Local Government Energy Audit:
Energy Audit Report

Freeman Hall

1 Normal Avenue

Montclair, New Jersey 07043

Montclair State University

August 10, 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 savings 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 Freeman 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

Freeman Hall is an 87,380 square foot facility. The seven-story building includes dorm rooms, lounges, offices, and a cafeteria.

Lighting at Freeman 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 a combination of window and split-system air-conditioning units. Steam is provided from the District Energy Plant to Freeman 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 radiators and heating units. 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 seven (7) measures that together represent an opportunity for Freeman Hall to reduce annual energy costs by roughly $32,634 and annual greenhouse gas emissions by 465,995 lbs CO_2e. We estimate that if all of these high priority measures are implemented as recommended, the project will pay for itself in roughly 5.1 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 Freeman Hall's annual energy use by 12%.

Figure 1 – Previous 12 Month Utility Costs

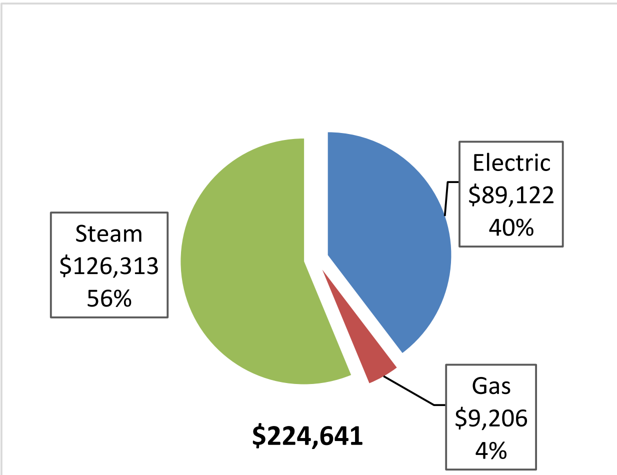
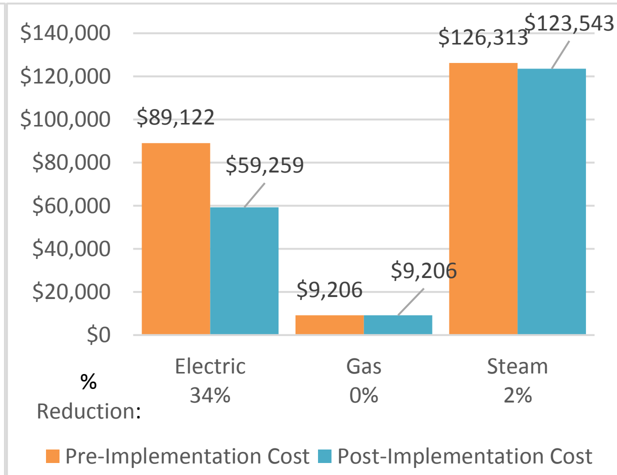


Figure 2 – Potential Post-Implementation Costs



A detailed description of Freeman 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)	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			**394,612**	**53.4**	**0.0**	**$27,004.87**	**$89,764.24**	**$11,860.00**	**$77,904.24**	**2.9**	**397,371**
ECM 1	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	Yes	7,299	0.7	0.0	$499.52	$2,018.00	$185.00	$1,833.00	3.7	7,350
ECM 2	Retrofit Fixtures with LED Lamps	Yes	387,313	52.7	0.0	$26,505.36	$87,746.24	$11,675.00	$76,071.24	2.9	390,021
Lighting Control Measures			**39,810**	**4.9**	**0.0**	**$2,724.34**	**$73,230.00**	**$9,415.00**	**$63,815.00**	**23.4**	**40,088**
ECM 3	Install Occupancy Sensor Lighting Controls	Yes	33,455	4.4	0.0	$2,289.44	$72,630.00	$9,415.00	$63,215.00	27.6	33,689
ECM 4	Install High/Low Lighitng Controls	Yes	6,355	0.5	0.0	$434.90	$600.00	$0.00	$600.00	1.4	6,399
Motor Upgrades			**0**	**0.0**	**0.0**	**$0.00**	**$2,588.85**	**$0.00**	**$2,588.85**	**0.0**	**0**
ECM 5	Premium Efficiency Motors	Yes	0	0.0	0.0	$0.00	$2,588.85	$0.00	$2,588.85	0.0	0
Domestic Water Heating Upgrade			**0**	**0.0**	**181.5**	**$2,770.60**	**$22,235.70**	**$0.00**	**$22,235.70**	**8.0**	**26,568**
ECM 6	Install Low-Flow Domestic Hot Water Devices	Yes	0	0.0	181.5	$2,770.60	$22,235.70	$0.00	$22,235.70	8.0	26,568
Plug Load Equipment Control - Vending Machine			**1,954**	**0.0**	**0.0**	**$133.74**	**$460.00**	**$0.00**	**$460.00**	**3.4**	**1,968**
ECM 7	Vending Machine Control	Yes	1,954	0.0	0.0	$133.74	$460.00	$0.00	$460.00	3.4	1,968
TOTALS FOR HIGH PRIORITY MEASURES			**436,376**	**58.2**	**181.5**	**$32,633.56**	**$188,278.79**	**$21,275.00**	**$167,003.79**	**5.1**	**465,995**
TOTALS FOR ALL EVALUATED MEASURES			**436,376**	**58.2**	**181.5**	**$32,633.56**	**$188,278.79**	**$21,275.00**	**$167,003.79**	**5.1**	**465,995**

* - 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.

Domestic Hot Water upgrade measures generally involve replacing older inefficient domestic water heating systems with modern energy efficient systems. New domestic hot water heating systems can provide equivalent, or greater, water heating capacity compared to older systems at a reduced energy cost. These measures save energy by reducing the fuel used for domestic hot water heating due to improved heating efficiency or reducing standby losses.

Plug Load Equipment control measures generally involve installing automated devices that limit the power usage or operation of equipment that is plugged into an electric outlets when not in use.

Energy Efficient Practices

TRC also identified 13 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 Freeman Hall include:

- Reduce Air Leakage
- Close Doors and Windows
- Use Window Treatments/Coverings
- Develop a Lighting Maintenance Schedule
- Ensure Lighting Controls Are Operating Properly
- Perform Routine Motor Maintenance
- Practice Proper Use of Thermostat Schedules and Temperature Resets
- Check for and Seal Duct Leakage
- Repair/Replace Steam Traps
- Perform Proper Boiler Maintenance
- Perform Proper Water Heater Maintenance
- Install Plug Load Controls
- 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 Freeman 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			
Smruti Srinivasan	Auditor	SSrinivasan@trcsolutions.com	(732) 855-0033

2.2 General Site Information

On April 19, 2017, TRC performed an energy audit at Blanton Hall located in Montclair, NJ. TRC met with Ana Pinto to review the facility operations and help focus our investigation on specific energy-using systems.

Freeman Hall is an 87,380 square foot facility. The seven-story building includes dorm rooms, lounges, offices, and a cafeteria.

Lighting at Freeman 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 a combination of window and split-system air-conditioning units. Steam is provided from the District Energy Plant to Freeman 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 radiators and heating units.

2.3 Building Occupancy

The facility is open every day for 40 weeks a year. During a typical day, the facility is occupied by approximately 500 students and staff.

Figure 5 - Building Schedule

Building Name	Weekday/Weekend	Operating Schedule
Freeman Hall	Weekday	All day
Freeman Hall	Weekend	All day

2.4 Building Envelope

Freeman Hall is a seven-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 operable metal-framed, single-pane windows, which are in good condition and show little signs of excess infiltration. The exterior doors are constructed of metal and glass and are in good condition.

Figure 6 - Freeman Hall Facade

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.

Freeman 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 that 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 and also some U-bend lamps. Interior lighting fixtures are controlled by manually operated switches.

Steam to Hot Water Heating System

The heating hot water (HHW) system consists of three (3) 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 radiators and heating units. The HHW is distributed by three (3) 5 hp constant speed pumps.

The equipment is well-maintained in good condition.

Direct Expansion Air Conditioning System (DX)

There are two (2) split-system AC units that serve a data closet and lounge 300A. Each unit has a cooling capacity of 2.5 tons and a 13.0 SEER efficiency rating. There are also 13 1-ton widow AC units with 10.8 SEER efficiencies throughout the building.

Domestic Hot Water Heating System

DHW for the building is provided by two (2) AERCO steam to water heat exchangers. There is also a backup electric water heater with a 40-gallon storage tank. The water is distributed by a fractional horsepower constant speed pump. The equipment is approximately ten years old and is in good condition.

Refrigeration and Food Service Equipment

Freeman Hall has small commercial kitchen for the cafeteria. Refrigeration equipment includes three (3) standalone refrigerators, a one (1) commercial freezer, and three (3) drink dispensers.

Gas equipment includes a stove with eight (8) burners and oven as well as a steamer box. There is also a commercial conveyor belt type dishwasher.

Building Plug Load

Plug load equipment includes multiple student computers, printers, and displays. Other plug load equipment includes washers, dryers, a dishwasher, refrigerators, an ice maker, coffee machines, and microwaves.

2.7 Water-Using Systems

There are approximately 250 dorm room bathrooms and common restrooms at Freeman Hall. A sampling of restrooms found that many faucets are rated for 1.5 gallons per minute (gpm) and showerheads at 2.5 gpm.

3 SITE ENERGY USE AND COSTS

This building receives electricity and natural gas through master meters. It also receives steam 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 3.6 for additional information.

3.1 Total Cost of Energy

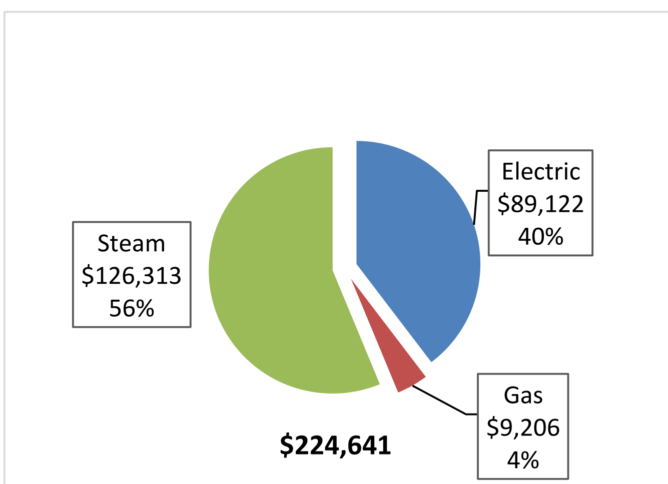
The following energy consumption and cost data is based on the last 12-month period of utility billing data that was provided for each utility. A profile of the annual energy consumption and energy cost of the facility was developed from this information.

Figure 7 - Utility Summary

Utility Summary for Freeman Hall		
Fuel	**Usage**	**Cost**
Electricity	1,302,313 kWh	$89,122
Natural Gas	12,525 Therms	$9,206
Steam	6,930 kLbs	$126,313
Total		**$224,641**

The current annual energy cost for this facility is $224,641 as shown in the chart below.

Figure 8 - 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 9 - Electric Usage & Demand

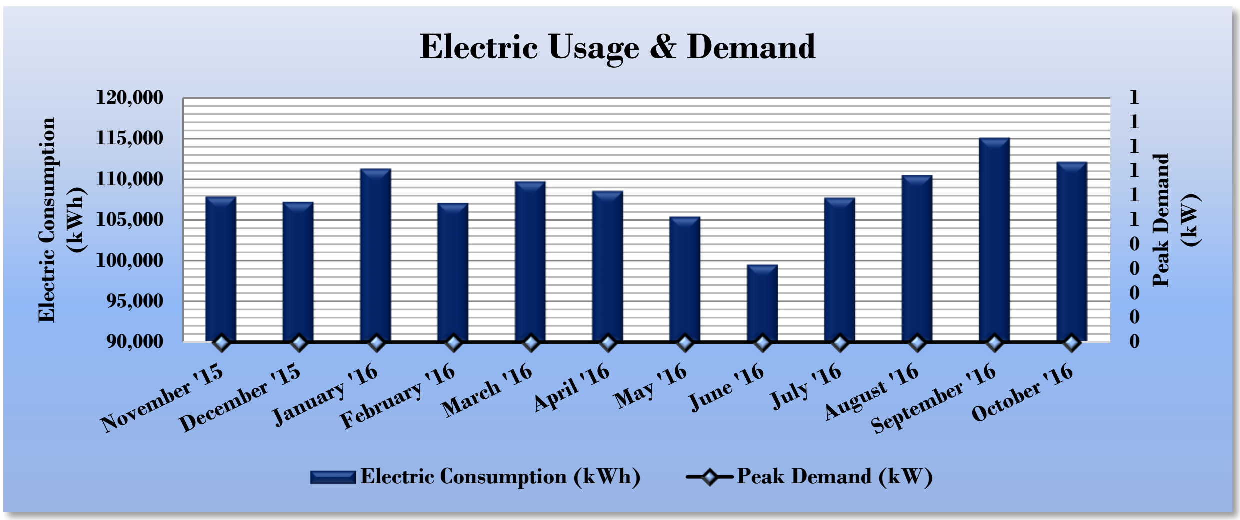


Figure 10 - Electric Usage & Demand

Electric Billing Data for Freeman Hall				
Period Ending	Days in Period	Electric Usage (kWh)	Total Electric Cost	TRC Estimated Usage?
11/30/15	30	107,887	$6,360	Yes
12/31/15	31	107,217	$8,055	Yes
1/31/16	31	111,318	$6,630	Yes
2/28/16	28	107,106	$15,383	Yes
3/31/16	31	109,737	$6,162	Yes
4/30/16	30	108,570	$6,149	Yes
5/31/16	31	105,435	$6,019	Yes
6/30/16	30	99,557	$6,478	Yes
7/31/16	31	107,763	$6,851	Yes
8/31/16	31	110,505	$7,268	Yes
9/30/16	30	115,072	$7,091	Yes
10/31/16	31	112,145	$6,676	Yes
Totals	**365**	**1,302,313**	**$89,122**	12
Annual	**365**	**1,302,313**	**$89,122**	

3.3 Natural Gas Usage

Natural gas is provided by PSE&G. The average gas cost for the past 12 months is $0.735/therm, which is the blended rate used throughout the analyses in this report. The monthly gas consumption is shown in the chart below.

Figure 11 - Natural Gas Usage

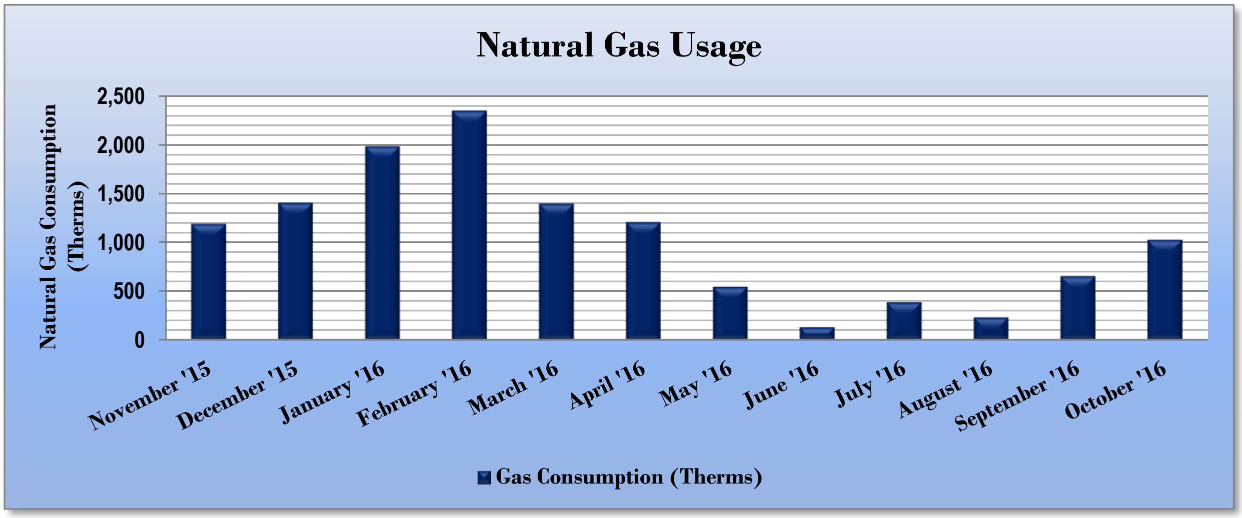


Figure 12 - Natural Gas Usage

Gas Billing Data for Freeman Hall				
Period Ending	Days in Period	Natural Gas Usage (Therms)	Natural Gas Cost	TRC Estimated Usage?
11/30/15	30	1,191	$1,408	Yes
12/31/15	31	1,408	$1,191	Yes
1/31/16	31	1,986	$1,536	Yes
2/28/16	28	2,349	$1,613	Yes
3/31/16	31	1,399	$685	Yes
4/30/16	30	1,208	$613	Yes
5/31/16	31	546	$283	Yes
6/30/16	30	133	$75	Yes
7/31/16	31	389	$240	Yes
8/31/16	31	234	$142	Yes
9/30/16	30	656	$402	Yes
10/31/16	31	1,026	$1,017	Yes
Totals	**365**	**12,525**	**$9,206**	12
Annual	**365**	**12,525**	**$9,206**	

3.4 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 13 – Table of 12 Months Steam Usage

Steam Billing Data for Freeman Hall				
Period Ending	Days in Period	Steam Usage (kLbs)	Fuel Cost	TRC Estimated Usage?
11/30/15	30	458	$6,987	Yes
12/31/15	31	615	$9,442	Yes
1/31/16	31	873	$13,638	Yes
2/28/16	28	788	$32,670	Yes
3/31/16	31	659	$10,003	Yes
4/30/16	30	539	$8,096	Yes
5/31/16	31	409	$6,384	Yes
6/30/16	30	399	$6,060	Yes
7/31/16	31	514	$7,741	Yes
8/31/16	31	536	$8,091	Yes
9/30/16	30	528	$7,915	Yes
10/31/16	31	612	$9,286	Yes
Totals	**365**	**6,930**	**$126,313**	12
Annual	**365**	**6,930**	**$126,313**	

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.

The EUI 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 14 - Energy Use Intensity Comparison – Existing Conditions

Energy Use Intensity Comparison - Existing Conditions		
	Freeman Hall	National Median Building Type: Higher Education - Public
Source Energy Use Intensity (kBtu/ft^2)	288.4	262.6
Site Energy Use Intensity (kBtu/ft^2)	159.9	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 15 - Energy Use Intensity Comparison – Following Installation of Recommended Measures

Energy Use Intensity Comparison - Following Installation of Recommended Measures		
	Freeman Hall	National Median Building Type: Higher Education - Public
Source Energy Use Intensity (kBtu/ft^2)	232.4	262.6
Site Energy Use Intensity (kBtu/ft^2)	140.8	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 and gas 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.

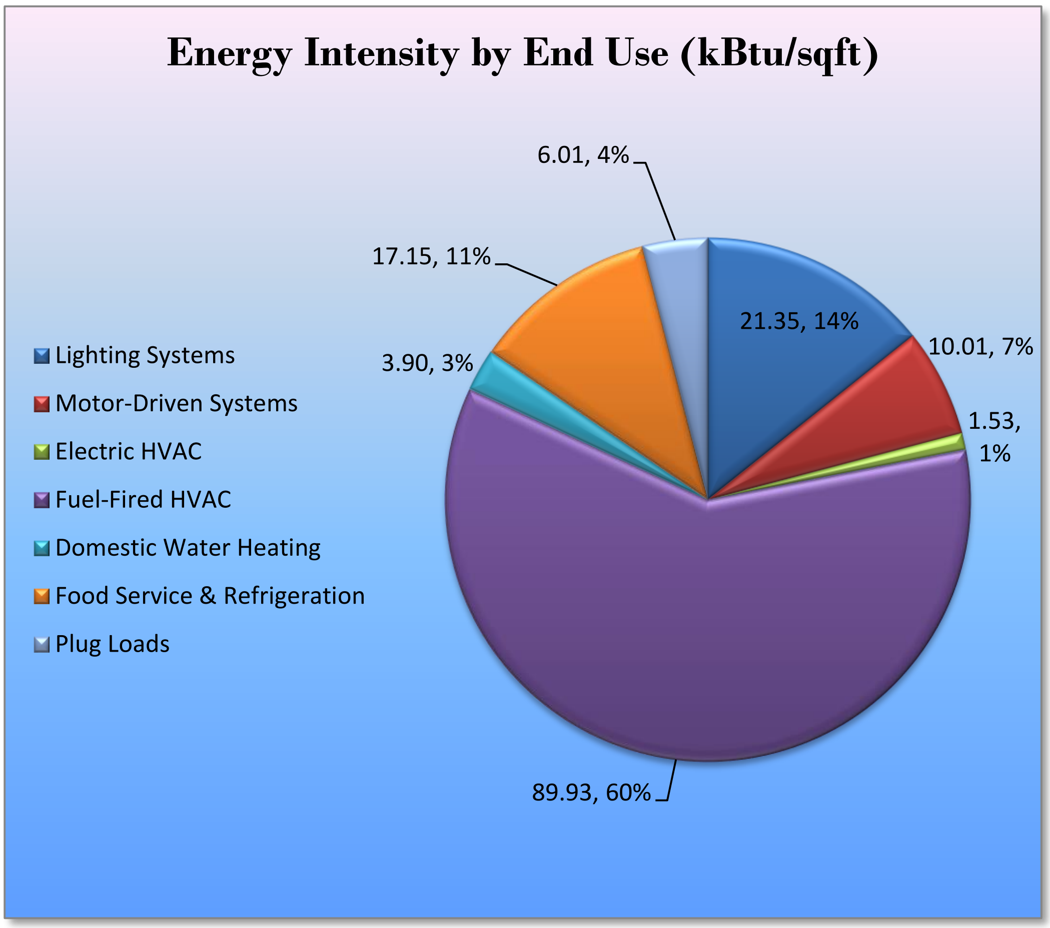
For more information on ENERGY STAR® certification go to: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/earn-recognition/energy-star-certification/how-app-1.

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 16 - Energy Balance (% and kBtu/SF)



4 Energy Conservation Measures

Level of Analysis

The goal of this audit report is to identify potential energy efficiency opportunities, help prioritize specific measures for implementation, and provide information to the Freeman 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 17 – Summary of High Priority ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	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		**394,612**	**53.4**	**0.0**	**$27,004.87**	**$89,764.24**	**$11,860.00**	**$77,904.24**	**2.9**	**397,371**
ECM 1	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	7,299	0.7	0.0	$499.52	$2,018.00	$185.00	$1,833.00	3.7	7,350
ECM 2	Retrofit Fixtures with LED Lamps	387,313	52.7	0.0	$26,505.36	$87,746.24	$11,675.00	$76,071.24	2.9	390,021
Lighting Control Measures		**39,810**	**4.9**	**0.0**	**$2,724.34**	**$73,230.00**	**$9,415.00**	**$63,815.00**	**23.4**	**40,088**
ECM 3	Install Occupancy Sensor Lighting Controls	33,455	4.4	0.0	$2,289.44	$72,630.00	$9,415.00	$63,215.00	27.6	33,689
ECM 4	Install High/Low Lighitng Controls	6,355	0.5	0.0	$434.90	$600.00	$0.00	$600.00	1.4	6,399
Motor Upgrades		**0**	**0.0**	**0.0**	**$0.00**	**$2,588.85**	**$0.00**	**$2,588.85**	**0.0**	**0**
ECM 5	Premium Efficiency Motors	0	0.0	0.0	$0.00	$2,588.85	$0.00	$2,588.85	0.0	0
Domestic Water Heating Upgrade		**0**	**0.0**	**181.5**	**$2,770.60**	**$22,235.70**	**$0.00**	**$22,235.70**	**8.0**	**26,568**
ECM 6	Install Low-Flow Domestic Hot Water Devices	0	0.0	181.5	$2,770.60	$22,235.70	$0.00	$22,235.70	8.0	26,568
Plug Load Equipment Control - Vending Machine		**1,954**	**0.0**	**0.0**	**$133.74**	**$460.00**	**$0.00**	**$460.00**	**3.4**	**1,968**
ECM 7	Vending Machine Control	1,954	0.0	0.0	$133.74	$460.00	$0.00	$460.00	3.4	1,968
TOTALS		**436,376**	**58.2**	**181.5**	**$32,633.56**	**$188,278.79**	**$21,275.00**	**$167,003.79**	**5.1**	**465,995**

* - 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).

4.2 Lighting Upgrades

Our recommendations for upgrades to existing lighting fixtures are summarized in Figure 18 below.

Figure 18 – Summary of Lighting Upgrade ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	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		**394,612**	**53.4**	**0.0**	**$27,004.87**	**$89,764.24**	**$11,860.00**	**$77,904.24**	**2.9**	**397,371**
ECM 1	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	7,299	0.7	0.0	$499.52	$2,018.00	$185.00	$1,833.00	3.7	7,350
ECM 2	Retrofit Fixtures with LED Lamps	387,313	52.7	0.0	$26,505.36	$87,746.24	$11,675.00	$76,071.24	2.9	390,021

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)	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	7,299	0.7	0.0	$499.52	$2,018.00	$185.00	$1,833.00	3.7	7,350
Exterior	0	0.0	0.0	$0.00	$0.00	$0.00	$0.00	0.0	0

Measure Description

We recommend retrofitting existing T12 fluorescent fixtures by removing 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 that are more than twice that of fluorescent tubes.

ECM 2: Retrofit Fixtures with LED Lamps

Summary of Measure Economics

Interior/ Exterior	Annual Electric Savings (kWh)	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	387,313	52.7	0.0	$26,505.36	$87,746.24	$11,675.00	$76,071.24	2.9	390,021
Exterior	0	0.0	0.0	$0.00	$0.00	$0.00	$0.00	0.0	0

Measure Description

We recommend retrofitting existing incandescent and fluorescent 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 that are more than twice that of fluorescent tubes and more than 10 times longer than many incandescent lamps.

4.3 Lighting Control Measures

Our recommendations for lighting control measures are summarized in Figure 19 below.

Figure 19 – Summary of Lighting Control ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	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		**39,810**	**4.9**	**0.0**	**$2,724.34**	**$73,230.00**	**$9,415.00**	**$63,815.00**	**23.4**	**40,088**
ECM 3	Install Occupancy Sensor Lighting Controls	33,455	4.4	0.0	$2,289.44	$72,630.00	$9,415.00	$63,215.00	27.6	33,689
ECM 4	Install High/Low Lighitng Controls	6,355	0.5	0.0	$434.90	$600.00	$0.00	$600.00	1.4	6,399

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)	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)
33,455	4.4	0.0	$2,289.44	$72,630.00	$9,415.00	$63,215.00	27.6	33,689

Measure Description

We recommend installing occupancy sensors to control lighting fixtures that are currently controlled by manual switches in dorm rooms, offices areas, and laundry rooms. 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)	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)
6,355	0.5	0.0	$434.90	$600.00	$0.00	$600.00	1.4	6,399

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 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.

4.4 Motor Upgrades

Our recommendations for motor upgrades are summarized in Figure 20 below.

Figure 20 – Summary of Motor Upgrades ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	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)
Motor Upgrades		**0**	**0.0**	**0.0**	**$0.00**	**$2,588.85**	**$0.00**	**$2,588.85**	**0.0**	**0**
ECM 5	Premium Efficiency Motors	0	0.0	0.0	$0.00	$2,588.85	$0.00	$2,588.85	0.0	0

ECM 5: Premium Efficiency Motors

Summary of Measure Economics

Annual Electric Savings (kWh)	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	0.0	0.0	$0.00	$2,588.85	$0.00	$2,588.85	0.0	0

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. 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.

4.5 Domestic Hot Water Heating System Upgrades

Our recommendations for domestic water heating system improvements are summarized in Figure 21 below.

Figure 21 - Summary of Domestic Water Heating ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	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)
Domestic Water Heating Upgrade		**0**	**0.0**	**181.5**	**$2,770.60**	**$22,235.70**	**$0.00**	**$22,235.70**	**8.0**	**26,568**
ECM 6	Install Low-Flow Domestic Hot Water Devices	0	0.0	181.5	$2,770.60	$22,235.70	$0.00	$22,235.70	8.0	26,568

ECM 6: Install Low-Flow DHW Devices

Summary of Measure Economics

Annual Electric Savings (kWh)	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	0.0	181.5	$2,770.60	$22,235.70	$0.00	$22,235.70	8.0	26,568

Measure Description

We recommend installing low-flow domestic hot water devices to reduce overall hot water demand. Energy demand from domestic hot water heating systems can be reduced by reducing water usage in general. Faucet aerators and low-flow showerheads can reduce hot water usage, relative to standard showerheads and aerators, which saves energy.

Low-flow devices reduce the overall water flow from the fixture, while still providing adequate pressure for washing. This reduces the amount of water used per day resulting in energy and water savings.

4.6 Plug Load Equipment Control - Vending Machines

Our recommendations for plug load equipment controls are summarized in Figure 22 below.

Figure 22 - Summary of Plug Load Equipment Cntrol ECMs

Energy Conservation Measure		Annual Electric Savings (kWh)	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)
Plug Load Equipment Control - Vending Machine		1,954	0.0	0.0	$133.74	$460.00	$0.00	$460.00	3.4	1,968
ECM 7	Vending Machine Control	1,954	0.0	0.0	$133.74	$460.00	$0.00	$460.00	3.4	1,968

ECM 7: Vending Machine Control

Summary of Measure Economics

Annual Electric Savings (kWh)	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)
1,954	0.0	0.0	$133.74	$460.00	$0.00	$460.00	3.4	1,968

Measure Description

Vending machines operate continuously, even during non-business hours. It is recommended to install occupancy sensor controls to reduce the energy use. These controls power down vending machines when the vending machine area has been vacant for some time, then power up at regular intervals, as needed, to turn machine lights on or keep the product cool. Energy savings are a dependent on vending machine and activity level in the area surrounding the machines.

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.

Use Window Treatments/Coverings

A substantial amount of heat gain can occur through uncovered or untreated windows, especially older single pane windows and east or west-facing windows. Treatments such as high-reflectivity films or covering windows with shades or shutters can reduce solar heat gain and, consequently, cooling load and can reduce internal heat loss and the associated heating load.

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.

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.

Practice Proper Use of Thermostat Schedules and Temperature Resets

Ensure thermostats are correctly set back. By employing proper set back temperatures and schedules, facility heating and cooling costs can be reduced dramatically during periods of low or no occupancy. As such, thermostats should be programmed for a setback of 5-10°F during low occupancy hours (reduce heating setpoints and increase cooling setpoints). Cooling load can be reduced further by increasing the facility's occupied setpoint temperature. In general, during the cooling season, thermostats should be set as high as possible without sacrificing occupant comfort.

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 Boiler Maintenance

Many boiler problems develop slowly over time, so regular inspection and maintenance is essential to retain proper functionality and efficiency of the heating system. Fuel burning equipment should undergo yearly tune-ups to ensure they are operating as safely and efficiently as possible from a combustion standpoint. A tune-up should include a combustion analysis to analyze the exhaust from the boilers and to ensure the boiler is operating safely. Buildup of dirt, dust, or deposits on the internal surfaces of a boiler can greatly affect its heat transfer efficiency. These deposits can accumulate on the water side or fire side of the boiler. Boilers should be cleaned regularly according to the manufacturer's instructions to remove this build up in order to sustain efficiency and equipment life.

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.

Plug Load Controls

There are a variety of ways to limit the energy use of plug loads including increasing occupant awareness, removing under-utilized equipment, installing hardware controls, and using software controls. Some control steps to take are to enable the most aggressive power settings on existing devices or install load sensing or occupancy sensing (advanced) power strips. For additional information refer to "Plug Load Best Practices Guide" http://www.advancedbuildings.net/plug-load-best-practices-guide-offices.

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).

Refer to Section 4.5 for any low-flow ECM recommendations.

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 23 for a list of the eligible programs identified for each recommended ECM.

Figure 23 - 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 Low-Flow Domestic Hot Water Devices				X		
ECM 7	Vending Machine Control	X			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 SmartSmart prescriptive incentive program provides fixed incentives for specific energy efficiency measures, whereas the custom SmartSmart 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.](http://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
Hallways	9	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	8,760	Relamp	Yes	9	LED - Linear Tubes: (2) 2' Lamps	High/Low Control	17	6,132	0.12	1,664	0.0	$113.84	$633.80	$90.00	4.78
Hallways	8	Compact Fluorescent: Screw-in	Wall Switch	42	8,760	Relamp	Yes	8	LED Screw-In Lamps: Screw-in	High/Low Control	29	6,132	0.13	1,726	0.0	$118.14	$551.62	$0.00	4.67
Hallways	1	U-Bend Fluorescent - T12: U T12 (34W) - 2L	Wall Switch	72	8,760	Relamp & Reballast	No	1	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	8,760	0.04	554	0.0	$37.92	$107.00	$10.00	2.56
Hallways	70	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	8,760	Relamp	Yes	70	LED - Linear Tubes: (2) 4' Lamps	High/Low Control	29	6,132	2.15	29,406	0.0	$2,012.37	$4,295.00	$700.00	1.79
Hallways	11	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	11	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Lounges	40	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	6,720	Relamp	Yes	40	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	4,704	1.47	15,487	0.0	$1,059.83	$2,738.00	$505.00	2.11
Single room	17	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	4,368	Relamp	Yes	17	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	3,058	0.52	3,561	0.0	$243.69	$1,264.50	$205.00	4.35
Single room	85	Incandescent: 60W	Wall Switch	60	4,368	Relamp	Yes	85	LED Screw-In Lamps: Screw-in	Occupancy Sensor	9	3,058	3.36	22,928	0.0	$1,569.08	$8,326.01	$1,020.00	4.66
Double room	162	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	4,368	Relamp	Yes	162	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	3,058	4.97	33,934	0.0	$2,322.22	$9,747.00	$1,655.00	3.48
Double room	810	Incandescent: 60W	Wall Switch	60	4,368	Relamp	Yes	810	LED Screw-In Lamps: Screw-in	Occupancy Sensor	9	3,058	32.01	218,494	0.0	$14,952.42	$79,341.93	$9,720.00	4.66
Triple room	54	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	4,368	Relamp	Yes	54	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	3,058	1.66	11,311	0.0	$774.07	$3,429.00	$575.00	3.69
Triple room	270	Incandescent: 60W	Wall Switch	60	4,368	Relamp	Yes	270	LED Screw-In Lamps: Screw-in	Occupancy Sensor	9	3,058	10.67	72,831	0.0	$4,984.14	$26,447.31	$3,240.00	4.66
Quad room	16	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	4,368	Relamp	Yes	16	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	3,058	0.49	3,351	0.0	$229.36	$1,206.00	$195.00	4.41
Quad room	80	Incandescent: 60W	Wall Switch	60	4,368	Relamp	Yes	80	LED Screw-In Lamps: Screw-in	Occupancy Sensor	9	3,058	3.16	21,580	0.0	$1,476.78	$7,836.24	$960.00	4.66
Laundry rooms	28	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	6,720	Relamp	Yes	28	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	4,704	0.86	9,023	0.0	$617.49	$1,908.00	$315.00	2.58
Boiler room	14	Compact Fluorescent: Screw-in	Wall Switch	42	6,720	Relamp	No	14	LED Screw-In Lamps: Screw-in	Wall Switch	29	6,720	0.13	1,363	0.0	$93.29	$615.34	$0.00	6.60
Boiler room	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	62	6,720	Relamp	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	6,720	0.05	510	0.0	$34.90	$117.00	$20.00	2.78
Boiler room	4	Incandescent: 60W	Wall Switch	60	6,720	Relamp	Yes	4	LED Screw-In Lamps: Screw-in	Occupancy Sensor	9	4,704	0.16	1,660	0.0	$113.60	$445.81	$55.00	3.44
Boiler room	1	Linear Fluorescent - T8: 2' T8 (17W) - 1L	Wall Switch	22	6,720	Relamp	No	1	LED - Linear Tubes: (1) 2' Lamp	Wall Switch	9	6,720	0.01	104	0.0	$7.14	$31.90	$5.00	3.77
Elevator room	3	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	6,720	Relamp & Reballast	Yes	3	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	4,704	0.15	1,570	0.0	$107.41	$621.00	$65.00	5.18
Housekeeping	7	Compact Fluorescent: Screw-in	Wall Switch	42	6,720	Relamp	Yes	7	LED Screw-In Lamps: Screw-in	Occupancy Sensor	29	4,704	0.11	1,159	0.0	$79.30	$577.67	$35.00	6.84
Data closet	3	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	6,720	Relamp	No	3	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	6,720	0.04	371	0.0	$25.39	$144.60	$30.00	4.51
Annex hall	4	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	8,760	Relamp	Yes	4	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	6,132	0.22	2,958	0.0	$202.41	$650.53	$115.00	2.65
Annex offices	19	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	6,720	Relamp	Yes	19	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	4,704	0.87	9,184	0.0	$628.52	$1,698.80	$320.00	2.19
Annex offices	6	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	6,720	Relamp	Yes	6	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	4,704	0.09	978	0.0	$66.95	$559.20	$95.00	6.93

	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
Annex offices	1	Linear Fluorescent - T12: 4' T12 (40W) - 1L	Wall Switch	46	6,720	Relamp & Reballast	No	1	LED - Linear Tubes: (1) 4' Lamp	Wall Switch	15	6,720	0.02	243	0.0	$16.66	$98.00	$5.00	5.58
Annex basement	6	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	6,720	Relamp & Reballast	Yes	6	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	4,704	0.30	3,139	0.0	$214.82	$972.00	$95.00	4.08
Annex basement	4	Linear Fluorescent - T12: 4' T12 (40W) - 3L	Wall Switch	127	6,720	Relamp & Reballast	Yes	4	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	4,704	0.28	2,985	0.0	$204.24	$796.00	$95.00	3.43
Restrooms	2	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	33	6,720	Relamp	No	2	LED - Linear Tubes: (2) 2' Lamps	Wall Switch	17	6,720	0.02	247	0.0	$16.92	$96.40	$20.00	4.51
Restrooms	2	Linear Fluorescent - T12: 4' T12 (40W) - 2L	Wall Switch	88	6,720	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	6,720	0.09	912	0.0	$62.41	$234.00	$20.00	3.43
4A, 4B, 4C, 4D	28	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	6,720	Relamp	Yes	28	LED - Linear Tubes: (3) 4' Lamps	Occupancy Sensor	44	4,704	1.29	13,535	0.0	$926.24	$3,185.60	$560.00	2.83
Cafeteria and kitchen	36	Compact Fluorescent: Screw-in	Wall Switch	42	5,376	Relamp	No	36	LED Screw-In Lamps: Screw-in	Wall Switch	29	5,376	0.33	2,804	0.0	$191.91	$1,582.31	$0.00	8.24
Cafeteria and kitchen	6	Linear Fluorescent - T8: 4' T8 (32W) - 3L	Wall Switch	93	5,376	Relamp	No	6	LED - Linear Tubes: (3) 4' Lamps	Wall Switch	44	5,376	0.22	1,836	0.0	$125.66	$451.20	$90.00	2.87
Cafeteria and kitchen	20	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	114	5,376	Relamp	No	20	LED - Linear Tubes: (4) 4' Lamps	Wall Switch	58	5,376	0.82	6,924	0.0	$473.86	$1,902.67	$400.00	3.17
Cafeteria and kitchen	12	Linear Fluorescent - T8: 2' T8 (17W) - 1L	Wall Switch	22	5,376	Relamp	No	12	LED - Linear Tubes: (1) 2' Lamp	Wall Switch	9	5,376	0.12	1,002	0.0	$68.54	$382.80	$60.00	4.71
Whole building	12	Exit Signs: LED - 2 W Lamp	None	6	8,760	None	No	12	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	Condensate pump	1	Other	0.3	77.0%	No	2,745	No	77.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	DHW	1	Water Supply Pump	0.3	85.5%	No	8,760	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	Condensate pump	2	Other	1.0	77.0%	No	2,745	No	77.0%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	Hot water circulation	3	Heating Hot Water Pump	5.0	89.5%	No	8,760	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	Exhaust	2	Exhaust Fan	1.0	85.5%	No	8,760	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	Food service	2	Water Supply Pump	3.0	89.5%	No	2,745	No	89.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	Air compressor	1	Air Compressor	0.8	85.5%	No	5,000	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	Air compressor	1	Air Compressor	1.5	86.5%	No	5,000	No	86.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	Packaged unit	1	Supply Fan	5.0	89.5%	No	8,760	Yes	89.5%	No		0.00	0	0.0	$0.00	$800.37	$0.00	0.00
Mechanical room	Storm water	2	Other	2.0	86.5%	No	2,745	Yes	86.5%	No		0.00	0	0.0	$0.00	$1,788.48	$0.00	0.00
Whole building	Fan coil units	15	Supply Fan	0.3	85.5%	No	6,000	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Restrooms	4	Exhaust Fan	1.0	85.5%	No	8,760	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Restrooms	7	Exhaust Fan	0.5	85.5%	No	8,760	No	85.5%	No		0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Roof	Elevator	1	Other	20.0	91.7%	No	3,391	No	91.7%	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
Lounges	Lounges	7	Window AC	1.00		No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Lounge 300A	Lounge 300A	1	Split-System AC	2.50		No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Data closet	Data closet	1	Split-System AC	2.50		No							No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Ground floor	Ground floor	6	Window AC	1.00		No							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
Mechanical room	Space heating	1	Forced Draft Steam Boiler	6,000.00	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00

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
Mechanical room	Backup DHW	1	Storage Tank Water Heater (≤ 50 Gal)	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	DHW - Dorms	1	Indirect System	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Mechanical room	DHW - Kitchen	1	Indirect System	No						0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Low-Flow Device Recommendations

	Recommendation Inputs				Energy Impact & Financial Analysis						
Location	Device Quantity	Device Type	Existing Flow Rate (gpm)	Proposed Flow Rate (gpm)	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Total Installation Cost	Total Incentives	Simple Payback w/ Incentives in Years
Dorm rooms	249	Showerhead	2.50	2.00	0.00	0	181.5	$2,770.60	$22,235.70	$0.00	8.03

Walk-In Cooler/Freezer Inventory & Recommendations

	Existing Conditions		Proposed Conditions			Energy Impact & Financial Analysis						
Location	Cooler/ Freezer Quantity	Case Type/Temperature	Install EC Evaporator Fan Motors?	Install Electric Defrost Control?	Install Evaporator Fan Control?	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
Kitchen	2	Cooler (35F to 55F)	No	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Kitchen	1	Medium Temp Freezer (0F to 30F)	No	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00

Cooking Equipment Inventory & Recommendations

	Existing Conditions			Proposed Conditions	Energy Impact & Financial Analysis						
Location	Quantity	Equipment Type	High Efficiency Equipement?	Install High Efficiency Equipment?	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
Kitchen	1	Electric Convection Oven (Full Size)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Kitchen	1	Electric Fryer	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Kitchen	1	Gas Griddle (4 Feet Width)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Kitchen	1	Gas Combination Oven/Steam Cooker (<15 Pans)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Kitchen	1	Gas Combination Oven/Steam Cooker (<15 Pans)	No	No	0.00	0	0.0	$0.00	$0.00	$0.00	0.00
Kitchen	1	Gas Large Vat Fryer	No	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?
Dorm	4	Desktop computer	110.0	Yes
Dorm	1	Laptop computer	80.0	No
Office	2	Printers	460.0	Yes
Kitchen	2	Refrigerator/Freezer	600.0	Yes
Laundry room	3	Washer	900.0	Yes
Laundry room	3	Dryer	1,600.0	Yes
Lounge	4	CRT (24")	120.0	Yes
Lounge	1	LCD (42")	120.0	Yes
Lounge	3	LCD (50")	150.0	Yes
Lounge	1	LED (50")	100.0	Yes
Café	4	Soda machine	40.0	Yes
Lounge	1	Refrigerator	50.0	Yes
Lounge	2	Toaster	1,200.0	No
Kitchen	1	Dishwasher	1,500.0	Yes
Kitchen	1	Microwave	1,000.0	Yes
Kitchen	1	Ice maker	100.0	Yes
Kitchen	1	Freezer	750.0	Yes
Kitchen	1	Refrigerator	600.0	Yes
Student devices	1	misc	65,500.0	No

Vending Machine Inventory & Recommendations

	Existing Conditions		Proposed Conditions	Energy Impact & Financial Analysis						
Location	Quantity	Vending Machine Type	Install Controls?	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
Lounge	1	Refrigerated	Yes	0.00	1,612	0.0	$110.30	$230.00	$0.00	2.09
Lounge	1	Non-Refrigerated	Yes	0.00	343	0.0	$23.44	$230.00	$0.00	9.81

APPENDIX B: ENERGY STAR® STATEMENT OF ENERGY PERFORMANCE

ENERGY STAR® Statement of Energy Performance

LEARN MORE AT energystar.gov

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)