Town Of Truro – Public Safety Facility

Climate Leader Communities

Decarbonization Roadmap Report

344 RTE-6, Truro MA

Prepared on November 8th, 2024

Hossam Mahmoud & Julian Joffe
HMahmoud@theRISEgroupinc.com; JJoffe@theRISEgroupinc.com

Contents

Contacts

Facility / Project Location			
Truro Public Safety Building 344 Route 6 Truro, Massachusetts 02666			
Program Administrator Representative(s)			
Laura Selmer	Energy Efficiency Analyst	Cape Light Compact	(508) 375-6644 Laura.Selmer@Capelightcompact.org
RISE Engineering			
Hossam Mahmoud	Senior Energy Engineer	RISE	(774) 994-7269 HMahmoud@theRISEgroupinc.com
Julian Joffe	Senior Energy Engineer	RISE	(401) 230-7464 JJoffe@theRISEgroupinc.com
Site Contact(s)			
Jarrod Cabral	Director – Dept. Of Public Works	Town of Truro	(508) 214-0400 jcabral@truro-ma.gov

Executive Summary

Overview

Cape Light Compact has retained RISE to evaluate the energy consumption and a potential decarbonization pathway that includes standard efficiency, load reduction, and electrification measures for multiple buildings owned and operated by the Town of Truro, MA. The intent of this review is to summarize and benchmark the site's existing energy consumption with respect to the policies set forth by the Massachusetts Department of Energy Resources (DOER) and to create a Municipal Decarbonization Roadmap to meet 2030 and 2050 net-zero goals. These measures will help offset the site's reliance on fossil fuels, improve efficiency levels, and move toward the town's overall decarbonization goals. All costs, savings, and incentives[1] are representative of findings observed on site.

The efficiency measures listed within this report as energy conservation measures (ECMs) will decrease the site's energy consumption and support the decarbonization pathway. Further measures such as load reduction, renewables, and electrification, will also support the reduction of on-site fossil fuels and grid-based energy consumption. Incentives and tax credits may be available to help defer the cost of implementation. These tax credits and incentives are subject to change based on programs sponsored by the government, the utilities, or other parties involved in determining eligibility. The energy savings and project costs presented below are based on preliminary data and are subject to change pending confirmation of existing conditions and formal proposals being developed for the identified energy efficiency measures. The building management team is interested in pursuing electrification measures to reduce emissions and operating costs while maintaining or increasing occupant comfort within the space(s).

This report details potential decarbonization measures found at the Town Public Safety in Truro, Massachusetts.

Summary of Findings

Year	EUI (kBtu/sf/yr)	CEI (MTCO2e/sf/yr)
2022	86.8	0.0020
Current (2023 Usage)	76.0	0.0013
2030 Target	65.1	0.0013
2030 Projected	46.2	0.0000

Table 1: EUI & CEI Summary (Target Values Based on a 25% EUI and 35% CEI Reduction from 2022 Consumption Values)

[1] Further site review may be necessary to develop final incentive approval.

Measure Type	Estimated Electric Savings (kWh)	Estimate Propane Savings (Gallons)	Savings ($)	Incentive ($)	Net Cost ($)
Weather Stripping	-	87	$305	-	$945
DHW Heat Pump	(1,909)	283	$571	$2,200	$5,800
Electrification HVAC	(18,022)	3,223	$7,316	$125,000	$625,000
Solar	46,024	-	$10,125	$30,510	$71,190
TOTAL:	**26,093**	**3,593**	**$18,317**	**$157,710**	**$702,935**

Table 2: Measures, Savings, and Cost Summary

Cost Savings are based on the estimated cost $0.22/kWh for electricity and $3.50/Gallon for propane.

Efficiency Measures	Load Reduction Measures	Electrification Measures	Renewables

Facility Overview

General Facility Information

Building Use

The Truro Public Safety building was constructed in 1996. There have been a variety of efficiency and site improvement projects over the years including the most recent replacement of windows and building exterior wall insulation in 2023. Some heat pump units have also been added over the years. The core use of this building is devoted to the Truro community to be used as a headquarters for the police, fire, and emergency management departments. The space is comprised of various areas which includes a dispatch area, offices, open truck bays, holding cells, a small gym, and other areas typically seen at police and fire department buildings. Based on the nature of the facility, the building is occupied 24/7 although any visitors are restricted between the hours of 9AM-3PM, 7 days per week.

Gross Floor Area

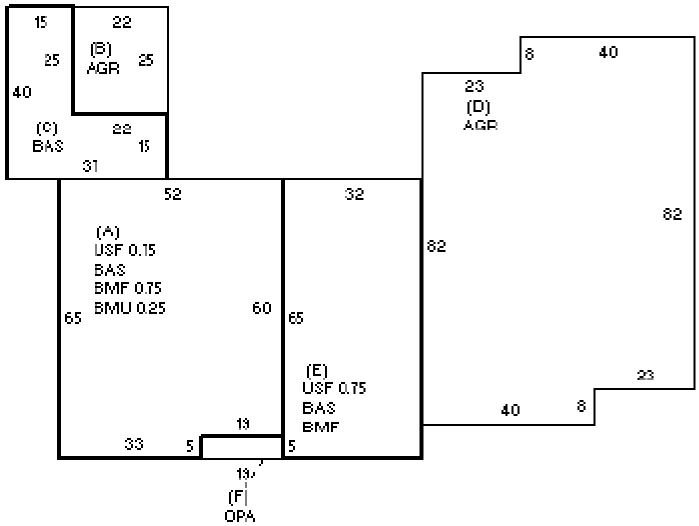
Below is a summary of the building areas which notes the size of each floor and size of the space occupied:

Area Description	Floor Area
Full Building	21,536 Square Feet
1st Floor	6,295 Square Feet
2nd Floor	4,024 Square Feet
Basement	5,365 Square Feet
Garage	5,852 Square Feet

Table 3: Floor Area & Square Footage

Building Overview

Year of Construction:	1996
Number of Stories:	1
Structure Material:	Wood Frame
Building Type:	Police/Fire station
Conditioned Floor Area:	21,536 sq. ft.



General Conditions of Facility

This facility is in very good condition and operates sufficiently for the type of occupancy. The recent and significant upgrades to the building envelope improve the overall efficiency of the site and is a supportive step to future energy reduction goals. The recent upgrades to the envelope comply with and exceed IECC 2021 requirements. The assessed spaces were all already converted to LED. The roof is shingled and in good condition although the exact age is unknown. The foundation is concrete. The flooring is a mix of carpet, tile, and concrete. Some exterior doors have end-of-life weatherstripping that can be repaired. There are no renewables on-site. There are two buried propane tanks serving the HVAC system.

System	Condition	Approximate Age	Useful Life (years)	Remaining Life (years)
HVAC – Boilers	Good	13	25	12
HVAC – AC Spit Systems	Fair	Varies	18	-
HVAC – Mini Split HPs	Fair	Varies	18	-
DHW	Good	8	13	5
Windows	Very Good	1	20+	20+
Envelope	Very Good	1	20+	20+
Lighting Systems	Good	5	10	5
Renewable Energy Systems	N/A	-	-	-

Table 4: Facility and System Conditions

Site Summary

The Truro Public Safety was built in 1996 and serves the Truro community. The site relies on electricity and propane to operate. However, to align with the local and state electrification goals there will be measures that will need to be implemented to net-zero carbon-based fuel emissions by the year 2050.

System	Description
Building Enclosure	The building is a wood framed building that was built in 1996. The recent building envelope upgrades meet IECC 2021 thermal resistance values for siding, exterior wall, and fenestrations. Attic and basement insulation R-values meet the MA building code during the time of design. Roof insulation was visible in the rafters and appear to be fiberglass batts. The building envelope appears to be mostly in good condition. However, the weather-stripping around a few exterior doors was noted to be worn out. The building has operable double hung double pane windows that are known to be brand new and in very good condition featuring low-E glass with U-values that exceed building code requirements.
Electrical Infrastructure	The main distribution panel is rated for 600A. There are several sub-panels providing downstream service to HVAC equipment, lighting, and plug loads. A 600A transfer switch located in the main electrical room provides the necessary operation to power the facility with the backup generator. Before implementing full electrification, further study into the capacity and loading constraints on the existing electrical infrastructure will be required.
Carbon-Based Fuel Sources	There is one underground propane tank fueling the gas-fired condensing boilers and the kitchen equipment. There is a 125kW diesel backup generator on site. There is no other carbon-based fuel source used on-site.
Lighting Systems	The lighting fixtures within the space consists of LED Fixtures. Office spaces are controlled by occupancy sensors. Exterior lighting is all LED.
HVAC	The HVAC system at this facility is comprised of (3) AC split systems with hydronic coils that provide heating, cooling, and ventilation. The split system unit that served the living quarters has been decommissioned in which there are now (2) 12 kBtu Ductless Mitsubishi heat pumps used to provide heating and cooling. Working areas and garage spaces are heated by hydronic Fan Coil Units (FCU). Supplemental perimeter zone heating is provided by fin tube radiation. The hydronic heating is provided by (2) 150 MBH condensing boilers and (1) 1/8 HP single-speed circulation pump, (2) 3/4 HP two-speed pumps, and one 1/15 HP single-speed pump that supplies the DHW tank. There are (2) 5 Ton and (1) 1.5 Ton outdoor AC condensers that are located outside the building perimeter and connect to the three AHUs to provide cooling.
Domestic Hot Water	The domestic hot water load is provided by (1) 80 gallons indirect tank that is fed by the two Alpine condensing boilers.

Building Controls	There is no central BMS system but all AHUs and main space temperature set points are controlled by stand-alone DDC thermostats. The boilers are controlled using their standalone on-board controls.
Renewable Energy Systems	There are no existing renewable energy systems on-site. There is a sloped roof section facing south above the garage space which appears to be suitable for solar that can significantly off-set the sites grid-based electric consumption.
EV-Charging	There are no electric vehicle charging stations on-site. However, the town will be required to reduce fossil fuel consumption for its fleet, and it is therefore recommended to add charging stations ahead of the conversion of fleet vehicles from internal combustion to electric.

Table 5: Description of Systems

Energy Use Overview

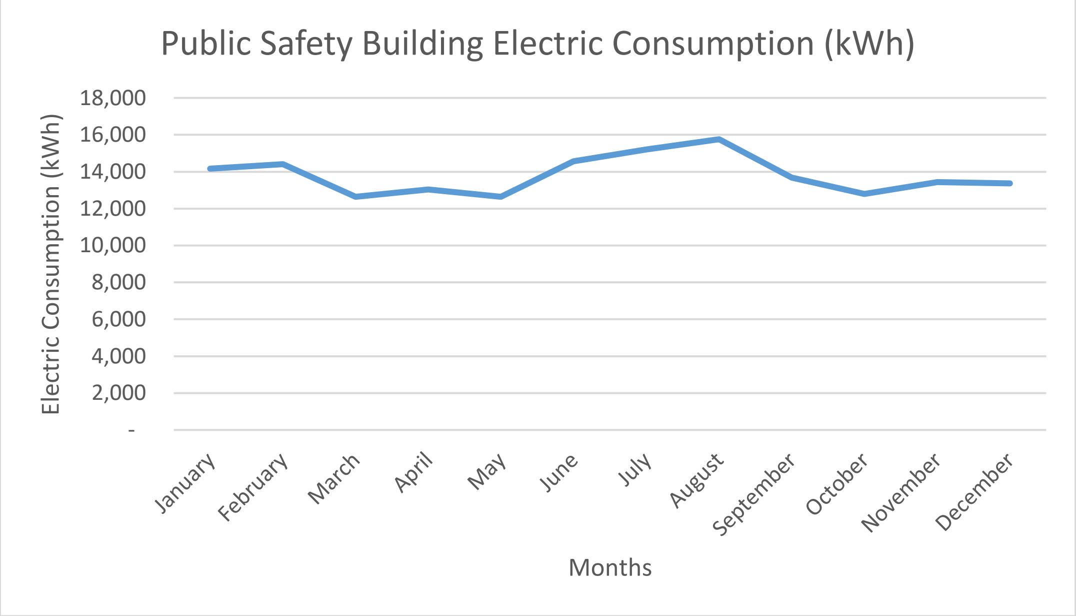
Electricity Consumption

The site has one electric account, Acct# 16004490021 that serves the entire facility. There is one electric meter (Meter# 5089945) feeding the 600A, 208/120V main distribution panel to energize the facilities sub-panels and downstream loads. The facility utilizes a gas-powered generator capable of providing backup power to a transfer switch.

Normalized Electric Usage

Month	2022 Electricity Consumption (kWh)	2023 Electricity Consumption (kWh)	Normalized Electricity Consumption (kWh)
January	14,160	13,920	14,108
February	14,400	13,680	14,515
March	12,640	12,160	12,640
April	13,040	12,880	13,120
May	12,640	12,240	12,640
June	14,560	13,840	12,720
July	15,200	15,920	12,720
August	15,760	15,840	12,720
September	13,680	15,600	13,821
October	12,800	14,400	12,814
November	13,440	14,240	13,671
December	13,360	14,160	13,484
Totals:	**165,680**	**168,880**	**158,973**

Table 6: Electricity Usage (2022 Usage, 2023 Usage, & Weather Normalized to Represent an Average Year)



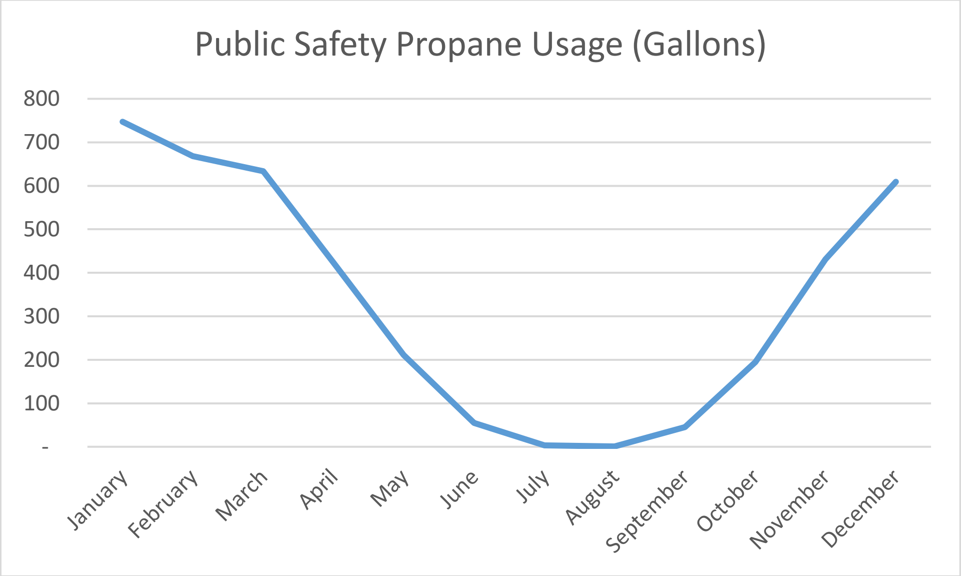
Deliverable Fuel Consumption (Propane & Diesel)

The utilizes propane for the hydronic boiler heating system. There is an on-site backup generator but there is no reported diesel usage.

Normalized Propane Usage

Month	2022 Propane Consumption (Gallons)	2023 Propane Consumption (Gallons)	Normalized Propane Consumption (Gallons)
January	774	360	747
February	627	375	668
March	545	347	634
April	343	210	423
May	191	119	211
June	51	32	55
July	3	-	3
August	1	1	1
September	43	6	45
October	169	73	195
November	332	301	431
December	514	437	610
Totals:	**3,593**	**2,260**	**4,023**

Table 7: Propane Usage (2022 Usage, 2023 Usage, & Weather Normalized to Represent an Average Year)



Energy Usage & Carbon Emissions Benchmarking

Energy Usage Intensity (EUI)

Energy Usage Intensity measures how much energy a facility uses with respect to its size. Based on the noted square footage and the available utility consumption data, the Truro Public Safety had an EUI of approximately 86.8 kBtu/Sqft/yr in 2022 which is above the national median reference value of 63.5 kBtu/Sqft/yr reported for "Public Services Fire & Police Stations" by Energy Star Portfolio Manager Data. Although this value is higher than the reference value, 2023 envelope upgrades were performed and there is the expectation that the facility will operate at a higher level moving forward.

https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf

Carbon Emissions Index (CEI)

Benchmarking the carbon emissions of any facility begins with identifying the quantity and types of the fuels used to operate a facility. Organizations such as local, state, and federal governments continue to implement regulatory compliance policies requiring carbon emissions of buildings to be calculated and benchmarked against ordinance defined emission limits.

For Climate Leader Communities in the state of Massachusetts, the carbon emissions index is a measure of Metric Tons (MT) of CO2e/sf/yr which accounts for the different carbon emissions values of each unit of fuel type considered. Based on the noted square footage of the facility and the quantities used of each fuel type, this facility has a CEI of 0.0013 MTCO2e/sf/yr. The only on-site fossil fuel use reported at this site is propane. Although the generator requires diesel there is no available or reported usage. The target carbon emissions reduction percentage is based on the total emissions from on-site fossil fuels.

EUI & CEI Benchmarking

The Climate Leader Communities program in Massachusetts requires the use of a greenhouse gas emission baseline in Metric Tons of CO2. This report utilizes DOER's MassEnergyInsight (MEI) data provided by Cape Light Compact. As noted in the table below, the decarbonization road map required by Climate Leaders lists that both emissions from onsite fossil fuels in buildings and the energy usage intensity must be reduced by the noted percentages in the noted years.

Suggested Emission Reduction Timeline

Targets	2027	2030	2040	2050
Reduce emissions from onsite fossil fuels in buildings	-20%	-35%	-60%	-100%
Zero emission vehicles (ZEVs) in light-duty fleet adoption	5%	20%	75%	100%
Zero emission vehicles (ZEVs) in medium-/heavy-duty fleet adoption	0%	20%	50%	100%
Energy Use Intensity reduction *(deep energy retrofits/retro commissioning)*	-20%	-25%	-25%	-30%
Total Emissions Reduction Goals (% of 2022 emissions)	**>15%**	**>35%**	**>65%**	**>95%**

https://www.mass.gov/doc/climate-leader-communities-municipal-decarbonization-roadmap/download#:~:text=The%202021%20Climate%20Law%2C%20statewide,reduction%20by%20calendar%20year%202030.

Public Safety - EUI				
Year	**Electricity Usage (kWh)**	**Propane Usage (Gal)**	**EUI (kBtu/sf/yr)**	**2030 EUI Compliance**
2022	165,680	3,593	86.8	-
2023	168,880	2,260	76.0	-
2030 (Projected)	139,587	-	46.2	Compliant

Table 8: EUI Benchmarking

Public Safety - CEI					
	Propane CO2e (MT/yr)	**Total CO2e (MT/yr)**	**CEI (MT/sf/yr)**	**2030 CEI Target - 35% Reduction (MT/sf/yr)**	**Compliance**
2022	20.70	20.70	0.0020	0.0013	-
2023	13.02	13.02	0.0013		-
2030 (Projected)	-	-	0.0000		Compliant

Table 9: CEI Benchmarking (2030 Projected Emissions are Based on the Implementation of the Proposed Measures)

Decarbonization Overview

The process of decarbonizing a building involves implementing measures to reduce or eliminate carbon dioxide (CO2) emissions associated with its operation. The goal is to make buildings more energy-efficient, use cleaner energy sources, and overall contribute to a lower carbon footprint. Here are key strategies for decarbonizing a building which includes Energy Efficiency (Foundational), Load Reduction, and Electrification measures.

The start to the decarbonization process takes a whole building approach similar to the energy efficiency process; the site is subject to an energy audit. Opportunities to upgrade the building envelope are identified and implemented. Here, envelope insulation and fenestration deficiencies are rectified to reduce heating and cooling loads. At this point, the site considers installing energy efficient equipment including but not limited to lighting, HVAC systems, appliances and any equipment specific to building use. The transition from fossil fuel-based heating systems to electric heat pumps for space heating and cooling needs to be considered at this part of the process. In concert, smart building technologies like controls based on occupancy or other parameters can be implemented to further reduce energy load.

Installing on-site renewable energy systems such as solar panels or wind turbines to generate clean, renewable electricity needs to be a part of the plan with the goals of electrification and decarbonization in mind. When the site's electric loads are reduced through energy efficiency and optimization, renewable energy systems like solar panels can be properly sized. Energy storage solutions to store excess energy generated by renewable sources, such as batteries, are part and parcel and will improve overall energy resilience.

Decarbonizing a building requires a holistic approach that considers both operational and embodied carbon, as well as the entire lifecycle of the structure. It often involves a combination of technological innovations, design considerations, and policy support to achieve meaningful reductions in carbon emissions.

Proposed Measures

Type	Measure Description	Implementation Difficulty	Cost Implication ($/$$/$$$)
Load Reduction Measure 1	Door Weatherstripping	Low	$
Electrification Measure 1	DHW Heat Pump	Moderate	$$
Electrification Measure 1	Air-to-Water HP Hydronic Boiler Replacement	High	$$$
Electrification Measure 2	Ducted AHU HP Units	High	$$$
Renewable Energy	Solar	High	$$$

Table 10: Proposed Emissions Reduction Measures

Efficiency Measures	Load Reduction Measures	Electrification Measures	Renewables

Efficiency & Load Reduction Measures:

The noted efficiency and load reduction strategies shown in the table above provide an overview of measures that can be explored before electrification options to immediately reduce the facility's consumption. Although some measures are more difficult to implement than others, any of these measures will either reduce the consumption to operate or will support the HVAC system by reducing envelope losses (i.e. Weatherization) and in turn, reduce the load on the HVAC system that is required to meet desired temperature setpoints.

Weatherization:

Removing gaps, cracks, and other spaces where conditioned air (heated or cooled) can be leaked is typically a low-cost option with immediate benefits to the facility. As air is leaked out or air infiltration makes its way through building fenestrations, it forces the HVAC system to make up for thermal losses and in turn, consume more energy whether it be electricity or a fossil-fuel. It is recommended to upgrade the few locations on exterior doors at this site to reduce the HVAC load and improve overall occupant comfort.

Incentives: Mass Save custom incentive for buildings over 8,000sqft.

Electrification Measures:

Replacing the gas-fired equipment via electrification with Heat Pump technology will reduce the carbon footprint of the facility. Although there may be challenges with implementation due to the nature of retrofitting new equipment to an existing system, the electrification pathway coupled with the previously noted load reduction strategies will not only support the movement away from fossil fuel, but it will also support decarbonization.

Heat Pump Domestic Hot Water Heater:

The existing domestic hot water heater is a storage water heater that is fed from the boilers. This can be replaced with a Heat Pump water heater to improve DHW efficiency and reduce the size of the proposed HVAC electrification equipment. Heat pump water heaters move heat rather than creating it and can provide efficiencies roughly three times higher than that of standard electric resistance units throughout the facility.

Incentives: Mass Save prescriptive incentives based on size of the unit (HP Water Heaters over 80 gallons may qualify for an incentive of $2,200/unit).

HVAC Electrification:

There are a variety of opportunities at this facility to electrify the heating system as well as improve the efficiency of the cooling system. It is recommended to replace the existing condensing boilers with an Air-to-Water heat pump system, and reconfigure the AHUs, so that they utilize heat pump technology. We recommend approaching HVAC electrification in two phases. Phase 1 is converting AHU 1, 2, and 3 to heat pumps since they're at the end of their useful life. The units can be replaced with new ducted heat pump systems coupled with Energy Recovery Ventilators (ERV) with CO2 sensors. The ERV will allow the system to provide MA building code required ventilation while reducing energy and; heating and cooling peak loads. The new heat pump ducted systems will be the primary source of heat.

Phase 2 will involve replacing the boiler with an air-to-water heat pump when it reaches the end of its useful life. The hydronic system will act as a supplemental source of heat to the Phase 1 ducted heat pumps. The proposed air-to-water system will need careful engineering design by an engineering professional where the existing hydronic infrastructure and distribution will be assessed for conversion. Additionally, it is recommended that the electrical infrastructure and loads are checked by a professional electrical engineer.

Incentives: Heat Pump incentives may vary depending on the current Mass Save program at the time of install but is currently $2,500/ton for qualified equipment.

Code Triggers:

OA Ventilation:

Replacing the existing systems with electrification measures will trigger the requirement for outdoor air ventilation. This can be performed by the addition of an Energy Recovery Ventilator (ERV). Not only do ERVs ensure that the proper ventilation rates are met by supplying the proper amount of fresh air to occupied spaces, but they also utilize a heat exchanger allowing for enthalpy (heat energy) within the air exhausted from the space to be re-used. Doing so enables the HVAC system to operate at higher efficiencies while meeting code requirements. An ERV in conjunction with interior CO2 sensors will allow for the system to provide the required code ventilation rate based on demand and will improve ventilation while recovering heat within the return air flow before it is exhausted improving the overall efficiency of the system.

Renewables

Solar Photovoltaic (PV) Array

Solar Photovoltaic (PV) systems harness sunlight to generate electricity, where semiconductor materials convert sunlight into direct current (DC) electricity. These systems consist of solar panels made up of interconnected solar cells, inverters to convert DC electricity into usable alternating current (AC), mounting structures, and often include energy storage solutions such as batteries for storing excess energy. Ideally in the northern hemisphere, solar panels are south facing to receive the most direct sunlight.

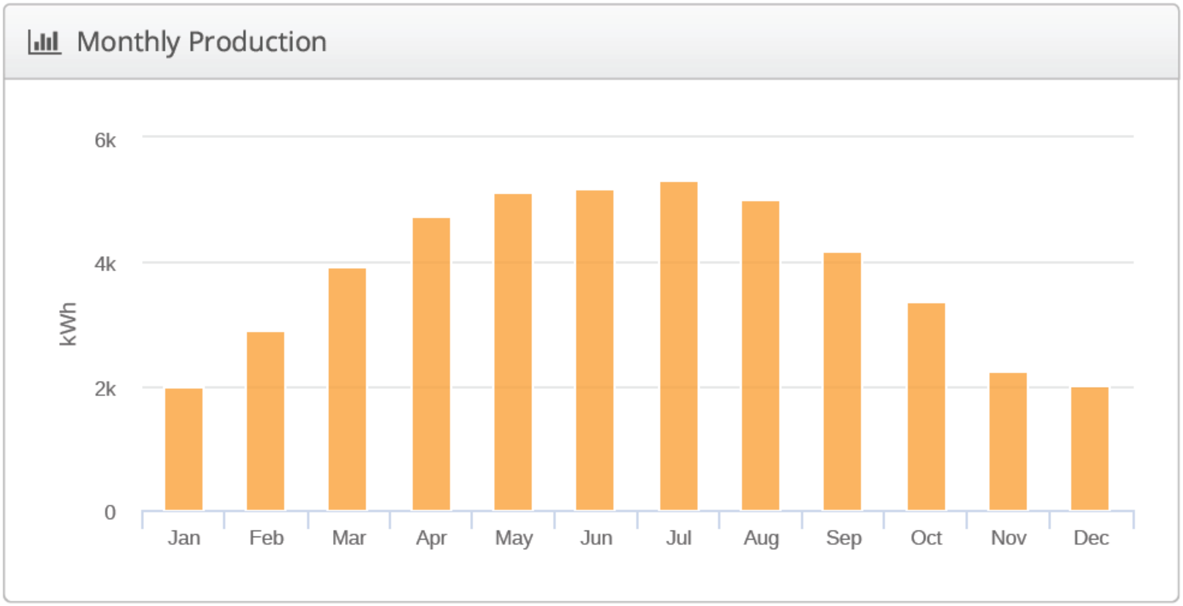
The main structure's roof has multiple sloped roof sections but based on the direction and shape of windows and perches on the second floor, the roof is not a simple gabled shape. However, there is space on the south-facing sloped section of the garage bay roof that would be suitable for solar. Other viable roof space would be shaded by trees or other parts of the structure. Solar PV modules in the north-east United States are most effective and receive the most solar irradiance when facing south-west leading to a high-performance ratio seen in the solar simulation performed for this site.

The usable roof space would not be sufficient to provide the building with all its electrical needs but any amount that can be implemented would be encouraged and would benefit the site by off-setting a portion of the annual grid-based electric consumption. As electrification measures are implemented and propane use is reduced/eliminated, the site will consume additional electricity to meet the required heating load. In this case, solar generation would significantly support the required reduction of the sites EUI and CEI. Nevertheless, the system was modeled, and a summary of results can be found below.

PV System Summary	
Module DC Nameplate	32.9 kW
Total Estimated Annual Production	46,024 kWh
Performance Ratio	85.9%
Total Estimated Cost (Est. $3/Watt Installed)	$101,700
Total Tax Credits (Est. 30% Credit, 179d)	$30,510
Total Cost Savings (Est. $0.22/kWh)	$10,125
Payback (After Tax Credits)	7.1 yrs

Table 11: Proposed PV System Summary


HelioScope


Monthly Production
6k
4k
2k
0
kWh
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Resiliency

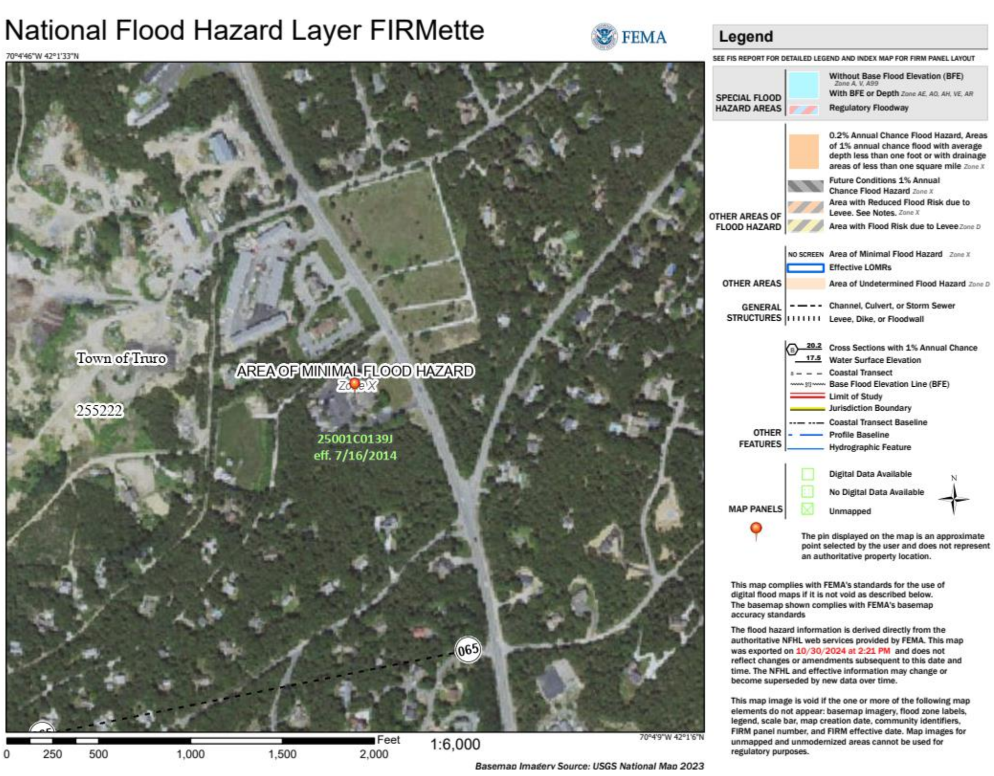
Backup Generator

A 50kW diesel backup generator is currently utilized by the facility. This generator is a crucial component to enhance and maintain reliability, resilience, and energy availability. In the event of a power outage or service disruption, the backup generator can quickly and automatically kick in, allowing the facility to operate in brief outage periods. This ensures a continuous and reliable power supply to critical loads, even during emergencies or natural disasters.

The backup generator seems to be in good condition and sufficiently sized for the site. This existing backup generator, while helpful, is still a fossil-fuel consuming piece of equipment. Further studies and development of a Solar PV system in conjunction with a battery storage system would support the facility with phasing out of fossil fuel use.

Coastal Flooding

The following depicts the National Flood Hazard FIRMette for the site location. The image below shows localized flood hazard data derived from the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps (FIRMs), which can help stakeholders identify flood risk and facilitate informed decision-making to mitigate potential risks. Based on this data, the building is in an area of minimal flood hazard. This indicates a low risk of flooding, with less than 0.2*% annual chance of flood events (500-year flood zone). Properties within this zone generally have a low probability of flood damage, and flood insurance is not typically required but may still be recommended for added protection. Incorporating flood-resistant designs and infrastructure ultimately safeguards lives and property and can reduce design costs when done in conjunction with designing for emission reduction measures.



Next Steps

It is recommended that you consider moving forward with the sustainable measures identified in this report. These measures represent a valuable opportunity to decarbonize the building while reducing energy usage and costs while leveraging available efficiency and sustainability incentives to decrease the overall implementation costs.

THREE EASY STEPS TO PARTICIPATE

- **Step #1:** Review your report with your Engineer and elect which measures to move forward with.
- **Step #2:** Sign proposal and schedule the installation of energy efficiency and microgrid improvements to ensure immediate meaningful energy savings and resiliency.
- **Step #3:** Recognize sustainable energy savings on a monthly basis!

Please be sure to contact Hossam Mahmoud, Sr. Energy Engineer at RISE engineering to take advantage of these opportunities today. I can be reached at hmahmoud@TheRISEGroupinc.com or (617)-852-5848.