ORC006

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Community College Building

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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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Building Efficiency Measure (EEM) Summary

These energy efficiency measures (EEMs) are suggested for the facility. Cost savings are based on average 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.

Table 1: EEM Summary

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	MMBtu			Year
EEM 1	Lighting Upgrade	33732	10	-		$ 1,080	$ 12,000	11
EEM 2	Reduce Ventilation	52671	-	8272	827	$ 8,471	$ 1,000	0.1
EEM 3	Insulate Refrigerant Piping	2287	-	-		$ 72	$ 100	1.4
Totals		88691		8272	827	$ 9,622	$ 13,100	1

Water Savings	Description	Annual Water Use and Cost Savings				
		Water Savings		Total Cost Savings (less Pumping Energy Cost)		Simple Payback
		Tgal	Cost			Year
EEM 4	Reinstate Functionality of Water Harvesting System	110	$ 1,964	$ 1,802		0.9

Building Description

The Opportunity Center serves as a hub to connect students, employers and community members to the Community College. The facility is conveniently located on a major light rail transit line. The 100,000 square foot facility houses programs for the Workforce Training Center and its partner agencies, along with serving approximately 7500 students from the Community College. The facility is open from 8:00 am to 8:00 pm Monday – Friday.

The facility was opened in 2008, achieving a LEED Platinum rating from the US Green Building Council. The facility is a three-story structure, heavy mass construction, with a flat membrane roof, and energy efficient windows. Operable windows are designed to provide automatic night time ventilation to pre-cool the facility. Windows at the lower level open to let cool air infiltrate into the main lobby, while third floor windows allow the warmer air to exfiltrate by means of the natural ventilation through central open lobby core.

In addition to night flushing capability, the facility has been designed to provide rain-harvesting for non-potable water use. Part of the rain-harvesting system includes large orange colored water gauges located at to front entrance to demonstrate the water level stored in the underground storage cisterns.

Best Practices

This audit is per ASHRAE Level 1 requirements. The building's energy cost and efficiency were assessed by analyzing 2021's 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 December 14, 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.

Energy Cost Analysis

Table 2: 2021 Utility Data

2021 Electrical Data						
Month	kWh	kWh Charge	Charge / kWh	kW	kW Charge	Fees
Jan	113400	$ 3,633	$0.03	199	$279.27	$1,754.34
Feb	96000	$ 3,072	$0.03	180	$237.51	$1,723.39
Mar	86400	$ 2,744	$0.03	192	$289.71	$1,729.25
Apr	97200	$ 3,089	$0.03	303	$409.77	$1,857.48
May	109200	$ 3,518	$0.03	318	$435.87	$1,987.47
Jun	133200	$ 4,258	$0.03	405	$571.59	$2,217.92
Jul	152400	$ 4,947	$0.03	472	$629.01	$2,377.72
Aug	151800	$ 5,002	$0.03	595	$785.61	$1,298.68
Sep	130200	$ 3,771	$0.03	452	$608.13	$3,918.28
Oct	126000	$ 3,598	$0.03	405	$568.98	$2,702.91
Nov	108600	$ 3,493	$0.03	340	$495.90	$2,628.68
Dec	112800	$ 3,658	$0.03	254	$294.93	$2,030.89
TOTALS	1,417,200	$ 44,784	$0.03	4,115	$5,606.28	$26,227.01

2021 Natural Gas Data					
Month	Therms	MMBTU	Cost	Cost / Therm	Other Charges
Jan	2,833	283	$2,371.69	$0.837	none
Feb	2,642	264	$2,075.93	$0.786	none
Mar	2,545	254	$2,090.77	$0.822	none
Apr	1,704	170	$1,418.77	$0.833	none
May	1,098	110	$952.83	$0.868	none
Jun	1,265	127	$749.46	$0.592	none
Jul	829	83	$694.82	$0.838	none
Aug	789	79	$611.45	$0.775	none
Sep	936	94	$777.95	$0.831	none
Oct	2,250	225	$1,869.20	$0.831	none
Nov	2,331	233	$1,992.90	$0.855	none
Dec	2,731	273	$2,457.45	$0.900	none
TOTALS	21,952.5	2,195	$18,063.22	$0.823	

The facility has an EUI (Energy Utilization Index) of 74 kBtu/sf. The Energy Star Performance Scorecard rates the facility at 59 out of 100, which indicates there is significant area of improvement available for energy savings.

Figure 1: 2021 Electrical Use

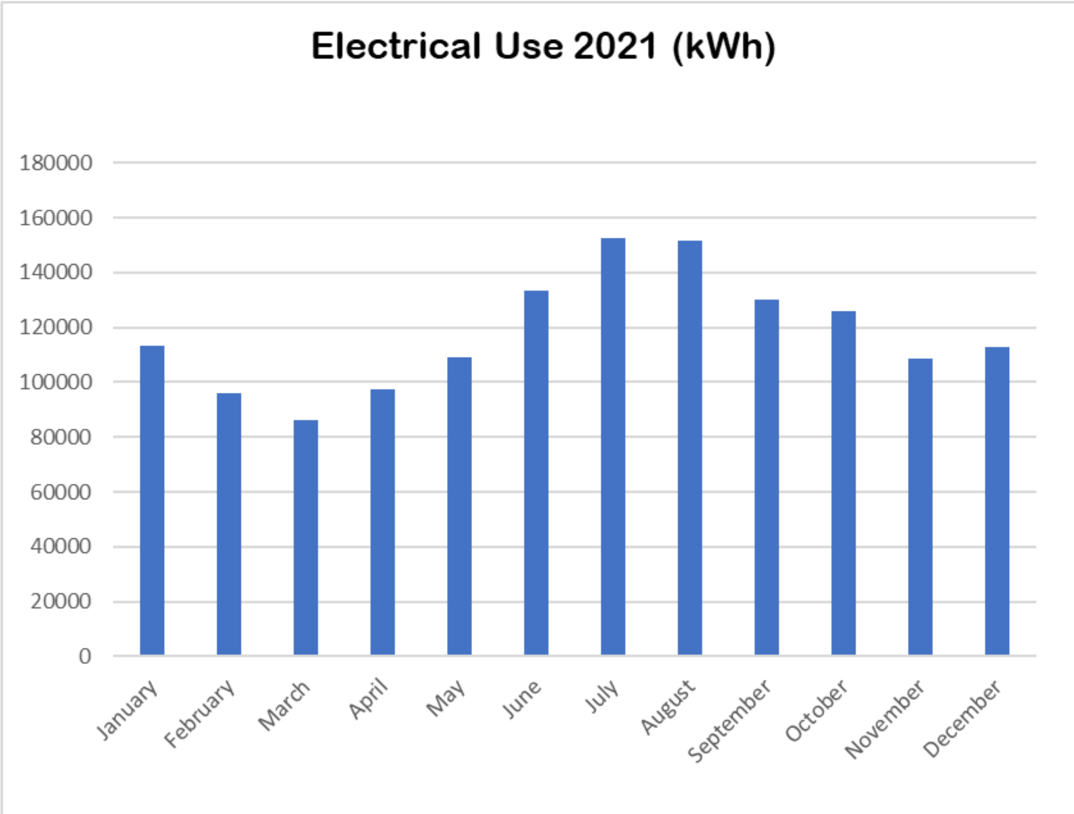


Figure 2: 2021 Natural Gas Use

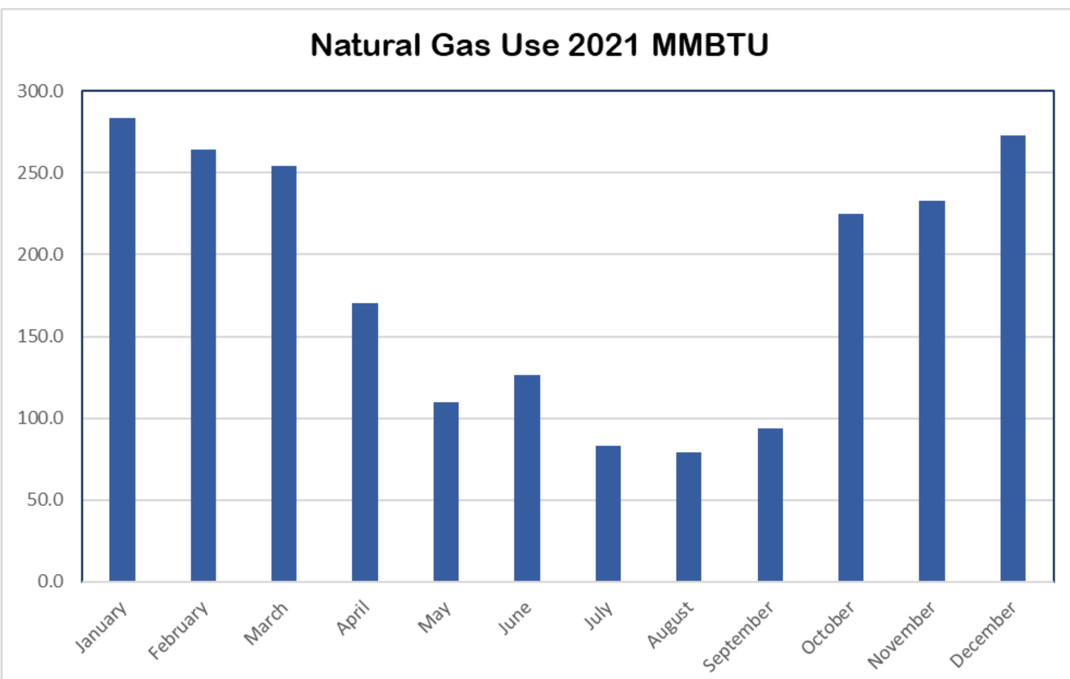
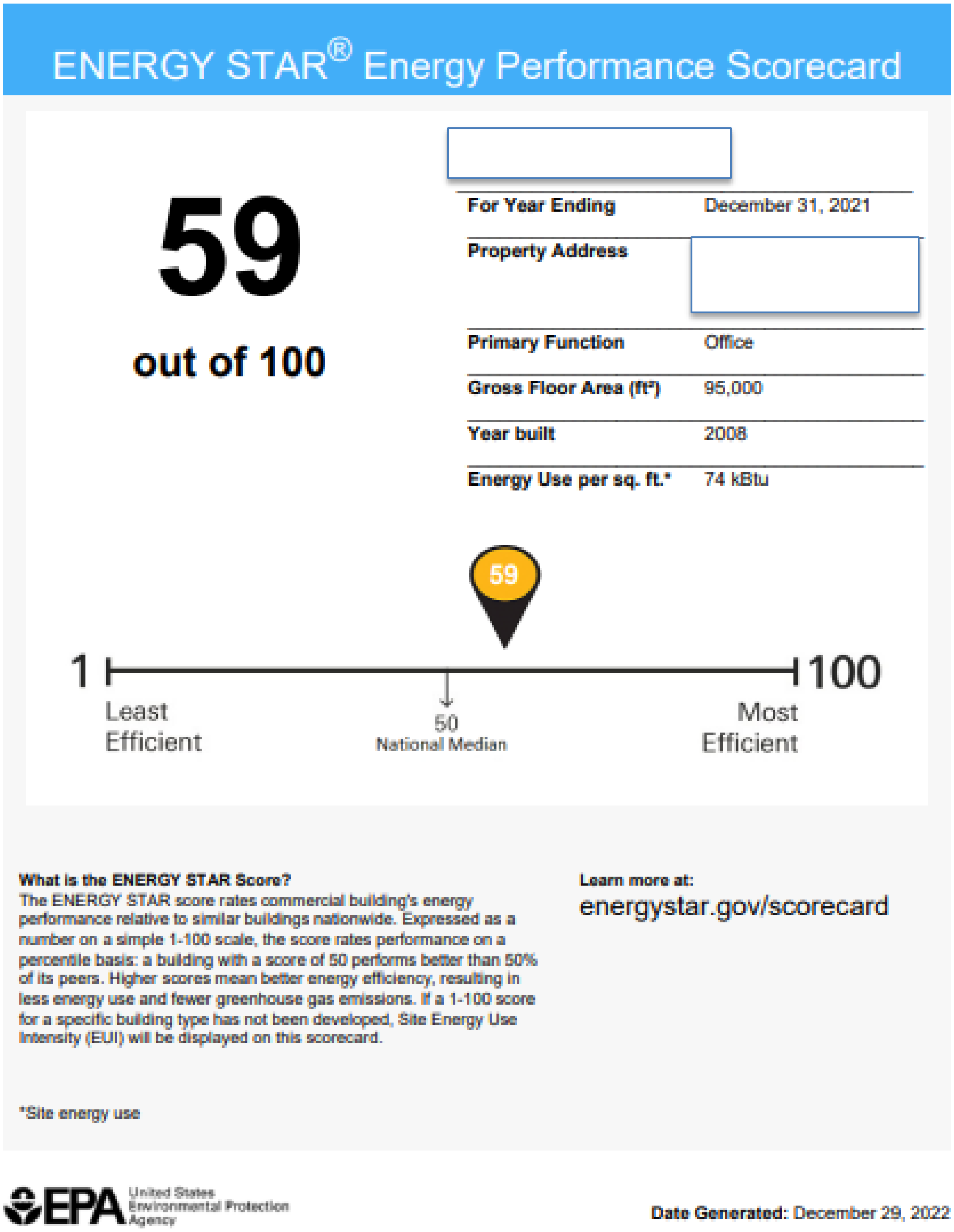


Figure 3: Energy Performance Scorecard



ENERGY STAR® Energy Performance Scorecard

59

out of 100

For Year Ending	December 31, 2021
Property Address	
Primary Function	Office
Gross Floor Area (ft²)	95,000
Year built	2008
Energy Use per sq. ft.*	74 kBtu

What is the ENERGY STAR Score?
The ENERGY STAR score rates commercial building's energy performance relative to similar buildings nationwide. Expressed as a number on a simple 1-100 scale, the score rates performance on a percentile basis: a building with a score of 50 performs better than 50% of its peers. Higher scores mean better energy efficiency, resulting in less energy use and fewer greenhouse gas emissions. If a 1-100 score for a specific building type has not been developed, Site Energy Use Intensity (EUI) will be displayed on this scorecard.

Learn more at:
energystar.gov/scorecard

*Site energy use

EPA United States Environmental Protection Agency

Date Generated: December 29, 2022

Major Energy Consuming Equipment

Mechanical

Roof Mounted Air Handling Units

RTU-1 and 2

There are two identical mounted air handlers located on the roof. These two units provide and distribute the conditioned air throughout the building. They each have a supply fan and return fan variable speed to modulated air flow. Hot water coils provide heating. The heating water is controlled by 2-way valves to modulate heating water flow. Chilled water coils provide cooling. The chilled water flow is controlled at the units by 2-way valves to vary the chilled water flow. Each unit has full economizer control along with capability for demand controlled ventilation.

Boilers

B-1 and B-2

The boiler room is located on the rooftop of the building There are two high efficiency condensing boilers which provide heating water to the roof mounted air handlers and to reheat coils in the variable air volume terminal units throughout the facility. Two variable speed pumps distribute the heating hot water through a single primary piping system.

Chiller

ACC-1

There is single air cooled chiller located on the roof. The chiller provides chilled water to the roof mounted air handling units. The pumping system is comprised on two chilled water loops. The primary loop circulates through the chilled water through the chiller. The secondary loop circulates chilled water to the air handling units. All the chilled water pumps are variable speed.

Terminal Units

Variable air volume terminal units provide zone control. There are two types of units within the facility: Fan powered units and modulating variable air volume units. Both types of terminal units have hot water reheat.

Split system AC units

Split system air conditioning units provide cooling to electric rooms, telecom spaces, and elevator equipment rooms. The outdoor condensing units are located on the roof.

General Exhaust Fans

Roof mounted exhaust fans provide general exhaust for restrooms and laundry.

Unit Heater

There is a single hot water heater that provides heating for the loading dock area.

Natural Ventilation

Operable windows on the first floor allow for natural ventilation, which can be vented from the facility through operable windows at the upper level of the main open lobby.

Domestic Hot water

There is a single high efficient condensing hot water heater located in the roof mechanical boiler room. It provides domestic hot water for the entire building. Water is tempered with a mixing valve located in the boiler room and recirculated throughout the system with a recirculation

pump.

Rain Harvesting System

Outside the building there is a 15,000 gallon cistern located underground that is designed to catch rainwater along with a 685 gallon storage tank in the Loading Dock Area. As part of the underground cistern system, there are that are large calibrated gauges visible from the main doors that demonstrate the real time water levels of the underground cistern. The rainwater system is designed to provide greywater for toilet flushing.

Table 3: Roof Mounted Air Handling Units

Rooftop Air Handling Units							
Tag	Area Served	Manufacturer	Model	Air Flow CFM	Supply Fan HP	Return Fan HP	Min OA CFM
RTU-1	All Floors	Haakon		45000	60	20	8500
RTU-2	All Floors	Haakon		45000	60	20	8500

Table 4: Air Cooled Chiller

Air Cooled Chiller						
Tag	Service	Manufacturer	Type	Nominal Capcity	Efficiency	
				Tons	kW/Ton	COP
ACC-1	RTU-1 & RTU-2	TRANE	High Efficiency	286.7	1.07	3.28

Table 5: Pumps

Pumps					
Tag	Service	Manufacturer	Type	Capacity	
				Flow (GPM)	Motor HP
HWP-1	Building Heating	B&G Series 80	In-Line	180	5
HWP-2	Building Heating	B&G Series 80	In-Line	180	5
HWP-3	RTU-1 Heating Coil	B&G Series 60	In-Line	25	3-Jan
HWP-4	RTU-2 Heating Coil	B&G Series 60	In-Line	25	3-Jan
CHWP-1	Boiler Room	B&G Series 80	In-Line	445	10
CHWP-2	Boiler Room	B&G Series 80	In-Line	400	10
CHWP-3	Boiler Room	B&G Series 80	In-Line	400	10

Table 6: Boilers

Boilers				
Tag	Service	Manufacture	Type	Capacity MBH
B-1	Building Heating	AERCO BMK	Condesing	1720
B-2	Building Heating	AERCO BMK	Condesing	1720

Table 7: Split System Air Conditioning Units

Split System Air Conditioning Units			
Tag	Service	Manufacturer	Efficiency (S)EER
ACCU-1/ACU-1	ACU-1	Mitsubishi MUY	16
ACCU-2/ACU-2	ACU-2	Mitsubishi MUY	16
ACCU-3/ACU-3	ACU-2	Mitsubishi MUY	13
ACCU-4/ACU-4	ACU-2	Mitsubishi MUY	13
ACCU-5/ACU-5	ACU-2	Mitsubishi MUY	13
ACCU-6/ACU-6	ACU-2	Mitsubishi MUY	13
ACCU-7/ACU-7	ACU-7	Mitsubishi PUY	13

Lighting

The lighting in the classrooms and offices consist of cable hung linear fluorescent direct/indirect fixtures with F32T8 lamps. The entrance lobby are recessed square fixtures with 32watt lamps. In the main floor hallway there are linear suspended pendant type fixtures. Stairwells are lit with surface wall mounted fixtures with F32T8 lamps. Mechanical rooms and general utility area lighting consist of fluorescent strip light fixtures with F32T8 lamps.

Lighting is controlled through the building automation control system (BAS).

Detailed Energy Efficiency Measures

EEM 1 Lighting Upgrade

EXISTING CONDITIONS

The lighting in the general offices and classrooms is the original lighting that was installed in 2008. The lighting consists of cable hung fixtures with F32 T8 lamps.

PROPOSED MEASURE DESCRIPTION

Replace the F32 lamps with LED lamps. This measure assumes LED replacement lamps have 9.2 watt/foot per current manufacturer data. There are approximately 50 fixtures in the classrooms and 70 fixtures in the offices to be replaced.

CALCULATIONS

Energy (kWh) = Fixture Watt x No. of Fixtures x “ON” Hrs per yesar

Demand (kW) = Lighting total watt/1000 kW/watt

Hours “ON” is assumed to be 3380 hours per year.

Estimated Cost = $100/Fixture

Hours "ON"		3380	hrs
Existing Energy =		58677	kWh
Existing Energy Cost =	$	1,854	
Proposed Energy =		24944	kWh
Proposed Energy Cost =	$	788	
Existing Demand =		17	
Existing Demand Cost =	$	24	
Proposed Demand =		7.4	
Proposed Demand Cost =		10	

Demand Savings =	**10**	**kW**
kWh Savings =	**33732**	**kWh**

Elec Demand Cost Savings =	**$**	**14**
Elec Cost Savings =	**$**	**1,066**
Total Savings =	**$**	**1,080**

EEM #1 Estimated Savings			
Annual Energy Usage & Savings Estimate	Baseline Electric Usage (kWh)		58677
	Proposed Electric Usage (kWh)		24944
	Electric Savings (kWh)		33732
	Electric Cost Savings ($)	$	1,066
	Demand Savings (kW)		10
	Electric Demand Savings ($)	$	14
	Baseline Natural Gas Usage (Therms)	-	
	Proposed Natural Gas Usage (Therms)	-	
	Natural Gas Savings (Therms)	-	
	Natural Gas Savings ($)	-	
	Annual Energy Cost Savings	$	1,080
Measure Cost & Simple Payback	Project Cost	$	12,000
	Simple Payback (Cost/Savings)		11.1

EEM 2 Reduce Ventilation

EXISTING CONDITIONS

The facility currently provides a constant ventilation rate. (This was established during recent concerns for health).

PROPOSED MEASURE DESCRIPTION

Provide demand control ventilation based on actual occupancy.

SAVINGS METHODOLOGY

Spreadsheet calculations were used to determine energy savings for heating and cooling systems by reducing the amount of outside air.

Calculations:

Calculations

Q = 1.08 x CFM * ΔT

Assume Ave Winter T OA is 45°F
Tinside = 68°
Hrs of operation = 12 hr/day ; 5 days per week ; 4 months per year (50 days)

Design Ventilation Air = 27000 CFM

Assume that ventilation can be reduced from 27,000 cfm OA to 8500 CFM OA

Hours Baseline = 1800 **hrs**

Heating (NG) savings
Baseline Energy Energy = 1207224000 Btu
12072 Therm
Reduces Energy = 380052000
3801 Therm

Assume Summer Ave T OA = 65°F
T Setpoint = 60°F
Same hrs

Same Design Ventilation'

Cooling Energy Baseline = 76872 kWh

Cooling (Elec) Savings 24200 kWh

3414 Btu= 1kWh

EEM #2 Estimated Savings		
Annual Energy Usage & Savings Estimate	Baseline Electric Usage (kWh)	76872
	Proposed Electric Usage (kWh)	24200
	Electric Savings (kWh)	52671
	Electric Cost Savings ($)	$ 1,664
	Baseline Natural Gas Usage (Therms)	12072
	Proposed Natural Gas Usage (Therms)	3801
	Natural Gas Savings (Therms)	8272
	Natural Gas Savings ($)	$ 6,806
	Annual Energy Cost Savings	$ 8,471
Measure Cost & Simple Payback	Project Cost	$ 1,000
	Simple Payback (Cost/Savings)	0.1

EEM 3 Insulate Refrigerant Piping

EXISTING CONDITIONS

Existing refrigerant piping on the roof mounted condensing units is worn exposing bare refrigerant piping.

PROPOSED MEASURE DESCRIPTION

Provide new closed cell type insulation on all refrigerant piping on the roof.

SAVINGS METHODOLOGY

Methodology

The suction line in the system is assumed to be 3/8" diameter.
The estimated temperature of the refrigerant is 44°F.
Q(Heat Transfer) = 1/Rvalue x Surface Area x Temperature Difference
Energy Use = Heat Transfer x hours

Calculations

Q(loss Btu/hr) = 1/(R Value) x Area (ft^2) x ΔT					
Area Piping = Circumference X length			C=2xpixR		
ΔT = (95-44)			A =cx l		
Units and Conversion Factors			C=2xpixR		
12" = 1 ft			C =	1.1775	inches
3410 Btu/hr = 1 kW			C =	0.10	ft
			L =	100	ft
Refrigerant Pipe Diameter =	0.375	inch	A =	9.8125	ft^2
Refrigerant Pipe Length =	100	ft			
R value Uninsu;ted =	0.25				
R value Insulated =	3				
ΔT =	51				
hours per year =	4250	hrs			
			Q1=	1/r(uninsulated) x Area x ΔT	
			Q1=	2001.75	Btu/hr
			Q2=	166.8125	Btu/hr
Energy 1 =	2495	kWh			
Energy 2 =	208	kWh			
Energy Saved = Energy 1 - Energy 2					
Energy Saved =	2287	kWh			
Refrigerant Piping Cost =	$ 1.00	per ft			
Cost =	$ 100.00				

EEM #3 Estimated Savings			
	Electric Savings (kWh)		2287
	Electric Cost Savings ($)	$	72
	Baseline Natural Gas Usage (Therms)		0
	Proposed Natural Gas Usage (Therms)		0
	Natural Gas Savings (Therms)		0
	Natural Gas Savings ($)	$	-
	Annual Energy Cost Savings	$	72
Measure Cost & Simple Payback	Project Cost	$	100
	Simple Payback (Cost/Savings)		1.4

EEM 4 Reinstate Functionality of Rainwater Harvesting System

EXISTING CONDITIONS

The existing rain harvesting system is currently non-functional.

PROPOSED MEASURE DESCRIPTION

Reinstate functionality of rain water harvesting system.

SAVINGS METHODOLOGY

Calculations

System is capable of storing 15,685 gallons of rain water to use for gray water.

Month	Bill Amount ($)	Consumption (gal)	Cost per Gallon	Potential Rain Harvest (gal)
Jan	641.02	29314	0.022	15685
Feb	413.18	6614	0.062	15685
Mar	883.13	57091	0.015	15685
Apr	1050.81	78183	0.013	15685
May	983.43	65714	0.015	7842.5
Jun	944.41	58495	0.016	
Jul	811.82	47312	0.017	
Aug	708.19	39017	0.018	
Sep	610.68	29278	0.021	
Oct	572.04	23552	0.024	7842.5
Nov	295.24	12156	0.024	15685
Dec	295.24	12156	0.024	15685
	8209.19			

Total gallon per year		458882	gallon per year				109795	potential savings (gal)
Total Cost per year	$	8,209.19				$	1,964.18	potential savings ($)
Ave Cost per gallon =	$	0.02						
10 HP Pump to maintain pessure in system				7.42	kW			
Assume operates 2 hr per day				728	hr/year			
				5401.76	kWh			
			$	162.05	per yr to run pump			
			$	1,802.13	Cost saving (minus cost to run pump)			

EEM #4 Estimated Savings			
	Water Savings (Gal)		109795
	Water Cost Savings ($)	$	1,964
	Pump Energy (kWh)		5402
	Pump Eneergy Cost	$	162
	Annual Energy Cost Savings	$	1,802
Measure Cost & Simple Payback	Project Cost	$	1,500
	Simple Payback (Cost/Savings)		0.8

U.S. DEPARTMENT OF ENERGY Oregon State University Lane Community College

Appendix

Appendix 1 Photos

Figure A: Primary Lobby Lighting

Figure B: Pendant Hung Fixtures in Corridor

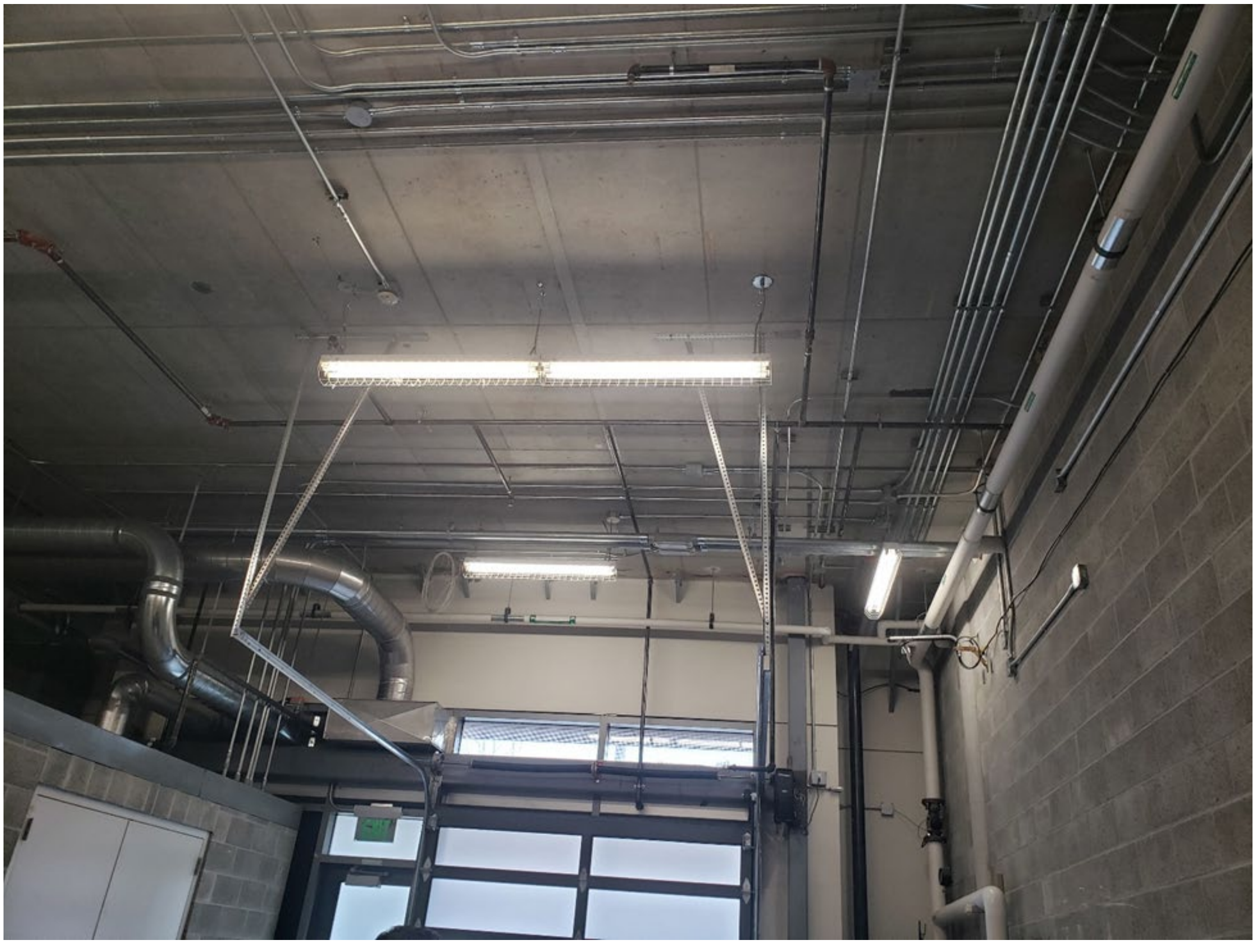


Figure C: Utility Bay Fixtures

Figure D: Rain Harvesting Storage and Pumps

Figure E : Roof Mounted Air Cooled Chiller (ACC-1)

Figure F: Roof Mounted PV Solar Array

Figure G: Roof Mounted General Restroom Exhaust Fan (EF-1)