



Yellowstone Airport Terminal
LEED Building Energy Performance Report
September 2023

Table of Contents

Executive Summary	2
Building Energy Performance Report	3
Introduction	3
Methodology	3
Building Details	4
Energy Simulation Details.....	9
Appendix.....	11
Lighting Summary Table	11
HVAC Summary Table	16
SolarWall	19
Energy Model Output Reports	22

Executive Summary

The Montana Department of Transportation - Division of Aeronautics (MDT) is building a new airport terminal building at the airfield in West Yellowstone, Montana. The new building is targeting certification under the United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEEDv4) program.

The table below indicates the energy efficiency components of the building design as it relates to LEED credits and cost savings. Key takweays include:

- ✓ The Proposed (X1) for the building is expected to gain 11 points under LEED EAc2 with using greenhouse gas and source energy as part of the savings calculation.

Annual Building Energy Performance Results							
#	Case	Electric Energy kWh	Natural Gas Energy therms	Electric Cost \$	Natural Gas Cost \$	Total Utility Cost \$	% Energy Cost Savings %
0	Baseline	318,677	9,562	\$ 24,074	\$ 13,133	\$ 37,207	0.0%
E1	0+Design Envelope	303,099	9,058	\$ 22,685	\$ 12,503	\$ 35,188	5.4%
L1	E1+Design Lighting	287,362	9,224	\$ 21,631	\$ 12,711	\$ 34,342	7.7%
M1	L1+Design Mechanical	272,414	5,416	\$ 20,484	\$ 7,950	\$ 28,434	23.6%
X1	M1+Solarwall	272,414	4,560	\$ 20,484	\$ 6,694	\$ 27,178	27.0%

EAC2 LEED Score Points	Source Energy MBTU	% Source Energy Savings %	CO2 Emissmisions kg	% GHG Savings %	EAP95 Savings %	EAP95 Savings LEED Score Points
0	4,418	0.0%	138,053	0.0%	0.0%	-
0	4,198	5.0%	131,110	5.0%	5.4%	-
1	4,047	8.4%	127,682	7.5%	8.0%	2
9	3,487	21.1%	103,364	25.1%	24.4%	10
11	3,397	23.1%	98,818	28.4%	27.7%	11

Building Energy Performance Report

Introduction

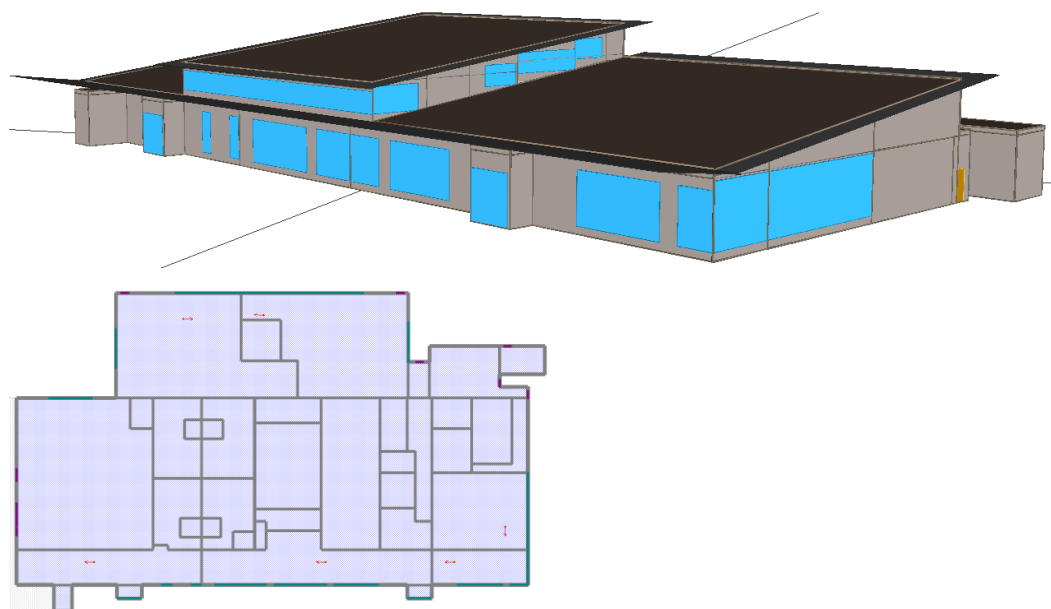
The Montana Department of Transportation - Division of Aeronautics (MDT) is building a new airport terminal building at the airfield in West Yellowstone, Montana. The new building is targeting certification under the United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEEDv4) program. This report is provided as supplemental information for a prerequisite and credit under this certification process, specifically the Energy and Atmosphere Prerequisite 2 (EA_p2), Minimum Energy Performance, and Energy and Atmosphere Credit 2 (EA_c2), Optimize Energy Performance.

Methodology

The energy modeling process was done using the eQUEST energy modeling software. A rendering of exterior of the building can be shown in the figure below, along with the 1st floor plan. The energy model is initially constructed using the [minimum requirements](#) ("baseline") for LEED v4 energy models. The model is then updated to reflect the current design though the incremental simulation runs to the proposed building systems that show the energy conservation measures ("ECMs") found in the design.

The simulation runs are categorized with the following acronyms:

- E – Envelope
- L – Lighting (Interior and Exterior)
- M – Mechanical / Domestic Hot Water ("DHW")
- X – Exceptional Calculations



Building Details

The following sections provide the inputs for the baseline energy model as well as the Proposed Design and possible ECMs.



Overview & Operation

The new building will contain the typical airport spaces: ticketing, baggage claim and screening, passenger check, circulation, and pre-boarding holding spaces. There will also administrative offices and public use space on the 2nd floor

The key expected operational assumptions of the new building are as follows:

- The airport will operate seasonally: Mid-May to Mid-October
 - A small number of full-time staff will operate year-round in 2nd floor offices
- The building operates with passengers 7:00am-7:00pm Monday-Sunday
 - Staff is expected 6:00am-8:00pm
 - This is based on the airport's [current flight schedule](#) as well as information provided from design team.
- Most of the building will be maintained at the design indoor conditions (74°F in cooling mode, 72°F in heating mode). Temperatures setpoints will be setback (82°F in summer, 64°F in winter) when the building is closed to save energy.
- During the off-season, the unused portion of the building is maintained at 50°F to prevent freezing



Location & Climate

The climate of West Yellowstone was approximated using weather data from Jackson Hole, Wyoming, which has a similar 'micro-climate'. The simulation used a TMY3 weather file, which consists of the average of a 30-year range of weather from 1976-2005.

The orientation of the building was set according to site plans.



Building Envelope

The following sections outline the thermal performance of the simulated building envelope components. Baseline values are based on LEEDv4 requirements: ASHRAE 90.1-2010 (Climate Zone 6). Surfaces not listed are modeled neutral to LEED v4 requirements.

Note – per Table G3.1.5 (a) (baseline) Exception 1, the baseline building is not required to rotate because the orientation is dictated by the site constraints. Specifically, the placement of the runway and the required flow of passengers determined how the building must be orientated.

Glazing

Baseline

Curtainwall/Storefront: U-0.45 (assembly), SHGC-0.40, VT-0.44

Proposed Design

Solarban 70XL (2) Clear - U-0.28 (glass), SHGC-0.27, VT-0.64 + thermally broken frames

Roof

Baseline

R-20ci Insulation Entirely Above Deck: U-0.048

Proposed Design

R-30ci Insulation Entirely Above Deck: U-0.032

Exterior Walls

Baseline

Steel-Framed R-13 (batt) + R7.5ci (continuous insulation): U-0.064

Proposed Design

Steel-Framed (16" OC) R-19 batt + R-7.5ci: U-0.060



Interior Lighting

The following sections list the lighting power density (LPD) of the energy model. Baseline values are based on LEEDv4 requirements: ASHRAE 90.1-2010 using the "Building Area Method" of lighting power allowance for a Transportation building. The design values reflect current drawings.

Lighting controls reflect final design values; any instance of occupancy sensors are given a 10% LPD credit per Table G3.2. This includes the applicable baseline LPD values in those spaces with mandatory occupancy sensors.

Baseline

LPD: **0.77 W/ft² (0.75 W/ft² with occupancy sensor impact)**

Proposed Design

LPD: **0.68 W/ft² (0.65 W/ft² with occupancy sensor impact)**



Exterior Lighting

The following sections outline the exterior lighting details of the energy model. Baseline values are based on LEEDv4 requirements: ASHRAE 90.1-2010. The Proposed Design reflect current design drawings. Lighting controls are neutral to LEEDv4 requirements.

Baseline

Zone 3: **7.27 kW**

Proposed Design

Per 100% CD Drawings: **5.49 kW**



Internal Loads

The internal loads on most interior spaces, such as occupancy and equipment, are based on industry standard values for energy modeling studies. Per LEED credit interpretation #10462, the enclosed offices are simulated with 20% higher equipment loads since they are not equipped with the mandatory occupancy controls.

Elevators and process exhaust fans were also accounted for separately.



HVAC & DHW

The following sections overview of the HVAC and Domestic Water Heating (DHW) equipment included in the energy model. Additional specific info can be found in the Appendix.

Baseline

The baseline primary HVAC system is determined from ASHRAE 90.1-2010; it is a packaged variable air volume (VAV) system with hot water (HW) reheat with a system per floor, though only the first floor has a unit. Controls reflect requirements of ASHRAE 90.1-2010, which include an air-side economizer, and a supply air temperature reset. Minimum flow at the VAV boxes are based on ventilation requirements or 30% of design values, whichever is less.

The HW system consists of 80% efficient natural draft boilers with variable primary pumping.

The heated-only transient spaces of the proposed design are represented with electric / natural gas unit heaters (matching the proposed heat source fuel) with minimum compliant efficiencies.

The IT room, electrical rooms, 2nd floor spaces, and kitchen have sufficiently different load and schedules to qualify for an exceptional system type: packaged DX with minimum compliant efficiencies and control strategies per baseline requirements.

Proposed Design

The proposed design primary HVAC system is like the baseline: a DX VAV system with hot water reheat. Two (2) AHUs will serve the building: AHU-1 serves the circulation, holding, and baggage handling areas and AHU-2 serves the 2nd floor, concession, TSA offices, and ticketing areas. The 2nd floor offices will be occupied year-round by airport staff.

The AHUs will have an air-side economizer, DCV controls, and supply air temperature and static pressure reset sequences. The duct static pressure was modeled using a fan curve from the Advanced Variable Air Volume VAV System Design Guide. The AHUs have 11.5 EER cooling efficiencies.

The AHUs' outdoor air is preheated using a [SolarWall](#), a highly absorptive perforated metal intake screen. **This is included as an exceptional calculation for credit under LEED EAc2.** See Appendix for detailed inputs that shows the inclusion of the SolarWall in the drawings, the modeling settings that were used to extract the surface temperature, and a screenshot of the hourly (conservative) Excel calculation used to calculate savings. The hourly calculation has been provided for review as well.

The kitchen is served by a make-up air unit (MAU) to condition the space and replace the air leaving from the kitchen exhaust fans (KEFs). The MAU uses DX cooling (11.2 EER condensing unit) and hot water heat. The MAU operates with DCV based on KEF operation (from kitchen heat). DCV is not required in the baseline kitchen space.

Yellowstone Airport Terminal

The HW system will consist of two 96% efficiency condensing boilers variable primary pumping. The system will provide 160°F water with a 40°F return temperature. This system will also serve a snow-melt system, which is also found in the Baseline system.

Transient spaces, such as vestibules, as well as critical spaces like the MEP rooms will be conditioned with HW unit heaters. There are a couple electric wall heaters serving similar purposes that are neutral to the baseline.

The IT and electric rooms have dedicated, high efficiency split system air conditioners.

DHW Heating

DHW loads consist of miscellaneous kitchen and restroom lavatories. These are modeled as neutral.

The main DHW system uses natural gas storage water heaters. These are minimal efficiency in the baseline and high efficiency in the proposed case.



Renewable Energy Systems

No renewable energy generating systems will be installed.



Utility Rates

The actual utility rates of the airport were used to calculate utility cost savings:

Electric (Fall River Rural Electric Cooperative):

- Monthly service charge: \$59.00/month
- Energy Rate: \$0.05284/kWh
- Peak Demand Rate: \$6.80/kW

Natural Gas (Energy West):

- Monthly service charge: \$98.35/month
- Energy Rate: \$1.25/therm

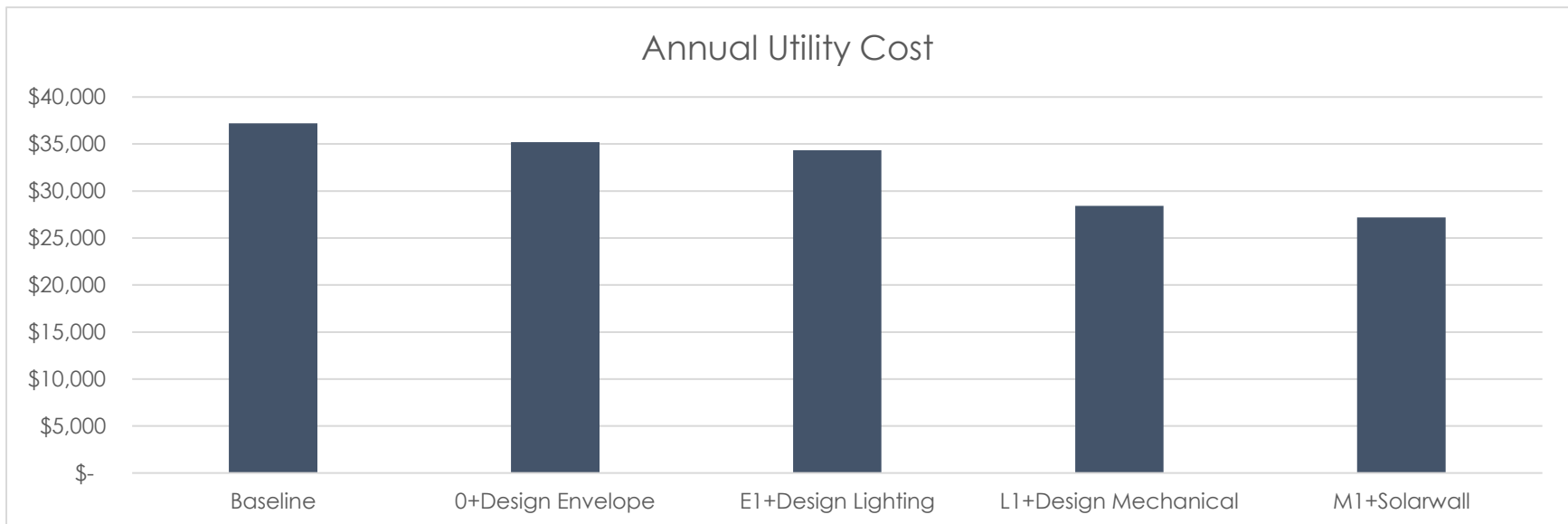
Energy Simulation Details

The energy simulation results are shown in the following sections.

Simulation Results

Annual Building Energy Performance Results							
#	Case	Electric Energy	Natural Gas Energy	Electric Cost	Natural Gas Cost	Total Utility Cost	% Energy Cost Savings
		kWh	therms	\$	\$	\$	%
0	Baseline	318,677	9,562	\$ 24,074	\$ 13,133	\$ 37,207	0.0%
E1	0+Design Envelope	303,099	9,058	\$ 22,685	\$ 12,503	\$ 35,188	5.4%
L1	E1+Design Lighting	287,362	9,224	\$ 21,631	\$ 12,711	\$ 34,342	7.7%
M1	L1+Design Mechanical	272,414	5,416	\$ 20,484	\$ 7,950	\$ 28,434	23.6%
X1	M1+Solarwall	272,414	4,560	\$ 20,484	\$ 6,694	\$ 27,178	27.0%

EAC2 LEED Score	Source Energy	% Source Energy Savings	CO2 Emissions	% GHG Savings	EAP95 Savings	EAP95 Savings LEED Score
Points	MBTU	%	kg	%	%	Points
0	4,418	0.0%	138,053	0.0%	0.0%	-
0	4,198	5.0%	131,110	5.0%	5.4%	-
1	4,047	8.4%	127,682	7.5%	8.0%	2
9	3,487	21.1%	103,364	25.1%	24.4%	10
11	3,397	23.1%	98,818	28.4%	27.7%	11

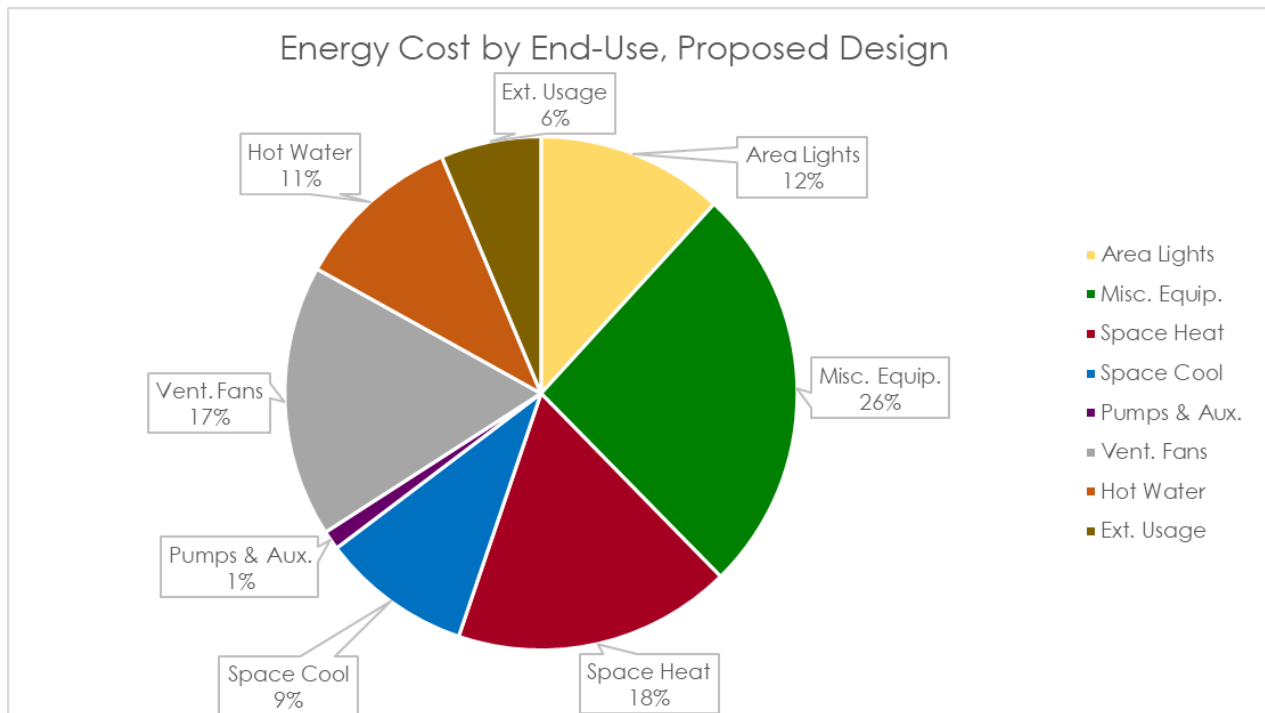




Simulation Analysis

The following are the key takeaways from the ECMs:

1. The Proposed Design (through X1) is expected to gain 11 LEED points.
 - Additional savings is gained through the use of a pilot credit (EApC 95) that accounts for greenhouse gas and source energy performance as alternative performance metrics from energy cost.
2. The building envelope and orientation is very efficient, enabling the project to gain more savings than most projects.
3. Lighting energy usage is a small fraction of energy use, due primarily to a small site (and thus limited exterior lighting needs) and only seasonal operation.
4. The HVAC design combined with the control sequences allow for significant energy savings through efficiency gains as well as limiting reheat and outside air heating.



Appendix

Lighting Summary Table

Interior Lighting

Space Name	Space Area (ft ²)	Building Type	Space Type	Baseline Lighting			Proposed Lighting		
				Lighting W	Lighting W/sf	Mandatory Occupancy Sensor?	Lighting W	Lighting W/sf	Lighting Controls
Fire Riser 134	92	Transportation	Mechanical	70.84	0.77	No	34.00	0.37	OS
Concourse-A 100A	1,284	Transportation	Transportation-Concourse	988.68	0.77	No	736.00	0.57	PC
Vestibule-A 135	66	Transportation	Corridor	50.82	0.77	No	90.00	1.36	
Baggage Claim 132	3,919	Transportation	Transportation-Baggage Area	3,017.25	0.77	No	3,428.00	0.87	
Women Restroom 180	584	Transportation	Restrooms	449.30	0.77	Yes	586.00	1.00	OS
Lactation 182	81	Transportation	Locker Room	62.22	0.77	Yes	144.00	1.78	OS
Family Restroom 183	72	Transportation	Restrooms	55.67	0.77	Yes	144.00	1.99	OS
Men Restroom 181	592	Transportation	Restrooms	455.84	0.77	Yes	522.00	0.88	OS
Elevator E-1	76	Transportation	Seperately Modeled (Elev, Walk-in, Shaft)	-	-	No	-	-	
Women Restroom 176	700	Transportation	Restrooms	538.62	0.77	Yes	596.00	0.85	OS

Yellowstone Airport Terminal

Lactation 174	64	Transportation	Locker Room	49.13	0.77	Yes	144.00	2.26	OS
Men Restroom 177	754	Transportation	Restrooms	580.20	0.77	Yes	650.00	0.86	OS
Family Restroom 175	81	Transportation	Restrooms	62.22	0.77	Yes	144.00	1.78	OS
Concourse B,C 101-102	1,789	Transportation	Transportation-Concourse	1,377.76	0.77	No	1,817.00	1.02	PC
Land Side Concessions 153	260	Transportation	Retail-Sales Area	200.43	0.77	No	132.00	0.51	
Kitchen 130	1,121	Transportation	Food Preparation	863.17	0.77	No	306.00	0.27	OS
Air Side Concessions 151	325	Transportation	Retail-Sales Area	249.87	0.77	No	244.00	0.75	
TSA Screening 111	1,742	Transportation	Transportation-Concourse	1,341.34	0.77	No	1,232.00	0.71	
Vestibule-B 136	66	Transportation	Corridor	50.82	0.77	No	90.00	1.36	
TSA 173	381	Transportation	Break Room	292.99	0.77	Yes	264.00	0.69	OS
Stair-B 110,122	282	Transportation	Stairs	217.14	0.77	No	156.00	0.55	OS
Circulation 112A	152	Transportation	Corridor	117.04	0.77	No	68.00	0.45	OS
Holdroom 125	2,993	Transportation	Transportation-Concourse	2,304.84	0.77	No	927.00	0.31	PC
Bar 118	315	Transportation	Dining (Bar Lounge/Leisure Dining)	242.55	0.77	No	667.44	2.12	
Holdroom 123	2,714	Transportation	Transportation-Concourse	2,089.40	0.77	No	1,078.00	0.40	PC
Concourse-D 103	659	Transportation	Transportation-Concourse	507.28	0.77	No	401.00	0.61	PC

Yellowstone Airport Terminal

Ticketing Counter 104	1,445	Transportation	Transportation-Ticket Counter	1,112.65	0.77	No	2,291.70	1.59	PC
ATO Office 113	341	Transportation	Office (Enclosed)	262.80	0.77	Yes	297.00	0.87	OS
ATO Office 117	236	Transportation	Office (Enclosed)	181.95	0.77	Yes	165.00	0.70	OS
TSA IT 107	63	Transportation	IDF	48.13	0.77	No	34.00	0.54	OS
Corridor 132B	135	Transportation	Corridor	103.95	0.77	No	50.00	0.37	
TSA 108	240	Transportation	Office (Enclosed)	185.03	0.77	Yes	132.00	0.55	OS
Circulation 112B	491	Transportation	Corridor	378.07	0.77	No	170.00	0.35	OS
Circulation 114	303	Transportation	Corridor	233.31	0.77	No	170.00	0.56	OS
ATO Office 115-116	522	Transportation	Office (Enclosed)	401.94	0.77	Yes	297.00	0.57	OS
Bag Screening 119A	776	Transportation	Transportation-Baggage Area	597.14	0.77	No	408.00	0.53	OS
Main Electrical Vault 120	250	Transportation	Electrical	192.50	0.77	No	68.00	0.27	
TSA 109	147	Transportation	Office (Enclosed)	113.42	0.77	Yes	66.00	0.45	OS
1st Floor Plenum		Transportation	Seperately Modeled (Elev, Walk-in, Shaft)	-	-	No	-	-	
Boiler 215	462	Transportation	Mechanical	355.74	0.77	No	204.00	0.44	
MEP Parts and Maintenance 221	278	Transportation	Workshop	213.68	0.77	No	102.00	0.37	OS
MEP 216	1,642	Transportation	Mechanical	1,264.34	0.77	No	374.00	0.23	
Breakroom 222	234	Transportation	Break Room	180.18	0.77	Yes	136.00	0.58	OS

Yellowstone Airport Terminal

Airport IT 208	143	Transportation	IDF	110.11	0.77	No	68.00	0.48	OS
Rental Car IT 205	85	Transportation	IDF	65.45	0.77	No	68.00	0.80	OS
Storage 204A	145	Transportation	Storage Active	111.65	0.77	Yes	80.00	0.55	OS
Reception 200	449	Transportation	Office (Open Plan)	345.96	0.77	No	269.00	0.60	OS
Restroom 203	115	Transportation	Restrooms	88.40	0.77	Yes	86.00	0.75	OS
Conference 202	290	Transportation	Conference/Meeting	223.53	0.77	Yes	198.00	0.68	OS
Office 201	128	Transportation	Office (Enclosed)	98.79	0.77	Yes	66.00	0.51	OS
Stairs-B S-B	198	Transportation	Stairs	152.46	0.77	No	44.00	0.22	OS
Stairs-A S-A2	157	Transportation	Stairs	120.74	0.77	No	90.00	0.57	OS
Elevator E-2	72	Transportation	Seperately Modeled (Elev, Walk-in, Shaft)	-	-	No	-	-	
Circulation 212	907	Transportation	Corridor	698.62	0.77	No	690.00	0.76	
OPEN TO BELOW 200B		Transportation	Seperately Modeled (Elev, Walk-in, Shaft)	-	-	No	-	-	
Corridor 204B	127	Transportation	Corridor	97.41	0.77	No	68.00	0.54	OS
Copy/Print 200A	93	Transportation	Corridor	71.61	0.77	No	34.00	0.37	OS
Corridor 213	266	Transportation	Corridor	204.82	0.77	No	136.00	0.51	OS
2nd Floor Plenum		Transportation	Seperately Modeled (Elev, Walk-in, Shaft)	-	-	No	-	-	

Yellowstone Airport Terminal

Exterior Lighting

Surface Name	Surface Type	Allowance	Measured Area	Units	Total Allowance	Total Design Watts	
	Base Site Allowance	750.00	n/a	Watts	750.00		
(Plan) West Covered Entry	Entry Canopies	0.40	3,489.00	ft2	1,395.60	1,072	
(Plan) East Covered Entry	Entry Canopies	0.40	2,408.00	ft2	963.20	836	
Other Doors	Other doors	20.00	59.00	Linear ft	1,180.00	578	
Airstrip Walkways	Walkways greater than 10 ft wide	0.16	16,400.00	ft2	2,624.00	2,923	
Main Entry Doors	Main entries	30.00	12.00	Linear ft	360.00	76	
					Baseline	Proposed	
					Total (W)	7,272.80	5,485.00
					Total (kW)	7.27	5.49

Code: ASHRAE 90.1-2010 Zone 3

Yellowstone Airport Terminal

HVAC Summary Table

Baseline - Airside

Unit Name	Total Area Served sf	# of Units	System Type	Supply Airflow CFM	Outside Airflow CFM	Supply Fan kW	Return Fan kW	Exhaust Fan kW	Total Fan kW	Cooling Capacity Btu/h	Heating Capacity Btu/h	Cooling Efficiency	Heating Efficiency
AHU-1	23,942	1	System #5: Pkgd VAV	28,174	5,212	22.49	12.11	-	34.60	987,057	1,454,638	9.5 EER	(HW)
VAV-201	1,064	1	System #3: Pkgd AC	855	234	0.92	-	-	0.92	25,711	44,794	13 SEER	80%
VAV-202	290	1	System #3: Pkgd AC	645	64	0.70	-	-	0.70	18,575	20,042	13 SEER	80%
VAV-203	128	1	System #3: Pkgd AC	357	28	0.39	-	-	0.39	9,831	10,251	13 SEER	80%
VAV-204	669	1	System #3: Pkgd AC	557	147	0.60	-	-	0.60	16,698	28,520	13 SEER	80%
VAV-205	234	1	System #3: Pkgd AC	202	52	0.22	-	-	0.22	6,023	10,102	13 SEER	80%
VAV-206	278	1	System #3: Pkgd AC	239	61	0.25	-	-	0.25	7,143	11,979	13 SEER	80%
MAU-1	1,121	1	System #4: Pkgd HP	2,730	2,730	1.26	-	1.37	2.63	117,090	503,814	10.8 EER	80%
FC-1A	63	1	System #4: Pkgd HP	242	-	0.21	-	-	0.21	6,268	6,193	13 SEER	7.7 HPSF
FC-2A	250	1	System #4: Pkgd HP	356	-	0.30	-	-	0.30	9,216	9,105	13 SEER	7.7 HPSF
FC-3A	143	1	System #4: Pkgd HP	554	-	0.47	-	-	0.47	14,331	14,159	13 SEER	7.7 HPSF
FC-4A	85	1	System #4: Pkgd HP	333	-	0.28	-	-	0.28	8,685	8,580	13 SEER	7.7 HPSF
HW Unit Heaters	2,654	6	System #9: Gas Furnace	1,908	-	0.57	-	-	0.57	-	39,194	n/a	80%
Elec Unit Heater	207	2	System #10: Electric Unit Heater	234	-	0.07	-	-	0.07	-	4,801	n/a	1.0 COP
Unconditioned Sys	773	0	n/a	-	-	-	-	-	-	-	-	n/a	n/a
Totals	31,901	20		37,386	8,528	28.73	12.11	1.37	42.20	1,226,628	2,166,172		

Proposed - Airside

Unit Name	Total Area Served sf	# of Units	System Type	Supply Airflow CFM	Outside Airflow CFM	Supply Fan kW	Return Fan kW	Exhaust Fan kW	Total Fan kW	Cooling Capacity Btu/h	Heating Capacity Btu/h	Cooling Efficiency	Heating Efficiency
AHU-1	13,361	1	DX VAV AHU	19,565	5,106	19.40	11.53	-	30.93	480,000	785,255	11.5 EER	(HW)
AHU-2	13,244	1	DX VAV AHU	25,260	4,092	27.02	16.50	-	43.53	464,000	929,020	11.5 EER	(HW)
MAU-1	1,121	1	SZVAV MAU	2,730	2,730	5.37	-	1.85	7.22	136,900	300,000	11.2 EER	(HW)
FC-1A	63	1	Split AC	706	-	0.14	-	-	0.14	30,000	-	19.3 SEER	n/a
FC-2A	250	1	Split AC w/EWH	770	-	0.15	-	-	0.15	36,000	3,412	17.9 SEER	1.0 COP
FC-3A	143	1	Split AC	770	-	0.15	-	-	0.15	36,000	-	17.9 SEER	n/a
FC-4A	85	1	Split AC	770	-	0.15	-	-	0.15	36,000	-	17.9 SEER	n/a
HW Unit Heaters	2,654	6	HW Unit Heater	5,130	-	0.36	-	-	0.36	-	199,146	n/a	(HW)
Elec Unit Heater	207	2	Elec Wall Heater	-	-	-	-	-	-	-	6,824	n/a	1.0 COP
Unconditioned Sys	773	0	Electric Unit heater	-	-	-	-	-	-	-	-	n/a	n/a
Totals	31,901	15		55,701	11,929	52.75	28.03	1.85	82.63	1,218,900	2,223,657		

Yellowstone Airport Terminal

Baseline – Waterside

Circulation Loops				
Loop Name	Type	Storage Gal	Heating Btu/h	Heating Eff
(ASH) HW Loop	Hot Water	-	n/a	n/a
Gas DHW Loop	Domestic Hot Water	238	800,000	80%

Boilers						
Boiler Name	Type	HW Loop	Heating Btu/h	Flow GPM	Efficiency %	Aux kW
(ASH) B-1	HW Boiler	(ASH) HW Loop	776,105	31.1	80%	0
(ASH) B-2	HW Boiler	(ASH) HW Loop	776,105	31.1	80%	0

Pumps								
Pump Name	Attached to	Circulation Loop	# of Pumps	Flow GPM	Head ft	Power kW	Pump Efficiency %	Motor Efficiency %
(ASH) HWP-(sec)	Circulation Loop	(ASH) HW Loop	1	62	60	1.18	70.0%	85.0%

Yellowstone Airport Terminal

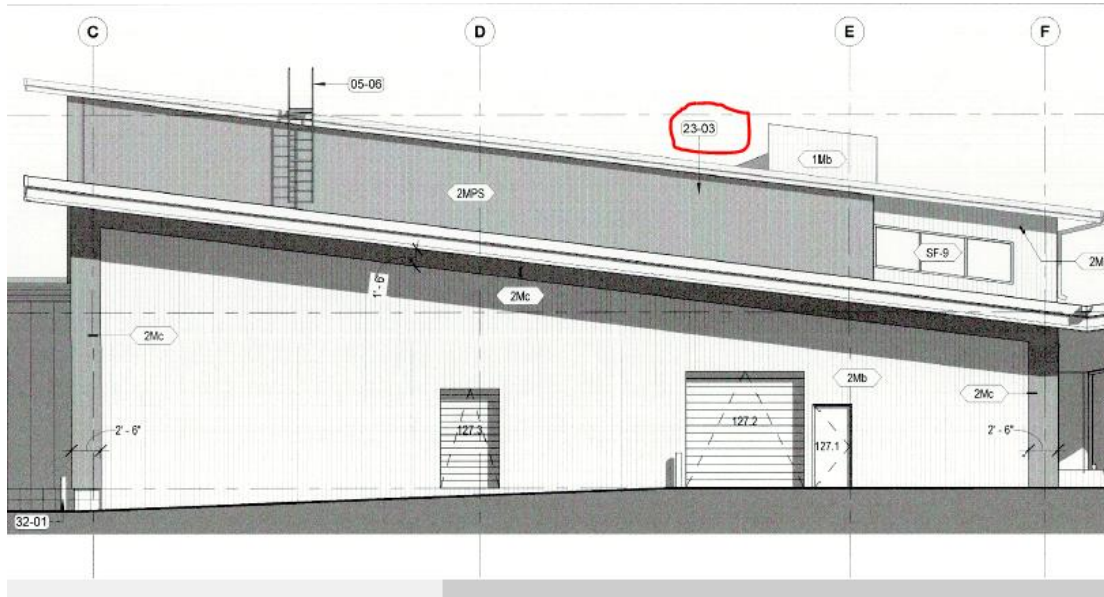
Proposed – Waterside

Circulation Loops				
Loop Name	Type	Storage Capacity Gal	Heating Capacity Btu/h	Heating Eff
HW Loop	Hot Water	-	n/a	n/a
Gas DHW Loop	Domestic Hot Water	238	800,000	95%

Boilers						
Boiler Name	Type	HW Loop	Heating Btu/h	Flow GPM	Efficiency %	Aux kW
B-1	Condensing HW Boiler	HW Loop	2,452,000	123.2	96%	1.50
B-2	Condensing HW Boiler	HW Loop	2,452,000	123.2	96%	1.50

Pumps									
Pump Name	Attached to	Circulation Loop	# of Pumps	Flow GPM	Head ft	Power kW	Pump Efficiency %	Motor Efficiency kW	
HWP-1,2	Circulation Loop	HW Loop	2	400	80	8.77	75.0%	91.7%	

SolarWall



KEYNOTES

- 05-06 CROSS OVER LADDER LAD-1
- 07-07 DOWNSPOUT FROM SECOND STORY ROOF TO LOWER ROOF DRAINS
- 08-01 ROOF HATCH HATCH-1
- 23-02 MECHANICAL LOUVER - COORDINATE PENETRATION W/ MECHANICAL
- 23-03 HATCH INDICATES AREA OF SOLAR WALL
- 32-01 CONCRETE-FILLED STEEL BOLLARD

SOLAR WALL AND SOLAR WALL BYPASS CONTROLLER

- PRIMARY SOURCE OF OUTSIDE AIR WILL BE SOLAR WALL, WITH SOLAR WALL DAMPER OPEN AND BYPASS DAMPER CLOSED, EXCEPT AS NEEDED FOR PRESSURE CONTROL.
- AS OUTSIDE AIR MIXED AIR TEMPERATURE RISES ABOVE MINIMUM DISCHARGE AIR TEMPERATURE SET-POINT BETWEEN THE TWO AIR HANDLING UNITS, SOLAR WALL BYPASS DAMPER SHALL MODULATE OPEN. AS OUTSIDE AIR MIXED AIR TEMPERATURE CONTINUES TO RISE, SOLAR WALL DAMPER SHALL MODULATE CLOSED.
- OUTSIDE AIR INTAKE PLENUM PRESSURE CONTROL
- SOLAR WALL BYPASS DAMPER WILL ALSO MODULATE TO PREVENT INTAKE DUCT FROM BECOMING TOO NEGATIVE. THE MINIMUM POSITION FOR THIS DAMPER WILL ADJUST TO MAINTAIN THE SOLAR WALL OA PRESSURE. THE SET-POINT FOR THIS PRESSURE WILL BE SET BY TEST AND BALANCE. INITIAL VALUE SHOULD BE -0.1" W.C.

RETURN AIR DAMPER

Hourly Results Selection ✕

Select Report or Block to View/Edit:

- Hourly Report
 - GLOBAL Blk
 - Wall Temp
 - AHU 1 Blk
 - AHU 2 Blk
- EM1 Hourly Report Block
- FM1 Hourly Report Block

Report Block Name:

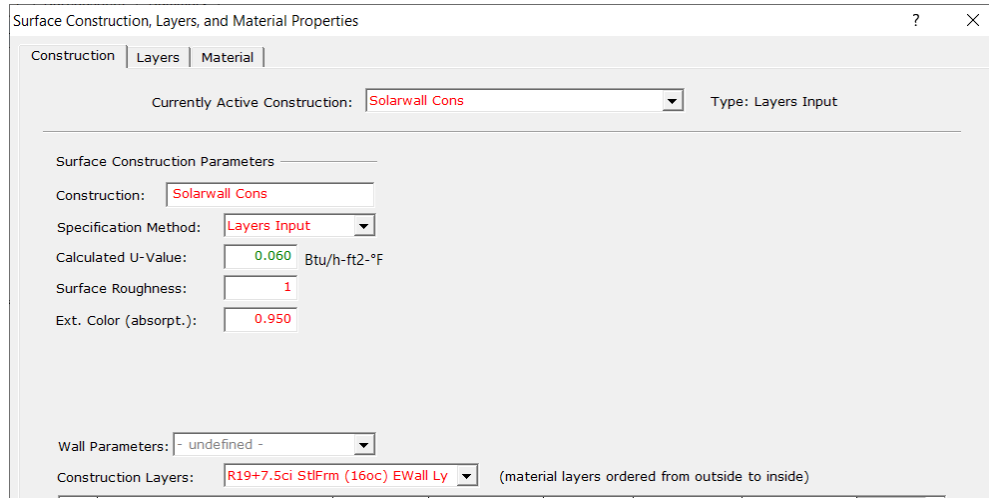
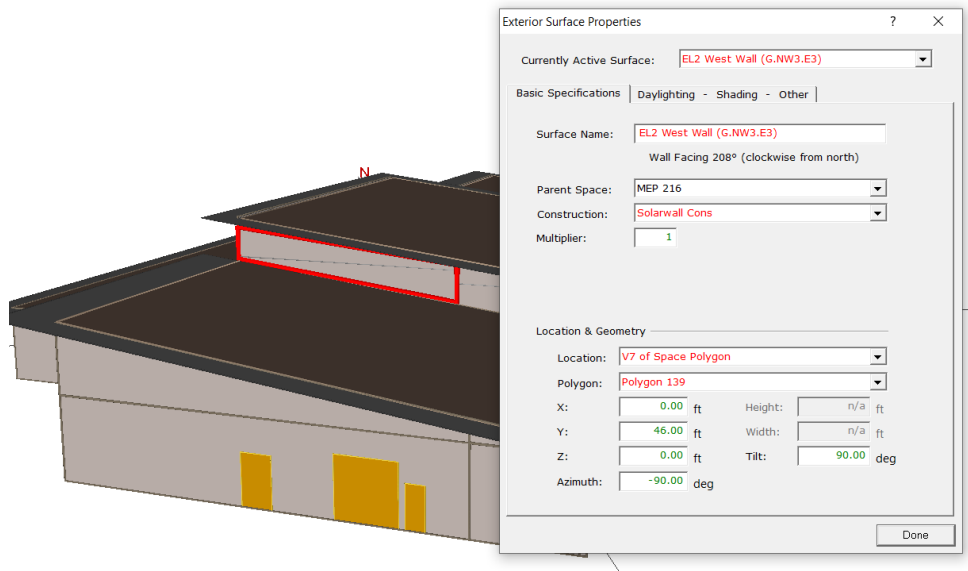
Variable Type:

Building Component:

Selected Hourly Results Series:

- Total solar rad on wall after shading (Btu/Hr-Ft2)
- Outside surface temp for delayed walls (Rankine)
- Fraction of wall shaded from direct solar rad
- Outside air film U-value

Yellowstone Airport Terminal



Yellowstone Airport Terminal

C:\Users\lgree\OneDrive - G2 Energy Solutions\Shared Documents\Inputs

Simulated: 2023-Sep-13 14:26:51

CSV Written: 2023-Sep-13 14:32:17

eQUEST 3.65.7175

Contact Factor **75%**

Boiler Eff **85%**

Preheat Savings: 856 therms
\$ 1,113

Pasted Data from Hourly Report

OA Heating Limit **55.00**
 OA to limit OA Preheat **55.00**
 Max OA heating above 55°F **65.00**

Ave DT
10.25

Month	Day	Hour	Type	Outside dry-bulb temp (F)	Total solar rad on wall after shading (Btu/Hr-Ft2)	Outside surface temp for delayed walls (Rankine)	Wall Surface Temp (F)	Winter/Summer (Summer =1)	Total system OA air flow rate (cfm)	Solarwall On Flag	Air Temp After SolarWall	SolarWall Preheat DT	Preheat Savings (MBTU)
1	1	1	8	25	-	481.76	23.09	-	-	0	-		0
9	26	12	7	61	26.93	524.39	65.72	1	22,906	0	-		0
9	26	13	7	64	50.78	538.92	80.25	1	23,326	0	-		0

Energy Model Output Reports

Baseline – Building Energy Performance

REPORT- BEPS Building Energy Performance

WEATHER FILE- JACKSON HOLE WY

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	175.5	0.0	308.6	8.1	177.6	0.0	11.4	295.3	0.0	2.8	0.0	108.3	1087.6
FM1 NATURAL-GAS													
MBTU	0.0	0.0	35.6	675.8	0.0	0.0	0.0	0.0	0.0	0.0	244.8	0.0	956.2
MBTU	175.5	0.0	344.2	683.9	177.6	0.0	11.4	295.3	0.0	2.8	244.8	108.3	2043.8

TOTAL SITE ENERGY 2043.85 MBTU 61.7 KBTU/SQFT-YR GROSS-AREA 61.7 KBTU/SQFT-YR NET-AREA
 TOTAL SOURCE ENERGY 4219.12 MBTU 127.3 KBTU/SQFT-YR GROSS-AREA 127.3 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 3.12
 PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
 HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 28
 HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 245

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Baseline – Building Utility Performance

REPORT- BEPU Building Utility Performance

WEATHER FILE- JACKSON HOLE WY

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
KWH	51421.	0.	90411.	2370.	52035.	0.	3339.	86537.	0.	833.	0.	31731.	318677.
FM1 NATURAL-GAS													
THERM	0.	0.	356.	6758.	0.	0.	0.	0.	0.	0.	2448.	0.	9562.

TOTAL ELECTRICITY 318677. KWH 9.618 KWH /SQFT-YR GROSS-AREA 9.618 KWH /SQFT-YR NET-AREA
 TOTAL NATURAL-GAS 9562. THERM 0.289 THERM /SQFT-YR GROSS-AREA 0.289 THERM /SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 3.12
 PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
 HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 28
 HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 245

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Baseline – Energy Cost Summary

REPORT- ES-D Energy Cost Summary

WEATHER FILE- JACKSON HOLE WY

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE (\$)	VIRTUAL RATE (\$/UNIT)	RATE USED ALL YEAR?
Fall River Elec Rate	ELECTRICITY	EM1	318677. KWH	24074.	0.0755	YES
Energy West Gas Rate	NATURAL-GAS	FM1	9562. THERM	13133.	1.3734	YES
				=====		
				37206.		
ENERGY COST/GROSS BLDG AREA:				1.12		
ENERGY COST/NET BLDG AREA:				1.12		

Proposed Design – Building Energy Performance

REPORT- BEPS Building Energy Performance

WEATHER FILE- JACKSON HOLE WY

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
E1 ELECTRICITY													
MBTU	152.3	0.0	317.5	18.8	122.5	0.0	15.6	221.3	0.0	0.0	0.0	81.8	929.7
F1 NATURAL-GAS													
MBTU	0.0	0.0	24.1	312.0	0.0	0.0	0.0	0.0	0.0	0.0	205.5	0.0	541.6
MBTU	152.3	0.0	341.5	330.9	122.5	0.0	15.6	221.3	0.0	0.0	205.5	81.8	1471.3

TOTAL SITE ENERGY 1471.31 MBTU 44.4 KBTU/SQFT-YR GROSS-AREA 44.4 KBTU/SQFT-YR NET-AREA
 TOTAL SOURCE ENERGY 3330.79 MBTU 100.5 KBTU/SQFT-YR GROSS-AREA 100.5 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 1.08
 PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
 HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
 HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 95

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Proposed Design – Building Utility Performance

REPORT- BEPU Building Utility Performance

WEATHER FILE- JACKSON HOLE WY

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
KWH	44623.	0.	93013.	5520.	35889.	0.	4559.	64849.	0.	0.	0.	23962.	272414.
FM1 NATURAL-GAS													
THERM	0.	0.	241.	3120.	0.	0.	0.	0.	0.	0.	2055.	0.	5416.

TOTAL ELECTRICITY	272414. KWH	8.222 KWH /SQFT-YR GROSS-AREA	8.222 KWH /SQFT-YR NET-AREA
TOTAL NATURAL-GAS	5416. THERM	0.163 THERM /SQFT-YR GROSS-AREA	0.163 THERM /SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 1.08
 PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
 HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
 HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 95

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Proposed Design – Energy Cost Summary

REPORT- ES-D Energy Cost Summary

WEATHER FILE- JACKSON HOLE WY

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE (\$)	VIRTUAL RATE (\$/UNIT)	RATE USED ALL YEAR?
Fall River Elec Rate	ELECTRICITY	EM1	272414. KWH	20484.	0.0752	YES
Energy West Gas Rate	NATURAL-GAS	FM1	5416. THERM	7950.	1.4679	YES
				=====		
				28434.		
ENERGY COST/GROSS BLDG AREA:				0.86		
ENERGY COST/NET BLDG AREA:				0.86		

Exceptional Calculation – Building Energy Performance

REPORT- BEPS Building Energy Performance												WEATHER FILE- JACKSON HOLE		WY
	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL	
EM1 ELECTRICITY														
MBTU	152.3	0.0	317.5	18.8	122.5	0.0	15.6	221.3	0.0	0.0	0.0	81.8	929.7	
FM1 NATURAL-GAS														
MBTU	0.0	0.0	24.1	312.0	0.0	0.0	0.0	0.0	0.0	0.0	205.5	0.0	541.6	
MBTU	152.3	0.0	341.5	330.9	122.5	0.0	15.6	221.3	0.0	0.0	205.5	81.8	1471.3	

TOTAL SITE ENERGY 1471.31 MBTU 44.4 KBTU/SQFT-YR GROSS-AREA 44.4 KBTU/SQFT-YR NET-AREA
 TOTAL SOURCE ENERGY 3330.79 MBTU 100.5 KBTU/SQFT-YR GROSS-AREA 100.5 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 1.08
 PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
 HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0
 HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 95

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Note – Excel calculation calculated savings – there is no difference in simulated usage as savings is manually subtracted.

Exceptional Calculation – Building Utility Performance

REPORT- BEPU Building Utility Performance												WEATHER FILE- JACKSON HOLE		WY
	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL	
EM1 ELECTRICITY														
KWH	44623.	0.	93013.	5520.	35889.	0.	4559.	64849.	0.	0.	0.	23962.	272414.	
FM1 NATURAL-GAS														
THERM	0.	0.	241.	3120.	0.	0.	0.	0.	0.	0.	2055.	0.	5416.	
TOTAL ELECTRICITY			272414. KWH	8.222 KWH /SQFT-YR GROSS-AREA			8.222 KWH /SQFT-YR NET-AREA							
TOTAL NATURAL-GAS			5416. THERM	0.163 THERM /SQFT-YR GROSS-AREA			0.163 THERM /SQFT-YR NET-AREA							
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 1.08														
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00														
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 0														
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 95														
NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.														

Note – Excel calculation calculated savings – there is no difference in simulated usage as savings is manually subtracted.

Exceptional Calculation – Energy Cost Summary

REPORT- ES-D Energy Cost Summary WEATHER FILE- JACKSON HOLE WY

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE (\$)	VIRTUAL RATE (\$/UNIT)	RATE USED ALL YEAR?
Fall River Elec Rate	ELECTRICITY	EM1	272414. KWH	20484.	0.0752	YES
Energy West Gas Rate	NATURAL-GAS	FM1	5416. THERM	7950.	1.4679	YES
				=====		
				28434.		
				ENERGY COST/GROSS BLDG AREA:	0.86	
				ENERGY COST/NET BLDG AREA:	0.86	

Note – Excel calculation calculated savings – there is no difference in simulated usage as savings is manually subtracted.