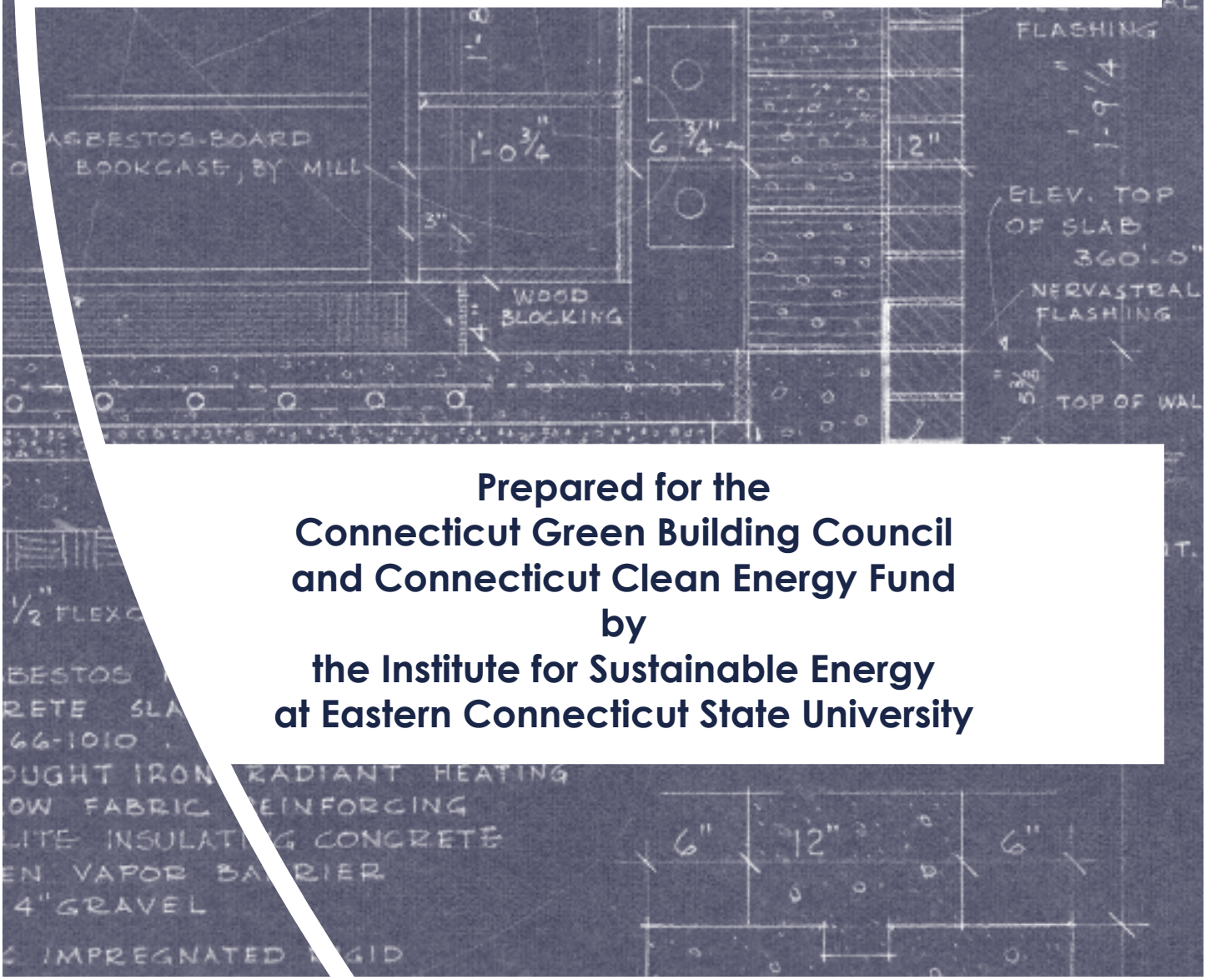
HIGH PERFORMANCE SCHOOL INITIATIVE

ENERGY EFFICIENY STUDY OF CONNECTICUT SCHOOLS

An opportunity to improve our educational infrastructure



Prepared for the
Connecticut Green Building Council
and Connecticut Clean Energy Fund
by
the Institute for Sustainable Energy
at Eastern Connecticut State University

Foreword

The Energy Efficiency Study of Connecticut Schools was first released by the Institute to the public on August 10, 2006 at the Connecticut Energy Summit held by Legislative leadership at the State Capitol in Hartford. Since its release, there have been a number of significant initiatives launched that have assisted communities in making their school more energy efficient.

Public Act 07-242, An Act Concerning Electricity and Energy Efficiency, signed into law in the summer of 2007, fully restored funding available for energy efficiency improvements from the Connecticut Energy Efficiency Fund. In addition, the law expanded the requirement for utilizing High Performance Building Standards for school construction and increased the funding base to cover the additional cost. The law included all new construction projects over $5 million and renovations over $2 million.

The Department of Public Utility Control in Docket 06-10-02 requested that the Institute develop a pilot training program for facility maintenance and management personnel in K-12 school systems throughout Connecticut. The pilot engages school systems with multiple related activities, including management training on energy issues for school administrators and business managers; benchmarking of all facilities; building operators training for the maintenance staff; and teacher workshops in eeSmart and CT Energy Education for the faculty.

For more information concerning this report or programs that can reduce energy use and costs for your schools, go to www.ctenergyinfo.com or contact the Institute for Sustainable Energy.

Cover

The architectural drawings used on the cover are from the actual construction documents for the Sweeney School built in 1959 in Windham, CT. The lack of wall, roof, and foundation slab insulation and use of single-glazed, metal-framed windows in this school is common among nearly 70 percent of all existing schools in Connecticut.

Energy Efficiency Study of Connecticut Schools

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Acknowledgements

The Energy Efficiency Study of Connecticut Schools was initiated by the Connecticut Green Building Council (CTGBC) and made possible by the financial support of the Connecticut Clean Energy Fund. Funding for the Institute to conduct the ENERGY STAR benchmarking analysis included in the report was provided by the Region 1 office of the U.S. Environmental Protection Agency in Boston.

The analysis was performed by the staff and student interns at the Institute for Sustainable Energy (ISE) at Eastern Connecticut State University. Special thanks to student interns Nicholas Policastro for data collection and analysis, and to Jennifer Keyes and Lauren Watkins for graphic support.

Energy Efficiency Study of Connecticut Schools
Executive Summary

The U.S. Environmental Protection Agency[1] (EPA) and the U.S. Department of Energy[2] (DOE) estimate that "school districts nationwide spend over $6 billion each year on energy, second only to salaries." According to the findings of the DOE collected through their ENERGY STAR program, school districts nationwide have the potential to "improve their energy efficiency and lower their energy bills by 30 percent or more" through cost effective improvements to existing facilities. Consequently, improvements in energy efficiency have the potential to yield significant monetary savings in the overall costs of delivering quality education. These energy cost savings are funds that could be better reallocated to activities and supplies that support improvements to educational activities.

The Institute for Sustainable Energy (ISE) at Eastern Connecticut State University calculated that during the 2004 – 2005 school year, public schools in Connecticut spent over $124 million on energy. Last year's 22 percent increase in electric rates for most Connecticut electric customers has directly affected our schools. In addition, the dramatic increase in heating fuel costs for oil and natural gas that resulted from hurricane damage in the Gulf Coast and political instability in foreign oil-producing countries has driven up energy costs even further. The ISE estimates that total energy costs to Connecticut schools for the 2005 – 2006 school year have risen over 35 percent, exceeding $160 million annually. Consequently, this sudden rise in operating expenses has forced to reallocate resources from educational and maintenance programs in order to pay energy bills. The state's newspapers frequently report on actions taken by local school boards as they attempt to cope with over-expenditures in their annual utility budgets. Typically, school boards are forced to reduce support for extra-curricular activities, including athletics and field trips, and freeze personnel hiring.

In this study, using 2004 – 2005 school year energy use and cost, ISE compares the benchmarking results for relative efficiency and potential savings for a control group of 119 public schools with information collected in a statewide survey of 237 additional schools. The efficiency ratings and savings projections were then applied to the demographics of Connecticut's 1026 schools provided by the CT Department of Education. The benchmarked schools and the surveyed schools represent 35 percent of Connecticut schools and provide a statistically accurate sample representative of all K-12 schools in the state. The benchmarking analysis utilized EPA ENERGY STAR Portfolio Manager and the DOE's Energy Information Administration national database for K-12 public schools. Portfolio Manager renders each benchmarked school with a score from 1 to 100. A score of 50 represents average energy consumption, while a score at 75 or higher qualifies the building for ENERGY STAR recognition. The average benchmarking score for the Connecticut benchmarked sample was 26, which makes them among the least energy efficient schools in the country. Further analysis revealed that if this result was consistent throughout Connecticut, raising the efficiency of all substandard schools to an average score of 50 would save school districts $46 million annually in 2005-2006 energy costs, and $69 million if raised to 75, the ENERGY STAR level. This report details the process used to arrive at this conclusion, discusses why Connecticut's schools rank so poorly when compared to schools, and offers action items to reverse this trend going forward.

Estimated 2006 CT Schools Energy Budget - $160 Million

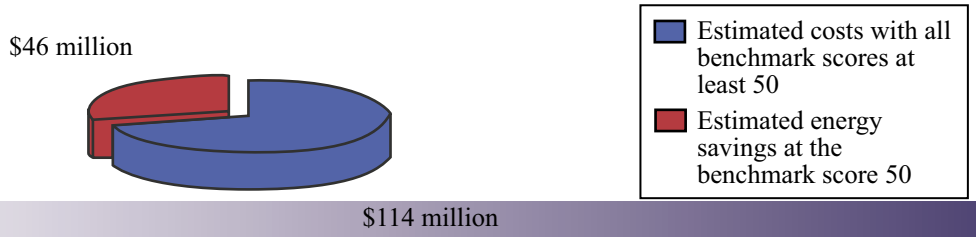


Figure 1- Saving potential for improving Connecticut schools

Project Overview

To raise awareness of the benefits of High Performance, energy efficient school design and construction, the CT Green Building Council[3] (CTGBC) embarked in 2005 on a program to promote the transformation of Connecticut schools. The "High Performance Schools Initiative," launched in February 2005, sets four tasks, including:

1. Conduct a stakeholder process on High Performance New School Design and Construction,
2. Increase educational outreach efforts on High Performance Building benefits to communities and policy makers,
3. Inventory the energy efficiency of all public schools in Connecticut, and
4. Promote High Performance, energy efficiency building standards through legislative action.

With the conclusion of the High Performance Schools Initiative stakeholder process in 2005, CTGBC published its final report[4] on the significant benefits and barriers to adopting High Performance design and construction building standards for schools in Connecticut. The report can be found at www.ctgbc.org.

Objectives of Report

The Energy Efficiency Report of Connecticut Schools is designed to complete Task 3 of the CTGBC High Performance School Initiative: an inventory of the relative energy efficiency of the existing public K-12 schools throughout Connecticut. In order to improve the general energy efficiency of public schools, the CTGBC identified that it would be remiss to focus only on new schools built in Connecticut while not addressing the inefficiency of the 1026 existing facilities in our communities. These facilities consume the majority of the energy purchased for K-12 public education in Connecticut. They also represent a group of buildings that are continually being renovated and reconfigured to achieve their community's educational objectives. Many of these same schools have come under close scrutiny for issues related to Indoor Air Quality[5] (IAQ). The CTGBC believes that communities renovating their schools could benefit from applying High Performance Building Standards to these projects, improving the educational and health environment in the schools, while reducing the tax burden they place on the community.

Evaluation Process

ISE used three sources of data to develop the analysis, observation and conclusions found in this study of the relative energy efficiency of Connecticut's public schools. They included:

1. Benchmarked Schools – reports generated from a statistically representative sample of 119 schools from 13 Connecticut school districts utilizing EPA's Portfolio Manager,
2. Surveyed Schools – surveys representing 237 Connecticut schools completed by local school superintendents from 56 school districts, and
3. 2005 "Condition of Connecticut's Public School Facilities"– demographics on all schools in Connecticut school districts, obtained from a report compiled by the Connecticut Department of Education.

Findings for energy use, relative efficiency and savings potential from the benchmarking group were compared to data collected in the survey group. Criteria used included: building age, building type, size, number of students, hours per week, month used per year, cost per square foot, and BTUs per square foot. Findings were then extrapolated statewide to all Connecticut schools by comparing buildings by type, age, size, and occupancy.

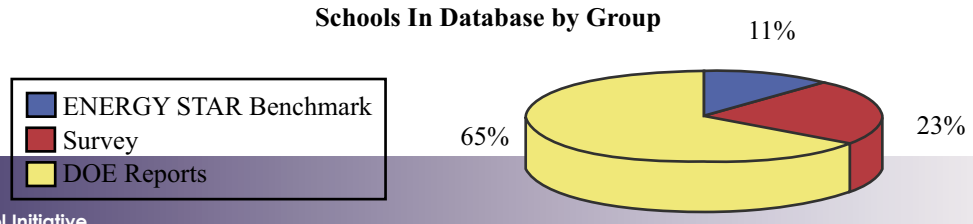


Figure 2- Make-up of school sample data

Comparative Data Sources

Benchmarking with EPA's Portfolio Manager

Since 2003, ISE has been an EPA ENERGY STAR Partner through its use of the Portfolio Manager benchmarking software. Over the past four years, ISE has benchmarked 250 state and municipal buildings, including many public schools. The benchmarking tool has proven valuable for assessing the relative energy efficiency between buildings, and for targeting the use of limited resources toward buildings that demonstrate the greatest potential for improvement.

Sponsored by the U.S. Department of Environmental Protection, ENERGY STAR has developed Portfolio Manager to help government and the business community continually track and compare energy use information which is critical to successful energy management. Portfolio Manager provides a comparative 1–100 rating of energy use for various building types, including office buildings, K-12 schools, hospitals, hotels, residence halls, and grocery stores. Portfolio Manager is designed to assess the comparative energy performance of similar-use buildings regionally in the United States with scores adjusted by regional weather, occupancy, and hours of use. The Portfolio Manager database includes over 7,000 schools. The Portfolio Manager database is updated with energy use information provided by the DOE's Energy Information Administration every five years. To ensure an accurate benchmark score, Portfolio Manager's benchmarking models require buildings to meet certain eligibility criteria. Additional information is available on the ENERGY STAR website at www.EnergyStar.gov.

For this benchmarking study, a sample of 119 school buildings statistically representing schools statewide and were selected based on type, size, age, county, and economic reference group (ERG). Statistical comparisons of the three groups can be found on the Institute's website, www.sustainenergy.org, under "High Performance School Initiative" and "Energy Efficiency Study of Connecticut Schools." The benchmarked sample provided a basis for BTUs per square foot, cost per square foot, and savings potential that could be extrapolated statewide. The benchmarked sample represented 11.5 percent of Connecticut's schools.

Survey of Public Schools

In an effort to improve the accuracy of the study sample, expand the database concerning energy use, cost, school age, and improve our ability to project relative efficiency and savings potential statewide, a survey was developed by the CTGBC and sent to all school superintendents. The survey asked for building demographics and annual energy consumption. Support for the survey was also provided by the president of the Connecticut Association of School Superintendents. Although the survey did not provide enough data to compute a benchmark score for these schools, it did provide valuable information including students per square foot, cost per square foot, and BTUs per square foot, increasing the total study sample size to 35 percent of all Connecticut schools.

Information from the Connecticut Department of Education

Data concerning the 1026 public schools in Connecticut was obtained from the CT Department of Education through the 2005 "Annual Condition of Connecticut's Public School Facilities" report. This report provided information on all 1026 public schools, including location, grade level, age of building, number of students, ERG, and general condition, but did not provide energy use or cost information.

Study Findings

Benchmark Findings

From the total sample of schools that were benchmarked by ISE, a group of 119 K – 12 schools that are statistically representative of Connecticut's 1026 schools were selected. The analysis for relative efficiency and potential savings utilized actual building demographics including building age, occupancy, use patterns, and 24 months of energy bills. Using EPA's ENERGY STAR Portfolio Manager software[6], the analysis compares the sample to the DOE's Energy Information Administration national database on public schools. Portfolio Manager renders each school with a score from 1 to 100, with 50 being average energy consumption, and 75 or higher being eligible for an ENERGY STAR award. Analysis is calculated on BTUs per square foot, normalized by regional weather, hours and months of use, occupancy, and age of building.

The average benchmarking score for the sample was 26, indicating that the Connecticut benchmarked schools were among the least energy efficient schools as compared to the national standards. The low scores raised concerns over why this group of Connecticut schools was performing so poorly on energy use when compared to schools nationwide and whether this sample reflected the general efficiency of all Connecticut schools.

Score for Benchmarked Schools

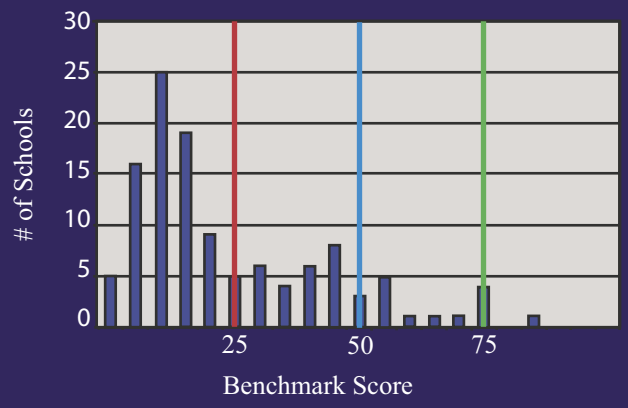


Figure 3 - Benchmarking scores of 119 Connecticut schools

Survey Sample Compared to Benchmarked Group

Analysis of the demographic data from the 119 schools in the benchmarked group was compared to the information provided by superintendents in the survey sample. This group included 237 buildings from 56 school districts. The black and red plotted line in figure 4 indicates a statistically accurate correlation between the two groups of schools when compared by cost per square foot. Similar correlations occurred when these two groups were compared to each other based on BTUs per square foot, age of buildings, and students per square foot.

Annual Energy Cost Per Square Foot

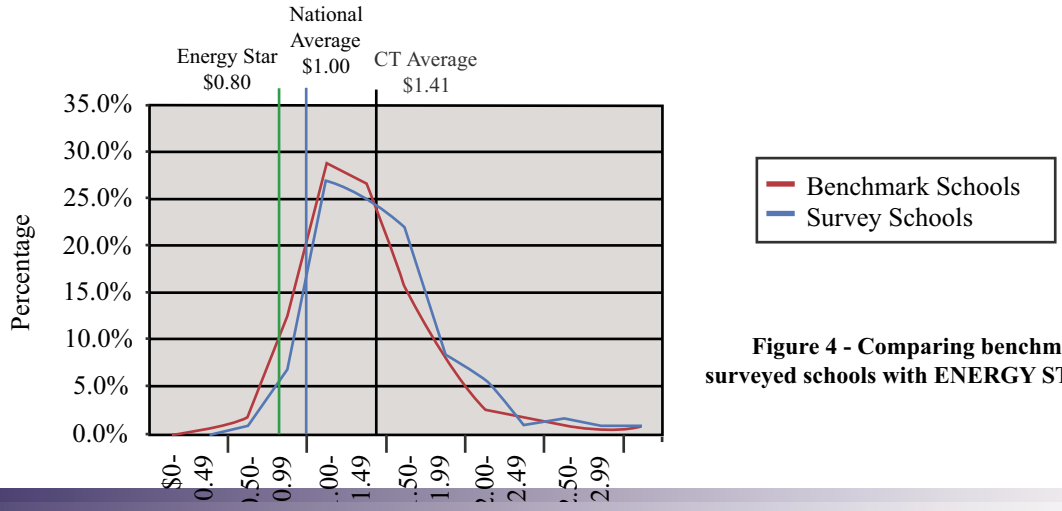


Figure 4 - Comparing benchmarked and surveyed schools with ENERGY STAR standards

Connecticut Department of Education Data

Comparing data from the benchmarked group, the survey sample, and the data in the Connecticut Department of Education annual report on the 2005 "Condition of Connecticut's Public School Facilities"[7] indicates a correlation between the three data sets. Schools were compared by age, grade level, number of students, students per square foot, county, and Educational Reference Group grouping. Figure 5 revealed that 90 percent Connecticut schools were constructed before 1978, prior to the first energy crisis and improvements to the insulation and HVAC requirements of the Connecticut building code standards.

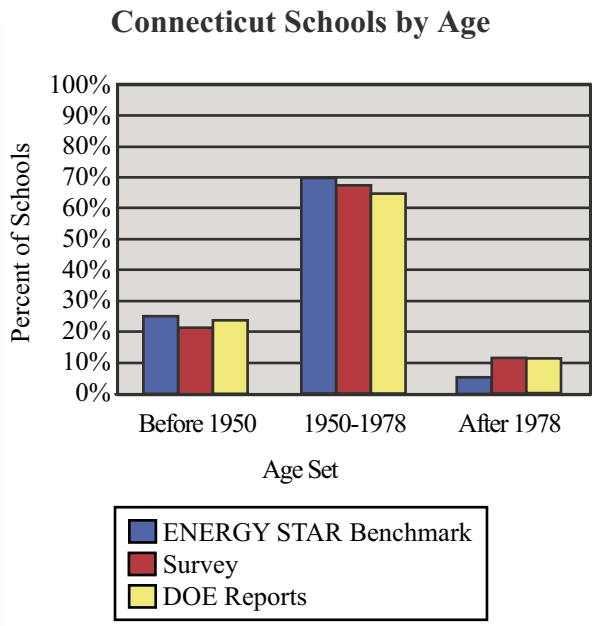


Figure 5 - Graph of Connecticut's schools by age

Conclusions

Having completed the collection and evaluation of energy use and cost data from a sample of 35 percent of Connecticut Schools, and through the comparison of that data to general demographic data on all Connecticut Schools, it became apparent that, in general, Connecticut's schools are very inefficient when compared to schools throughout the country. The question remains, why are they performing so poorly?

What seems problematic is that the vast majority, over 90 percent, of Connecticut schools were built before 1978. Furthermore, 68 percent of Connecticut's schools were built between 1950 and 1978, when our communities were feeling the stress of population growth created by the post-World War II baby boom and urban sprawl. This group of publicly financed buildings was designed and built during a time of rapid growth, and under building codes that had minimal thermal standards because they were built during a time of cheap energy, (e.g. 4¢ per kWh for electricity and 17¢ per gallon fuel oil). Consequently, most Connecticut schools are still inefficient users of energy, especially in their use of fossil fuels. It should be noted that many of the schools in Connecticut have participated in electric conservation programs and had fluorescent lighting systems upgraded over the past 15 years through the Connecticut Energy Efficiency Fund programs.

A seemingly small decrease in energy usage is apparent between pre-1978 schools and those built in later years, approximately 15 percent less in post-1978 buildings. In reality, this represents a substantial difference when one considers that most new schools utilized building codes that required more energy intensive HVAC systems, and meet educational requirements which include more computers and other energy consuming technologies.

The Tashua Elementary School in Trumbull is a typical design for schools built in Connecticut in the mid-1960s.

What are the problems with pre-1978 schools?

Based on the Energy Design Guideline for High Performance Schools in cool and humid climates developed by the Department of Energy, facilities from this era have a number of design and construction characteristics that inherently make them energy inefficient and unhealthy indoor environments. These design problems include:

- A predominant design style of single-level buildings, built on a cement slab with maximum exposure to the elements. Vapor barriers were ineffective and seldom used, leading to mold problems.
- Insulation levels are minimal, if used at all. Slabs were not always insulated around the perimeter, nor were the knee wall and block side walls insulated, magnifying heat losses.
- Large single-pane glass/aluminum wall construction was most common. These window walls were not solar oriented, and often exposed the classroom to harsh winter conditions on the north and west and to glare from direct sunlight on the east and south.
- Buildings were not designed to make optimal use of day-lighting opportunities.
- Roofs were either flat, or constructed with a minimum pitch and minimal insulation. Leaks are common in these roofs and lead to mold problems.
- Most of these schools do not have an efficient way to dehumidify interior air or to introduce fresh air.
- Heating systems relied on convection heating within the classroom. These systems include baseboard convectors, radiators, or unit heaters along the window walls. These systems do not adequately address the need for proper ventilation, and are often blocked by teaching materials which hamper the circulation of heat.
- In many of these 25 to 50-year-old schools, the original inefficient boilers are still in use, although the burners and boiler controls may have been upgraded.
- The building temperature control systems are often in disrepair, making classroom comfort control difficult. Many of these building rely on antiquated pneumatic controllers.
- If the building shell was made more energy efficient in the 1980s, the results may have limited fresh air infiltration into the building, exacerbating condensation and mold growth.

Rippowam Middle School in Stamford was built in 1959 and renovated in 2006 improving the original exterior walls by adding insulated high-E glass windows and insulated wall panels.

What about schools built before 1950?

Many of the schools built before 1950 that are still in use are actually performing better than the schools from the 1950 to 1978 era. This could be due, in part, to the fact that most of them have undergone major renovation in the past 20 years, receiving new heating systems and controls, energy efficient lighting, and operable insulated glass windows. The heavy thermal mass of these older structures, their vertical multi-story design, and the relatively limited window areas compared to glass wall construction, help them to distribute heat better and to weather Connecticut's harsh winter conditions. New operable windows, combined with the thermal mass of their sidewalls, also make these older buildings cooler in the warm weather.

The Natchaug Elementary School in Windham, CT was built in 1914 and underwent extensive renovation in 1998.

What about the newer, post-energy crisis buildings?

As demonstrated in the graph below, schools built after 1978 used approximately 15,000 BTU/sq ft per year less energy on average than schools built during earlier periods. This is primarily due to the state adopting more energy-minded building codes which were put into effect after the energy crisis, and to technology advancements in more energy efficient lighting, HVAC and building envelope materials. Today's High Performance Building Standards, such as ENERGY STAR and LEED Silver, reduce energy use by as much as 40 percent below levels achieved with the current building code. The average energy use for HP schools is approximately 63,000 BTU/square foot as indicated by the horizontal green line on Figure 6.

ENERGY STAR Findings

Nationally, the least efficient schools use three times more energy than the best energy performers, and top performing ENERGY STAR labeled schools cost 40 cents per square foot less to operate than the average performers.

Buildings achieving a rating of 75 or higher and professionally verified to meet current indoor environment standards use only 60,000 BTUs per square foot and are eligible to apply for the ENERGY STAR award and receive the ENERGY STAR plaque to convey superior performance to students, parents, taxpayers, and employees.

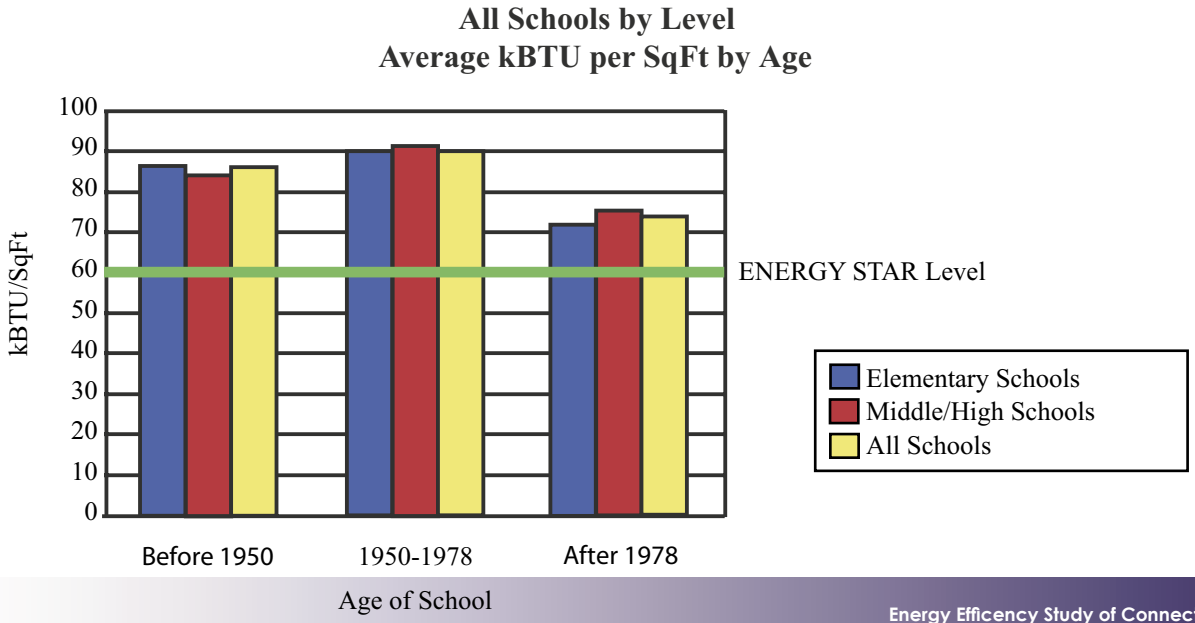


Figure 6 - Comparing energy use per square foot by age of building

	Benchmarked Schools		Surveyed Schools		Remainder of CT Schools		Total	$/sqft	%
	Score 50	Saving/SqFt	Score 50	Saving/SqFt	Score 50	Saving/SqFt	Potential	@50	Reduction
Savings to 50% Total	$5,115,073	$0.38	$7,889,845	$0.38	$21,261,816	$0.38	$34,266,734	$0.98	28%
Elementary	$2,041, 697	$0.38	$5,095,175	$0.38	$13,730,648	$0.38	$20,867,521	$0.94	29%
Middle	$963,904	$0.43	$1,799,487	$0.43	$4,849,317	$0.43	$7,612,708	$0.86	33%
High	$2,095,242	$0.36	$1,297,633	$0.36	$3,496,906	$0.36	$6,889,781	$1.06	26%

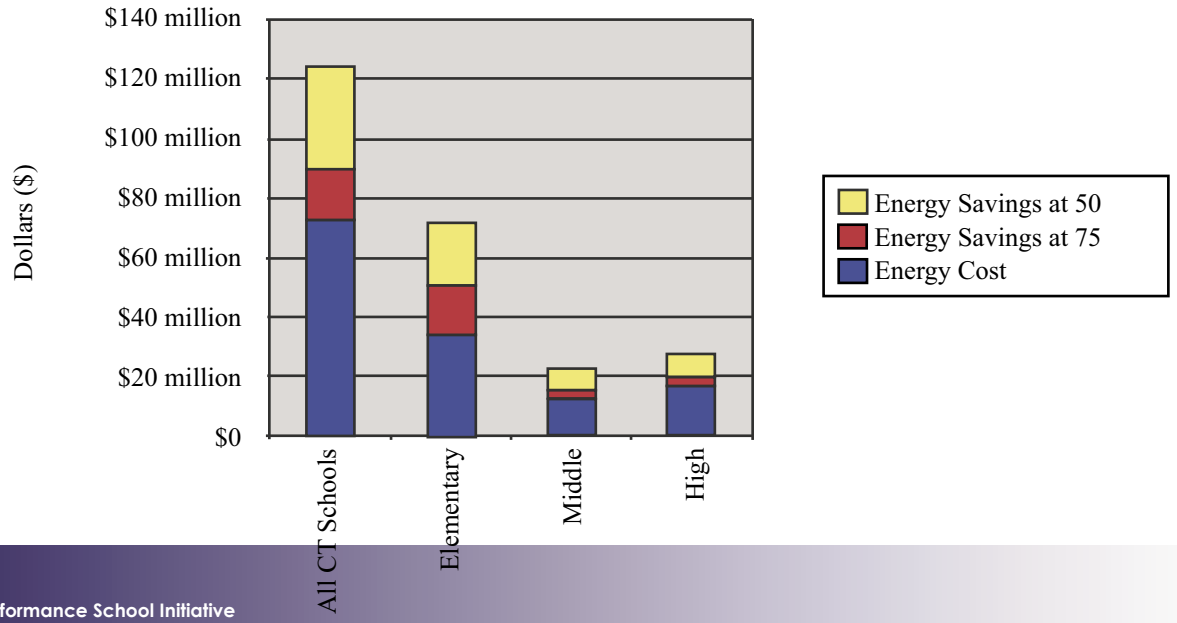
	Benchmarked Schools		Surveyed Schools		Remainder of CT Schools		Total	$/sqft.	%
	Score 75	Saving/SqFt	Score 75	Saving/SqFt	Score 75	Saving/SqFt	Potential	@75	Reduction
Savings to 75% Total	$7,747,271	$0.57	$11,949,930	$0.57	$32,203,069	$0.57	$51,900,270	$0.79	42%
Elementary	$3,028,079	$0.57	$7,556,750	$0.57	$20,364,181	$0.57	$30,949,010	$0.75	43%
Middle	$1,364,811	$0.61	$2,547,930	$0.61	$6,866,246	$0.61	$10,778,986	$0.68	47%
High	$3,227,803	$0.56	$1,999,055	$0.56	$5,387,121	$0.56	$10,613,980	$0.86	39%

Figure 7 - Potential for energy savings in Connecticut schools

What is the bottom line?

Connecticut's towns, taxpayers and students have a great deal to gain from the adoption of High Performance energy efficiency building standards as a requirement in school renovation projects. Money invested today in energy efficiency provides greater resources in the future to address pressing educational needs. As indicated in Figures 7 and 8, if the state set a goal to bringing all Connecticut schools up to at least the national average, 50 on the ENERGY STAR scale, it would reduce energy use by 28 percent. Annual savings in 2005 dollars would be $34 million, and approximately $46 million at the higher 2006 energy rates. If the state adopted a more aggressive goal of becoming an ENERGY STAR state, raising the standard for new and renovated schools to the ENERGY STAR 75 level, Further, a portion of the potential savings from improving the energy efficiency could be invested in the installation of renewable energy sources, such as photovoltaic (PV) electric panels, solar thermal systems, and geothermal heating and cooling systems. This would yield additional savings and stability in energy cost for many years. For example, with incentives available through the Connecticut Clean Energy Fund, and using the state reimbursement formula at the time of school renovation, a school district could install PV panels for 10 to 25 percent of their retail cost of PV systems, stabilizing electric costs for 20 years and supporting the state's goal to reduce air emissions and

Cost and Saving Breakdown Based on 2004 Billing



Recommendations

Connecticut communities and the State Legislature should adopt energy efficiency building standards for construction and renovation to bring Connecticut's public schools to the ENERGY STAR level and include features of the High Performance Building Standards recommended by the CTGBC High Performance School Initiative Stakeholders Process.

The Connecticut Energy Efficiency Fund[8] has incentives available to encourage additional building improvements. Investment in energy efficiency would increase future resources available for both Connecticut communities and public education. Indeed, the adoption of energy efficiency standards and reduction in energy waste could become an avenue for Connecticut to increase the overall funds available for education. An added benefit of using less energy as a result of efficiency would be a reduction in Connecticut's greenhouse gas emissions (GHG's) which would help to mitigate the effects of climate change. In fact, the Connecticut Energy Efficiency Fund (CEEF) already promotes energy efficiency programs that have reduced energy costs, producing savings already enjoyed by many school districts. Efforts thus far have only addressed retrofits to electric equipment, and do little to reduce thermal losses and improve heating plant efficiency. A CEEF program, Energy Conscious Blueprint, addresses specifying energy efficient electric equipment in new school construction, however participation in this program is voluntary and many schools are built without consideration for energy efficiency beyond code compliance and with little consideration for life cycle cost.

The Connecticut DPUC[9] has an incentive program to support the installation of distributed generation, making the electric system more reliable and reducing federally mandated congestion charges. These generators, installed in an efficient combined heat and power configuration, can substantially reduce overall energy costs to the school while providing emergency generation so that schools can be used as community emergency evacuation shelters.

The Connecticut Clean Energy Fund[10] has incentives available to include renewable energy sources in school projects, further reducing dependence on fossil fuel. Further, towns could dedicate a percentage of the annual energy savings from improving the energy efficiency of schools towards investments in on-site, clean distributed generation. For example, if only 10 percent of the $34 million in energy savings were reinvested into solar photovoltaic systems, then over $300,000 in annual electricity savings could be achieved each year for at least 25 years. This would offer new schools and major renovation projects a 10-year payback for on-site clean energy systems that would provide a hedge against rising energy prices; back-up power for a community facility such as a school; and a reduced greenhouse gas footprint.

Specific Actions Steps

1. If your community hasn't already, benchmark your schools using EPA's ENERGY STAR Portfolio Manager. A full explanation of this free software can be found on the www.EnergyStar.gov website.

2. Conduct an energy audit on any schools that score below the 50 level on the ENERGY STAR scale.

3. Encourage your community to adopt High Performance building design standards for all new building and renovation projects.

4. Adopt ENERGY STAR appliance and equipment standards for all new equipment purchases.

5. Participate in energy efficiency programs available from the Connecticut Energy Efficiency Fund. Information can be found on the www.ctsavesenergy.org website.

6. Consider installing clean, renewable energy sources when designing new or renovating public buildings to stabilize electric costs, reduce emissions and reduce reliance on fossil fuels. Information can be found at www.ctcleanenergy.com.

7. Support efforts in the Connecticut General Assembly to adopt High Performance building design standards for all new building and renovation projects that utilize state funding. Support the provision that energy efficiency improvements in these projects be funded at 100 percent of the incremental cost.

8. Teach students in your school system about ecology, energy efficiency, and sustainability. Use your school as a "learning laboratory" for learning about practical alternatives that reduce energy waste and model a more sustainable lifestyle. For more information on programs for schools, refer to "CT Energy Education" and "Green Campus Initiative" on the Institute's

A Success Story in High Performance Green Schools

Consider the following case study from the CT Green Building Council.

A paper published for the Connecticut Clean Energy Fund (CCEF) written by Steven Weisman, from Peregrine Energy Group[11], documents the success of the New Haven community which instituted High Performance Building Standards for all of its new and renovated public schools.

The city plans to build or renovate "50 schools" over the next ten years. The community has set a goal of reaching "a minimum energy score of 75 out of 100 on the ENERGY STAR scale" for all of its new schools. New Haven has planned eight new schools which are likely to save its taxpayers $400,000 per year or $10 million throughout the building's projected life cycle of 20 years.

Additionally, New Haven may serve as a model for the development of High Performance schools which employ renewable distributed generation such as photovoltaics. Utilizing a combination of grants which are made possible by the CCEF and the Connecticut Department of Education, the school was able to install 68kw of photovoltaic power capacity. After grants, the entire project cost the city only $12,503 at a payback rate of 1.1 years. At the time of Weisman's study, electricity was priced at $.13/kwh in New Haven. In the future it is likely to be much higher which would produce a much faster payback. Thus, installing PV on High Performance schools could be another money-saving and environmentally friendly strategy which communities could employ to reduce the associated energy costs of education. In addition, students could use the installed PV and its associated technologies to enhance their studies of advanced energy technologies and sustainability.

CTGBC's High Performance School Initiative

What is the CTGBC doing about raising energy efficiency standards?

To raise awareness of the benefits of High Performance Schools, the CTGBC has embarked on a program to promote the transformation of schools in Connecticut. Launched in February 2005, the High Performance Schools Initiative is operating on four tracks, including a stakeholder process, an educational outreach effort, an inventory of all public school buildings, and monitoring of legislative action. The stakeholder process began in February 2005, when the CTGBC invited representatives of key constituencies, including superintendents; educators; representatives of local governments; state officials; health and environmental advocates; and design professionals to be part of a team to define the benefits and obstacles related to building High Performance schools in Connecticut. With the conclusion of the stakeholder process, the CTGBC published its final report of stakeholders findings, and their suggested actions for raising the building standards used for constructing new schools in Connecticut. The benefits from High Performance Building Standards include:

- **Cost Effectiveness**

  Stakeholders identified cost effectiveness as the primary benefit of designing and building High Performance Schools. Energy efficiency, decreased liability, building longevity and durability, and reduced maintenance costs result in significant life cycle cost savings. The bottom line is that High Performance Schools save taxpayers money.

- **Enhanced Student Performance**

  The group of Education Stakeholders found it especially important that High Performance Schools enhance student learning. This is accomplished through the use of natural daylighting in classrooms, which studies show assists the learning process. The building itself also acts as a learning laboratory for sustainability among students and members of the community. Studies have indicated that students in High Performance Schools with significant natural lighting can learn math and reading at rates as high as 28 percent faster than students taught in traditional classrooms.

- **Health of Occupants**

  The second most important benefit of High Performance Schools concerns the health of the building users. A high-performance school is a safer, more comfortable building with exceptional indoor air quality. The result is that students and teachers are sick less often, and consequently are absent less often. Studies show that, because the building occupants feel better, attitude, performance, and productivity are enhanced.

- **Concern for the Environment**

  High Performance Schools are also beneficial for the environment. This benefit is derived through energy conservation, water conservation, improved land use, and through the opportunity presented for education about sustainability by using the school as a "learning laboratory." These benefits apply not only at the local level, but also at the state, national, and global levels.

The Inter-District Environmental Magnet School in Stamford is being designed to LEED Silver standards.

Guidelines for Local Schools

The Connecticut Green Building Council has identified the following guidelines for adopting High Performance school standards in your community:

1. All future new construction or major renovation of school buildings should utilize an integrated **design process** that is consistent with Connecticut's climate. This process should facilitate the design and construction of school buildings that include all the essential elements of High Performance, energy-efficient design that are most appropriate to the building site. This is contrary to the method used in most communities where they continue to build and renovate schools following the low first cost model, accepting the lowest bid and not considering the life cycle cost of energy when planning of their facilities.

2. Newly constructed school buildings or major renovations should **utilize an independent third-party verifiable rating system** such as LEED or some comparable standard. At a minimum, all buildings should be designed and built to the LEED silver standard or an equivalent standard.

3. All newly constructed buildings should be designed and built to **be at least 20 percent more energy efficient than current Connecticut building code** requires and should utilize properly designed solar orientation and day lighting to the greatest extent possible.

4. **Building Commissioning should be mandatory** prior to occupancy of any school that is newly built or significantly renovated, in order to ensure proper design and operation of the specified equipment and systems. Particular attention should be given to achieving superior indoor air quality within the occupied spaces. Maintenance manuals and proper training of maintenance personnel should be given priority along with the establishment of periodic refresher training.

CTGBC brought together education, environmental and health professionals, and designers to define those features that meet both educational and energy goals.

5. **An educational outreach effort should be undertaken** to convey the benefits of High Performance, energy-efficient, healthy schools. Such efforts should target local decision makers, such as school administrators, boards of education, and local building committees. In addition, statewide policy makers and agencies responsible for public building design, finance, and oversight should be educated in the benefits of High Performance building design.

High Performance Standards include site preparation, solar orientation, and foundation insulation.

Adopting High Performance Building Standards

In establishing local High Performance Building Standards, CTGBC recommends these building standards, including the following mandatory elements:

All HP building standard programs should include

- Indoor air quality (IAQ) requirements that exceed current standards
- A building commissioning required before occupancy
- A 20 percent more energy-efficient standard than the prevailing building code
- Use of an integrated design process
- A minimum mandatory day-lighting contribution
- Operations and Maintenance manuals and training for building operators

Additional elements that should be considered

- Required use of sustainable, environmentally friendly materials
- HP certification by an independent third party
- A life cycle analysis to be performed on the energy system options
- A requirement that the design include on-site provisions for recycling
- An accreditation process available for local design professionals
- Guidelines available for the design and construction teams
- Life cycle analyses for material's durability
- Project planning materials available for the building committee

CTGBC recommends the following process for building a High Performance school

- Get local school administrators to support High Performance design
- Provide training and planning support to the building committee
- Secure early decision to build to a proven High Performance building standard
- Hire an experienced design and construction team
- Use an integrated design process
- Use dynamic modeling for building energy systems
- Use life cycle analysis for building system and material selection
- Include commissioning of both the design and completed construction
- Provide training to the maintenance staff on proper operation of the building

Sponsors of the High Performance School Initiative

The Connecticut Green Building Council is a non-profit 501(C)3 organization that seeks to improve the quality of life in Connecticut through the promotion of intelligently designed and constructed High Performance energy efficient buildings. Throughout the year CTGBC holds a series of workshops on green building topics, networking opportunities, membership meetings, educational forums, seminars on green buildings and periodic CT-based LEED™ training in connection with the U.S. Green Building Council. The CTGBC also monitors activities in Connecticut related to High Performance green buildings and maintains a speaker's bureau. Go to www.ctgbc.org for more information.

The Connecticut Clean Energy Fund is engaged in a long-term effort in Connecticut to foster the production and use of energy from clean and renewable sources by investing in enterprises and initiatives aimed at developing a vibrant market for clean power, educating consumers about the benefits and availability of clean power, and building a base of renewable energy technologies and infrastructure. The Connecticut General Assembly created the Connecticut Clean Energy Fund in 1998 as part of legislation deregulating Connecticut's electric utility industry. The statute directed that the fund be used to foster growth, development, and commercialization of renewable energy technologies and sources; stimulate Connecticut consumers' demand for renewable energy; and promote deployment of renewable energy sources that serve Connecticut's energy customers. Go to www.ctcleanenergy.com for more information.

The Henry P. Kendall Foundation[12] is a legacy of its namesake, an early twentieth-century New England entrepreneur and industrialist (1878-1959) from Walpole, MA. Kendall's wide-ranging, venturesome business instincts led to acquisitions of factories and other companies through the company that bore his name, The Kendall Company. Henry W. and John P. Kendall established the Norfolk Charitable Trust in 1957. Following the death of their father in 1959, they changed the name to the Henry P. Kendall Foundation in his honor. The Kendall Foundation began an emphasis on environmental concerns in the early 1970s by supporting land, water and wildlife conservation. Environmental advocacy and nuclear non-proliferation and arms control activities have been the hallmark of their focus. The Foundation emphasizes the imperative of protecting nature's integrity. Go to www.kendall.org for more information.

At Eastern Connecticut State University

Study Author

The Institute for Sustainable Energy[13] at Eastern Connecticut State University was established in 2001 to identify, develop, and implement the means for achieving a sustainable energy future. The Institute focuses on matters relating to public policy; conservation and load management; efficient and renewable distributed generation; protection of environmental resources; and the dissemination of useful information on energy alternatives and sustainability to users and providers of energy. The Institute adds an unbiased focus on practical applications and dissemination of information about how to improve the energy profile and sustainability of the region. Go to www.sustainenergy.org for more information.

End Notes

1 Environmental Protection Agency http://www.epa.gov

2 DOE Reference http://www.eere.energy.gov/buildings/info/schools

3 CTGBC High Performance Schools Initiative http://www.ctgbc.org/hps/index.htm

4 CTGBC High Performance Schools Initiative Final Report http://www.ctgbc.org/hps/docs/hpschools_finalreport_2006.pdf

5 CT Indoor Air Quality http://www.dph.state.ct.us/BRS/EOHA/iaqcm.htm

6 Portfolio Manager http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

7 CT Department of Education "2005 Condition of Connecticut Public School Facilities" http://www.csde.state.ct.us/public/dgm/edoso/pockyear.asp

8 CT Energy Efficiency Fund http://www.ctsavesenergy.org

9 Department of Public Utility Control http://www.state.ct.us/dpuc

10 CT Clean Energy Fund http://www.ctinnovations.com/index.php

11 "Installing Renewable DG in High Performance School in CT" by Peregrine Energy Group, Inc. http://www.easternct.edu/depts/sustainenergy/HPSchoolSummary/HPSchools.htm

12 Kendall Foundation http://www.kendall.org/index_flash.html

13 Institute for Sustainable Energy: http://www.sustainenergy.org

100% Post-Consumer content paper

Manufactured with windpower

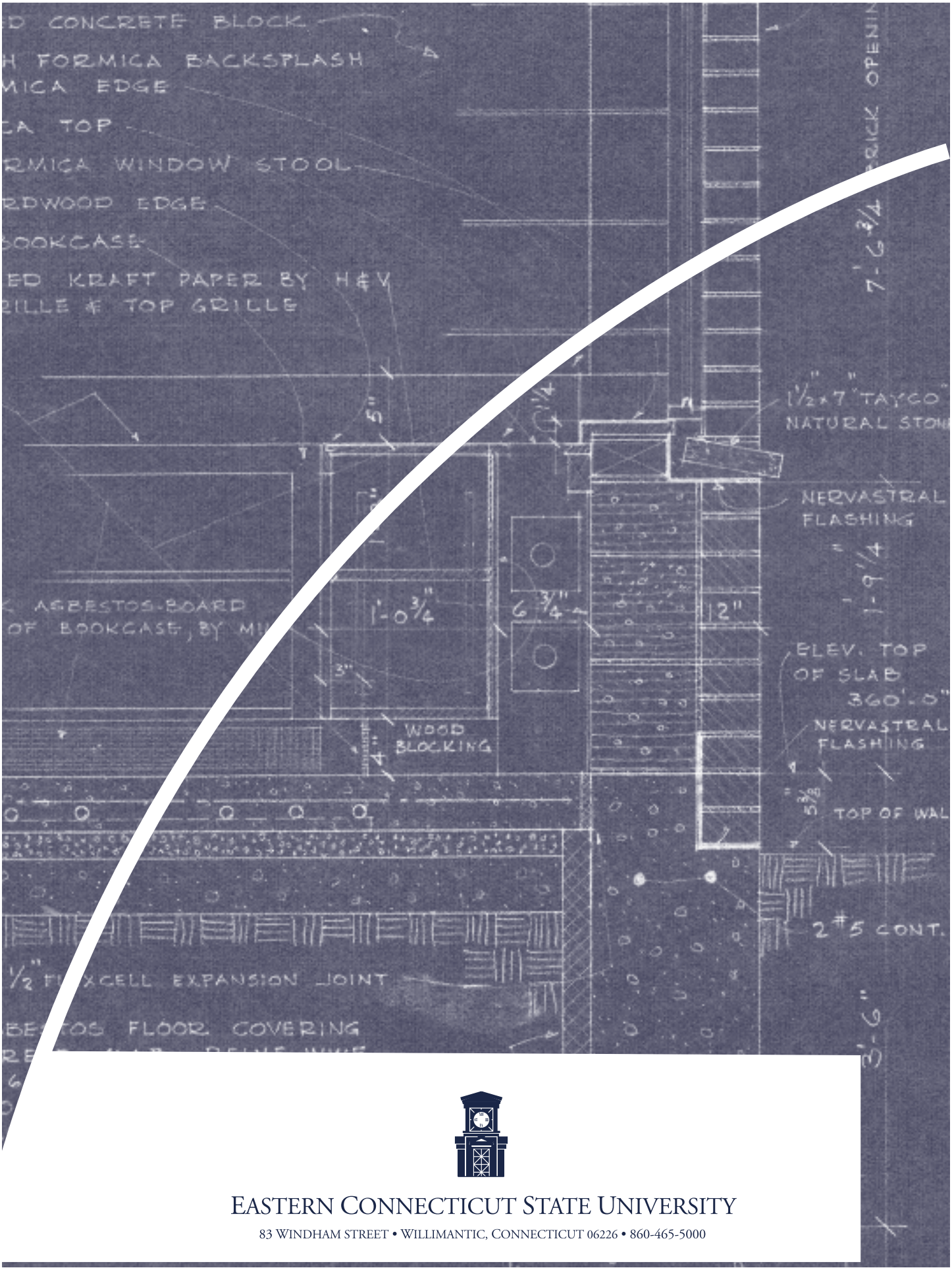
Printed with soy-based inks

Savings derived from using post-consumer fiber:

- 1.51 trees preserved for the future
- 4.36 lbs. waterborne waste not created
- 641 gallons wastewater flow avoided
- 71 lbs. solid waste not generated
- 140 lbs. greenhouse gas prevented
- 1,067,475 BTUs of energy not consumed

Savings from using emission-free wind generated electricity:

- 73 lbs. air omission not generated
- 172 cubic feet of natural gas not consumed



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