Generation Measures

On-site generation measure options include both renewable (e.g., solar, wind) and non-renewable (e.g., fuel cells) on-site technologies that generate power to meet all or a portion of the electric energy needs of a facility, often repurposing any waste heat where applicable. Also referred to as distributed generation, these systems contribute to Greenhouse Gas (GHG) emission reductions, demand reductions and reduced customer electricity purchases, resulting in the electric system reliability through improved transmission and distribution system utilization.

The State of New Jersey's Energy Master Plan (EMP) encourages new distributed generation of all forms and specifically focuses on expanding use of combined heat and power (CHP) by reducing financial, regulatory and technical barriers and identifying opportunities for new entries. The EMP also outlines a goal of 70% of the State's electrical needs to be met by renewable sources by 2050.

Preliminary screenings were performed to determine the potential that a generation project could provide a cost-effective solution for your facility. Before making a decision to implement, a feasibility study should be conducted that would take a detailed look at 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 Photovoltaic

Sunlight can be converted into electricity using photovoltaics (PV) modules. Modules are racked together into an array that produces direct current (DC) electricity. The DC current is converted to alternating current (AC) through an inverter. The inverter is interconnected to the facility's electrical distribution system. The amount of unobstructed area available determines how large of a solar array can be installed. The size of the array combined with the orientation, tilt, and shading elements determines the energy produced.

A preliminary screening based on the campus' electric demand and the size and location of free areas on campus was performed and is addressed in the campus level summary report.

For more information on solar PV technology and commercial solar markets in New Jersey, or to find a qualified solar installer, who can provide a more detailed assessment of the specific costs and benefits of solar develop of the site, please visit the following links below:

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

6.2 Combined Heat and Power

Combined heat and power (CHP) is the on-site generation of electricity along with the recovery of heat energy, which is put to beneficial use. Common technologies for CHP include reciprocating engines, microturbines, fuel cells, backpressure steam turbines, and (at large facilities) gas turbines. Electric generation from a CHP system is typically interconnected to local power distribution systems. Heat is recovered from exhaust and ancillary cooling systems and interconnected to the existing hot water (or steam) distribution systems.

The campus has a CHP plant that uses natural gas fired turbines to generate electricity. Waste heat from the turbines is used to produce steam which is either delivered to buildings on campus or used to produce chilled water which is delivered to buildings on campus. Since the campus has a CHP that serves a significant portion of the campus further evaluation of individual building CHP applications were not done.

7 Demand Response

Demand Response (DR) is a program designed to reduce the electric load of commercial facilities when electric wholesale prices are high or when the reliability of the electric grid is threatened due to peak demand. Demand Response service providers (a.k.a. Curtailment Service Providers) are registered with PJM, the independent system operator (ISO) for mid-Atlantic state region that is charged with maintaining electric grid reliability.

By enabling grid operators to call upon Curtailment Service Providers and commercial facilities to reduce electric usage 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 DR programs. Program participation is voluntary and participants receive payments whether or not their facility is called upon to curtail their electric usage.

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

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

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

The first step toward participation in a DR program is to contact a Curtailment Service Provider. A list of these providers is available on PJM's website and it includes contact information for each company, as well as the states where they have active business (http://www.pjm.com/markets-and-operations/demand-response/csps.aspx). PJM also posts training materials that are developed for program members interested in specific rules and requirements regarding DR activity (http://www.pjm.com/training/training%20material.aspx), along with a variety of other DR program information.

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

In our opinion this building is not a good candidate for DR.

8 PROJECT FUNDING / INCENTIVES

The NJCEP is able to provide the incentive programs described below, and other benefits to ratepayers, because of the Societal Benefits Charge (SBC) Fund. The SBC was created by the State of New Jersey's Electricity Restructuring Law (1999), which requires all customers of investor-owned electric and gas utilities to pay a surcharge on their monthly energy bills. As a customer of a state-regulated electric or gas utility and therefore a contributor to the fund your organization is eligible to participate in the LGEA program and also eligible to receive incentive payment for qualifying energy efficiency measures. Also available through the NJBPU are some alternative financing programs described later in this section. Please refer to Figure 22 for a list of the eligible programs identified for each recommended ECM.

Figure 22 - ECM Incentive Program Eligibility

Energy Conservation Measure		SmartStart Prescriptive	SmartStart Custom	Direct Install	Pay For Performance Existing Buildings	Large Energy Users Program	Combined Heat & Power and Fuel Cell
ECM 1	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	X			X		
ECM 2	Retrofit Fixtures with LED Lamps	X			X		
ECM 3	Install Occupancy Sensor Lighting Controls	X			X		
ECM 4	Install High/Low Lighitng Controls				X		
ECM 5	Premium Efficiency Motors				X		
ECM 6	Install VFDs on Constant Volume (CV) HVAC	X			X		
ECM 7	Install VFDs on Chilled Water Pumps	X			X		
ECM 8	Install VFDs on Hot Water Pumps				X		
ECM 9	Implement Demand Control Ventilation				X		

SmartStart is generally well-suited for implementation of individual measures or small group of measures. It provides flexibility to install measures at your own pace using in-house staff or a preferred contractor. Direct Install caters to small to mid-size facilities that can bundle multiple ECMs together. This can greatly simplify participation and may lead to higher incentive amounts, but requires the use of pre-approved contractors. The Pay for Performance (P4P) program is a "whole-building" energy improvement program designed for larger facilities. It requires implementation of multiple measures meeting minimum savings thresholds, as well as use of pre-approved consultants. This facility does not meet all of the criteria for participating in the P4P program based on the measures identified in this study. However, since additional measures may be identified during the P4P evaluation and the facility is close to meeting the P4P program criteria it is worth considering the P4P program for this site. The Large Energy Users Program (LEUP) is available to New Jersey's largest energy users giving them flexibility to install as little or as many measures, in a single facility or several facilities, with incentives capped based on the entity's annual energy consumption. LEUP applicants can use in-house staff or a preferred contractor.

Generally, the incentive values provided throughout the report assume the SmartStart program is utilized because it provides a consistent basis for comparison of available incentives for various measures, though in many cases incentive amounts may be higher through participation in other programs.

Brief descriptions of all relevant financing and incentive programs are located in the sections below. Further information, including most current program availability, requirements, and incentive levels can be found at: www.njcleanenergy.com/ci.

8.1 SmartStart

Overview

The SmartStart program offers incentives for installing prescriptive and custom energy efficiency measures at your facility. Routinely the program adds, removes or modifies incentives from year to year for various energy efficiency equipment based on market trends and new technologies.

Equipment with Prescriptive Incentives Currently Available:

Electric Chillers
Electric Unitary HVAC
Gas Cooling
Gas Heating
Gas Water Heating
Ground Source Heat Pumps
Lighting
Lighting Controls
Refrigeration Doors
Refrigeration Controls
Refrigerator/Freezer Motors
Food Service Equipment
Variable Frequency Drives

Most equipment sizes and types are served by this program. This program provides an effective mechanism for securing incentives for energy efficiency measures installed individually or as part of a package of energy upgrades.

Incentives

The SmartStart prescriptive incentive program provides fixed incentives for specific energy efficiency measures, whereas the custom SmartStart program provides incentives for more unique or specialized technologies or systems that are not addressed through prescriptive incentive offerings for specific devices.

Since your facility is an existing building, only the retrofit incentives have been applied in this report. Custom Measure incentives are calculated at $0.16/kWh and $1.60/therm based on estimated annual savings, capped at 50% of the total installed incremental project cost, or a project cost buy down to a one year payback (whichever is less. Program incentives are capped at $500,000 per electric account and $500,000 per natural gas account, per fiscal year.

How to Participate

To participate in the SmartStart program you will need to submit an application for the specific equipment to be installed. Many applications are designed as rebates, although others require application approval prior to installation. Applicants may work with a contractor of their choosing and can also utilize internal personnel, which provides added flexibility to the program. Using internal personnel also helps improve the economics of the ECM by reducing the labor cost that is included in the tables in this report.

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

8.2 Pay for Performance - Existing Buildings

Overview

The Pay for Performance – Existing Buildings (P4P EB) program is designed for larger customers with a peak demand over 200 kW in any of the preceding 12 months. Under this program the minimum installed scope of work must include at least two unique measures resulting in at least 15% energy savings, where lighting cannot make up the majority of the savings. P4P is a generally a good option for medium to large sized facilities looking to implement as many measures as possible under a single project in order to achieve deep energy savings. This program has an added benefit of evaluating a broad spectrum of measures that may not otherwise qualify under other programs. Many facilities pursuing an Energy Savings Improvement Program (ESIP) loan also utilize the P4P program.

Incentives

Incentives are calculated based on estimated and achieved energy savings ranging from $0.18-$0.22/kWh and $1.80-$2.50/therm, capped at the lesser of 50% total project cost, or $1 million per electric account and $1 million per natural gas account, per fiscal year, not to exceed $2 million per project. An incentive of $0.15/square foot is also available to offset the cost of developing the Energy Reduction Plan (see below) contingent on the project moving forward with measure installation.

How to Participate

To participate in the P4B EB program you will need to contact one of the pre-approved consultants and contractors ("Partners"). Under direct contract to you, the Partner will help further evaluate the measures identified in this report through development of the Energy Reduction Plan (ERP), assist you in implementing selected measures, and verify actual savings one year after the installation. At each of these three milestones your Partner will also facilitate securing program incentives.

Approval of the final scope of work is required by the program prior to installation completion. Although installation can be accomplished by a contractor of your choice (some P4P Partners are also contractors) or by internal personnel, the Partner must remain involved to ensure compliance with the program guidelines and requirements.

Detailed program descriptions, instructions for applying, applications and list of Partners can be found at: www.njcleanenergy.com/P4P.

8.3 Energy Savings Improvement Program

The Energy Savings Improvement Program (ESIP) is an alternate method for New Jersey's government agencies to finance the implementation of energy conservation measures. An ESIP is a type of "performance contract," whereby school districts, counties, municipalities, housing authorities and other public and state entities enter in to contracts to help finance building energy upgrades. This is done in a manner that ensures that annual payments are lower than the savings projected from the ECMs, ensuring that ESIP projects are cash flow positive in year one, and every year thereafter. 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 can be leveraged to help further reduce the total project cost of eligible measures.

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 utilized 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 (ESP) 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. Entities should carefully consider all alternatives to develop an approach that best meets their needs. A detailed program descriptions and application can be found at: www.njcleanenergy.com/ESIP.

Please note that ESIP is a program delivered directly by the NJBPU and is not an NJCEP incentive program. As mentioned above, you may utilize NJCEP incentive programs to help further reduce costs when developing the ESP. You should refer to the ESIP guidelines at the link above for further information and guidance on next steps.

9 ENERGY PURCHASING AND PROCUREMENT STRATEGIES

9.1 Retail Electric Supply Options

In 1999, New Jersey State Legislature passed the Electric Discount & Energy Competition Act (EDECA) to restructure the electric power industry in New Jersey. This law deregulated the retail electric markets, allowing all consumers to shop for service from competitive electric suppliers. The intent was to create a more competitive market for electric power supply in New Jersey. As a result, utilities were allowed to charge Cost of Service and customers were given the ability to choose a third party (i.e. non-utility) energy supplier.

Energy deregulation in New Jersey has increased energy buyers' options by separating the function of electricity distribution from that of electricity supply. So, 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 is purchasing electricity from a third party supplier, review and compare prices at the end of the current contract or every couple years.

A list of third party electric suppliers, who are licensed by the state to provide service in New Jersey, can be found online at: www.state.nj.us/bpu/commercial/shopping.html.

9.2 Retail Natural Gas Supply Options

The natural gas market in New Jersey has also been deregulated. Most customers that remain with the utility for natural gas service pay rates that are market-based and that fluctuate on a monthly basis. The utility provides basic gas supply service (BGSS) 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 is typically dependent upon whether a customer seeks 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 is not purchasing natural gas from a third party supplier, consider shopping for a reduced rate from third party natural gas suppliers. If your facility is purchasing natural gas from a third party supplier, review and compare prices at the end of the current contract or every couple years.

A list of third party natural gas suppliers, who are licensed by the state to provide service in New Jersey, can be found online at: 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	Watts per Fixture	Annual Operating Hours	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	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Hall	32	U-Bend Fluorescent - T12: U T12 (34W) - 2L	Wall Switch	72	2,808	Relamp & Reballast	Yes	32	LED - Linear Tubes: (2) U-Lamp	High/Low Control	33	1,966	1.00	4,394	0.0	$738.19	$4,744.00	$0.00	6.43
Hall	32	Compact Fluorescent: 2l CFL Pin	Wall Switch	36	2,808	Relamp	Yes	32	LED Screw-In Lamps: Plug-in (18W) 2L	High/Low Control	25	1,966	0.43	1,897	0.0	$318.73	$3,812.99	$0.00	11.96
119	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
120	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
118	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
117	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
121	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
122	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
123	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
112	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
111	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
110	4	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	4	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	0.20	874	0.0	$146.91	$738.00	$75.00	4.51
117	3	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	3	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.13	572	0.0	$96.02	$351.00	$30.00	3.34
114	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
115	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
109	6	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	6	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	0.30	1,312	0.0	$220.37	$972.00	$95.00	3.98
Women's Room	2	Linear Fluorescent - T12: 4' T12 (40W) - 1L	Wall Switch	46	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,808	0.05	203	0.0	$34.18	$196.00	$10.00	5.44
Women's Room	6	Compact Fluorescent: CFL	Wall Switch	20	2,808	Relamp	No	6	LED Screw-In Lamps: Screiw-in 1L	Wall Switch	14	2,808	0.03	116	0.0	$19.53	$263.72	$0.00	13.50
Men's Room	1	Linear Fluorescent - T8: 4' T8 (32W) - 1L	Wall Switch	32	2,808	Relamp	No	1	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,808	0.01	57	0.0	$9.49	$35.90	$5.00	3.25
Men's Room	2	Incandescent: Screw In	Wall Switch	75	2,808	Relamp	No	2	LED Screw-In Lamps: Screw-in 1L	Wall Switch	11	2,808	0.09	412	0.0	$69.17	$87.91	$10.00	1.13
108	12	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	12	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	0.60	2,623	0.0	$440.73	$1,674.00	$155.00	3.45
135	24	Linear Fluorescent - T12: 4' T12 (40W) - 4L	Wall Switch	176	2,808	Relamp & Reballast	Yes	24	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,966	2.39	10,494	0.0	$1,762.93	$4,154.00	$515.00	2.06
Display Case	2	Linear Fluorescent - T12: 4' T12 (40W) - 1L	Wall Switch	46	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,808	0.05	203	0.0	$34.18	$196.00	$10.00	5.44
131	16	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	16	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	0.80	3,498	0.0	$587.64	$2,142.00	$195.00	3.31
131	2	Incandescent: Screw In	Wall Switch	100	2,808	Relamp	No	2	LED Screw-In Lamps: Screw-in 1L	Wall Switch	15	2,808	0.13	549	0.0	$92.23	$87.91	$10.00	0.84

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	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	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
131	15	Incandescent: Screw In	Wall Switch	75	2,808	Relamp	Yes	15	LED Screw-In Lamps: Screw-in 1L	Occupancy Sensor	11	1,966	0.74	3,251	0.0	$546.24	$929.30	$110.00	1.50
129	56	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	56	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	2.79	12,243	0.0	$2,056.75	$6,822.00	$595.00	3.03
Stairs	2	Linear Fluorescent - T12: 4' T12 (40W) - 1L	Wall Switch	46	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,808	0.05	203	0.0	$34.18	$196.00	$10.00	5.44
Stairs	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,808	Relamp	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.05	213	0.0	$35.81	$117.00	$20.00	2.71
Hall	16	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Wall Switch	62	2,808	Relamp	Yes	16	LED - Linear Tubes: (2) U-Lamp	High/Low Control	33	1,966	0.46	2,010	0.0	$337.66	$1,411.20	$0.00	4.18
Hall	29	Compact Fluorescent: 2l CFL Pin	Wall Switch	36	2,808	Relamp	Yes	29	LED Screw-In Lamps: Plug-in (18W) 2L	High/Low Control	25	1,966	0.39	1,719	0.0	$288.85	$3,349.27	$0.00	11.60
210	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
211	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
212	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
215	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
216	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
217	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
218	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
219	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
220	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
221	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
222	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
Women's Room	1	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.04	191	0.0	$32.01	$117.00	$10.00	3.34
Women's Room	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,808	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.02	107	0.0	$17.90	$58.50	$10.00	2.71
Women's Room	4	Compact Fluorescent: CFL	Wall Switch	33	2,808	Relamp	No	4	LED Screw-In Lamps: Screiw-in 1L	Wall Switch	23	2,808	0.03	128	0.0	$21.48	$175.81	$0.00	8.18
Men's Room	1	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.04	191	0.0	$32.01	$117.00	$10.00	3.34
Men's Room	2	Compact Fluorescent: CFL	Wall Switch	33	2,808	Relamp	No	2	LED Screw-In Lamps: Screiw-in 1L	Wall Switch	23	2,808	0.01	64	0.0	$10.74	$87.91	$0.00	8.18
209	9	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	2,808	Relamp	Yes	9	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,966	0.49	2,133	0.0	$358.38	$1,126.20	$215.00	2.54
Display Cases	4	Linear Fluorescent - T12: 4' T12 (40W) - 1L	Wall Switch	46	2,808	Relamp & Reballast	No	4	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,808	0.09	407	0.0	$68.36	$392.00	$20.00	5.44
Women's Room	1	U-Bend Fluorescent - T8: U T8 (32W) - 2L	Wall Switch	62	2,808	Relamp	No	1	LED - Linear Tubes: (2) U-Lamp	Wall Switch	33	2,808	0.02	94	0.0	$15.73	$63.20	$0.00	4.02

	Existing Conditions					Proposed Conditions							Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	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	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
228	37	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	37	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	1.84	8,089	0.0	$1,358.92	$4,599.00	$405.00	3.09
224a	15	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	15	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	0.75	3,279	0.0	$550.91	$2,025.00	$185.00	3.34
229	28	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	28	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	1.40	6,121	0.0	$1,028.37	$3,546.00	$315.00	3.14
224	18	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	18	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	0.90	3,935	0.0	$661.10	$2,376.00	$215.00	3.27
224	6	Compact Fluorescent: CFL	Wall Switch	33	2,808	Relamp	Yes	6	LED Screw-In Lamps: Screiw-in 1L	Occupancy Sensor	23	1,966	0.07	326	0.0	$54.78	$533.72	$35.00	9.10
231	28	Linear Fluorescent - T12: 8' T12 (75W) - 2L	Wall Switch	158	2,808	Relamp & Reballast	Yes	28	LED - Linear Tubes: (2) 8' Lamps	Occupancy Sensor	72	1,966	2.22	9,729	0.0	$1,634.46	$5,926.00	$35.00	3.60
225	44	Linear Fluorescent - T12: 8' T12 (75W) - 2L	Wall Switch	158	2,808	Relamp & Reballast	Yes	44	LED - Linear Tubes: (2) 8' Lamps	Occupancy Sensor	72	1,966	3.48	15,288	0.0	$2,568.44	$9,158.00	$35.00	3.55
225	2	Linear Fluorescent - T12: 4' T12 (40W) - 4L	Wall Switch	176	2,808	Relamp & Reballast	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,966	0.20	874	0.0	$146.91	$593.67	$75.00	3.53
Electrical Room	1	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.04	191	0.0	$32.01	$117.00	$10.00	3.34
208	5	Halogen Incandescent: MR16	Wall Switch	50	2,808	Relamp	Yes	5	LED Screw-In Lamps: Screw-in 1L	Occupancy Sensor	8	1,966	0.16	723	0.0	$121.39	$612.27	$60.00	4.55
Stairs	2	Linear Fluorescent - T12: 4' T12 (40W) - 1L	Wall Switch	46	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	2,808	0.05	203	0.0	$34.18	$196.00	$10.00	5.44
Stairs	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
126	57	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	57	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	2.84	12,461	0.0	$2,093.47	$6,939.00	$605.00	3.03
134	30	Linear Fluorescent - T12: 4' T12 (40W) - 4L	Wall Switch	176	2,808	Relamp & Reballast	Yes	30	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,966	2.99	13,117	0.0	$2,203.66	$5,125.00	$635.00	2.04
131	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,808	0.09	381	0.0	$64.02	$234.00	$20.00	3.34
131	12	Incandescent: Screw In	Wall Switch	60	2,808	Relamp	Yes	12	LED Screw-In Lamps: Screw-in 1L	Occupancy Sensor	9	1,966	0.47	2,081	0.0	$349.59	$797.44	$95.00	2.01
130	32	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	32	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	1.59	6,996	0.0	$1,175.28	$4,014.00	$355.00	3.11
226	32	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	2,808	Relamp	Yes	32	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	0.98	4,309	0.0	$723.92	$2,142.00	$355.00	2.47
226	9	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	9	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	0.45	1,968	0.0	$330.55	$1,323.00	$125.00	3.62
230	20	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	20	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	1.00	4,372	0.0	$734.55	$2,610.00	$235.00	3.23
230	20	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	2,808	Relamp & Reballast	Yes	20	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,966	1.00	4,372	0.0	$734.55	$2,610.00	$235.00	3.23
Whole building	20	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	20	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

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?	Annual Operating Hours	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	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Mechanical Room	Whole Building	2	Heating Hot Water Pump	5.0	87.5%	No	2,745	Yes	89.5%	Yes	2	1.35	10,306	0.0	$1,731.38	$8,152.44	$0.00	4.71
Mechanical Room	Whole Building	2	Chilled Water Pump	3.0	86.0%	No	2,745	No	86.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical Room	Whole Building	2	Other	3.0	86.0%	No	2,745	No	86.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical Room	Whole Building	1	Air Compressor	3.0	89.5%	No	400	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical Room	Theater/Offices	1	Supply Fan	1.5	89.5%	No	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical Room	Theater/Offices	1	Return Fan	1.5	86.5%	No	2,745	No	86.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab	2	Exhaust Fan	0.5	70.0%	No	2,745	No	70.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab	1	Exhaust Fan	0.3	67.0%	No	2,745	No	67.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab	1	Exhaust Fan	0.5	70.0%	No	2,745	No	70.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab	1	Exhaust Fan	0.3	67.0%	No	2,745	No	67.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab - EF-6	1	Exhaust Fan	7.5	88.0%	No	3,391	No	88.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab	2	Exhaust Fan	0.3	67.0%	No	2,745	No	67.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab	1	Exhaust Fan	10.0	90.0%	No	3,391	No	90.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab	2	Exhaust Fan	0.8	70.0%	No	2,745	No	70.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab - EF4	1	Exhaust Fan	20.0	91.0%	No	3,391	No	91.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab	2	Exhaust Fan	0.3	67.0%	No	2,745	No	67.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Lab	1	Exhaust Fan	30.0	92.0%	No	4,067	No	92.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	MZ-1	1	Supply Fan	20.0	91.0%	No	3,391	Yes	93.0%	Yes	1	5.57	20,188	0.0	$3,391.54	$8,582.03	$1,600.00	2.06
Roof	MZ-2	1	Supply Fan	20.0	91.0%	No	3,391	Yes	93.0%	Yes	1	5.57	20,188	0.0	$3,391.54	$8,582.03	$1,600.00	2.06

		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?	Annual Operating Hours	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	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Roof	Pkgd unit	1	Supply Fan	20.0	91.0%	No	3,391	Yes	93.0%	Yes	1	5.57	20,188	0.0	$3,391.54	$8,582.03	$1,600.00	2.06
Roof	Pkgd unit	1	Supply Fan	15.0	91.0%	No	3,391	Yes	93.0%	Yes	1	4.17	15,141	0.0	$2,543.65	$7,041.17	$1,200.00	2.30
Roof	Exhaust - EF-5	1	Exhaust Fan	10.0	90.0%	No	3,391	Yes	91.7%	Yes	1	1.39	5,317	0.0	$893.31	$5,151.50	$800.00	4.87
Mechanical Room	Space heating	1	Heating Hot Water Pump	5.0	87.5%	No	2,745	Yes	89.5%	Yes	1	0.68	5,153	0.0	$865.69	$4,076.22	$0.00	4.71
Mechanical Room	Space cooling	1	Chilled Water Pump	5.0	87.5%	No	2,745	Yes	89.5%	Yes	1	0.68	5,153	0.0	$865.69	$4,076.22	$0.00	4.71
Mechanical Room	Space cooling	2	Chilled Water Pump	5.0	87.5%	No	2,745	Yes	89.5%	Yes	2	1.35	10,306	0.0	$1,731.38	$8,152.44	$0.00	4.71
Mechanical Room	Condensate	2	Process Pump	5.0	87.5%	No	2,745	No	87.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Electric 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 (kBtu/hr)	Install High Efficiency System?	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (kBtu/hr)	Cooling Mode Efficiency (SEER/EER)	Heating Mode Efficiency (COP)	Install Dual Enthalpy Economizer?	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Rooftop	2nd Floor	1	Packaged AC	30.00		No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Rooftop	1st Floor	1	Packaged AC	20.00		No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mech Room	Theater/Offices	1	Packaged AC	3.00		No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Lab	Lab	1	Electric Resistance Heat		34.00	No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mech Room	Theater/Offices	1	Water Source HP	3.00	34.00	No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

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)	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	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Central plant	Whole building	1	Water-Cooled Centrifugal Chiller	70.00	No							0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Fuel Heating 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)	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	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Central plant	Whole building	1	Forced Draft Steam Boiler	3,000.00	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	Space heating	1	Furnace	56.00	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Demand Control Ventilation Recommendations

		Recommendation Inputs				Energy Impact & Financial Analysis					
Location	Area(s)/System(s) Affected	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 Annual Ton-Hr Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Building	large rooms	14	62.00		887.00	4,216	57.7	$2,260.23	$19,031.88	$0.00	8.42

DHW Inventory & Recommendations

		Existing Conditions		Proposed Conditions						Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	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	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Mech Room	Whole Building	1	Indirect System	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Plug Load Inventory

	Existing Conditions			
Location	Quantity	Equipment Description	Energy Rate (W)	ENERGY STAR Qualified?
Pottery Lab	3	Electric Kiln	8,250.0	No
Pottery Lab	1	Electric Kiln	27,750.0	No
Pottery Lab	1	Electric Kiln	3,375.0	No
Pottery Lab	2	Electric Kiln	3,375.0	No
Pottery Lab	1	Electric Kiln	12,450.0	No
Pottery Lab	1	Electric Kiln	11,250.0	No

Appendix B: ENERGY STAR® Statement of Energy Performance

ENERGY STAR® Statement of Energy Performance

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N/A

ENERGY STAR® Score[1]

Montclair State University Campus (Buildings 1-41)

Primary Property Type: College/University
Gross Floor Area (ft²): 2,925,896
Built: 1908

For Year Ending: October 31, 2016
Date Generated: October 10, 2017

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
Montclair State University Campus (Buildings 1-41) 1 Normal Avenue Montclair, New Jersey 07043	Montclair Statet University 1 Normal Avenue Montclair, NJ 07043 973-655-3244	Ana Pinto 1 Normal Avenue Montclair, NJ 07043 973-655-3244 pintoa@montclair.edu

Property ID: 6069294

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
172.3 kBtu/ft²

Annual Energy by Fuel

District Chilled Water - Other (kBtu)	81,507,530 (16%)
District Steam (kBtu)	223,798,259 (44%)
Electric - Grid (kBtu)	161,334,839 (32%)
Natural Gas (kBtu)	37,406,141 (7%)

Source EUI
306.4 kBtu/ft²

National Median Comparison

National Median Site EUI (kBtu/ft²)	147.6
National Median Source EUI (kBtu/ft²)	262.6
% Diff from National Median Source EUI	17%

Annual Emissions

Greenhouse Gas Emissions (Metric Tons CO2e/year)	N/A

Signature & Stamp of Verifying Professional

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

Signature: ____________________ Date: __________

Licensed Professional

____ ________
,
(___)___-_____
____

Professional Engineer Stamp
(if applicable)