APRIL 5, 2022

DRAFT REPORT

Energy Audit & Retrocommissioning Study

[redacted]

NY E&E
ENERGY AND ENVIRONMENTAL

Table of Contents

Executive Summary

[redacted] is a 318,000-square-foot 6-story office building located in [redacted]. Built in 1920s the building used to be a manufacturing facility for [redacted], who are also one of the major tenants at the building. The building also bears the name and is known as the [redacted] building. By installing recommended measures in package A, the building value is expected to increase by $8M (based on the energy cost savings increasing NOI and market cap rate of 5%).

[redacted] contracted New York Energy and Environmental (NYE&E) to perform an ASHRAE Level 2 Energy Audit and Retro-Commissioning Study at the [redacted] building. The purpose of the energy audit is to identify energy savings opportunities which can be categorized into low-cost/no-cost and capital improvements. The purpose of the retro commissioning study is to identify building operational and maintenance issues that do not reflect the facilities current requirements.

NYE&E team surveyed all major energy consuming equipment at the base building including the boiler plant which serves the entire building. Space heating is provided by a single 500 hp fuel oil#2 fired steam boiler supplying 6 psi steam to radiators located throughout the building. The boiler is controlled by Heat -Timer MPC controls providing outdoor reset heat cycling controls. Space cooling for the common areas is provided by a 10-ton Trane DX AC unit. The unit has a 2 hp constant speed fan and is controlled locally by a space thermostat.

Lighting in most areas is linear fluorescent T5 and T8 lamp fixtures. Some areas do have upgraded to LEDs. Most lighting in the base building operates all year round. Lighting is mostly controlled by wall switches.

The building has a green roof over the entire room area. The area is used for planting various fruits and vegetables. The roof also hosts a 'farmer's market' to sell the produce. Green roofs are great as sustainability practices and help keep the building cool during hot weather days.

Several energy conservation measures were studied including the building heating, ventilation, and air-conditioning (HVAC), lighting, as well as potential for renewable energy generation. Together these measures have the potential to reduce electric energy use by 389,547 kWh and save 58,000 gallons of fuel oil#2 annually. The total energy savings projected from all measures is 5,244 MMbtu which represents 13.3% of the entire building energy use. Implementing all measure would save a total of $159,834 in utility costs annually. The total measure

cost is estimated to be at $2,145,049 with a potential utility incentive of $559,292 bringing the combined simple payback of all measures to 9.9 tons.

The energy conversation measure (ECM) summary table below presents the detail of each measure along with the potential utility incentive and simple payback calculations.

ECM SUMMARY TABLE

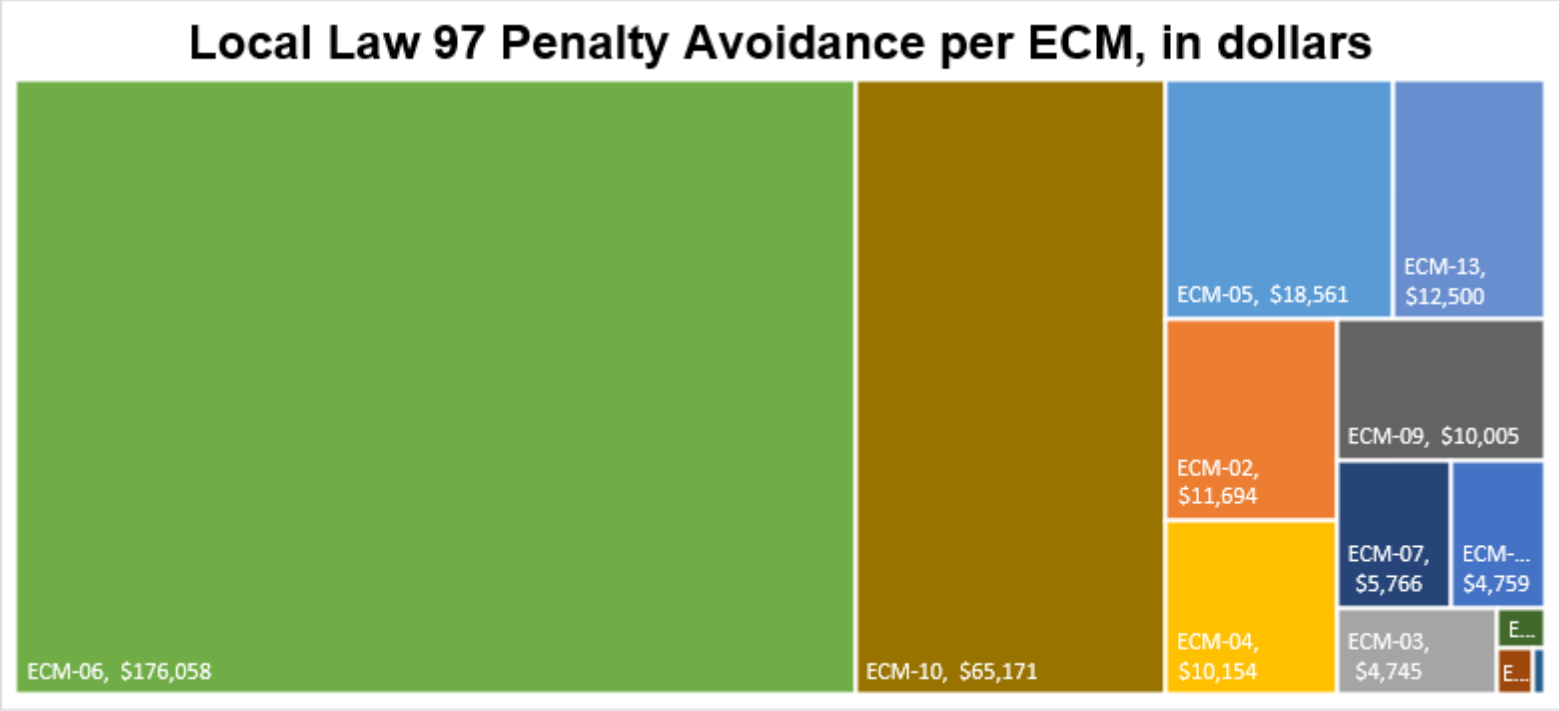
Each energy conservation measure is calculated below for cost values of energy savings, measure cost, incentive, and penalty avoidance.

Measure Number	Measure Description	Annual Energy and Cost Savings				Payback with Incentive + LL97					
		Electric Cost Savings ($)	Gas/Fuel Cost Savings	Total Energy Savings	Measure Cost	Potential Utility Incentive	GHG Penalty Avoidance per year	Net Measure Cost	Simple Payback (yr)	Net Measure Cost w GHGR	Simple Payback with GHG (yr)
ECM-01	Adjust Boiler Pressure Settings	$ -	$ 3,870	$ 3,870	$ 1,000	$ 1,000	$ 4,759	$ -	-	$ (80,905)	-
ECM-02	Insulate Steam Supply Risers	$ -	$ 9,510	$ 9,510	$ 13,000	$ 10,000	$ 11,694	$ 3,000	0.3	$ (20,388)	0.3
ECM-03	Steam Trap Replacements	$ -	$ 3,859	$ 3,859	$ 18,000	$ 9,000	$ 4,745	$ 9,000	2.3	$ (490)	2.3
ECM-04	LED Lighting Upgrade	$ 23,601	$ -	$ 23,601	$ 100,009	$ 32,780	$ 10,154	$ 67,229	2.8	$ 67,229	2.8
ECM-05	Solar PV Installation	$ 28,761	$ -	$ 28,761	$ 450,000	$ 351,000	$ 18,561	$ 99,000	3.4	$ (216,535)	3.4
ECM-06	VRF Heating and Cooling System	$ (136,976)	$ 248,075	$ 111,099	$ 5,000,000	$ 1,843,801	$ 176,058	$ 3,156,199	28.4	$ 163,219	15.9
ECM-07	Install Dedicated DHW Heater	$ -	$ 4,689	$ 4,689	$ 38,000	$ -	$ 5,766	$ 38,000	8.1	$ (2,361)	8.0
ECM-08	Install VFDs on Domestic Water Pumps	$ 1,341	$ -	$ 1,341	$ 14,400	$ 1,415	$ 577	$ 12,985	9.7	$ 11,831	9.2
ECM-09	Install TRV Valves for Heating Control	$ -	$ 8,136	$ 8,136	$ 96,000	$ 10,061	$ 10,005	$ 85,939	10.6	$ 15,907	9.1
ECM-10	Gas-Fired Hot Water Boilers	$ -	$ 63,868	$ 63,868	$ 750,000	$ 15,000	$ 65,171	$ 735,000	11.5	$ (372,910)	9.7
ECM-11	Install Premuim Efficiency Motors	$ 461	$ -	$ 461	$ 8,000	$ 1,153	$ 198	$ 6,847	14.8	$ 6,450	12.8
ECM-12	Elevator Controls Upgrade	$ 1,574	$ -	$ 1,574	$ 72,000	$ 2,186	$ 677	$ 69,815	44.4	$ 68,461	33.4
ECM-13	Install Window Film Throughout	$ -	$ 10,165	$ 10,165	$ 584,640	$ 125,698	$ 12,500	$ 458,942	45.2	$ 433,943	24.7
TOTALS (Package A)		**$ (81,238)**	**$ 262,928**	**$ 181,690**	**$ 6,267,049**	**$ 2,358,032**	**$ 224,490**	**$ 3,909,017**	**21.5**	**$ 532,237**	**14.0**
TOTALS (Package B)		**$ 55,738**	**$ 86,858**	**$ 142,596**	**$ 2,113,049**	**$ 539,292**	**$ 123,608**	**$ 1,573,757**	**11.0**	**$ 12,015**	**9.6**
TOTALS (Package C)		**$ 55,738**	**$ 40,228**	**$ 95,966**	**$ 1,395,049**	**$ 544,292**	**$ 79,635**	**$ 850,757**	**8.9**	**$ 283,142**	**8.5**

LOCAL LAW 97 PENALTIES

In accordance with Local Law 97, [redacted] will face greenhouse gas emissions limits and be required to pay corresponding annual penalties. The penalties for the building's current utility usage are calculated in the table below. A visualization of the weight of each ECM has been provided to show how much of the emissions penalty each measure would save annually following 2030.

PENALTY PER EMISSIONS	$268 / TCO2E
2024-2029 Annual Penalty	$0 / year
2030-2034 Annual Penalty	$136,463 / year
2035-2050 Annual Penalty	$403,215 / year



ECM PACKAGE SUMMARY AND INCREASE TO BUILDING VALUE

Multiple measures can be stacked and implemented to save on utilities and avoid emissions fines, but since some measures overlap three potential packages have been developed. The packages differ with how they address the heating system. Package A installs a VRF Heating and Cooling System. Package B installs Gas-Fired Hot Water Boilers. Package C simply Adjusts Boiler Pressure Settings and uses other steam conserving measures. Cost, Incentives, Savings, emissions reduction, and Savings with emissions reduction have all been calculated.

PACKAGE	CONSTRUCTION COST	INCENTIVES	NET CONSTRUCTION COST	ANNUAL ENERGY SAVINGS	ANNUAL ENERGY SAVINGS WITH PENALTIES AVOIDED	NET OPERATING INCOME INCREASE
A	$6,267,049	$2,358,032	$3,909,017	$181,690	$406,180	$8,075,156
B	$2,113,049	$539,292	$1,573,757	$142,596	$266,204	$5,292,327
C	$1,395,049	$544,292	$850,757	$95,966	$175,601	$3,491,078

Upon completion of installation, building value will immediately increase due to a lower net operating income. The net operating income increase has been calculated via energy savings and penalty avoidance. Annual energy savings with penalties avoided is the change in net operating income. Given a capitalization rate of 5% from Marcus & Millichap's Institutional Property Advisors (IPA), the following equation was used to calculate the net operating income increase per recommended package.

$$Capitalization\ Rate = \frac{\Delta\ Net\ Operating\ Income}{\Delta\ Value\ of\ Property}$$

ECMS – PACKAGE A - RECOMMENDED

Measure Number	Measure Description	Annual Energy and Cost Savings					
		Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)	Fuel Savings (Gallons)	Total Energy Savings (MMBtu)	ton CO2e saved
ECM-04	LED Lighting Upgrade	17.5	131,119	-	-	447.4	37.89
ECM-05	Solar PV Installation	180.0	239,675	-	-	817.8	69.26
ECM-06	VRF Heating and Cooling System	(31.2)	(760,978)	118,155	58,000	9,219.0	656.93
ECM-07	Install Dedicated DHW Heater	-	-	2,899	2,093	289.9	21.51
ECM-08	Install VFDs on Domestic Water Pumps	4.4	7,448	-	-	25.4	2.15
ECM-11	Install Premuim Efficiency Motors	0.7	2,563	-	-	8.7	0.74
ECM-12	Elevator Controls Upgrade	-	8,742	-	-	29.8	2.53
ECM-13	Install Window Film Throughout	-	-	6,285	4,538	628.5	46.64
TOTALS (Selected Measures)		**171.4**	**(371,431)**	**127,339**	**58,000**	**11,467**	**838**

ECMS – PACKAGE B

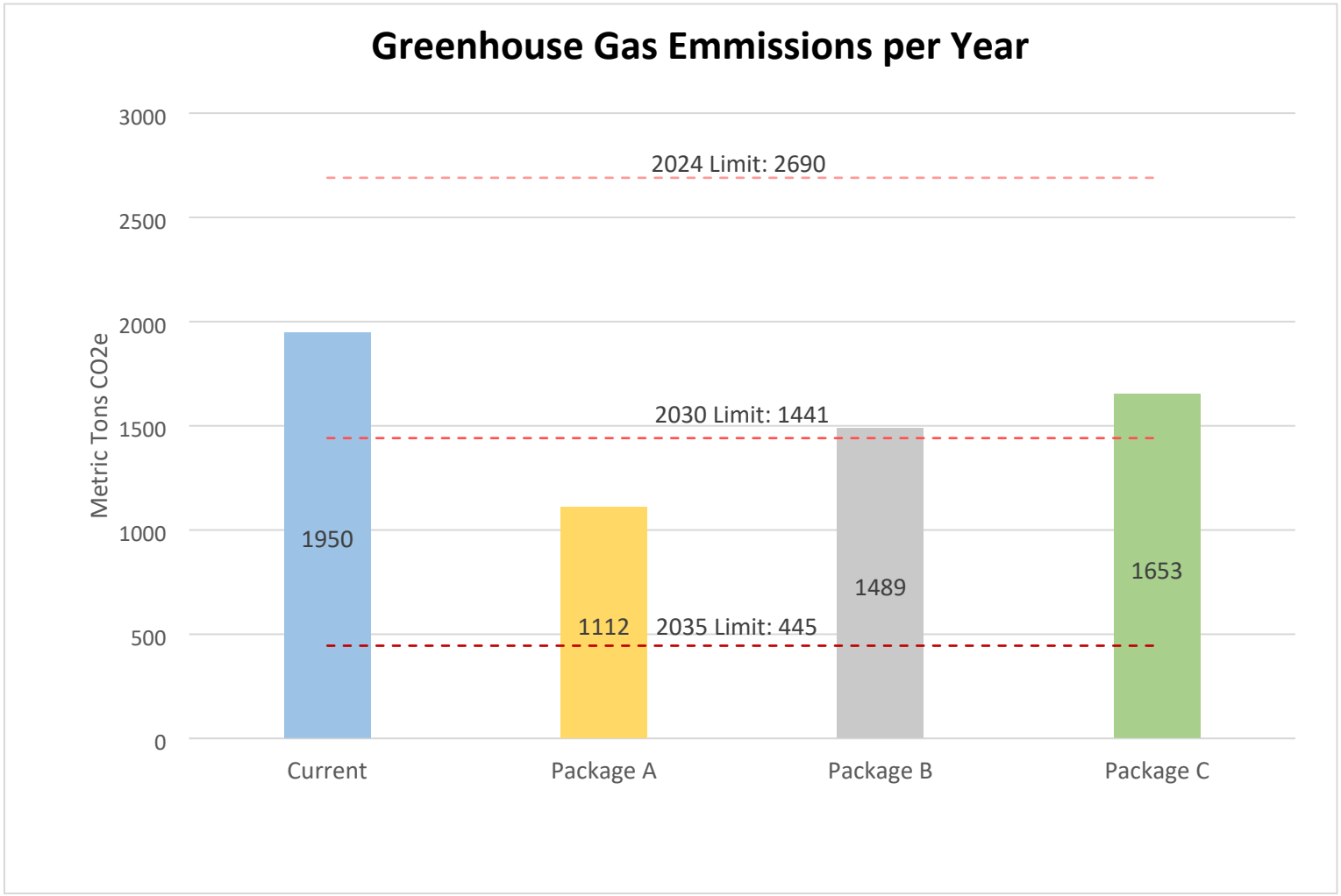
Measure Number	Measure Description	Annual Energy and Cost Savings					
		Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)	Fuel Savings (Gallons)	Total Energy Savings (MMBtu)	ton CO2e saved
ECM-04	LED Lighting Upgrade	17.5	131,119	-	-	447.4	37.89
ECM-05	Solar PV Installation	180.0	239,675	-	-	817.8	69.26
ECM-07	Install Dedicated DHW Heater	-	-	2,899	2,093	289.9	21.51
ECM-08	Install VFDs on Domestic Water Pumps	4.4	7,448	-	-	25.4	2.15
ECM-09	Install TRV Valves for Heating Control	-	-	5,030	3,632	503.0	37.33
ECM-10	Gas-Fired Hot Water Boilers	-	-	(66,052)	58,000	1,427.8	243.18
ECM-11	Install Premuim Efficiency Motors	0.7	2,563	-	-	8.7	0.74
ECM-12	Elevator Controls Upgrade	-	8,742	-	-	29.8	2.53
ECM-13	Install Window Film Throughout	-	-	6,285	4,538	628.5	46.64
TOTAL PACKAGE B		**202.6**	**389,547**	**(51,837)**	**58,000**	**4,178**	**461**

ECMS – PACKAGE C

Measure Number	Measure Description	Annual Energy and Cost Savings					
		Peak Demand Savings (kW)	Electricity Savings (kWh)	Gas/Fuel Savings (therms)	Fuel Savings (Gallons)	Total Energy Savings (MMBtu)	ton CO2e saved
ECM-01	Adjust Boiler Pressure Settings	-	-	2,393	1,728	239.3	17.76
ECM-02	Insulate Steam Supply Risers	-	-	5,880	4,245	588.0	43.64
ECM-03	Steam Trap Replacements	-	-	2,386	1,723	238.6	17.70
ECM-04	LED Lighting Upgrade	17.5	131,119	-	-	447.4	37.89
ECM-05	Solar PV Installation	180.0	239,675	-	-	817.8	69.26
ECM-07	Install Dedicated DHW Heater	-	-	2,899	2,093	289.9	21.51
ECM-08	Install VFDs on Domestic Water Pumps	4.4	7,448	-	-	25.4	2.15
ECM-09	Install TRV Valves for Heating Control	-	-	5,030	3,632	503.0	37.33
ECM-11	Install Premuim Efficiency Motors	0.7	2,563	-	-	8.7	0.74
ECM-12	Elevator Controls Upgrade	-	8,742	-	-	29.8	2.53
ECM-13	Install Window Film Throughout	-	-	6,285	4,538	628.5	46.64
TOTAL PACKAGE C		**202.6**	**389,547**	**24,873**	**4,538**	**3,816**	**297**

EMISSIONS OUTLOOK PER PACKAGE

Each measures package will result in a different annual utility usage and a new annual building emissions level. The following displays the three packages compared to the emissions limits enforced by Local Law 97 penalties.



Building Description

BUILDING ADDRESS

BUILDING		TENANT LOCATIONS	SPACE	
Owner	[redacted]	[redacted]	**Office**	267,536 GSF
Energy Star	65(C)	[redacted]	**Vacant**	24,609 GSF
Total SF	318,000 SF	[redacted]	**Food Sales**	7,650 GSF
Bin #	[redacted]	[redacted]	**Total GFA (Building)**	299,795 GSF
Block #	[redacted]	[redacted]	**Total GFA (Parking)**	0
Lot #	[redacted]	[redacted]		
BBL #	[redacted]			
# Stories	[redacted]			

All tenants in the facility are responsible for providing and maintaining their own air conditioning and mechanical ventilation systems. Most tenant spaces are cooled by small capacity, split direct-expansion (dx) units, whose condensers exhaust air through wall vents. The base building only utilizes one trane air-cooled dx air conditioning (ac) unit for cooling in summer. The unit uses r-22 refrigerant, and is rated for 10 tons. The ac unit is controlled by a space temperature thermostat, and are typically set at 70-74°f during the cooling season. There are three small window ac units serving the first floor building manager's office and two passenger elevator machine rooms. Their sizes are about 10,000 to 13,000 btu/hr. All window ac units are manually controlled and activate whenever needed by space occupancy.

HEATING SYSTEM

One scotch marine firetube boiler (Boiler #1) produces steam to serve the heating system. The operating pressuretrol setting is from 1.5 psi to 5 psi, and the high limit pressuretrol setting is 10 psi. This means that the boiler will automatically stop running if the steam pressure goes above 10 psi and will normally operate if the steam pressure falls between 1.5 to 5 psi. The modulating pressuretrol settings are set to a range of 6 psi to 10.2 psi, which means that the burner will modulate to maintain a steam pressure set-point between 6 psi and 10.2 psi. It is obvious that the modulating pressuretrol setting (6 - 10.2 psi) is outside the range of operating pressuretrol setting (1.5 – 5 psi).

The boiler was installed in 1975. It appears to be in average condition, as evidenced by visual inspection and the results of the combustion analyzer results.

The boilers are equipped with a mechanical jackshaft to control the position of the fuel valves and air damper. The boiler uses forced draft combustion, delivered by a 25 HP combustion air fan. The boiler utilizes Industrial Combustion #4 oil burner to produce the steam. The burner is rated at 140 GPH oil input, which is fully modulating.

The facility is equipped with one 10,000-gallon #2 oil storage tank, located in the oil tank room in the basement. The oil loop is served by a two-pump oil skid located in the boiler room that circulates oil from the tank to the boiler.

The boiler control is managed by a Heat-Timer MPC Gold. The MPC manages the duration of boiler cycles to control heat distribution and energy use in the building. The Heat Timer settings on the MPC are set to 55°F day cutoff and 50°F night cutoff, with a heat adjustment setting of “F” for day and “E” for night. The boiler is configured to 60-minute morning boost. The outside air temperature sensor is located on the north facing wall beside the main entrance.

The boiler is operating with an appropriate amount of air delivered to the combustion chamber at medium and high fire, but a significant amount of excess air at low fire. Excess air delivered was measured to be around 90.9% at low fire using a Bacharach PCA2 calibrated unit. Based on the results of the combustion testing, it does not appear that the draft damper calibration is achieving effective O2 trim throughout all firing rates.

The steam is distributed to approximately 500 2-pipe cast iron radiators. The radiators are not controlled locally, as they only have a manual valve that can be opened and closed by the occupant.

COOLING SYSTEM

All tenants in the facility are responsible for providing and maintaining their own air conditioning and mechanical ventilation systems. Most tenant spaces are cooled by small capacity, split direct-expansion (dx) units, whose condensers exhaust air through wall vents. The base building only utilizes one trane air-cooled dx air conditioning (ac) unit for cooling in summer. The unit uses r-22 refrigerant, and is rated for 10 tons. The ac unit is controlled by a space temperature thermostat, and are typically set at 70-74°f during the cooling season. There are three small window ac units serving the first floor building manager’s office and two passenger elevator machine rooms. Their sizes are about 10,000 to 13,000 btu/hr. All window ac units are manually controlled and activate whenever needed by space occupancy.

VENTILATION SYSTEM

Ventilation for this building is either accomplished by natural ventilation or provided by tenant air-cooled DX units. These fans owned or operated by the tenants are excluded from the Local Law 87 scope. There are no dedicated

exhaust fans serving the bathrooms. The only package air conditioner maintained by the base building is equipped with one 2 HP supply fan motor. The unit has a maximum airflow capacity of 4,500 CFM.

DOMESTIC HOT WATER

DHW is provided by a heat exchanger loop located within the boiler. The loop is heated to 180°F whenever the boiler fires. A mixing valve tempers water going out to the building to 110°F. The loop serves DHW needs of the common bathrooms.

LIGHTING SYSTEM

The base building is responsible for lighting in the common bathrooms, first floor lobby, mechanical rooms, basement through 6th floor corridors, and the three building stairwells. In the common bathrooms and corridors, the building utilizes a mixture of T5, T8 linear fluorescent fixtures. The mechanical rooms and stairwells are outfitted with T8 linear fluorescent fixtures. The main building lobby is outfitted with a mixture of different types of LED lighting, which are retrofitted recently during lobby renovation.

The majority of base building lighting is on 24/7. However, the east and west stairwell fixtures utilize occupancy sensor controls. As a result, the stairwell fixtures are typically off when stairwells are vacant and increase to 100% light output whenever occupants enter the stairwell.

BUILDING ENVELOPE

The building envelope is comprised of brick masonry with a decorative finish. The gross area of the wall measured on the exterior face is approximately 75,000 ft² (including window area). Based on the age of the building and discussions with building staff, the wall construction is assumed to be 8-inch concrete blocks separated by a 1-inch air gap and a 4-inch stone masonry finish. The interior walls are gypsum board. It is assumed that there is no insulation. This assembly has an estimated R-value of 4.9 (°F-sqft-hr)/Btu.

Windows throughout the building are glazed, double-pane, single-hung with aluminum frames. The windows are operable. The estimated glazed window area of the building is approximately 39,000 ft², representing a window to wall ratio of 52%. The windows are installed recently and in excellent condition.

The gross square footage of the roof is approximately 43,000 ft². The roof is the home of an approximately 40,000 ft2 rooftop organic farm operated by Brooklyn Grange. Planting beds are about 7.5" deep with 1" deep walkways and hundreds of plants are cultivated2. The rooftop farm naturally keeps the building cool and decreases water runoff.

CONVEYANCE EQUIPMENT

There are 2 passenger elevators and 2 freight elevators in the facility. The freight elevator serves every floor in the building from the basement to the 6th floor. Of the two passenger elevators, there is one serving each floor from the basement to the 6th floor, the other one serving up to rooftop from basement.

All elevators at the facility are geared traction elevators with AC motors range from 20 HP to 40 HP. One old freight elevator is using relay logic controls, and all the others are digital controlled. Passenger elevators were installed in 1988 and 2012, and freight elevators were installed in 1988 and 2016 respectively.

Energy Benchmarking

Several years of utility data is available since the acquisition of the [redacted]

OCCUPANCY

Occupancy at [redacted] has remained unchanged as 6AM to 6PM weekdays.

EPA ENERGY STAR PORTFOLIO MANAGER SCORE

[redacted] has a current Energy Star score of 65 out of 100. Within the NYC Climate Mobilization Act, Local Law 33 of 2018 requires Energy Star scores and corresponding letter grades for all buildings over 25,000 square feet. The letter grades are to be displayed on the face of the building and visible from the street. At 318,000 square feet [redacted] is required to comply.

Energy Star Portfolio Manager provides [redacted] with a site energy use intensity rating or EUI of 71.9 kBtu/ft². Compared to the national median office building site EUI of 52.9, [redacted] uses 36% more energy than other office buildings.

UTILITY USAGE

Utility usage at [redacted] include electricity measured in kilowatt-hours, fuel oil #2 measured in therms, and natural gas measured in therms.

Electricity is used for the following applications by base building and tenants:

- Base building
  - Interior Lighting in Common Areas
  - Plug Loads in Building Manager Office and Rooftop Elevator Room
  - Cellar Water Pumps
  - IT/Networking
  - Instantaneous Hot Water Heaters in Bathrooms
- Tenant
  - Interior Lighting in Tenant Spaces
  - Plug Loads in Tenant Spaces
  - Rooftop DX Units

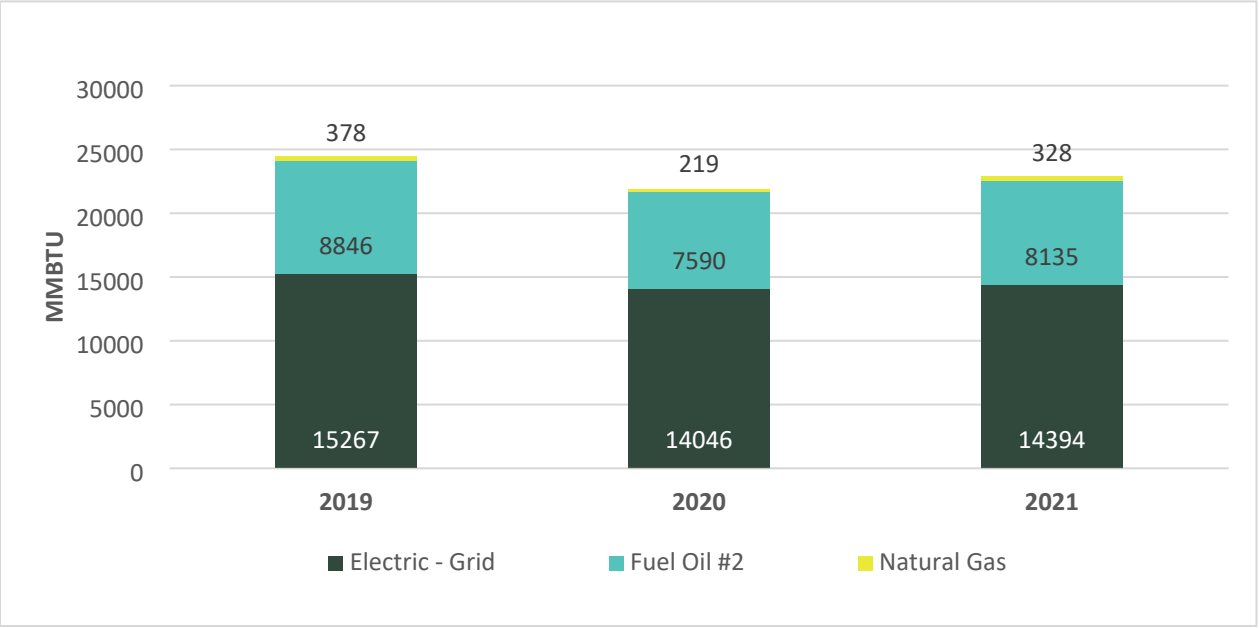
Fuel Oil #2 is used for the following appliances by base building.

- Boiler

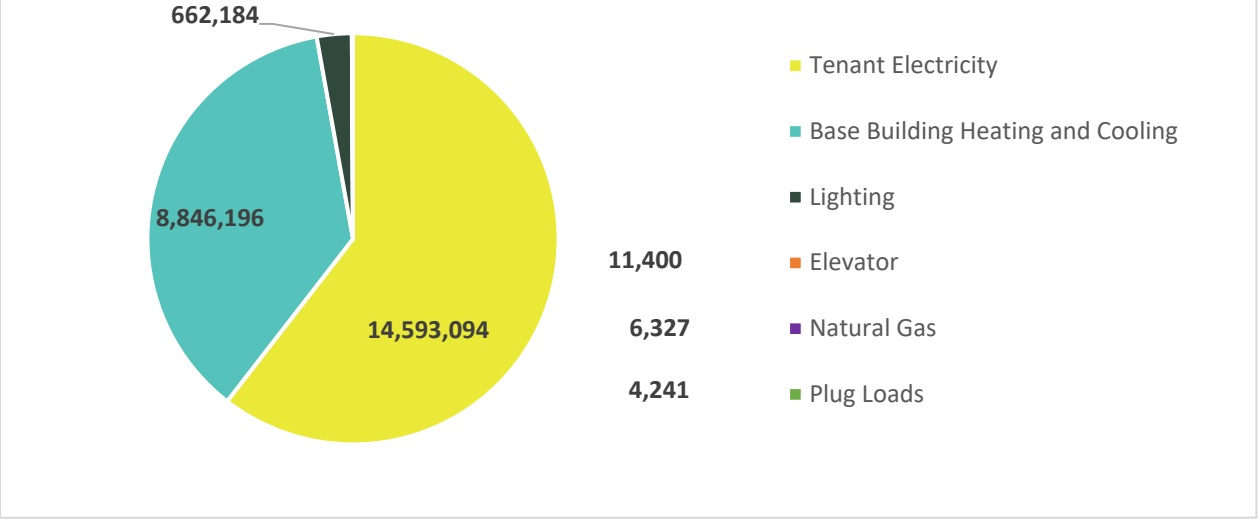
Natural Gas is used for the following appliances by tenants.

- Boiler Pilot

ENERGY USAGE PER YEAR



BUILDING ANNUAL UTILITY BY END USAGEIN KBTU



UTILITY COST

- Electricity
  - Supplied by: Con Edison
  - Billed to: [redacted]
- Natural Gas

  - Supplied by: Con Edison
  - Billed to: [redacted]
- Fuel Oil #2
  - Supplied by: Chief Energy Corporation
  - Billed to: [redacted]

Local Law 97 Analysis

Local Law 97 was included in the Climate Mobilization Act (CMA) passed by the NYC City Council in 2019. The law combats carbon emissions from utility usage of energy. The following are the carbon intensity factors of each utility type in emissions per energy unit ($kgCO_2e/kBTU$). Note that the electricity carbon intensity factor decreased from 2018 to 2019 and from 2019 to 2020.

GREENHOUSE GAS COEFFICIENT PER UTILITY, KGCO2E/KBTU

YEAR	ELECTRIC	GAS	FUEL OIL #2	FUEL OIL #4	STEAM
2018	0.0845	0.05306	0.07504	0.07504	0.04493
2019	0.0793	0.05306	0.07504	0.07504	0.04493
2020	0.0736	0.05306	0.07504	0.07504	0.04493

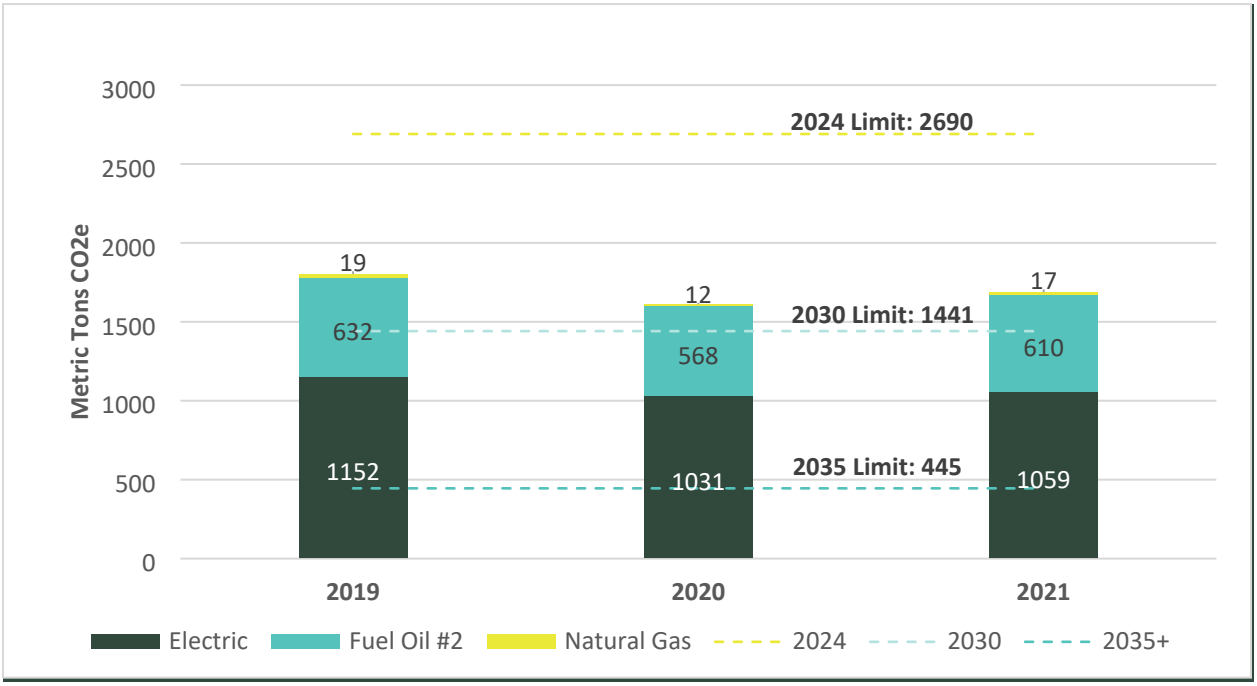
The city government expects renewable energy production to make these goals and limits easier to reach. This entails a continuously decreasing carbon intensity factor for electricity. This will help all buildings using electricity and encourage electronification of equipment.

Buildings need to meet increasingly demanding Greenhouse Gas (GHG) emission intensity thresholds by 2025, 2030, 2035, and 2050 or face a penalty by the NYC DOB. These thresholds are based on building occupancy groups and are defined with the following emissions limits per square foot in the following table.

LOCAL LAW 97 EMISSIONS INTENSITY LIMITS BY OCCUPANCY GROUP

OCCUPANCY GROUP	2024-2029 EMISSIONS LIMIT (TCO2E/SF)	2030-2034 EMISSIONS LIMIT (TCO2E/SF)	2035-2050 EMISSIONS LIMIT (TCO2E/SF)	2050 EMISSIONS LIMIT (TCO2E/SF)
A - Assembly	0.01074	0.00420	TBD	0.0014
B - Offices	0.00846	0.00453	TBD	0.0014
E - Educational	0.00758	0.00344	TBD	0.0014
F - Factory/Industrial	0.00574	0.00167	TBD	0.0014
I - Institutional	0.01138	0.00598	TBD	0.0014
M - Mercantile	0.01181	0.00403	TBD	0.0014
R1 - Hotels/Dorms	0.00987	0.00526	TBD	0.0014
R2 - Multifamily Residences	0.00675	0.00407	TBD	0.0014
S - Storage	0.00426	0.00110	TBD	0.0014

[redacted] greenhouse gas emissions has lowered slightly in the last two years. Based on the data from these three years, the building will stay under the 2024-2029 penalty cap and surpass the lowered cap in 2030. The building's emissions broken down by utility (electricity, fuel oil #2, and natural gas usage) are displayed in the graph below and compared to the three Local Law 97 emissions limits. Carbon emissions analysis should consider the pandemic year of 2020 resulting in a decrease of heating and electricity usage.



YEAR	ELECTRIC	FUEL OIL #2	NATURAL GAS	GHG TOTAL
2019	1211	664	20	**1895**
2020	1034	570	12	**1615**
2021	1059	610	17	**1687**

The recommended Energy Conservation Measures for [redacted] all decrease energy usage and therefore greenhouse gas emissions. Each measure corresponds to an annual amount of greenhouse gas emissions saved and a step closer to meeting the penalization limit. The strength of each measure's savings is displayed in the graphic below. In addition to greenhouse gas emissions and long-term penalty avoidance, the cost and savings of each measure should be considered. All measures should be considered but there is overlap between the measures meaning that not all can be applied to the building as once.

Meeting the emissions limits is important to avoid annual recurring fines that will quickly become more expensive than building upgrades to avoid the fines. The building emissions thresholds and estimated penalty are listed below.

Energy Conservation Measures

ECM #1 ADJUST BOILER PRESSURE SETTINGS

Measure Description	Reduce boiler pressure settings to reduce steam supply pressure. Currently the boiler pressure settings showed a guage pressure from 6-8 psi. Normal operating range is from 2 to 4 psi. • Industry standard for low-pressure steam settings is 2 psig. • At lower pressure steam occupies more volume. By running the steam at higher pressure of 6 psig the boiler will need to produce more steam (18-20%) than at 2 psig to fill the pipes. • Steam traps will operate at correct temperature differential of the steam and condensate. At higher pressure the condensate temperature also rises increasing the chances of flash steam and potentially adversely affect condensate pump.

Operation and Maintenance Impacts	Reducing steam pressure will likely result in better performance of steam traps requiring less frequent replacements. Piping losses and steam trap performance will improve requiring less frequent replacements.		
Design Considerations	Items to consider for the existing steam boiler: • Installed in 1975 has passed its useful life • Single boiler with no backup • Uses fuel oil #2 which emits 40% more CO2 per kbtu as compared to natural gas. Pressure Reduction • Should be implemented in consultation with boiler service provider. • Boiler plant is oversized for heating load in the building so meeting space temperature setpoints with lower pressure should see improvement in cycle time.		
Estimated Project Costs	$1,000	**Measure life, years**	N/A
Annual Fuel Oil Savings	1,728 gallons	**Simple Payback, year**	Immediate
Annual Cost Savings	$3,870	**Carbon Impact, tCO_2 reduced**	
Potential Utility Incentive	$1,000		

ECM #4 LED LIGHTING UPGRADE

Measure Description	Replacement of the existing light fixtures with LED lighting. This measure will provide the following benefits: • Hours of operation were 8760 annually (24/7) for hallways, stairwells, and lobbies. • Back of house rooms such as slop sinks, electrical rooms, and staff offices had operating hours between 1300-6000 annually depending on the type of space. • Hours of operation were confirmed with site management team. • In the core hallways, ceiling mounted occupancy sensors were present but did not seem to be functioning as the lighting did not react as we moved throughout the building. All lights in these areas remained on at 100% power.

	• The main building lobby has already been converted to LED. Building staff said the LEDs in place were 5-7 years old and nearing the end of their lifespan. • The rest of the building owned areas predominantly consist of T5 and T8 linear fluorescent lamps.		
Operation and Maintenance Impacts	Equipment replacement will reduce energy that is being wasted to illuminate areas of the building during times when they are unoccupied.		
Design Considerations	Items to consider for the existing light fixtures: • Sensor integrated LED fixtures in the hallways and stairwells. Building owned restrooms had the same fixture type as the hallways, and would benefit from occupancy sensors, so the same fixture type is proposed in all restrooms. • For back of house rooms with low hours and low sensor savings, ECS proposes a Type B LED		
Estimated Project Costs	$100,009	**Measure life, years**	8
Annual Fuel Oil Savings	$131,119	**Simple Payback, year**	2.8
Annual Cost Savings	$23,601	**Carbon Impact, tCO_2 reduced**	
Potential Utility Incentive	$32,780		

ECM #5 SOLAR PV INSTALLATION

Measure Description	Addition of rooftop photovoltaic solar system. The measure will provide the following benefits: • A 18,000 square foot system will provide 180 kW of energy • Offset of retail energy rates • Net metering allows the building to send unused electricity back to the grid in exchange for electricity bill credits • Minimize solar heat gain on roof via shading • Provide shading to farm vegetation if canopy option is selected
Operation and Maintenance Impacts	Operations & Maintenance can increase efficiency, decrease downtime, extend system life, and keep costs low. This will require administration to review billing and budget management. Monitoring via the computer control system will track metering revenue, alarms, and diagnostics. Scheduled preventative and condition-based corrective maintenance will keep the system running and revenue maximized.

Design Considerations	There is no current rooftop solar system. Tie-in to Transmission infrastructure will be required to sell excess power back to the grid. The 41,000 rooftop is utilized as a farm that produces food and hosts events such as weddings. The rooftop holds many tenant-owned rooftop units that would need to be built around and afforded clearance. A canopy solar photovoltaic system that allows room for farming underneath is an option but is more expensive.		
Estimated Project Costs	$450,000	**Measure life, years**	25
Annual Energy Production	180 kW dc	**Simple Payback, year**	3.4
Annual Cost Savings	$28,761	**Carbon Impact, Metric Tons**	69.26
Potential Utility Incentive	$351,000		

ECM #8 INSTALL VFDS ON DOMESTIC WATER PUMPS

Measure Description	Install variable frequency drive (VFD) on two domestic water booster pumps (7.5 hp each) that supply domestic water throughout the building. These same pumps also circulate water from the hot water coil inside the steam boiler. This measure will provide the following benefits: • One 7.5 hp pump was observed to be running continuously and other one is a backup. • Based on DHW demand calculations the building would only require 350 GPH while the hot water coil is sized for 550 GPH. Assuming the pumps are oversized, running at constant speed wastes energy. VFDs will help throttle the pump flow to match demand and saving significant pumping energy. • Reducing the speed by factor of 1 reduces the power draw by factor of 3 per the pump laws.
Operation and Maintenance Impacts	Each of the listed pumps should have a VFD installed. The flow control valve(s) currently in use should be fully opened, and flow varied by changing the speed of the pump. The savings are based on controlling the pump to maintain the existing rate of flow to the process. Typically, this type of installation requires installing pressure sensors, level sensors, or flow sensors that provide the control point for the pump. Installing this measure will require reprogramming the control system to control the pump speed instead of controlling the valve position.)

Design Considerations	Items to consider for the TRVs and steam piping: • Installing VFDs usually requires a mechanical/controls contractor. A testing, adjusting, and balancing (TAB) contractor may also be required. A simplified list of implementation steps is shown below • Verify the existing (balancing, flow control, pressure control) valve is throttled down to restrict pump flow. • Verify the existing or new pump motors are inverter duty rated • Open the balancing valve/triple duty valve to full flow, if applicable • Add control points to the BAS and control wiring for communications to/from BAS as necessary. • Controls should be reconfigured to control the VFD speed instead of varying valve position to maintain (flow, pressure, etc.)		
Estimated Project Costs	$14,400	**Measure life, years**	10
Annual Fuel Oil Savings	7,448 kWh	**Simple Payback, year**	9.7
Annual Cost Savings	$1,341	**Carbon Impact, tCO_2 reduced**	
Potential Utility Incentive	$1,415		

ECM #9 INSTALL TRV VALVES FOR HEATING CONTROL

Measure Description	TRV valves are self-regulating that provide local control of the space temperature by modulating the flow of steam into radiators. This measure will provide the following benefits: • It was observed during the site visit that space temperature is maintained at 74F at minimum. Some zones also were noticeably warmer than others. TRVs will help regulate zones temperature to a constant setpoint, ideally around 70F. • The facility has replaced 25% of the current manual valves with TRVs already. The temperature setting on those was at 70F. • TRVs are self-regulating valves that require no ancillary power. • Provide additional modulation to have control in individual zones. • Can also modulate temperatures individually in a larger zone.

Operation and Maintenance Impacts	TRVs are relatively easy to install and settings can be altered quickly if a room is unoccupied for longer periods. TRVs are generally very reliable and operate for many years without major problems.		
Design Considerations	Items to consider for the TRVs and steam piping: • Piping original to the boiler circa 1975 • Steam operating at 6psi through the radiators • 25% of the radiators already have the Danfoss TRVs. • Should be implemented in consultation with boiler service provider. • Greatest potential for savings when combined with balancing and commission of boiler control set points, tuning, boiler cleaning and repair of any leaking inlets and air vents.		
Estimated Project Costs	$96,000	**Measure life, years**	$10,061
Annual Fuel Oil Savings	3,632 gallons	**Simple Payback, year**	15
Annual Cost Savings	$8,136	**Carbon Impact, tCO_2 reduced**	10.6
Potential Utility Incentive	$10,061		

ECM #10 GAS-FIRED HOT WATER BOILERS

Measure Description	Replacement of the existing steam boiler with modular condensing boilers. This measure will provide the following benefits: • The single 20,000 MBH steam boiler should be replaced by (3) or (4) natural gas fired hot water condensing boilers. • The modular arrangement will allow for better temperature control with high burner turndown to closely match the heating demand. • Minimize heat loss through on-off cycling as well as stand-by losses of the steam boiler. • Use latent heat from the exhaust gases to preheat feedwater. • Increase in efficiency from 75-80% of traditional boilers to up to 93% in condensing mode.
Operation and Maintenance Impacts	Equipment replacement will reduce need for frequent maintenance as well as longer equipment life for all new units due to shared loads and scheduled rotation.
Design Considerations	Items to consider for the existing steam boiler: • Installed in 1975 has passed its useful life • Single boiler with no backup

	• Uses fuel oil #2 which emits 40% more CO2 per kbtu as compared to natural gas. Condensing Boiler(s) • Will run on natural gas and no need fuel oil #2 purchase or storage. • New hot water pumps will need to be installed (3 x 15 hp, with all 3 required on a design heating day. • New hydronic piping will need to be installed along with new hot water baseboard radiators. • Costs presented below account for the new piping and radiators.		
Estimated Project Costs	$750,000	**Measure life, years**	$15,000
Annual Fuel Oil Savings	58,000 gallons	**Simple Payback, year**	25
Annual Cost Savings	$63,868	**Carbon Impact, tCO_2 reduced**	11.5
Potential Utility Incentive	$15,000		

ECM #11 INSTALL PREMIUM EFFICIENCY MOTORS

Measure Description	Replace existing motors with NEMA premium efficiency motors. This measure will provide the following benefits: • There are six 3 hp groundwater pumps used for pumping groundwater from the boiler room into to the sewage system. Two of the six pumps run continuously (8760) while the others are back up. • The current efficiency rating of the pump motors is less than the NEMA premium efficiency standard. • Additionally, there are two 7.5 hp domestic water booster pumps that run during occupied hours and have nominal efficiency motors • Installing NEMA premium efficiency motors will increase energy efficiency and savings while no change in current pump operation.
Operation and Maintenance Impacts	This change should not affect operation, but only improve system efficiency. Installation should be coordinated with occupancy schedules since a short amount of downtime may be required during implementation.
Design Considerations	Items to consider for the NEMA PE motor replacement: • Replacing a motor typically involves facility personnel or a mechanical contractor. A simplified list of implementation steps is shown below:

	• Confirm the existing motor specifications. Work with a vendor to identify a direct replacement that meets the system requirements and has an ultra-premium efficiency rating. • Install the new motor and align it to the application. • Commission operation and confirm original system controls were not affected.		
Estimated Project Costs	$8,000	**Measure life, years**	10
Annual Fuel Oil Savings	2,563 kWh	**Simple Payback, year**	14.8
Annual Cost Savings	$461	**Carbon Impact, tCO_2 reduced**	
Potential Utility Incentive	$1,153		

ECM #12 ELEVATOR CONTROLS UPGRADE

Measure Description	Replacement of the existing controls for the elevator system. This measure will provide the following benefits: • There are 2 passenger elevators and 2 freight elevators in the facility. • The freight elevator serves every floor in the building from the basement to the 6th floor. Of the two passenger elevators, there is one serving each floor from the basement to the 6th floor, the other one serving up to rooftop from basement.		
Operation and Maintenance Impacts	Equipment replacement will reduce the amount of energy being used. It will generate electricity when going up and down on the elevator.		
Design Considerations	Items to consider for the existing elevator controls: • Make sure that the system is compatible with the current setup that they have. • The controller should maintain the voltage power between 24V to 12V; the motor is the only part that requires a 3-phase supply. • Everything must meet all of the doe requirements for traditional elevator control systems.		
Estimated Project Costs	$72,000	**Measure life, years**	10
Annual Fuel Oil Savings	$8,742	**Simple Payback, year**	44.4
Annual Cost Savings	$1,574	**Carbon Impact, tCO_2 reduced**	

Potential Utility Incentive	$2,186	

ECM #13 INSTALL WINDOW FILM THROUGHOUT

Measure Description	Installation of insulating film on windows. The measure will provide the following benefits: • Upgrades double pane windows to triple pane windows • Improves glass' winter insulation, improving comfort and relieving heating load • Reduces heat gain by reducing solar radiation		
Operation and Maintenance Impacts	None		
Design Considerations	Current windows are double pane clear glass. Each window cluster is approximately 160 square feet. Approximate window areas per building wall are as follows: • North: 16,000 square feet • South: 15,680 square feet • East: 4,800 square feet • West: 4,800 square feet		
Estimated Project Costs	$584,640	**Measure life, years**	10
Annual Energy Production	6,285 therms	**Simple Payback, year**	45.2
Annual Cost Savings	$10,165	**Carbon Impact, Metric Tons**	46.64
Potential Utility Incentive	$125,698		

BUILDING ENERGY EFFICIENCY RATING

Existing Building Performance

C

65

2022 RATING

B / 70

2021 RATING

C / 65

BUILDING SPECIFICATIONS	MORE INFORMATION
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BUILDING ENERGY EFFICIENCY RATING

Building Performance After Implementation

B

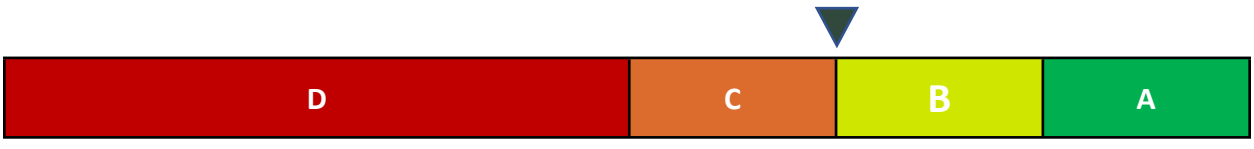
70

2022 RATING

B / 70

2021 RATING

C / 65



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