

Harvard Green Campus Initiative High Performance Building Resource

46 Blackstone Renovation Case Study LEED-NC Platinum May 2006



Summary

Embracing principles of sustainability from the project's inception, the 46 Blackstone Street complex is the most ambitious green building project Harvard has ever undertaken. The client, University Operations Services (UOS), set sustainability goals early in the process by including sustainability language in the Request for Proposals to the designers. This ensured that sustainability was a primary focus at every stage of the design and construction process. The project team's dedication to sustainability was recognized in April 2007, when the building was awarded a LEED Platinum rating. This is the highest level possible in the USGBC LEED system, and is Harvard's first LEED Platinum building.

The 40,000-square-foot renovation, completed in May 2006, is the new home of several formerly decentralized UOS departments and will serve as an example of Harvard's commitment to environmentally responsible building for years to come.

Building Highlights

- Energy use in the summer is reduced by 42% over code.
- Ground source heat pumps for cooling
- Occupant water use is reduced by 43%
- Former parking lot converted into green space
- Diverted 99.42% of its construction and demolition waste from landfills
- Environmentally responsible materials
- Metering equipment installed to monitor energy use

Location

On the site of the former Cambridge Electric Light Company, 46 Blackstone is on the south side of the Cambridge, Massachusetts campus of Harvard University, along Memorial Drive and the Charles River and south of Western Avenue.

Project Team

Client: University Operations Services

Project Management: Harvard Real Estate Services

Architect: Bruner Cott & Associates, Inc.

Mechanical Engineer: Ove Arup & Associates

Geotechnical Engineer: Haley & Aldrich

Landscape Architect: Landworks, Inc.

Civil Engineer: Green International Affiliates

Contractor: Consigli Construction Co., Inc.

Cost Estimation: Shawmut Construction

Sustainability Consultant: Harvard Green Campus Initiative

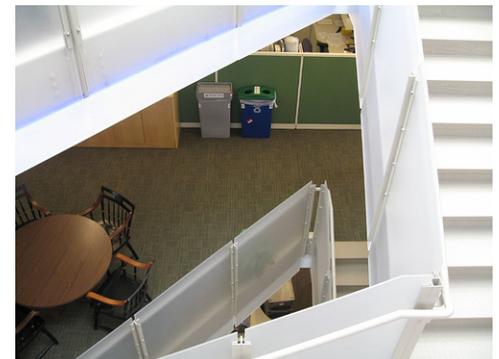
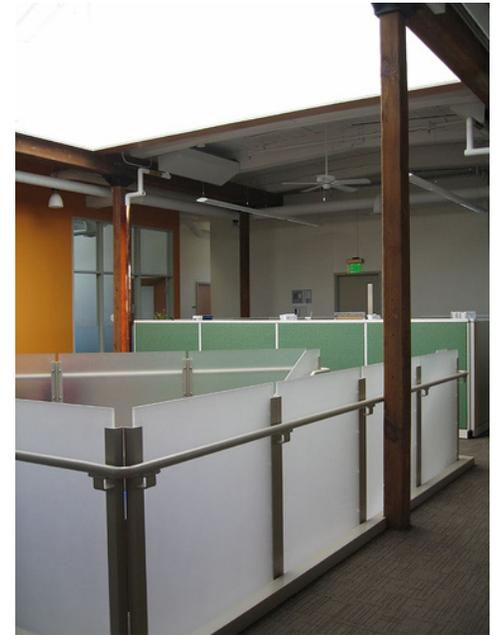
Project Cost

The hard costs for construction of the Blackstone office renovation project were \$250 per foot (\$10M / 40K sq. ft.), which is consistent with other institutional renovations of existing buildings in the area.

There was no "green premium" on this project, in the way that costs are generally characterized. This was achieved, in part, by hiring a cost estimator early in the process to attend project meetings and understand the project goals. However, there was a significant premium from the standpoint of direct owner involvement and commitment needed to ensure that *all* parties (designers, construction contractors, project managers) stay true their intentions of completing a sustainable project. This is a key lesson to note.

Program

The 40,000-square-foot renovation of the Blackstone outbuildings combined Building 7 (1926), Building 10a (1929), and the Dairy Building (1889) to create the headquarters for several formerly decentralized UOS departments: Engineering & Utilities; Environmental Health and Safety; Facilities Maintenance Operations; Transportation Services; the Green Campus Initiative; the University Operations Center; and the UOS administrative, financial, and technology groups. Since these groups frequently interact, physically unifying them at the Blackstone building was a logical way to facilitate interaction between the departments. The former parking lot in front of the building was converted into a green courtyard.



Project History

In June 1888 the Cambridge Electric Light Company built the Blackstone power station to provide sufficient electricity for the growing city. The power station has provided steam to heat the Harvard campus since 1930. Harvard UOS purchased the Blackstone plant and its several outbuildings in April 2003. When UOS initiated the renovation of several buildings of the project, UOS Associate Vice President Tom Vautin made it clear that a firm would be selected based on its knowledge and demonstrated experience in applying sustainability concepts and principles to facilities and infrastructure problems through an integrated design approach. Sustainability and LEED goals were included in the RFP so that firms would realize that winning the Blackstone project was contingent on incorporating sustainable design features. Firms were interviewed based on their sustainable design experience.

Sustainable Strategies

Site

In Massachusetts, most green spaces are watered from April 15 to September 30 at a rate of 10,000 to 15,000 gallons per acre per week. In one year, this sums to more than an Olympic swimming pool worth of potable water per acre of land. To avoid this waste, the design team at Blackstone created an open space planted with native, drought-tolerant species that require no irrigation at all. This has **eliminated all potable water consumption for irrigation** purposes. A series of stormwater runoff mitigation strategies reduces polluted runoff to the Charles River.

A **bioswale**, or bioretention system, filters stormwater runoff from the adjacent 25,000 square foot parking lot through the site to prevent contamination of the Charles River. This system filters stormwater and allows it to naturally infiltrate into the soil layer. Microorganisms in the soil digest oils and greases in runoff, preventing these contaminants' entry into water bodies. Plants take up phosphorous to prevent eutrophication, the over-enrichment of water bodies that results in excessive algal growth, reduced oxygen levels, and animal death. A sand bed at the bottom of the pond filters solids out of the stormwater so that they are not carried into the soil. The bioretention pond also creates habitat for urban animal species. Drainage to the municipal sewer system has been eliminated.

Permeable paving: Impervious, paved urban areas prevent water from soaking into soil and instead divert stormwater to creeks or sewer systems. This stormwater can overwhelm rivers or creeks with water that has picked up pollutants during its interaction with impermeable surfaces. If stormwater flows to a storm sewer, it must be treated and released, which is inefficient, burdensome to the municipality, and resource-intensive. Impervious surfaces also prevent natural infiltration of rain water into groundwater aquifers, our main source of drinking water. If too much rain water is diverted in this way, aquifers can become depleted or unusable. The original site was a 100% impervious parking lot. 658 tons of asphalt were removed and recycled. These pavers have recycled content and are **expected to reduce stormwater runoff by over 37%**.

Erosion and sedimentation controls were put in place during construction, such as silt fences, hay bales, and filter fabric, to prevent runoff.



The Blackstone site was a **brownfield** as a result of a century of operations as an industrial site. Brownfield rehabilitation is encouraged by several groups, including the U.S. EPA, because redevelopment can revitalize the host community and reuse existing built land, which is more efficient than consuming undeveloped tracts.

High albedo surfaces and shading reduce heat island effect.

The site offers thorough **public transportation access**, via bus, T, and the Charles River bikepath. Employees have access to Harvard's Commuter Choice program.

The **cut-off angle of the exterior lighting** is designed to prevent light trespass.



Energy

The building was designed as an integrated system by using the energy model as a design tool to optimize efficiency. Energy use in the summer is reduced by over 42% better than code requirements.

Ground-source heat pumps are used to cool the building. (The building is heated using hot water from the adjacent steam plant.) Two 6"-diameter wells, 1500 feet deep utilize the nearly constant temperature of the ground to reject heat from the building. A wide loop of PVC piping pumps room temperature water into the earth, where it is naturally cooled.

Valance units containing coils cool and heat the space through convection. As warm air rises, it passes over the cool coils, and sinks to the floor. This system is decoupled from the ventilation system, providing significant energy savings. There are various heating and cooling zones throughout the building, so that an office with southern exposure will be heated by sun and no additional heat, while an office with northern exposure can be heated at the same time.

The ventilation system provides up to 5100 CFM 100% outside air, with an **enthalpy wheel** for latent and sensible heat recovery (heat and humidity). This system allows exhaust air to closely interact with incoming fresh air. In the winter, exhaust air warms cold incoming air, and in the summer it cools it. Efficiency of this exchange is close to 80 percent, which greatly reduces the amount of energy needed to heat or cool incoming air.

Demand control ventilation increases or decreases the supply of outside air in conference rooms, using carbon dioxide monitors to gauge occupancy.

An ENERGY STAR, **cool/high-albedo roof** reduces heat island effect and the cooling load. Solar reflectance of the roof is 65%, emittance is .92, and U-values are .024 to .032



Water

See the 'Site' section above for information on water strategies in relation to the landscape

Occupant water use is reduced by 43% compared to Energy Policy Act of 1992-compliant plumbing fixtures. Water reduction is achieved by using dual-flush toilets, waterless urinals, and low-flow sinks.





- Blackstone was able to reduce the size of its mechanical system by optimizing the insulation. Blackstone installed a board-type insulation at foundations, a spray-applied Icynene foam insulation (which provides a vapor barrier and is vapor permeable) and sprayed-in-place insulation at exterior door frames.
- **Occupancy and daylight sensors** are built into the lighting fixtures to increase energy efficiency. White ceilings further brighten the space by reflecting the direct/indirect light.
- Windows are operable, with double pane, argon-filled low-e glass, with a U-value of 0.25.
- The equivalent of 100% of the site's energy use is covered using Renewable Energy Certificates

The **Ecospace elevator is 60% more efficient** than a conventional hydraulic elevator. It is located in the shaft where the old utilitarian elevator was originally in the Dairy Building. The new elevator uses energy effectively through a variable frequency microprocessor which drives motor control of its gearless machine. Though it does not require a machine room as a traditional hydraulic elevator would, the space for a mechanical room is required by Massachusetts code.

Measurement and Verification: The building is metered to monitor energy use. UOS is responsible for calibrating the simulation and calculating the projected savings between the actual energy use of the facility and the simulated energy use of the baseline building. The primary item which will be monitored and verified is the whole building's energy use, specifically to verify the savings which are documented by the ASHRAE 90.1 comparison between the designed building and the baseline building. However, with the use of sub-metering, they will have the ability to monitor the energy use and the energy savings associated with various systems and components. Both consumption and demand of all utilities will be monitored. Blackstone installed metering equipment for lighting systems and controls, constant and variable motor loads, variable frequency drive operation, chiller efficiency at variable loads, cooling load, air distribution static pressures and ventilation air volumes, building-specific energy efficiency systems and equipment, indoor water risers.

Materials and Waste

The project **diverted 99.42% of its construction and demolition waste by weight from landfills**, resulting in a net savings of 15% due to recycling instead of sending materials to the dump. Aggregate (brick, concrete and block) contributed a large part to the weight, and will be reused as rubble fill on other projects. Un-painted wood was ground into mulch. All the plumbing fixtures removed were sent to Guatemala, where a volunteer team from Shawmut construction erected a village water center for a small town of eighty-six residents. The windows were sent to Spanishtown, Jamaica, providing shelter for those whose homes suffered damage in summer hurricanes. Construction waste accounts for a surprising 40 percent of the total solid waste produced in the United States. Much of this waste can be reused or diverted into a useful pathway. However, responsible waste management is not always applied. Employing a responsible waste management strategy has yielded huge rewards — the total salvaged and recycled construction material is equivalent to an energy savings of 69,000 gallons of gasoline!

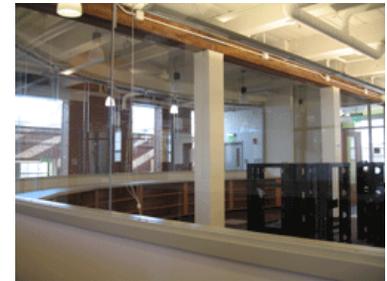


The central communicating stair encourages occupant interaction while increasing daylight. In order to create the communicating stair, the carpenters had to cut through the old growth timber beams and original tongue-and-groove floorboards. They cut the beams, then re-used them to support the opening for the communicating stair. The clerk of the works counted over 170 rings on the beams. Given that the Dairy building was built in 1887, these trees used were saplings when Harvard was fifty years old. The shell of the existing building was preserved, along with many of its unique features.

Recycled content materials: Blackstone chose low-energy, renewable materials when possible. 16.66% of the materials cost includes materials with recycled content. Some of the materials with recycled content include Uni Ecostone Pavers, EFCO windows, Shaw carpet, and recycled rebar, steel, gypsum, and cubicle fabric, and rubber flooring.

Renewable materials: Wood floors are made from bamboo, which grows much more quickly than hardwood species. Tiles are marmoleum linoleum, which is made of linseed oil, instead of PVC, which comes from petrochemicals. The specific products used are Plyboo bamboo and Forbo Marmoleum flooring.

Certified wood: Almost 60 percent of the new wood used in the Blackstone Project is certified by the Forest Stewardship Council, an independent, international organization that certifies commercial forests if certain legal, cultural, economic, and environmental standards are met. Certified wood is from Certified Wood Products, Inc.



Environmental Quality

Carpet tile, fabrics, adhesives, and paints in Blackstone are all non-toxic and **emit zero or very low levels of volatile organic compounds (VOCs)**, which can be health hazards or irritants. The carpet tile is manufactured by Shaw and are also recyclable. ICI Lifemaster 2000 paints contain little or no VOCs.

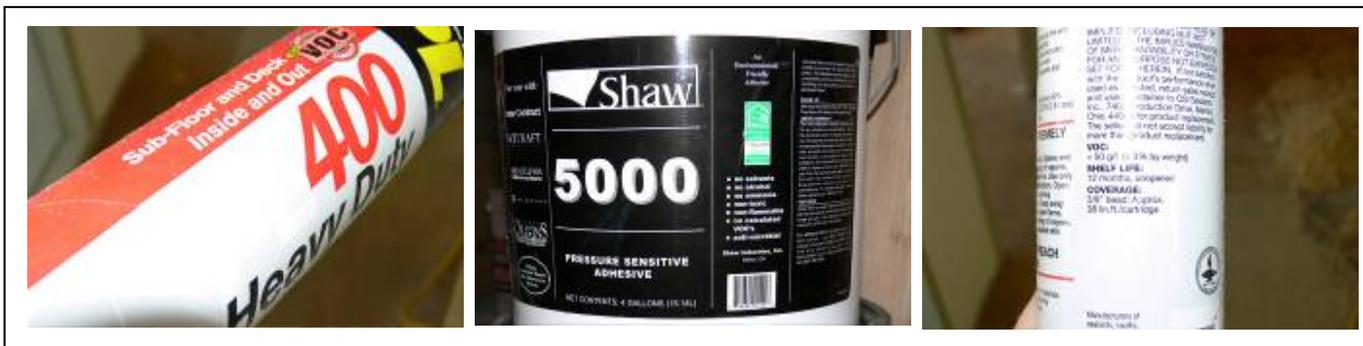
Blackstone employs Harvard's Facilities Maintenance Operations (FMO), which uses a green cleaning program to minimize fumes from solvents and other cleaning supplies.

During construction, the indoor air quality was controlled by implementing an Indoor Air Quality Plan. This included storing ductwork in a dry and dust-free environment, sealing the open ends once installed, installing temporary filters and then replacing before start-up. Environmental control was achieved by keeping the building under negative pressure and again by providing temporary protection and installing temporary media filtration at start up. Another environmental control measure implemented was to establish a common space within the building for wood cutting activities after the building was enclosed (Bldg 7 Parking Office). This common space was vented via an exhaust fan, with hepa filter, through an operable window resulting in significantly less air borne wood dust.

Daylight and views have been emphasized in the design. Views to the Charles River are possible from the west side of the building. Because the building has a relatively large footprint, the architects designed an insulated skylight to bring light through the center space of the fourth floor to the second and third floors via a new stairwell. Over 90% of occupants have access to daylight and views. The interior design allows light infiltration deep into the core.

Operable windows give occupants local control over air flow and temperature during temperate conditions.

Indoor air quality is expected to be very good. A post-doctorate at the Harvard School of Public Health is conducting an occupant health study at Blackstone. She is monitoring the air quality in the employees' current workspaces around the university. The future occupants completed questionnaires to document occurrences of discomfort. She will continue this study in the new building.



Lessons Learned

There was no distinct value engineering phase. By including a cost estimator on the project beginning in the early stages, the project was closely in tune with its budget.

Life cycle costing was done to compare the possibility of using geothermal wells to cool the building versus using a more conventional cooling tower. The geothermal wells proved more financially beneficial, and had the advantages of increasing efficiency, decreasing noise, and delimiting the need for an unsightly cooling tower on the roof.

The integrated design process, emphasized and supported by the Client team throughout the project, was essential to the project's success, and resulted in a project that acts as a model for all future Harvard projects.



before



after

