Local Government Energy Audit Report

Power House/Cogeneration Plant

March 6, 2021

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Disclaimer

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

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

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

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. Please review all available program incentives and eligibility requirements prior to selecting and installing any energy conservation measures.

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

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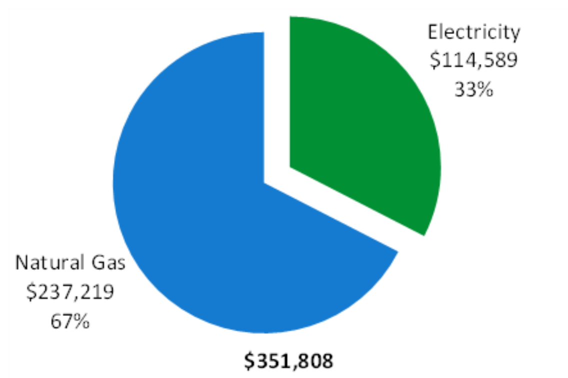
1 EXECUTIVE SUMMARY

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

BUILDING PERFORMANCE REPORT

Annual Utilities	Costs: $351,808 Electricity: 4,022,236 kWh Natural Gas: 560,665 Therms	
ENERGY STAR® Benchmarking Score	N/A *(1-100 scale)*	A standard energy use benchmark is not available for this facility type. This report contains suggestions about how to improve building performance and reduce energy costs.

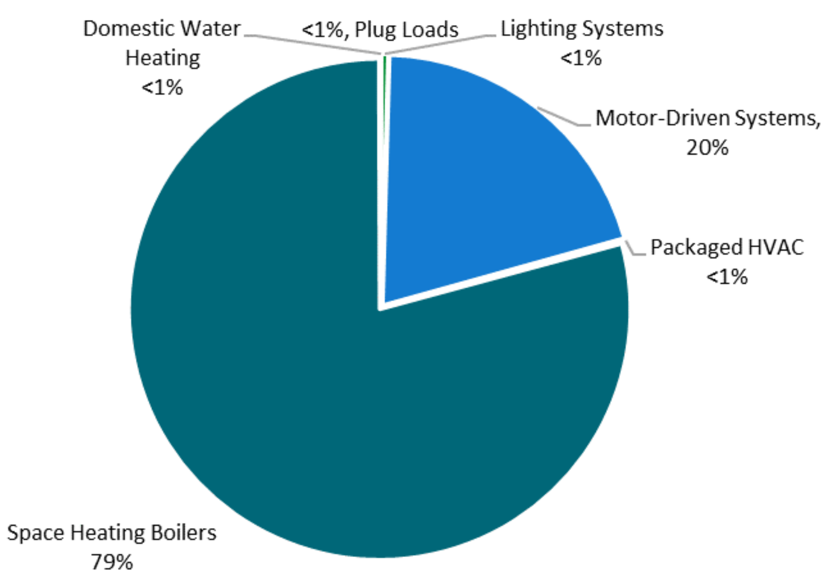


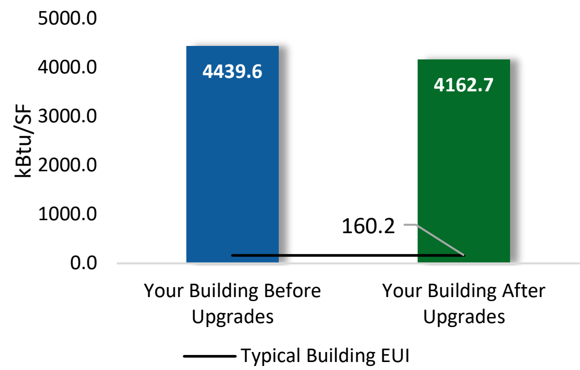
Figure 1 - Energy Use by System

POTENTIAL IMPROVEMENTS

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

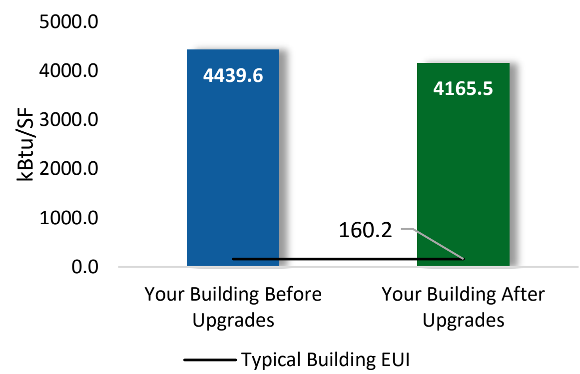
Scenario 1: Full Package (all evaluated measures)

Installation Cost	$379,909
Potential Rebates & Incentives[1]	$31,862
Annual Cost Savings	$49,834
Annual Energy Savings	Electricity: 236,767 kWh Natural Gas: 35,455 Therms
Greenhouse Gas Emission Savings	327 Tons
Simple Payback	7.0 Years
Site Energy Savings (all utilities)	6%



Scenario 2: Cost Effective Package[2]

Installation Cost	$305,698
Potential Rebates & Incentives	$30,914
Annual Cost Savings	$47,877
Annual Energy Savings	Electricity: 223,465 kWh Natural Gas: 35,455 Therms
Greenhouse Gas Emission Savings	320 Tons
Simple Payback	5.7 Years
Site Energy Savings (all utilities)	6%



On-site Generation Potential

Photovoltaic	None
Combined Heat and Power	None

[1] Incentives are based on current SmartStart Prescriptive incentives. Other program incentives may apply.

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

Installation Costs include cost of previously implemented steam pipe insulation measure.

#	Energy Conservation Measure	Cost Effective?	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades			**51,510**	**4.2**	**-12**	**$7,528**	**$11,111**	**$1,759**	**$9,352**	**1.2**	**50,486**
ECM 1	Install LED Fixtures	Yes	20,426	1.6	-5	$2,985	$6,608	$650	$5,958	2.0	20,019
ECM 2	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	Yes	1,503	0.1	0	$220	$257	$40	$217	1.0	1,473
ECM 3	Retrofit Fixtures with LED Lamps	Yes	29,581	2.5	-7	$4,323	$4,246	$1,069	$3,177	0.7	28,994
Lighting Control Measures			**987**	**0.1**	**0**	**$144**	**$1,274**	**$185**	**$1,089**	**7.5**	**967**
ECM 4	Install Occupancy Sensor Lighting Controls	Yes	987	0.1	0	$144	$1,274	$185	$1,089	7.5	967
Motor Upgrades			**9,952**	**2.9**	**0**	**$1,464**	**$56,262**	**$0**	**$56,262**	**38.4**	**10,021**
ECM 5	Premium Efficiency Motors	No	9,952	2.9	0	$1,464	$56,262	$0	$56,262	38.4	10,021
Variable Frequency Drive (VFD) Measures			**170,691**	**60.6**	**0**	**$25,112**	**$143,228**	**$22,650**	**$120,578**	**4.8**	**171,884**
ECM 6	Install VFDs on Constant Volume (CV) Fans	Yes	9,359	2.6	0	$1,377	$17,270	$450	$16,820	12.2	9,424
ECM 7	Install VFDs on Cooling Tower Fans	Yes	34,628	-4.0	0	$5,094	$53,487	$10,000	$43,487	8.5	34,870
ECM 8	Install Boiler Draft Fan VFDs	Yes	27,373	14.9	0	$4,027	$17,501	$3,000	$14,501	3.6	27,565
ECM 9	Install VFDs on Boiler Feedwater Pumps	Yes	79,616	44.8	0	$11,713	$37,390	$5,400	$31,990	2.7	80,173
ECM 10	Install VFDs on Condensate Pumps	Yes	19,714	2.4	0	$2,900	$17,580	$3,800	$13,780	4.8	19,852
Unitary HVAC Measures			**3,350**	**2.3**	**0**	**$493**	**$17,949**	**$948**	**$17,001**	**34.5**	**3,373**
ECM 11	Install High Efficiency Air Conditioning Units	No	3,350	2.3	0	$493	$17,949	$948	$17,001	34.5	3,373
HVAC System Improvements			**0**	**0.0**	**3,558**	**$15,052**	**$108,071**	**$6,312**	**$101,759**	**6.8**	**416,541**
ECM 12	Install Pipe Insulation	Yes	0	0.0	3,558	$15,052	$108,071	$6,312	$101,759	6.8	416,541
Domestic Water Heating Upgrade			**278**	**0.0**	**0**	**$41**	**$14**	**$8**	**$6**	**0.2**	**280**
ECM 13	Install Low-Flow DHW Devices	Yes	278	0.0	0	$41	$14	$8	$6	0.2	280
Custom Measures			**0**	**0.0**	**0**	**$0**	**$42,000**	**$0**	**$42,000**	**0.0**	**0**
ECM 14	Connect Existing Plant Steam Flow Meter & Install a Chilled Water Flow Meter	Yes	0	0.0	0	$0	$42,000	$0	$42,000	0.0	0
TOTALS (COST EFFECTIVE MEASURES)			**223,465**	**65.0**	**3,545**	**$47,877**	**$305,698**	**$30,914**	**$274,784**	**5.7**	**640,158**
TOTALS (ALL MEASURES)			**236,767**	**70.2**	**3,545**	**$49,834**	**$379,909**	**$31,862**	**$348,048**	**7.0**	**653,552**

* - All incentives presented in this table are based on NJ SmartStart 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).

ECM 12 has already been implemented. The measure is included to provide TCNJ an assessment of the savings associated with the implemented insulation project.

Figure 2 – Evaluated Energy Improvements

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

1.1 Planning Your Project

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

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

Pick Your Installation Approach

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

The potential ECMs identified for this building likely qualify for multiple incentive and funding programs. Based on current program rules and requirements, your measures are likely to qualify for the following programs:

Energy Conservation Measure		SmartStart	Direct Install	Pay For Performance
ECM 1	Install LED Fixtures	X		X
ECM 2	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	X		X
ECM 3	Retrofit Fixtures with LED Lamps	X		X
ECM 4	Install Occupancy Sensor Lighting Controls	X		X
ECM 5	Premium Efficiency Motors	X		X
ECM 6	Install VFDs on Constant Volume (CV) Fans	X		X
ECM 7	Install VFDs on Cooling Tower Fans	X		X
ECM 8	Install Boiler Draft Fan VFDs	X		X
ECM 9	Install VFDs on Boiler Feedwater Pumps	X		X
ECM 10	Install VFDs on Condensate Pumps	X		X
ECM 11	Install High Efficiency Air Conditioning Units	X		X
ECM 12	Install Pipe Insulation	X		X
ECM 13	Install Low-Flow DHW Devices	X		X
ECM 14	Connect Existing Plant Steam Flow Meter & Install a Chilled Water Flow Meter			

Figure 3 – Funding Options

New Jersey's Clean Energy Programs At-A-Glance

	SmartStart Flexibility to install at your own pace	**Direct Install** Turnkey installation	**Pay for Performance** Whole building upgrades
Who should use it?	Buildings installing individual measures or small group of measures.	Small to mid-size facilities that can bundle multiple measures together. Average peak demand should be below 200 kW. Not suitable for significant building shell issues.	Mid to large size facilities looking to implement as many measures as possible at one time. Peak demand should be over 200 kW.
How does it work?	Use in-house staff or your preferred contractor.	Pre-approved contractors pass savings along to you via reduced material and labor costs.	Whole-building approach to energy upgrades designed to reduce energy use by at least 15%. The more you save, the higher the incentives.
What are the Incentives?	Fixed incentives for specific energy efficiency measures.	Incentives pay up to 70% of eligible costs, up to $125,000 per project. You pay the remaining 30% directly to the contractor.	Incentives are paid out in three installments. The first installment is meant to help offset the costs of the initial engineering study. The subsequent incentives are paid based on the level of energy savings up to 50% of the total project cost. See Section 7.3 for all incentive details.
How do I participate?	Submit an application for the specific equipment to be installed.	Contact a participating contractor in your region.	Contact a pre-qualified Partner to develop your Energy Reduction Plan and set your energy savings targets.

Take the next step by visiting **www.njcleanenergy.com** for program details, applications, and to contact a qualified contractor.

Individual Measures with SmartStart

For facilities wishing to pursue only selected individual measures (or planning to phase implementation of selected measures over multiple years), incentives are available through the SmartStart program. To participate, you can use internal resources or an outside firm or contractor to perform the final design of the ECM(s) and install the equipment. Program pre-approval is required for some SmartStart incentives, so only after receiving pre-approval should you proceed with ECM installation.

Turnkey Installation with Direct Install

The Direct Install program provides turnkey installation of multiple measures through an authorized network of participating contractors. This program can provide substantially higher incentives than SmartStart, up to 70 percent of the cost of selected measures. Direct Install contractors will assess and verify individual measure eligibility and, in most cases, they perform the installation work. The Direct Install program is available to sites with an average peak demand of less than 200 kW.

Whole Building Approach with Pay for Performance

Pay for Performance can be a good option for medium to large sized facilities to achieve deep energy savings. Pay for Performance allows you to install as many measures as possible under a single project as well as address measures that may not qualify for other programs. Many facilities pursuing an Energy Savings Improvement Program (ESIP) loan also use this program. Pay for Performance works for larger customers with a peak demand over 200 kW. The minimum installed scope of work must include at least two unique measures resulting in at least 15 percent energy savings, where lighting cannot make up the majority of the savings.

More Options from Around the State

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

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

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

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

Ongoing Electric Savings with Demand Response

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

2 Existing Conditions

The New Jersey Board of Public Utilities (NJBPU) has sponsored this Local Government Energy Audit (LGEA) Report for the Power House/Cogeneration Plant. This report provides information on how your facility uses energy, identifies energy conservation measures (ECMs) that can reduce your energy use, and provides information and assistance to help you implement the ECMs. This report also contains valuable information on financial incentives from New Jersey's Clean Energy Program (NJCEP) for implementing ECMs.

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

2.1 Site Overview

On October 1, 2020, TRC performed an energy audit at the Power House/Cogeneration Plant located in Ewing, New Jersey. TRC met with Jim Kirchner to review the facility operations and help focus our investigation on specific energy-using systems.

The Power House/Cogeneration Plant at TCNJ is a 2-story, 15,720 square foot utility building built in 1996. This central plant includes the cogeneration, boiler, and chilled water plants along with a control room and administrative offices. Much of the campus wide heating and cooling requirements and a portion of the electric load are met by these facilities. Steam and chilled water are supplied to buildings through campus wide distribution systems.

The Power House has a 750-kW emergency diesel generator that is in good condition.

Recent improvements include installation of a new heat recovery steam generator (HRSG) and duct burner, as well as a new steam boiler.

Facility concerns include the old and inefficient high-pressure gas compressors which require excessive maintenance expenditures, and the deaerators (DAs). The facility also expressed the need for additional steam and chilled water metering systems.

Aerial View - Power House/Cogeneration Plant

The following facilities receive utilities from the central plant. The list below includes those buildings that were audited as a part of this LGEA project:

Electricity	Gross Floor Area (sf)	Campus Produced Electricity	Campus Produced Steam	Campus Produced Chilled Water
Ely Allen Brewster House	54,144	Y	Y	N
Armstrong Hall	71,647	N	Y	Y
Art & IMM	70,580	N	Y	Y
Administrative Service Building	32,339	Y	N	N
Biology Building	77,893	N	Y	Y
Bliss Hall	35,915	N	Y	Y
Brower Student Center	106,430	Y	Y	Y
School of Business	46,000	N	Y	Y
Cromwell Hall	49,944	Y	Y	N
Centennial Hall	85,847	Y	Y	N
Decker Hall	103,816	Y	Y	N
Education Building	79,885	Y	Y	Y
Eickhoff Hall	147,100	Y	Y	Y
Forcina Hall	77,380	Y	Y	Y
Green Hall	71,808	N	Y	Y
Hausdoerffer Hall	70,000	Y	N	N
Kendall Hall	83,000	N	Y	Y
Maintenance Building	21,049	Y	Y	Y
Music Building	50,200	N	Y	Y
New Residence Hall	57,875	Y	Y	Y
Norsworthy Hall	43,200	Y	Y	N
Packer Hall	69,519	Y	Y	Y
Phelps Hall	70,000	Y	N	N
Athletic Recreation Center	53,861	Y	Y	Y
Roscoe L West 68 Building	59,140	Y	Y	Y
Chemistry, Physics & Math's Bdgs	123,068	Y	Y	Y
Social Science Building	74,000	N	Y	Y
Spiritual Center	4,450	Y	Y	N
R. Barbara Gitenstein Library	153,515	N	Y	Y
Travers Wolfe Hall	280,494	Y	Y	N
Townhouse West/East (Cluster 1)	133,749	Y	N	N
Power House/Cogen	15,720	N	Y	N
Trenton Hall	33,097	N	Y	N
Townhouse South (Cluster 2)	65,000	Y	N	N
Bliss Annex	20,667	N	Y	Y
STEM Building/Forum	106,380	Y	Y	Y
Chemistry Addition	29,681	Y	Y	Y

TCNJ Campus Map

2.2 Building Occupancy

The Utility Plant is in function year-round, continuously. The administrative offices are occupied Monday to Friday while the control room is occupied every day, all day. Typical weekday occupancy is 8 staff.

Building Name	Weekday/Weekend	Operating Schedule
Power House/Cogen	Weekday	12:00 AM - 12:00 AM
	Weekend	12:00 AM - 12:00 AM

Figure 4 - Building Occupancy Schedule

2.3 Building Envelope

Building walls are concrete block over structural steel with a brick veneer facade. The roof is flat and covered with white membrane. It is in good condition. The flat roof is supported with steel trusses and reinforced concrete deck.

The windows are a combination of single and double paned. The single pane windows have wood frames. The glass-to-frame seals are in poor condition. The window weather seals are in poor condition. The double-glazed windows have metal frames and are in good condition. Exterior doors have aluminum frames and are in fair condition.

Building Walls & Roof

Wood & Metal Frame Windows

2.4 Lighting Systems

The primary interior lighting system uses 32-Watt linear fluorescent T8 lamps with electronic ballasts. Fixture types include 2- or 4-lamp, 2- or 4-foot long troffer, recessed, surfaced mounted fixtures. Additionally, there are some metal halide lamps found in the electrical room, gas turbine area, and high-pressure compressor room. There are four high bay LED fixtures in the gas turbine area. Most fixtures are in good condition. All exit signs are LED fixtures. Interior lighting levels were generally sufficient. Lighting fixtures in space are controlled by wall switches.

Exterior fixtures include wall packs, flood lights, and pole mounted fixtures with LEDs and CFLs. They are controlled by photocells and timeclock.

Linear Fluorescent T8 Fixtures

HID & LED Lamps, LED Exit Sign

CFL & LED Exterior Fixtures

2.5 Air Handling Systems

Unitary Electric HVAC Equipment

The main office is air conditioned by a roof mounted 10-ton York packaged unit which delivers airflow at constant volume. Cooling is provided by a direct expansion system. The unit is controlled by a room thermostat. It appears to be in poor operating condition and has been evaluated for replacement.

The control room is cooled by a 1.5-ton Sanyo split system. The unit is 18 years old and has passed its useful service life. It is being evaluated for replacement. The main electrical room is conditioned using three Bard packaged air source heat pumps, which are in good condition. They each have a cooling capacity of two tons and a heating capacity of 25.59 MBh. Four window ACs with cooling capacities ranging from 0.5 to 1-ton serve the BMS Office, water quality control room, and offices E1 and E4. They all appear in good condition.

Packaged & Split System Units

Window AC

2.6 Domestic Hot Water

Hot water is produced by a 40-gallon 4.5 kW electric storage water heater located in the boiler plant. The domestic hot water pipes are insulated, and the insulation is in good condition.

40 Gallon Electric Water Heater

2.7 Plug Load & Vending Machines

There are approximately 10 computer workstations throughout the facility. Plug loads in the offices include general office equipment, mini refrigerators, water cooler, microwaves, and fans. There is one residential style refrigerator.

2.8 Water-Using Systems

There are two restrooms with toilets, urinals, and sinks. Faucet flow rates are at 2.2 gallons per minute (gpm) or higher. Toilets are rated at 2.5 gallons per flush (gpf) and urinals are rated at 25 gpf.

2.9 Cogeneration Plant Equipment

Gas Turbine

The cogeneration plant has a 5.2 MW Solar Taurus 60 gas turbine, which is located in the main gas turbine room. Due to ongoing operation of the system, the turbine and electric generator could not be visually inspected. However, the plant Director has reported that the equipment is in good condition and its operation and performance are efficient. The inlet air for the turbine is cooled with a chilled water coil on the roof. The turbine is maintained regularly by a private company.

Taurus 60 Gas Turbine Enclosure

Digital Screenshot of the Turbine Parameters

Heat Recovery Steam Generator (HRSG) and Duct Burner

The Cleaver Brooks HRSG and the duct burner were replaced recently as part of the last major plant equipment upgrade. They are located adjacent to the gas turbine.

The HRSG has a capacity of 43,000 MBh (28,000 MBh unfired, plus 15,000 MBh from the gas duct burner). The HRSG recovers substantial amounts of heat from the exhaust gas of the Taurus gas turbine. Heat is recovered in the form of steam which serves as a secondary power source. The unit is equipped with an economizer that is in good working condition.

The gas turbine produces a significant portion of the total electricity used on campus and HRSG is used as the primary source for generating steam. Auxiliary equipment includes deaerators and feed water pumps, condensate receivers and condensate pumps, high pressure gas compressors, chemical treatment, Deaerator #1, and blowdown equipment. These are described in more detail in the section addressing the boiler plant.

Cleaver Brooks HRSG

Duct Burner

High Pressure (HP) Gas Compressors

The compressor room houses two high pressure gas compressors (No. 1 and 2) that provide compressed gas to the gas turbine.

Each compressor is equipped with a 300 hp motor. The compressors and their accessories are old, appear to be in poor condition, and are one of the main concerns of the plant. According to the plant Director, the current cost of maintaining the units is approximately $125,000 annually. The units operate in a lead/lag scheme. During the site inspection, compressor No. 1 was leading, indicating 245 psig discharge pressure at 283.4 °F.

The HP gas compressors are cooled using two high pressure gas coolers that are equipped with coils, fans, and cooling water pumps. These are water-cooled pressure gas coolers that reject the heat added by compressor equipment to the compressed gas flow. They were installed in 2014 and are in good condition.

Replacing the high-pressure compressors could significantly reduce the plant operation and maintenance costs but would be a capital project. It is not clear whether significant energy savings would result from upgrading the compressors. The most likely source of energy savings would result from an increase in the compressor motor efficiency.

HP Gas Compressors

High Pressure Gas Coolers

2.10 Boiler Plant

The boiler plant is comprised of the following equipment:

- Water tube boiler #1: 41,400 MBh,
- Water tube boiler #2: 40,000 MBh,
- Deaerator #2 with feed water pumps,
- Condensate receivers and condensate pumps,
- Blowdown equipment, oil pumps, and chemical treatment system

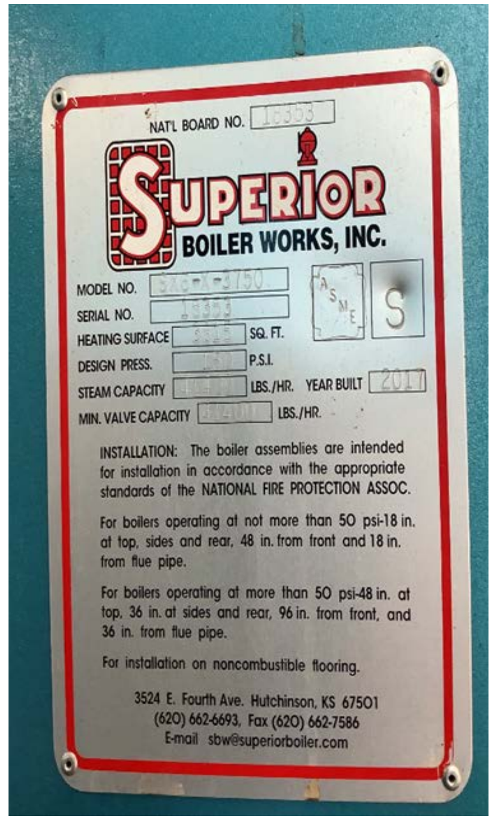
Steam Boilers

The Superior steam boiler (#1) was installed in 2017. The burner has a 75 hp variable speed combustion fan motor. The boiler is equipped with an economizer that captures waste heat from boiler stack gases (flue gas) and transfers it to the boiler feedwater loop. Boiler #1 was operating on the primary fuel source, natural gas, during the time of the inspection. It has good turndown and modulates well.

Boiler #2 was made by Cleaver Brooks and is 23 years old. It appears in good condition and well maintained. It is equipped with a flue gas recirculation (FGR) that significantly reduces NOx emissions by recirculating flue gas from the boiler exhaust duct into the main combustion chamber.

Typically, the plant runs the gas turbine and duct burner to provide base load steam production. In the winter, the plant can meet the steam load typically with the HRSG and one boiler. However, the second boiler can also be used on the coldest days. In the summer, the plant mainly uses the turbine and duct burner for steam and with one boiler on hot standby most of the time.

The boiler and the HRSG are connected to the same steam header. Steam is distributed to the campus at 100 psi. In the summer of 2020, the campus steam distribution was turned down to 60 psi without any issues. Many of the buildings have reheat systems for humidity control in the summer. There are also some process loads, particularly in the science complex.



Steam Boiler #1

Steam Boiler #2

Deaerators (DAs)

There are two deaerators (DAs) at the TCNJ Power House. DA #1 is located in the cogeneration plant while DA #2 is located on the mezzanine of the boiler plant. They remove dissolved gases from the boiler and HRSG feedwater and protect the steam system from the effects of corrosive gases. The feedwater piping is cross-connected, so either DA can serve the requirements of the boilers and HRSG.

The DAs appear in fair to poor condition. In particular, DA #1 is not operating at full capacity and is one of the main concerns of the Power House. It was leaking during the inspection. Plant personnel are planning for its replacement. The pipes are not properly insulated and the insulation is only in fair condition.

Deaerator #1

Boilers and HRSG Feed Water Pumps

There are four vertical turbine type feedwater pumps. Two 25 hp constant speed pumps (P3 and P4) located in the boiler plant, primarily serve the boiler plant. Two 20 hp constant speed pumps (P1 and P2) primarily serve the HRSG and are located in the cogeneration plant. The pumps and motors are in good condition.

Boiler Plant & Cogeneration Plant Feedwater Pumps

Condensate Pumps

TCNJ Power House has four vertical turbine condensate pumps that are cross-connected and can take suction from either of the two condensate receivers, described below. The two 7.5 hp constant speed pumps (P1 and P2) are located in the cogeneration plant while the two 5 hp constant speed (P3 and P4) are in the boiler plant. The pumps and motors are in good condition. Condensate piping insulation is in fair to good condition.

7.5 hp & 5 hp Condensate Pumps

<u>Condensate Receivers</u>

There are two condensate receivers (1 and 2) located respectively in the cogeneration plant and the boiler plant. The condensate piping is cross connected, so either receiver can serve the needs of the boilers and HRSG. Condensate receiver 1 was in service at the time of the inspection. The receivers are old and condensate receiver 2 appears to be in fair condition.

Additionally, the Chilled Water Plant pit area houses a high pressure (HP) condensate return flash tank and two steam pressure driven condensate return pumps. The equipment was not fully inspected as it was in operation. There appeared to be an active vibration in the piping known as “water hammer”. Based on the limited inspection, it appears the equipment is in good condition.

Condensate Receiver 1 & 2

High Pressure Condensate Return Flash Tank

Boilers and HRSG Blowdown System

There are two blowdown tanks at the Power House. One located in the cogeneration plant serves the HRSG and the second serves the two boilers in the boiler plant. Both tanks receive mud and sediment from bottom blowdown and suspended sediment resulting from surface continuous blowdown with heat recovery. The tanks and piping are in good condition.

Boiler Blowdown Tank

Fuel Oil System

Natural gas is the primary fuel at the TCNJ Power House while fuel oil is used as backup. The fuel oil system consists of an outdoor fuel oil storage tank and five oil pumps. The two 5 hp fuel oil #2 and #3 pumps serve the boiler plant. They are equipped with a pressure relief valve connection and appear in good condition. Two 1 hp (#1 and #2) and one 10 hp (#5) serve the cogeneration plant. Pump #2 appears in poor condition. The fuel oil pumps run approximately 10 days a year for testing purposes. The outdoor fuel oil storage tank is in good condition.

Fuel oil use is negligible at this site; therefore, fuel oil use has not been incorporated into the utility analysis provided in Section 3, “Energy Use and Costs”.

Fuel Oil Pumps #2, 3 & #1 & 2

2.11 Chilled Water Plant

The chilled water plant at TCNJ provides chilled water to 22 buildings for space cooling. The plant has 6,760 tons of total installed capacity and is comprised of the chillers listed below. Auxiliary equipment includes two cooling towers, seven variable speed condenser water pumps, six primary and six secondary chilled water pumps.

- Chiller #1: 2,000 ton centrifugal steam chiller (18,000 Pound Per Hour)
- Chiller #2: 2,000 ton centrifugal steam chiller (18,000 Pound Per Hour)
- Chiller #3: 1,480 ton electric variable speed drive chiller
- Chiller #5: 1,200 ton electric chiller

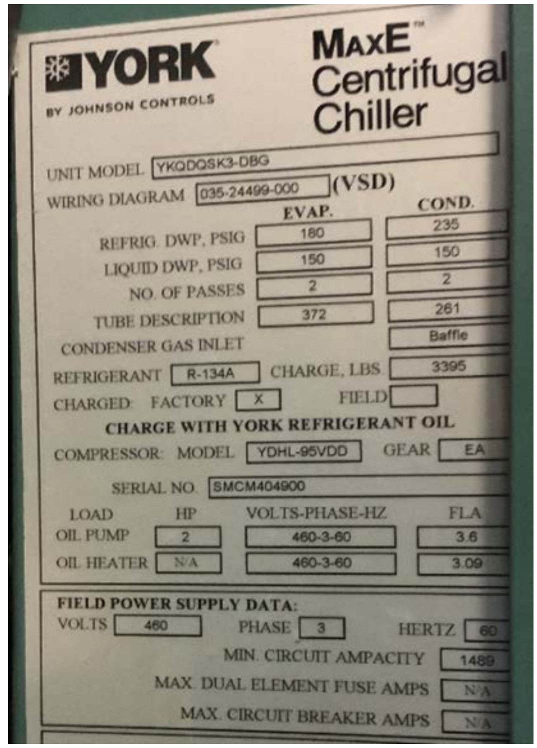
Chillers

The overall condition of the chillers ranges from good (for the electric chillers) to fair (for the steam driven chillers). Chiller #3 was in operation during the inspection. Chiller #1's steam turbine drive was temporarily out of service for overhaul and repair.

Each steam driven chiller is equipped with two 7.5 hp vacuum pumps. There is also a heat exchanger to facilitate free cooling, but it is not in use. The two steam driven centrifugal chillers (#1 and 2) were installed in 2002. The Trane electric chiller (#5) was installed in 1997.

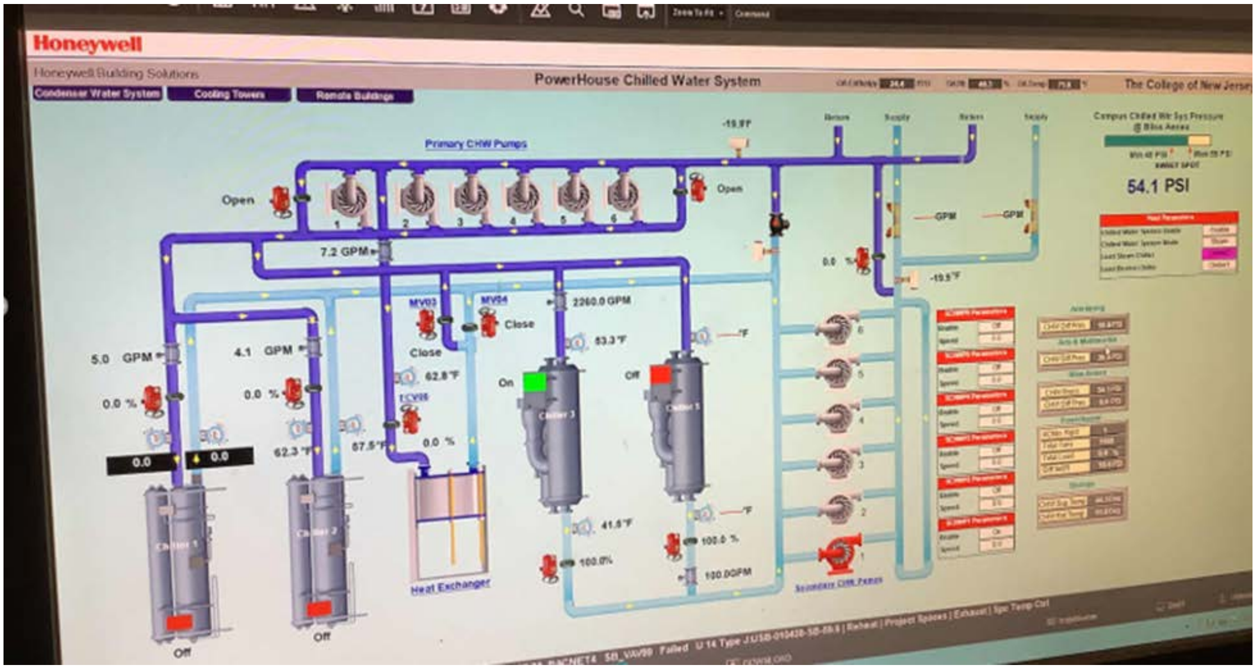
Typically, the chilled water plant uses the steam driven chillers. However, during the summer the chilled water load does exceed the steam chiller capacity and an electric chiller is used to meet peak chilled water load. Additionally, during the spring and fall moderate days, an electric chiller is often used since it is easier to start an electric chiller than a steam driven chiller. The chiller plant is shut down in early November and restarts around April/May.

Steam Turbine Drive Chiller #1



Electric Chiller #3 with Variable Speed Drive

Trane Centrifugal Chiller #5

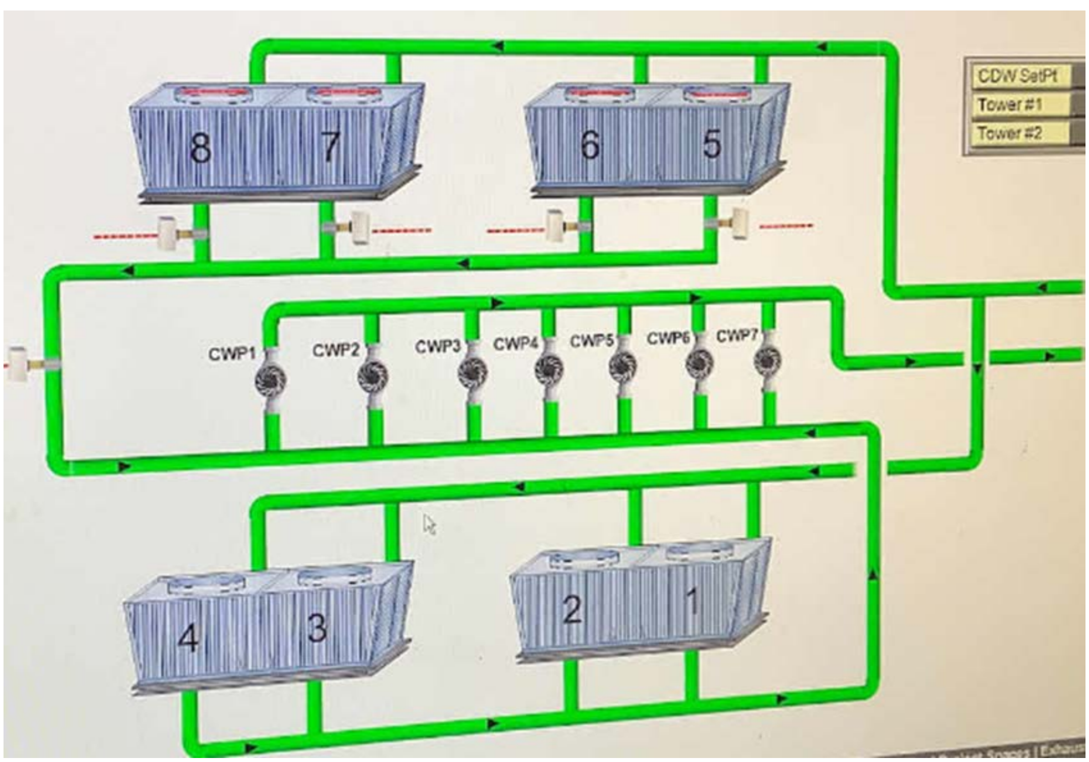


EMS Screen - Chilled Water Diagram

Cooling Towers

There are two cooling towers, each consisting of four cells that are induced-draft cross-flow. Each cell has a capacity of 1,500 gallons per minute (gpm). The Marley cooling tower was recently installed and has four 100 hp variable speed drive fans. This tower is in good condition. The BAC cooling tower, equipped with four 40 hp constant speed fans, appears in poor condition. The Marley cooling tower is the primary tower and according to the Plant Director, the BAC cooling tower is used only during the summer hot days to supplement the Marley cooling tower. Because of limited accessibility we could not fully inspect.

Cooling Towers

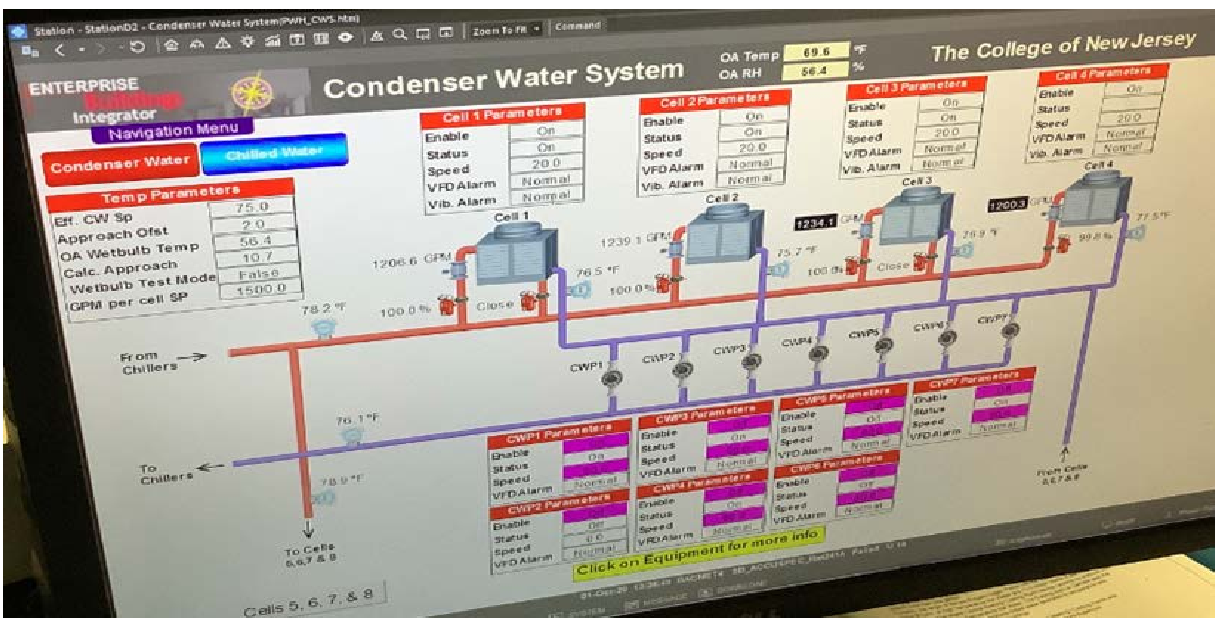


EMS Screen - Cooling Towers Diagram

Condenser Water Pumps

The condenser water system is served by seven 125 hp variable speed drive pumps physically located outdoors between the two cooling towers. The pumps, motors, and piping insulation are in good condition.

Condenser Water Pumps



EMS Screen - Condenser Water System

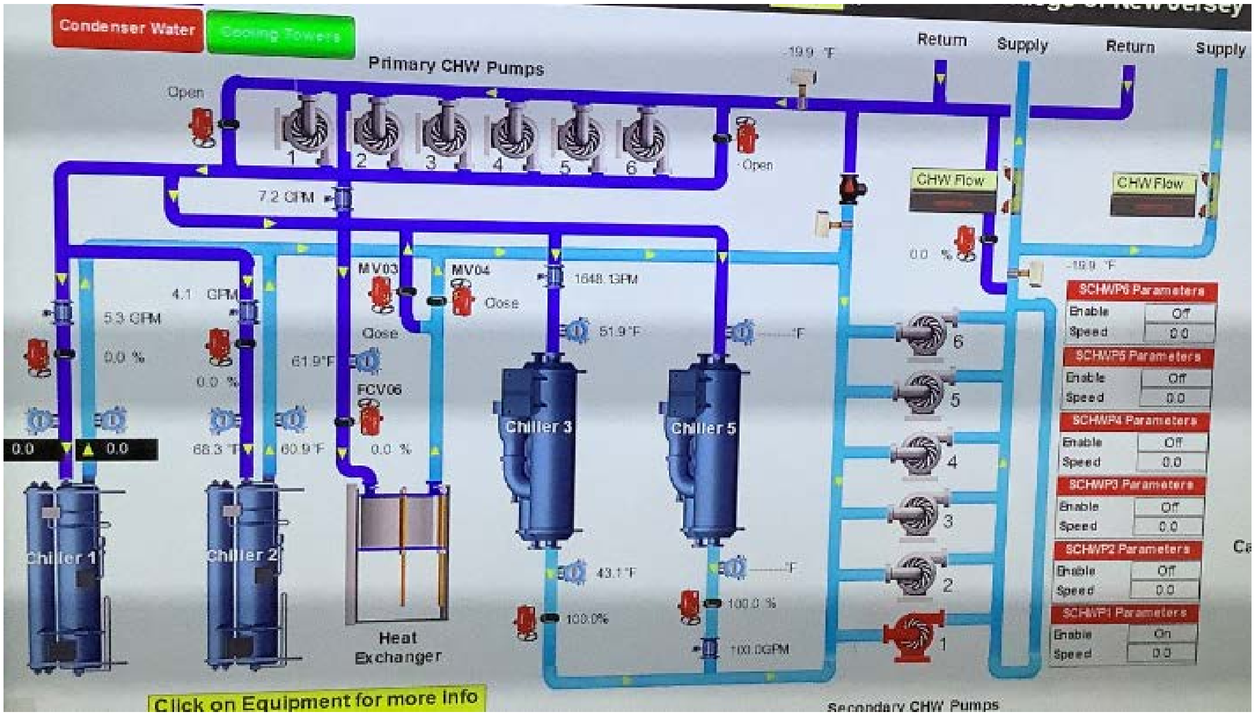
Chilled Water Pumps

The chilled water pumping system was originally designed as a primary-secondary-tertiary flow system. The six primary pumps are still in place but have been bypassed and are not currently in operation. The primary and secondary pumps are physically located in the chilled water plant. The tertiary pumps are located in individual buildings.

Chilled water is now circulated in the distribution system using the secondary pumps. Additionally, due to the high chilled water pressure, the secondary pumps also recirculate chilled water through buildings that are closer to the plant. The tertiary pumps are only used in buildings that do not have adequate pressure from the secondary chilled water pumps.

There are five 125 hp (P1 – P5) and one 200 hp (P6) variable speed secondary pumps ranging in capacity from 2,000 to 4,000 GPM. Secondary pump 1 was in operation during the inspection. Overall, the pumps are in fair condition.

Secondary Pumps



EMS -Chillers & Pumping Diagram

2.12 Compressed Air System

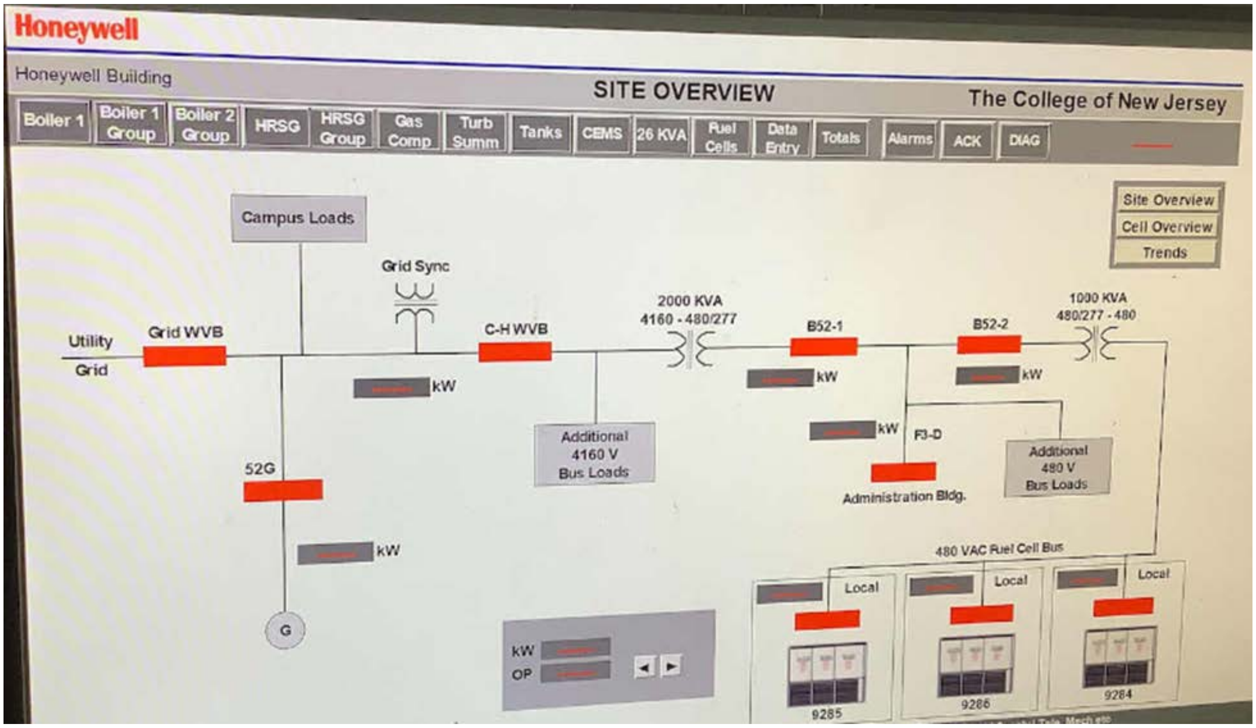
The Power House compressed air system consists of four air compressors, one dryer, and one receiver. The main compressor is a 41 hp Quincy unit manufactured in 2019. Two 30 hp units and a packaged rotary screw air compressor serve as backup. One of the 30 hp reciprocating compressors appears in fair operating condition while the remaining three compressors are in good operating condition.

Newer & Old Air Compressors

2.13 Building Energy Management Systems (EMS)

TCNJ has an energy management system contract with Honeywell. The Honeywell system provides broad control of the Power House equipment and many individual campus buildings.

The EMS provides equipment status, scheduling control and monitors and controls space temperature, diagnostic overview, daily plant meter readings, supply air temperature, humidity, heating water loop temperatures, and chilled water loop temperatures. The system is well maintained.



EMS - Site Overview

2.14 On-Site Generation

The Power House generates electricity with a 5.2 MW natural gas fired turbine manufactured by Solar Turbines. Waste heat from the turbines is used to produce steam. The steam is delivered to some of the buildings on campus and used to produce chilled water, which is also delivered to some of the buildings on campus.

3 ENERGY USE AND COSTS

All of the campus buildings included in the audit receive electricity through the PSE&G master meter. Campus electricity is also supplied from the campus cogeneration system. The campus cogeneration system produced over 80% of the total 46,000,940 kWh used on the campus in 2019.

PSE&G delivers natural gas for the cogeneration system and supplemental boilers, which provide steam as a campus wide utility as described in Section 2. Typically, steam is converted to hot water at the various buildings and used for space heat and domestic water heating. There are some campus buildings have dedicated natural gas meters.

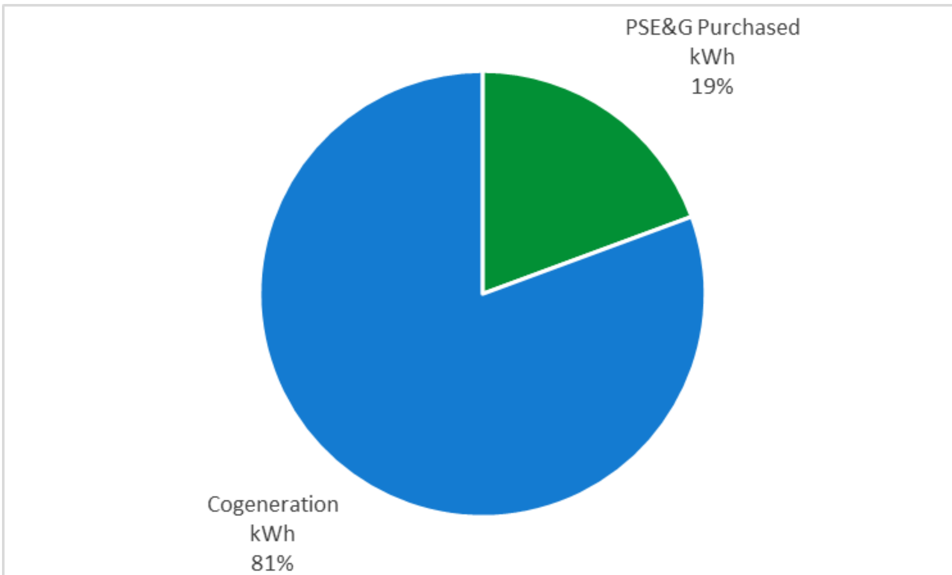


Figure 5 – Campus Electricity

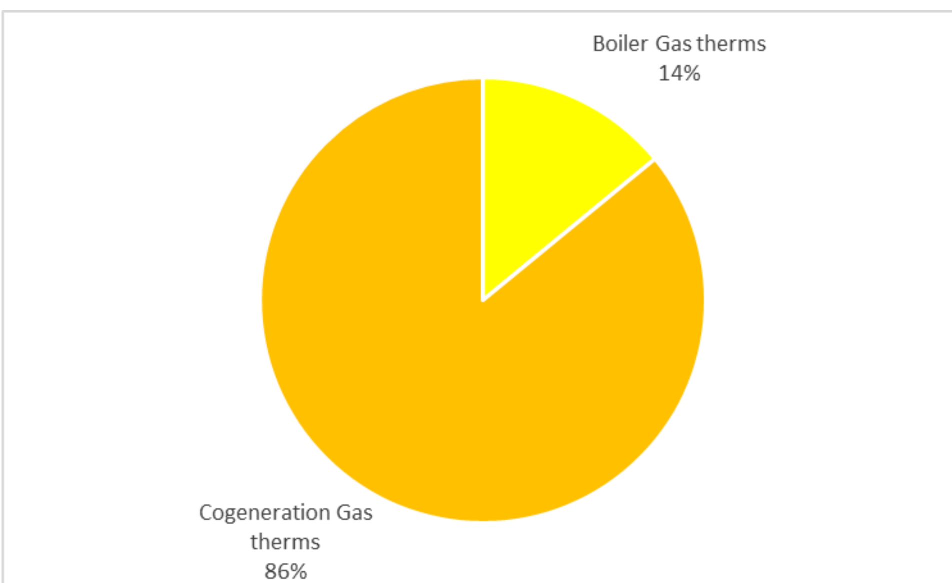


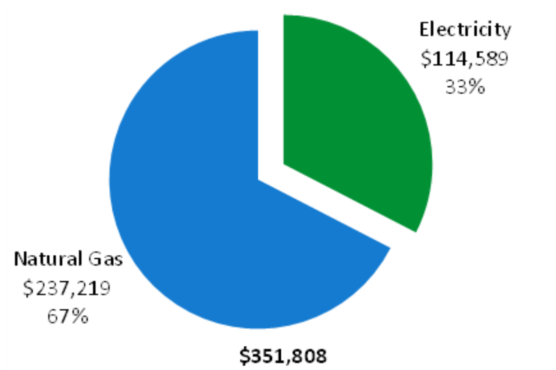
Figure 6 – Power House Natural Gas

Prorated and direct purchase utility data were evaluated to determine the annual energy performance metrics for the building in energy cost per square foot and energy usage per square foot. These metrics are an estimate of the relative energy efficiency of each building. There are a number of factors that could cause the energy use of a 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 3.3 for additional information.

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

Below is a graph indicating the pro-rated utilities assigned to Power House based on the operation of the space heating boilers, plant motors, and other loads. The energy use associated with producing steam and chilled water was attributed to the campus buildings the use occurs in. The electricity generated at the Power House was also allocated to individual campus buildings based on the building submeter data. The natural gas use assigned to the Power House reflects internal uses as well as steam system losses.

Utility Summary		
Fuel	**Usage**	**Cost**
Electricity	4,022,236 kWh	$114,589
Natural Gas	560,665 Therms	$237,219
Total		**$351,808**



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

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

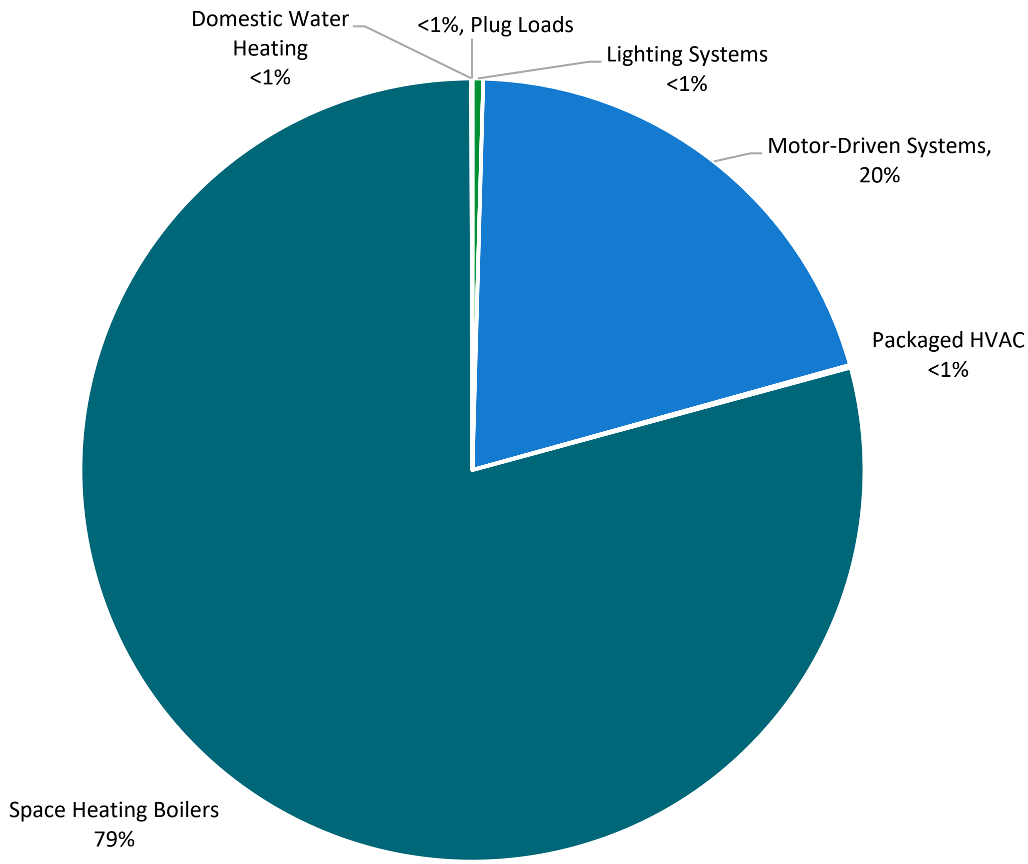
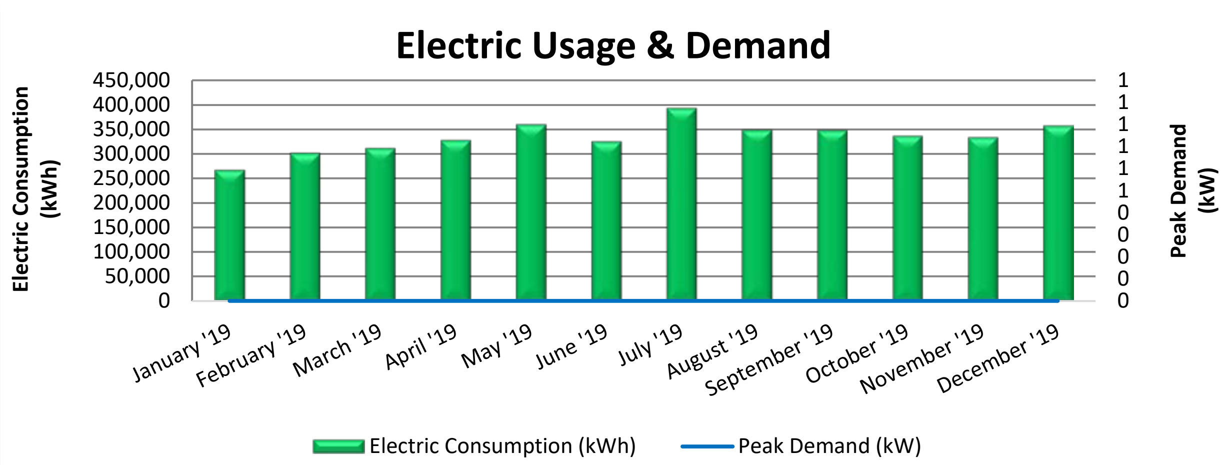


Figure 7 - Energy Balance

3.1 Electricity

PSE&G delivers electricity under rate class High Tension Service (HTS). Electricity for the building is supplemented by the cogeneration plant.



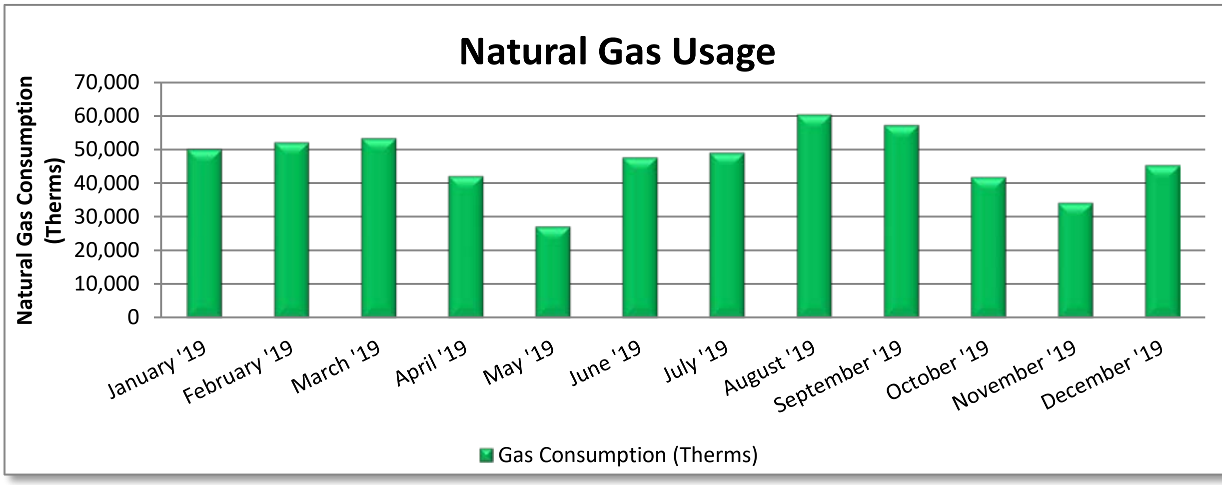
Electric Billing Data						
Period Ending	Days in Period	Electric Usage (kWh)	Demand (kW)	Demand Cost	Total Electric Cost	TRC Estimated Usage?
1/28/19	31	267,890	0	$0	$5,846	Yes
2/28/19	31	302,357	0	$0	$7,439	Yes
3/28/19	28	312,783	0	$0	$6,800	Yes
4/28/19	31	328,627	0	$0	$7,397	Yes
5/29/19	31	360,916	0	$0	$13,308	Yes
6/27/19	29	326,116	0	$0	$10,363	Yes
7/29/19	32	393,747	0	$0	$14,193	Yes
8/27/19	29	349,736	0	$0	$9,929	Yes
9/26/19	30	349,546	0	$0	$10,873	Yes
10/25/19	29	337,784	0	$0	$9,374	Yes
11/25/19	31	334,577	0	$0	$8,084	Yes
12/11/19	33	358,157	0	$0	$10,982	Yes
Totals	**365**	**4,022,236**	**0**	**$0**	**$114,589**	
Annual	**365**	**4,022,236**	**0**	**$0**	**$114,589**	

Notes:

- Electric data has been estimated based on a campus wide approach and utilization of sub metered data. Please refer elsewhere in this report for details regarding utility baseline and campus building utility desegregation.
- The peak demand for this facility was unavailable because the building is served with electricity from the master meter.
- The average purchased electric cost over the past 12 months was $0.147/kWh, which is the blended rate that includes energy supply, distribution, demand, and other charges. This report uses this blended rate to estimate energy cost savings.
- Effectively all of the electricity generated on-site is used on-site.

3.2 Natural Gas

PSE&G delivers natural gas for the main boiler meter under rate class TSGNF and for the cogeneration system under rate class Cogeneration (CIG).



Gas Billing Data				
Period Ending	**Days in Period**	**Natural Gas Usage (Therms)**	**Natural Gas Cost**	**TRC Estimated Usage?**
1/31/19	31	50,122	$18,803	Yes
2/28/19	28	52,114	$24,798	Yes
3/31/19	31	53,395	$23,966	Yes
4/30/19	30	42,166	$17,652	Yes
5/31/19	31	27,128	$11,734	Yes
6/30/19	30	47,640	$20,549	Yes
7/31/19	31	49,066	$19,834	Yes
8/31/19	31	60,360	$23,638	Yes
9/30/19	30	57,253	$22,921	Yes
10/31/19	31	41,836	$17,865	Yes
11/30/19	30	34,253	$15,075	Yes
12/31/19	31	45,332	$20,384	Yes
Totals	**365**	**560,665**	**$237,219**	
Annual	**365**	**560,665**	**$237,219**	

Notes:

- Natural gas data has been estimated based on a campus wide approach. Please refer elsewhere in this report for details regarding the utility baseline and campus building utility desegregation analysis.
- The average gas cost for the past 12 months is $0.423/therm, which is the blended rate used throughout the analysis.

3.3 Benchmarking

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

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

Benchmarking Score	N/A

Due to its unique characteristics, this building type is not able to receive a benchmarking score. This report contains suggestions about how to improve building performance and reduce energy costs.

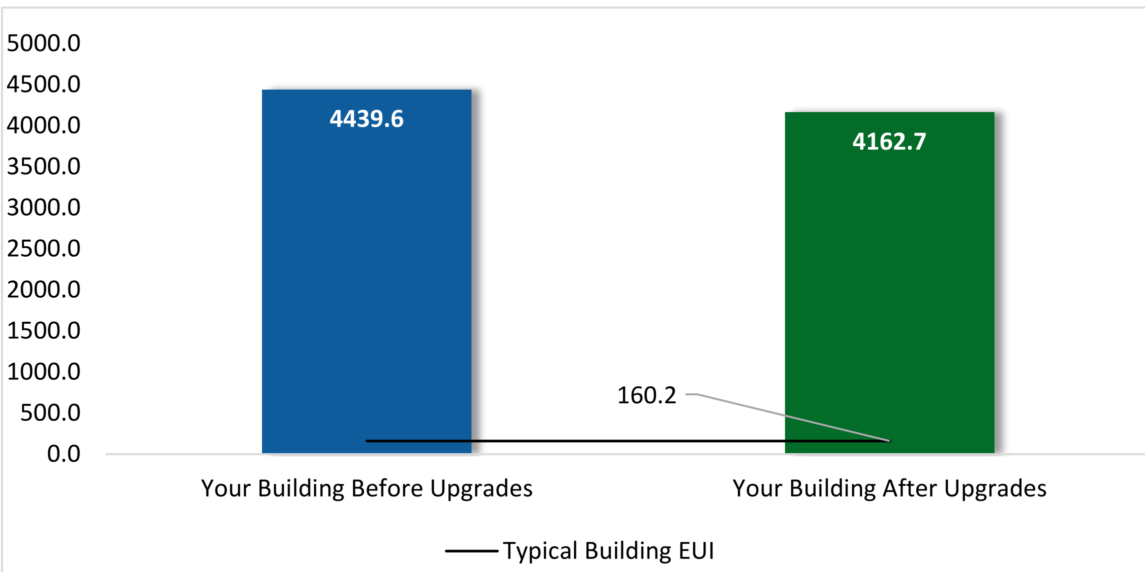


Figure 8 - Energy Use Intensity Comparison[3]

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

Benchmarking is provided for The College of New Jersey's campus. Please refer to the Power House/Cogen report for additional details regarding the benchmarking approach within Portfolio Manager®.

[3] Based on all evaluated ECMs

Tracking Your Energy Performance

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

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

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

For more information on ENERGY STAR® and Portfolio Manager®, visit their website[4].

[4] https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/earn-recognition/energy-star-certification/how-app-1.

4 Energy Conservation Measures

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

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

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

Financial incentives are based on the current NJCEP prescriptive SmartStart program. A higher level of investigation may be necessary to support any SmartStart Custom, Pay for Performance, or Direct Install incentive applications. Some measures and proposed upgrades may be eligible for higher incentives than those shown below through other NJCEP programs described in a following section of this report.

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

#	Energy Conservation Measure	Cost Effective?	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades			**51,510**	**4.2**	**-12**	**$7,528**	**$11,111**	**$1,759**	**$9,352**	**1.2**	**50,486**
ECM 1	Install LED Fixtures	Yes	20,426	1.6	-5	$2,985	$6,608	$650	$5,958	2.0	20,019
ECM 2	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	Yes	1,503	0.1	0	$220	$257	$40	$217	1.0	1,473
ECM 3	Retrofit Fixtures with LED Lamps	Yes	29,581	2.5	-7	$4,323	$4,246	$1,069	$3,177	0.7	28,994
Lighting Control Measures			**987**	**0.1**	**0**	**$144**	**$1,274**	**$185**	**$1,089**	**7.5**	**967**
ECM 4	Install Occupancy Sensor Lighting Controls	Yes	987	0.1	0	$144	$1,274	$185	$1,089	7.5	967
Motor Upgrades			**9,952**	**2.9**	**0**	**$1,464**	**$56,262**	**$0**	**$56,262**	**38.4**	**10,021**
ECM 5	Premium Efficiency Motors	No	9,952	2.9	0	$1,464	$56,262	$0	$56,262	38.4	10,021
Variable Frequency Drive (VFD) Measures			**170,691**	**60.6**	**0**	**$25,112**	**$143,228**	**$22,650**	**$120,578**	**4.8**	**171,884**
ECM 6	Install VFDs on Constant Volume (CV) Fans	Yes	9,359	2.6	0	$1,377	$17,270	$450	$16,820	12.2	9,424
ECM 7	Install VFDs on Cooling Tower Fans	Yes	34,628	-4.0	0	$5,094	$53,487	$10,000	$43,487	8.5	34,870
ECM 8	Install Boiler Draft Fan VFDs	Yes	27,373	14.9	0	$4,027	$17,501	$3,000	$14,501	3.6	27,565
ECM 9	Install VFDs on Boiler Feedwater Pumps	Yes	79,616	44.8	0	$11,713	$37,390	$5,400	$31,990	2.7	80,173
ECM 10	Install VFDs on Condensate Pumps	Yes	19,714	2.4	0	$2,900	$17,580	$3,800	$13,780	4.8	19,852
Unitary HVAC Measures			**3,350**	**2.3**	**0**	**$493**	**$17,949**	**$948**	**$17,001**	**34.5**	**3,373**
ECM 11	Install High Efficiency Air Conditioning Units	No	3,350	2.3	0	$493	$17,949	$948	$17,001	34.5	3,373
HVAC System Improvements			**0**	**0.0**	**3,558**	**$15,052**	**$108,071**	**$6,312**	**$101,759**	**6.8**	**416,541**
ECM 12	Install Pipe Insulation	Yes	0	0.0	3,558	$15,052	$108,071	$6,312	$101,759	6.8	416,541
Domestic Water Heating Upgrade			**278**	**0.0**	**0**	**$41**	**$14**	**$8**	**$6**	**0.2**	**280**
ECM 13	Install Low-Flow DHW Devices	Yes	278	0.0	0	$41	$14	$8	$6	0.2	280
Custom Measures			**0**	**0.0**	**0**	**$0**	**$42,000**	**$0**	**$42,000**	**0.0**	**0**
ECM 14	Connect Existing Plant Steam Flow Meter & Install a Chilled Water Flow Meter	Yes	0	0.0	0	$0	$42,000	$0	$42,000	0.0	0
TOTALS			**236,767**	**70.2**	**3,545**	**$49,834**	**$379,909**	**$31,862**	**$348,048**	**7.0**	**653,552**

* - All incentives presented in this table are based on NJ SmartStart 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).

Figure 9 – All Evaluated ECMs

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**51,510**	**4.2**	**-12**	**$7,528**	**$11,111**	**$1,759**	**$9,352**	**1.2**	**50,486**
ECM 1	Install LED Fixtures	20,426	1.6	-5	$2,985	$6,608	$650	$5,958	2.0	20,019
ECM 2	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	1,503	0.1	0	$220	$257	$40	$217	1.0	1,473
ECM 3	Retrofit Fixtures with LED Lamps	29,581	2.5	-7	$4,323	$4,246	$1,069	$3,177	0.7	28,994
Lighting Control Measures		**987**	**0.1**	**0**	**$144**	**$1,274**	**$185**	**$1,089**	**7.5**	**967**
ECM 4	Install Occupancy Sensor Lighting Controls	987	0.1	0	$144	$1,274	$185	$1,089	7.5	967
Variable Frequency Drive (VFD) Measures		**170,691**	**60.6**	**0**	**$25,112**	**$143,228**	**$22,650**	**$120,578**	**4.8**	**171,884**
ECM 6	Install VFDs on Constant Volume (CV) Fans	9,359	2.6	0	$1,377	$17,270	$450	$16,820	12.2	9,424
ECM 7	Install VFDs on Cooling Tower Fans	34,628	-4.0	0	$5,094	$53,487	$10,000	$43,487	8.5	34,870
ECM 8	Install Boiler Draft Fan VFDs	27,373	14.9	0	$4,027	$17,501	$3,000	$14,501	3.6	27,565
ECM 9	Install VFDs on Boiler Feedwater Pumps	79,616	44.8	0	$11,713	$37,390	$5,400	$31,990	2.7	80,173
ECM 10	Install VFDs on Condensate Pumps	19,714	2.4	0	$2,900	$17,580	$3,800	$13,780	4.8	19,852
HVAC System Improvements		**0**	**0.0**	**3,558**	**$15,052**	**$108,071**	**$6,312**	**$101,759**	**6.8**	**416,541**
ECM 12	Install Pipe Insulation	0	0.0	3,558	$15,052	$108,071	$6,312	$101,759	6.8	416,541
Domestic Water Heating Upgrade		**278**	**0.0**	**0**	**$41**	**$14**	**$8**	**$6**	**0.2**	**280**
ECM 13	Install Low-Flow DHW Devices	278	0.0	0	$41	$14	$8	$6	0.2	280
Custom Measures		**0**	**0.0**	**0**	**$0**	**$42,000**	**$0**	**$42,000**	**0.0**	**0**
ECM 14	Connect Existing Plant Steam Flow Meter & Install a Chilled Water Flow Meter	0	0.0	0	$0	$42,000	$0	$42,000	0.0	0
TOTALS		**223,465**	**65.0**	**3,545**	**$47,877**	**$305,698**	**$30,914**	**$274,784**	**5.7**	**640,158**

* - All incentives presented in this table are based on NJ SmartStart 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).

ECM 12 has already been implemented. The measure is included to provide TCNJ an assessment of the savings associated with the implemented insulation project.

Figure 10 – Cost Effective ECMs

4.1 Lighting

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Upgrades		**51,510**	**4.2**	**-12**	**$7,528**	**$11,111**	**$1,759**	**$9,352**	**1.2**	**50,486**
ECM 1	Install LED Fixtures	20,426	1.6	-5	$2,985	$6,608	$650	$5,958	2.0	20,019
ECM 2	Retrofit Fluorescent Fixtures with LED Lamps and Drivers	1,503	0.1	0	$220	$257	$40	$217	1.0	1,473
ECM 3	Retrofit Fixtures with LED Lamps	29,581	2.5	-7	$4,323	$4,246	$1,069	$3,177	0.7	28,994

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

ECM 1: Install LED Fixtures

Replace existing fixtures containing metal halide lamps with new LED light fixtures. This measure saves energy by installing LEDs which use less power than other technologies with a comparable light output.

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

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

Affected building areas: interior metal halide fixtures.

ECM 2: Retrofit Fluorescent Fixtures with LED Lamps and Drivers

Retrofit fluorescent T12 fixtures by removing the fluorescent tubes and ballasts and replacing them with LED tubes and LED drivers (if necessary), which are designed to be used in retrofitted fluorescent fixtures.

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

Affected building areas: gas turbine room.

ECM 3: Retrofit Fixtures with LED Lamps

Replace fluorescent T8, CFL and incandescent lamps with LED lamps. Many LED tubes are direct replacements for existing fluorescent tubes and can be installed while leaving the fluorescent fixture ballast in place. LED lamps can be used in existing fixtures as a direct replacement for most other lighting technologies.

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

Affected building areas: All areas with fluorescent fixtures with T8 tubes. Exterior and gas turbine room CFL and halogen lamps.

4.2 Lighting Controls

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Lighting Control Measures		**987**	**0.1**	**0**	**$144**	**$1,274**	**$185**	**$1,089**	**7.5**	**967**
ECM 4	Install Occupancy Sensor Lighting Controls	987	0.1	0	$144	$1,274	$185	$1,089	7.5	967

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

ECM 4: Install Occupancy Sensor Lighting Controls

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

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

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

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

Affected building areas: offices and control room.

4.3 Motors

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Motor Upgrades		**9,952**	**2.9**	**0**	**$1,464**	**$56,262**	**$0**	**$56,262**	**38.4**	**10,021**
ECM 5	Premium Efficiency Motors	9,952	2.9	0	$1,464	$56,262	$0	$56,262	38.4	10,021

ECM 5: Premium Efficiency Motors

We have evaluated replacing the standard efficiency chilled water secondary pump motors with IHP 2014 efficiency motors. This evaluation assumes that existing motors will be replaced with motors of equivalent size and type. In some cases, additional savings may be possible by downsizing motors to better meet the motor's current load requirements.

Affected motors:

Location	Area(s)/System(s) Served	Motor Quantity	Motor Application	HP Per Motor	Additional Motor Description
Chilled Water Plant	Secondary Pump P4	1	Chilled Water Pump	125.0	Chilled Water Pump
Chilled Water Plant	Secondary Pump P1, P2, P5	3	Chilled Water Pump	125.0	Chilled Water Pump
Chilled Water Plant	Secondary Pump P6	1	Chilled Water Pump	200.0	Chilled Water Pump
Chilled Water Plant	Secondary Pump P3	1	Chilled Water Pump	125.0	Chilled Water Pump

Savings are based on the difference between baseline and proposed efficiencies and the assumed annual operating hours. The base case motor energy consumption is estimated using the efficiencies found on nameplates or estimated based on the age of the motor and our best estimates of motor run hours. Efficiencies of proposed motor upgrades are obtained from the current *New Jersey's Clean Energy Program Protocols to Measure Resource Savings*.

4.4 Variable Frequency Drives (VFD)

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Variable Frequency Drive (VFD) Measures		**170,691**	**60.6**	**0**	**$25,112**	**$143,228**	**$22,650**	**$120,578**	**4.8**	**171,884**
ECM 6	Install VFDs on Constant Volume (CV) Fans	9,359	2.6	0	$1,377	$17,270	$450	$16,820	12.2	9,424
ECM 7	Install VFDs on Cooling Tower Fans	34,628	-4.0	0	$5,094	$53,487	$10,000	$43,487	8.5	34,870
ECM 8	Install Boiler Draft Fan VFDs	27,373	14.9	0	$4,027	$17,501	$3,000	$14,501	3.6	27,565
ECM 9	Install VFDs on Boiler Feedwater Pumps	79,616	44.8	0	$11,713	$37,390	$5,400	$31,990	2.7	80,173
ECM 10	Install VFDs on Condensate Pumps	19,714	2.4	0	$2,900	$17,580	$3,800	$13,780	4.8	19,852

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

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

Install VFDs to control constant volume exhaust fan motor speeds. Energy savings result from reducing the fan speed (and power) when conditions allow for reduced air flow.

Affected motors: cogeneration plant exhaust fans

ECM 7: Install VFDs on Cooling Tower Fans

Install a VFD to control the cooling tower fan motors. The VFD will allow the cooling tower fan to operate at the minimum speed necessary to maintain the temperature of the condenser water returning to the chiller.

Energy savings result from reducing fan speed (and power) when there is a reduced load on the chiller and outside air wet bulb temperatures are depressed. The magnitude of energy savings is based on the estimated amount of time that the system will operate at reduced load.

Affected motors: Tower #2, four cooling tower fans

ECM 8: Install Boiler Draft Fan VFDs

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

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

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

Affected motors: Cleaver Brooks boiler draft fan

ECM 9: Install VFDs on Boiler Feedwater Pumps

Install VFDs to control boiler feedwater pumps. The existing level control valve will need to be maintained fully open and its control signal used by the VFD to modulate the feedwater speed.

Energy savings result from reducing the pump motor speed (and power) at reduced feedwater flow. The magnitude of energy savings is based on the estimated amount of time that the pumping system will operate at reduced load.

Affected motors: four boiler feedwater pump motors for boilers and HRSG systems.

ECM 10: Install VFDs on Condensate Pumps

Install VFDs to control the condensate return pumps. The condensate pump flow will have to be controlled to work in conjunction with the boiler feed water pump. The VFD control feedback should be based on a pressure transducer located in the main steam header. Before implementing this measure co-ordinate with the pump and boiler manufacturer.

Energy savings result from reducing the pump motor speed (and power) at reduced condensate flow from the condensate receiver. The magnitude of energy savings is based on the estimated amount of time that the pumping system will operate at reduced load.

Affected motors: condensate return pumps in the boiler and cogeneration plant.

4.5 Unitary HVAC

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Unitary HVAC Measures		**3,350**	**2.3**	**0**	**$493**	**$17,949**	**$948**	**$17,001**	**34.5**	**3,373**
ECM 10	Install High Efficiency Air Conditioning Units	3,350	2.3	0	$493	$17,949	$948	$17,001	34.5	3,373

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

ECM 11: Install High Efficiency Air Conditioning Units

Replace standard efficiency York packaged and Sanyo split system air conditioning units with high efficiency packaged and split system air conditioning units. The magnitude of energy savings for this measure depends on the relative efficiency of the older unit versus the new high efficiency unit, the average cooling and heating load and the estimated annual operating hours.

Affected units: York packaged and Sanyo split system serving the main office and the control room respectively.

4.6 HVAC Improvements

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
HVAC System Improvements		**0**	**0.0**	**3,558**	**$15,052**	**$108,071**	**$6,312**	**$101,759**	**6.8**	**416,541**
ECM 12	Install Pipe Insulation	0	0.0	3,558	$15,052	$108,071	$6,312	$101,759	6.8	416,541

ECM 12: Install Pipe Insulation

Install insulation on steam system piping. Distribution system losses are dependent on system fluid temperature, the size of the distribution system, and the level of insulation of the piping. Significant energy savings can be achieved when insulation has not been well maintained. When the insulation is exposed to water, when the insulation has been removed from some areas of the pipe, or when valves have not been properly insulated system efficiency can be significantly reduced. This measure saves energy by reducing heat transfer in the distribution system.

This measure is capturing the savings associated with steam pipe insulation upgrades the campus has implemented. This does not reflect future potential savings.

Affected Systems: steam system piping.

4.7 Domestic Water Heating

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Domestic Water Heating Upgrade		**278**	**0.0**	**0**	**$41**	**$14**	**$8**	**$6**	**0.2**	**280**
ECM 12	Install Low-Flow DHW Devices	278	0.0	0	$41	$14	$8	$6	0.2	280

ECM 13: Install Low-Flow DHW Devices

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

Device	Flow Rate
Faucet aerators (lavatory)	0.5 gpm
Faucet aerator (kitchen)	1.5 gpm
Showerhead	2.0 gpm

Low-flow devices reduce the overall water flow from the fixture, while still providing adequate pressure for washing. Additional cost savings may result from reduced water usage.

4.8 Custom Measures

#	Energy Conservation Measure	Annual Electric Savings (kWh)	Peak Demand Savings (kW)	Annual Fuel Savings (MMBtu)	Annual Energy Cost Savings ($)	Estimated M&L Cost ($)	Estimated Incentive ($)*	Estimated Net M&L Cost ($)	Simple Payback Period (yrs)**	CO_2e Emissions Reduction (lbs)
Custom Measures		**0**	**0.0**	**0**	**$0**	**$42,000**	**$0**	**$42,000**	**0.0**	**0**
ECM 14	Connect Existing Plant Steam Flow Meter & Install a Chilled Water Flow Meter	0	0.0	0	$0	$42,000	$0	$42,000	0.0	0

ECM 14: Connect Existing Plant Steam Flow Meter and Install a Chilled Water Flow Meter

The TCNJ Power House has an existing plant steam flow meter that has not been installed and commissioned.

The plant Director has expressed interest in connecting the steam flow meter and installing a chilled water flow meter to monitor plant production. Utility submeters alone do not save energy, but they are a useful tool under the right circumstances. Utility sub-meters can provide facility staff with real-time energy use data for specific buildings, information that enhances the potential for greater energy management activities. Revenue grade submeters are a tool that allow owners to bill tenants or departments for the energy consumed in the spaces they occupy. Better resolution on building system performance can lead to occupant behavioral changes which often result in reduced energy use.

At TCNJ, many campus buildings are equipped with electric submeters and few buildings have submeters that measure incoming utilities, including steam and chilled water. Additional steam, chilled water, and smart electric submetering projects have been identified for various buildings where incoming utilities are unmetered. The building level submeters will provide the facility staff with a good map of how energy is being used on the campus. Cost estimates for building level meters were developed using Means Cost data and typical building flow rates. For this analysis the following submeter costs were used: $2,400 electric, $6,700 steam, and $9,700 chilled water.

By metering the central plant outgoing utilities, the campus will be able to track production (outflow) of steam and chilled water, to compare with the consumption of those utilities (as measured at the building). This information will provide improved visibility to site personnel on potential distribution issues, such as potential steam and chilled water system leaks.

The estimated cost of the metering procurement and installation is $40,000 for the plant chilled water meter and $2,000 to finish connecting the steam meter based on Means cost data. The actual scope of work and implementation costs will need to be determined by a contractor.

4.9 Measures for Future Consideration

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

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

- evaluate these measures further
- develop firm costs
- determine measure savings
- prepare detailed implementation plans.

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

Natural Gas Compressors

The natural gas compressors for the cogeneration system use 300 hp, 705 rpm (10 pole), horizontal motors. The motor nameplate does not include an efficiency rating[5]. These motors have reached the end of their normal useful life.

It is possible that the current compressor motors are oversized for the application. However, replacing the compressor motors with smaller capacity motors does not guarantee a reduction in energy use. The compressor motor will operate at the required percent load to meet the compressor load so a smaller motor will just operate at a higher percent load than the existing motors. Therefore, the motor energy requirement will be a function of the motor efficiency at the associated motor load.

If the flow rate of compressed natural gas varies over a reasonable range (e.g. 20% difference from minimum to maximum flow) then controlling the compressor motors with a variable frequency drive (VFD) may be beneficial. For centrifugal compressors the motor power will vary approximately with the cube of the motor speed. For positive displacement compressors (reciprocating and rotary) the motor power will

[5] The National Electrical Manufacturers Association (NEMA) first made a distinction between standard and energy-efficient motors with the 1990 revision of its MG 1-1987 standard, which would become the standard for the Energy Policy Act of 1992 (EPAct). In October 1997, the EPAct took effect, mandating minimum energy-performance standards for 1 to 200 hp, 2, 4 and 6 pole general motors. The Consortium for Energy Efficiency (CEE) established "premium"-efficiency guidelines that were used by many utilities for rebate programs in 1996. By August 2001, NEMA and CEE harmonized their efficiency standards, establishing NEMA Premium efficiency standards for 1 to 500 hp 2, 4 and 6 pole low and medium-voltage motors. The Energy Independence and Security Act (EISA) of 2007 expanded on the previous motor efficiency requirements and included motors up to 500 hp and added 900 rpm (8 pole) motors. The 2016 US DOE Integral Horsepower Motor rule did not expand the motor hp or speed ratings that are covered.

vary directly with the motor speed. Installation of a VFD will likely require replacement of the existing motor with an inverter duty rated motor. Inverter-duty motors are designed to handle much lower speeds than standard AC motors without overheating and they are capable of withstanding higher voltage spikes without their insulation failing.

There are no US efficiency standards that apply to 10 pole motors which means there is no direct historical document to reference for the likely efficiency of the existing compressor motors. The motor efficiency was estimated at 91.5% for the study. Research identified one 300 hp, 720 rpm, 460 V motor with an efficiency rating of 94.1% at 75% load. The energy savings from replacing both the compressor motors with 94.1% efficient motors would be approximately 44,000 kWh/yr for an annual savings of $6,500. List price for a single 300 hp, 720 rpm motor is about $40,000.

TCNJ has set a goal of 2040 for carbon neutrality, and an updated Climate Action Plan is currently in development. Preliminary studies suggest that recommendations will include a broad reconfiguration of the central plant, phasing out the existing boilers and cogeneration system. TRC wholly supports TCNJ's climate initiative, however, the current infrastructure will need to be maintained in the interim. We concur that maintaining and rebuilding existing equipment to ensure reliability, when possible, is best until a long- range plan is finalized

5 Energy Efficient Best Practices

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

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

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

Energy Tracking with ENERGY STAR® Portfolio Manager®

You've heard it before - you can't manage what you don't measure. ENERGY STAR® Portfolio Manager® is an online tool that you can use to measure and track energy and water consumption, as well as greenhouse gas emissions[6] . Your account has already been established. Now you can continue to keep tabs on your energy performance every month.

Lighting Maintenance

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

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

Lighting Controls

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

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

Motor Maintenance

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

Economizer Maintenance

Economizers can significantly reduce cooling system load. A malfunctioning economizer can increase the amount of heating and mechanical cooling required by introducing excess amounts of cold or hot outside air. Common economizer malfunctions include broken outdoor thermostat or enthalpy control, or dampers that are stuck or improperly adjusted.

Periodic inspection and maintenance will keep economizers working in sync with the heating and cooling system. This maintenance should be part of annual system maintenance, and it 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.

Chiller Maintenance

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

AC System Evaporator/Condenser Coil Cleaning

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

HVAC Filter Cleaning and Replacement

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

Steam Trap Repair and Replacement

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

Boiler Maintenance

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

Water Heater Maintenance

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

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

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

Compressed Air System Maintenance

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

- Inspection, cleaning, and replacement of inlet filter cartridges
- Cleaning of drain traps
- Daily inspection of lubricant levels to reduce unwanted friction
- Inspection of belt condition and tension
- Check for leaks and adjust loose connections
- Overall system cleaning

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

Water Conservation

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

For more information regarding water conservation go to the EPA's WaterSense® website[7] or download a copy of EPA's "WaterSense® at Work: Best Management Practices for Commercial and Institutional Facilities"[8] to get ideas for creating a water management plan and best practices for a wide range of water using systems.

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

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

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

Procurement Strategies

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

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

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

6 On-site Generation

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

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

6.1 Solar Photovoltaic

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

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

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

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

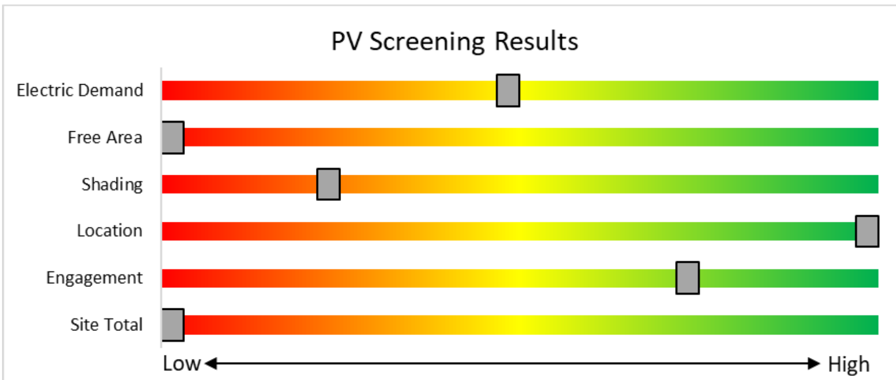


Figure 11 - Photovoltaic Screening

Transition Incentive (TI) Program

The TI program is a bridge between the Legacy SREC Program and a to-be determined Successor Incentive Program. The program 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 prior to the start of construction to establish the project's eligibility to earn TRECs (Transition Incentive Renewable Energy Certificates). The Transition Incentive is structured as a factorized renewable energy certificate. The factors allow the TI Program to provide differentiated financial incentives for different types of solar installation.

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

Transition Incentive (TI) Program: https://www.njcleanenergy.com/renewable-energy/programs/transition-incentive-program

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

6.2 Combined Heat and Power

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

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

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

The facility has a CHP system with waste heat to chiller plant.

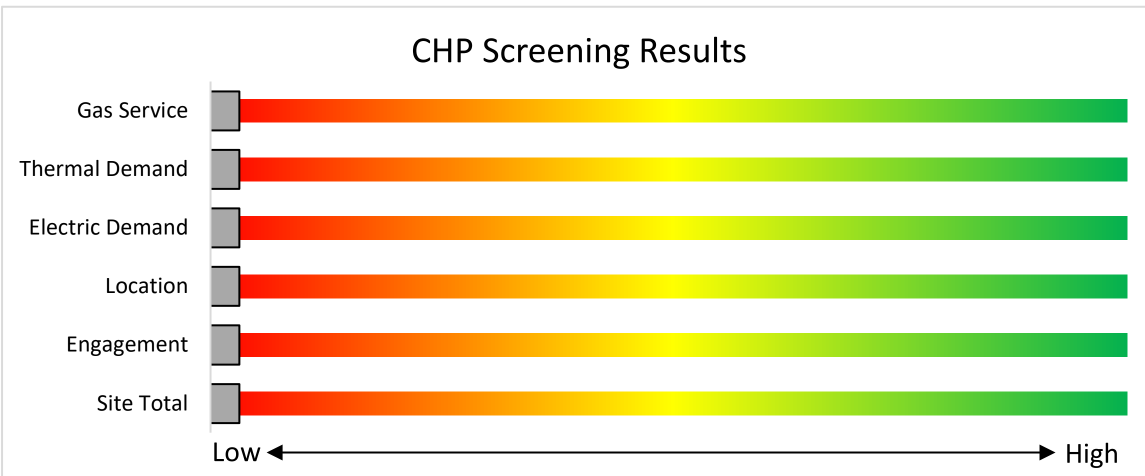


Figure 12 - Combined Heat and Power Screening

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

7 Project Funding and Incentives

Ready to improve your building's performance? New Jersey's Clean Energy Programs can help. Pick the program that works best for you. Incentive programs that may apply to this facility are identified in the Executive Summary. This section provides an overview of currently available New Jersey's Clean Energy Programs.

	SmartStart *Flexibility to install at your own pace*	**Direct Install** *Turnkey installation*	**Pay for Performance** *Whole building upgrades*
Who should use it?	Buildings installing individual measures or small group of measures.	Small to mid-size facilities that can bundle multiple measures together. Average peak demand should be below 200 kW. Not suitable for significant building shell issues.	Mid to large size facilities looking to implement as many measures as possible at one time. Peak demand should be over 200 kW.
How does it work?	Use in-house staff or your preferred contractor.	Pre-approved contractors pass savings along to you via reduced material and labor costs.	Whole-building approach to energy upgrades designed to reduce energy use by at least 15%. The more you save, the higher the incentives.
What are the Incentives?	Fixed incentives for specific energy efficiency measures.	Incentives pay up to 70% of eligible costs, up to $125,000 per project. You pay the remaining 30% directly to the contractor.	Incentives are paid out in three installments. The first installment is meant to help offset the costs of the initial engineering study. The subsequent incentives are paid based on the level of energy savings up to 50% of the total project cost. See Section 7.3 for all incentive details.
How do I participate?	Submit an application for the specific equipment to be installed.	Contact a participating contractor in your region.	Contact a pre-qualified Partner to develop your Energy Reduction Plan and set your energy savings targets.
Take the next step by visiting **www.njcleanenergy.com** for program details, applications, and to contact a qualified contractor.			

7.1 SmartStart

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

SmartStart routinely adds, removes, or modifies incentives from year-to-year for various energy efficient equipment based on market trends and new technologies.

<u>Equipment with Prescriptive Incentives Currently Available</u>:

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

Incentives

The SmartStart Prescriptive program provides fixed incentives for specific energy efficiency measures. Prescriptive incentives vary by equipment type.

SmartStart Custom provides incentives for more unique or specialized technologies or systems that are not addressed through prescriptive incentives. Custom incentives are calculated at $0.16/kWh and $1.60/therm based on estimated annual savings. Incentives are 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

Submit an application for the specific equipment to be installed. Many applications are designed as rebates, although others require application approval prior to installation. You can work with your preferred contractor or use internal staff to install measures.

Visit www.njcleanenergy.com/SSB for a detailed program description, instructions for applying, and applications.

7.2 Direct Install

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

Based on the site building and utility data provided, the facility does not meet the requirements of the current DI program.

Incentives

The program pays up to 70 percent of the total installed cost of eligible measures, up to $125,000 per project. Each entity is limited to incentives up to $250,000 per fiscal year.

How to Participate

To participate in Direct Install, you will need to contact the participating contractor assigned to the region of the state where your facility is located. A complete list of Direct Install program partners is provided on the Direct Install website linked below. The contractor will be paid the measure incentives directly by the program, which will pass on to you in the form of reduced material and implementation costs. This means up to 70 percent of eligible costs are covered by the program, subject to program caps and eligibility, while the remaining 30 percent of the cost is paid to the contractor by the customer.

Detailed program descriptions and applications can be found at: www.njcleanenergy.com/DI.

7.3 Pay for Performance - Existing Buildings

Pay for Performance works for larger customers with a peak demand over 200 kW. The minimum installed scope of work must include at least two unique measures that results in at least 15 percent source energy savings, and lighting cannot make up the majority of the savings.

P4P is a generally a good option for medium-to-large sized facilities looking to implement as many measures as possible under a single project to achieve deep energy savings. This program has an added benefit of addressing measures that may not qualify for other programs. Many facilities pursuing an Energy Savings Improvement Program loan also use this program.

For master metered campuses, such as The College of New Jersey, P4P eligibility is evaluated at the campus level. For the purposes of reporting P4P eligibility is being presented at all of the buildings. Final eligibility will be assessed once all of the reports are completed and will be addressed at the Exit Meeting. If the campus does not meet the 15% savings threshold based on measures identified during the LGEA Program process it is possible that additional measures could be identified at a later point in time, for example through further evaluation or the Energy Savings Improvement Program process.

Incentives

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

How to Participate

Contact one of the pre-approved consultants and contractors ("Partners"). Under direct contract to you, they will help further evaluate the measures identified in this report through development of the energy reduction plan), assist you in implementing selected measures, and verify actual savings one year after the installation. Your Partner will also help you apply for incentives.

Approval of the final scope of work is required by the program prior to installation. Installation can be done by the contractor of your choice (some P4P Partners are also contractors) or by internal staff, but the Partner remains involved throughout construction to ensure compliance with the program requirements.

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

7.4 Combined Heat and Power

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

Incentives

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

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

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

How to Participate

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

7.5 Energy Savings Improvement Program

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

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

How to Participate

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

(1) Use an energy services company or "ESCO."

(2) Use independent engineers and other specialists, or your own qualified staff, to provide and manage the requirements of the program through bonds or lease obligations.

(3) Use a hybrid approach of the two options described above where the ESCO is used for some services and independent engineers, or other specialists or qualified staff, are used to deliver other requirements of the program.

After adopting a resolution with a chosen implementation approach, the development of the energy savings plan (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. Carefully consider all alternatives to develop an approach that best meets your needs. A detailed program descriptions and application can be found at www.njcleanenergy.com/ESIP.

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

7.6 Transition Incentive (TI) Program

The TI program is a bridge between the Legacy SREC Program and a to-be determined Successor Incentive Program. The program 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 prior to the start of construction to establish the project's eligibility to earn TRECs (Transition Incentive Renewable Energy Certificates). The Transition Incentive is structured as a factorized renewable energy certificate. The factors allow the TI Program to provide differentiated financial incentives for different types of solar installations. NJBPU calculates the value of a Transition Renewable Energy Certificate (TREC) by multiplying the base compensation rate ($152/MWh) by the project's assigned factor (i.e. $152 x 0.85 = $129.20/MWh). The TREC factors are defined based on the chart below:

Project Type	Factor
Subsection (t): landfill, brownfield, areas of historic fill	1.00
Grid supply (Subsection (r)) rooftop	1.00
Net metered non-residential rooftop and carport	1.00
Community solar	0.85
Grid supply (Subsection (r)) ground mount	0.60
Net metered residential ground mount	0.60
Net metered residential rooftop and carport	0.60
Net metered non-residential ground mount	0.60

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 TRECs.

Eligible projects may generate TRECs for 15 years following the commencement of commercial operations (also referred to as the "Transition Incentive Qualification Life"). After 15 years, projects may be eligible for a NJ Class I REC.

TRECs will be used by the identified compliance entities to satisfy a compliance obligation tied to a new Transition Incentive Renewable Portfolio Standard ("Tl-RPS"), which will exist in parallel with, and completely separate from, the existing Solar RPS for Legacy SRECs. The Tl-RPS is a carve-out of the current Class I RPS requirement. The creation of TRECs is based upon metered generation supplied to PJM-EIS General Attribute Tracking System ("GATS") by the owners of eligible facilities or their agents. GATS would create one TREC for each MWh of energy produced from a qualified facility.

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

Solar projects help the State of New Jersey reach renewable energy goals outlined in the state's Energy Master Plan. The Transition Incentive Program online portal is now open to new applications effective May 1, 2020. There are instructions on "How and When to Transfer my SRP Registration to the Transition Incentive Program". If you are considering installing solar photovoltaics on your building, visit the following link for more information:

https://www.njcleanenergy.com/renewable-energy/programs/transition-incentive-program

8 Project Development

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

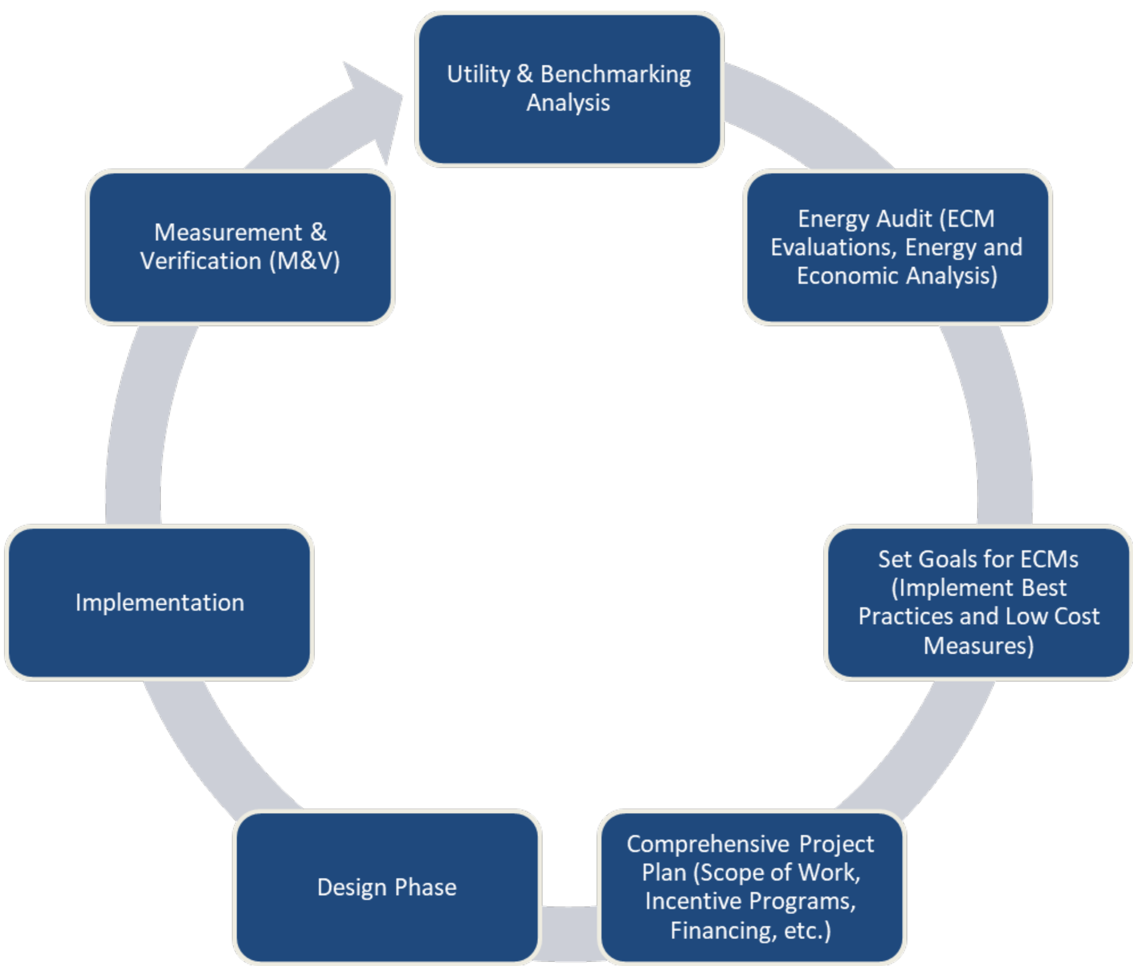


Figure 13 – Project Development Cycle

9 ENERGY PURCHASING AND PROCUREMENT STRATEGIES

9.1 Retail Electric Supply Options

Energy deregulation in New Jersey has increased energy buyers' options by separating the function of electricity distribution from that of electricity supply. 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 already buys electricity from a third-party supplier, review and compare prices at the end of each contract year.

A list of licensed third-party electric suppliers is available at the NJBPU website[9].

9.2 Retail Natural Gas Supply Options

The natural gas market in New Jersey is also deregulated. Most customers that remain with the utility for natural gas service pay rates that are market-based and that fluctuate monthly. 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 typically depends on whether a customer prefers budget certainty and/or longer-term rate stability. Customers can secure longer-term fixed prices by signing up for service through a third-party retail natural gas supplier. Many larger natural gas customers may seek the assistance of a professional consultant to assist in their procurement process.

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

A list of licensed third-party natural gas suppliers is available at the NJBPU website[10].

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

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

Appendix A: Equipment Inventory & Recommendations

Lighting Inventory & Recommendations

	Existing Conditions						Proposed Conditions								Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Light Level	Watts per Fixture	Annual Operating Hours	ECM #	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
BMS Office	2	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	2,080	3, 4	Relamp	Yes	2	LED - Linear Tubes: (4) 4' Lamps	Occupancy Sensor	58	1,435	0.1	308	0	$45	$262	$60	4.5
Electrical Room Cooling Tower	2	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	2	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Electrical Room Cooling Tower	5	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,184	3	Relamp	No	5	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,184	0.1	360	0	$53	$183	$50	2.5
Electrical Room Cooling Tower	2	Metal Halide: (1) 70W Lamp	Photocell		95	4,380	1	Fixture Replacement	No	2	LED - Fixtures: High-Bay	Photocell	29	4,380	0.1	583	0	$85	$1,162	$100	12.5
Exterior Wall Pack	1	Compact Fluorescent: (1) 42W Plug-In Lamp	Timeclock		42	4,380	3	Relamp	No	1	LED Lamps: LED Plug-In Lamp	Timeclock	29	4,380	0.0	55	0	$8	$25	$2	2.9
Exterior Wall Pack	1	LED Fixture: Outdoor Wall-Mounted Area Fixture	Timeclock		35	4,380		None	No	1	LED Fixture: Outdoor Wall-Mounted Area Fixture	Timeclock	35	4,380	0.0	0	0	$0	$0	$0	0.0
Exterior Pole Light	7	LED Fixture: Outdoor Pole/Arm-Mounted Area/Roadway Fixture	Photocell		80	4,380		None	No	7	LED Fixture: Outdoor Pole/Arm-Mounted Area/Roadway Fixture	Photocell	80	4,380	0.0	0	0	$0	$0	$0	0.0
Exterior Wall Pack	1	LED Fixture: Outdoor Wall-Mounted Area Fixture	Timeclock		10	4,380		None	No	1	LED Fixture: Outdoor Wall-Mounted Area Fixture	Timeclock	10	4,380	0.0	0	0	$0	$0	$0	0.0
Exterior Wall Pack	3	LED Fixture: Outdoor Wall-Mounted Area Fixture	Timeclock		30	4,380		None	No	3	LED Fixture: Outdoor Wall-Mounted Area Fixture	Timeclock	30	4,380	0.0	0	0	$0	$0	$0	0.0
Exterior Wall Pack	2	Compact Fluorescent: (1) 26W Plug-In Lamp	Photocell		26	4,380	3	Relamp	No	2	LED Lamps: LED Plug-In Lamp	Photocell	18	4,380	0.0	68	0	$10	$50	$4	4.6
Main Control Room	1	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Main Control Room	16	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	S	33	8,736	3, 4	Relamp	Yes	16	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	6,028	0.2	2,973	-1	$434	$1,060	$166	2.1
Office	4	Linear Fluorescent - T8: 2' T8 (17W) - 2L	Wall Switch	S	33	2,340	3, 4	Relamp	Yes	4	LED - Linear Tubes: (2) 2' Lamps	Occupancy Sensor	17	1,615	0.1	199	0	$29	$400	$59	11.7
Main GasTurbine Room	2	Compact Fluorescent: (1) 250W Spiral Screw-In Lamp	Wall Switch	S	250	8,736	3	Relamp	No	2	LED Lamps: LED Screw-In Lamp	Wall Switch	38	8,736	0.3	3,713	-1	$543	$70	$2	0.1
Main GasTurbine 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	0.0	0	0	$0	$0	$0	0.0
Main GasTurbine Room	1	Halogen Incandescent: (1) 50W Halogen Screw-In Lamp	Wall Switch	S	50	8,736	3	Relamp	No	1	LED Lamps: LED Screw-In Lamp	Wall Switch	8	8,736	0.0	371	0	$54	$17	$1	0.3
Main GasTurbine Room	4	LED Fixture: High-Bay	Wall Switch	S	50	8,736		None	No	4	LED Fixture: High-Bay	Wall Switch	50	8,736	0.0	0	0	$0	$0	$0	0.0
Main GasTurbine Room	2	Linear Fluorescent - T12: 8' T12 (75W) - 2L	Wall Switch	S	158	8,736	2	Relamp & Reballast	No	2	LED - Linear Tubes: (2) 8' Lamps	Wall Switch	72	8,736	0.1	1,503	0	$220	$257	$40	1.0
Main GasTurbine Room	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	8,736	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	8,736	0.0	288	0	$42	$37	$10	0.6
Main GasTurbine Room	5	Metal Halide: (1) 250W Lamp	Wall Switch	S	295	8,736	1	Fixture Replacement	No	5	LED - Fixtures: High-Bay	Wall Switch	89	8,736	0.7	9,020	-2	$1,318	$2,475	$250	1.7
High Pressure Compressor 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	0.0	0	0	$0	$0	$0	0.0
High Pressure Compressor Room	6	Metal Halide: (1) 250W Lamp	Wall Switch	S	295	8,736	1	Fixture Replacement	No	6	LED - Fixtures: High-Bay	Wall Switch	89	8,736	0.8	10,824	-2	$1,582	$2,970	$300	1.7
Boiler room	8	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	8	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Boiler room	1	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	1	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Boiler room	39	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	8,736	3	Relamp	No	39	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	8,736	0.8	11,243	-3	$1,643	$1,424	$390	0.6

	Existing Conditions						Proposed Conditions								Energy Impact & Financial Analysis						
Location	Fixture Quantity	Fixture Description	Control System	Light Level	Watts per Fixture	Annual Operating Hours	ECM #	Fixture Recommendation	Add Controls?	Fixture Quantity	Fixture Description	Control System	Watts per Fixture	Annual Operating Hours	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Boiler room	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	8,736	3	Relamp	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	8,736	0.0	577	0	$84	$73	$20	0.6
Boiler room	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	8,736	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	8,736	0.0	288	0	$42	$37	$10	0.6
Chiller Room	30	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	8,736	3	Relamp	No	30	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	8,736	0.7	8,649	-2	$1,264	$1,095	$300	0.6
Office - E1	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,340	3, 4	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,615	0.1	197	0	$29	$189	$40	5.2
Office - E2	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,340	3, 4	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,615	0.1	197	0	$29	$189	$40	5.2
Office - E4	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,340	3, 4	Relamp	Yes	2	LED - Linear Tubes: (2) 4' Lamps	Occupancy Sensor	29	1,615	0.1	197	0	$29	$189	$40	5.2
Office - Water Quality	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,340	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,340	0.0	77	0	$11	$37	$10	2.3
Offices Hallway	2	Exit Signs: LED - 2 W Lamp	None		6	8,760		None	No	2	Exit Signs: LED - 2 W Lamp	None	6	8,760	0.0	0	0	$0	$0	$0	0.0
Offices Hallway	2	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	8,736	3	Relamp	No	2	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	8,736	0.0	577	0	$84	$73	$20	0.6
Restroom - Unisex 1	1	Linear Fluorescent - T8: 4' T8 (32W) - 4L	Wall Switch	S	114	2,600	3	Relamp	No	1	LED - Linear Tubes: (4) 4' Lamps	Wall Switch	58	2,600	0.0	146	0	$21	$73	$20	2.5
Restroom - Unisex 2	1	Linear Fluorescent - T8: 4' T8 (32W) - 2L	Wall Switch	S	62	2,600	3	Relamp	No	1	LED - Linear Tubes: (2) 4' Lamps	Wall Switch	29	2,600	0.0	86	0	$13	$37	$10	2.1

Motor Inventory & Recommendations

		Existing Conditions									Proposed Conditions					Energy Impact & Financial Analysis						
Location	**Area(s)/System(s) Served**	**Motor Quantity**	**Motor Application**	**HP Per Motor**	**Full Load Efficiency**	**VFD Control?**	**Manufacturer**	**Model**	**Remaining Useful Life**	**Annual Operating Hours**	**ECM #**	**Install High Efficiency Motors?**	**Full Load Efficiency**	**Install VFDs?**	**Number of VFDs**	**Total Peak kW Savings**	**Total Annual kWh Savings**	**Total Annual MMBtu Savings**	**Total Annual Energy Cost Savings**	**Estimated M&L Cost ($)**	**Total Incentives**	**Simple Payback w/ Incentives in Years**
Compressor Room	Gas Turbine Engine	2	Air Compressor	300.0	91.5%	No			B	4,380		No	91.5%	No		0.0	0	0	$0	$0	$0	0.0
Compressor Room	Compressed Air System	1	Air Compressor	30.0	89.5%	No	Marathon		W	1,643		No	89.5%	No		0.0	0	0	$0	$0	$0	0.0
Compressor Room	Compressed Air System	1	Air Compressor	41.0	94.1%	No	Quincy		W	4,380		No	94.1%	No		0.0	0	0	$0	$0	$0	0.0
Compressor Room	Compressed Air System	1	Air Compressor	30.0	92.4%	No	Toshiba		W	1,643		No	92.4%	No		0.0	0	0	$0	$0	$0	0.0
Boiler Plant	Boilers	2	Boiler Feed Water Pump	25.0	92.4%	No	Baldor		W	2,912	8	No	92.4%	Yes	2	24.9	44,082	0	$6,485	$20,738	$2,800	2.8
Cogen Plant	Heat Recovery Steam Generator	2	Boiler Feed Water Pump	20.0	91.7%	No	Baldor		W	2,912	8	No	91.7%	Yes	2	19.9	35,535	0	$5,228	$16,651	$2,600	2.7
Chilled Water Plant	Secondary Pump P4	1	Chilled Water Pump	125.0	94.5%	Yes	Lincoln		B	2,500	5	Yes	95.4%	No		0.5	1,745	0	$257	$7,613	$0	29.6
Chilled Water Plant	Secondary Pump P1, P2, P5	3	Chilled Water Pump	125.0	94.5%	Yes	Marathon		B	2,500	5	Yes	95.4%	No		1.5	5,236	0	$770	$22,839	$0	29.6
Chilled Water Plant	Secondary Pump P6	1	Chilled Water Pump	200.0	95.4%	Yes	US Motors		B	2,500	5	Yes	95.8%	No		0.4	1,224	0	$180	$13,527	$0	75.1
Chilled Water Plant	Secondary Pump P3	1	Chilled Water Pump	125.0	94.5%	Yes	Century Electric		B	2,500	5	Yes	95.4%	No		0.5	1,745	0	$257	$12,284	$0	47.8
Exterior Ground Floor	BAC Cooling Tower (Backup Tower)	4	Cooling Tower Fan	40.0	94.1%	No			B	728	7	No	94.1%	Yes	4	-4.0	34,628	0	$5,094	$53,487	$10,000	8.5
Exterior Ground Floor	Marley Cooling Tower (Main Tower)	4	Cooling Tower Fan	100.0	95.4%	Yes			W	1,820		No	95.4%	No		0.0	0	0	$0	$0	$0	0.0
Boiler Plant	Superior Steam Boiler	1	Combustion Air Fan	75.0	94.5%	Yes	Baldor		W	1,820		No	94.5%	No		0.0	0	0	$0	$0	$0	0.0
Boiler Plant	Cleaver Steam Brooks Boiler	1	Combustion Air Fan	50.0	93.0%	No			W	1,820	8	No	93.0%	Yes	1	14.9	27,373	0	$4,027	$17,501	$3,000	3.6
Boiler Plant	Condensate Pumps	2	Condensate Pump	5.0	89.5%	No	Baldor		W	2,548	9	No	89.5%	Yes	2	1.0	7,964	0	$1,172	$8,260	$1,800	5.5
Cogen Plant	Condensate Pumps	2	Condensate Pump	7.5	91.0%	No	Baldor		W	2,548	9	No	91.0%	Yes	2	1.4	11,750	0	$1,729	$9,320	$2,000	4.2
Exterior Gound Floor	Cooling Towers	7	Condenser Water Pump	125.0	95.4%	Yes			W	1,350		No	95.4%	No		0.0	0	0	$0	$0	$0	0.0
Cogen Plant	Cogen Plant	1	Exhaust Fan	1.5	84.0%	No			W	3,294	6	No	86.5%	Yes	1	0.5	1,731	0	$255	$3,391	$75	13.0
Cogen Plant	Cogen Plant	1	Exhaust Fan	1.0	84.0%	No			W	3,294	6	No	85.5%	Yes	1	0.3	1,132	0	$166	$3,010	$75	17.6
Roof	Cogen Plant	3	Exhaust Fan	2.0	86.0%	No			W	3,294	6	No	86.5%	Yes	3	1.8	6,496	0	$956	$10,869	$300	11.1

		Existing Conditions									Proposed Conditions					Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Motor Quantity	Motor Application	HP Per Motor	Full Load Efficiency	VFD Control?	Manufacturer	Model	Remaining Useful Life	Annual Operating Hours	ECM #	Install High Efficiency Motors?	Full Load Efficiency	Install VFDs?	Number of VFDs	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Boiler Plant	Boiler Plant	2	Exhaust Fan	0.8	70.0%	No			W	3,294		No	70.0%	No		0.0	0	0	$0	$0	$0	0.0
Cogen Plant	Boilers	2	Other	5.0	84.0%	No			W	240		No	84.0%	No		0.0	0	0	$0	$0	$0	0.0
Cogen Plant	HRSG - Oil Pump	1	Other	10.0	91.7%	No			W	240		No	91.7%	No		0.0	0	0	$0	$0	$0	0.0
Chilled Water Plant	Vacuum Pump (Chillers)	4	Process Pump	7.5	91.5%	No			W	2,912		No	91.5%	No		0.0	0	0	$0	$0	$0	0.0
Exterior Gound Floor	High Pressure Gas Cooler Fans	2	Process Fan	10.0	91.7%	No			W	2,912		No	91.7%	No		0.0	0	0	$0	$0	$0	0.0
Cogen Plant	Gas Turbine Engine Cooling Fan	1	Process Fan	7.5	91.7%	No			W	2,912		No	91.7%	No		0.0	0	0	$0	$0	$0	0.0
Cogen Plant	High Pressure Gas Compressor	2	Water Supply Pump	2.0	80.0%	No			W	1,820		No	80.0%	No		0.0	0	0	$0	$0	$0	0.0
Cogen Plant	HRSG - Oil Pump	2	Other	1.0	84.0%	No			W	240		No	84.0%	No		0.0	0	0	$0	$0	$0	0.0
Chilled Water Plant	Chiller Plant - Sand Filter Pump	1	Process Pump	10.0	89.5%	No			W	1,820		No	89.5%	No		0.0	0	0	$0	$0	$0	0.0
Roof	Main Office	1	Supply Fan	3.0	86.0%	No			W	8,760		No	86.0%	No		0.0	0	0	$0	$0	$0	0.0
Electric Room	Electric Room	3	Supply Fan	0.2	65.0%	No			W	8,760		No	65.0%	No		0.0	0	0	$0	$0	$0	0.0

Packaged HVAC Inventory & Recommendations

		Existing Conditions									Proposed Conditions								Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (MBh)	Cooling Mode Efficiency (SEER/IEER/EER)	Heating Mode Efficiency	Manufacturer	Model	Remaining Useful Life	ECM #	Install High Efficiency System?	System Quantity	System Type	Cooling Capacity per Unit (Tons)	Heating Capacity per Unit (MBh)	Cooling Mode Efficiency (SEER/IEER/EER)	Heating Mode Efficiency	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Exterior Ground Floor	Cogen Control Room	1	Split-System	1.50		10.67		Sanyo	CL1852	B	10	Yes	1	Split-System	1.50		16.00		0.3	414	0	$61	$5,678	$158	90.6
Electrical Room	Electrical Room	3	Packaged Air-Source HP	2.00	25.59	11.00	3.5 COP	Bard		W		No							0.0	0	0	$0	$0	$0	0.0
Roof	Main Office	1	Package Unit	10.00		9.55		York	DM120C00N4	B	10	Yes	1	Package Unit	10.00		14.00		2.0	2,936	0	$432	$12,271	$790	26.6
BMS Office	BMS Office	1	Window AC	1.00		10.70		Frigidaire		W		No							0.0	0	0	$0	$0	$0	0.0
Water Quality Control Rom	Water Quality Control Rom	1	Window AC	0.50		12.20		Frigidaire	FFRE0633S14	W		No							0.0	0	0	$0	$0	$0	0.0
Office E1	Office E1	1	Window AC	0.67		10.70		Frigidaire		W		No							0.0	0	0	$0	$0	$0	0.0
Office E4	Office E4	1	Window AC	0.67		10.70		Frigidaire		W		No							0.0	0	0	$0	$0	$0	0.0

Electric Chiller Inventory & Recommendations

		Existing Conditions						Proposed Conditions								Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	Chiller Quantity	System Type	Cooling Capacity per Unit (Tons)	Manufacturer	Model	Remaining Useful Life	ECM #	Install High Efficiency Chillers?	Chiller Quantity	System Type	Constant/ Variable Speed	Cooling Capacity (Tons)	Full Load Efficiency (kW/Ton)	IPLV Efficiency (kW/Ton)	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Chiller Plant	Chiller #5 - Chilled Water System	1	Water-Cooled Centrifugal Chiller	1,280	Trane	CVRE203UEA01FF	W		No							0.0	0	0	$0	$0	$0	0.0
Chiller Plant	Chiller #3 - Chilled Water System	1	Water-Cooled Centrifugal Chiller	1,480	York	YKQDQSK3-DBQ	W		No							0.0	0	0	$0	$0	$0	0.0
Chiller Plant	Chiller #1,2 - Chilled Water System	2	Steam Driven Chiller	2,000	York	YKVHVDJ4-STES	W		No							0.0	0	0	$0	$0	$0	0.0

Space Heating Boiler Inventory & Recommendations

		Existing Conditions						Proposed Conditions							Energy Impact & Financial Analysis						
Location	Area(s)/System(s) Served	System Quantity	System Type	Output Capacity per Unit (MBh)	Manufacturer	Model	Remaining Useful Life	ECM #	Install High Efficiency System?	System Quantity	System Type	Output Capacity per Unit (MBh)	Heating Efficiency	Heating Efficiency Units	Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Boiler Plant	Boiler #1 Steam Heating System	1	Forced Draft Steam Boiler	41,400	Superior Boiler	SX6-X-3750	N		No						0.0	0	0	$0	$0	$0	0.0
Boiler Plant	Boiler #2 Steam Heating System	1	Forced Draft Steam Boiler	40,000	Cleaver Brooks	Serila # NG-3946	B		No						0.0	0	0	$0	$0	$0	0.0
Gogen Plant	Steam System	1	Heat Recovery Steam Generator (Duct Burner)	43,000	Cleaver Brooks	ER-S-3-2613-250	N		No						0.0	0	0	$0	$0	$0	0.0
Gogen Plant	Steam System	1	Gas Turbine (Solar Taurus)		Solar	CTLM02	N		No						0.0	0	0	$0	$0	$0	0.0

Pipe Insulation Recommendations

Location	Area(s)/System(s) Affected	Recommendation Inputs: ECM #	Length of Uninsulated Pipe (ft)	Pipe Diameter (in)	Energy Impact & Financial Analysis: Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Boiler Room	Steam Pipe Insulation	11	252	0.50	0.0	0	97	$412	$6,436	$252	15.0
Boiler Room	Steam Pipe Insulation	11	216	0.75	0.0	0	103	$434	$5,517	$432	11.7
Boiler Room	Steam Pipe Insulation	11	387	1.00	0.0	0	228	$966	$9,884	$774	9.4
Boiler Room	Steam Pipe Insulation	11	552	1.25	0.0	0	404	$1,711	$14,098	$1,104	7.6
Boiler Room	Steam Pipe Insulation	11	111	1.50	0.0	0	95	$402	$3,057	$222	7.0
Boiler Room	Steam Pipe Insulation	11	363	2.00	0.0	0	380	$1,610	$9,997	$726	5.8
Boiler Room	Steam Pipe Insulation	11	435	2.50	0.0	0	551	$2,333	$11,980	$870	4.8
Boiler Room	Steam Pipe Insulation	11	591	3.00	0.0	0	956	$4,043	$16,276	$1,182	3.7
Boiler Room	Steam Pipe Insulation	11	294	4.00	0.0	0	566	$2,395	$8,097	$588	3.1
Boiler Room	Steam Pipe Insulation	11	81	5.00	0.0	0	176	$746	$2,231	$162	2.8

DHW Inventory & Recommendations

Location	Area(s)/System(s) Served	Existing Conditions: System Quantity	System Type	Manufacturer	Model	Remaining Useful Life	Proposed Conditions: ECM #	Replace?	System Quantity	System Type	Fuel Type	System Efficiency	Efficiency Units	Energy Impact & Financial Analysis: Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Boiler Plant	Domestic Hot Water	1	Storage Tank Water Heater (≤ 50 Gal)	A O Smith	ECT40 200	W		No						0.0	0	0	$0	$0	$0	0.0

Low-Flow Device Recommendations

Location	Recommedation Inputs: ECM #	Device Quantity	Device Type	Existing Flow Rate (gpm)	Proposed Flow Rate (gpm)	Energy Impact & Financial Analysis: Total Peak kW Savings	Total Annual kWh Savings	Total Annual MMBtu Savings	Total Annual Energy Cost Savings	Estimated M&L Cost ($)	Total Incentives	Simple Payback w/ Incentives in Years
Restroom	12	1	Faucet Aerator (Lavatory)	2.20	0.50	0.0	139	0	$20	$7	$4	0.2
Restroom	12	1	Faucet Aerator (Lavatory)	2.20	0.50	0.0	139	0	$20	$7	$4	0.2

Plug Load Inventory

	Existing Conditions					
Location	Quantity	Equipment Description	Energy Rate (W)	ENERGY STAR Qualified?	Manufacturer	Model
Cogen Plant	10	Desktop	120	Yes		
Cogen Plant	3	Coffee Machine	600	No		
Cogen Plant	1	Dehumidifier	250	No		
Cogen Plant	1	Large Fan	430	No		
Cogen Plant	1	Large Fan	100	No		
Cogen Plant	1	Large Fan	60	No		
Cogen Plant	3	Microwave	1,000	No		
Cogen Plant	2	Printer	112	Yes		
Cogen Plant	1	Copier	600	No		
Cogen Plant	3	Mini Refrigerator	150	Yes		
Cogen Plant	1	Refrigertor	224	Yes		
Cogen Plant	1	Toaster	500	No		
Cogen Plant	1	Water Cooler	190	No		
Cogen Plant	1	Grinder	559	No		
Cogen Plant	1	Drill Press	375	No		

APPENDIX B: ENERGY STAR® STATEMENT OF ENERGY PERFORMANCE

EUI is presented in terms of *site energy* and *source energy*. Site energy is the amount of fuel and electricity consumed by a building as reflected in utility bills. Source energy includes fuel consumed to generate electricity consumed at the site, factoring in electric production and distribution losses for the region.

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ENERGY STAR® Statement of Energy Performance

N/A

ENERGY STAR® Score[1]

The College of New Jersey

Primary Property Type: College/University
Gross Floor Area (ft²): 2,830,421
Built: 1855

For Year Ending: January 31, 2020
Date Generated: December 13, 2020

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
The College of New Jersey
2000 Pennington Road
Ewing, New Jersey 08628

Property ID: 5984875

Property Owner
The College of New Jersey
2000 Pennington Rd
Ewing, NJ 08628
609-771-2874

Primary Contact
David Matlack
2000 Pennington Road
Ewing, NJ 08628
609-771-2874
sstewart@trccompanies.com

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
229 kBtu/ft²

Source EUI
258.3 kBtu/ft²

Annual Energy by Fuel

Natural Gas (kBtu)	619,522,872 (96%)
Electric - Grid (kBtu)	28,774,949 (4%)

National Median Comparison

National Median Site EUI (kBtu/ft²)	160.2
National Median Source EUI (kBtu/ft²)	180.6
% Diff from National Median Source EUI	43%

Annual Emissions

Greenhouse Gas Emissions (Metric Tons CO2e/year)	35,660

Signature & Stamp of Verifying Professional

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

LP Signature: ______________________ Date: ___________

Licensed Professional

____ ________
,
(____)____-______
____

Professional Engineer or Registered Architect Stamp
(if applicable)

Appendix C: Glossary

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

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

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