# Local Government Energy Audit:
## Energy Audit Report

***Princeton Public Library***

65 Witherspoon Street

Princeton, New Jersey 08542

Princeton Public Library

August 14, 2018

Final Report by:

**TRC Energy Services**

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# 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 the Princeton Public Library.

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 local governments in controlling energy costs and protecting our environment by offering a wide range of energy management options and advice.

## 1.1 Facility Summary

The Princeton Public Library is a 55,000 square foot facility constructed in 2003. The building is a four-story commercial facility that includes book cases and open reading areas, meeting and study rooms, conference rooms, staff offices, a cafe, and a mechanical room that occupies a large portion of the fourth floor.

Lighting at the Princeton Public Library, with the exception of the second floor, consists mainly of T8 linear fixtures, compact fluorescent fixtures, and incandescent fixtures, all of which are inefficient in performance when compared to the latest lighting technology available in the market. Only the second floor of the library, renovated in 2017, has been upgraded with LED lighting in its entirety. Exterior lighting is provided by a combination of compact fluorescent decorative fixtures and incandescent ground flood lights.

Space cooling at the library is provided by a screw chiller, two split-system air conditioners and two split-system air-source heat pumps that provide cooling to select spaces in the building. Heating is provided by two non-condensing gas-fired boilers.

A thorough description of the facility and our observations are located in Section 2.

## 1.2 Your Cost Reduction Opportunities

### Energy Conservation Measures

TRC evaluated nine measures and recommended seven measures which together represent an opportunity for the Princeton Public Library to reduce annual energy costs by $76,894 and annual greenhouse gas emissions by 573,748 lbs $CO_2e$. We estimate that if all measures were implemented as recommended, the project would pay for itself in 5.7 years. 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 the Princeton Public Library's annual energy use by 17%.

*Figure 1 – Previous 12 Month Utility Costs*

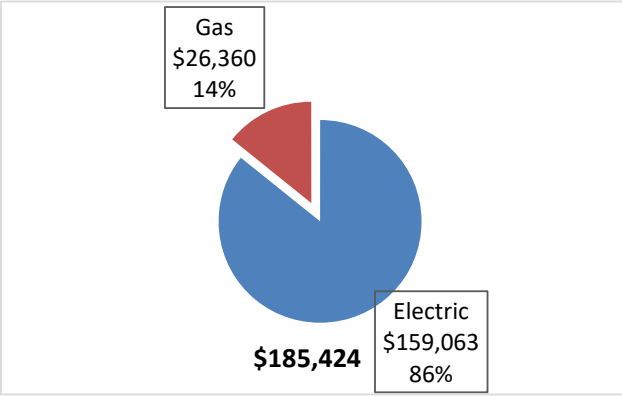
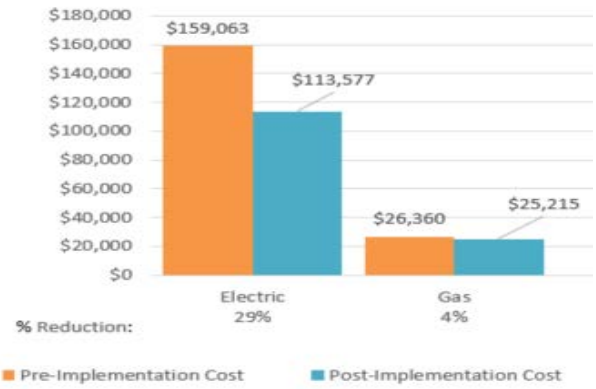



*Figure 2 – Potential Post-Implementation Costs*




A detailed description of the Princeton Public Library's existing energy use can be found in Section 3.

Estimates of the total cost, energy savings, and financial incentives for the proposed 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 | | Recommend? | 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** | | | **168,319** | **30.3** | **0.0** | **$23,152.04** | **$73,285.46** | **$6,775.00** | **$66,510.46** | **2.9** | **169,495** |
| ECM 1 | Install LED Fixtures | Yes | 5,799 | 1.0 | 0.0 | $797.62 | $16,111.20 | $900.00 | $15,211.20 | 19.1 | 5,839 |
| ECM 2 | Retrofit Fixtures with LED Lamps | Yes | 162,520 | 29.3 | 0.0 | $22,354.42 | $57,174.26 | $5,875.00 | $51,299.26 | 2.3 | 163,656 |
| **Lighting Control Measures** | | | **25,144** | **4.4** | **0.0** | **$3,458.56** | **$7,040.00** | **$1,615.00** | **$5,425.00** | **1.6** | **25,320** |
| ECM 3 | Install Occupancy Sensor Lighting Controls | Yes | 23,789 | 4.1 | 0.0 | $3,272.19 | $6,290.00 | $865.00 | $5,425.00 | 1.7 | 23,956 |
| ECM 4 | Install Daylight Dimming Controls | Yes | 1,355 | 0.2 | 0.0 | $186.37 | $750.00 | $750.00 | $0.00 | 0.0 | 1,364 |
| **Motor Upgrades** | | | **1,499** | **0.7** | **0.0** | **$206.18** | **$9,273.08** | **$0.00** | **$9,273.08** | **45.0** | **1,509** |
| | Premium Efficiency Motors | No | 1,499 | 0.7 | 0.0 | $206.18 | $9,273.08 | $0.00 | $9,273.08 | 45.0 | 1,509 |
| **Variable Frequency Drive (VFD) Measures** | | | **26,542** | **4.9** | **0.0** | **$3,650.89** | **$16,216.00** | **$0.00** | **$16,216.00** | **4.4** | **26,728** |
| ECM 5 | Install VFDs on Chilled Water Pumps | Yes | 9,211 | 3.0 | 0.0 | $1,267.03 | $9,002.40 | $0.00 | $9,002.40 | 7.1 | 9,276 |
| ECM 6 | Install VFDs on Hot Water Pumps | Yes | 17,331 | 1.9 | 0.0 | $2,383.86 | $7,213.60 | $0.00 | $7,213.60 | 3.0 | 17,452 |
| **Electric Chiller Replacement** | | | **110,687** | **54.5** | **0.0** | **$15,224.92** | **$213,296.05** | **$7,500.00** | **$205,796.05** | **13.5** | **111,461** |
| ECM 7 | Install High Efficiency Chillers | Yes | 110,687 | 54.5 | 0.0 | $15,224.92 | $213,296.05 | $7,500.00 | $205,796.05 | 13.5 | 111,461 |
| **Gas Heating (HVAC/Process) Replacement** | | | **0** | **0.0** | **164.0** | **$1,145.69** | **$62,818.65** | **$4,900.00** | **$57,918.65** | **50.6** | **19,199** |
| | Install High Efficiency Hot Water Boilers | No | 0 | 0.0 | 164.0 | $1,145.69 | $62,818.65 | $4,900.00 | $57,918.65 | 50.6 | 19,199 |
| **TOTAL FOR ALL RECOMMENDED MEASURES** | | | **330,693** | **134** | **164** | **$ 76,893.57** | **$ 469,197.62** | **$ 29,180.00** | **$ 440,017.62** | **5.7** | **573,748** |
| **TOTALS FOR ALL EVALUATED MEASURES** | | | **332,192** | **94.8** | **164.0** | **$ 46,838.27** | **$ 381,929.24** | **$ 20,790.00** | **$ 361,139.24** | **7.7** | **353,714** |
| **TOTAL OF ALL NON-RECOMMENDED MEASURES** | | | **1,499** | **1** | **164** | **$ 1,351.87** | **$ 72,091.73** | **$ 4,900.00** | **$ 67,191.73** | **49.7** | **20,709** |

* - 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 measures 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 (NEMA Premium). Motors replacements generally assume the same size motors, just higher efficiency. Although occasionally additional savings can be achieved by downsizing motors to better meet current load requirements. This measure saves energy by reducing the power used by the motors, due to improved electrical efficiency.

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

**Electric Chiller** measures generally involve replacing older inefficient hydronic chillers with modern energy efficient systems. New chillers can provide equivalent cooling compared to older chillers at a reduced energy cost. These measures save energy by reducing chiller energy usage, due to improved electrical and heat transfer efficiency.

## Energy Efficient Practices

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

- Perform Proper Lighting Maintenance
- Develop a Lighting Maintenance Schedule
- Ensure Lighting Controls Are Operating Properly
- Perform Routine Motor Maintenance
- Ensure Economizers are Functioning Properly
- Assess Chillers & Request Tune-Ups
- Clean Evaporator/Condenser Coils on AC Systems
- Clean and/or Replace HVAC Filters
- Check for and Seal Duct Leakage
- Perform Proper Boiler Maintenance
- Perform Proper Furnace 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 the Princeton Public Library. Based on the configuration of the site and its loads there is a high potential for installing a photovoltaic (PV) array.

***Figure 4 – Photovoltaic Potential***

| | | |
|---|---|---|
| Potential | High | |
| System Potential | 64 | kW DC STC |
| Electric Generation | 76,248 | kWh/yr |
| Displaced Cost | $6,630 | /yr |
| Installed Cost | $183,000 | |

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
- SREC (Solar Renewable Energy Certificate) Registration Program (SRP)
- 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. 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.

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 5 – Project Contacts*

| Name | Role | E-Mail | Phone # |
|---|---|---|---|
| Customer | | | |
| Susan Chernik | Finance Director | schernik@princetonlibrary.org | 609-924-9529 ext. 1252 |
| TRC Energy Services | | | |
| Smruti Srinivasan | Auditor | ssrinivasan@trcsolutions.com | 732-855-0033 |

## 2.2 General Site Information

On February 13, 2018, TRC performed an energy audit at the Princeton Public Library located in Princeton, New Jersey. TRC's team met with Pat McAvenia to review the facility operations and help focus our investigation on specific energy-using systems.

## 2.3 Building Occupancy

The typical library schedule is presented in the table below.

*Figure 6 - Building Schedule*

| Building Name | Weekday/Weekend | Operating Schedule |
|---|---|---|
| Princeton Public Library | Weekday | 7:00 AM - 9:30 PM |
| Princeton Public Library | Saturday | 7:00 AM - 6:00 PM |
| Princeton Public Library | Sunday | 1:00 PM - 6:00 PM |

## 2.4 Building Envelope

The building is constructed of structural steel with a brick and glass facade. The building has a flat roof covered with black EPDM rubber membrane and double-pane windows which are in good condition and show little sign of excessive infiltration. The building has exterior metal frame glass doors in good condition.

*Figure 7 – Building Façade*

## 2.5 On-Site Generation

The Princeton Public Library does not have 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.

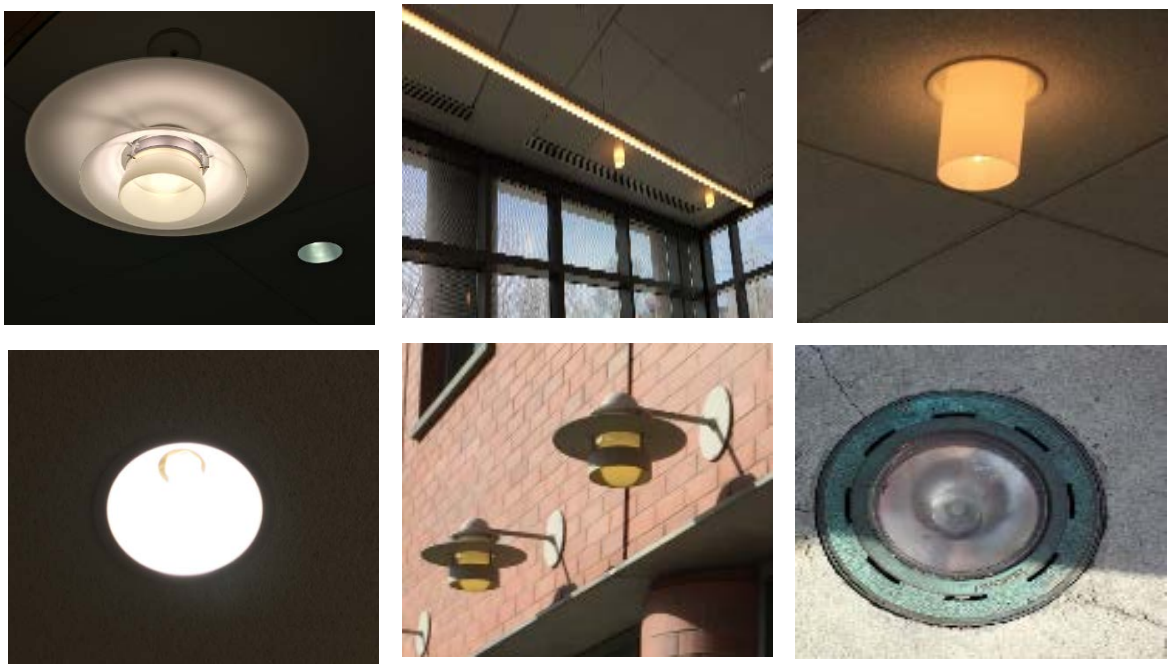
### Lighting System

Lighting at the Princeton Public Library, with the exception of the second floor, consists mainly of T8 linear fixtures in 3-lamp configurations, compact fluorescent (CFL) recessed cans and decorative fixtures and a few incandescent fixtures, all of which are inefficient in performance when compared to the latest lighting technology available in the market. Only the second floor of the library, renovated in 2017, has been upgraded with LED lighting in its entirety.

U-bend fluorescent and T8 linear fixtures in 1, 2, and 4-lamp configurations also illuminate portions of the library, and six metal halide (MH) fixtures provide lighting in the library's high ceiling chandeliers. All the exit signs are LED-based fixtures. Although wall and ceiling-mounted occupancy sensors are installed in various spaces, a considerable amount of interior lighting is controlled only by manual switches.

The building's exterior lighting is provided by a combination of CFL decorative fixtures and incandescent ground flood lights controlled by timers.

*Figure 8 - Building Lighting Systems*



## Chilled Water System

The facility is served by a chilled water plant that consists of one 250-ton, York, R-134a, screw chiller with a primary distribution loop. The primary loop has two constant-flow primary pumps, 10 and 15 hp, respectively, in a lead-lag configuration. The chiller plant supplies chilled water to two air handlers. The condenser water system consists of one cooling tower with one fan motor. Condenser water is supplied to the chiller by two 15 hp, constant flow pumps.

*Figure 9 - Building Chilled Water System*

## Hot Water Heating System

The hot water heating system consists of two Unilux 1,400 kBtu/hr output, forced-draft boilers. Each boiler has a 0.5 hp forced draft fan and a nominal combustion efficiency of 85%. The boilers operate in a lead-lag configuration and are configured in a primary-secondary distribution loop with two 7.5 hp and two 1.0 hp pumps. Both boilers may be required during cold weather.

*Figure 10 - Building Hot Water Heating System*

## Chilled Water Air Conditioning System (CHW)

There are two air handling units (AHUs) that serve the library. The two AHUs, located in the penthouse, are variable air volume (VAV) systems with some VAV terminal reheat boxes. Each AHU has one 50 hp supply fan controlled by a VFD. The supply fans maintain a constant duct static pressure of 1.9 inch water gauge. The AHU has an outside air economizer to utilize free cooling when the outside air temperature is lower than the return air temperature.

## Air Conditioning Split-Systems

Multiple split-systems provide space air conditioning to select spaces in the library.

A single-ton EMI split-system air-source heat pump provides space air conditioning to the first floor telephone room; the fan and evaporator are located within the room. One Fujitsu 2-ton split-system air conditioner and one single-ton EMI split-system air-source heat pump serve the second floor tech room. Finally, a 1.5-ton EMI split-system air conditioner serves the third floor tech room. All compressors and condensing units are located in the roof of the building.

*Figure 11 - Building Air-Conditioning Split-Systems*

## Building Energy Management System (BEMS)

The majority of the facility is controlled with a Johnson Controls Metasys building energy management system (BEMS). The BEMS aggregates the DDC points from throughout the building, and provides scheduling capabilities for AHUs and chilled water pumps. The chiller has a separate York control system.

## Domestic Hot Water Heating System

The domestic hot water heating system for the facility consists of one AO Smith gas-fired condensing hot water heater with an input rating of 80 kBtu/hr each and a nominal efficiency of 80%. The water heater has a 75 gallon storage tank. Two 0.25 hp pumps distribute water to the entire site.

*Figure 12 – Domestic Hot Water System*

## Building Plug Load

There are 122 computer work stations throughout the library with no centralized PC power management software installed. There is other office equipment such as printers, projectors and televisions also found at the facility. A microwave oven, electric stove, and refrigerator are located in the staff lounge. Typical café equipment such as espresso and coffee machines, toaster oven, refrigerators, ice-maker machine, and a food warmer were found in the Terra Libri Lounge that resides in the first floor of the library.

# 3 SITE ENERGY USE AND COSTS

Utility data for electricity and natural gas was analyzed to identify opportunities for savings. In addition, data for electricity and natural gas was 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 3.4 for additional information.

## 3.1 Total Cost of Energy

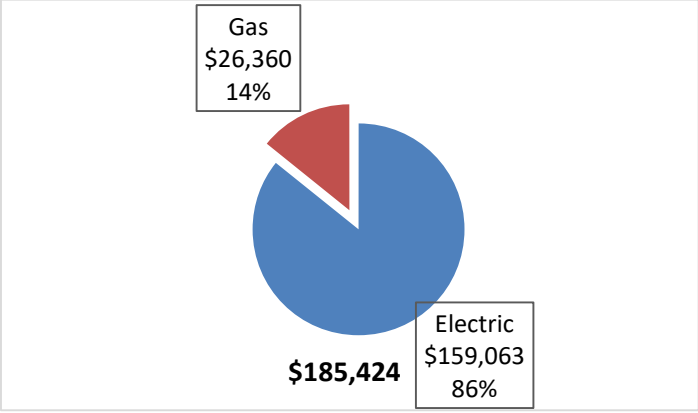
The following energy consumption and cost data is based on the last 12-month period of utility billing data that was provided for each utility. A profile of the annual energy consumption and energy cost of the facility was developed from this information.

*Figure 13 - Utility Summary*

| Utility Summary for Princeton Public Library | | |
|---|---|---|
| Fuel | Usage | Cost |
| Electricity | 1,156,412 kWh | $159,063 |
| Natural Gas | 37,728 Therms | $26,360 |
| Total | | $185,424 |

The current annual energy cost for this facility is $185,424 as shown in the chart below.

*Figure 14 - Energy Cost Breakdown*



## 3.2 Electricity Usage

Electricity is provided by PSE&G. The average electric cost over the past 12 months was $0.138/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. The monthly electricity consumption and peak demand are shown in the chart below.

*Figure 15 - Electric Usage & Demand*

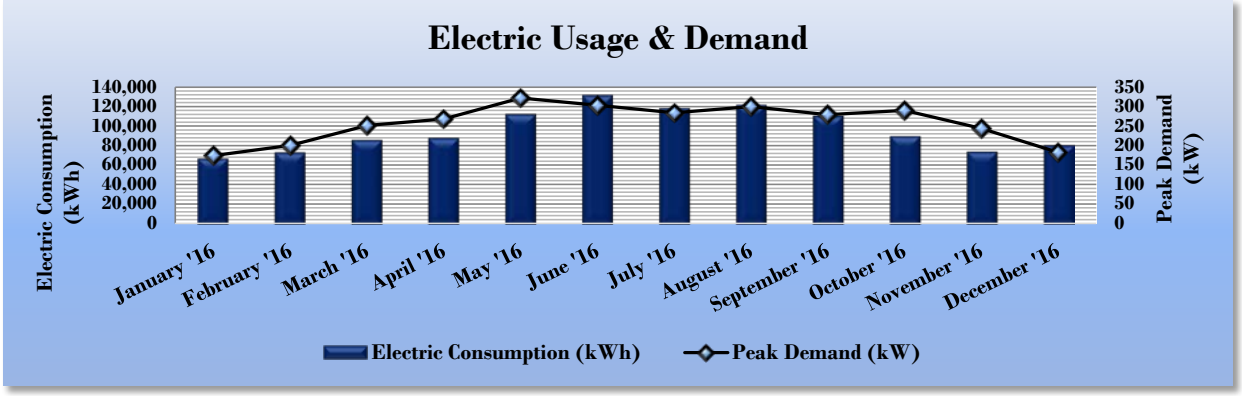



*Figure 16 - Electric Usage & Demand*

| Electric Billing Data for Princeton Public Library | | | | | |
|---|---|---|---|---|---|
| Period Ending | Days in Period | Electric Usage (kWh) | Demand (kW) | Demand Cost | Total Electric Cost |
| 2/10/16 | 29 | 67,426 | 174 | $631 | $8,690 |
| 3/11/16 | 30 | 73,540 | 201 | $730 | $9,524 |
| 4/12/16 | 32 | 86,210 | 251 | $921 | $11,166 |
| 5/11/16 | 29 | 88,167 | 268 | $983 | $11,453 |
| 6/10/16 | 30 | 112,496 | 322 | $1,181 | $16,709 |
| 7/12/16 | 32 | 131,758 | 303 | $3,273 | $19,955 |
| 8/10/16 | 29 | 118,584 | 284 | $1,040 | $18,139 |
| 9/9/16 | 30 | 121,859 | 300 | $1,105 | $18,753 |
| 10/10/16 | 31 | 110,950 | 279 | $1,039 | $14,663 |
| 11/8/16 | 29 | 90,131 | 290 | $1,081 | $10,886 |
| 12/9/16 | 31 | 74,460 | 244 | $909 | $9,109 |
| 1/11/17 | 33 | 80,831 | 182 | $679 | $10,017 |
| Totals | 365 | 1,156,412 | 322.3 | $13,571 | $159,063 |
| Annual | 365 | 1,156,412 | 322.3 | $13,571 | $159,063 |

## 3.3 Natural Gas Usage

Natural gas is provided by PSE&G. The average gas cost for the past 12 months is $0.699/therm, which is the blended rate used throughout the analyses in this report. The monthly gas consumption is shown in the chart below.

*Figure 17 - Months Natural Gas Usage*

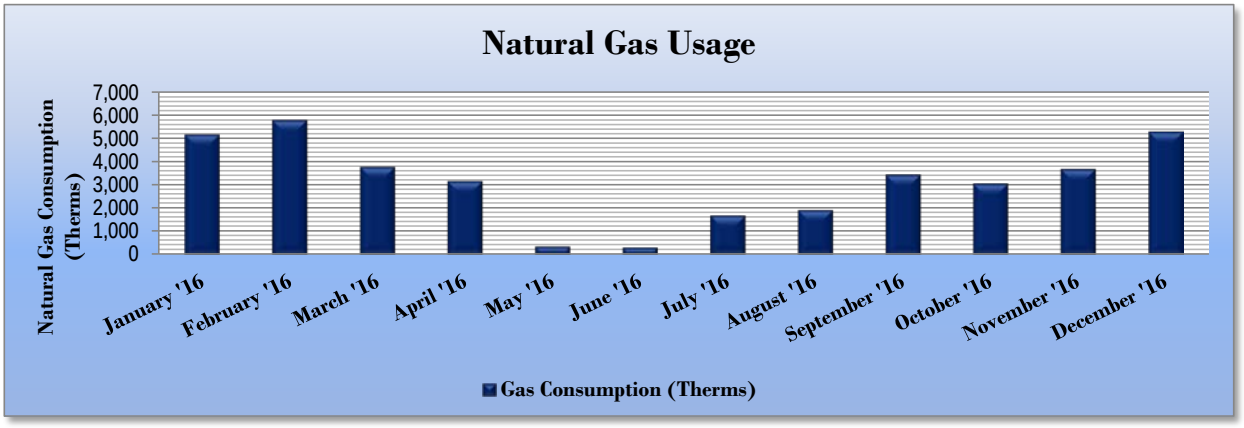



*Figure 18 - Natural Gas Usage*

| Gas Billing Data for Princeton Public Library | | | |
|---|---|---|---|
| Period Ending | Days in Period | Natural Gas Usage (Therms) | Natural Gas Cost |
| 2/10/16 | 29 | 5,185 | $4,203 |
| 3/11/16 | 30 | 5,796 | $4,160 |
| 4/12/16 | 32 | 3,791 | $2,268 |
| 5/11/16 | 29 | 3,165 | $1,671 |
| 6/10/16 | 30 | 355 | $563 |
| 7/12/16 | 32 | 308 | $1,296 |
| 8/10/16 | 29 | 1,696 | $737 |
| 9/9/16 | 30 | 1,924 | $742 |
| 10/11/16 | 32 | 3,447 | $1,154 |
| 11/8/16 | 28 | 3,068 | $2,098 |
| 12/9/16 | 31 | 3,697 | $3,286 |
| 1/11/17 | 33 | 5,296 | $4,182 |
| Totals | 365 | 37,728 | $26,360 |
| Annual | 365 | 37,728 | $26,360 |

## 3.4 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 19 - Energy Use Intensity Comparison – Existing Conditions*

| Energy Use Intensity Comparison - Existing Conditions | | |
|---|---|---|
| | Princeton Public Library | National Median Building Type: Library |
| Source Energy Use Intensity (kBtu/ft$^2$) | 297.3 | 235.6 |
| Site Energy Use Intensity (kBtu/ft$^2$) | 140.3 | 91.6 |

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

*Figure 20 - Energy Use Intensity Comparison – Following Installation of Recommended Measures*

| Energy Use Intensity Comparison - Following Installation of Recommended Measures | | |
|---|---|---|
| | Princeton Public Library | National Median Building Type: Library |
| Source Energy Use Intensity (kBtu/ft$^2$) | 232.9 | 235.6 |
| Site Energy Use Intensity (kBtu/ft$^2$) | 119.8 | 91.6 |

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% of all similar buildings nationwide and may be eligible for ENERGY STAR® certification. Your building, a library, is not is one of the building categories that are eligible to receive a score.

A Portfolio Manager® Statement of Energy Performance (SEP) was generated for this facility, see Appendix B: ENERGY STAR® Statement of Energy Performance.

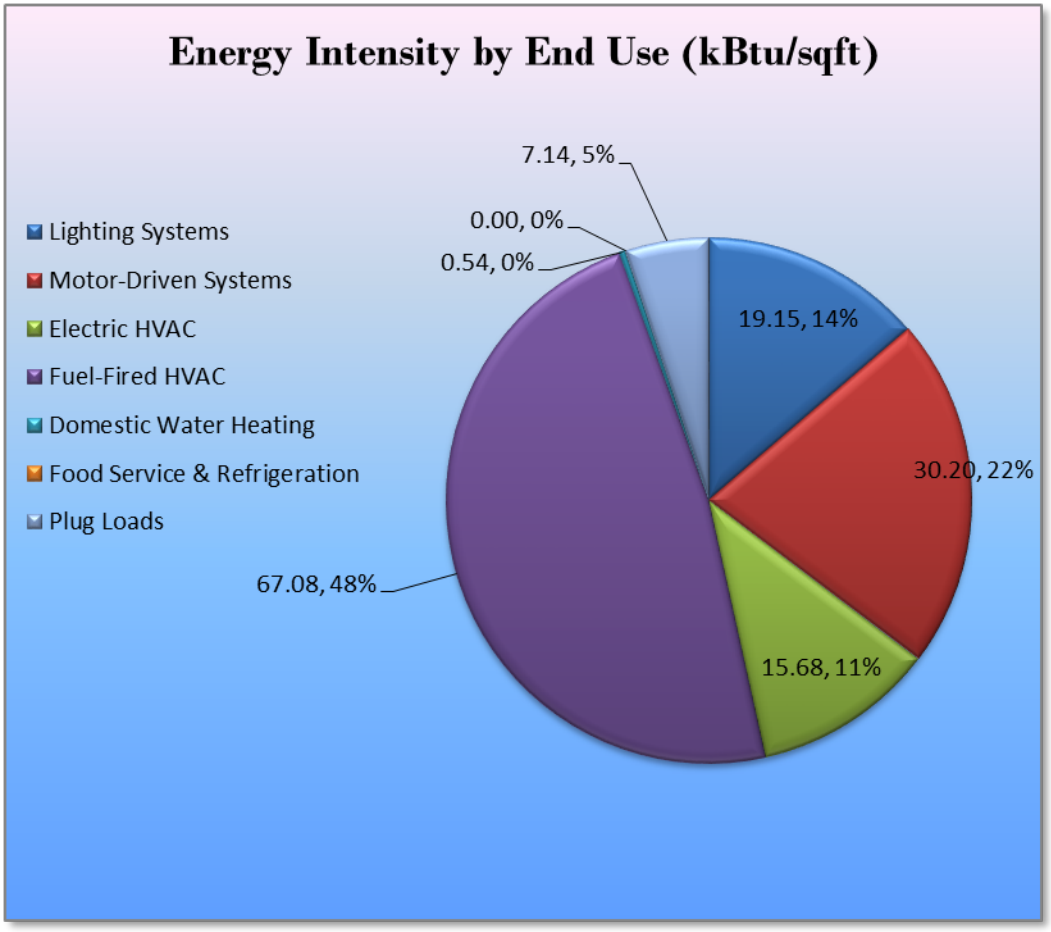
For more information on ENERGY STAR® certification go to: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/earn-recognition/energy-star-certification/how-app-1.

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.

## 3.5 Energy End-Use Breakdown

In order to provide a complete overview of energy consumption across building systems, an energy balance was performed at this facility. 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 21 - Energy Balance (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 Princeton Public Library 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 Recommended ECMs

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

***Figure 22 – Summary of Recommended 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** | | **168,319** | **30.3** | **0.0** | **$23,152.04** | **$73,285.46** | **$6,775.00** | **$66,510.46** | **2.9** | **169,495** |
| ECM 1 | Install LED Fixtures | 5,799 | 1.0 | 0.0 | $797.62 | $16,111.20 | $900.00 | $15,211.20 | 19.1 | 5,839 |
| ECM 2 | Retrofit Fixtures with LED Lamps | 162,520 | 29.3 | 0.0 | $22,354.42 | $57,174.26 | $5,875.00 | $51,299.26 | 2.3 | 163,656 |
| **Lighting Control Measures** | | **25,144** | **4.4** | **0.0** | **$3,458.56** | **$7,040.00** | **$1,615.00** | **$5,425.00** | **1.6** | **25,320** |
| ECM 3 | Install Occupancy Sensor Lighting Controls | 23,789 | 4.1 | 0.0 | $3,272.19 | $6,290.00 | $865.00 | $5,425.00 | 1.7 | 23,956 |
| ECM 4 | Install Daylight Dimming Controls | 1,355 | 0.2 | 0.0 | $186.37 | $750.00 | $750.00 | $0.00 | 0.0 | 1,364 |
| **Variable Frequency Drive (VFD) Measures** | | **26,542** | **4.9** | **0.0** | **$3,650.89** | **$16,216.00** | **$0.00** | **$16,216.00** | **4.4** | **26,728** |
| ECM 5 | Install VFDs on Chilled Water Pumps | 9,211 | 3.0 | 0.0 | $1,267.03 | $9,002.40 | $0.00 | $9,002.40 | 7.1 | 9,276 |
| ECM 6 | Install VFDs on Hot Water Pumps | 17,331 | 1.9 | 0.0 | $2,383.86 | $7,213.60 | $0.00 | $7,213.60 | 3.0 | 17,452 |
| **Electric Chiller Replacement** | | **110,687** | **54.5** | **0.0** | **$15,224.92** | **$213,296.05** | **$7,500.00** | **$205,796.05** | **13.5** | **111,461** |
| ECM 7 | Install High Efficiency Chillers | 110,687 | 54.5 | 0.0 | $15,224.92 | $213,296.05 | $7,500.00 | $205,796.05 | 13.5 | 111,461 |
| **TOTAL FOR ALL RECOMMENDED MEASURES** | | **330,693** | **134** | **164** | **$ 76,893.57** | **$ 469,197.62** | **$ 29,180.00** | **$ 440,017.62** | **5.7** | **573,748** |

## 4.1.1 Lighting Upgrades

Our recommendations for upgrades to existing lighting fixtures are summarized in Figure 23 below.

***Figure 23 – 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 | | 168,319 | 30.3 | 0.0 | $23,152.04 | $73,285.46 | $6,775.00 | $66,510.46 | 2.9 | 169,495 |
| ECM 1 | Install LED Fixtures | 5,799 | 1.0 | 0.0 | $797.62 | $16,111.20 | $900.00 | $15,211.20 | 19.1 | 5,839 |
| ECM 2 | Retrofit Fixtures with LED Lamps | 162,520 | 29.3 | 0.0 | $22,354.42 | $57,174.26 | $5,875.00 | $51,299.26 | 2.3 | 163,656 |

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: Install LED Fixtures

*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 | 5,799 | 1.0 | 0.0 | $797.62 | $16,111.20 | $900.00 | $15,211.20 | 19.1 | 5,839 |
| Exterior | 0 | 0.0 | 0.0 | $0.00 | $0.00 | $0.00 | $0.00 | 0.0 | 0 |

*Measure Description*

We recommend replacing existing fixtures containing metal halide high ceiling lamp fixtures with new high performance LED light fixtures. This measure saves energy by installing LEDs which use less power than other technologies with a comparable light output.

The facility only has six, 250-Watt metal halide high bay fixtures. Due to the limited quantity of these fixtures and potential access issues due to the fixture mounting height, this measure appears to have a project payback roughly equivalent to the expected useful life of the replacement fixture. However, LED fixture pricing continues to decline as the technology becomes more widely available. In light of that, we have recommended this measure.

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

## 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 | 154,424 | 27.9 | 0.0 | $21,240.79 | $54,862.88 | $5,790.00 | $49,072.88 | 2.3 | 155,503 |
| Exterior | 8,096 | 1.3 | 0.0 | $1,113.63 | $2,311.38 | $85.00 | $2,226.38 | 2.0 | 8,153 |

*Measure Description*

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

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

### 4.1.2 Lighting Control Measures

Our recommendations for lighting control measures are summarized in Figure 24 below.

***Figure 24 – 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 | | 25,144 | 4.4 | 0.0 | $3,458.56 | $7,040.00 | $1,615.00 | $5,425.00 | 1.6 | 25,320 |
| ECM 3 | Install Occupancy Sensor Lighting Controls | 23,789 | 4.1 | 0.0 | $3,272.19 | $6,290.00 | $865.00 | $5,425.00 | 1.7 | 23,956 |
| ECM 4 | Install Daylight Dimming Controls | 1,355 | 0.2 | 0.0 | $186.37 | $750.00 | $750.00 | $0.00 | 0.0 | 1,364 |

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) |
|---|---|---|---|---|---|---|---|---|
| 23,789 | 4.1 | 0.0 | $3,272.19 | $6,290.00 | $865.00 | $5,425.00 | 1.7 | 23,956 |

*Measure Description*

We recommend installing occupancy sensors to control lighting fixtures that are currently controlled by manual switches in offices, study rooms, meeting rooms, reading areas, and storage 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 Daylight Dimming 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) |
|---|---|---|---|---|---|---|---|---|
| 1,355 | 0.2 | 0.0 | $186.37 | $750.00 | $750.00 | $0.00 | 0.0 | 1,364 |

*Measure Description*

We recommend installing daylight dimming controls that use photosensors to reduce electric lighting in areas when ample daylight lighting is present. Photosensor controls are recommended for fixtures that are adjacent to windows that receive lots of sunlight. As sunlight level increase in the room, fixture lighting is decreased or turned off. This measure reduces energy use in spaces, such as the Community Room, where sufficient lighting levels can be met by ambient daylight.

Optimum light levels and the method of dimming should be determined during lighting design. 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.

## 4.1.3 Variable Frequency Drive Measures

Our recommendations for variable frequency drive (VFD) measures are summarized in Figure 25 below.

***Figure 25 – Summary of Variable Frequency Drive 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable Frequency Drive (VFD) Measures | | 26,542 | 4.9 | 0.0 | $3,650.89 | $16,216.00 | $0.00 | $16,216.00 | 4.4 | 26,728 |
| ECM 5 | Install VFDs on Chilled Water Pumps | 9,211 | 3.0 | 0.0 | $1,267.03 | $9,002.40 | $0.00 | $9,002.40 | 7.1 | 9,276 |
| ECM 6 | Install VFDs on Hot Water Pumps | 17,331 | 1.9 | 0.0 | $2,383.86 | $7,213.60 | $0.00 | $7,213.60 | 3.0 | 17,452 |

### ECM 5: Install VFDs on Chilled Water Pumps

*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) |
|---|---|---|---|---|---|---|---|---|
| 9,211 | 3.0 | 0.0 | $1,267.03 | $9,002.40 | $0.00 | $9,002.40 | 7.1 | 9,276 |

*Measure Description*

We recommend installing a variable frequency drives (VFD) to control chilled water pumps. This measure requires that chilled water coils be served by 2-way valves and that a differential pressure sensor be installed in the chilled water loop. As the chilled water valves close, the differential pressure increases. The VFD modulates pump speed to maintain a differential pressure setpoint. Energy savings results from reducing pump motor speed (and power) as chilled water valves close. The magnitude of energy savings is based on the estimated amount of time that the system operates at reduced loads.

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

## ECM 6: Install VFDs on Hot Water Pumps

*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) |
|---|---|---|---|---|---|---|---|---|
| 17,331 | 1.9 | 0.0 | $2,383.86 | $7,213.60 | $0.00 | $7,213.60 | 3.0 | 17,452 |

*Measure Description*

We recommend installing variable frequency drives (VFD) to control the two 7.5 hp hot water pumps. This measure requires that a majority of the hot water coils be served by 2-way valves and that a differential pressure sensor is installed in the hot water loop. As the hot water valves close, the differential pressure increases. The VFD modulates pump speed to maintain a differential pressure setpoint. Energy savings results from reducing pump motor speed (and power) as hot water valves close. The magnitude of energy savings is based on the estimated amount of time that the system will operate at reduced load.

### 4.1.4 Electric Chiller Replacement

Our recommendations for electric chiller replacements are summarized in Figure 26 below.

***Figure 26 – Summary of Electric Chiller Replacement 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| Electric Chiller Replacement | | 110,687 | 54.5 | 0.0 | $15,224.92 | $213,296.05 | $7,500.00 | $205,796.05 | 13.5 | 111,461 |
| ECM 6 | Install High Efficiency Chillers | 110,687 | 54.5 | 0.0 | $15,224.92 | $213,296.05 | $7,500.00 | $205,796.05 | 13.5 | 111,461 |

## ECM 7: Install High Efficiency Chillers

*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) |
|---|---|---|---|---|---|---|---|---|
| 110,687 | 54.5 | 0.0 | $15,224.92 | $213,296.05 | $7,500.00 | $205,796.05 | 13.5 | 111,461 |

*Measure Description*

We recommend replacing older inefficient electric chillers with new high efficiency chillers. The type of chiller to be installed depends on the magnitude of the cooling load and variability of the cooling load profile. Positive displacement chillers are usually under 600 tons of cooling capacity and centrifugal chillers generally start at 150 tons of cooling capacity. Constant speed chillers should be used to meet cooling loads with little or no variation while variable speed chillers are more efficient for variable cooling load profiles. Water cooled chillers are more efficient than air cooled chillers but require cooling towers

and additional pumps to circulate the cooling water. In any given size range variable speed chillers tend to have better partial load efficiency, but worse full load efficiency, than constant speed chillers.

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

## 4.2 ECMs Evaluated But Not Recommended

The measures below have been evaluated by the auditor but are not recommended for implementation at the facility. Reasons for exclusion can be found in each measure description section.

*Figure 27 – Summary of Measures Evaluated, But Not Recommended*

| Energy Conservation Measure | Recommend? | 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** | | **1,499** | **0.7** | **0.0** | **$206.18** | **$9,273.08** | **$0.00** | **$9,273.08** | **45.0** | **1,509** |
| Premium Efficiency Motors | No | 1,499 | 0.7 | 0.0 | $206.18 | $9,273.08 | $0.00 | $9,273.08 | 45.0 | 1,509 |
| **Gas Heating (HVAC/Process) Replacement** | | **0** | **0.0** | **164.0** | **$1,145.69** | **$62,818.65** | **$4,900.00** | **$57,918.65** | **50.6** | **19,199** |
| Install High Efficiency Hot Water Boilers | No | 0 | 0.0 | 164.0 | $1,145.69 | $62,818.65 | $4,900.00 | $57,918.65 | 50.6 | 19,199 |
| **TOTAL OF ALL NON-RECOMMENDED MEASURES** | | **1,499** | **1** | **164** | **$ 1,351.87** | **$ 72,091.73** | **$ 4,900.00** | **$ 67,191.73** | **49.7** | **20,709** |

* - 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).

### 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) |
|---|---|---|---|---|---|---|---|---|
| 1,499 | 0.7 | 0.0 | $206.18 | $9,273.08 | $0.00 | $9,273.08 | 45.0 | 1,509 |

*Measure Description*

We evaluated replacing standard efficiency motors (one 10 hp chilled water pump and two 7.5 hp hot water pump that are 15 years old) with *NEMA Premium™* 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.

## Install High Efficiency Hot Water Boiler

*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 | 164.0 | $1,145.69 | $62,818.65 | $4,900.00 | $57,918.65 | 50.6 | 19,199 |

*Measure Description*

We evaluated replacing older inefficient hot water boilers with high efficiency hot water boilers. Significant improvements have been made in combustion technology resulting in increased overall boiler efficiency. Energy savings results from improved combustion efficiency and reduced standby losses at low loads.

The most notable efficiency improvement is condensing hydronic boilers that can achieve over 90% efficiency under the proper conditions. Condensing hydronic boilers typically operate at efficiencies of approximately 85% and 87% (comparable to other high efficiency boilers) when the return water temperature is above 130°F. If the return water temperature drops below 130°F, the unit will enter "condensing mode" providing more efficient operation. Condensing hydronic boilers were only recommended when it could be confirmed that the return water temperature is less than 130°F during most of the operating hours. Please be aware that condensing boilers are typically 10% - 15% more expensive than standard high efficiency boilers and should only be selected if the design conditions support "condensing mode" operation. Based on the information available, condensing hydronic boilers are not recommended for this site.

In addition to determining the appropriate type of new high efficiency boiler, we recommend consideration be made regarding the new unit size(s) and where appropriate, implementation of multiple (modular) boilers versus larger capacity units. We recommend that the site staff work with the design team to evaluate the heating load for the facility prior to replacing the boilers. The new boilers should be sized to meet the current heating requirements rather than simply installing boilers with the same capacity as the existing boilers. The capital cost of the project can generally be reduced if the overall boiler plant capacity can be reduced. In addition, we recommend that the design team consider designing the plant using several lower capacity modular boilers. Configuring a boiler plant with several modular boilers, rather than one or two high capacity boilers, results in a plant that can more efficiently match and serve the load, provides a high level of redundancy, reduces standby losses, and is more flexible to expand if the heating load increases in the future. Finally, we recommend working with the design team to determine if the updated boiler plant can be operated such that the return water temperature is generally lower than 130 °F so that condensing boilers could be used

*Reasons for not Recommending*

Although these equipment are old enough to be evaluated for replacement, the payback period on this investment is higher than the useful life of the equipment itself. In the future, if these equipment are up for replacement, we suggest replacing it with high efficiency equipment.

# 5 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.

## Perform Proper Lighting Maintenance

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

## Develop a Lighting Maintenance Schedule

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

## Ensure Lighting Controls Are Operating Properly

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

## 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.

## Ensure Economizers are Functioning Properly

Economizers, when properly configured, can be used to significantly reduce mechanical cooling. However, if the outdoor thermostat or enthalpy control is malfunctioning or the damper is stuck or improperly adjusted, benefits from the economizer may not be fully realized. As such, periodic inspection and maintenance is required to ensure proper operation. This maintenance should be scheduled with maintenance of the facility's air conditioning system and should include proper setting of the outdoor thermostat/enthalpy control, inspection of control and damper operation, lubrication of damper connections, and adjustment of minimum damper position. A malfunctioning economizer can significantly increase the amount of heating and mechanical cooling required by introducing excess amounts of cold or hot outside air.

## Assess Chillers & Request Tune-Ups

Chillers are responsible for a substantial portion of a commercial building's overall energy usage. When components of a chiller are not optimized, this can quickly result in a noticeable increase in energy bills. Chiller diagnostics can produce a 5% to 10% cost avoidance potential from discovery and implementation of low/no cost optimization strategies.

## Clean Evaporator/Condenser Coils on AC Systems

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

## Clean and/or Replace HVAC Filters

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

## Check for and Seal Duct Leakage

Duct leakage in commercial buildings typically accounts for 5% to 25% 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.

## 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.

# 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.

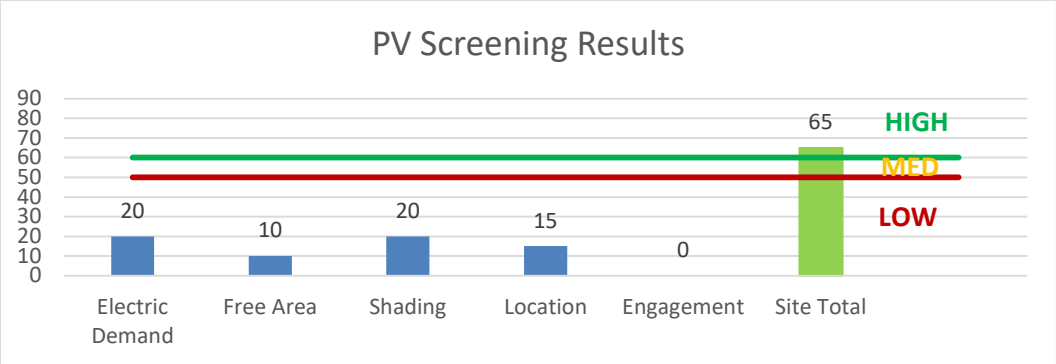
## 6.1 Photovoltaic

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 facility's electric demand, size and location of free area, and shading elements shows that the facility has a **High** potential for installing a PV array.

The amount of free area, ease of installation (location), and the lack of shading elements contribute to the high potential for PV at the site. A PV array located on the roof of the main building may be feasible. If the Princeton Public Library is interested in pursuing the installation of PV, we recommended a full feasibility study be conducted.

*Figure 28 - Photovoltaic Screening*



| | | |
|---|---|---|
| Potential | High | |
| System Potential | 64 | kW DC STC |
| Electric Generation | 76,248 | kWh/yr |
| Displaced Cost | $6,630 | /yr |
| Installed Cost | $183,000 | |

Solar projects must register their projects in the SREC (Solar Renewable Energy Certificate) Registration Program (SRP) prior to the start of construction in order to establish the project's eligibility to earn SRECs. Registration of the intent to participate in New Jersey's solar marketplace provides market participants with information about developed new solar projects and insight into future SREC pricing. Refer to Section 8.3 for additional information.

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

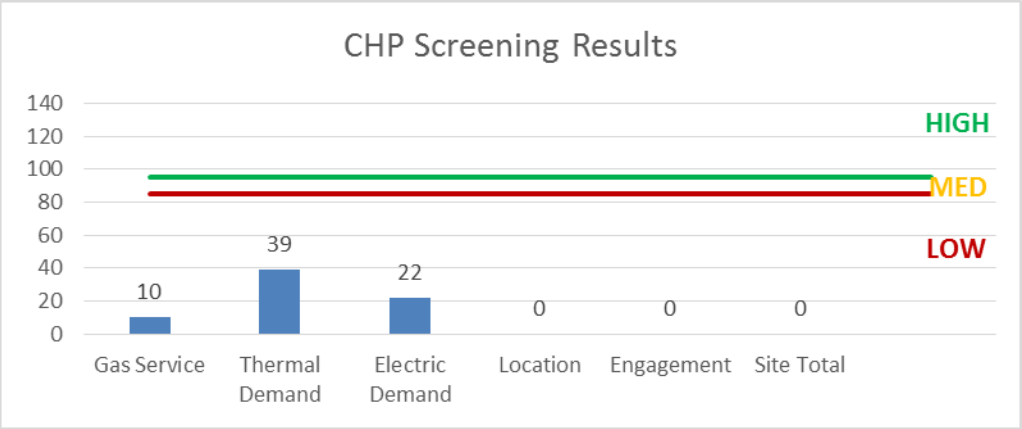
## 6.2 Combined Heat and Power

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.

CHP systems are typically used to produce a portion of the electric power used onsite by a facility, with the balance of electric power needs supplied by grid purchases. The heat is used to supplement (or supplant) existing boilers for the purpose of space heating and/or domestic hot water heating. Waste heat can also be routed through absorption chillers for the purpose of space cooling. The key criteria used for screening, however, is the amount of time the system operates at full load and the facility's ability to use the recovered heat. Facilities with continuous use for large quantities of waste heat are the best candidates for CHP.

A preliminary screening based on heating and electrical demand, siting, and interconnection shows that the facility has a **Low** potential for installing a cost-effective CHP system.

*Figure 29 – Combined Heat & Power Screening*



# 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.

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

*Figure 30 - ECM Incentive Program Eligibility*

| Energy Conservation Measure | | SmartStart Prescriptive | Pay For Performance Existing Buildings |
|---|---|---|---|
| ECM 1 | Install LED Fixtures | x | x |
| ECM 2 | Retrofit Fixtures with LED Lamps | x | x |
| ECM 3 | Install Occupancy Sensor Lighting Controls | x | x |
| ECM 4 | Install Daylight Dimming Controls | | x |
| ECM 5 | Install VFDs on Chilled Water Pumps | x | x |
| ECM 6 | Install VFDs on Hot Water Pumps | | x |
| ECM 7 | Install High Efficiency Chillers | 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. The Large Energy Users Program (LEUP) is available to New Jersey's largest energy users giving them flexibility to install as little or as many measures, in a single facility or several facilities, with incentives capped based on the entity's annual energy consumption. LEUP applicants can use in-house staff or a preferred contractor.

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

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

## 8.1 SmartStart

**Overview**

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

**Equipment with Prescriptive Incentives Currently Available:**

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

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

**Incentives**

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

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

**How to Participate**

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

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

## 8.2 SREC Registration Program

The SREC (Solar Renewable Energy Certificate) Registration Program (SRP) is used to register the intent to install solar projects in New Jersey. Rebates are not available for solar projects, but owners of solar projects MUST register their projects in the SRP prior to the start of construction in order to establish the project's eligibility to earn SRECs. Registration of the intent to participate in New Jersey's solar marketplace provides market participants with information about the pipeline of anticipated new solar capacity and insight into future SREC pricing.

After the registration is accepted, construction is complete, and final paperwork has been submitted and is deemed complete, the project is issued a New Jersey certification number which enables it to generate New Jersey SRECs. SRECs are generated once the solar project has been authorized to be energized by the Electric Distribution Company (EDC).

Each time a solar installation generates 1,000 kilowatt-hours (kWh) of electricity, an SREC is earned. Solar project owners report the energy production to the SREC Tracking System. This reporting allows SRECs to be placed in the customer's electronic account. SRECs can then be sold on the SREC Tracking System, providing revenue for the first 15 years of the project's life.

Electricity suppliers, the primary purchasers of SRECs, are required to pay a Solar Alternative Compliance Payment (SACP) if they do not meet the requirements of New Jersey's Solar RPS. One way they can meet the RPS requirements is by purchasing SRECs. As SRECs are traded in a competitive market, the price may vary significantly. The actual price of an SREC during a trading period can and will fluctuate depending on supply and demand.

Information about the SRP can be found at: www.njcleanenergy.com/srec.

## 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 description 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 |
| Penthouse | 18 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | Yes | 18 | LED - Linear Tubes: (2) 4' Lamps | Occupancy Sensor | 29 | 2,899 | 0.61 | 3,513 | 0.0 | $483.21 | $1,323.00 | $215.00 | 2.29 |
| Book Storage-Penthouse | 6 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | Yes | 6 | LED - Linear Tubes: (2) 4' Lamps | Occupancy Sensor | 29 | 2,899 | 0.20 | 1,171 | 0.0 | $161.07 | $467.00 | $80.00 | 2.40 |
| Elevator | 30 | Incandescent: 60W Incandescent Bulbs | Wall Switch | 60 | 4,142 | Relamp | No | 30 | LED Screw-In Lamps: LED- 9W Bulbs | Wall Switch | 9 | 4,142 | 1.24 | 7,161 | 0.0 | $984.95 | $1,612.59 | $150.00 | 1.48 |
| Emergency Stairwell | 17 | LED - Fixtures: Stairwell/Passageway Lighting | Occupancy Sensor | 30 | 2,899 | None | No | 17 | LED - Fixtures: Stairwell/Passageway Lighting | Occupancy Sensor | 30 | 2,899 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Emergency Stairwell | 17 | LED - Fixtures: Stairwell/Passageway Lighting | Occupancy Sensor | 30 | 2,899 | None | No | 17 | LED - Fixtures: Stairwell/Passageway Lighting | Occupancy Sensor | 30 | 2,899 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Admin Office | 4 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | Yes | 4 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.20 | 1,171 | 0.0 | $161.07 | $416.80 | $80.00 | 2.09 |
| 318 Office | 4 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Occupancy Sensor | 93 | 2,899 | Relamp | No | 4 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.16 | 649 | 0.0 | $89.23 | $300.80 | $60.00 | 2.70 |
| 316 Office | 4 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Occupancy Sensor | 93 | 2,899 | Relamp | No | 4 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.16 | 649 | 0.0 | $89.23 | $300.80 | $60.00 | 2.70 |
| 314 Office | 4 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Occupancy Sensor | 93 | 2,899 | Relamp | No | 4 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.16 | 649 | 0.0 | $89.23 | $300.80 | $60.00 | 2.70 |
| Office | 6 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | Yes | 6 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.31 | 1,756 | 0.0 | $241.60 | $567.20 | $110.00 | 1.89 |
| 310A- Conference | 4 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Occupancy Sensor | 93 | 2,899 | Relamp | No | 4 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.16 | 649 | 0.0 | $89.23 | $300.80 | $60.00 | 2.70 |
| Women's Restrooms | 12 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | No | 12 | LED Screw-In Lamps: LED- 29 Watts | Wall Switch | 29 | 4,142 | 0.12 | 708 | 0.0 | $97.34 | $645.04 | $0.00 | 6.63 |
| Women's Restrooms | 39 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 39 | LED - Linear Tubes: (2) 4' Lamps | Wall Switch | 29 | 4,142 | 1.05 | 6,023 | 0.0 | $828.52 | $2,281.50 | $390.00 | 2.28 |
| Men's Restrooms | 12 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | No | 12 | LED Screw-In Lamps: LED- 29 Watts | Wall Switch | 29 | 4,142 | 0.12 | 708 | 0.0 | $97.34 | $645.04 | $0.00 | 6.63 |
| Men's Restrooms | 39 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 39 | LED - Linear Tubes: (2) 4' Lamps | Wall Switch | 29 | 4,142 | 1.05 | 6,023 | 0.0 | $828.52 | $2,281.50 | $390.00 | 2.28 |
| Staff Lounge 322 | 24 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Occupancy Sensor | 93 | 2,899 | Relamp | No | 24 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.97 | 3,892 | 0.0 | $535.35 | $1,804.80 | $360.00 | 2.70 |
| Staff Lounge Restroom | 24 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | No | 24 | LED Screw-In Lamps: LED- 29 Watts | Wall Switch | 29 | 4,142 | 0.25 | 1,415 | 0.0 | $194.67 | $1,290.07 | $0.00 | 6.63 |
| 324 Office | 6 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | Yes | 6 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.31 | 1,756 | 0.0 | $241.60 | $567.20 | $110.00 | 1.89 |
| 327 Maintenance | 1 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 1 | LED - Linear Tubes: (2) 4' Lamps | Wall Switch | 29 | 4,142 | 0.03 | 154 | 0.0 | $21.24 | $58.50 | $10.00 | 2.28 |
| Restroom | 4 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | No | 4 | LED Screw-In Lamps: LED- 29 Watts | Wall Switch | 29 | 4,142 | 0.04 | 236 | 0.0 | $32.45 | $215.01 | $0.00 | 6.63 |
| 321 Office | 2 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | Yes | 2 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.10 | 585 | 0.0 | $80.53 | $266.40 | $50.00 | 2.69 |
| 340 Office | 7 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Occupancy Sensor | 93 | 2,899 | Relamp | No | 7 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.28 | 1,135 | 0.0 | $156.14 | $526.40 | $105.00 | 2.70 |
| 340A Storage | 1 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 1 | LED - Linear Tubes: (2) 4' Lamps | Wall Switch | 29 | 4,142 | 0.03 | 154 | 0.0 | $21.24 | $58.50 | $10.00 | 2.28 |
| 323 Office | 14 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | Yes | 14 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.71 | 4,098 | 0.0 | $563.74 | $1,322.80 | $245.00 | 1.91 |
| 354 Study Room | 4 | Compact Fluorescent: 18W CFL Bulbs | Occupancy Sensor | 18 | 2,899 | Relamp | No | 4 | LED Screw-In Lamps: LED- 13W Bulb | Occupancy Sensor | 13 | 2,899 | 0.02 | 71 | 0.0 | $9.73 | $215.01 | $0.00 | 22.09 |

| | 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 |
| 352 Study Room | 4 | Compact Fluorescent: 18W CFL Bulbs | Occupancy Sensor | 18 | 2,899 | Relamp | No | 4 | LED Screw-In Lamps: LED- 13W Bulb | Occupancy Sensor | 13 | 2,899 | 0.02 | 71 | 0.0 | $9.73 | $215.01 | $0.00 | 22.09 |
| 301 Storage Room | 13 | Halogen Incandescent: 150W 2-Pin Halogen Bulbs | Occupancy Sensor | 150 | 2,899 | Relamp | No | 13 | LED Screw-In Lamps: LED- 23W bulbs | Occupancy Sensor | 23 | 2,899 | 1.35 | 5,430 | 0.0 | $746.92 | $698.79 | $65.00 | 0.85 |
| 301 Storage Room | 6 | Incandescent: 40W Incandescent Bulbs | Occupancy Sensor | 40 | 2,899 | Relamp | No | 6 | LED Screw-In Lamps: LED- 6W Bulbs | Occupancy Sensor | 6 | 2,899 | 0.17 | 668 | 0.0 | $91.93 | $263.72 | $30.00 | 2.54 |
| Open Area - Books | 141 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | No | 141 | LED - Linear Tubes: (3) 4' Lamps | Wall Switch | 44 | 4,142 | 5.68 | 32,666 | 0.0 | $4,493.13 | $10,603.20 | $2,115.00 | 1.89 |
| Open Area - Books | 4 | Compact Fluorescent: 32W CFL Bulbs | Wall Switch | 32 | 4,142 | Relamp | No | 4 | LED Screw-In Lamps: LED- 22W Bulbs | Wall Switch | 22 | 4,142 | 0.03 | 180 | 0.0 | $24.72 | $215.01 | $0.00 | 8.70 |
| Decorative Fixtures | 4 | LED Screw-In Lamps: LED Lamps in Decorative Fixtures | Wall Switch | 20 | 4,142 | None | No | 4 | LED Screw-In Lamps: LED Lamps in Decorative Fixtures | Wall Switch | 20 | 4,142 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Desk Front | 11 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | No | 11 | LED Screw-In Lamps: LED- 29 Watts | Wall Switch | 29 | 4,142 | 0.11 | 649 | 0.0 | $89.23 | $591.28 | $0.00 | 6.63 |
| Reading Table | 10 | LED Screw-In Lamps: LED Lamps in Recessed Cans | Wall Switch | 12 | 4,142 | None | No | 10 | LED Screw-In Lamps: LED Lamps in Recessed Cans | Wall Switch | 12 | 4,142 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Above Book Shelves | 9 | Compact Fluorescent: 18W CFL Bulbs | Wall Switch | 18 | 4,142 | Relamp | No | 9 | LED Screw-In Lamps: LED- 13W Bulb | Wall Switch | 13 | 4,142 | 0.04 | 227 | 0.0 | $31.29 | $483.78 | $0.00 | 15.46 |
| Reading Area | 8 | Compact Fluorescent: 18W CFL Bulbs | Wall Switch | 18 | 4,142 | Relamp | Yes | 8 | LED Screw-In Lamps: LED- 13W Bulb | Daylight Dimming | 13 | 2,071 | 0.08 | 438 | 0.0 | $60.26 | $680.02 | $360.00 | 5.31 |
| Reading Area | 8 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | Yes | 8 | LED Screw-In Lamps: LED- 29 Watts | Daylight Dimming | 29 | 2,071 | 0.18 | 1,022 | 0.0 | $140.60 | $680.02 | $360.00 | 2.28 |
| Front of Office Administration | 4 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | No | 4 | LED - Linear Tubes: (3) 4' Lamps | Wall Switch | 44 | 4,142 | 0.16 | 927 | 0.0 | $127.46 | $300.80 | $60.00 | 1.89 |
| Front of Office Administration | 11 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | No | 11 | LED Screw-In Lamps: LED- 29 Watts | Wall Switch | 29 | 4,142 | 0.11 | 649 | 0.0 | $89.23 | $591.28 | $0.00 | 6.63 |
| Outside Restroom | 3 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | No | 3 | LED Screw-In Lamps: LED- 29 Watts | Wall Switch | 29 | 4,142 | 0.03 | 177 | 0.0 | $24.33 | $161.26 | $0.00 | 6.63 |
| Main Stairwell | 12 | Compact Fluorescent: 18W CFL Bulbs | Wall Switch | 18 | 4,142 | Relamp | No | 12 | LED Screw-In Lamps: LED- 13W Bulb | Wall Switch | 13 | 4,142 | 0.05 | 303 | 0.0 | $41.72 | $645.04 | $0.00 | 15.46 |
| | | | | | | | | | | | | | | | | | | | |
| Main Stairwell | 4 | Compact Fluorescent: 26W CFL Bulbs | Wall Switch | 26 | 4,142 | Relamp | No | 4 | LED Screw-In Lamps: LED- 18W Bulb | Wall Switch | 18 | 4,142 | 0.03 | 146 | 0.0 | $20.09 | $215.01 | $0.00 | 10.70 |
| IT Office | 6 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | Yes | 6 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.31 | 1,756 | 0.0 | $241.60 | $567.20 | $110.00 | 1.89 |
| Server Room | 2 | Linear Fluorescent - T8: 4' T8 (32W) - 4L | Wall Switch | 114 | 4,142 | Relamp | No | 2 | LED - Linear Tubes: (4) 4' Lamps | Wall Switch | 58 | 4,142 | 0.09 | 524 | 0.0 | $72.10 | $190.27 | $40.00 | 2.08 |
| Study Room 9 | 1 | LED - Fixtures: Cove Mount | Occupancy Sensor | 60 | 2,899 | None | No | 1 | LED - Fixtures: Cove Mount | Occupancy Sensor | 60 | 2,899 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| News Room Storage | 2 | LED-Fixtures: Cove Mount | Occupancy Sensor | 30 | 2,899 | None | No | 2 | LED-Fixtures: Cove Mount | Occupancy Sensor | 30 | 2,899 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| News Room | 14 | LED - Fixtures: Cove Mount | Wall Switch | 60 | 4,142 | None | Yes | 14 | LED - Fixtures: Cove Mount | Occupancy Sensor | 60 | 2,899 | 0.21 | 1,179 | 0.0 | $162.23 | $270.00 | $35.00 | 1.45 |
| News Room | 12 | Linear Fluorescent - T8: 4' T8 (32W) - 1L | Wall Switch | 32 | 4,142 | Relamp | Yes | 12 | LED - Linear Tubes: (1) 4' Lamp | Occupancy Sensor | 15 | 2,899 | 0.21 | 1,227 | 0.0 | $168.79 | $700.80 | $95.00 | 3.59 |
| Staff Office Suite | 9 | LED - Fixtures: Cove Mount | Occupancy Sensor | 60 | 2,899 | None | No | 9 | LED - Fixtures: Cove Mount | Occupancy Sensor | 60 | 2,899 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Head of Adult Services | 2 | LED-Fixtures: Cove Mount | Occupancy Sensor | 30 | 2,899 | None | No | 2 | LED-Fixtures: Cove Mount | Occupancy Sensor | 30 | 2,899 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |

| | 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 |
| Assitant Director's Office | 2 | LED-Fixtures: Cove Mount | Occupancy Sensor | 60 | 2,899 | None | No | 2 | LED-Fixtures: Cove Mount | Occupancy Sensor | 60 | 2,899 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Princeton Room | 2 | Linear Fluorescent - T8: 4' T8 (32W) - 1L | Occupancy Sensor | 32 | 2,899 | Relamp | No | 2 | LED - Linear Tubes: (1) 4' Lamp | Occupancy Sensor | 15 | 2,899 | 0.03 | 115 | 0.0 | $15.77 | $71.80 | $10.00 | 3.92 |
| Princeton Room | 8 | Linear Fluorescent - T8: 5' T8 (40W) - 1L | Occupancy Sensor | 46 | 2,899 | Relamp | No | 8 | LED - Linear Tubes: (1) 5' Lamp | Occupancy Sensor | 20 | 2,899 | 0.17 | 681 | 0.0 | $93.73 | $303.20 | $0.00 | 3.23 |
| Princeton Room | 10 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Occupancy Sensor | 12 | 2,899 | None | No | 10 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Occupancy Sensor | 12 | 2,899 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Conference Room | 8 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Occupancy Sensor | 12 | 2,899 | None | No | 8 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Occupancy Sensor | 12 | 2,899 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Conference Room | 2 | Linear Fluorescent - T8: 5' T8 (40W) - 1L | Occupancy Sensor | 46 | 2,899 | Relamp | No | 2 | LED - Linear Tubes: (1) 5' Lamp | Occupancy Sensor | 20 | 2,899 | 0.04 | 170 | 0.0 | $23.43 | $75.80 | $0.00 | 3.23 |
| Tower Room | 9 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Occupancy Sensor | 12 | 2,899 | None | No | 9 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Occupancy Sensor | 12 | 2,899 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Open Area- 2nd Floor | 26 | LED - Fixtures: 8' LED Strip Fixtures | Wall Switch | 60 | 4,142 | None | Yes | 26 | LED - Fixtures: 8' LED Strip Fixtures | Occupancy Sensor | 60 | 2,899 | 0.38 | 2,190 | 0.0 | $301.28 | $540.00 | $70.00 | 1.56 |
| Open Area- 2nd Floor | 3 | LED - Fixtures: 6' LED Strip Fixtures | Wall Switch | 45 | 4,142 | None | Yes | 3 | LED - Fixtures: 6' LED Strip Fixtures | Occupancy Sensor | 45 | 2,899 | 0.03 | 190 | 0.0 | $26.07 | $0.00 | $0.00 | 0.00 |
| IT Area | 7 | LED - Fixtures: 8' LED Strip Fixtures | Wall Switch | 60 | 4,142 | None | No | 7 | LED - Fixtures: 8' LED Strip Fixtures | Wall Switch | 60 | 4,142 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| IT Area | 2 | LED - Fixtures: 6' LED Strip Fixtures | Wall Switch | 45 | 4,142 | None | No | 2 | LED - Fixtures: 6' LED Strip Fixtures | Wall Switch | 45 | 4,142 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Book Shelves | 51 | LED - Linear Tubes: (1) 4' Lamp | Wall Switch | 15 | 4,142 | None | No | 51 | LED - Linear Tubes: (1) 4' Lamp | Wall Switch | 15 | 4,142 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Book Shelves | 12 | LED - Fixtures: 8' LED Strip Fixtures | Wall Switch | 60 | 4,142 | None | No | 12 | LED - Fixtures: 8' LED Strip Fixtures | Wall Switch | 60 | 4,142 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Print and Copy | 4 | LED - Fixtures: 8' LED Strip Fixtures | Wall Switch | 60 | 4,142 | None | No | 4 | LED - Fixtures: 8' LED Strip Fixtures | Wall Switch | 60 | 4,142 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Elevator Entrance | 1 | Linear Fluorescent - T8: 4' T8 (32W) - 1L | Wall Switch | 32 | 4,142 | Relamp | No | 1 | LED - Linear Tubes: (1) 4' Lamp | Wall Switch | 15 | 4,142 | 0.01 | 82 | 0.0 | $11.27 | $35.90 | $5.00 | 2.74 |
| Study Room 8 | 8 | LED - Fixtures: Decorative: Other | Wall Switch | 28 | 4,142 | None | Yes | 8 | LED - Fixtures: Decorative: Other | Occupancy Sensor | 28 | 2,899 | 0.05 | 315 | 0.0 | $43.26 | $116.00 | $20.00 | 2.22 |
| Study Room 8 | 7 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Wall Switch | 12 | 4,142 | None | Yes | 7 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Occupancy Sensor | 12 | 2,899 | 0.02 | 118 | 0.0 | $16.22 | $0.00 | $0.00 | 0.00 |
| Hallways Open Area | 28 | LED - Fixtures: 8' LED Strip Fixtures | Wall Switch | 60 | 4,142 | None | Yes | 28 | LED - Fixtures: 8' LED Strip Fixtures | Occupancy Sensor | 60 | 2,899 | 0.41 | 2,359 | 0.0 | $324.46 | $540.00 | $70.00 | 1.45 |
| Hallways Open Area | 6 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Wall Switch | 12 | 4,142 | None | Yes | 6 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Occupancy Sensor | 12 | 2,899 | 0.02 | 101 | 0.0 | $13.91 | $270.00 | $35.00 | 16.90 |
| Reading Room | 12 | LED - Fixtures: 8' LED Strip Fixtures | Wall Switch | 60 | 4,142 | None | Yes | 12 | LED - Fixtures: 8' LED Strip Fixtures | Occupancy Sensor | 60 | 2,899 | 0.18 | 1,011 | 0.0 | $139.05 | $270.00 | $35.00 | 1.69 |
| Reading Room | 3 | LED - Fixtures: Decorative: Other | Wall Switch | 28 | 4,142 | None | No | 3 | LED - Fixtures: Decorative: Other | Wall Switch | 28 | 4,142 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Reading Room | 16 | LED - Linear Tubes: (1) 4' Lamp | Wall Switch | 15 | 4,142 | None | Yes | 16 | LED - Linear Tubes: (1) 4' Lamp | Occupancy Sensor | 15 | 2,899 | 0.06 | 326 | 0.0 | $44.81 | $270.00 | $35.00 | 5.24 |
| | | | | | | | | | | | | | | | | | | | |
| High Ceiling Lights | 8 | U-Bend Fluorescent - T8: U T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 8 | LED - Linear Tubes: (2) U-Lamp | Wall Switch | 33 | 4,142 | 0.19 | 1,086 | 0.0 | $149.35 | $505.60 | $0.00 | 3.39 |
| High Ceiling Lights-chandelier | 6 | Metal Halide: (1) 250W Lamp | Wall Switch | 295 | 4,142 | Fixture Replacement | No | 6 | LED - Fixtures: High-Bay | Wall Switch | 89 | 4,142 | 1.01 | 5,799 | 0.0 | $797.62 | $16,111.20 | $900.00 | 19.07 |

| | 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 |
| Main Stairwell | 11 | Compact Fluorescent: 32W CFL Bulbs | Wall Switch | 32 | 4,142 | Relamp | No | 11 | LED Screw-In Lamps: LED- 22W Bulbs | Wall Switch | 22 | 4,142 | 0.09 | 494 | 0.0 | $67.98 | $591.28 | $0.00 | 8.70 |
| Under Main Stairwell | 4 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Wall Switch | 12 | 4,142 | None | No | 4 | LED Screw-In Lamps: 12W LED Screw-in Lamps | Wall Switch | 12 | 4,142 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Lending Services | 10 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | No | 10 | LED - Linear Tubes: (3) 4' Lamps | Wall Switch | 44 | 4,142 | 0.40 | 2,317 | 0.0 | $318.66 | $752.00 | $150.00 | 1.89 |
| Office 121 | 4 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | Yes | 4 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.20 | 1,171 | 0.0 | $161.07 | $416.80 | $80.00 | 2.09 |
| Office 121 | 2 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | No | 2 | LED - Linear Tubes: (3) 4' Lamps | Wall Switch | 44 | 4,142 | 0.08 | 463 | 0.0 | $63.73 | $150.40 | $30.00 | 1.89 |
| 124 - Elevator | 2 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 2 | LED - Linear Tubes: (2) 4' Lamps | Wall Switch | 29 | 4,142 | 0.05 | 309 | 0.0 | $42.49 | $117.00 | $20.00 | 2.28 |
| Facilities Manager Office | 1 | U-Bend Fluorescent - T8: U T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | Yes | 1 | LED - Linear Tubes: (2) U-Lamp | Occupancy Sensor | 33 | 2,899 | 0.03 | 182 | 0.0 | $25.04 | $179.20 | $20.00 | 6.36 |
| 126- Maintenance | 1 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 1 | LED - Linear Tubes: (2) 4' Lamps | Wall Switch | 29 | 4,142 | 0.03 | 154 | 0.0 | $21.24 | $58.50 | $10.00 | 2.28 |
| 140 Office | 17 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | Yes | 17 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.87 | 4,977 | 0.0 | $684.54 | $1,548.40 | $290.00 | 1.84 |
| 141 Storage | 1 | U-Bend Fluorescent - T8: U T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 1 | LED - Linear Tubes: (2) U-Lamp | Wall Switch | 33 | 4,142 | 0.02 | 136 | 0.0 | $18.67 | $63.20 | $0.00 | 3.39 |
| 142 Electrical | 1 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 1 | LED - Linear Tubes: (2) 4' Lamps | Wall Switch | 29 | 4,142 | 0.03 | 154 | 0.0 | $21.24 | $58.50 | $10.00 | 2.28 |
| 143 Tech Services Manager | 2 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | Yes | 2 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 0.10 | 585 | 0.0 | $80.53 | $266.40 | $50.00 | 2.69 |
| 146 N/W services | 1 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 1 | LED - Linear Tubes: (2) 4' Lamps | Wall Switch | 29 | 4,142 | 0.03 | 154 | 0.0 | $21.24 | $58.50 | $10.00 | 2.28 |
| Open Area- 1st Floor | 21 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | Yes | 21 | LED Screw-In Lamps: LED- 29 Watts | Occupancy Sensor | 29 | 2,899 | 0.37 | 2,105 | 0.0 | $289.58 | $1,398.81 | $35.00 | 4.71 |
| Community Room | 18 | Incandescent: Halo Incandescent | Wall Switch | 90 | 4,142 | Relamp | Yes | 18 | LED Screw-In Lamps: LED Relamp | Daylight Dimming | 14 | 2,071 | 1.22 | 7,013 | 0.0 | $964.68 | $1,217.55 | $900.00 | 0.33 |
| Community Room | 10 | Incandescent: Halo Incandescent | Wall Switch | 60 | 4,142 | Relamp | Yes | 10 | LED Screw-In Lamps: LED Relamp | Occupancy Sensor | 9 | 2,899 | 0.44 | 2,513 | 0.0 | $345.70 | $807.53 | $85.00 | 2.09 |
| Community Room | 7 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | Yes | 7 | LED Screw-In Lamps: LED- 29 Watts | Occupancy Sensor | 29 | 2,899 | 0.12 | 702 | 0.0 | $96.53 | $376.27 | $0.00 | 3.90 |
| Community Room | 24 | Halogen Incandescent: 150W 2-Pin Halogen Bulbs | Wall Switch | 150 | 4,142 | Relamp | Yes | 24 | LED Screw-In Lamps: LED- 23W bulbs | Occupancy Sensor | 23 | 2,899 | 2.62 | 15,080 | 0.0 | $2,074.20 | $1,560.07 | $155.00 | 0.68 |
| Community Room Storage | 3 | Linear Fluorescent - T8: 4' T8 (32W) - 4L | Wall Switch | 114 | 4,142 | Relamp | No | 3 | LED - Linear Tubes: (4) 4' Lamps | Wall Switch | 58 | 4,142 | 0.14 | 786 | 0.0 | $108.15 | $285.40 | $60.00 | 2.08 |
| Terra Libri | 3 | Incandescent: 60W Incandescent Bulbs | Wall Switch | 60 | 4,142 | Relamp | No | 3 | LED Screw-In Lamps: LED- 9W Bulbs | Wall Switch | 9 | 4,142 | 0.12 | 716 | 0.0 | $98.50 | $161.26 | $15.00 | 1.48 |
| Terra Libri | 3 | Compact Fluorescent: 32W CFL Bulbs | Wall Switch | 32 | 4,142 | Relamp | No | 3 | LED Screw-In Lamps: LED- 22W Bulbs | Wall Switch | 22 | 4,142 | 0.02 | 135 | 0.0 | $18.54 | $161.26 | $0.00 | 8.70 |
| Terra Libri | 2 | U-Bend Fluorescent - T8: U T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 2 | LED - Linear Tubes: (2) U-Lamp | Wall Switch | 33 | 4,142 | 0.05 | 271 | 0.0 | $37.34 | $126.40 | $0.00 | 3.39 |
| Open Area- 1st Floor | 33 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | Yes | 33 | LED Screw-In Lamps: LED- 29 Watts | Occupancy Sensor | 29 | 2,899 | 0.58 | 3,308 | 0.0 | $455.05 | $2,043.85 | $35.00 | 4.41 |
| Open Area- 1st Floor | 17 | Compact Fluorescent: 42W CFL Bulbs | Wall Switch | 42 | 4,142 | Relamp | Yes | 17 | LED Screw-In Lamps: LED- 29 Watts | Occupancy Sensor | 29 | 2,899 | 0.30 | 1,704 | 0.0 | $234.42 | $1,183.80 | $35.00 | 4.90 |
| Open Area- 1st Floor | 108 | Linear Fluorescent - T8: 4' T8 (32W) - 3L | Wall Switch | 93 | 4,142 | Relamp | Yes | 108 | LED - Linear Tubes: (3) 4' Lamps | Occupancy Sensor | 44 | 2,899 | 5.50 | 31,617 | 0.0 | $4,348.86 | $8,391.60 | $35.00 | 1.92 |

| | 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 |
| Study Room | 12 | Compact Fluorescent: 26W CFL Bulbs | Wall Switch | 26 | 4,142 | Relamp | Yes | 12 | LED Screw-In Lamps: LED- 18W Bulb | Occupancy Sensor | 18 | 2,899 | 0.13 | 745 | 0.0 | $102.44 | $915.04 | $35.00 | 8.59 |
| Spot High on Book Shelves | 21 | LED Screw-In Lamps: 7W LED Screw-Lamps | Wall Switch | 7 | 4,142 | None | No | 21 | LED Screw-In Lamps: 7W LED Screw-Lamps | Wall Switch | 7 | 4,142 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Maintenance Hallway | 3 | Linear Fluorescent - T8: 4' T8 (32W) - 2L | Wall Switch | 62 | 4,142 | Relamp | No | 3 | LED - Linear Tubes: (2) 4' Lamps | Wall Switch | 29 | 4,142 | 0.08 | 463 | 0.0 | $63.73 | $175.50 | $30.00 | 2.28 |
| | | | | | | | | | | | | | | | | | | | |
| Wall Fixtures | 14 | Compact Fluorescent: 18W CFL Bulbs | Wall Switch | 18 | 4,380 | Relamp | No | 14 | LED Screw-In Lamps: LED- 13W Bulb | Wall Switch | 13 | 4,380 | 0.06 | 374 | 0.0 | $51.47 | $752.54 | $0.00 | 14.62 |
| Wall Fixures Dec. Near Entrance | 6 | Compact Fluorescent: 46W CFL Bulbs | Wall Switch | 46 | 4,380 | Relamp | No | 6 | LED Screw-In Lamps: LED- 32W bulbs | Wall Switch | 32 | 4,380 | 0.07 | 410 | 0.0 | $56.37 | $322.52 | $0.00 | 5.72 |
| Wall Fixures Dec. Near Entrance | 6 | Compact Fluorescent: 18W CFL Bulbs | Wall Switch | 18 | 4,380 | Relamp | No | 6 | LED Screw-In Lamps: LED- 13W Bulb | Wall Switch | 13 | 4,380 | 0.03 | 160 | 0.0 | $22.06 | $322.52 | $0.00 | 14.62 |
| Ground Focus Lighting | 17 | Incandescent: 100W Incandescent Bulbs | Wall Switch | 100 | 4,380 | Relamp | No | 17 | LED Screw-In Lamps: LED- 15W Bulbs | Wall Switch | 15 | 4,380 | 1.18 | 7,152 | 0.0 | $983.73 | $913.80 | $85.00 | 0.84 |
| Penthouse | 2 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | None | No | 2 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Book Storage-Penthouse | 1 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | None | No | 1 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Office | 1 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | None | No | 1 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Open Area- Books | 3 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | None | No | 3 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Front of Office Administration | 1 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | None | No | 1 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| IT Office | 5 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | None | No | 5 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Staff Office Suite | 1 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | None | No | 1 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Open Area- 2nd Floor | 4 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | None | No | 4 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Community Room | 2 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | None | No | 2 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Study Room | 4 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | None | No | 4 | Exit Signs: LED - 2 W Lamp | None | 6 | 8,760 | 0.00 | 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 |
| Penthouse | Chiller | 1 | Chilled Water Pump | 10.0 | 91.0% | No | 1,050 | Yes | 91.7% | Yes | 1 | 1.26 | 3,760 | 0.0 | $517.20 | $5,151.50 | $0.00 | 9.96 |
| Penthouse | Chiller | 1 | Chilled Water Pump | 15.0 | 93.0% | No | 1,050 | No | 93.0% | Yes | 1 | 1.81 | 5,496 | 0.0 | $755.93 | $5,194.45 | $0.00 | 6.87 |
| Penthouse | Boiler | 2 | Heating Hot Water Pump | 7.5 | 88.5% | No | 3,240 | Yes | 91.0% | Yes | 2 | 2.03 | 18,091 | 0.0 | $2,488.35 | $9,476.48 | $0.00 | 3.81 |
| Penthouse | Chiller | 2 | Condenser Water Pump | 15.0 | 88.5% | No | 1,050 | Yes | 91.7% | No | | 0.49 | 695 | 0.0 | $95.59 | $5,666.65 | $0.00 | 59.28 |
| Penthouse | Boiler | 2 | Heating Hot Water Pump | 1.0 | 82.5% | No | 3,240 | No | 82.5% | No | | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Penthouse | AHU 1 | 1 | Supply Fan | 50.0 | 94.5% | Yes | 4,067 | No | 94.5% | No | | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Penthouse | AHU2 | 1 | Supply Fan | 50.0 | 94.5% | Yes | 4,067 | No | 94.5% | No | | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Penthouse | DHW | 2 | Other | 0.3 | 85.5% | No | 4,380 | No | 85.5% | No | | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Penthouse | Bioler | 2 | Combustion Air Fan | 0.5 | 77.0% | No | 2,745 | No | 77.0% | No | | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Penthouse | AHU 1 | 1 | Return Fan | 25.0 | 93.6% | Yes | 4,067 | No | 93.6% | No | | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Penthouse | AHU2 | 1 | Return Fan | 25.0 | 93.6% | Yes | 4,067 | No | 93.6% | No | | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| Penthouse | Cooling Tower | 1 | Cooling Tower Fan | 40.0 | 94.0% | No | 2,100 | No | 94.0% | 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 |
| 2nd Floor Tech Room | Rooms | 1 | Split-System AC | 2.00 | | No | | | | | | | No | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| 1st Floor Tel Room | Rooms | 1 | Split-System Air-Source HP | 1.00 | 11.20 | No | | | | | | | No | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| 2nd Floor Tech Room | Rooms | 1 | Split-System Air-Source HP | 1.00 | 11.20 | No | | | | | | | No | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |
| 3rd Floor Tech Room | Rooms | 1 | Split-System AC | 1.50 | | No | | | | | | | No | 0.00 | 0 | 0.0 | $0.00 | $0.00 | $0.00 | 0.00 |

## Electric Chiller Inventory & Recommendations

| | | Existing Conditions | | | Proposed Conditions | | | | | | | Energy Impact & Financial Analysis | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Area(s)/System(s) Served | Chiller Quantity | System Type | Cooling Capacity per Unit (Tons) | Install High Efficiency Chillers? | Chiller Quantity | System Type | Constant/ Variable Speed | Cooling Capacity (Tons) | Full Load Efficiency (kW/Ton) | IPLV Efficiency (kW/Ton) | Total Peak kW Savings | Total Annual kWh Savings | Total Annual MMBtu Savings | Total Annual Energy Cost Savings | Total Installation Cost | Total Incentives | Simple Payback w/ Incentives in Years |
| Penthouse | Entire Building | 1 | Water-Cooled Screw Chiller | 250.00 | Yes | 1 | Water-Cooled Centrifugal Chiller | Variable | 250.00 | 0.64 | 0.39 | 54.53 | 110,687 | 0.0 | $15,224.92 | $213,296.05 | $7,500.00 | 13.52 |

## 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 |
| Penthouse | Entire Building | 2 | Non-Condensing Hot Water Boiler | 1,400.00 | 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 |
| Penthouse | Entire Building | 1 | Storage Tank Water Heater (> 50 Gal) | 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? |
| Entire Building | 122 | Desktop Computer + Monitor | 161.0 | No |
| Entire Building | 6 | Printers (small) | 20.0 | No |
| Entire Building | 6 | Printers (medium) | 515.0 | No |
| Entire Building | 2 | Printers (large) | 515.0 | No |
| Entire Building | 2 | Projector | 200.0 | No |
| Library Kitchen Area | 1 | Microwave Oven | 1,000.0 | No |
| Library Kitchen Area | 1 | Refrigerator (large) | 600.0 | No |
| Entire Building | 1 | TV (flat screen medium) | 120.0 | No |
| Entire Building | 5 | TV (flat screen large) | 150.0 | No |
| Entire Building | 1 | Hot/Cold Water Dispenser | 500.0 | No |
| Library Kitchen Area | 1 | Electric Stove | 1,200.0 | No |
| Terra Libri | 1 | Espresso Machine | 800.0 | No |
| Terra Libri | 1 | Ice Maker (small) | 50.0 | No |
| Terra Libri | 1 | Food Warmer Display | 670.0 | No |
| Terra Libri | 1 | Refrigerator (large) | 600.0 | No |
| Terra Libri | 3 | Coffee Machine | 400.0 | No |
| Terra Libri | 1 | Cash Register | 40.0 | No |
| Terra Libri | 1 | Toaster Oven | 1,200.0 | No |
| Terra Libri | 1 | Solid Door Underconter Refrigerator | 50.0 | No |

# *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]

### Princeton Public Library

**Primary Property Type:** Library
**Gross Floor Area (ft²):** 55,000
**Built:** 2004

**For Year Ending:** December 31, 2016
**Date Generated:** March 01, 2018

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 |
|---|---|---|
| Princeton Public Library<br>65 Witherspoon Street<br>Princeton, New Jersey 08542 | Princeton Public Library<br>65 Witherspoon Street<br>Princeton, NJ 08542<br>609-924-9529 | Susan Chernik<br>65 Witherspoon Street<br>Princeton, NJ 08542<br>609-924-9529 ext 1252<br>schernik@princetonlibrary.org |

**Property ID:** 6239685

### Energy Consumption and Energy Use Intensity (EUI)

**Site EUI**
140.2 kBtu/ft²

**Source EUI**
297.4 kBtu/ft²

| Annual Energy by Fuel | |
|---|---|
| Electric - Grid (kBtu) | 3,952,795 (51%) |
| Natural Gas (kBtu) | 3,757,060 (49%) |

| National Median Comparison | |
|---|---|
| National Median Site EUI (kBtu/ft²) | 111.1 |
| National Median Source EUI (kBtu/ft²) | 235.6 |
| % Diff from National Median Source EUI | 26% |
| **Annual Emissions** | |
| Greenhouse Gas Emissions (Metric Tons CO2e/year) | 638 |

### 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)**