410 Sheldon Street Hartford – SCOPING STUDY

Utility/Site Contacts

[redacted]
Supervisor, Facilities
Eversource Energy
[redacted]

Justin Marmaras
Principal
QGM Consulting
860-515-6331
m@qgmconsulting.com

Padraic Hagan
Senior Energy Advisor
QGM Consulting
860-634-6298
phagan@QGMconsulting.com

Austin Malik
Associate Energy Advisor
QGM Consulting
austin.malik@qgmconsulting.com

Executive Summary

QGM Consulting (Padraic Hagan, & Austin Malik) conducted an energy efficiency scoping study at an Eversource Connecticut building located at 410 Sheldon Street in Hartford, CT on Wednesday, September 25th, 2024. QGM analyzed the site's electric and natural gas use and associated Greenhouse Gas emissions. Objectives were to identify and quantify potential Energy Efficiency Measures (EEMs) for site energy reduction and estimated Greenhouse Gas reductions to meet corporate initiatives or targets.

Included in this report is a list of potential EEMs with savings and implementation cost estimates. Please note that the values presented in this report are meant to provide an order of magnitude and are not final values or guarantees for the determination of any incentives. A measure summary is provided in the table below. These are the initial measures identified during the brief walk through, additional measures may be possible with more time on site. Simple paybacks do not include potential incentives or any non-energy such as maintenance savings, labor savings, water savings, etc.

QGM - 410 Sheldon Street - Scoping Study Measure Summary								
EEM#	Energy Efficiency Measure (EEM)	Estimated Annual Cost Savings	Estimated Annual Energy and GHG Savings			Potential GHG Reduction	Estimated Project Cost	Simple Payback
#	Description	$	kWh	CCF	GHG (MT CO2e)	% Site GHG	$	years
1	BMS Upgrade - Scheduling and AOSS	$7,885	9,000	6,000	35.7	7.1%	$150,000	19.0
2	BMS Upgrade - Demand Control Ventilation	$4,728	10,000	3,000	19.4	3.9%	$50,000	10.6
3	Building Envelope	$6,642	8,000	5,000	29.9	6.0%	$50,000	7.5
4	Building Heating Electrification	n/a	(255,000)	36,000	124.2	24.8%	$750,000	n/a
TOTAL		$19,256	27,000	14,000	85.0	17%	$250,000	13.0

Note that Measure (4) – Building Heating Electrification is presented as a GHG emissions reduction measure, with minimal or no direct energy or cost savings associated.

REDACTED

General Facility Description

The site has approximately 135,000 square feet of total space in a single building originally constructed in 1928, with significant renovations in 2010. The facility includes offices/administration, garage/ repair areas, warehouse, and storage.

The facility operates a regular schedule, with typical staff occupancy Monday – Friday 6:00 AM – 6:00 PM, and occasional weekend hours. Some critical support areas were noted to have 24/7 staffing. Annual hours are estimated to be ~3,500 hours/year.

HVAC Systems Description
HVAC systems consist of roof mounted air handling units (AHUs) and 1 additional Rooftop Unit (RTU). Air is cooled via roof-mounted air-cooled chiller and heated via condensing boilers in the basement. Air delivery is via VAV boxes and a chilled beam system.

Building Management System is noted to no longer function. Replacement is planned with a new controls system.

Site Lighting Description
Site lighting has been replaced within the last few years with controls-integrated LED fixtures. Controls are programmed for motion/occupancy, dimming, and scheduling.

Site Production and CAIR Equipment Description
Site garage and repair areas contain typical hoists, air and electric tools, and powered washing equipment.

Garage utilizes a 2x7.5hp Saylor-Beall dual-piston reciprocating compressor. Compressed air is used for garage air tools and minor tank pressurization.

Monthly Billing Analysis

Historical electrical and natural gas use for the past three years is reviewed below. The site has (1) electric and (1) natural gas meter. Due to the type of site and use accounting, historical records for this site are annual use only. $0.1428/kWh was used as an electric rate based upon Eversource Facilities' third-party electric supply costs for similar type facilities.

An annual summary of the most recent year can be seen below:

Existing Building Baseline Most Recent 12 Month Total						
Energy Usage and Costs	Costs		Energy		Unit Cost ($/kWh, $/CCF)	CO2 Emitted (MT)
	Amount - $	% of Total	Amount - CCF, kWh	% of Total		
Natural Gas (CCF)	$ 39,512	21%	35,920	84%	$1.10	198
Electric Energy (kWh)	$ 148,883	79%	1,042,598	81%	$0.143	145
TOTAL	**$188,395**	**100%**		**164%**		

REDACTED

The energy use intensity (EUI) shown below calculated in kbtu/sf is an indicator of building performance in terms of energy use per building square foot:

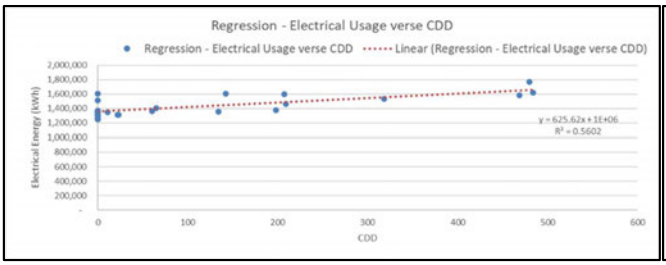
Building Energy Use Intensity (EUI)			
Utility	**Site EUI**	**Source EUI**	**Unit**
Natural Gas	36	38	kbtu/sf
Electricity	14	39	kbtu/sf
TOTAL	**50**	**77**	**kbtu/sf**

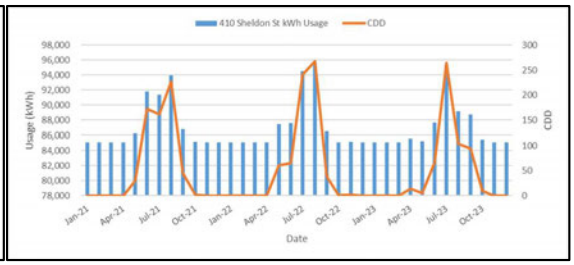
Source-site ratio per national average, source:
https://portfoliomanager.energystar.gov/pdf/reference/Source%20Energy.pdf

The EUI metric can be used to baseline existing energy use for future comparison or to compare to similar buildings, though it should be noted the EUI does not consider production levels.

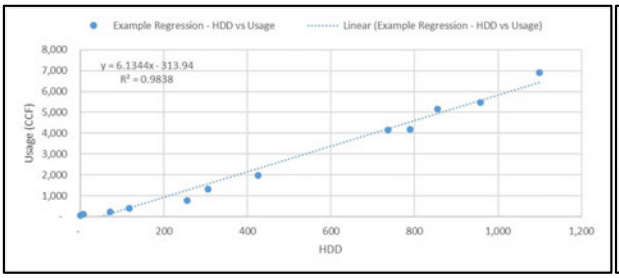
Lacking monthly use data, profiles for electricity and natural gas were modelled for this site using provided annual totals and linear regression models developed from similar sites. Regression models based on weather impact from similar buildings/operations were used to provide basic linear regression equations for heating and cooling, which were then scaled for total use and building footprint and used to estimate monthly usage. A building was selected with some garage/process electrical use to reflect the garage/repair operation at the site, as well as a significant summer cooling load. Some variability would be expected in the non-cooling season baseline use – the flat result is due to the use of a weather-impact regression equation to model use.

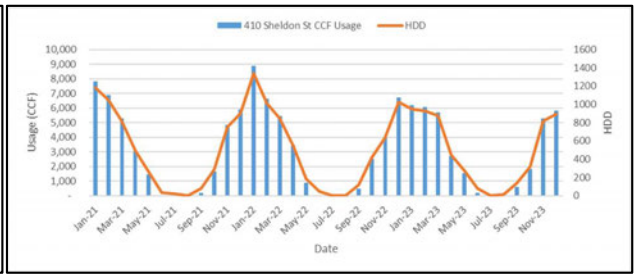
Below are graphs showing the example regression used and the resulting modeled electrical use:





Similar analysis was performed for natural gas use, as seen below:





As above, modeled use would expect to show some variability. The use of a weather-impact regression equation creates a model with a close correlation.

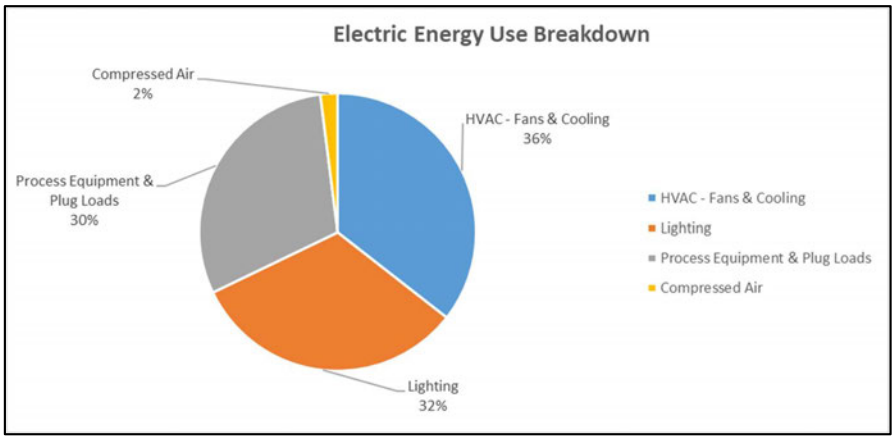
Based on these models, monthly use and estimated costs are shown in the table below:

Monthly Utility Bill Summary									
Electric					Natural Gas				
Month	CDD (Balance Point 65 °F)	Billed Energy (kWh)	Total Electric Cost	Blended Rate ($/kWh)	Month	HDD (Balance Point 65°F)	Billed Usage (CCF)	Estimated Total Cost ($)	Average Blended Rate ($/CCF)
Jan-23	-	85,067	$ 12,147	$ 0.14	Jan-23	949	6,199	$ 6,819	$ 1.10
Feb-23	-	85,067	$ 12,147	$ 0.14	Feb-23	931	6,075	$ 6,682	$ 1.10
Mar-23	-	85,067	$ 12,147	$ 0.14	Mar-23	875	5,688	$ 6,257	$ 1.10
Apr-23	14	85,615	$ 12,226	$ 0.14	Apr-23	443	2,705	$ 2,976	$ 1.10
May-23	5	85,263	$ 12,175	$ 0.14	May-23	274	1,539	$ 1,692	$ 1.10
Jun-23	66	87,654	$ 12,517	$ 0.14	Jun-23	78	185	$ 204	$ 1.10
Jul-23	264	95,418	$ 13,626	$ 0.14	Jul-23	-	-	$ -	$ -
Aug-23	104	89,144	$ 12,730	$ 0.14	Aug-23	14	-	$ -	$ -
Sep-23	94	88,752	$ 12,674	$ 0.14	Sep-23	136	586	$ 644	$ 1.10
Oct-23	9	85,419	$ 12,198	$ 0.14	Oct-23	317	1,835	$ 2,019	$ 1.10
Nov-23	-	85,067	$ 12,147	$ 0.14	Nov-23	816	5,281	$ 5,809	$ 1.10
Dec-23	-	85,067	$ 12,147	$ 0.14	Dec-23	895	5,826	$ 6,409	$ 1.10
TOTAL		**1,042,598**	**$ 148,883**	**$ 0.14**	**TOTAL**		**35,920**	**$ 39,512**	**$ 1.10**

Mechanical System Energy Use Breakdown

Based on the initial walk-through, the following electric energy use breakdown was developed. These results are considered high level at this point by using motor nameplates, typical load factors and estimated operational hours. Actual data logging is required to confirm these assumptions.

REDACTED



End Use Breakdown - Electricity	
Electric End Use	**Energy Use (kWh)**
HVAC - Fans & Cooling	371,509
Lighting	337,500
Process Equipment & Plug Loads	315,000
Compressed Air	20,888
TOTAL	**1,044,897**

HVAC Equipment:

To calculate the breakout of energy use described above, the following equipment data was used to estimate equipment loads and use (capacities estimated for units with worn nameplates):

410 Sheldon Street HVAC Equipment List										
Site ID #	**Type**	**Manufacturer**	**Model**	**Serial #**	**Fan hp**	**Fan CFM**	**Cooling capacity (Tons)**	**Heating Capacity (MBH)**	**VFD (1,0)**	**Notes**
RTU-1	RTU	Lennox	LGH060S4TM1G	5611E01394	2.5	1,147	5	84	0	EER 12.5
AHU-1	AHU	McQuay			5	10,000				
AHU-2	AHU	McQuay			5	10,000				
AHU-3	AHU	McQuay		FBOU110501200	5	10,000				
CH	Chiller	McQuay	AGZ160DHHNN-ER10	STNU110500124			160		1	VFDs on CHWPs
B-1	Boiler	Hydrotherm	KN-20	KN-H-NET-M11NB-6357				1,854	1	VFDs on HWPs
B-2	Boiler	Hydrotherm	KN-20	KN-H-NET-M11NB-6356				1,854	1	VFDs on HWPs
HW-1	HWH	Hubbell	SE-120-0-27SLR	S8576S				92		Electric
HW-2	HWH	Hubbell	SE-120-0-27SLR	S9778S				92		Electric
HW-3	HWH	Hubbell	SE-120-0-27SLR	S9776S				92		Electric
EF-2	EF	Greenheck	GB-121-5-X	12461477 1105	0.50	2,000			0	
EF-3	EF	Greenheck	CWB-141-7-x	12562546 1108	1	2,500			0	
EF-8	EF	Greenheck	GB-091-4-X	12461430 1105	0.13	1,000			0	
UH	UH							Avg. 1	0	multiple
Split	Split System	Mitsubishi Electric	PUY-A18NHA4	-			1.5	-	-	
Split	Split System	Mitsubishi Electric	PUY-A18NHA4	-			1.5	-	-	
Split	Split System	Mitsubishi Electric	PUY-A12NHA4	-			1	-	-	
Split	Split System	Mitsubishi Electric	PUY-A12NHA4	-			1	-	-	
Split	Split System	Mitsubishi Electric	PUY-A24NHA4	-			2	-	-	

Lighting Equipment:

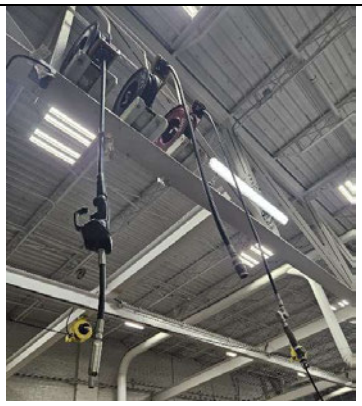
Lighting was noted to be LED, primarily modern controls-integrated fixtures, with some LED strip/TLED replacements in lower-traffic areas. Controls were noted to be commissioned and functioning. With modern lighting and programmed controls in place, no lighting measures are recommended for this site.

Compressed Air Plant:

Site current operates a 2x7.5 Saylor-Beall dual-piston reciprocating air compressor with an estimated max capacity of 65 SCFM at 100 psig. Pictures below show detail:



Garage/shop air compressor



Air end-use in garage/shop

Unit was observed to be lightly loaded. Compressed air plant was scanned via ultrasonic tool for air leaks with none found. With a lightly loaded reciprocating compressor and no detected air leaks, the site is running an efficient compressed air plant and no CAIR measures are recommended.

Best Practices

- Site was observed to be following the following energy Best Practices:LED lighting and integrated controls in most/all areas
- Condensing boilers in hot water applications
- High efficiency and well-maintained compressed air plant

Recent Energy Efficiency Projects Overview

The site has completed several energy efficient projects in recent years. Listed below are some of the various energy projects:

- Upgrade to LED Lighting and advanced motion controls
- Upgrades to energy-savings equipment on replacement

With the Best Practices and projects described above, the identification of additional energy efficiency measures (EEMs) and sustainability projects during the time of the survey was challenging. Some potential recommendations are outlined below that may require some additional analysis and monitoring.

Site Energy Efficiency Measures/Recommendations

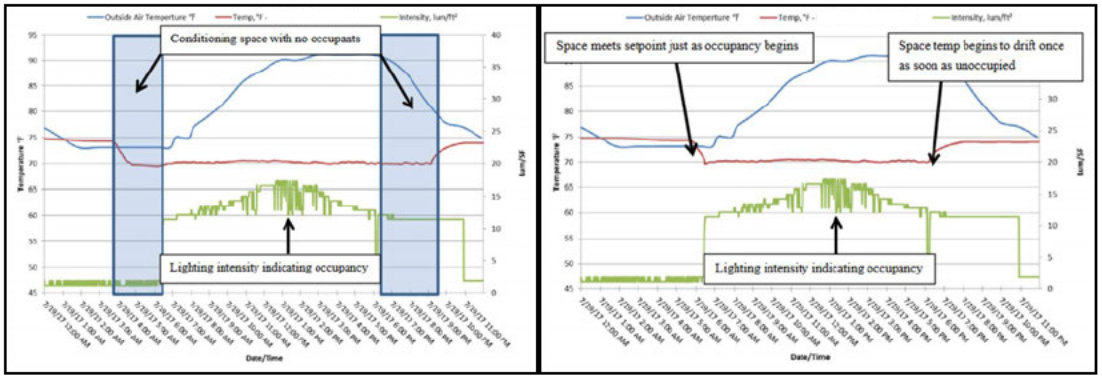
EEM – 01 – Building Management System – Scheduling and AOSS

The site currently uses an aged INet Building Management System (BMS) for all HVAC controls. The system was installed in 2012 and is understood to be failing, with limited to no capability and functionality. The site is strongly recommended to move forward with plans to replace the failing system with a new DDC, remote-access capable BMS with ability to:

- Handle detailed scheduling by area/unit – with temporary overrides and ability to revert back
- Adaptive Optimal Start-Stop (AOSS) – help building with heating/cooling schedules

Adaptive/Optimal Start/Stop (AOSS) is a control sequence available within modern Building Management Systems. AOSS allows the control system to iteratively "learn" the most optimal times to start up heating or cooling equipment so that the space is meeting setpoints just as it becomes occupied. The example below is historical data from an example building, with the blue curve representing outdoor air temperature, the red curve, space temperature, and the green series lighting intensity (indicating occupancy).

The blue rectangles highlight the unnecessarily long equipment ramp up and cool down periods in the "before" graph, while in the "after" graph with AOSS enabled, the equipment enables precisely and only when needed to meet setpoint once occupancy begins:



New BMS savings estimates below assume site would be able to:

- Effectively schedule setback or equipment shutdown hours
- Optimize scheduling and startups via AOSS

REDACTED

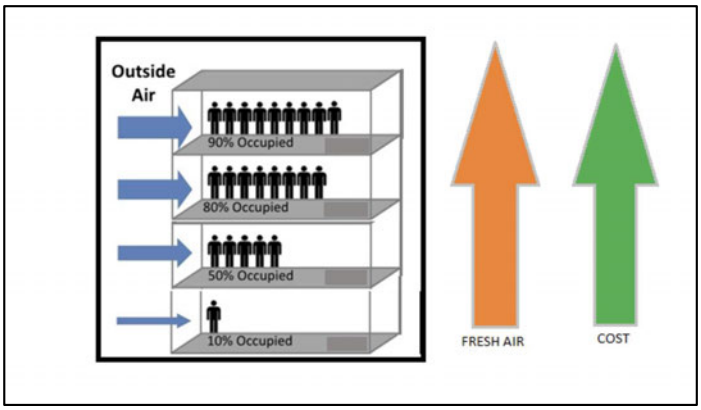
Table below shows estimated cost and savings from the installation of a new BMS:

BMS Upgrade - Scheduling & Adaptive Optimal Start Stop			
Description	**Number**	**Unit**	**Notes**
Building footprint, SF	81,900	SF	3 story offices only
Average Ceiling Ht, Ft	10	LF	Average
Estimated office volume, CF	819,000	CF	
Typical Air Change per Hour (ACH)	0.75	ACH	
Estimated Average Outdoor Air Intake, CFM	10,238	CFM	
Estimated Existing Operation			
Estimated Annual Cooling Energy	72,000	kWh	
Estimated Annual Natural Gas Heating Energy	16,000	CCF	
Estimated Annual Electric Heating Energy	-	kWh	
Proposed Operation			
Proposed Annual Cooling Energy	63,000	kWh	
Proposed Annual Natural Gas Heating Energy	10,000	CCF	
Proposed Annual Electric Heating Energy	-	kWh	
Estimated New Control Strategy Savings			
Estimated Annual Electrical Savings	9,000	kWh	
Estimated Annual Natural Gas Savings	6,000	CCF	
Estimated Annual Cost Savings	**$ 7,885**	**$**	**@$0.1428/kWh and $1.10/CCF**
Change Cost - Upgrade BMS	**$ 150,000**	**$**	
Simple Payback - no incentives	**19.0**	**yrs**	
Estimated Annual GHG Reduction	**36**	**MT CO2e**	
$/Lifetime GHG Reduction	**$ 420.42**	**$/MT CO2e**	**10 year measure life**

Recommended next steps for this project involve working with a local vendor to develop a controls scope of work and cost quotation and move forward with the installation.

EEM – 02 – Building Management System – Demand Controlled Ventilation

The site is not currently able to control the introduction of outside air with existing (failing) HVAC controls. When upgrading the BMS system, the site is recommended to consider Demand Controlled Ventilation (DCV). DCV works by modulating the outdoor air intake to only what is needed to satisfy the space occupancy. As the graphic below illustrates, a higher occupant load requires more outdoor air and higher HVAC costs, while lower (or no) occupant load requires less (or even no) outdoor air:



Demand Control Ventilation (DCV) uses CO2 sensors in the space and/or return airstream to monitor the level of CO2 in the space and modulate RTU outdoor air dampers to introduce only as much outdoor air as needed. Sites are commonly found to be introducing significant excess outdoor air, well beyond any occupant requirements – outdoor air dampers often come from the factory set at 20 – 50% without any ability to modulate.

Table below shows estimated cost and savings from the installation of DCV controls on (4) RTUs:

Consider Switching HVAC Equipment to Demand Control Ventilation			
Description	**Value**	**Unit**	**Notes**
Existing Cooling Load	63,000	kWh	3 story offices only
Existing Heating Load	10,000	CCF	
Proposed Demand Controlled Cooling Load	53,000	kWh	
Proposed Demand Controlled Heating Load	7,000	CCF	
Estimated Demand Control Savings (cooling)	10,000	kWh	
Estimated Demand Control Savings (heating)	3,000	CCF	
Annual Cost Savings	**$ 4,728**	**$**	**@ $0.1428/kWh & $1.10/CCF**
Estimated Annual GHG Reduction	19.4	MT CO2e	@ 0.0055 MT/CCF & 0.000291 MT/kWh
Estimated Cost to Upgrade	$ 50,000	$	Programming, RTU dampers/actuators
Simple Payback	**10.6**	**$**	
Estimated $/Lifetime MT CO2e	**$ 258**	**$**	**estimated 10 yr measure lifetime**

Recommended next steps for this project involve working with a local vendor to develop a controls scope of work and cost quotation, moving to implement this measure as a facet of the planned BMS upgrade/installation.

EEM – 03 – Building Envelope

The age of the building was noted during site walkthrough, as well as a recent and thorough 2012 renovation. Relatively low heating energy use indicates the structure is sound and retains heat well, and staff is active in reducing unneeded air infiltration and movement via sealing ducts and openings not in use.

However, some areas were noted where the thermal envelope could be improved – air seal deficiencies were noted in doors and garage area bay doors, and based on discussion with site staff, it is likely that building plane

transitions (e.g., roof/wall joint) have deteriorated seals simply due to building age. Pictures below detail some noted envelope deficiencies:

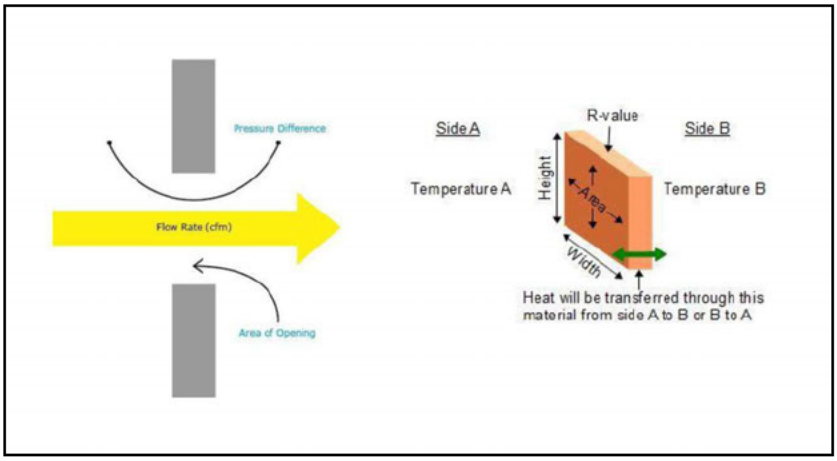


Aged window systems in the garage likely have leakage through seals



Visible daylight through door indicating air leakage

Diagram below summarizes the possible heat transfers due to infiltration and thermal envelope deficiencies:



Site is recommended to engage with a vendor to perform a full building shell assessment of the site and to follow the recommendations regarding thermal envelope and air infiltration. The table below shows a high-level estimate of potential cost and savings from this measure:

REDACTED

Building Shell Savings Calculation			
Description	**Value**	**Unit**	**Notes**
Existing Cooling Load	238,000	kWh	Whole building
Existing Heating Load	34,000	CCF	Whole building
Proposed Cooling Load	230,000	kWh	
Proposed Heating Load	29,000	CCF	
Estimated Building Shell Remediation Savings (cooling)	8,000	kWh	
Estimated Building Shell Remediation Savings (heating)	5,000	CCF	
Annual Cost Savings	**$ 6,642**	**$**	**@ $0.1428/kWh & $1.10/CCF**
Estimated Annual GHG Reduction	29.8	MT CO2e	@ 0.0055 MT/CCF & 0.000291 MT/kWh
Estimated Install Cost	$ 50,000	$	Including survey cost
Simple Payback	**7.5**	**$**	
Estimated $/Lifetime MT CO2e	**$ 112**	**$**	**estimated 15 yr measure lifetime**

Next steps involve working with a local vendor to obtain a building shell assessment and recommendations, determining path forward with regard to performing remediations, then working with a local vendor to remediate gaps and cracks.

EEM – 04 – Building Heating Electrification

Existing heating and cooling are via roof-mounted AHUs and VAV/chilled beams in the spaces. Air or water source heat pumps would likely not be a good immediate fit for this building given the recent installation of high efficiency equipment and size of the rooftop HVAC units.

Ground source heat pumps are a highly efficient method of building heating and cooling but are likely not a good fit at this location due to proximity to the Connecticut River and permitting and approval difficulties associated with drilling for ground source wells.

Existing heating is primarily through natural gas fired hot water boilers – heating electrification could potentially be achieved with the installation of electric boilers. Note that existing boilers are condensing (high efficiency) and recent installation, and at 724 MBH peak output, (2) new electric boilers would require an additional ~300 – 600A, which would likely require an additional service to the building at significant cost.

As a future means of electrification, site could consider eventual replacement of existing heating and cooling equipment with air source heat pumps. Energy and GHG emissions savings would be realized via:

- Associated site Greenhouse Gas emissions reduction the switch from natural gas to lower GHG emissions grid electricity

Additionally, this would require a switch to electricity as a heating fuel, with similar energy costs to achieve site heating than existing natural gas (increased heating efficiency/COP but also higher $/btu cost fuel).

Table below estimates costs and associated GHG reduction from electrification of all existing natural gas heating applications:

REDACTED

Convert Natural Gas Building Heating Systems to Air Source Heat Pumps			
Description	**Value**	**Unit**	**Notes**
Estimated Annual Natural Gas Heating Usage	36,000	CCF	Direct fire applications
Estimated Annual Natural Heating Gas Cost	$ 39,600	$	
Annual Associated GHG Emissions	200	MT CO2e	
Average Air Source Heat Pump COP	3.4	#	Average, COP variable based on OAT
Proposed Annual Heating Energy	255,000	kWh	
Proposed Area Heating Cost	$ 36,400	$	
Proposed Associated GHG Emissions	70.0	MT CO2e	
Estimated Annual Natural Gas Savings	36,000	CCF	
Estimated Annual Electric Savings	(255,000)	kWh	
Estimated Annual Cost Savings	$ 3,200	$	
Estimated Change Cost	$ 750,000	$	ASHPs installed
Simple Payback - no incentives	**n/a**	**yrs**	
GHG Emissions Reduction	**130**	**MT CO2e**	
Lifetime Cost per MT CO2e	**$ 288**	**$/MT**	**20 year measure life**

QGM can recommend design vendors if desired for a more precise cost and scope of work. Site is encouraged to consider all available opportunities for efficiency and conservation before heating electrification due to high costs involved.

Additional Opportunities

Occupancy Based Scheduling for Conference rooms and other lower-use areas
Discussion with site indicates that conference and meeting rooms are regularly used, thus additional scheduling or occupancy-based HVAC settings will not have a large impact on building energy use.

Site is encouraged to continue to monitor variable use areas, should utilization lower from its current state, occupancy-based scheduling for these spaces may make more sense.

Ensure proper functioning of Economizers

Estimates indicate that only about one in four economizers works properly, with the remaining three providing sub-par performance or wasting energy. A 1995 survey of commercial buildings in the U.S. shows that about 461,000 buildings have economizers assisting HVAC systems that condition more than 16 billion square feet of building space. Proper economizer operation enhances energy efficiency, reduces costs, and extends equipment life. See the following online resources for more information:

https://www.energytocare.org/system/files/media/file/2020/11/17_Perform_Economizer_Maintenance.pdf

https://www.cedengineering.com/userfiles/M02-014%20-%20Economizers%20in%20Air%20Handling%20Systems%20-%20US.pdf

Sustainability Considerations

Background

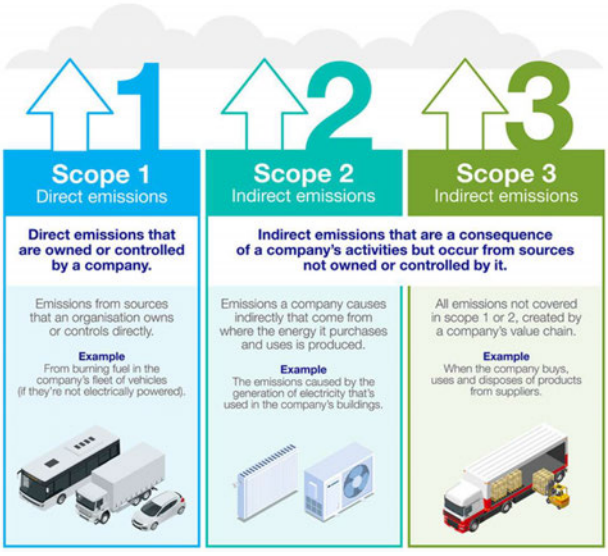
Site and portfolio sustainability is best guided by the framework and methodology set forth in ASHRAE Standard 228-2023 *Standard Method of Evaluating Zero Net Energy and Zero Net Carbon Building Performance* (available for purchase here: https://www.ashrae.org/technical-resources/bookstore/ansi-ashrae-standard-228-standard-method-of-evaluating-zero-net-energy-and-zero-net-carbon-building-performance). The site is not known to have a present net-zero strategy; however, the ASHRAE standard presents a strong method to:

- Assess current building energy use and carbon emissions
- Establish a baseline
- Develop milestones
- Develop a plan to reach milestones

The data and information shown below is intended to help develop an understanding of where current portfolio sustainability goal aligns with current position.

Emissions Scopes

Emissions reporting is generally addressed across three Emissions Scopes, as seen below:



An important aspect of developing a sustainability plan is the determination of which emissions scopes will be targeted for reduction. The majority of sustainability planning at the time of this report is focused on Scopes 1 and 2, although large corporations with significant supply and delivery chains have begun to address Scope 3 as well. The focus of the sustainability plan in this report is on Scope 1 and 2 emissions.

ASHRAE Standard 228-2023 *Standard Method of Evaluating Zero Net Energy and Zero Net Carbon Building Performance*

ASHRAE 228-2023 includes the following diagram illustrating energy flows into, from, and out of a site:

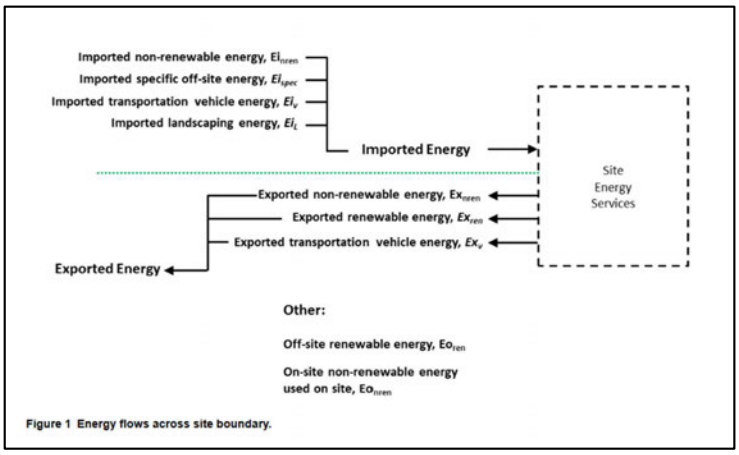


Figure 1 Energy flows across site boundary.

The difference between energy flow into a site, and energy flow out, is site net energy. The primary goal of sustainability is to reduce this net energy, and therefore, net carbon emissions associated with the site and its operation.

ASHRAE 228-2023 – examples of data gathering and forms

ASHRAE 228-2023 recommends site conduct an all-energy and associated carbon emissions accounting as seen in the tables shown below. Known values are filled in as a beginning of the process:

Form 1
General Building and Site Description

ID:	410 Sheldon St	Measurement Start Date:	9/25/2024
Address:	410 Sheldon St		
City, State, Country, ZIP Code:	Hartford, CT		
Primary Year of Construction:	1918	Secondary:	

Gross Floor Area (GFA):	140,000
Physical site area, SF:	140,000
Non-green-roof building footprint area:	70,000
Other Physical site area not requiring landscape care:	
Landscape area (LA):	

On-site renewable energy system type:		On-site renewable energy system design max output, kW:	

Compliance Type

Portion of building:	All
Building:	(1)
Part of a Commnuity? If "Yes," Community Name?	

REDACTED

Form 2
Annual Site Energy Conversion Calculation

		Energy Use Numerical Value	Units	Conversion Factor to kWh	Annual site Energy, kWh/yr
1a	Imported grid electricity	1,042,598	kWh	1	1,042,598
1b	Imported specific electricity				
2a	Imported grid natural gas	35,920	CCF	30.2	1,083,275
2b	Imported renewable natural gas				
3	Imported steam				
4	Imported hot water				
5	Imported chilled water				
6a	Imported grid fuel oil				
6b	Imported renewable fuel oil				
7a	Imported grid propane				
7b	Imported renewable propane				
8	Imported coal or other				
9	Imported biomass				
10	On-site nonrenewable energy				
11	Imported transportation vehicle energy				
12	Imported landscape energy				
13	Exported nonrenewable electricity				
14	Exported renewable electricity				
15	Exported steam				
16	Exported hot water				
17	Exported chilled water				
18	Exported other				
19	Exported transportation vehicle energy				

REDACTED

Form 3
Annual Site Energy Conversion Calculation

		Energy Use Numercial Value	Source Energy Conversion Factor	Annual Source Energy, kWh/yr
1a	Imported grid electricity	1,042,598		1,042,598
1b	Imported specific electricity			
2a	Imported grid natural gas	1,083,275		1,083,275
2b	Imported renewable natural gas			
3	Imported steam			
4	Imported hot water			
5	Imported chilled water			
6a	Imported grid fuel oil			
6b	Imported renewable fuel oil			
7a	Imported grid propane			
7b	Imported renewable propane			
8	Imported coal or other			
9	Imported biomass			
10	On-site nonrenewable energy			
11	Imported transportation vehicle energy			
12	Imported landscape energy			
13	Exported nonrenewable electricity			
14	Exported renewable electricity			
15	Exported steam			
16	Exported hot water			
17	Exported chilled water			
18	Exported other			
19	Exported transportation vehicle energy			
20	Qualified off-site renewable energy			

**Source energy factors typically available from local utilities*

REDACTED

Form 4
Annual Greenhouse Gas Emissions (GHG) Net Calculation

	nergy Form	Annual Site Energy, kWh/yr	GHG Emissions Factor, kg CO2e/kWh	Annual GHG Emissions, kg CO2e/yr
1a	Imported grid electricity	1,042,598	0.291	303,396
1b	Imported specific electricity			
2a	Imported grid natural gas	1,083,275	0.183	198,239
2b	Imported renewable natural gas			
3	Imported steam			
4	Imported hot water			
5	Imported chilled water			
6a	Imported grid fuel oil			
6b	Imported renewable fuel oil			
7a	Imported grid propane			
7b	Imported renewable propane			
8	Imported coal or other			
9	Imported biomass			
10	On-site nonrenewable energy			
11	Imported transportation vehicle energy			
12	Imported landscape energy			
13	Exported nonrenewable electricity			
14	Exported renewable electricity			
15	Exported steam			
16	Exported hot water			
17	Exported chilled water			
18	Exported other			
19	Exported transportation vehicle energy			
20	Qualified off-site renewable energy			
21	Refrigeration Loss (Form 4A)			

Annual GHG Net Emissions	501,635	**Annual GHG Net Emissions, kg CO2e**	501,635
Previous Measurement Period	none	**Previous GHG Net Emissions, kg CO2e**	none
Sum, Two-Year GHG Net Emissions	501,635	**Sum, Two-Year GHG Net Emissions kg CO2e**	501,635

**Refrigerant loss form not included as not relevant at site.*

QGM CONSULTING

REDACTED

Site sustainability team or personnel are encouraged to determine and enter applicable values. As seen above, these tables and final conversions result in an annual carbon baseline for the site.

The next step is the determination of the carbon reduction goal and the timeframe to reach it. Carbon emissions are suggested to be tracked monthly and annually along with energy use to assess the impact of reduction efforts.

Sustainability Plan

With a carbon baseline established and a goal and timeframe put in place, the next step is to develop a sustainability plan to reduce site net energy and carbon. A four-step plan, as outlined in an article from CBRE (Decarbonizing Commercial Real Estate | CBRE) and shown in the chart below, is recommended:



The table below details the four-step plan with narrative descriptions and progress to date for the target site. Note that the process is by nature to be repeated for continuous improvement and consideration of new technologies:

410 Sheldon Street Potential Sustainability Plan			
Step	Description	Progress	Notes
1	Efficiency/Conservation	50%	In process, identifying and determining measures
2	Electrify Remaining Loads	0%	Identify and electrify remaining energy loads
3	Renewable Energy Offset	50%	Onsite or purchased renewable electricity
4	Offset Remaining Loads	0%	Purchase RECs on open market, consider portfolio offsets

Step 1: Efficiency and Conservation

Identify possible efficiency and conservation measures at the target site to reduce energy use and associated carbon. This step is in progress at this site – this study has identified several possible measures for the reduction of energy use. These measures should be considered for implementation.

Step 2: Electrify Remaining Loads

Site net energy loads not able to be reduced should be considered for electrification. This step has not been addressed at the target site.

Step 3: Renewable Energy Offset

Offset of site electrical energy use via renewable energy: either generated onsite or through purchasing of renewable energy from sources such as community solar or solar farms as well as energy brokerage.

Step 4: Offset Remaining Loads

Lastly, the site may consider RECs and/or purchased carbon offsets to meet the remaining site net carbon. ASHRAE 228-2023 rigorously defines each of these categories and is strongly recommended as a guideline for these efforts and associated accounting.

Repeat: Steps 1 – 4

A sustainability plan should be viewed as a process of continuous improvement. The site is encouraged to consider additional opportunities and technologies as they become available and more economical.

Next Steps:

- Site to review suggestions in report (and calculation assumptions) and discuss internally if any interest to move forward with any of the recommended opportunities. BMS replacement was noted to be planned for near-term future implementation.
- QGM and Eversource would like to have a virtual report out to discuss this report. The goal of the meeting is to determine which, if any, of the suggested ECMs are to be acted upon in the near to intermediate future.
- For those ECMs that require input from designers, site is suggested to initiate the process sooner than later. Site is encouraged to get contractors/vendors to site to review and provide budgetary costs.