Photo: Architecture Involution 3 LLC; © www.brucetmartin.com

Whitman-Hanson Regional High School Whitman, Massachusetts

The Massachusetts Green School Initiative works with regions throughout Massachusetts to design and build schools that use less energy, cost less to operate, and provide healthier learning environments for students. Like the U.S. Department of Energy's EnergySmart Schools program, the Massachusetts Green School Initiative encourages a team approach to high-performance building projects, with active stakeholder involvement from the start of the design process. This team approach is key to ensuring the next generation of schools consumes less energy and reserves financial resources for educational tools and programming.

A Green School—Practical and Beneficial

In 2005, the Massachusetts Green School Initiative helped the Whitman-Hanson Regional School District build a new high school. The project started by engaging town citizens, school staff and faculty, local utilities, and many others in the community to gain their support. Stakeholder involvement reduced the amount of changes needed during construction and enabled the project to be completed on time and under budget. The project used an integrated design approach, which enabled the team to determine how daylighting, solar power, site orientation, and high-performance building envelope components would affect the energy requirements of the HVAC and lighting systems. As a result, the team correctly sized the HVAC and lighting systems, saving the district $100,000 every year. The team also

> "The Whitman-Hanson Regional High School saves on energy costs, and the building is a learning tool for students, teachers, and the community. The Massachusetts Green Schools Initiative made it possible for us to make this a high-performance school. And the money the school saves on energy goes to purchase state-of-the-art educational aids, such as built-in facilitator stations, interactive white boards, and LCD projectors. It's a win for everybody."
>
> —John McEwan, Former Superintendent, Whitman-Hanson Regional School District

This photovoltaic array provides 150,000 kWh of electricity annually.

Natural lighting in the library reduces energy use.

Photos: Massachusetts Technology Collaborative; © www.brucetmartin.com

Whitman-Hanson Regional High School—EnergySmart Choices

Feature	Benefit
Solar power	A 51 kW solar electric array mounted on the gymnasium roof provides supplemental electricity during peak demand hours. It has also been incorporated into the cross-disciplinary curriculum. The solar panels were manufactured in Marlborough, Mass.
Building envelope	In addition to wall cavity insulation, TR-10 continuous insulation is on the outside face of the exterior wall. The roof has R-20 continuous insulation. The floors have under-slab insulation.
Daylighting	Four large skylights (U-value 0.29) and daylight-harvesting controls are used in the cafeteria. Natural light is used in the classrooms, library, lecture hall, performing arts center, and double gymnasium, which reduces the need for artificial light. A courtyard allows daylight into core spaces.
Windows	The windows are solar screen low-emissivity (low-e), blue green with a U-value of 0.31 and a shading coefficient of 0.46. These reduce the cooling and heating loads to save electricity and natural gas.
Heating, ventilating, and air conditioning	The HVAC system senses the level of occupancy activity and responds accordingly. A high-efficiency hybrid air-cooled and evaporative-cooled chiller system significantly reduces energy consumption.
Water	A 20,000 gallon underground gray water storage tank collects rainwater runoff from the roof and uses it to flush toilets and urinals. The sinks and toilets are low-flow. Native plants reduce landscape irrigation.
Site orientation	The building is oriented on an elongated east-west axis to maximize classroom daylight, save energy, control erosion, and minimize light pollution. Much of the building is three stories to reduce its footprint. Trees, wetlands, and wind patterns were preserved as much as practical.
Lighting	The pendant-mounted direct-indirect lighting fixtures are high-efficiency fluorescent lamps. All lighting fixtures were manufactured in Massachusetts or Rhode Island. The average lighting power density is 1.15 W/ft^2.
System controls	Occupancy sensors control ventilation dampers and variable air volume boxes to adjust the heating and air conditioning in each classroom.
Cool roof	A white PVC membrane was installed on 95% of the surface to reduce cooling energy. Its initial absorptance is 0.17.
Appliances	The school uses ENERGY STAR® for equipment such as computer monitors.
Recycling	Materials from the old school were recycled for other uses.
Boiler plant	Six water boilers have a minimum efficiency of 86%; efficiency in condensing mode is as high as 95%.

focused on how the building would be used and incorporated features that would enhance the learning experience for students and improve teacher and student health.

Specifically, elements of the integrated design approach used to build this school included:

- Site considerations to protect habitats, take advantage of established infrastructure, and orient new buildings to maximize daylighting opportunities.
- Water efficiency measures to lower operating costs and benefit the environment.
- Indoor air quality improvements that would impact teacher and student health and performance.
- HVAC systems that control temperature and humidity and enable the school to be at least 20 percent more efficient than Massachusetts energy code.
- A high-efficiency lighting system that improves the visual comfort of teachers, students, and staff and reduces the school's operating budget.
- Daylighting techniques (which include proper building orientation, classroom location, window placement, clerestories, top lighting, light tubes, and roof monitors) to provide a high-quality light source and reduce the use of artificial light.
- Sustainable materials, products, and equipment, including construction materials that have at least one environmental attribute (such as salvaged materials, recycled content, bio-based content, or sustainable wood certification). The team strived to use regionally produced or harvested materials and ENERGY STAR® appliances.
- Renewable energy technologies to reduce the environmental impact of burning fossil fuels and decrease the school's dependence on nonrenewable energy sources.

Goals

The Massachusetts Green School Initiative and the assembled team focused on an overarching goal as they built the Whitman-Hanson Regional High School: construct a building that offers more amenities, such as air conditioning, but uses less energy than a less-efficient, outdated school. While accomplishing this goal, the team aimed to:

- Create a healthy and comfortable environment to encourage learning
- Encourage the community to use the facility as a teaching tool for environmental design and stewardship
- Construct a building that costs less to operate.

In a step toward accomplishing the team's overarching goal, Andelman and Lelek Engineering Inc. used software to simulate the proposed building's energy consumption and evaluated its performance. The company created PowerDOE models of the as-designed building and a baseline building and quantified the difference in annual energy consumption. The base case building elements (building envelope construction, mechanical systems performance, lighting system performance, etc.) meet the requirements of Chapter 13 of the Massachusetts State Building Code, Energy Conservation.

Striving for these goals resulted in a building saving tens of thousands of dollars per year. In addition, because the new facility is air conditioned, it can remain open in the summer for school and community programs.

Financing

The Massachusetts Technology Collaborative provided $650,000 in design and technology grants. Keyspan (now National Grid), which supplies gas and electric service to more than seven million customers in New York, Massachusetts, New Hampshire, and Rhode Island, provided $43,631 as an energy delivery-technology incentive, $19,000 in design assistance, $372,186 in a comprehensive design assistance incentive, and funded commissioning services.

"We have had so much positive feedback on this building. The state has made it a model school and wants other schools to copy the design. The students are involved in giving tours—the Student Environmental Awareness Club is becoming extremely popular. The teachers are also learning about using the building automation data as a tool for education. This school is truly a tool for education, not just a place for education."

—Jim Armstrong, CPE, CEM, LEED AP
Building Committee Chairman

Whitman-Hanson Regional School District—Energy-Related Outcomes	
Energy savings beyond code	39% better than ASHRAE 90.1-1999
Annual gas savings	11,700 therms relative to code
Annual energy cost savings over the old school	$100,000
Annual water savings	972,000 gallons relative to code
Annual energy savings from energy efficiency measures	577,000 kWh savings relative to code
Annual energy generated from photovoltaics	150,000 kWh

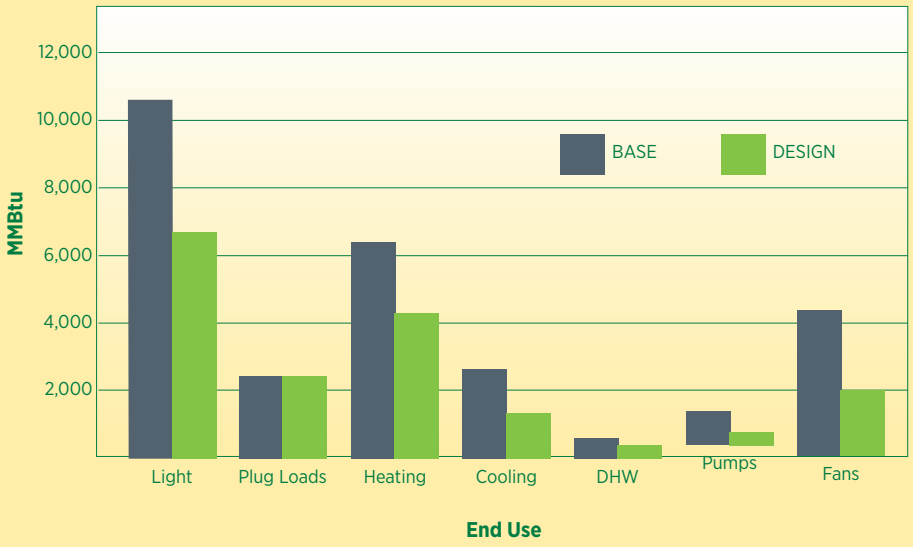
Data from NREL and Whitman-Hanson Regional School District

A Successful Model

The district successfully built a high-performance school because the district committed to the goal and secured support from the Massachusetts Green School Initiative, utility companies, the Massachusetts School Building Authority, the project team, and the citizens of the towns of Whitman and Hanson. The entire team worked together to determine the functional needs and realities of the stakeholders and to achieve environmental sustainability and optimal energy performance. The team approach resulted in a reduction of the number of change orders required throughout the design and construction process. Moreover, although the Massachusetts legislature placed a temporary hold on all school construction, Whitman-Hanson was one of the few exceptions. The team approach included well-thought-out plans and specifications that enabled the project to be completed on time and under budget.

Participants learned many lessons along the way to success. For one, energy-efficient design requires a substantial amount of time and cooperation; it's helpful to establish and engage a design team early on. Also, life-cycle cost analysis is essential, but the process illustrates that the benefits are much greater than the costs.

Whitman-Hanson Regional High School Total Energy End-Use Comparison



Project Details

Pilot project for the Massachusetts Green Schools Initiative

Building: Two and three stories, 234,500 square feet

Completed: 2005

Grades served: 9–12

Funding and grants:

- $650,000 Massachusetts Technology Collaborative design and technology grants
- $19,000 design assistance from Keyspan/National Grid
- $43,631 Keyspan energy delivery-technology incentive
- $372,186 National Grid comprehensive design assistance incentive
- Commissioning services funded by National Grid
- $30 million, or 74%, of construction costs paid by the Massachusetts School Building Authority (2% awarded through a state high-performance building incentive)
- Remainder funded through a bond passed by the citizens of Whitman and Hanson

Cost: $41 million; $175 per square foot

Capacity: 1,350 students (current enrollment of 1,250)

Energy performance and savings:

- 39% energy savings better than ASHRAE 90.1-1999
- 577,000 kWh energy savings from energy efficiency measures per year
- 11,700 therms gas savings per year
- 972,000 gallons water savings per year
- 150,000 kilowatt-hours generated from photovoltaics
- Energy cost savings of $100,000 per year

Rating: Collaboration for High Performance Schools (CHPS) Level—35 points

Whitman-Hanson Regional School District:

- 9 schools; 4,500 students

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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