[redacted]

ZERO OVER TIME REPORT

Supported by Boston's Building Decarbonization Advisor Program (BDAP)

[redacted]

March 28, 2025

prepared by

GREENER U

307 Waverley Oaks Road, Suite 202
Waltham, MA 02452
781-209-5760 | www.greeneru.com

EXECUTIVE SUMMARY

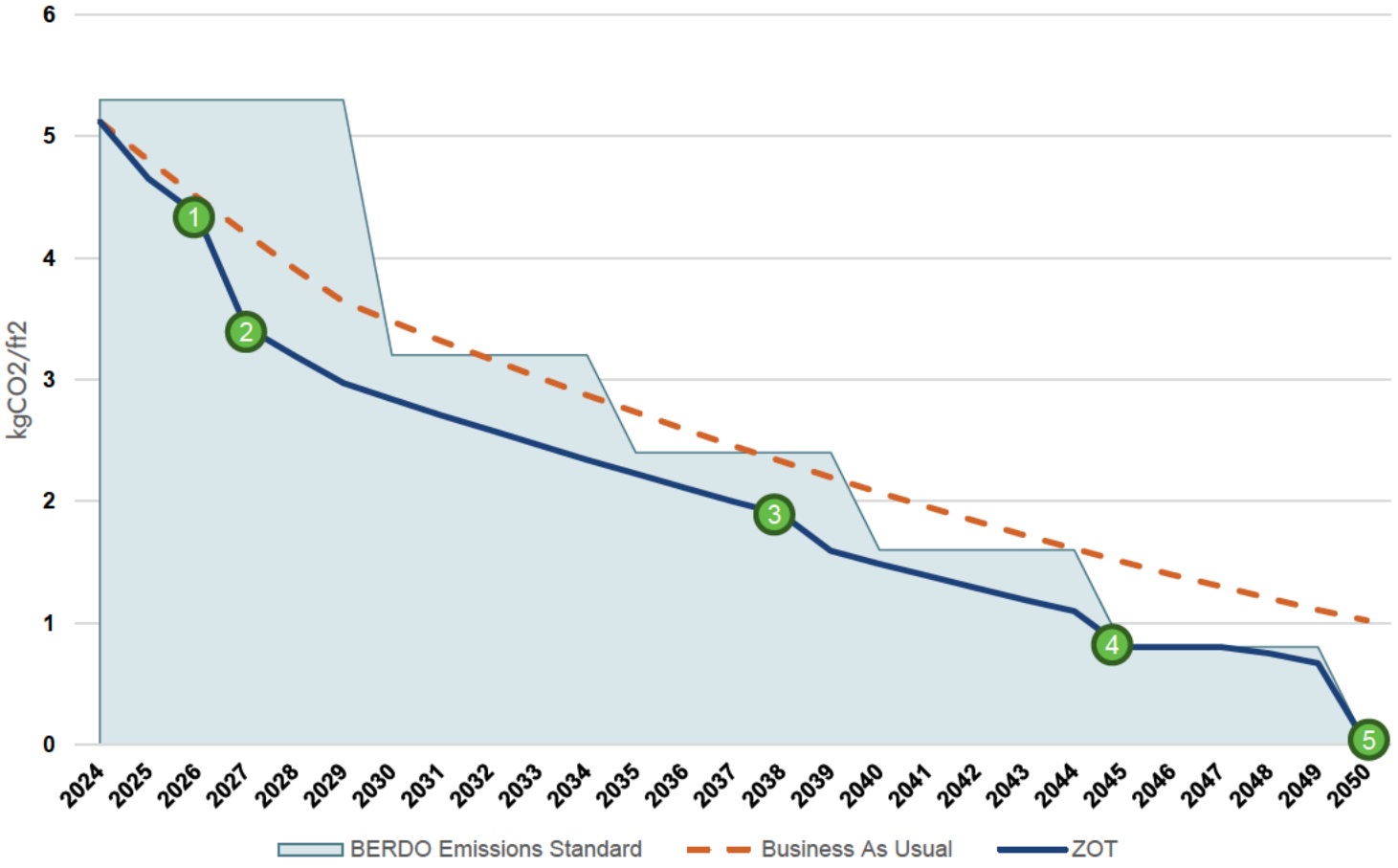
FACILITY DESCRIPTION

[redacted] is an office building located in Roxbury. The building is home to the non-profit organization [redacted] The building is primarily made up of offices, conference rooms and common working spaces.

ZERO OVER TIME SUMMARY

The [redacted] building can achieve zero emissions and BERDO compliance by implementing this plan. The plan involves implementing energy conservation measures from 2025 - 2030, electrifying natural gas burning equipment in 2039 and paying Alternative Compliance Payments (ACPs) from 2045 – 2047 and in 2050.

[redacted] Zero Over Time (ZOT) Plan



COMPLIANCE TIMELINE

1. 2025: BAS Controls (already implemented)
2. 2027: ECM 2-5 Implementation
3. 2039: Decarbonization measures
4. 2045 - 2047: ACPs for a total of $2,000
5. 2050: ACP for $3,400

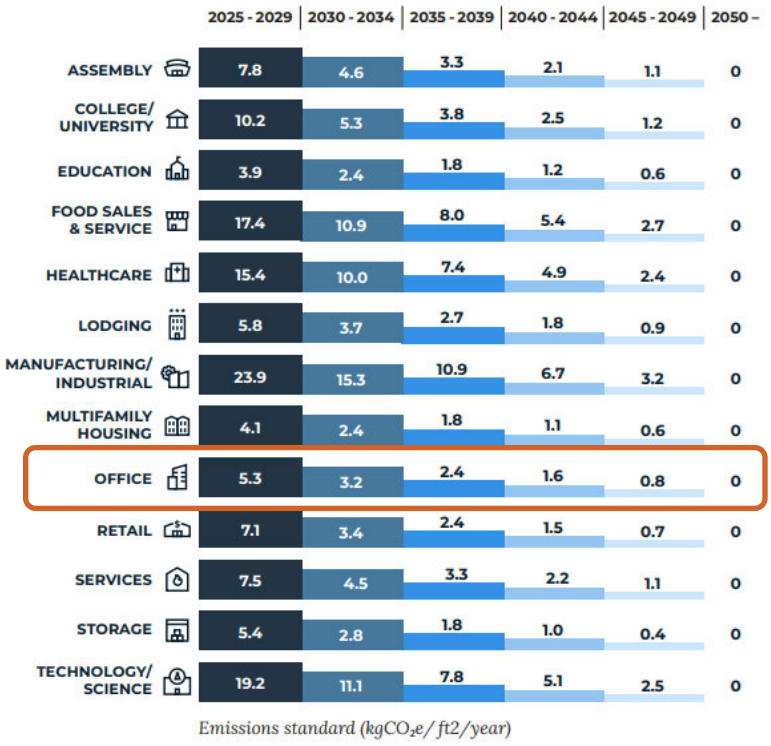
BERDO AT A GLANCE

WHAT IS BERDO?

The Building Emissions Reduction and Disclosure Ordinance (BERDO) is a local law that aims to reduce air pollution and greenhouse gas emissions generated by large buildings in Boston. Owners of buildings subject to BERDO are required to report their buildings' annual energy and water consumption. Starting in either 2025 or 2030, they will also need to comply with building emissions standards (limits). The emissions standards set by BERDO decrease over time, with all buildings expected to reach net-zero emissions by 2050.

BERDO COMPLIANCE

The following table shows the BERDO emissions standards by building type. These are the emissions standards that buildings will need to comply with, starting in 2025. [redacted] primary use type under BERDO is considered "Office."



HOW TO COMPLY?

There are multiple ways for building owners to comply with BERDO emissions standards. These different options are called *compliance mechanisms*.

Reduce energy use in the building:

This report details different ways in which the building owner can reduce the energy use in the building. Throughout this report, these are referred to as energy conservation measures (ECMs). These measures involve modifying the equipment's operation to lower energy use, improving the building envelope and/or add supplemental equipment to save more energy.

Decarbonize fossil fuel burning equipment:
This involved replacing fossil fuel burning equipment with electric options. This report provides a high-level overview of what work is required to electrify the building.

Obtain renewable energy:
There are multiple ways to obtain and procure renewable energy such as:

- Opting in to the Boston Community Choice Electricity's (BCCE) Green 100 plan
- Purchasing MA Class I Renewable Energy Certificates (RECs)
- Onsite solar energy generation
- Power purchasing agreements (PPA)

Alternative Compliance Payments (ACP):
ACPs are payments of $234 for every metric ton of CO2e above its emissions limit. The payments go to the Equitable Emissions Investment Fund, which helps fund future decarbonization projects in Boston's environmental justice communities.

FACILITY OVERVIEW

FACILITY DESCRIPTION

The facility is located at [redacted]. The building was originally constructed in 2004 and with varying ages of equipment. The building is a three-story building comprised primarily of offices, conference rooms, common working spaces and kitchenettes/break rooms on each floor. There is a small data center/IT room which houses servers and other IT equipment.

The facility is served by three rooftop air handling units (RTU) with direct natural gas heating and DX cooling. Each RTU can utilize return airflow control and economizer cooling. The RTUs supply airflow to VAV boxes in the space, each of which are equipped with an electric resistance heating coil. There is a small electric domestic hot water heater which generates hot water to the faucets and kitchenettes. There are seven electric unit heaters which are utilized frequently to prevent the fire protection system from freezing.

BUILDING INFO

Owner	[redacted]
Address	[redacted]
BERDO ID	[redacted]
Parcel ID	[redacted]
Floor area	24,072 gsf
Site EUI	90.2 kBtu/sf
Emissions intensity (2023 data)	6.37 kgCO2e/sf/yr
Primary Use Type Under BERDO	Office
2025 BERDO Emissions Standard	5.3 kgCO2e/sf/yr

SYSTEMS OVERVIEW

Ventilation and Airflow Distribution				
	Unit	**Install Year**	**Service**	**Operating Notes**
Primary Equipment	RTU-1	2021	Building VAVs	Scheduled from 6AM - 6PM VFDs with static pressure control Return airflow with economizer
	RTU-2	2021	3rd floor conference room	
	RTU-3	2021	1st floor meeting area	
Secondary Equipment	VAVs (41 total)	2004	Offices, break rooms, etc	

Heating System				
	Unit	**Install Year**	**Heating Source**	**Operating Notes**
Primary Equipment	RTUs	See above	Direct fire natural gas heating	AHUs have discharge air temperature reset
Secondary Equipment	VAVs + Unit Heaters	2004	Electric resistance	Unit heaters operate frequently for freeze protection
Domestic Hot Water		2023	Electric resistance	Expected small load

Cooling System				
	Unit	**Install Year**	**Cooling Source**	**Operating Notes**
Primary Equipment	RTUs	See above	Direct Expansion (DX) coils	Economizer cooling enabled

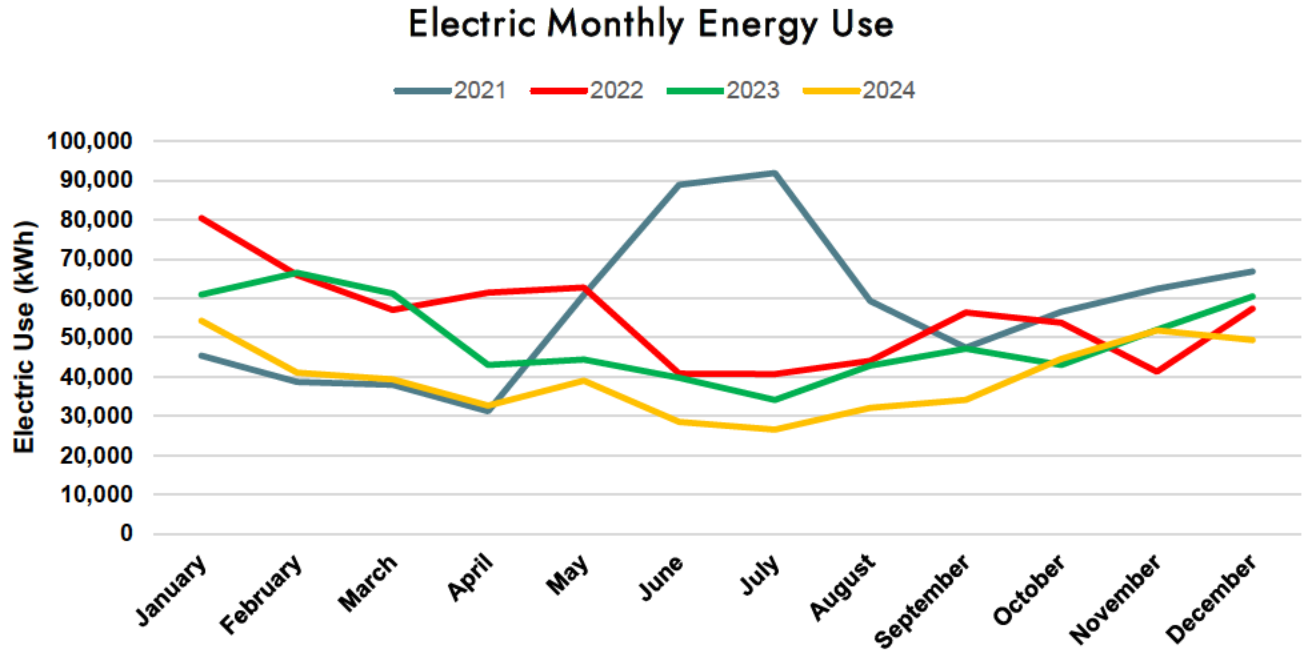
Electric System			
	Capacity	**Install Year**	**Electric System Description**
Primary Service	1,000 amps	2004	2-3 sub-panels per floor, rated for 100 - 250 amps

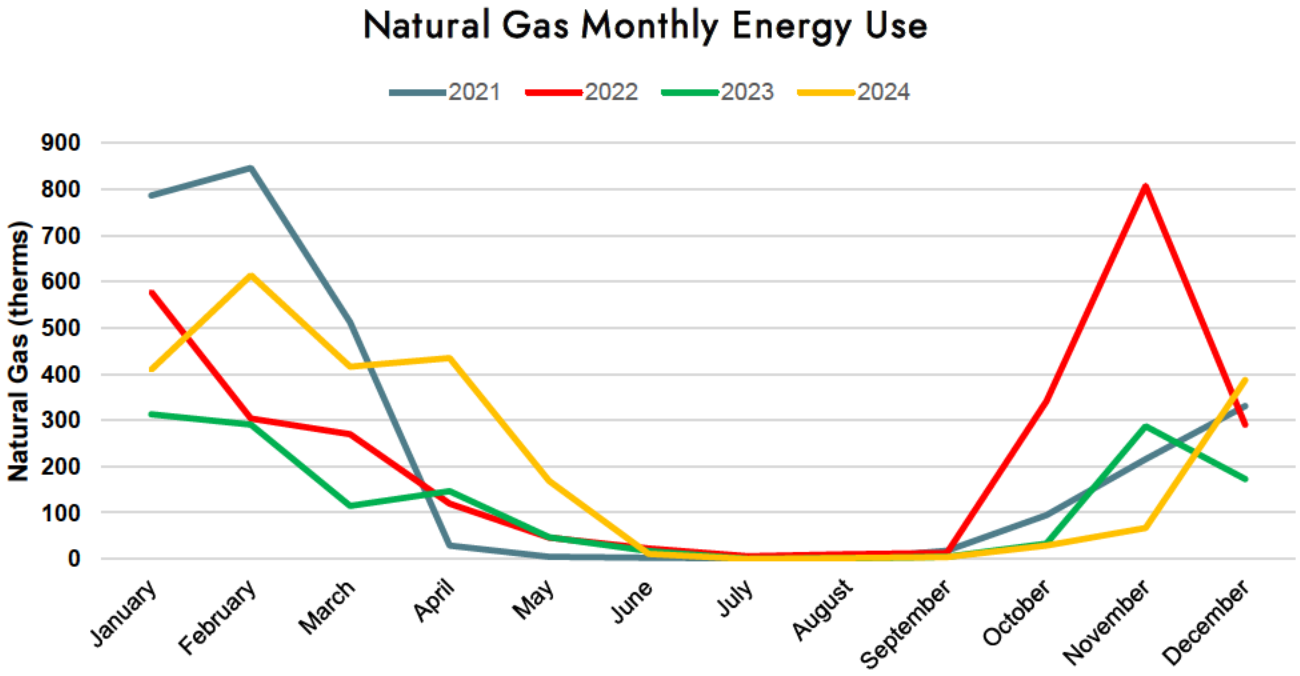
Building Envelope	
Envelope Description and Notes	**Insulation Description and Notes**
• Brick and metal panel exterior • Recently replaced white membraned roof	• Insulation could be improved on the roof to lower use of unit heaters

ENERGY BASELINE

The charts below shows the year over year energy use. The electric energy use is roughly constant throughout the year with a slightly higher winter load. This is to be expected because there is significant electric heating in the building. The natural gas use decreases to zero in the summer, which is to be expected because natural gas is only used for heating.

There is a noticeable decrease in electricity use in 2024 compared to prior years - this could be attributed to energy measures implemented such as LED lighting conversions. There is less of an observable decrease in natural gas use.





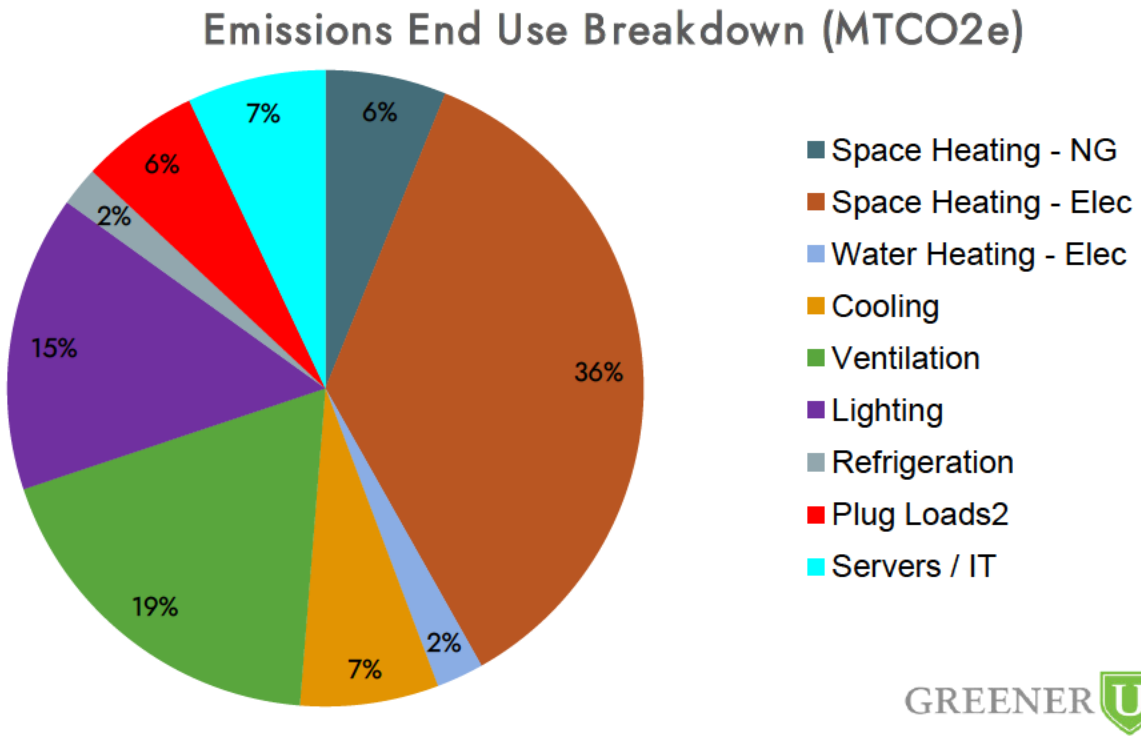
END USE BREAKDOWN AND BASELINING

The table below shows the estimated energy and emissions end use breakdown. The table also compares the energy use to buildings of a similar type in the New England areas. **As you can see in the table below, [redacted] energy use is 147% more than a comparable building.**

	[redacted]					Benchmarking[1]	
End Use Category	**Energy Use**	**% Energy Use**	**Energy Use Intensity**	**Annual Emissions**	**Emissions Intensity**	**Energy Use**	**Energy Use Intensity**
	kBtu/yr	%	kBtu/ft2	kgCO2e	kgCO2e/ft2	kBtu/yr	kBtu/ft2
Space Heating - NG	142,900	7%	5.9	7,589	0.32	736,614	30.6
Space Heating - Elec	772,237	36%	32.1	44,005	1.83		
Water Heating - Elec	52,169	2%	2.2	2,973	0.12		
Cooling	152,161	7%	6.3	8,671	0.36	31,097	1.3
Ventilation	402,139	19%	16.7	22,915	0.95	274,645	11.4
Lighting	326,058	15%	13.5	18,580	0.77	273,663	11.4
Refrigeration	43,474	2%	1.8	2,477	0.10	112,725	4.7
Plug Loads[2]	130,423	6%	5.4	7,432	0.31	9,629	0.4
Servers / IT	152,161	7%	6.3	8,671	0.36	13,256	0.6
Total	**2,173,722**	**100%**	**90.3**	**123,313**	**5.12**	**1,479,657**	**61.5**

1: Benchmarking data comes from the Commercial Building Energy Consumption Survey (CBECS), the results in this table are based on similar building type normalized to the New England region

2: Plug loads is the energy consumed at the outlets in the building by occupants. These are things such as computers, monitors, phone chargers, etc.



SOLUTIONS - ECMs

The table below shows the potential energy conservation measures (ECMs) that could be implemented at [redacted]. ECMs are measures that can be performed to reduce the building's energy consumption by modifying operation of existing equipment, adding supplemental pieces of equipment that conserve energy or improving the building envelope and insulation.

The measures are based on observations and information gathered during our site walkthrough. Each of the measures presented below has been developed to "concept level." Additional steps would need to be taken to fully develop the measure and have them ready for implementation.

Energy Conservation Measures Overview		
Measure Number	**Measure Scope**	**Next Steps**
ECM-1	• Add a building automation system (BAS) to control equipment • Add static pressure control of air handlers • Add outside air temperature-based discharge air temperature setback	None*
ECM-2	• Turn off the unit heaters (UH) that heat the ceiling plenum on the 3rd floor for freeze protection on the sprinkler system • Add appropriate levels of insulation on the roof/ceiling plenum to prevent frost concerns • Modify control strategies of the UHs to shut them off when not needed	Insulation proposal
ECM-3	• Modify the existing discharge air temperature setback to shift the heating load more to the air handlers - this results in a more efficient heating source.	Further control sequence development + control proposal
ECM-4	• Install occupancy sensors to adjust settings for the spaces served by RTU-2 and RTU-3. • These spaces include a large conference room and a sensor-based area on the 1st floor with occasional use. • The plan is to reduce airflow and temperature settings when the spaces are not in use.	Further control sequence development + control proposal
ECM-5	• Install energy recovery ventilators (ERVs) on RTU-1, RTU-2 and RTU-3 • The ERVs will recovery energy (heat during cold weather and cooling during warm weather) from exhaust sources • This will effectively offset some of the mechanical heating and cooling load at each RTU	Engineering + equipment selection

* This measure was implemented in January 2025, it is included in this analysis to show the potential energy savings and how they impact the emissions targets

SOLUTIONS - DECARBONIZATION

The table below gives a summary of the work needed to decarbonize the building. This work will replace fuel powered equipment with electric alternatives or add renewable energy sources. It assumes that by 2050, the electric grid will be decarbonized, meaning the electricity we buy should have zero emissions.

The information presented below represents one path to electrification. Based on our experience, the path presented below will provide an economical, feasible and efficient building. The decarbonization overview presented below is a high-level summary - a full engineering design effort is needed to properly size and select equipment for decarbonization.

Electrification and Decarbonization Overview		
Category of Work	**Primary systems**	**Zone level systems**
Electric upgrades	Based on preliminary review, the electric service should be sufficient for electrification*	New circuits and/or panels dedicated for heat pumps
Heating systems	Replace gas fired roof top units with air source heat pumps	No work expected - zone level systems are currently heated with electric resistance
Cooling systems	Replace direct expansion roof top units cooling with air source heat pumps	No work expected - zone level systems can cool with VAV airflow control
Domestic hot water	No work expected - domestic hot water heating is already electric.	n/a
Onsite renewable generation	Space for canopy solar array on top of existing parking lot	n/a
*This is based upon preliminary review and needs to be confirmed when equipment is sized and selected.		

ENERGY CONSERVATION MEASURES

The table below summarizes the economic impacts of the potential energy conservation measures (ECMs) that are included as part of the zero over time plan. The following page presents a similar table with the decarbonization impacts.

The Projected Implementation Years shown below are suggested to help the building comply with BERDO emissions limits. The key takeaways from this table are:

- If the measures are implemented as planned, the facility is projected to comply with BERDO emissions limits **until 2040**
- The payback for these projects are expected to be **between 5 and 7 years**.
- This payback does not include avoided ACP payments that would be incurred if the work is not done. In other words, if the upgrades are not made, ACP payments will be needed to stay in compliance with BERDO starting in 2030

Energy Conservation Measures (ECM) Emissions Impact

Measure Number	Measure Description	Electric Energy Savings	Natural Gas Energy Savings	Avoided Energy Costs	Projected Implementation Year	Emissions Savings[1]	Projected Emissions After ECM[1]	Projected Emissions Intensity After ECM	Over or Under Emissions Limit During Implementation Year
		kWh	therms	$/yr	yr	kgCO2e/yr	kgCO2e/ft^2	kgCO2e/ft^2	
ECM-1	BAS Controls	18,000	70	$6,214	2025	3,871	115,591	4.8	Under
ECM-2	UH Control + Insulation	33,000	0	$11,136	2027	6,416	91,491	3.8	Under
ECM-3	RTU DA-T Setback	18,000	-70	$5,934	2027	3,128	88,363	3.7	Under
ECM-4	Occupancy Setbacks for RTU-2 and RTU-3	29,000	70	$9,926	2027	6,010	82,353	3.4	Under
ECM-5	Add ERVs on RTUs	8,000	275	$3,250	2027	3,016	79,337	3.3	Under
Total		**106,000**	**345**	**$36,460**		**22,442**			

	Baseline	After ECMs	% Savings
Electric Use (kWh)	595,200	489,200	17.8%
Natural Gas Use (therms)	1,429	1,084	24.1%
Energy Use Intensity (kBtu/ft^2)	90.3	73.8	18.2%
Emissions Intensity[2] (kgCO2e/ft^2)	5.1	3.3	35.7%

Total Range of Expected Implementation Costs:
$200,000 - $250,000

Estimated Range of Simple Paybacks:
5 - 7 years

1: Based on the projected emissions factors during year of implementation
2: This is the emissions in 2027 after all ECMs have been implemented

ENERGY CONSERVATION MEASURES

The table below summarizes the economic impacts of the potential decarbonization measures.

The implementation year shown below was determined based upon the expected end of life of the equipment and to comply with the BERDO emissions limit. Note the following key takeaways:

- The equipment to be replaced was installed in 2021 and will be approaching the end of life in 2040. Therefore, the work shown in the table below is expected to be an **end-of-life upgrade** to air source heat pumps.
- The heat pump conversion shown in the table below will completely **remove all onsite fossil fuel burning equipment** from the building (all natural gas will be removed). This means the sole source of emissions will be from the grid purchased electricity.
- If the measures are implemented as planned, the facility is projected to comply with BERDO emissions limits **until 2050.**

Electrification and Decarbonization Economic Impact

Measure Name	Description of Work	Elec Energy Savings	Natural Gas Energy Savings	Avoided Energy Costs[1]	Avoided Alternative Compliance Payments	Projected Implementation Year	Emissions Savings[2]	Opinion of Probable Cost[3]
		kWh	therms	$/yr	$/yr	yr	kgCO2e/yr	$
DECARB-1	Convert RTUs to Air Source Heat Pumps	-14,000	1,084	$1,672	$1,650	2040	8,334	~$600,000
Total		**-14,000**	**1,084**	**$1,672**	**$1,650**		**8,334**	**~$600,000**

	Baseline	After Decarb	% Savings
Electric Use (kWh)	489,200	503,200	-2.9%
Natural Gas Use (therms)	1,084	0	100.0%
2040 Emissions (kgCO2e)	44,055	35,721	18.9%
2040 Emission Intensity (kgCO2e/ft²)	1.83	1.48	18.9%
Energy Use Intensity (kBtu/ft2)	73.8	71.3	3.4%

Projected Emissions Intensity After Decarb Measure	1.48
BERDO Emissions Limit in 2040	1.60
Over/Under BERDO Limit	Under

1: Based on projected 200 natural gas and electricity rates
2: Based on 2040 natural gas and electricity emissions factors
3: The costs presented here are the total projected cost to complete this project. Note that the equipment will be nearing the end of its useful life should be considered an end-of-life replacement

PROJECT FINANCING

Decarbonization and energy efficiency projects can require creative funding strategies. Below is an overview of some basic approaches to funding projects.

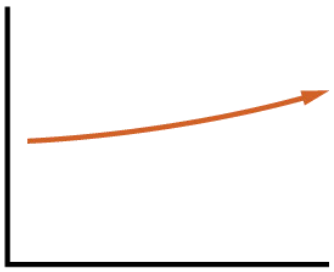
FUNDING METHOD	PROS	CONS
SELF-FUNDING		
Budget allocation - Incorporating energy project spending into annual budgets	-No interest payments -Institution can realize full potential of energy savings immediately (IF funds can be secured immediately)	-Projects may require a large capital outlay (first costs) -Can take years to secure budget allocation for projects
Fundraising - Asking for donations to fund specific projects		
DEBT		
Leases - Simple financing secured by a lien that gets cancelled at the end of the finance term	-Multiple vehicles (loans, leases and performance contracts) -Provides needed capital sooner -Can be structured as cash flow positive	-Counts against institution's total debt capacity (on balance sheet) -Costs of financing can vary
Loans - Unsecured through a lender such as a bank (loan), or through investors with collateral (bond)		
C-PACE - Secured as a lien against the property		
Performance contracts - paid through guaranteed energy/financial savings		
SERVICE AGREEMENTS		
Power Purchase Agreement (PPA) –Offering space to a developer for a renewable energy system and buying power at a fixed rate	-Traditionally used for solar, but also available for energy efficiency measures -Leverages tax incentives, even for tax-exempt hosts -Treated as operating expense (off balance sheet)	-Possibly more expensive borrowing than traditional loans/leases
Energy service agreements – Service agreement to purchase units of energy savings		

TOTAL COST OF OWNERSHIP

What is "Total Cost of Ownership"?
The total cost of ownership represents the net present value (NPV) of all energy- and emissions-related costs associated with owning and operating the property. This includes both one-time project costs (capital costs) and ongoing or recurring expenses like utilities (operating costs). Costs included in our model are:

- Energy costs (gas and electricity)
- Capital costs for projects and equipment replacements
- Alternative compliance payments

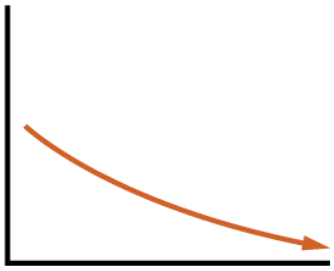
The lifetime cost savings compared to BAU shown below represents the total cost savings across the 25-year period modeled. This shows the amount of money in today's dollars that would be saved if the zero over time plan was implemented as proposed in this report.



BUSINESS AS USUAL

Business as Usual: this represents the NPV if the energy use remains the same and equipment is replaced in kind as it fails.

Total cost of ownership
(2025 – 2050)
$4,598,732

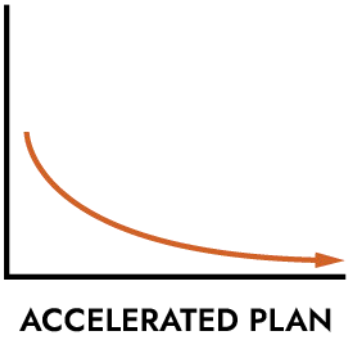


ZERO OVER TIME

Zero over time: this represents the NPV for implementing the ZOT plan described in this report.

Total cost of ownership
(2025 – 2050)
$4,093,401

Lifetime Cost Savings Compared to BAU
$505,330



ACCELERATED PLAN

Accelerated Plan: this represents the NPV for implementing all the recommended actions immediately.

Total cost of ownership
(2025 – 2050)
$4,318,618

Lifetime Cost Savings Compared to BAU
$280,114

NEXT STEPS

As you see in the chart below, we are recommending more immediate action on four sets of energy conservation measures (ECM2-ECM5), which help with both short-term BERDO compliance and immediate energy savings. We recommend waiting to move forward with the longer-term and more expensive fuel-switching decarbonization work until as late as 2040, to better time this investment with your equipment's end-of-life. While we listed the year 2027 for the more immediate work, it is wise to start talking about these projects now as it may take time to secure funding and consensus to make these investments, and because acting early will allow for earlier and greater energy savings.

All Measures Economic Impact

Measure Number	Measure Description	Avoided Energy Cost + ACPs	Projected Implementation Year	Budgetary Total Cost[1]	Simple Payback Before Incentive	Potential Utility Incentive	Net Cost	Simple Payback After Incentive
		$/yr	yr	$	yrs	$	$	yrs
ECM-1	BAS Controls	$6,214	2025					
ECM-2	UH Control + Insulation	$11,136	2027					
ECM-3	RTU DA-T Setback	$5,934	2027	$250,000	6.9	$27,000	$223,000	6.1
ECM-4	Occupancy Setbacks for RTU-2 and RTU-3	$9,926	2027					
ECM-5	Add ERVs on RTUs	$3,250	2027					
DECARB-1	Convert RTUs to Air Source Heat Pumps[2]	$3,322	2040	$600,000	180.6	$150,000	$450,000	135.5
Total		**$39,782**		**$850,000**	**21.4**	**$177.000**	**$673,000**	**16.9**

1: The projected costsfor the ECMs are shown as a package because of the unknown of the full scope of the measures. The final costs on a per measure basis will be determined during the next phase of measure development as discussed below.
2: This measure assumes the equipment is at its end of life and therefore the measure should not be considered in terms of simple payback. The simple payback is shown for informative purposes only.

Recommended Next Steps:

- ECM-1: None, this has been implemented by [redacted]
- ECM-2: Request a proposal from an insulation contractor – GreenerU can facilitate this
- ECM-3: Engineering development and implementation scope development – GreenerU can perform this work
- ECM-4: Engineering development and implementation scope development – GreenerU can perform this work
- ECM-5: Engineering development and implementation scope development – GreenerU can perform this work
- DECARB-1: Long-term planning for end-of-life replacements – GreenerU can perform this work and assist in planning

For more information, questions, or discussion of next steps, contact craig.a@greeneru.com

GLOSSARY OF TERMS

ACP	Alternative compliance payment – means of complying with BERDO by paying $234 for every metric ton of CO2e the building is above it's emissions limit. This payment goes into the City's Equitable Emissions Investment Fund.
ASHP	Air Source Heat Pump – an all electric (no fossil fuels used at site) solution for heating and cooling where heat is transferred to the air. Generally, less efficient than a Ground Source Heat Pump.
BAS	Building automation system – the system that controls and manages the building HVAC equipment
BAU	Business as usual
BTU	British thermal unit (energy) – unit of energy typically used to measure the amount of heat used
DX	Direct expansion – a means of air conditioning in mechanical equipment
ECM	Energy Conservation Measures
GSHP	Ground Source Heat Pump - an all electric (no fossil fuels used at site) solution for heating and cooling where heat is transferred to the ground. Generally, more efficient than an Air Source Heat Pump.
kWh	kilowatt-hour (unit of electric energy) – typically used to measure electric use in a building
kgCO2e	Kilogram of CO2-equivalent – this is the primary measurement of emissions in this report and BERDO
MTCO2e	Metric ton of CO2-equivalent – 1,000 kgCO2e = 1 MTCO2e
RTU	Rooftop unit – mechanical equipment located on the roof that delivers air to the building
VAV	Variable air volume – mechanical equipment located within spaces that regulates air to different zones in the building
ZOT	Zero over time (plan) - a clear plan to reduce a building's greenhouse gas emissions over time, comply with BERDO, and reach net-zero emissions by 2050. It considers budget, the building's energy use, its condition, and the age of equipment, while making improvements over time to lower energy use, add renewable energy, and replace old equipment with more efficient options over time.