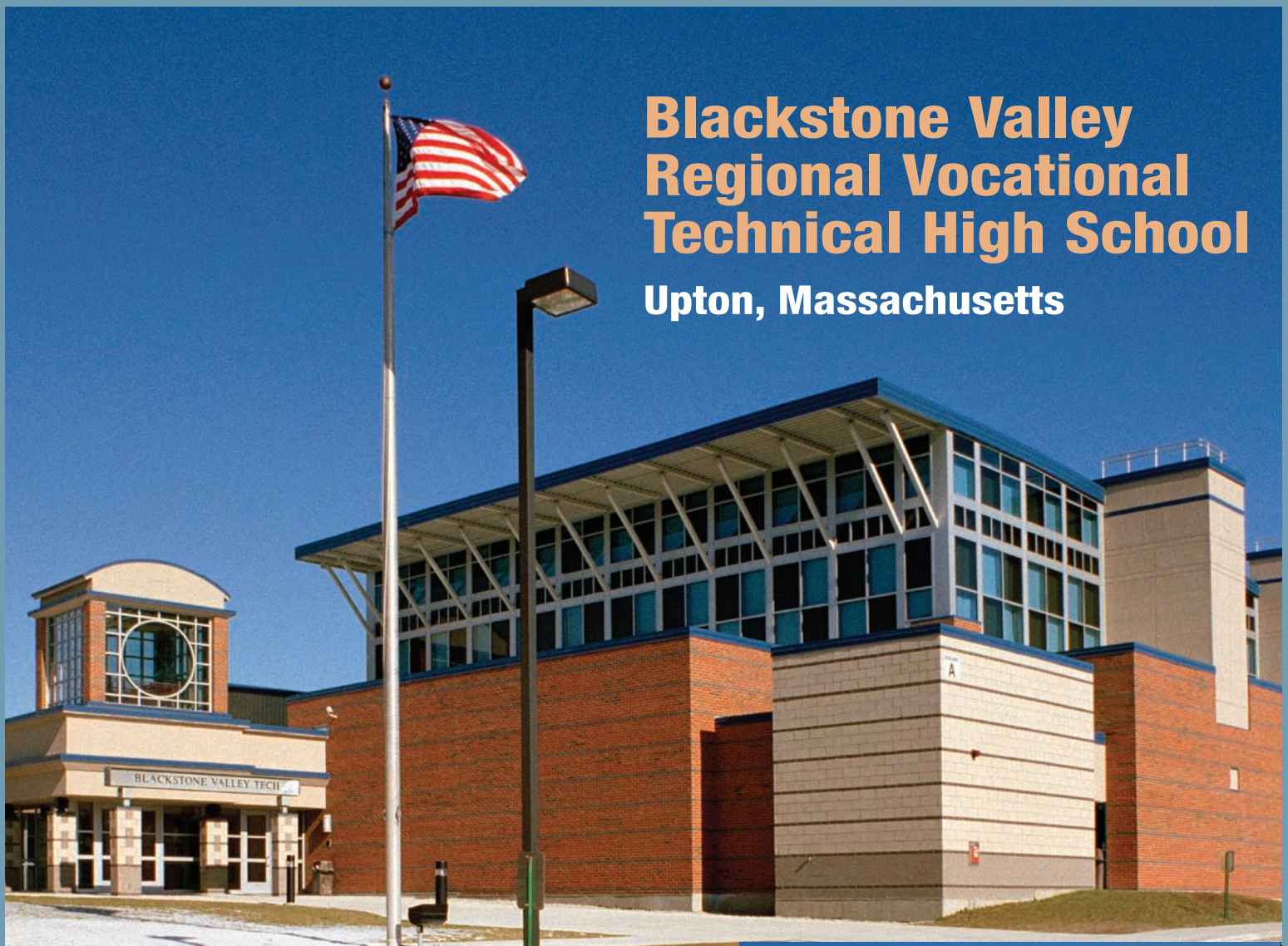
# Blackstone Valley Regional Vocational Technical High School

## Upton, Massachusetts




## Highlighting high performance

Several years ago Blackstone Valley Tech was experiencing great demand for its popular vocational programs, but the school had two significant problems: overcrowded classrooms and expensive utility bills.

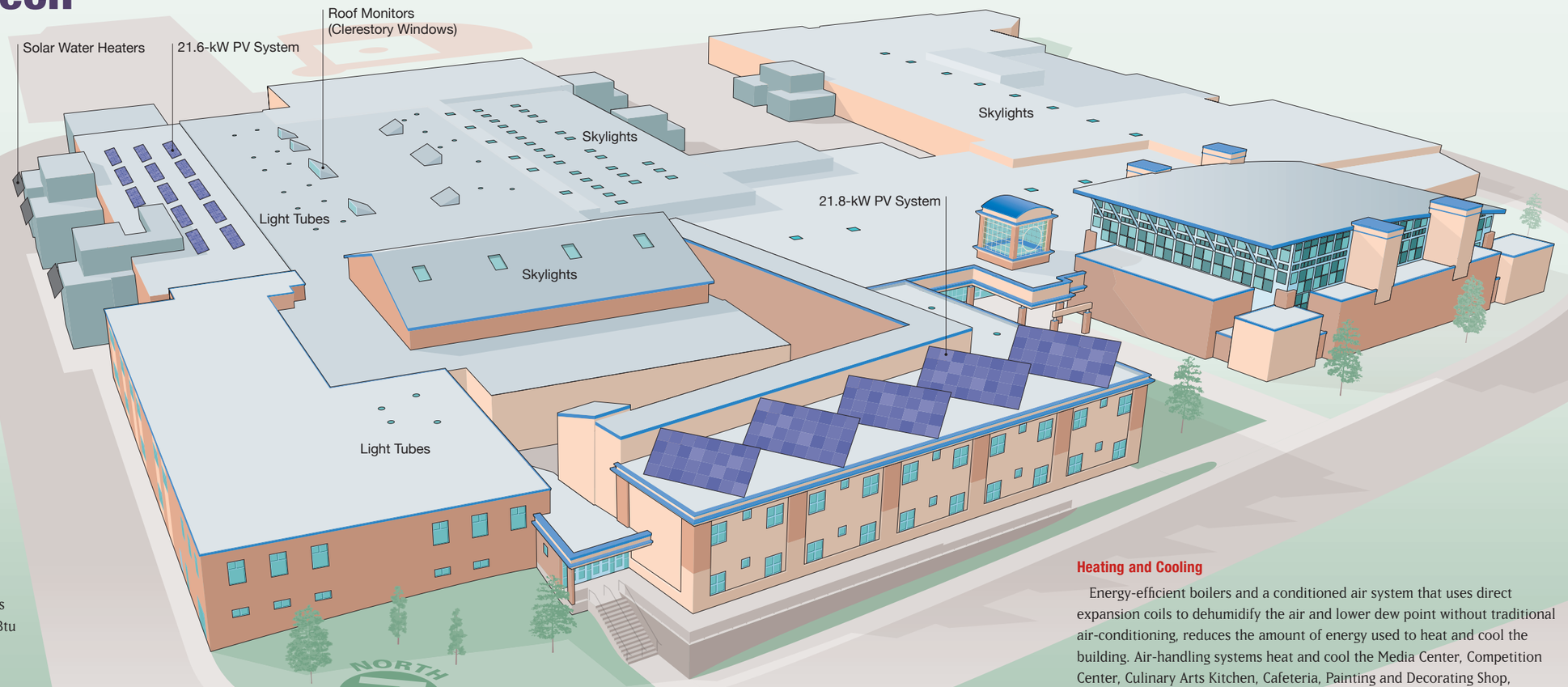
To address these problems, the old school was remodeled and upgraded with high-performance features that save energy. In addition, a new 80,000-ft² building space was added that houses classrooms and showcases the school's commitment to energy conservation in a big way—it supports large solar panels on the roof and over the doorway of the south entrance.

Five large solar arrays spaced evenly along the roof of the new classroom wing welcome students and staff arriving from the south. These five striking arrays make up a 21.8 kW solar electric system and in combination with another 21.6 kW solar electric array installed farther back on the roof, are expected to produce more than 60,000 kWh of electricity for the school each year. In addition to the solar electric system, solar water heating arrays are installed on the south-facing side of the school.

The school is designed to save more than 40% in energy compared to a building that simply meets the state energy code. Among the energy-saving technologies used in both the old and new buildings are displacement ventilation, high-efficiency lighting, occupancy and daylight sensors, and energy-efficient air-conditioning equipment. Natural lighting is enhanced with light tube technology, reducing the need for electrical lighting. All these energy-saving features are predicted to save the school $160,000 per year.

**High-performance building features such as solar energy are helping the Blackstone school conserve a predicted 40% in energy use beyond code. Energy-efficient building features are predicted to save the school $160,000 per year.**

# Key High-Performance Features at Blackstone Valley Tech




## Solar Power

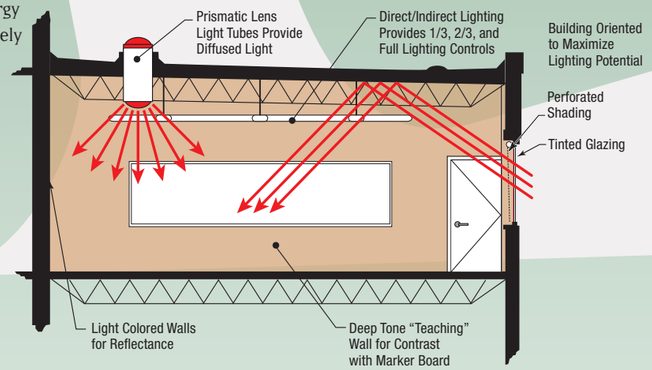
The most visible of the two solar electric, or photovoltaic, systems, is made up of five large angled arrays installed at a 37 degree angle along the roof of the main entrance to the school. The arrays are mounted to an aluminum tubular frame structure that contributes to the system's sleek appearance. The mounting structure also allows the system to extend over the edge of the roof, increasing system size without increasing the building footprint. The second solar electric system is installed at a 5-degree angle on the roof of the original school. The two systems total 43.4 kW peak capacity with the potential of providing around $8,000 or more in annual electricity savings.

Hot water for the school is heated by an integrated system that comprises a 21-panel solar water heating system and an 800-gallon, gas-fired water heater. The solar panels pre-heat water before it enters the school's central water heater, allowing sunlight to do most of the work during the early fall and late spring. Placing the collectors high on the south wall allows for a gravity-powered, drain-back design. When the tank inside is sufficiently heated and the collector temperature is close to the tank temperature, the circulating pump shuts down. Gravity drains the water back to a reservoir, which prevents the system from overheating during periods of low attendance (e.g., summer). Variable frequency drives control the speed of the main heating pumps to allow the pump speed to decrease when less water flow is needed. The solar domestic hot water system provides 120 million Btu per year, which equates to approximately $1,800 in annual savings.

## Daylighting with Light Tubes and High-Efficiency Lighting

Light tubes bring more daylight into the classrooms to reduce electrical lighting loads. A light tube collects daylight on the roof and bounces it down a highly reflective tube to a diffusing lens. On sunny days, the tubes provide the daylighting equivalent of four lamp fixtures, helping to reduce electrical lighting needs in the classrooms without windows, by one-third. In addition to installing tubes in interior classrooms, 14 light tubes were added to classrooms with windows (two per classroom) and were located opposite the window wall in each room. Photocells, or light controls, automatically shut off the electric lights in these rooms to conserve energy when enough daylight is present. Overall energy savings are conservatively estimated at 500 kWh per year.

The lighting power density of the entire school is less than 1.0 Watt per square foot, which is 33% more efficient than the energy code. This is accomplished through the use of higher efficiency fluorescent fixtures that provide sufficient illumination levels but use less electricity. To save even more energy at Blackstone Valley Tech, occupancy sensors automatically turn off lights when rooms (and areas of larger rooms) are unoccupied. In addition, photo-sensors installed in the seven exterior classrooms with windows, detect the level of daylight present and send a signal to the lighting fixture to raise or dim the lights. All of these lighting measures contribute to considerable electricity savings for the school.




## Water Conservation

The design team focused its efforts on replenishing groundwater by using 4-foot perforated pipes buried under the front parking lot to disperse stormwater on the site. This groundwater recharge system is designed to offset the well water used for sports field irrigation. Inside the school, waterless urinals were installed to cut down on the water used for flushing, saving approximately 150,000 gallons per year.

## Energy-Efficient Building Envelope

A well-designed building envelope not only saves energy but reduces maintenance costs and improves student health by preventing excessive moisture and mold, which can damage buildings and has adverse health effects on children and adults. The Blackstone Valley Tech building envelope was constructed with materials that will last for 50+ years. It has a tight, high-performing envelope that maintains the continuous integrity of the insulation layer from below grade to the roof peak. High-performance window glazing and window frames with low U values allow quality natural light to penetrate into the building and reduce heat loss. A white roof was installed on the new addition to help reduce heat gain during the hot months. In addition to having an energy-efficient building envelope, Blackstone Valley Tech incorporated recycled content building materials into the school.

## Heating and Cooling

Energy-efficient boilers and a conditioned air system that uses direct expansion coils to dehumidify the air and lower dew point without traditional air-conditioning, reduces the amount of energy used to heat and cool the building. Air-handling systems heat and cool the Media Center, Competition Center, Culinary Arts Kitchen, Cafeteria, Painting and Decorating Shop, Welding Shop, and Auto Body Shop. The air-handling systems are equipped with variable speed drives (VSDs) to control fan speed and the amount of air delivered. Operating the fans at lower speeds saves electricity; however, the VSDs automatically return to full speed when needed. In the shop areas and kitchens, the speed of the air-handling fan responds to the quantity of exhaust required at the time. In the Media Center and Competition Center, the fan speed is dependent on cooling requirements and responds to carbon dioxide concentration (increasing ventilation when more carbon dioxide is in the air). A direct digital control system is used for the air-handling systems and hydronic heating systems, and automatically adjusts to varying occupancy conditions.

## Ventilation

Blackstone Valley Tech uses displacement ventilation to deliver 100% fresh air, primarily to classroom spaces. Displacement ventilation delivers air low in a space through floor- or wall-mounted diffusers with perforated faces and exhausts air at or near the ceiling. These systems rely on convective air flow that is generated by heat from people, computers, and equipment. As the fresh supply air rises from the floor, it collects indoor pollutants from the breathing zone and lifts them out of the space. Because the supply air is delivered at a low velocity, fan loads are decreased, which results in electricity savings. Displacement ventilation systems are used in 24 of the air-handling systems throughout the school.

# 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

MASSACHUSETTS TECHNOLOGY COLLABORATIVE
RENEWABLE ENERGY TRUST

For More Information on MTC

**Massachusetts Technology Collaborative**
**75 North Drive**
**Westborough, MA 01580**
**Phone: 508-870-0312**
**E-mail: mtc@masstech.org**
**Web site: www.masstech.org**

**The use of "light tubes" to bring more daylight into the classrooms reduces electrical lighting loads. Natural light is also used throughout the building to reduce lighting loads and enhance social interaction.**

**Photo Credits: All photos by Wayne Soverns, Inc.**

## Predicting Savings with Computer Modeling

To improve the energy performance of Blackstone Valley Tech, designers ran a computer simulation of the energy use of a base-case building and the proposed building, to determine the theoretical reduction in energy consumption between the two models. The model of the new design used the same size, shape, orientation, and HVAC zoning of the base building, but included highly efficient elements such as building envelope, windows, lighting systems, and mechanical equipment. This enabled designers to "test" different combinations and configurations of building systems, ensuring that the most healthy, energy-smart and cost-effective school was designed.

| | Total Energy Savings at Blackstone Valley (MMBtu) | | | | |
|---|---|---|---|---|---|
| | Base Case* | Efficient Design Case | Renewable Energy Offset | Total Energy Savings | % Energy Savings |
| Electricity | 28,710 | 16,640 | 605 | 12,675 | 44% |
| Fuel | 9,565 | 6,647 | 204 | 3,122 | 33% |
| **Total** | **38,275** | **23,287** | **809** | **15,797** | **41%** |

* (ASHRAE 90.1 -99)

### Contacts:

Dr. Michael Fitzpatrick
Superintendent
Phone: 508-529-7758 ext 3034
Web site: www.valleytech.k12.ma.us

Daniel R. Stonecipher
Associate Project Manager
Senior Architectural Designer
The H.L. Turner Group Inc.
27 Locke Road, Concord, NH 03301
Phone: 603-228-1122 ext 107
E-mail: dstonecipher@hlturner.com

### More Information

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

National Review of Green Schools: Costs, Benefits, and Implications for Massachusetts
www.masstech.org/RenewableEnergy/green_schools/Kats-study.pdf

The Incremental Costs and Benefits of Green Schools in Massachusetts
www.masstech.org/RenewableEnergy/green_schools/HMFHstudy121905.pdf

Daylighting in Schools
www.h-m-g.com/projects/daylighting/projects-PIER.htm

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/

Produced for the
Massachusetts Technology Collaborative
by the National Renewable Energy Laboratory,
a DOE national laboratory

NREL/BR-550-39404
October 2006

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% postconsumer waste