

Panorama Village Elementary School and the Energy Model

Introduction

The Panorama Village Elementary School is located in State College, PA and consists of a 1.5 story building totaling 57,924 ft² gross area. The purpose of this energy modeling analysis is to evaluate various energy efficiency measures (EEMs) that would optimize the building's energy performance. Some of these EEMs would reduce the building loads, thereby reducing the size of the HVAC equipment needed, while others address optimizing the HVAC systems.

An ASHRAE 90.1-2004 compliant building is used as a baseline in the analysis. This model uses an air-cooled chiller and a natural gas hot water boiler to condition the building. There are assumed to be unit ventilators in each classroom and packaged rooftop units for large assembly spaces.

Energy Model Descriptions

In accordance with LEED EA Credit 1 Optimize Energy Performance, the Baseline energy model for Panorama Village Elementary School was developed during the schematic design process using a 4-pipe system with air-cooled chiller and gas-fired boiler serving unit ventilators in each space, except the Multi-Purpose Room and Large Group Instruction Rooms which are served by a packaged rooftop unit with DX cooling and hot water heat as the HVAC system and ASHRAE 90.1-2007 Performance Rating Method and BER Table 5 and industry standards. Certain process loads are omitted from the models including, but not necessarily limited to elevators, cooking, refrigeration, and exterior lighting. Each classroom is assumed to have 20 occupants and occupancy for other space is determined based upon the default occupant densities from ASHRAE 62.1-2007. In the absence of system operational parameters, the Appendix G operating characteristics described in Section G3.1.3 are applied. Weather data is located in the TMY file for State College, PA. Generally, the instructional and ancillary spaces are assumed to be occupied weekdays from 8 am to 3 pm during the school year and the offices are occupied from 8 am until 5 pm through out the year. Energy Opportunities, Inc. created these models using eQuest v3.60.

Energy Efficiency Measures (EEMs)

The Ferguson Township Elementary School energy model analysis evaluates a number of EEMs to minimize energy use in the building. These EEMs listed below are evaluated independently and collectively using the baseline HVAC system. The alternate HVAC system runs use the combination of all EEMs. The details for each EEM can be found in the attached "Building Energy Enduse Summary".

Regulated Measures

- EEM 1 - Increased Roof Insulation to R30 and overall Wall Insulation to R25 (initial envelope performance specified)
- EEM 2 - Improved windows (U=0.25, SHGC=0.25, Vlt=0.6)
- EEM 3 - Interior lighting reduced to 0.75 W/sqft
- EEM 4 - Daylight dimming controls with reduced lighting power (EEM3)
- EEM 5 - Combination Run - EEM1 through EEM4
- EEM 6 - Packaged Variable Air Volume (VAV) Units with hot water reheat
- EEM 7 - Variable Refrigerant Volume (VRV) System with energy recovery for ventilation air
- EEM 8 - Ground-source heat pumps with energy recovery for ventilation air

Panorama Village Elementary School

eQuest v3.6 Modeling Results Summary

Building Energy Enduse Summary for Individual Energy Efficiency Measures (EEMs)

Individual EEM Design Runs	Baseline	EEM 1 R30 Roof & R25 Walls	EEM 2 Windows	EEM 3 LPD	EEM 4 LPD + Daylighting	EEM 5 EEM 1-4 Combination	EEM 6 VAV Units	EEM 7 VRV System	EEM 8 GSHP
Estimated Operating Costs									
Electric	\$28,853	\$27,857	\$26,939	\$22,974	\$18,114	\$15,277	\$15,621	\$39,406	\$33,056
Gas	\$43,428	\$38,140	\$35,413	\$45,054	\$46,204	\$33,604	\$41,091	\$1,566	\$1,566
Total	\$72,281	\$65,997	\$62,352	\$68,028	\$64,318	\$48,881	\$56,712	\$40,972	\$34,622
Cost/SqFt	\$1.25	\$1.14	\$1.08	\$1.17	\$1.11	\$0.84	\$0.98	\$0.71	\$0.60
Building Energy Use (MBtus)									
Electric (MBtu)	773.1	748.5	728.0	603.9	479.8	407.2	410.6	1,135.5	1,042.1
Gas (MBtu)	3,948.0	3,467.3	3,219.4	4,095.8	4,200.4	3,054.9	3,735.5	142.4	142.4
Total (MBtu)	4,721.1	4,215.8	3,947.4	4,699.7	4,680.2	3,462.1	4,146.1	1,277.9	1,184.5
Consumption									
Site (kBtu / SqFt / Yr)	81.5	72.8	68.2	81.1	80.8	59.8	71.6	22.1	20.5
Source (kBtu / SqFt / Yr)	108.2	98.6	93.3	102.0	97.4	73.8	85.8	61.3	56.5
Building Electric Use (kWh)									
Lights	121,594	121,594	121,594	75,996	42,272	42,272	42,272	42,272	42,272
Task Lights	0	0	0	0	0	0	0	0	0
Misc. Equip.	38,504	38,504	38,504	38,504	38,504	38,504	38,504	38,504	38,504
Space Heat	0	0	0	0	0	0	0	145,847	122,060
Space Cool	20,619	19,141	16,684	18,396	16,988	11,194	15,031	7,077	5,749
Heat Rejection	0	0	0	0	0	0	0	0	0
Pumps & Aux.	12,034	11,287	10,124	11,388	11,076	8,206	6,833	7,421	43,158
Ventilation Fans	33,844	28,836	26,450	32,703	31,772	19,158	17,691	30,113	53,684
Refrig Display	0	0	0	0	0	0	0	0	0
Ht Pump Supplement	0	0	0	0	0	0	0	61,555	0
Domestic Hot Water	0	0	0	0	0	0	0	0	0
Exterior Usage	0	0	0	0	0	0	0	0	0
Total	226,595	219,362	213,356	176,987	140,612	119,334	120,331	332,789	305,427
Building Gas Use (Therms)									
Space Heat	38,059	33,252	30,772	39,536	40,582	29,125	35,931	0	0
Domestic Hot Water	1,421	1,421	1,422	1,422	1,422	1,424	1,424	1,424	1,424
Total	39,480	34,673	32,194	40,958	42,004	30,549	37,355	1,424	1,424
Sum of Building Space Peak Loads (without Ventilation)									
Heating (kBtu/h)	1,047.0	878.0	780.0	1,057.0	1,061.0	634.0	634.0	634.0	634.0
Cooling (Tons)	98	89	86	92	87	65	65	65	65
EEM Economics									
EEM Savings	NA	\$6,284	\$9,929	\$4,253	\$7,963	\$23,400	\$15,570	\$31,309	\$37,659
EEM Costs	NA	(in base cost)		-\$81,094	\$52,132	----- see Life Cycle Cost Analysis -----			
Payback	NA	NA	0.00	Immediate	6.55	----- see Life Cycle Cost Analysis -----			

EEM Descriptions

Baseline - ASHRAE minimum constructions, 1.2 W/sqft LPD, 4-pipe unit ventilators with packaged rooftop units serving the assembly spaces

EEM 1 - Increased Roof Insulation to R30 and overall Wall Insulation to R25

EEM 2 - Improved windows (U=0.25, SHGC=0.25, Vlt=0.6)

EEM 3 - Interior lighting reduced to 0.75 W/sqft

EEM 4 - Reduced Lighting Power Density and Daylight Dimming

EEM 5 - Combination Run (EEMs 1-4)

EEM 6 - EEM 1-4 Combination with VAV Rooftop Units

EEM 7 - EEM 1-4 Combination with VRV System

EEM 8 - EEM 1-4 Combination with Ground Source Heat Pumps