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Energy Modeling for the Artisan Food Center

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May 2013

Pacific Northwest
NATIONAL LABORATORY

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Pacific Northwest National Laboratory
Richland, Washington 99352

1.0 Energy Modeling for the Artisan Food Center

1.1 Overview

The Artisan Food Center is a 6912 sq.ft food processing plant located in Dayton, Washington. PNNL was contacted by Strecker Engineering to assist with the building's energy analysis as a part of the project's U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) submittal requirements. The project is aiming for LEED Silver certification, one of the prerequisites to which is a whole building energy model to demonstrate compliance with American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) 90.1 2007 Appendix G, Performance Rating Method. The building incorporates a number of energy efficiency measures as part of its design and the energy analysis aimed at providing Strecker Engineering with the know-how of developing an energy model for the project as well as an estimate of energy savings of the proposed design over the baseline design, which could be used to document points in the LEED documentation.

This report documents the ASHRAE 90.1 2007 baseline model design, the proposed model design, the modeling assumptions and procedures as well as the energy savings results in order to inform the Strecker Engineering team on a possible whole building energy model.

1.2 Model Description

The food-processing center is comprised of seven suites expected to be leased to different food processing companies. The figure below shows a 3D view of the energy model of the building.

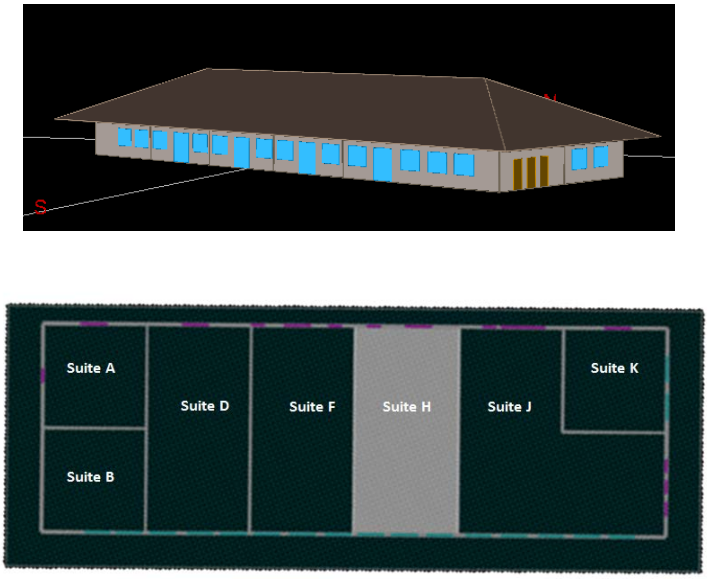

Figure 1. 3D View and Plan of the Artisan Food Center

The models are set in climate zone (CZ) 5B, which is a cool-dry climate which is defined as a region with between 5,400 e and 9,000 heating degree-days (65°F basis)[1].

[1] http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/ba_climateguide_7_1.pdf

1.3 Envelope: Baseline and Proposed

Table 1. Envelope Properties for both Proposed and Baseline Design

Component	Proposed Construction		Baseline Construction (90.1 2007 CZ 5B)	
Exterior Wall	2 x 6 Wood Frame Wall, 16 " OC Batt Insulation	R-21	Steel Framed (2 x 6, 16" OC)	U-0.064 Btu/h-ft2-F R-13 + R-7.5
Exterior Roof	24" OC Wooden Truss Batt Insulation at the ceiling	R-49	Insulation above deck	U-0.048 Btu/h-ft2-F R-20 ci
Fenestration	Metal Framing	U-0.45 Btu/h-ft2-F [2]SHGC-0.35	Metal Framing (All Other)	U-0.55 Btu/h-ft2-F SHGC-0.40
Exterior Floor	Slab-on-Grade	R-10 for 24"	Slab-on-Grade	R-10 for 24"
Door	Metal Door	U-0.500 Btu/h-ft2-F	Metal Door	U-0.500 Btu/h-ft2-F

The proposed building envelope is more efficient than the code requirements and results is lower heating and cooling loads.

1.4 Interior Lighting

Table 2. Lighting Power Density (LPD) for Proposed and Baseline Design

	90.1 Space Type	Area (sq.ft)[3]	Proposed Design Total Watts (W)	Proposed Design LPD W/sq.ft	Baseline Design LPD W/sq.ft
Suite A	Food Processing	576	492.8	0.856	1.2
Suite B	Food Processing	576	719.8	1.25	1.2
Suite D	Food Processing	1152	969.8	0.842	1.2
Suite F	Sales Area	1152	688.8	0.598	1.7
Suite H	Food Processing	1152	904.8	0.785	1.2
Suite J	Food Processing	1728	1866.6	1.08	1.2
Suite K	Food Processing	576	618.8	1.074	1.2

The proposed building has a lower lighting power density for most spaces as compared to 90.1 2007 requirements. This results in lower lighting energy consumption as well as lower cooling loads due to reduced heat gain through lighting.

1.5 Process Loads

Process loads are not accurately known for the building hence a default value of 1.4 W/sq.ft has been used for both baseline and proposed building. Equipment loads constitute over 35% of the baseline building's energy use and hence meet the LEED minimum requirements for process loads.

[2] SHGC is solar heat gain coefficient
[3] sq.ft is square feet

1.6 HVAC Systems

The proposed design includes packaged single zone heat pump units serving each suite. The baseline system requirements is a system type 4- Packaged Single Zone Heat Pump, which is in accordance to ASHRAE 90.1 2007 Appendix G, for a building <25,000 sq.ft, 3 stories or less, with electric heating. The tables below document the baseline and proposed system details including cooling and heating coefficient of performance (COP) and fan power.

Table 3. Baseline System Description

Zone	Cooling		Heating		Fans	
	Capacity[4] (Btu/h)[5]	**SEER**[6] 90.1 2007 Table 6.8.1**B**	Capacity (Btu/h)	**HSPF**[7] 90.1 2007 Table 6.8.1**B**	Supply KW/CFM[8]	Return KW/CFM
Suite A	12930	13	11251	7.7	0.00071	0.00024
Suite B	14250	13	12400	7.7	0.00071	0.00024
Suite D	26924	13	23964	7.7	0.00071	0.00024
Suite F	25883	13	22211	7.7	0.00071	0.00024
Suite H	25498	13	21248	7.7	0.00071	0.00024
Suite J	38750	13	32291	7.7	0.00071	0.00024
Suite K	13335	13	11603	7.7	0.00071	0.00024

Table 4. Proposed System Description

Zone	Fans Design Documents			Cooling Design Documents		Heating Design Documents	
	Supply CFM	OSA[9]	SP in WG[10]	Capacity (Btu/h)	SEER	Capacity (Btu/h)	HSPF
Suite A	1200	150	0.5	35,200	15.2	32000	9
Suite B	1200	150	0.5	35,200	15.2	32000	9
Suite D	1600	150	0.5	35,200	15	45600	9.2
Suite F	1400	150	0.5	35,200	15.2	42000	8.7
Suite H	1600	150	0.5	35,200	15	46600	9.2
Suite J	1600	150	0.5	35,200	15	45600	9.2
Suite K	1200	150	0.5	35,200	15.2	32000	9

[4] Autosized from simulation software.
[5] Btu/h is British thermal units per hour
[6] SEER is seasonal energy efficiency ratio
[7] HSPF is heating seasonal performance factor
[8] KW/CFM is kilowatts per cubic feet per minute. This is calculated in accordance to ASHRAE 90.1 2007, Section G3.1.2.9
[9] OSA is Outside Air
[10] SP in WG is Static Pressure in inches of Water Gauge

The proposed system design has a higher efficiency rating and results in significant heating and cooling energy savings.

1.7 Water Heating Systems

The proposed building design uses a 100-gallon gas storage water heater with high thermal efficiency (95%) and low stand-by losses. Several water efficiency measures reduced the water consumption by 54% for the proposed building design.

Table 5. Water Heater Calculations for Baseline and Proposed Design

		Power		Thermal Efficiency		Tank UA	
	Volume (gallons)	Capacity (Btu/hr)	Capacity (MBtu)	Efficiency	HIR	Standby Loss (Btu/hr)	Tank UA
Proposed Model Description							
AO Smith BTH-250	100	250,000	0.25	95%	1.053	748	10.6857
Baseline Model Description							
Gas Storage >75,000 Btu/hr	100	250,000	0.25	80%	1.25	1412.5	20.1786

1.8 Results

The proposed design has design features that go above the ASHRAE 90.1 2007 requirements for building envelope, system efficiency as well as water heater efficiency, resulting in 27% energy savings over the ASHRAE 90.1 2007 baseline. Energy efficient lighting, high efficiency heat pumps as well as the high efficiency water heater results in most of the modeled savings.

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