Michael E. Capuano Early Childhood Center

Somerville, Massachusetts

Highlighting high performance

The Capuano School teaches Somerville's youngest students to read and educates the community about green schools. The two-story, 80,000-ft² school is designed to accommodate 560 students from toddlers to first graders. It sits on the edge of a city park and is also a neighborhood resource with a full-size gymnasium, public gardens, soccer fields, and basketball courts.

Daylighting is a key high-performance feature to reduce energy and construction costs and enhance the learning environment. Daylighting uses natural light to significantly reduce costs from electrical lighting, and may improve student learning. Skylights on the top floor brighten classroom play areas and art tables. Clerestory windows and light shelves capture daylight on the ground floor. Natural light brightens the atrium, which links classrooms with community and administrative areas to foster social interaction. Skylights also bring out the color and openness in the upper lobby, which is used by students and the community after school and on weekends.

Other energy-saving measures include a 35-kW solar electric system to produce energy, an energy-efficient building envelope, and mechanical and electrical systems that reduce energy costs by more than 38% based on energy modeling simulations. Water conservation measures include waterless urinals, metered sink faucets, and a drip irrigation system. Fiberglass acoustic ceiling tiles soak up twice as much noise as traditional acoustic ceiling tiles and provide a higher light reflectance from the windows and indirect lighting.

Occupied since September 2003, the school is the first in New England to register with the U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) program. The project received significant funding from the local utility and a "Green School" grant from the Massachusetts Technology Collaborative.

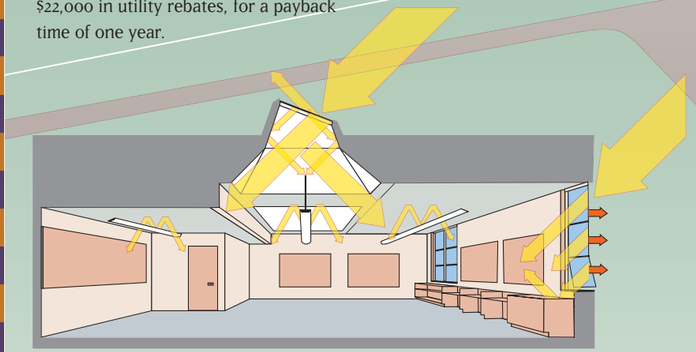
The Capuano school (top) is predicted to save 38% energy beyond code and more than $58,000 per year in energy costs. Inset: The bright daylit atrium welcomes students and saves the school money in avoided energy costs.

Key High-Performance Features at the Capuano School

Lighting

The primary source of light at the Capuano Center is daylight. Translucent skylights with diffuse double glazing broadly distribute light and reduce glare in second-floor classrooms. The 45° skylights have light wells and are painted white to increase the reflection of light into interior work spaces. Clerestory windows and south-side light shelves bring natural light deeper into the first-floor classrooms, reducing the need for electric lighting. In addition, classrooms use light-colored walls near windows to bounce light deeper into the room. The ceiling tiles have an 88% light reflectance that bounces more light from the fixtures down to the work surfaces.

To complement the natural light, photo-sensors near windows and skylights dim the fluorescent lights as daylighting increases. Occupancy sensors are located in all rooms, and lights have multiple bulbs to allow one, two, or all three bulbs to be on at a given time. These three upgrades are projected to reduce lighting energy consumption by 32% and save the school $8,800 annually in utility costs. Additionally, the upgrades provided the school more than $22,000 in utility rebates, for a payback time of one year.

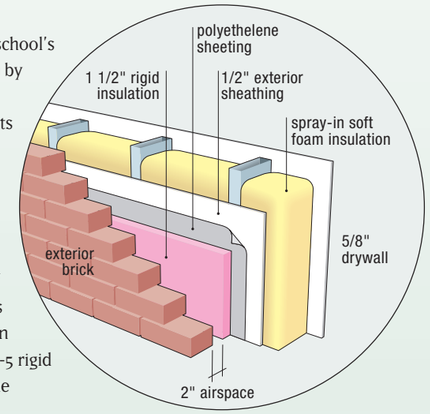


Indoor Air Quality

To create a more healthy school environment by improving air quality, the designers chose vinyl-backed carpeting, under-slab insulation, and fiberglass ceiling tiles to reduce mold and mildew. Further, paints with low volatile organic compounds and wood containing no arsenic or chromium were used. Recessed walk-off mats in entryways reduce dirt tracked into the building, helping to ensure superior indoor air quality and reducing cleaning costs. Classroom windows are operable to enable natural ventilation.

Building Envelope

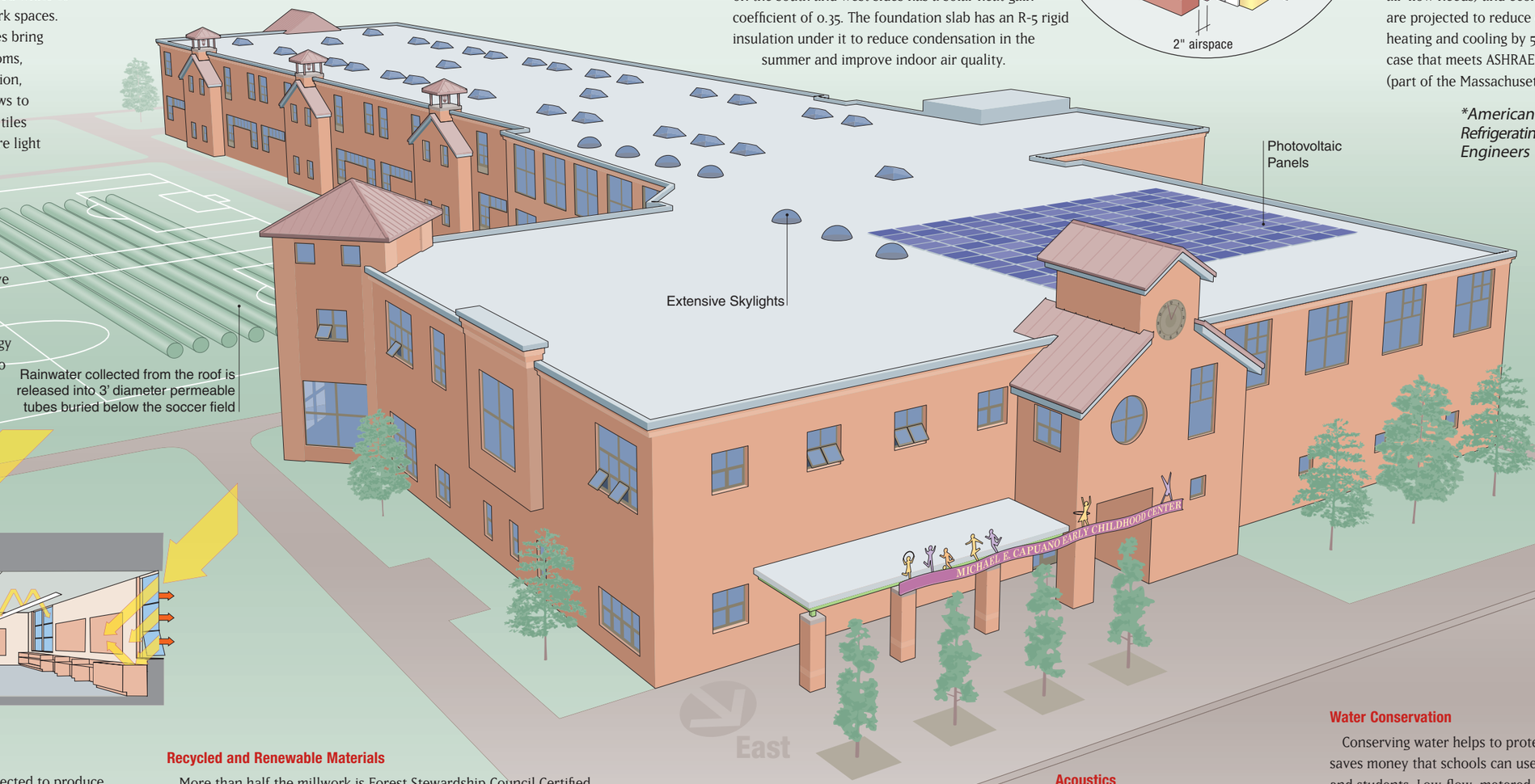
A well-designed building envelope reduces a school's maintenance costs and improves student health by preventing excessive moisture and molds that damage buildings and have adverse health effects in children and adults. It also saves energy. The R-value of the entire exterior wall system is higher than 22, well over the R-7 minimum. The R-value of the roof is 27, which exceeds the code required R-20. Windows have a U-value not exceeding 0.21. Windows have two layers of glass with a third layer of heat mirror film. Glass on the south and west sides has a solar heat gain coefficient of 0.35. The foundation slab has an R-5 rigid insulation under it to reduce condensation in the summer and improve indoor air quality.



Heating and Cooling

An improved building envelope and careful analysis of expected diversity of facility use enabled the designers to significantly minimize the size of the heating and cooling systems. All classrooms and offices use their own thermostats for individual heating and cooling control. Offices use variable air volume systems to allow spaces to respond individually to temperature conditions. Other energy efficiency measures include variable frequency drives (to match motor speed with actual pumping and air-flow needs) and economizer modes, which are projected to reduce electrical use for heating and cooling by 51% compared to a base case that meets ASHRAE* Standard 90.1-1999 (part of the Massachusetts State Building Code).

**American Society of Heating, Refrigerating and Air-Conditioning Engineers*



Solar and Wind Energy

A 35-kW rooftop photovoltaic system is projected to produce more than 37,000 kWh per year and provide 9% of the facility's electrical needs. The designers also installed a 400-watt wind turbine with stand-alone DC power and battery system as a demonstration project for students. The wind turbine powers lights for a garden tool shed. Both systems are wired to a data acquisition system that will allow students throughout the city to monitor the energy performance and participate in renewable energy education curriculum programs via the Internet.

Recycled and Renewable Materials

More than half the millwork is Forest Stewardship Council Certified Wood, including the cafeteria platform, the wood ceiling at the canopy, and custom case work. The concrete is made from 30% waste from steel manufacturing (furnace slag), which reduces landfill use and makes the concrete stronger. Other materials, including the gypsum wallboard, particle board, gym flooring, vinyl carpet backing, fiberglass acoustic ceiling tiles, and playground equipment contain a percentage of recycled content. The playground surfacing is made from three-inch-thick salvaged rubber tires. More than 90% of the construction waste was recycled.

Acoustics

Special attention was paid to acoustics to improve learning. Classrooms were located away from traditionally loud, thumping mechanical rooms. An oversized unit ventilator system runs on a lower fan speed, which is quieter than a smaller system running at high capacity. Lastly, the ceiling tiles have a noise reduction coefficient of 0.90, which absorbs 90% of the sound hitting the tiles. This is approximately double the absorption of a typical school acoustic ceiling tile.

Water Conservation

Conserving water helps to protect the environment and saves money that schools can use instead for teachers and students. Low-flow, metered faucets and waterless urinals conserve water inside the building. A 10,140-ft² underground infiltration/detention system below the soccer field and one parking lot stores rainwater from the roof and slowly releases it back into the water table. Native plants further reduce water use along with the drip-irrigation system in all non-play field areas, which is projected to use one-eighth the water of a traditional spray-head system.

Green Schools Initiative

The goal of the Green Schools Initiative is to design and build schools that offer productive learning environments, save money, and are resource efficient. It encourages school districts in Massachusetts to construct or renovate school buildings that cost less to operate through energy and water conservation and renewable energy measures while providing a healthy setting for students. The Massachusetts Technology Collaborative (MTC) and the Massachusetts School Building Authority are partners in this initiative; they work as a team to provide school districts in the state with the information and resources necessary to design and build high-performance schools. The initiative provides:

- The Massachusetts High Performance Green Schools Guidelines (MA-CHPS) — Planning Guide and Criteria Document
- Information about utility rebate programs and MTC grants
- Technical assistance
- Studies and reports for comparison information

For More Information on MTC

MASSACHUSETTS TECHNOLOGY COLLABORATIVE
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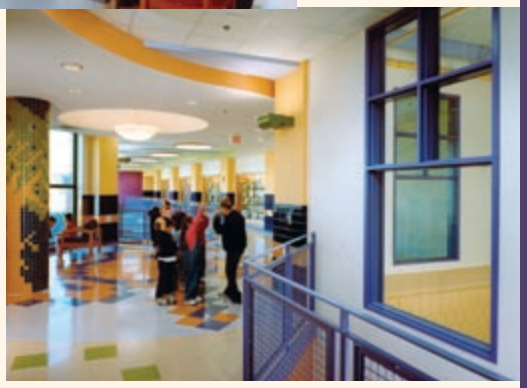
Skylights save energy and highlight classroom play and study areas with daylight, which can improve learning. Inset: Sunlight pours into the upper lobby from large windows and skylights, enhancing social interaction and providing sustainable lighting.

Predicting Savings with Computer Modeling

HMFH Architects, Inc., the building designers, used energy and daylight modeling early in the design process to improve the building's energy performance. The energy modeling also provided a detailed understanding of the short-term costs and longer-term paybacks for achieving the energy saving and educational performance goals, leading to improved decision-making.



Energy Cost Savings at Capuano

Total Energy Cost Reduction	Base Case Costs (ASHRAE 90.1-99)	Projected Costs	% Energy Savings
Electricity Use	$115,185	$71,228	38
Electricity Production	$0	-$5,929	
Green Attributes	$0	$0	
Natural Gas Use	$34,462	$26,288	23
Total	$149,647	$91,587	38
Annual Savings			$58,060
Incremental Cost			$162,518
Simple Payback			2.8 years

Source: HMFH Architects, 2004

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More Information

MTC Green Schools Initiative
www.masstech.org/RenewableEnergy/green_schools.htm

National Review of Green Schools: Costs, Benefits and Implications for Massachusetts
http://masstech.org/renewableenergy/katsstudy.html

The Costs and Benefits of Green Schools in Massachusetts
http://masstech.org/renewableenergy/hmfhstudy.html

Daylighting in Schools
www.h-m-g.com/

High-Performance Schools: Affordable Green Design for K-12 Schools
www.nrel.gov/docs/fy04osti/34967.pdf

Energy Design Guidelines for High-Performance Schools
www.eere.energy.gov/buildings/highperformance/design_guidelines.html

High-Performance Buildings Database
www.eere.energy.gov/buildings/database

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