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TESTIMONY BEFORE THE SENATE
ENVIRONMENT AND PUBLIC WORKS COMMITTEE

Hearing on High-Performance Schools, October 1, 2002

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Mr. Chairman and members of the Committee, my name is Alex Wilson. I am very honored and pleased to have this opportunity to address the issue of high-performance or "green" schools before this Committee.

I am president of BuildingGreen, Inc., a small company in Brattleboro that is recognized as one of the leading national providers of information on environmentally responsible design and construction. My company publishes *Environmental Building News*, which is read by over 10,000 architects and other building professionals nationally and internationally.

I also serve on the boards of the U.S. Green Building Council and the Sustainable Buildings Industry Council, both here in Washington and both involved in efforts to advance the implementation of energy-efficient, environmentally responsible buildings. I am pleased to report that the membership of the U.S. Green Building Council, which has been growing by 100% per year for the past five years, has just surpassed 2,000 companies, and the Leadership in Energy and Environmental Design (LEED) building rating program the organization runs is quickly becoming the most important driver of green design in the country.

The Sustainable Buildings Industry Council (SBIC) has been particularly active in advancing high-performance schools nationwide. Senator Bond may be interested to learn that SBIC is today leading a workshop on high-performance schools in St. Louis.

My hope here is to provide a quick overview of what a high-performance school is, address the benefits of these schools, describe a few examples, and provide recommendations as to how the Federal Government can support the implementation of high-performance school design, construction, and operation.

What is a High-Performance School?

The Collaborative for High Performance Schools in California defines high-performance schools as "facilities that improve the learning environment while saving energy

resources and money."[1] The Sustainable Buildings Industry Council (SBIC) describes a high-performance school as having three key characteristics[2]:

1. It is **healthy and productive** for students and teachers, in that it provides:
    - High levels of acoustic, thermal, and visual comfort;
    - Significant amounts of natural daylighting;
    - Superior indoor air quality; and
    - A safe and secure environment.

2. It is **cost-effective** to operate and maintain, because its design employs:
    - Energy analysis tools that optimize energy performance;
    - A life-cycle cost approach that reduces the total costs of ownership; and
    - A commissioning process to ensure that the facility will operate in a manner consistent with design intent.

3. It is **sustainable**, because it integrates:
    - Energy conservation and renewable energy strategies;
    - High-performance mechanical and lighting systems;
    - Environmentally responsive site planning;
    - Environmentally preferable materials and products; and
    - Water-efficient design.

Organizations seeking to advance high-performance schools all emphasize an ***integrated, whole-building*** approach to the design process. This means that the different elements—building envelope, lighting, mechanical systems, etc.—must be considered holistically, from the beginning of the design process through construction and operation of the building.

This is quite different from the design process used in creating most non-residential buildings. The conventional design process is like a relay race, in which the architect designs the basic building and passes the baton to the mechanical engineer. The mechanical engineer designs the mechanical systems needed to maintain comfort, then passes the baton on to the lighting designer, and so on. With integrated design, all members of the design team meet periodically throughout the planning and design process. Synergies are identified—for example, recognition that if better glazings and energy-efficient lighting systems are installed, the air conditioning system (chiller) can be downsized. Identifying these opportunities becomes possible only through a collaborative, or integrated design process.

The other key aspect of a high-performance school is that it is the product of well-thought-out **goal-setting** on the part of the school district and the design team.

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[1] *Best Practices Manual, Volume I – Planning*, the Collaborative for High Performance Schools, , 2001.
[2] *High Performance School Buildings: Resource and Strategy Guide*, Sustainable Buildings Industry Council, Washington, DC, 2001.

I am currently the environmental consultant on a complex school project in Brattleboro, Vermont. This is the largest school construction project ever undertaken in Vermont, involving three schools serving 1,600 students. With a $57 million budget, the project will involve 184,000 square feet of renovation and 126,000 square feet of new construction over a four-year construction phase. Listed below are several of the sustainability goals identified by the design team at the beginning of the design process:[3]

- Exceed ASHRAE 90.1 (1999) energy performance levels by at least 20%
- Reduce total greenhouse gas emissions for the building complex by 50%, despite a 45% increase in total square footage (much of this to be met by a wood-chip-fired distributed heating system);
- Achieve significant daylighting (2% daylight factor) in 60% of classrooms;
- Generate no net increase in stormwater runoff from the site, despite a significant increase in impervious surfaces;
- Reduce per-square-foot water consumption by 40%;
- Reduce student, teacher, and staff absenteeism by at least 10% compared to prior three years by improving indoor air quality;
- Provide recycling and composting facilities that can achieve an 80% recovery for solid waste generated by the school; and
- Achieve a building that would earn a LEED Silver rating.

Benefits of High-Performance Schools

The benefits of a high-performance school accrue to students, teachers, taxpayers or other supporters of a facility, and the local, regional, and global environment. Eight primary benefits are described below:

1. Improved Student Performance

While data is still limited, there is growing evidence that a school's physical condition—especially its lighting and indoor air quality (IAQ)—can have a direct impact on student performance. The most comprehensive study to date, conducted in school districts in California, Washington, and Colorado, examined the causal relationship between natural daylighting and student performance. In the California district studied, students in classrooms with the most daylight progressed 20% faster on math tests and 26% faster on reading tests over the course of one year compared to students in classrooms with the least daylighting.[4] An earlier, less scientific study in North Carolina produced similar findings.

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[3] *BUHS/BAMS/SVCEC – Renovations & Additions: Project Feasibility Report*, Truex Cullins & Partners, May, 2002.

[4] "Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance," by the Heschong Mahone Group for Pacific Gas & Electric, August, 1999. A follow-up Re-Analysis Report released in February, 2002 responded to technical questions that had been raised by reviewers and verified the original results. Reports available at www.h-m-g.com and www.newbuildings.org/PIER.

Benefits don't only accrue to new, well-funded schools. Here in Washington, DC, the renovation of the run-down Charles Young Elementary School, completed in 1997, resulted in dramatic improvements in math and reading test scores. Prior to the restoration, almost half of the students scored in the lowest quartile on standardized tests (49% in math and 41% in reading); after the renovation, those percentages dropped to 24% and 25%, respectively.[5]

These studies confirm what teachers, students, and parents have known anecdotally for years: a better facility—one with good acoustics, lighting, indoor air quality, and other high performance features—will enhance learning.

2. Increased Average Daily Attendance

A high-performance school provides superior indoor air quality by controlling sources of contaminants, providing adequate ventilation, and preventing moisture accumulation. Through these strategies, pollutants are kept out of classrooms, stale air is eliminated, and mold growth is inhibited—all of which will keep students healthier and reduce absenteeism, especially among those suffering from respiratory problems. Indoor environments are believed to be a major causal factor of asthma, which is mushrooming in significance and now affects approximately one out of eight children in America.[6] In some states, such as California, a school's operating budget is dependent on the *average daily attendance*, so an increase in attendance boosts the operating budget. The renovation of the Charles Young Elementary School resulted in an increase in student attendance from 89% to 93%.[7] The U.S. Environmental Protection Agency (EPA) has a useful summary of studies addressing indoor air quality and student health.[8]

3. Increased Staff Satisfaction and Retention

High-performance schools are designed to be pleasant places to work. They are visually and thermally comfortable, incorporate good acoustics to minimize distraction, and provide indoor air that is fresh and clean. Such environments become positive factors in recruiting and retaining teachers and in improving overall teacher satisfaction.

4. Reduced Operating Costs

K-12 schools in the U.S. spend approximately $6 billion dollars per year on energy—this is more than they spend on computers and textbooks combined.[9] High-performance schools are designed—using life-cycle costing methods—to minimize long-term costs of operation. They use significantly less energy and water than conventional schools and are designed to be easier to maintain. Many high-performance schools built over the

[5] "Healthy School Environment and Enhanced Educational Performance: The Case of Charles Young Elementary School, Washington, DC," by Dr. Michael A. Barry, prepared for the Carpet and Rug Institute, January, 2002.
[6] 1999 data from the American Lung Association showing an incidence of 121.8 asthma cases per 1,000 among people aged five to 17. This age group has the highest incidence rate of asthma, well above the average for all people (90.0 cases per 1,000). "Trends in Asthma Morbidity and Mortality," American Lung Association, Epidemiology and Statistics Unit, February, 2002.
[7] "Healthy School Environment and Enhanced Educational Performance: The Case of Charles Young Elementary School, Washington, DC," by Dr. Michael A. Barry, prepared for the Carpet and Rug Institute, January, 2002.
[8] EPA Office of Indoor Air Quality, http://www.epa.gov/iaq/schools/perform.html.
[9] Alliance to Save Energy, www.ase.org.

past several years are realizing energy savings of 40% or more. A school in Iowa is even using windmills to generate more power than it uses and will soon be supplementing its operating budget with this revenue stream! The benefits of reduced operating costs in high-performance schools will continue throughout the life of the buildings.

5. Reduced Liability Exposure

Because high-performance schools are healthy, they reduce a school district's liability exposure over health-related lawsuits. In the past few years, a number of highly publicized school closings, such as that of the McKinnely School in Fairfield, Connecticut, have occurred due to mold problems. The high cost of remediation in schools with IAQ problems (often a quarter-million dollars in a school) are reason alone to do it right the first time. While we still have a lot to learn about such building science issues as mold and moisture control, high-performance schools are generally designed with much greater attention to these issues than conventional schools.

6. Reduced Environmental Impacts

High-performance schools are designed to have low environmental impact. They use energy and water efficiently. They use durable, nontoxic materials that are high in recycled content and can themselves be recycled. Attention is paid to protecting wetlands and natural areas on the school grounds, and efforts are made to allow stormwater to infiltrate into the ground, replenishing groundwater, rather than being carried off site in storm sewers. Many of these schools are being built to use non-polluting, renewable energy systems to the greatest extent possible. Wastes are minimized or recycled during construction. And the schools are designed to facilitate recycling of waste during operation. Through measures such as these, high-performance schools are good environmental citizens.

7. Using the School as a Teaching Tool

Schools are places of learning, and many of the technologies and techniques used to create high-performance schools can also be used as teaching tools. Renewable energy systems—solar, wind, and biomass—are ideal hands-on demonstrations of scientific principles. Mechanical and lighting equipment and controls can illustrate lessons on energy use and conservation. Daylighting systems can help students understand the daily and yearly movements of the sun. Wetlands and other natural features on a school grounds can be used as outdoor laboratories.

The Alliance to Save Energy, of which Senator Jeffords is vice-chair, has offered since 1996 a tremendous program encouraging energy savings in existing buildings. Their Green Schools Program gets students involved with assessing energy issues in their schools, implementing changes, and monitoring the results.[10] Through this program, schools in Pennsylvania, new York, and Washington saved an average of $7,700 per year on energy bills (10-15%) with no expenditure.

8. Schools as Disaster Shelters

Schools often play a role in a community's disaster planning—serving as storm shelters, central collection points during evacuations, or emergency housing during extended

[10] Alliance to Save Energy, www.ase.org/greenschools.

power outages. High-performance school buildings built to incorporate natural daylighting, highly energy-efficient envelope systems, and renewable power generation can function far better during power outages than conventional buildings.

High-Performance Schools: A Few Examples

Described below are a few high-performance schools in operation (or nearing completion) around the country.

Boscawen Elementary School, New Hampshire

Completed in 1996 and located just north of Concord, this elementary school was designed with a special focus on indoor air quality. The school it replaced was so crowded that some classes were held in hallways and the air so bad that people were regularly getting sick; the school was even evacuated once due to foul odors. Designed by the H.L. Turner Group, the 48,000 square-foot school for 400 students was the first in the U.S. to be designed to provide 100% fresh air to the building using a "displacement ventilation" system, controlled by carbon dioxide monitors. Ventilation air flows upward through the classrooms and better air quality is provided with less than half the typical ventilation rates in schools (and much lower fan energy). An energy-efficient building shell is combined with extensive daylighting, energy-efficient electric lighting, and low-VOC materials. An integrated, whole-building design process was used, and, remarkably, construction costs for the building were only $65 per square foot in 1996 dollars (exclusive of site costs).

Edgerly Early Childhood Development Center, Somerville, Massachusetts

Designed by HMFH Architects, Inc. and currently under construction, the 80,000 square-foot Edgerly Center will serve 560 pre-kindergarten through first-grade children in this city outside Boston. Somerville is the most densely populated city in New England, so carving out a site for the school was difficult. The need to share functions with a neighborhood park led to other green considerations for the school. A wide range of energy-saving and sustainability features were included in the design, such as extensive daylighting, high-performance glazings, high insulation levels around the entire envelope, superb acoustical isolation, and low-VOC and natural building materials. With funding from the Massachusetts Green School Pilot Program, a fairly large (25-32 kW) photovoltaic (solar electricity) system will be installed on the school, and a small (400 W) wind turbine will be erected in the community garden at the school. The energy features are projected to reduce energy consumption by 31%, compared with a conventional new school. Total cost of the school is expected to be $152/square foot.

Clearview Elementary School, Hannover, Pennsylvania

Due to be completed this fall, Clearview Elementary School was one of five buildings nationwide selected to represent the United States at the International Green Building Challenge, held last week in Oslo, Norway. This 44,000 square-foot, two-story school, designed by Kimball Architects of Harrisburg, Pennsylvania, is designed to achieve a 40% savings in energy and 30% savings in water, compared with a standard school. Among green design strategies employed in the building are daylighting, a high-

performance envelope (high insulation levels and advanced glazings), a ground-source heat pump system, an access-floor system for conditioned air supply, demand-controlled ventilation (with carbon dioxide sensors), extensive use of recycled-content building materials, and use of low-VOC paints and other products. Total construction costs were $133 per square foot, exclusive of site work and design fees. The building is expected to achieve a LEED Silver rating.

Dalles Middle School, Oregon

This 96,000 square-foot school serving 600 middle-school students 80 miles east of Portland opened in September, 2002. Designed by BOORA Architects of Portland and built for $12.5 million, the school features a sophisticated daylighting system with light shelves and light tubes to bring natural light deep into the school interior. The school makes superb use of an unusual resource: groundwater pumped from a nearby hillside to reduce landslide risk. This 58- to 60-degree water is used in a ground-source heat pump that provides both heating and cooling for the school. Natural ventilation is used whenever outside temperatures permit, and a wide variety of recycled-content, locally sourced, and nontoxic building materials were used. Overall savings in annual energy consumption are projected to be 46%, compared with a conventional school. The school was built for $105 per square foot, excluding site work.

Ross Middle School, Ross, California

The original Ross School was built in 1941 and a series of six, fairly haphazard additions had been added over the years to expand capacity. In Phase I of the most recent effort, designed by EHDD Architects and completed in 2000, five existing middle-school classrooms were replaced with nine new classrooms and support facilities on two floors. This addition is heavily daylit. Comfort is maintained using natural ventilation rather than an air conditioning system, saving $200,000 on mechanical equipment (these savings paid for all of the other green features). Considerable attention was paid to material selection to avoid IAQ problems and make use of recycled-content and sustainably sourced materials. For example, 90% of all wood used in the building was certified as sustainably harvested, and arsenic-treated wood was avoided in favor of safer pressure-treated wood.

McKinney Elementary School, Texas

Located near Dallas, Texas and designed by the SHW Group in Dallas, the priorities of this school were quite different from those mentioned above. Because water was a very significant issue, an extensive rainwater harvesting system using the school's roof was designed to provide water for outdoor irrigation. Completed in 2000, the 70,000 square-foot building uses extensive daylighting throughout. Energy-conserving electric lighting technologies are used, native landscaping is emphasized, and a great deal of attention was paid to selection of green building materials. Another key feature at the McKinney School was attention to how building features and elements could be used as teaching tools. The school was named one of the AIA Committee on the Environment Top Ten green buildings for 1999.

Durant Road Middle School, Raleigh, North Carolina

The 149,000 square foot school for 1,300 students was completed in 1995 as one of the first examples of a heavily daylit, "green" school. Some of the daylighting strategies

used in this school have been adopted in schools across the country. Designed by Innovative Design, the school, the school is realizing annual savings in energy for lighting, cooling, heating, and ventilation of 50-60 percent. Construction costs came in at $3.6 million under-budget!

Recommendations

The movement to create high-performance, green schools is moving along at a healthy pace. The U.S. Green Building Council, for example, has 32 K-12 schools registered for certification under the LEED rating program.[11] These schools are located in 14 states and represent approximately 4.5 million square feet of floor space. However, compared with the magnitude of school construction occurring today, this is just a drop in the bucket.

American School & University reports in its 28th Annual Official Education Construction Report that $26.7 billion in K-12 school construction was completed in 2001.[12] This was split between new construction (42%), additions (16%), and modernizations (42%). During the period 2002 through 2004, total K-12 school construction is expected to total $108 billion. Nationwide, a total of 6,000 new schools are expected to be built by 2007.[13]

Clearly, a lot of school design and construction is occurring. Each new building will be occupied, hopefully, for 50 to 100 years. For the vast majority of them, very little if anything is being done to ensure that they will be high-performance.

While not by any means a comprehensive list, the following are offered as initial recommendations of how the Federal Government could support the creation of high-performance schools. These recommendations are grouped into several areas.

Research

- Support carefully designed, scientifically based studies to measure the effect of high performance schools on attributes such as academic performance, absenteeism, teacher satisfaction and retention, and operating costs of school buildings (including energy, water, maintenance, and repairs).
- Support building science research to learn more about the causal factors of indoor air quality and moisture problems in buildings. One aspect of this could be the development of a protocol for evaluating what the long-term moisture performance (i.e., mold risk) of a building is likely to be based on its design.
- Support research on IAQ remediation, particularly mold problems, in buildings.
- Support research into advanced mechanical and electrical "packages" that could greatly improve school design and simplify their integration into high-performance buildings. Such systems could include displacement air delivery systems and lighting control systems. Until integrated packages are developed

[11] U.S. Green Building Council, LEED Building Registration List, 23 September, 2002.
[12] "28th Annual Official Education Construction report," *American School & University*, May 2002; www.asumag.com.
[13] *High Performance School Buildings: Resource and Strategy Guide*, Sustainable Buildings Industry Council, Washington, DC, 2001.

that are pre-engineered and perhaps even pre-manufactured, implementing leading-edge HVAC and lighting systems with require expensive custom engineering. Efforts to encourage manufacturers to invest in the development of such packaged HVAC and lighting systems could be structured like the "Golden Carrot" awards for high-efficiency refrigerators several years ago.

- Support prototype development of high-performance portable (relocatable) classrooms. In some states a high proportion of K-12 students are housed in portable classrooms—one-third of students in California, for example. Portable classrooms today often have poor indoor air quality, low energy performance, and poor acoustic performance.
- Support the development of improved daylighting design tools. According to some architects, the lack of a plug-in module for DOE-2 to accurately model the energy impacts of daylighting is a significant obstacle.[14] Rather than funding development of an end-user tool, federal support should go into the building blocks of such simulation tools, such as the calculation engine and data sets. Creating design tools that use those components should probably remain the purview of the private sector.
- Support the development of national protocols for quantifying hazardous emissions from building materials.

Education and Technology transfer

- Fund the dissemination of planning guides, design manuals, general information resources for the lay public, and other resources to assist in the creation of high-performance schools on a state and local level. While a few states, such as California, Oregon, Pennsylvania, and Massachusetts, already have effective state-wide programs in place to promote high-performance schools, most states do not. Excellent resources on high-performance schools are already available—from the Sustainable Buildings Industry Council, the California High Performance Schools Program, EPA, and DOE (especially the EnergySmart Schools Program). Support is needed to effectively disseminate these materials through state education departments.
- Fund educational workshops, seminars, and other training programs on high-performance school design and construction.
- Fund the compilation and Internet posting of information on leading examples of high-performance schools. The DOE High Performance Buildings Program maintains a database of high-performance buildings, and includes a category for K-12 schools.[15]
- Fund the creation of regional videos about high-performance schools that can serve to educate school boards and communities about the benefits of such practices. The State of Pennsylvania has just produced a superb half-hour program.[16]

[14] Personal communication with Mike Nicklas, FAIA, of Innovative Design, a North Carolina firm well-known for designing daylit schools.
[15] See http://www.eren.doe.gov/buildings/highperformance/case_studies/
[16] "Better Places to Learn: Building Green Schools in Pennsylvania," Governor's Green Government Council, www.gggc.state.pa.us.

Support of High-Performance School Design and Construction

- Provide flow-through (block grant) funding to state education departments to pay for computer modeling during the design of high-performance schools and commissioning[17] of schools prior to occupancy. Energy modeling and commissioning are two critical steps in the creation of high-performance schools, but they are expenses that are often seen as expendable. Computer modeling for a moderate-sized school may cost $10,000 to $15,000 and commissioning can cost from one-half to one-and-one-half percent of the total construction budget. The Healthy and High Performance Schools component of the 2001 Education Bill provides a mechanism for this, but additional funding is required for that effort to reach its potential.

Support of a Collaborative Effort to Advance High-Performance Schools

- Fund the development of a LEED for Schools Application Manual. This could be a collaborative effort among the U.S. Green Building Council, the California High Performance Schools Program, the Sustainable Buildings Industry Council, and perhaps other organizations. The LEED program provides a third-party mechanism for certifying the "greenness" of buildings. This third-party verification is very important in ensuring that the best of intentions on the part of a school board or community are really turned into the best building.

Summary

More than any other type of building, schools are an investment in our country's future. We are in a period of dramatic growth in the number of schools, and that offers a tremendous opportunity to improve these places of learning even as we significantly reduce their use of energy and other resources. We know how to do that. Dozens of high-performance schools have been being built over the past few years and many more are on the drawing boards. But for high-performance features to be incorporated into all schools, we need to identify key leverage points and assist at these points. Integrated, whole-systems design is the mechanism to do that, and the Federal government can do a great deal to make that available to school systems nationwide.

I thank you, Senator Jeffords and Committee members, for this opportunity to address these issues today. I look forward to following the high-performance schools agenda and would be glad to follow up on any of these ideas with Committee staff. I am sure that the two organizations I represent, the U.S. Green Building Council and the Sustainable Buildings Industry Council, would also be happy to provide additional information at any time.

Respectfully submitted,

Alex Wilson, President
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[17] Commissioning is a quality-assurance step that can be taken prior to occupancy to ensure that building systems are performing as they were designed. If commissioning identifies problems with the construction of the building, it may be possible to have corrective measures taken at no cost to the school district.