COMMERCIAL BUILDING
ENERGY AUDIT PROGRAM

ENERGY AUDIT FOR:
Retail Store

PROJECT NO:
ORC002

DATE:
August 23, 2022

PREPARED BY:

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Contents

Abbreviations

AFUE	Annual Fuel Utilization Efficiency
AHU	Air Handling Unit
BTU	British Thermal Unit
CFM	Cubic Feet (per) Minute
CMU	Concrete Masonry Unit
CV	Constant Volume
DAT	Discharge Air Temperature
DDC	Direct Digital Control(s)
DegF	Degrees Fahrenheit
DOE	Department of Energy
DHW	Domestic Hot Water
dP	Discharge Pressure
dT	Delta T (Temperature difference)
DX	Direct Expansion
EEM	Energy Efficiency Measure
EFLH	Estimated Full Load Hours
ETO	Energy Trust of Oregon
EUI	Energy Use Index
HC	Heating Coil
HP	Horsepower
hr	Hour
HVAC	Heating Ventilating & Air Conditioning
HW	Heating Water
HWP	Heating Water Pump
IAC	Industrial Assessment Center
kBtu	1,000 Btus
kW	Kilowatt
kWh	Kilowatt-hours
lbs	Pounds
LPD	Lighting Power Density
MBH	kBtu/hr (1,000 BTU/hr)
MAT	Mixed Air Temperature
OAT	Outside Air Temperature
RAT	Return Air Temperature
RF	Return Fan
SAT	Supply Air Temperature
sf	Square Feet
SF	Supply Fan
SOO	Sequence of Operations
SP	Static Pressure
TMY3	Typical Meteorological Year
TU	Terminal Unit
VAV	Variable Air Volume
VFD	Variable Frequency Drive
W	Watts
Yr	Year

Disclaimer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

The intent of this energy analysis is to estimate energy savings associated with the recommended energy efficiency upgrades. This report is not intended to serve as a detailed engineering design document. Any description of proposed improvements that may be diagrammatic in nature are for the purpose of documenting the basis of cost and savings estimates for potential energy efficiency measures only. Detailed design efforts may be required by the participant to implement measures recommended as part of this energy analysis. While the recommendations in this study have been reviewed for technical accuracy and are believed to be reasonably accurate, all findings listed are estimates only. Actual savings and incentives may vary based on final installed measures and costs, actual operating hours, energy rates and usage.

Preface

The Commercial Building Energy Audit (CBEA) program is funded by the DOE and structured within the framework of its predecessor and parent program, the Industrial Assessment Center (IAC). The purpose of the CBEA is to provide customers with free energy assessments of commercial buildings, thereby increasing energy efficiency while simultaneously expanding the workforce of building efficiency professionals through the application of student participation from partnered colleges and universities. The scope of such audits is limited in nature, for the express purpose of identifying no-cost and low-cost energy savings opportunities, and a general view of potential capital improvements. This is accomplished by means of utility usage and billing evaluation, along with observation and analysis of energy using systems. The findings and recommendations within this report represent the conditions observed at the time of this site survey. Conditions and equipment usage are subject to change, and therefore the conclusions expressed within this report may not be evident in the future. The CBEA audit team has endeavored to meet what it believes is the applicable standard of care ordinarily exercised by others in conducting this energy audit. No other warranty, express or implied, is made regarding the information contained in this report.

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2 Energy Efficiency Measure (EEM) Summary

These energy efficiency measures (EEM)s are suggested for the facility. Cost savings are based on 2021 utility rates for electricity and natural gas. Actual rates and cost savings will differ. Non-energy cost benefits are related to cost savings due to as-avoided maintenance. Simple payback is estimated using current utility rates and estimated project costs, which may vary over time.

Measure Number	Measure Description	Annual Energy and Cost Savings				Measure Cost and Simple Payback	
		Electricity Savings		Gas Fuel Savings	Total Cost Savings	Measure Cost	Simple Payback
		kWh	kW	Therms			Year
EEM 1	Lighting Upgrade	185916	32	-	$ 5,503	$ 26,686	5
EEM 2	Control Vestibule Elec Heaters	13440		-	$ 390	$ 300	1
EEM 3	Demand Control Ventilation	50683		3202	$ 4,723	$ 300	0.1
EEM 4	Provide New Thermostats on Elec Heaters	58806		-	$ 1,705	$ 8,500	5
Totals (Recommended Measures)		308846		3202	$ 12,321	$ 35,786	3

3 Building Description

The retail store is located in Portland Oregon.
It encompasses roughly 124,000 sf attached to a mall shopping center. The building was constructed in 2014. The current envelope consists of a flat metal roof covered with thermal insulation, and a dark membrane roofing material. The interior of the building contains a large sales floor space with a 30 ft ceiling, one warehouse space, storage rooms, public restrooms, private offices, employee lounge, bathrooms, and conference room, with a mezzanine level accessed via stairway/elevator and a ladder access to one side of the roof.

The building is open every day, with operating hours for staff from 6AM to 10 PM, and customer access between 9 AM and 9 PM Monday through Saturday, and 10 AM – 7 PM Sundays. The building staff averages approximately 100 employees per day. The annual building energy consumption averages approximately 11275 MMBtu as measured across three years from 2019 and 2021.

The store has an EUI of 91 kBtu/sf per year. According to the Energy Star Benchmarking metric the median EUI for retail is 55.8 kBtu/sf per year.

4 Best Practices

This audit is per ASHRAE Level 1 requirements. The building's energy cost and efficiency were assessed by analyzing 3 years of utility data.

Utility analysis was used to produce reports on the monthly consumption of both electricity and natural gas. The output from these reports was used to benchmark this building against the median EUI for buildings of its size and type in the local vicinity.

The mechanical and lighting schedules were used to generate outlines of energy usage in terms of demand and energy consumption.

A site visit conducted on June 16th, 2022 provided a walk-through survey of the facility including its construction, operation, and maintenance, and major energy consuming equipment. Feedback from the customer related to facility performance and comfort was used to inform the survey and the resulting recommendations within this report.

The data was then used to identify no-cost and low-cost measures for improving energy efficiency. Because calculations at this level are minimal, savings and costs are approximate.

5 Energy Cost Analysis

Table 1: 2021 Utility Data

2021 Electrical Data						
Month	**kWh**	**kWh Charge**	**Charge / kWh**	**kW**	**kW Charge**	**Fees**
Jan	253,200	$7,342.28	$0.029	556.00	$1,857.26	$2,292.84
Feb	198,000	$5,743.17	$0.029	452.00	$1,738.61	$1,916.75
Mar	190,200	$5,507.13	$0.029	394.00	$1,616.57	$1,854.73
Apr	195,600	$5,663.28	$0.029	382.00	$1,565.72	$1,887.61
May	225,000	$6,512.40	$0.029	400.00	$1,630.13	$1,842.10
Jun	252,000	$7,358.58	$0.029	611.00	$2,016.59	$2,301.53
Jul	291,600	$8,535.12	$0.029	733.00	$2,184.03	$2,567.40
Aug	301,800	$8,788.05	$0.029	733.00	$2,203.73	$2,633.21
Sep	264,600	$7,740.91	$0.029	606.00	$1,973.21	$2,382.94
Oct	227,400	$6,621.77	$0.029	535.00	$1,912.19	$2,136.16
Nov	205,800	$5,983.71	$0.029	467.00	$1,766.42	$1,989.34
Dec	231,600	$6,690.72	$0.029	454.00	$1,715.57	$2,154.64
TOTALS	2,836,800	$82,487.12		6,323.00	$22,180.03	$25,959.25

2021 Natural Gas Data					
Month	**Therms**	**Cost**	**Cost / Therm**	**Other Charges**	**Total**
Jan	755.9	$641.38	$0.848	$58.00	$699.38
Feb	770.4	$604.40	$0.785	$16.87	$621.27
Mar	541.3	$434.74	$0.803	$44.45	$479.19
Apr	318.4	$249.36	$0.783	$32.31	$281.67
May	192.7	$184.07	$0.955	$28.04	$212.11
Jun	53.9	$43.24	$0.802	$18.81	$62.05
Jul	1.2	$0.96	$0.800	$16.05	$17.01
Aug	1.2	$0.96	$0.800	$16.05	$17.01
Sep	2.4	$1.93	$0.804	$16.11	$18.04
Oct	15.4	$12.35	$0.802	$16.79	$29.14
Nov	313.1	$251.17	$0.802	$42.71	$293.88
Dec	597.5	$603.70	$1.010	$55.52	$659.22
TOTALS	3,563.4	$3,028.26	$1.05	$361.71	$3,389.97

Table 2: Historical Energy Use

Month	Electrical Use (kWh)					Natural Gas Use (Therms)		
	2019	2020	2021	3-year Ave.	2019	2020	2021	3-Year Ave.
January	298,200	274,200	253,200	275200	659.0	731.2	755.9	715.4
February	265,800	276,000	198,000	246600	583.9	624.2	770.4	659.5
March	295,200	260,400	190,200	248600	589.6	496.0	541.3	542.3
April	285,000	232,200	195,600	237600	329.2	103.9	318.4	250.5
May	309,600	240,600	225,000	258400	85.3	7.1	192.7	95.0
June	375,000	242,400	252,000	289800	69.8	1.2	53.9	41.6
July	349,200	253,200	291,600	298000	19.4	2.4	1.2	7.7
August	354,000	262200	301,800	306000	1.2	1.2	1.2	1.2
September	378,000	285,000	264,600	309200	1.2	1.2	2.4	1.6
October	309,000	226,800	227,400	254400	254.1	14.4	15.4	94.6
November	291,600	208,200	205,800	235200	354.3	577.3	478.0	469.9
December	306,600	237,000	231,600	258400	711	718.2	597.5	675.6
Annual Energy Usage								
Annual Elec Energy Usage (kWh)	3,819,219	3,000,220	2,838,821	3,217,400				
Annual NG Energy Usage (Therms)					2,999	2,547	2,972	2,840
Annual Elec Energy kBtu	13038814	10242751	9691735	10984204				
Annual NG Energy Usage kBtu	299900	254710	297240	283950				
Total Annual Energy Usage (MMBtu)	13339	10497	9989	11275				
Energy Performace of the Facility								
Conditioned Space Area (sqft)				124,000				
Total Energy Use (MMBtu per year, 3-year ave.)				11,275				
Energy Use Intensity, EUI (kBtu/sqft/year)				91				
*Median EUI for Facility Type in the US				55.8				

Elec Energy Use in kBtu = Annual kWh x 3414 Btu/kWh / 1000

NG Energy Use in Btu = Therms/100,000

NG Energy Use in kBtu = Btu/1000

! MMBtu = 1000 kBtu

*Median EUI Source: https://www.energystar.gov/buildings/benchmark/understand_metrics/what_eui

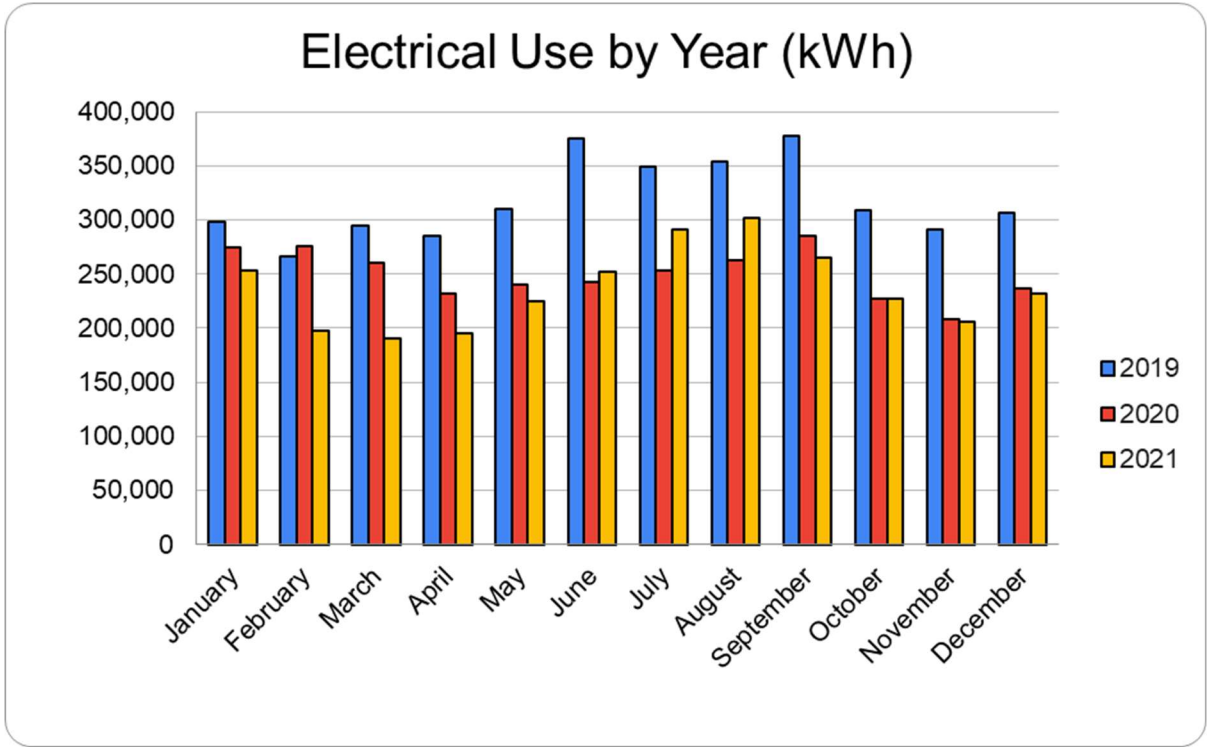

Figure 1: Electrical Use by Year (in kWh)

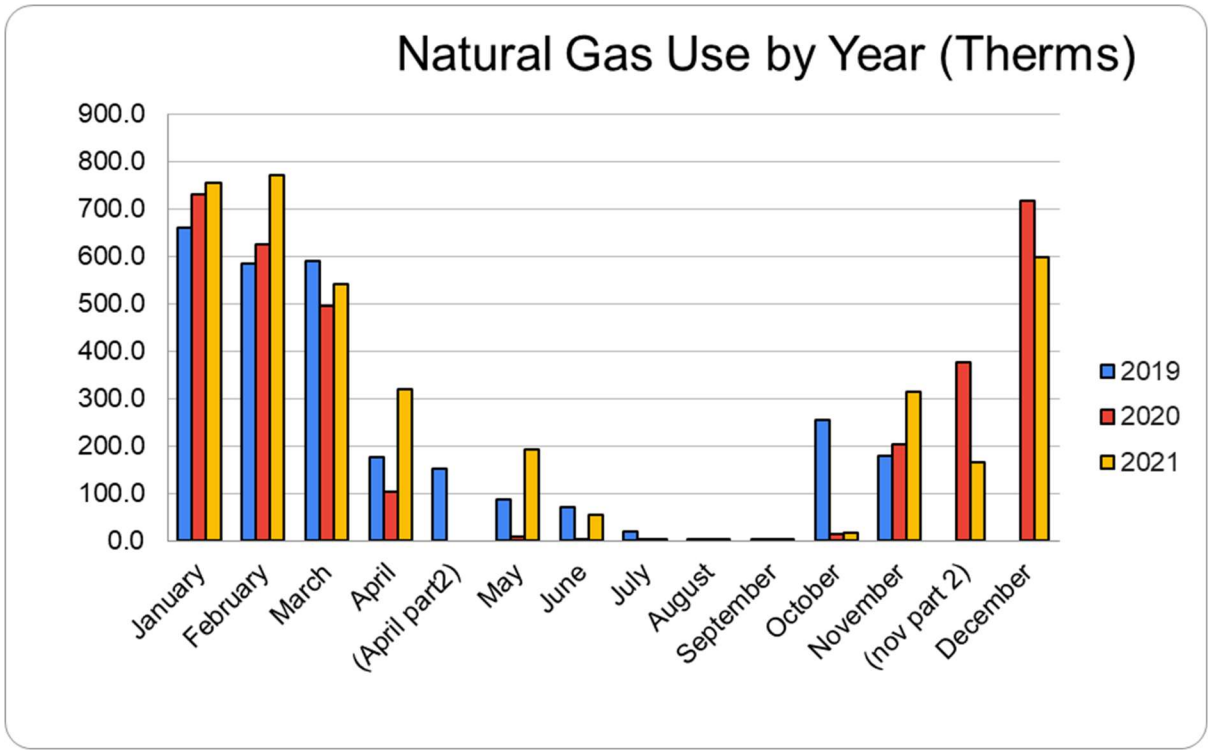

Figure 2: Natural Gas Use by Year (in Therms)

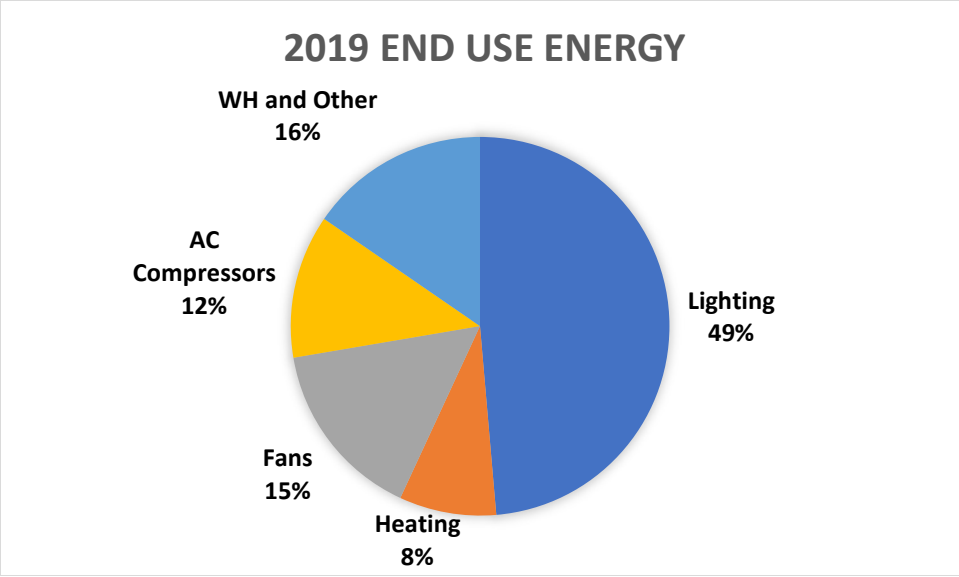

Figure 3: 2019 Pre-Pandemic End Use Summary

6 Major Energy Consuming Equipment

6.1 Mechanical Systems

The retail space, warehouse, mezzanine, and offices are conditioned by gas heat, electric cooling roof mounted packaged units. There are 27 roof units installed during the initial construction. All units are single zone and constant volume, ranging in size from 3 to 25 tons nominal cooling capacities. The equipment schedules indicate that there are economizers and CO2 sensors for each unit, and a VFD for supply fans. The warehouse is heated by gas-fired radiant heat and has infrared heaters above the loading dock doors. Radiant heat is also present in the three vestibules.
Two split-system units provide cooling to the elevator equipment and MIS rooms.
Roof mounted exhaust fans provide exhaust for the archery range, vault, kitchen, restrooms, and electrical room.

The following Tables summarize the major mechanical equipment.

Table 3: Rooftop Unit Schedule

Rooftop Unit Schedule (Gas Heating / Electric Cooling)												
Tag	Area Served	Manufacturer	Model	Air Flow (CFM)	Min OA (CFM)	Heating Capacity (MBH)	Heating Efficiency	Cooling Capacity (MBH)	Cooling Efficiency (EER)	Econ	Supply Fan HP	SF VFD
RTU-1, 3, 4, 6, 7	Sales Floor	YORK	ZJ-120	4,000	300	144	80%	121.1	12.0	Yes	3	Yes
RTU-2, 5, 8	Sales Floor	YORK	ZJ-150	5,000	300	144	80%	157.4	12.0	Yes	5	Yes
RTU-9	Gun Storage	YORK	ZR-037	1,200	150	49	80%	28.6	12.2	Yes	1.5	No
RTU-10	Gun Library	YORK	ZR-037	1,080	100	49	80%	30.3	12.2	Yes	1.5	No
RTU-11	Kitchen/Seating	YORK	ZJ-102	3,060	300	96	80%	91.7	12.0	Yes	3	No
RTU-12	Conference	YORK	ZJ-037	1,080	100	49	80%	29.0	12.2	Yes	1.5	No
RTU-13	Check-Out	YORK	ZJ-102	3,060	600	144	80%	91.7	12.0	Yes	3	No
RTU-14	Cust. Service	YORK	ZJ-037	1,080	150	49	80%	29.4	12.2	Yes	1.5	No
RTU-15	Warehouse	YORK	ZJ-300	10,000	500	320	80%	282.8	10.5	Yes	15	Yes
RTU-16	Bargain Cave	YORK	ZJ-061	2,000	100	129	80%	56.3	12.2	Yes	2	No
RTU-17, 20, 23	Salesfloor	YORK	ZJ-150	5,000	300	144	80%	157.4	12.0	Yes	5	Yes
RTU-18, 19, 21, 22, 24	Salesfloor	YORK	ZJ-120	4,000	300	144	80%	121.1	12.0	Yes	3	Yes
RTU-25	Mis Room	YORK	ZJ-078	2,340	125	96	80%	70.9	11.2	Yes	2	No
RTU-26	Admin. 2nd Floor	YORK	ZJ-102	2,060	450	144	80%	90.3	12.0	Yes	3	No
RTU-27	Admin. 1st Floor	YORK	ZJ-090	2,060	300	144	80%	82.1	12.0	Yes	3	No

Table 4: Split System Air Conditioner Schedule

Split System Air Conditioner						
Tag	Area Served	Manufacturer	Model	Air Flow (CFM)	Cooling Capacity (MBH)	Cooling Efficiency (SEER)
AC-1 / ACCU-1	Mis	CARRIER	40-MVC-012	365	12.0	13.0
AC-2 / ACCU-2	Elev Equip Room	CARRIER	40-MVC-009	325	9.0	13.0

Table 5: Electric Heating Coil Schedule

Electric Heating Coil					
Tag	Area Served	Manufacturer	Model	Air Flow (CFM)	Heating Capacity (MBH)
EDH-1	Conference	INDEECO	QUZ	225	6.8
EDH-2	Security	INDEECO	QUZ	225	6.8
EDH-3	Office	INDEECO	QUZ	175	5.1
EDH-4	Conference	INDEECO	QUZ	175	5.1
EDH-5	Conference	INDEECO	QUZ	410	11.9

Table 6: Air-to-Air Heat Pump Schedule

Air-to-Air Heat Pump							
Tag	Area Served	Manufacturer	Model	Heating Capacity (MBH)	Heating Efficiency	Cooling Capacity (MBH)	Cooling Efficiency (EER)
HP-1	FCU-1	YORK	YHJD36-S44S4	32.5	-	35.5	11

Table 7: Exhaust Fan Schedule

Exhaust Fan Schedule						
Tag	Area Served	Manufacturer	Model	Air Flow (CFM)	Exhaust Fan HP	Fan RPM
EF-1A	Kitchen	GREENHECK	CUBE-101HP	600	0.5	1,725
EF-1B	Service	GREENHECK	CUBE-101HP	600	0.5	1,725
EF-2	Archery	GREENHECK	SQ-120-VG	1000	0.5	1,725
EF-3	Mountain	GREENHECK	SQ-120-VG	1000	0.5	1,725
EF-4	Restrooms	GREENHECK	GB-131	1,675	0.75	1,725
EF-5	Electrical	GREENHECK	GB-121	1,200	0.75	1,725
TF-1 THRU 8	Vault	GREENHECK	SQ-130-VG	1,500	0.75	1,725

Table 8: Fan Coil Unit Schedule

Fan Coil Unit (Electric)									
Tag	Area Served	Manufacturer	Model	Air Flow (CFM)	Min OA (CFM)	Heating Capacity (MBH)	Heating Efficiency	Cooling Capacity (MBH)	Cooling Efficiency (EER)
FCU-1	Equip Room	YORK	MA16CN41	1,200	300	45.2	-	35.5	-

6.2 Lighting

The main lighting in the open main floor retail space consists of suspended 16" diameter pendant fixtures with compact fluorescent lamps. Flood task lighting is used to highlight special retail features primarily around the perimeter. The lighting in the offices consists of 2 ft x 4 ft T8 recessed troffers. The warehouse lighting consists of a mixture of three lighting fixture types: 2ft x 4 ft T5 suspended high bay fluorescent fixtures with 6 lamps per fixture or 3 lamps per fixture, and 48 inch long 2 lamp T8 strip lighting. The Storage area, electrical rooms and server room lighting consists of T8 4 ft suspended linear fixtures.

6.3 Controls

According to the Regional Facilities Manager, the facilities have web-based DDC of the HVAC systems. All adjustments and monitoring of the controls are conducted through an outside independent agency. A contracted firm provides quarterly Preventive Maintenance (PM) on the units. The PM includes changing filters, performing functional testing on the units and calibration of sensors.

There are a total of 27 roof top units (RTUs) that serve the facility. All units are scheduled to operate from 6:00 am – 10:00 pm Monday – Saturday and 6:00 am – 8:00 pm Sunday. One unit is scheduled to operate continuously to provide minimum conditioning during off hours. During occupied periods the building controls in the sales, office and warehouse spaces are set to maintain 72 degF cooling and 67 degF heating. The IT room is set to always maintain 65 degF. The unoccupied temperatures are set for 76 degF cooling and 61 degF heating. Local area sensors maintain space temperature. Each unit has a CO2 sensor but it is not confirmed that the units are configured to provide demand control ventilation. Each unit has economizer function. It is not confirmed that the economizers are operational.

The lighting in the retail area, offices and warehouse are scheduled to be ON from 6:30 am – 9:30 pm Monday – Sunday. Track and accent lighting are scheduled ON from 6:30 am – 9:30 pm Monday – Sunday. Occupancy sensors are used in conference spaces.

7 Detailed Energy Efficiency Measures

EEM 1 – Upgrade Lighting in Retail Area and Warehouse

EXISTING CONDITIONS – Retail Area

The general lighting in the retail space consists of 338 fixtures suspended from the ceiling with compact fluorescent fixture in each, with an estimated 168 watt per fixture.

Replace the existing lamps with LED lamps in each fixture. Replacement fixtures are estimated to have 84 watts per fixture.

EXISTING CONDITIONS - Warehouse

In the warehouse there are three types of suspended light fixtures. According to the Lighting Fixture Schedule and current drawings these are as follows:

Type FL: 6 lamp 32 watt T5; 192 watt per fixture; 9 fixtures total
Type FZ: 3 lamp 32 watt T5; 96 watt per fixture; 37 fixtures total
Type FP: 48” long strip lighting fixture, 2 lamp, T8 64 watt per fixture; 52 fixtures total

PROPOSED MEASURE DESCRIPTION

Replace the existing lamps in the Retail Area with LED lamps in each fixture. Replacement fixtures are estimated to have 84 watts per fixture.

Replace existing Warehouse lamps with 150 watt LED lamp in each fixture.

SAVINGS METHODOLOY

Savings are estimated using a spreadsheet calculation.

ESTIMATED COST

The estimated cost for Retail lighting upgrade is $16 per fixture and an additional cost of $40 per fixture for installation.

The estimated cost for the Warehouse lighting upgrade is $110 per Type FL and FZ fixture and $40 per Type FP fixture, including installation.

EEM #1 Estimated Savings		
Annual Energy Usage & Savings Estimate	Baseline Electric Usage (kWh)	381889
	Proposed Electric Usage (kWh)	195973
	Electric Savings (kWh)	185916
	Electric Cost Savings ($)	$ 5,392
	Baseline Demand (kW)	65
	Proposed Demand (kW)	34
	Demand Savings (kW)	32
	Demand Cost Savings =	$ 112
	Baseline Natural Gas Usage (Therms)	0
	Proposed Natural Gas Usage (Therms)	0
	Natural Gas Savings (Therms)	0
	Natural Gas Savings ($)	$ -
	Annual Energy Cost Savings	$ 5,503
Measure Cost & Simple Payback	Project Cost	$ 26,686
	Simple Payback (Cost/Savings)	4.8

EEM 2 – Vestibule Electric Heaters Scheduling

EXISTING CONDITIONS

There are 3 ceiling mounted electric heaters of 4 kW each located in each of the entry vestibules. According to the store manager the heaters run in mild conditions, prompting the store personnel to open the doors to relieve the heat from the spaces. During the site visit, the ambient temperature was 60 degF, the electric heaters were operating, and the vestibules were overheating. Currently the staff does not have control over the electric heater temperature settings.

PROPOSED MEASURE DESCRIPTION

Reset the electric heater temperature control to prevent vestibule spaces from overheating.

SAVINGS METHODOLOY

Savings are estimated using a spreadsheet calculation and bin data.

Energy savings calculations assumes that the electric heaters are operating when the ambient temperature is between 50-60 degF, or approximately 1120 hours per year which can be reduced with control strategy to lock out operation of heaters at ambient temperature of 50 degF and above.

ESTIMATED COST

The estimated cost is $100 per unit heater.

EEM #2 Estimated Savings			
	Electric Savings (kWh)		13440
	Electric Cost Savings ($)	$	390
	Baseline Natural Gas Usage (Therms)		0
	Proposed Natural Gas Usage (Therms)		0
	Natural Gas Savings (Therms)		0
	Natural Gas Savings ($)	$	-
	Annual Energy Cost Savings	$	300
Measure Cost & Simple Payback	Project Cost	$	300
	Simple Payback (Cost/Savings)		1.0

EEM 3 – Demand Control Ventilation on Roof Top Units

EXISTING CONDITIONS

There are 15 packaged rooftop units that serve the retail portion of the facility. The units all have economizer dampers and CO2 sensors. There is no evidence that the units vary the outside air based on occupancy. In the main store the patron occupancy varies throughout the day, with peak occupancy occurring from noon- 4:00 pm daily. The Contract Documents show that the design minimum outside air is based on ASHRAE 62.1. This equates to 18,000 CFM for the 15 units that serve the main retail space.

PROPOSED MEASURE DESCRIPTION

Configure the existing DDC system to vary the outside air based on CO2 sensors.

SAVINGS METHODOLOY

Savings are estimated using a spreadsheet calculation.

EEM is calculated for savings assuming the OSA varies based on CO2 readings and a varying occupancy of patrons. The current OSA values assume 18,000 CFM during the occupied periods. The design documents indicate that the minimum OSA based on demand control ventilation can be reduced to 4,500 CFM.

EEM savings based on bin data for Portland, Oregon, and savings calculations for reducing the outside air heating and cooling energy use.

ESTIMATED COST

The estimated cost is estimated at $300. The units currently have CO2 sensors and DDC.

EEM #3 Estimated Savings		
Annual Energy Usage & Savings Estimate	Baseline Electric Usage (kWh)	67578
	Proposed Electric Usage (kWh)	16894
	Electric Savings (kWh)	50683
	Electric Cost Savings ($)	$ 1,520
	Baseline Natural Gas Usage (Therms)	4447
	Proposed Natural Gas Usage (Therms)	1112
	Natural Gas Savings (Therms)	3336
	Natural Gas Savings ($)	$ 3,202
	Annual Energy Cost Savings	$ 4,723
Measure Cost & Simple Payback	Project Cost	$ 300
	Simple Payback (Cost/Savings)	0.1

EEM 4 – Economizer Control of Roof Top Units (RTUs)

EXISTING CONDITIONS

There are 15 packaged rooftop units that serve the retail portion of the facility. The units all have economizer dampers specified on the Mechanical Equipment Schedules. There is no evidence that the economizer control is currently functioning.

PROPOSED MEASURE DESCRIPTION

Configure the existing DDC system to provide economizing on all rooftop units, provide fault detection on units to verify economizer operation, and send a signal to the DDC system in case of economizer failure.

SAVINGS METHODOLOY

Savings are estimated using a spreadsheet calculation.

EEM is calculated for savings assuming 100% ambient outside air provides cooling during occupied periods when free cooling is available.

EEM savings based on bin data for Portland, Oregon, and savings calculations for reducing compressor use when free cooling is available.

ESTIMATED COST

The estimated cost is $560 per unit to provide economizer fault detection. The units currently have economizers and DDC.

EEM #4 Estimated Savings		
Annual Energy Usage & Savings Estimate	Baseline Electric Usage (kWh)	277506
	Proposed Electric Usage (kWh)	218700
	Electric Savings (kWh)	58806
	Electric Cost Savings ($)	$ 1,705
	Baseline Natural Gas Usage (Therms)	0
	Proposed Natural Gas Usage (Therms)	0
	Natural Gas Savings (Therms)	0
	Natural Gas Savings ($)	$ -
	Annual Energy Cost Savings	$ 1,705
Measure Cost & Simple Payback	Project Cost	$8,500
	Simple Payback (Cost/Savings)	5.0

8 Appendices

8.1 Site Photos

Figure A: Rooftop Surface Area

Figure B: RTU (YORK)

Figure C: Primary Sales Floor Lighting

Figure D: Warehouse Track Lighting

Figure E: Warehouse Lighting, 3 Lamp

Figure F: Warehouse Lighting, 6 Lamp

Figure G: Break Room

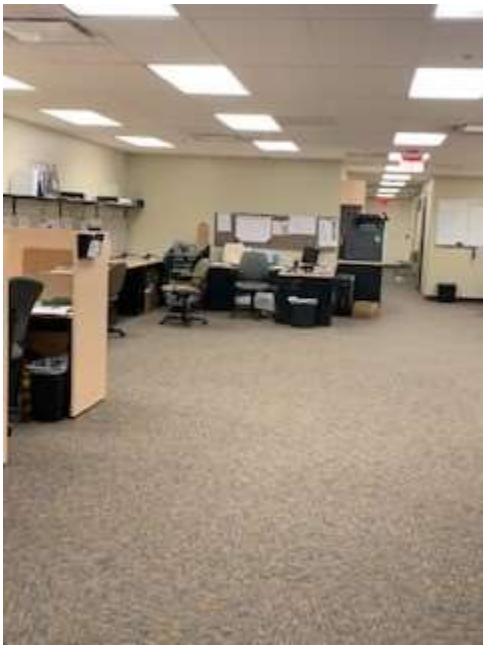

Figure H: Office Spaces