



Case Study: High Performance Schools in New Haven

A Model Program for Green Building Renovation and Construction of Public Spaces

Introduction

Since 1996, New Haven has been committed to incorporating high performance energy features into its public school buildings. As of mid-2006, eight newly constructed schools had incorporated such features, a change that should yield annual energy cost savings of approximately \$400,000. These savings are expected to result from a 30% reduction in energy use by the schools. The 20-year savings for these new schools is expected to exceed \$10 million.

By the end of 2012, New Haven will have completed 46 school projects, incorporating not only higher energy efficiency building systems but also clean energy technologies like solar photovoltaics. Under Connecticut's school construction grant formula, between 20% and 80% of the cost a town incurs to incorporate high performance design and technology in new construction can be reimbursed by the State.

Background

Connecticut's public schools are estimated to purchase 750,000,000 kWh's of electricity annually. At an average electricity cost of \$0.1397/kWh¹ in April 2006, this electricity use accounts for \$104 million of annual public school expense. This is in addition to expenses incurred for purchases of oil and natural gas for space heating and hot water. In 2004, the total energy bill for Connecticut's public schools was in the range of \$125 million. This annual total approaches \$200 million today, due to significant increases in natural gas and oil prices as well as rises in the cost to generate electricity.

A recent study by the Institute for Sustainable Energy of Eastern Connecticut State University highlighted the inefficient use of energy by Connecticut public schools. The Institute found that the performance of Connecticut schools falls well below that of schools nationwide, with 80% scoring below the national average. This means that Connecticut schools use significantly more energy than comparable schools elsewhere. In fact, over half of Connecticut's schools (59.2%) performed in the bottom 25 percent nationally.



Students enjoy some free time at New Haven's Edgewood Elementary School

While many schools continue to use traditional energy systems, a growing number of "high performance" schools are being built across the country. These schools emphasize "life cycle cost" over "first cost" and have been shown to significantly reduce energy use and cost while increasing student and teacher comfort.

High performance schools cost a bit more to build, but cash-strapped localities in Connecticut can recover much of the "high performance premium" through State reimbursements. State school construction grants to towns pay a percentage of eligible expenditures for new school construction and renovation² using a 20% to 80% sliding scale based on each town's relative wealth.

Reimbursements of up to 95% are possible for specialized schools (e.g., magnet schools). And the remaining additional first cost is quickly recouped in lower year-on-year energy bills.

¹EIA Database: Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State. Connecticut commercial customer data for April 2006, report released: July 11, 2006.

²These are projects that comply with the definition of Renovation in Section 10-282 of the Connecticut General Statutes. Under this section, a Renovation is a school building project which totally refurbishes an existing building and results in the renovated facility taking on a useful life comparable to that of a new facility.

“Today, energy costs over the life of a school will far exceed the initial cost of the building. As prices rise, it will be even more critical to comprehensively address this issue. Our schools can make a strong statement that saving energy and resources, while protecting our environment, is important. The message that we give to future generations should be embodied in the buildings we use to teach them.”

*-Energy Design Guidelines for High Performance Schools
U.S. DOE National Renewable Laboratory, June 2002*

Were “high performance” principles and standards to be incorporated into all new construction (as opposed to simply meeting code), schools could avoid an additional 20% to 30% of energy consumption and expense. This lost opportunity is particularly significant, when one considers the 50-year or greater life span of most school buildings.

New Haven Commits to High Performance and Clean Energy

In 1996, the City of New Haven pledged to build only high performance schools in the future. Since then, New Haven has been engaged in a fifteen-year construction program that will ultimately result in 46 renovated or new schools valued at \$1.5 billion³. Since 2003, all schools have been designed to meet both LEED⁴ and Energy Star⁵ standards, though only one of the new schools (the Barnard Environmental Magnet School) will seek LEED certification.

New Haven generally uses the Energy Star Target Finders for project goal setting, seeking a minimum score of 75 on a scale of 100. This means that New Haven schools will use 30% less energy than a school meeting code requirements (i.e., receiving a score of 50).

As of winter 2006, eight new schools had been built, with anticipated annual savings of \$400,000 that will result from a 30% anticipated reduction in energy use. The 20-year savings from these projects is expected to exceed \$10 million. And under Connecticut’s school construction reimbursement formula, approximately 80% of the incremental first cost for high performance will be paid by the state.

In addition, a 68 kW (AC) photovoltaic project will be incorporated into New Haven’s Barnard Environmental Magnet School, New Haven’s only LEED-certified school, with funding support from the Connecticut Clean Energy Fund (CCEF), the State of Connecticut and the City of New Haven. The photovoltaic system will generate electricity for the school and result in an estimated 6% reduction in annual energy consumption, saving the school over \$10,000 annually.

The total cost of purchasing and installing this photovoltaic system is \$612,443. CCEF has pledged \$361,940, and the remaining cost of \$250,503 will be covered through a grant of \$238,000 from the State of Connecticut and \$12,503 from the City of New Haven. As a magnet school, the Barnard School qualifies for 95% reimbursement from the Connecticut Department of Education (applied to the total cost less the CCEF grant). New Haven will recover its contribution through energy cost savings over time.

Total materials and labor	\$ 612,443
CCEF grant	\$ 361,940
CT DOE grant (95% reimbursement)	\$ 238,000
Net cost to City of New Haven	\$ 12,503
Project Simple Payback @\$0.13/kWh	1.1 years

While the economics of the Barnard School project are particularly favorable because of the 95% reimbursement, they speak to the potential for other schools to move forward with clean energy projects. The table below depicts costs and payback scenarios, in other communities, for photovoltaic projects of the same size and scope as the Barnard School project. The reimbursement rates noted are specific to those communities⁶:



Architect’s vision for a renovated Barnard Environmental Magnet School including a 229 foot pedestrian bridge over the Ella T. Grasso Boulevard that leads to a new Nature Center in West River Memorial Park. CCEF provided funding for a 68 kW Solar PV system as part of the school’s renovation.

Town / City	School Type	Reimbursement Rate	Net Cost to City or Town	Net Project Payback
New Haven	Magnet	95%	\$12,503	1.1 years
Hartford	Public	80%	\$50,012	4.3 years
Middletown	Public	61%	\$97,348	8.3 years
Greenwich	Public	20%	\$200,048	17.6 years

Keys to New Haven's Success

- Leadership and a Long-Term Perspective:** Enthusiastic support for the goals of New Haven's program is seen at all levels, starting from the top and continuing to all key personnel within the schools.
- Design Standards:** New Haven created a High Performance Schools Design Guide that includes both mandatory and optional standards for new school construction and major rehabilitation and, perhaps most importantly, lays out a detailed process for design, energy modeling, construction oversight, and measurement and verification of results.
- Integrated Design:** A building design team that includes all of the professionals engaged in a project (architects, landscape architects, site planners, engineers, and operations specialists) works collaboratively to develop a design that optimally addresses the project owner's needs and requirements.

When high performance requirements were set near the beginning of the design process, many of the new building and major addition design teams were able to generate designs that promised savings in the range of 30% above ASHRAE 90.1 2001 standards. Even with severe site constraints, teams were generally able to improve building orientation and massing when features were introduced early on.



- Building Modeling:** The design engineering process makes extensive use of computerized modeling to test the performance of design alternatives and optimize design components. Energy modeling contributed significant value to the process in helping design teams understand the economics of high performance systems and then incorporate envelope and system improvements.
- Early and Ongoing Commissioning:** An independent commissioning agent is brought on early in the design process to monitor discussions and decisions, ensure that design standards are followed, confirm that construction activity and systems meet design specifications, and verify that all installed equipment operates as intended.
- Process and Performance Auditing for Continuous Improvement:** The construction team employs an iterative process, including retro-commissioning as appropriate, to ensure that building systems and components are performing properly and generating expected results. All aspects of the project, including the design and construction process, are evaluated so lessons learned can be applied to future projects.

Savings Opportunities for Connecticut Cities and Towns

The results of New Haven's school construction program warrant the attention and potential emulation by other Connecticut cities and towns concerned about controlling local costs. Interested communities should focus on:

- Replicable features of the New Haven initiative, including integrated design, modeling, and ongoing commissioning.
- Use of Department of Education reimbursements to pay most of the incremental cost for high performance design and construction.
- Participation in CCEF's Renewable On-Site Distributed Generation program and other CCEF initiatives. Those projects supported with funds from the State of Connecticut will be particularly attractive.
- Participation in the Connecticut Energy Efficiency Fund's Energy Conscious Blueprint Program and other initiatives.

³ By the summer of 2006, 22 projects valued at \$723 million will have been completed.

The 24 remaining projects valued at \$760 million will be completed between 2007 and 2012.

⁴ LEED stands for "Leadership in Energy and Environmental Design" and is a nationally-recognized building certification standard promoted by the U.S. Green Building Council, a non-profit organization committed to transforming construction practices.

⁵ ENERGY STAR is a standard for energy efficiency developed by the U.S. Environmental Protection Agency with the U.S. Department of Energy.

⁶ Like projects in Waterbury and Bridgeport receive reimbursements of 79.29% and 78.97% respectively.

The Connecticut Clean Energy Fund

The Connecticut Clean Energy Fund (CCEF) was created by the Connecticut General Assembly and is administered by Connecticut Innovations, a quasi-public organization. CCEF promotes the development and commercialization of clean energy technologies and stimulates markets for electricity from clean renewable sources. CCEF's funding comes from a surcharge on electric ratepayers' utility bills.

CCEF's main goals are to:

- create clean energy supply for Connecticut;
- accelerate the development of clean energy technologies; and
- educate Connecticut consumers about the benefits and availability of clean energy.



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