Getting the Most from Your Energy Dollar: The High-Performance School

If you're like many school officials, you find the idea of constructing an energy-efficient school appealing, but you're daunted by the cost and design process. Yet, there has never been a better time to pursue a green building project.

In the past, building an energy-efficient school cost more than a conventional one, but these expenses have decreased radically. Now, most green schools cost no more to build than their traditional counterparts—with the added benefit of saving thousands of dollars on energy costs every year. After personnel, energy costs are most districts' highest expense—and energy costs are expected to continue to rise nationwide.

Districts that want to go green today have more places to turn for help than ever before. In fact, one source of help may be sitting in your office right now.

With support from the Department of Energy, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers has written the *ASHRAE Advanced Energy Design Guide for K–12 School Buildings* to help owners and designers of elementary, middle, and high school buildings obtain energy savings of at least 30% over current codes (compared with the minimum requirements of ASHRAE Standard 90.1–1999). The guide features easy-to-follow recommendations for various climate zones and how-to tips using real-life construction case studies of schools around the country.

Can We Afford It?

Contrary to what many think, thoughtfully designed, energy-efficient schools can cost less to build than traditional schools. With its photovoltaic-paneled canopies and white reflective roof, Poudre School District's Fossil Ridge High School in Colorado is a marvel of energy efficiency. It buys wind power for 100% of its electricity needs, uses advanced water conservation techniques, and has high-performance occupancy sensors and dimming systems. It looks expensive, but in fact, the $38 million budget was no more than the cost of a similarly sized conventional school.

"The key factor is rightsizing," says Stu Reeve, energy manager for Poudre School District. "You're building a better building envelope and the insulation is better, so your mechanical systems get smaller. You rightsize your HVAC [heating, ventilation, and air-conditioning]—you look at the whole picture, including how asphalt parking lots generate heat in sunshine. It's building smarter. That's how you do it."

Reeve stresses the intricate process of integrated design and the need to commission a construction and design team that understands high-performance building. Every decision is made with energy efficiency in mind and a clear understanding of how different building elements interact.

Better insulation and windows, for example, mean heating systems can be downsized. The heating system at Topham Elementary School in Langley, British Columbia, requires half as much fuel (natural gas in this case) as the next most efficient school in its district, costs half as much to maintain,

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and was less expensive to install. Likewise, cooling systems can often be downsized with a properly designed daylighting system and better walls and windows. Some strategies may cost more up front, but the energy they save means they often pay for themselves within a few years.

How Much Can We Save?

Durant Road Middle School in Raleigh, North Carolina, used many of the recommendations found in the *ASHRAE Guide*. The district recouped its initial investment within two years and saves thousands of dollars annually. The school's energy cost for 2006 was only $1.01 a square foot, whereas the average for the United States was $1.15 a square foot.

Durant chose a smart use of their site's climatic resources and more efficient envelope design to reduce the building's overall energy requirements. Efficient equipment and energy management programs then help meet those requirements more cost-effectively. This helps the district better manage operating costs because there is less effect from unstable energy prices. Investing in energy efficiency is like buying into energy futures at a known fixed cost.

By using energy efficiently and lowering a school's energy bills, districts can redirect millions of dollars each year into teachers' salaries, computers, or textbooks. Strategic up-front investments in energy efficiency provide significant long-term savings. Fossil Ridge High School's energy costs are about $100,000 less a year than the same district's comparable, but conventionally built, Fort Collins High School.

District Energy Manager Reeve sees energy efficiency as a good business decision; of Colorado's 178 school districts, Poudre School District's operational funding from the state is ranked at 170. "We're not rich, and we know that when we have the opportunity to build a new school, we may not get another chance for some time," Reeve says. "These buildings compete with education mission and goals. I look at the savings and say, 'How many teachers could that buy you?'"

Can Saving Energy Help Students Learn?

The savings generated by energy-efficient schools can be devoted to educational supplies or teacher salaries. And some studies have shown that educational benefits reach much further. Improvements in heating, ventilation, and indoor air quality—as well as increased use of natural light—keep students more alert and improve their educational performance.

The 2006 report *Greening America's Schools: Costs and Benefits* examined 16 different studies to demonstrate that greener, healthier school buildings provide superior work environments for students and teachers, reducing absenteeism and improving test scores by 15% to 25%.

High-performance schools also contribute directly to math and science programs. Desert Edge High School in Arizona uses an in-school kiosk to showcase many of that school's unique features through a virtual tour and the display of electricity, water, and carbon dioxide savings. The kiosk also displays real-time animations of the heating and

Case Study: Whitman-Hanson Regional High School, Massachusetts

A pilot project for the Massachusetts Green Schools Initiative, Whitman-Hanson Regional High School is a 234,500-square-foot building designed for 1,350 students. The total construction cost was $41 million, or $175 a square foot. Whitman-Hanson is 39% more efficient than ASHRAE Standard 90.1–1999 requires. The facility incorporates daylighting, a well-insulated envelope, energy-efficient mechanical systems, a white roof, and energy-efficient appliances to reduce energy use.

Natural light is used in the library, a two-story lecture hall, the classrooms, a performing arts center, and a double gymnasium to reduce the electrical lighting. The cafeteria is lit with natural light through skylights and daylight harvesting. Daylighting sensors are used in each classroom and the gymnasium to control electrical lighting, supplied by high-efficiency fluorescent fixtures.

The windows are highly insulated and low-emittance coated to reduce heat loss; they are also designed to allow natural light to penetrate farther into the building than in conventional schools.

Occupancy sensors are used throughout the building; based on the occupancy, heating and air-conditioning of each classroom are carefully controlled. The primary base load chiller is a high-efficiency water-cooled chiller, and an air-cooled chiller provides additional capacity for peak periods. High-efficiency condensing boilers, demand-controlled ventilation with an energy recovery system, and variable-flow pumping are additional HVAC energy-saving features.

Photovoltaic panels on the roof supply approximately 5% of the school's annual energy, and solar energy has become part of the students' curriculum. The school uses the money it saves on energy to purchase high-tech, state-of-the-art educational aids, including interactive whiteboards and LCD projectors for all classrooms.

The ASHRAE Guide

The *ASHRAE Advanced Energy Design Guide for K–12 School Buildings* was developed through the collaboration of ASHRAE, the American Institute of Architects, the Illuminating Engineering Society of North America, and the U.S. Green Building Council, with support from the U.S. Department of Energy. Every school district in the United States was mailed a copy in January 2008. The guide is also available as a free download at http://www.ashrae.org/freeaedg.

We look forward to learning about your new energy-efficient schools through the case study database at www.ashrae.org/aedg. Be sure to visit www.energysmartschools.gov for information about energy-efficiency resources for schools.

cooling systems, an interactive building directory, bus routes and schedules, real-time weather conditions, and more. The school itself teaches students about energy efficiency and environmental concerns.

Other schools have placed their HVAC equipment behind glass walls so students can understand how the energy-efficient equipment works and give tours of the schools' unique features to visitors.

Getting Started

At the outset of the design phase for your high-performance school, the following four steps will speed you toward your energy-efficiency goal.

1. **Determine Your Climate Zone**
   A school designed for Florida has different requirements than a school being built in Minnesota. Locate your correct climate zone. The U.S. Department of Energy has identified eight climate zones for the United States. The *ASHRAE Guide* uses these zones to define the energy recommendations. It includes climate zone recommendation tables, each with a set of common items arranged by building subsystem: envelope, daylighting, lighting, and HVAC.
2. **Use the Sun to Save Energy**
   The careful use of daylighting can drastically reduce energy costs. When designed with energy in mind, vertical fenestration and skylights can provide interior illumination without excessive solar heat gain. Electric lighting systems can then be extinguished or dimmed for most school hours, saving significant energy and maintenance costs.

   The key to daylighting is an integrated design in which HVAC and electric lighting controls are optimized to take full advantage of and harvest energy savings, and additional window costs are offset by reduced costs in HVAC equipment. Good lighting and daylighting design can provide predictable and persisting lighting energy savings of up to 43%.
3. **Save on Electrical Costs with Inexpensive Changes**
   Electric lighting is one of the largest energy users in schools. Depending on climate, lighting energy use can be as high as 40% of the total energy use for a basic, energy code–compliant school. Lighting-related improvements can be inexpensive, can offer rapid payback, and often top the list of recommendations for meeting an overall target of 30% in energy savings.

   The *ASHRAE Guide*'s recommendations include lighting systems with the most current, energy-efficient lamps, ballasts, and integrated controls. Because energy-efficient lighting also generates less wasted heat, HVAC energy savings of 10% to 15% are also possible in cooling-dominated climates.
4. **Save on Heating and Air-Conditioning Costs with New Technology**
   One important component of saving costs on HVAC equipment is choosing the right equipment for your climate and school size. Energy-saving HVAC strategies often use zone heating, occupancy sensors, demand-controlled ventilation, high-efficiency HVAC equipment, and a variety of other technologies.

   Designing a highly efficient building envelope (walls and windows) with high-performance lighting can also mean building a school with significantly reduced heating and cooling needs; HVAC equipment can be downsized from the start.

Case Study: Bolingbrook High School, Illinois

Located in a suburban setting, Bolingbrook High School is a 569,000-square-foot building with a capacity of 3,600 students. The total project cost for the new school was $96 million, or about $169 a square foot.

The educational planning concept of a school-within-a-school was used in the design, with two academic houses in distinct wings and interior courtyards to maximize exterior views and daylight. In addition, the school incorporated an auditorium, a physical education gym, and a field house that is partially buried to reduce scale. Energy and environmental features include the following:

- A fully automated digital control system that automatically turns HVAC systems on and off via a time schedule set according to the projected use of the different areas;
- Fans that do not run unless scheduled and room thermostats that are digitally programmed between 68 and 74 degrees Fahrenheit to optimize energy savings;
- Lights equipped with override switches that automatically turn on via a programmed schedule before school starts and automatically turn off after school;
- Lights equipped with daylight-harvesting sensors in the upper levels of the main concourse;
- A condensate recovery system projected to save 360,000 gallons of water annually that collects and reuses water from the rooftop chillers;
- Bioswales to filter impurities from surface-water runoff; and
- A well-irrigation system for athletic fields and indigenous plantings.

A Goal Within Reach

Saving 30% or more on energy is within the reach of any school district with the will to do so. It is a good deal for students, teachers, administrators, and taxpayers. Join us in the goal to save energy, save money, protect the environment, and create a more secure energy future. ■

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