Wayland High School
Energy Model
Report Summary

Wayland, MA

May 12, 2011

Wayland High School

Prepared by: Garcia, Galuska & DeSousa
Consulting Engineer, Inc.

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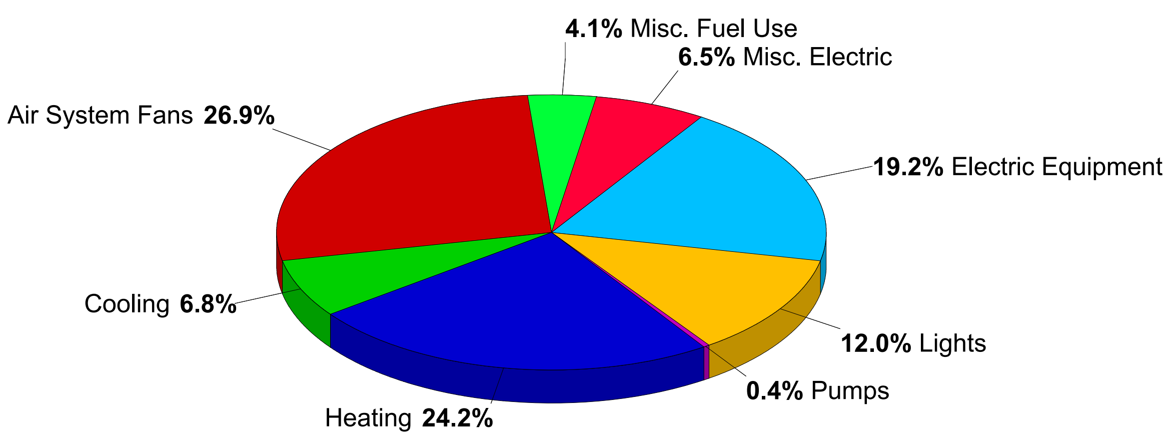
PROPOSED BUILDING ANNUAL COMPONENT COSTS



Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	119,710	0.594	26.9
Cooling	30,398	0.151	6.8
Heating	107,517	0.533	24.2
Pumps	1,559	0.008	0.4
Cooling Tower Fans	0	0.000	0.0
HVAC Sub-Total	**259,183**	**1.285**	**58.3**
Lights	53,260	0.264	12.0
Electric Equipment	85,234	0.423	19.2
Misc. Electric	29,114	0.144	6.5
Misc. Fuel Use	18,036	0.089	4.1
Non-HVAC Sub-Total	**185,643**	**0.921**	**41.7**
Grand Total	**444,826**	**2.206**	**100.0**

Note 1: Cost per unit floor area is based on the gross building floor area of 201,643 ft².
Note 2: Building schedules based ASHRAE 90.1-2007 default school schedules.

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Executive Summary

To determine and assess energy consumption profiles for buildings, and the impact of applying energy conservation measures to a building or system, requires the development of a computerized model of the building which incorporates all conditions which affect the flow of energy through a building and the ability of various systems to recover the energy introduced to offset the transfer flow rates. The report does not necessarily predict actual yearly energy cost, but more importantly the differential in systems operating cost compared with one another assuming that all parameters used to calculate energy flow in each system are applied equally to each energy model.

This office utilizes Carrier HAP Version 4.50 which is accepted by the U.S. Green Building Council for its LEED® (Leadership in Energy and Environmental Design) Rating System. This program allows modeling of all buildings types and components, and the wide variation in thermal transmittance of different material envelope components which make up composite wall and roof sections. The software also permits modeling of various lighting systems, HVAC systems, and power plant equipment and also has the ability to incorporate a wide variety of utility rate structures determined by local power company providers.

The *proposed* model was prepared gathering information from the architectural drawings by HMFH Architect's, Inc. and the electrical, mechanical, and plumbing drawings by this office (Garcia Galuska DeSousa Consulting Engineers). Occupancy, electrical equipment, HVAC, lighting, and thermostat schedules use AHSHRAE Standard 90.1 2007's school schedules. Utility rates were provided by the local providers' published data. Weather data was obtained from the closest airport observatory and in this case Boston weather data (in TMY format) was utilized.

The comparison of the *baseline* and *proposed* models which include envelope, lighting, mechanical systems, and domestic hot water systems are each performed in accordance with the MA-CHPS and ASHRAE Standard 90.1-2007. Each model also considers identical populations, mechanical system zones, ventilation rates, and operating schedules.

In accordance with MA-CHPS, the requirement for minimum performance of the *baseline* building and systems is based on ASHRAE Standard 90.1-2007 and 780 CMR Chapter 13. As a result, the *baseline* building model was developed representing a building of the same size and shape that the architect has proposed, however, which meets the minimum heat flow transfer rates (“U” factors) of the wall, roof, and glass per 780 CMR Chapter 13. The mechanical systems that were considered in the *baseline* building model would be a conventional academic building approach which meet the minimum standards of ventilation, air quality, and cost-effectiveness. The *proposed* building model represents the actual design by the architect, electrical engineer, mechanical engineer, and plumbing engineer.

To verify that the Wayland High School achieves a minimum of twenty percent less energy cost than a Massachusetts energy code minimum building (780 CMR 13) an energy model has been simulated using Carrier Hourly Analysis Program Version 4.50. The energy model was simulated in accordance with ASHRAE 90.1-2007 and LEED savings calculation protocol.

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The chart below summarizes the performance of the baseline and proposed building by load category:

End Use	Process	Baseline Building Units	Baseline Building Results	Proposed Design Energy Type	Proposed Design Units	Proposed Building Results	Percent Savings
Interior Lighting	No	Energy kWh	471,594	Electric	Energy kWh	285,879	39 %
		Demand kW	195.9		Demand kW	118.7	39 %
Space Heating	No	Energy kWh	0	Electric	Energy kWh	61,168	n/a
		Demand kW	0.0		Demand kW	55.1	n/a
Space Heating	No	Energy Therm	150,144	Natural Gas	Energy Therm	73,940	51 %
		Demand MBH	11,306.4		Demand MBH	5,094.6	55 %
Space Cooling	No	Energy kWh	302,991	Electric	Energy kWh	163,168	46 %
		Demand kW	342.4		Demand kW	190.9	44 %
Pumps	No	Energy kWh	10,958	Electric	Energy kWh	8,366	24 %
		Demand kW	4.1		Demand kW	1.8	56 %
Heat Rejection	No	Energy kWh	0	Electric	Energy kWh	0	n/a
		Demand kW	0.0		Demand kW	0.0	n/a
Fans - Interior	No	Energy kWh	530,267	Electric	Energy kWh	642,552	-21 %
		Demand kW	165.9		Demand kW	158.8	4 %
Receptacle Equipment	Yes	Energy kWh	457,509	Electric	Energy kWh	457,509	0 %
		Demand kW	187.8		Demand kW	187.8	0 %
Exterior Lighting	No	Energy kWh	257,137	Electric	Energy kWh	62,068	76 %
		Demand kW	52.2		Demand kW	12.6	76 %
Kitchen Equipment (Gas)	Yes	Energy Therm	12,335	Natural Gas	Energy Therm	12,335	0 %
		Demand MBH	1,112.0		Demand MBH	1,112.0	0 %
Kitchen Equipment (Elec)	Yes	Energy kWh	52,445	Electric	Energy kWh	52,445	0 %
		Demand kW	47.3		Demand kW	47.3	0 %
Domestic Hot Water	No	Energy Therm	1,739	Natural Gas	Energy Therm	1,539	12 %
		Demand MBH	60.6		Demand MBH	53.6	12 %
Elevators	Yes	Energy kWh	41,760	Electric	Energy kWh	41,760	0 %
		Demand kW	20.0		Demand kW	20.0	0 %
Energy Totals	Baseline Total Energy Use (kBTU)		23,671,156	Proposed Total Energy Use (kBTU)		14,837,347	37 %
	Baseline Annual Process Energy (kBTU)		3,115,934	Proposed Annual Process Energy (kBTU)		3,115,934	0 %
	Process Energy Modeling Compliance					N	

The chart below summarizes annual energy consumption and cost for the baseline and design buildings:

	Proposed Design		Baseline Design	
Energy Type	**Energy Use**	**Cost ($)**	**Energy Use**	**Cost ($)**
Electric	1,774,914 kWh	330,667	2,124,661 kWh	395,824
Natural Gas	87,813 Therm	114,157	164,218 Therm	213,484
Subtotal (Model Outputs)	**14,837,347 kBTU**	**444,824**	**23,671,156 kBTU**	**609,308**
	Energy Generated	**Renewable Energy Cost Savings ($)**		
Total On Site Renewable Energy				
	Energy Savings	**Cost Savings ($)**		
Exceptional Calculation Totals				
	Energy Use	**Cost ($)**		
Net Proposed Design Total	**14,837,347 kBTU**	**444,824**		
	Percent Savings		**Energy Use Intensity**	
	Energy	**Cost**	**Proposed Design ($kBTU/ft^2$)**	**Baseline Design ($kBTU/ft^2$)**
Summary Data	**37.3 %**	**27.0 %**	**73.58**	**117.39**

In conclusion, the design building achieves an energy cost savings of 27.0% over the baseline.

ENERGY CONSERVATION MEASURES

Architectural Conservation Measures

- Enhanced building shell resulting in decreased electrical and gas consumption.

Water Conservation Measures

- Condensing gas fired water heater with electronic ignition.

HVAC Conservation Measures

- 100% Outside Air Central Ventilation Rooftop Units w/ Energy Recovery for displacement systems serving classrooms. Resulting in decreased gas consumption.

- 100% Outside Air Central Ventilation Rooftop Units w/ Energy Recovery for displacement systems serving the Auditorium and Stage. Resulting in decreased gas consumption.

- 100% Outside Air Central Ventilation Rooftop Units w/ Energy Recovery for displacement systems serving the Cafeteria. Resulting in decreased gas consumption.

- 100% Outside Air Central Ventilation Rooftop Units w/ Energy Recovery for displacement systems serving the Library. Resulting in decreased gas consumption.

- 100% Outside Air Central Ventilation Rooftop Units w/ Energy Recovery for induction unit systems serving the administration. Resulting in decreased gas consumption.

- Demand Ventilation for the Gymnasium limiting outdoor air during unoccupied hours reducing gas consumption.

- High Efficiency Gas Fired Condensing Boilers and Controls including hot water reset which varies hot water temperature.

- High Efficiency Chiller

- Building Management System controlling HVAC and Lighting.

- VFDs for Hot Water/Chilled Water Pumps

- VFDs for all supply, return and exhaust fans of all air handling/rooftop units

Electrical Conservation Measures

- Performance Lighting System utilizing high efficiency fixtures and ballasts.

- Daylight Harvesting System for classrooms with dual zone control.

- Daylight Harvesting System for auditorium.
- Occupancy sensors in classrooms and large spaces.
- Time of day schedule control of corridor lighting through building management system.
- LED site lighting designed to meet but not exceed IES Guidelines.

#REF!

Massachusetts Collaborative for High Performance Schools (MA-CHPS)

#REF!

MA-CHPS SCORECARD

This matrix includes each point that is available. Please fill in the credits you are applying for with a numerical value for a **Total Project Score**. Prerequisites in light blue are required for all major renovation and new construction projects and those in dark blue must be achieved by projects seeking green school funding.

41	Total Project Score	Total Possible Points	89

9	Points		SITE	Possible Points 16
	---	SP 1	**Joint Use of Facilities**	
	---	SP 2	**Joint Use of Parks**	
1	1	SC 1.1	**Sustainable Site Selection**	
1	1	SC 1.2	**No Development on Floodplains**	
	1	SC 1.3	**No Development Near Wetlands**	
2	1-2	SC 1.4	**No Development on Greenfields**	
	1	SC 1.5	**Centrally Located Site/Smart Growth**	
1	1	SC 1.6	**Reduced Building Footprint**	
1	1	SC 1.7	**Sustainable Site and Building Layout**	
	1	SC 2.1	**Locate Near Public Transit**	
	1	SC 2.2	**Pedestrian/Bike Access**	
	1	SC 2.3	**Minimize Parking**	
	1	SC 3	**Post-Construction Stormwater Management**	
	1	SC 4.1	**Design to Reduce Heat Islands,** Non-Roof	
1	1	SC 4.2	**Design to Reduce Heat Islands,** Roof	
2	2	SC 5	**Exterior Light Pollution Reduction**	

2	Points		WATER	Possible Points 5
	---	WP 1	**Indoor Water Use Reduction,** 20% Reduction	
1	1	WC 1.1	**Indoor Water Use Reduction,** 30% Reduction	
	1	WC 1.2	**Reduce Water Used for Sewage Conveyance**	
1	1	WC 2.1	**No Permanent Irrigation For Landscaping**	
	1	WC 2.2	**Water Reduction and Sports Turf Management**	
	1	WC 2.3	**Irrigation System Commissioning**	

6	Points		ENERGY	Possible Points 25
	---	EP 1	**Elimination of CFC-based Refrigerants**	
	---	EP 2	**Commissioning**	
	---	EP 3	**Fundamental Building Systems,** Training	
	---	EP 4	**Exceed Energy Code by 20%,** Prescriptive Approach	
	---	EP 4	**Exceed Energy Code by 20%,** Performance Approach	
	1-2	EC 1	**Superior Energy Performance,** Prescriptive Approach	
3	1-10	EC 1	**Superior Energy Performance,** Performance Approach	
2	2	EC 2	**Minimize Air Conditioning**	
	2-11	EC 3	**Renewable Energy**	
1	1	EC 4.1	**Energy Management Systems**	
	1	EC 4.2	**Submetering**	

4	Points		MATERIALS	Possible Points 13
	---	MP 1	**Storage & Collection of Recyclables**	
	---	MP 2	**Site Waste Management,** 75% Diversion	
1	1	MC 1	**Site Waste Management,** 90% Diversion	
	1-4	MC 2.1	**Building Reuse,** Maintain 50-95% of Existing Shell	
	1	MC 2.2	**Building Reuse,** Maintain 50% Interior	
3	1-7	MC 3	**Combined Materials Attributes**	

15	Points		IEQ	Possible Points 22
	---	IEQP 1	**ASHRAE Standard 62.1-2004 Compliance**	
	---	IEQP 2	**SMACNA IAQ Guidelines**	
	---	IEQP 3	**Construction IAQ,** Duct Protection	
	---	IEQP 4	**Pollutant Source Control,** Off-gassing	
	---	IEQP 5	**Walk-Off Mats**	
	---	IEQP 6	**Drainage**	
	---	IEQP 7	**Irrigation Design**	
	---	IEQP 8	**Mold Protection**	
	---	IEQP 9	**Electric Ignitions,** Gas-Fired Equipment	
	---	IEQP 10	**Air Intake Location**	
	---	IEQP 11	**Duct Liners**	
	---	IEQP 12	**Prohibit Fossil Fuel Burning Equipment,** Indoors	
	---	IEQP 13	**Filter Requirements for HVAC Equipment**	
	---	IEQP 14	**ASHRAE Standard 55-2004 Compliance**	
	---	IEQP 15	**Access to Views,** 70%	
	2	IEQC 1.1	**Access to Views,** 90%	
3	1-4	IEQC 1.2	**Daylighting in Classrooms**	
4	1-4	IEQC 2.1	**Low-Emitting Materials**	
1	1	IEQC 2.2	**Pollutant Source Control,** Ducted HVAC Returns	
1	1	IEQC 2.3	**Pollutant Source Control,** High Efficiency Filters	
1	1	IEQC 2.4	**Construction IAQ,** HEPA Vacuuming	
2	2	IEQC 2.5	**Construction IAQ,** Building Flushout	
1	1	IEQC 3.1	**Acoustical Performance in Classrooms,** Max 40 NC	
1	1	IEQC 3.2	**Acoustical Performance in Classrooms,** Max 35 NC	
	2	IEQC 3.3	**Acoustical Performance in Classrooms,** Max 30 NC	
	1	IEQC 3.4	**Reducing Sound Transmission**	
	1	IEQC 4.1	**Controllability of Systems,** Operable Windows	
1	1	IEQC 4.2	**Controllability of Systems,** Temperature/Light Control	

5	Points		POLICY & OPERATIONS	Possible Points 8
	---	P&OP 1	**Maintenance Plan**	
	---	P&OP 2	**Anti-Idling Measures**	
1	1	P&OC 1	**Maintenance Plan,** CMMS	
	1	P&OC 2	**Indoor Environmental Management Plan**	
1	1	P&OC 3	**Energy Star Equipment Performance**	
	1	P&OC 4.1	**Clean Energy,** 50%	
	1	P&OC 4.2	**Clean Energy,** 100%	
3	1-3	P&OC 5	**Innovation**	

Requirement for all schools

Requirement for green schools only

Point Thresholds

30 points - 1.5% Financing of Maximum Allowable Cost

34 points - 2.0% Financing of Maximum Allowable Cost