George Robert White Environmental Conservation Center

at Mass Audubon's Boston Nature Center

A Case Study of Boston's First Green Building

A collaborative project between
Mass Audubon and the City of Boston

September 2005

Mass Audubon
Protecting the Nature of Massachusetts

BOSTONIA. CONDITA A.D. 1630.

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Overview

- Location: Boston (Mattapan), MA
- Building Type: Interpretive Nature Center
- New construction
- 10,300 sq. feet (943 sq. meters)
- Total project cost (in 2002 US dollars): $1,949,185; $189.24 per square foot.
- Completed: October 2002
- Owner: City of Boston's George Robert White Fund
- Occupant: Massachusetts Audubon Society
- Building Uses:
    - Indoor Spaces: lobby/reception, exhibit space, office, restrooms, classrooms
    - Outdoor Spaces: interpretive landscape, wildlife habitat, restored landscape, community gardens, parking, retention pond for storm water runoff
- Special Features: geothermal heat pumps, photovoltaic roof shingles, solar hot water, parallel strand lumber, use of local Roxbury Puddingstone, recycled materials

The George Robert White Environmental Conservation Center (GRWECC), located at the Massachusetts Audubon Society's Boston Nature Center in Mattapan, was developed as a partnership between the Massachusetts Audubon Society (Mass Audubon) and the City of Boston through the George Robert White Fund. It is the first municipal green building in Boston. Heralded by Boston's Mayor Thomas M. Menino as the "**building that teaches**," the GRWECC is intended to serve as a regional model for environmentally responsible building principles.

The GRWECC is designed, constructed, and maintained in a manner that protects and conserves the natural environment. It also provides employees and visitors with a comfortable, healthy environment in which to work and learn. The building employs a number of strategies to minimize its environmental impacts. It uses renewable energy technologies such as geothermal heat pumps, photovoltaic shingles, and a solar hot water system. Using advanced insulation, high-performance glass, and sound construction techniques, the building is constructed with a tight envelope to maximize energy efficiency. A number of other steps have been taken to maximize energy and water efficiency. Where possible, the building uses environmentally-sound materials such as wood from certified sustainably-harvested forests, as well as products with recycled content, and local sources including Roxbury Puddingstone.

The Boston Nature Center (BNC) is a community based education center and wildlife sanctuary. Its all-inclusive programs are offered both on-site and off-site and often occur with an array of collaborators and partners. The BNC seeks to engage its diverse community in the understanding of our role as human beings within the natural world and create a sense of connection among all living creatures. The BNC serves more than 20,000 visitors each year and provides environmental education programs to over 40 Boston elementary schools through its Boston Schools Initiative.

The GRWECC is located within a 67-acre parcel of land that is owned and maintained by the Massachusetts Audubon Society ("Mass Audubon"). The building itself and the land where it is situated are owned by the City of Boston's George Robert White Fund and leased to Mass Audubon. The wildlife sanctuary which surrounds the GRWECC is home to a variety of wildlife and includes wheelchair accessible trails and boardwalks, as well as a community garden.

Established in 1896 and supported by 65,000 members, Mass Audubon maintains 43 wildlife sanctuaries that are open to the public and serve as bases for its conservation, education, and advocacy work across the state. Mass Audubon protects more than 30,000 acres of conservation land, conducts educational programs for 250,000 children and adults annually, and advocates for sound environmental policies at the local, state, and federal levels. Mass Audubon is committed to promoting the development of green buildings, both through education and through the gradual renovation of its own facilities.

Established in 1922 through the bequest of George Robert White, this Fund is a public charitable trust of the City of Boston. A sole-source capital construction and acquisition fund, the White Fund holds title to the twenty-two facilities it has built in Boston and leases the facilities at no charge to the City agencies and non-profit organizations which utilize them. The Fund is managed by the Trust Office of the City of Boston's Treasury Department.

Team and Process

Predesign

The idea of designing the GRWECC as a green building was initiated by the City of Boston's George Robert White Fund in 1998 in partnership with the Mass Audubon. In 1999, stakeholders were invited to participate in an Earth Day Building Charette to offer input and ideas about how to achieve the desired goals.

The key recommendations resulting from the charette are summarized below:

- The building should educate by example with a multi-cultural and multi-generational audience in mind.
- Invest up-front money in green design expertise to maximize long-term benefits.
- Use this design process to influence future public buildings.
- Make design decisions on the building and landscape together, and meld the building with the landscape.
- Implement site and building designs that mirror ecological systems.
- The building design, materials and construction practices should show a strong commitment to environmental restoration and protection.
- The educational mission should include showcasing green design principles and technologies, and demonstrating how visitors can utilize green design in their own lives.
- The Center should be a bridge between urban and natural environments.
- The building should strive to meet certification requirements of the U.S. Green Building Council's LEED program, or equivalent.

Design and Review Process

An active and committed design and review team played an integral role in achieving the green goals established for the GRWECC. The ten-member team included representatives from the George Robert White Fund, the City of Boston, Mass Audubon staff, architects, contractors, and others. The team met regularly throughout the design and construction process to evaluate various design options and to ensure that the building was meeting the design goals as it took shape. Throughout the design process, the architects listened closely to the needs of the future building occupants. Mass Audubon staff provided the design team with very clear direction from the start and worked closely with the project team to ensure that the building would be designed and built to meet their needs.

During the construction phase, a full-time Clerk of the Works provided oversight and quality assurance, a service that is rare for a project of this size. The collaborative nature of the design and review process added about six months to the building's development timeline, but those involved with the project believe that the investment of time was well worth it, and was critical to the project's success.

Land and Community / Sustainability of Site

The BNC is located on 67 acres that were formerly part of the Boston State Hospital. The once-neglected property has been restored to its natural state and transformed into a wildlife sanctuary. Two and a half miles of wheelchair accessible trails and boardwalks traverse meadows and wetlands where visitors can see native plants and wildlife including coyotes, pheasants, and many species of migratory birds. The site is also home to the Clark Cooper Community Gardens, one of Boston's oldest and largest community gardens which provides food and a green oasis for 250 local families.

In addition to serving as a regional model for green design, the GRWECC strives to meet the needs of the local community. The Center is situated in one of the highest density residential neighborhoods in the City of Boston, with more than 230,000 residents and over 40 schools located within two miles.

A number of elements contribute to the environmental sustainability of the site. Located within a half mile of two bus routes and within two miles of a commuter rail and subway station, the building can be easily accessed by public transit. Showers are available in an adjacent building and a bicycle rack is also available on-site making the building bicycle-friendly.

The building's location and orientation on the site were chosen to maximize the availability of natural daylight and, thus, limit the building's need for artificial lighting and winter heating. The building's orientation on the site also facilitates the use of solar technologies to harness the sun's energy for water heating and electricity generation.

Storm water retention basin will control erosion during major rain events.

An erosion and sedimentation plan was in place during construction to minimize the effects on the local watershed. The building is sited such that it avoids interference with the natural flow

of surface water, thus minimizing runoff. The surface water runoff that does occur is routed through a system of retention ponds, or constructed wetlands, which improve water quality and minimize erosion during major rain events. In addition, the driveway and parking area are unpaved in an effort to limit runoff and avoid the "heat-island" effect. Finally, the site is landscaped with native and climate-tolerant plants to reduce the need for watering and special landscape maintenance.

Energy and Atmosphere

The GRWECC uses a variety of proven equipment and design strategies to minimize the building's heating and cooling loads and to generate on-site renewable energy. The strategies used to minimize the building's energy demands are described below.

Building Envelope

The selection of building materials and the construction process itself were geared toward achieving superior insulation and weather resistance properties for the building.

All windows consist of two layers of glass that are filled with argon; an inert gas that reduces air circulation between the layers of glass, thus increasing the insulation properties of the windows. The glass is also coated with a metal oxide "Low-e" layer that blocks indoor heat from escaping in the winter and reflects over 80% of the sun's rays to keep the building cool during the summer.

Air infiltration barriers were used to ensure a tight building envelope and the walls are insulated with a combination of faced and un-faced fiberglass insulation with an R-value of 21.[1] The fiberglass insulation was factory-cut to fit snugly in the cavity between the studs. Formaldehyde-free rigid polystyrene insulation was used under the slab.

Structural Insulated Panel Systems (SIPS) were used in the roof of the building. SIPS consist of a core of rigid insulation sandwiched between two layers of oriented strand board. 10 ¼" of expanded polystyrene was used as the insulating material in the SIPS at the GRWECC. SIPS can be used in the walls, floors or roofs of commercial or residential buildings. Because SIPS possess so many beneficial features, they are widely used in green buildings. Some of the key benefits of SIPS include the following:

- *Energy Savings and Indoor Comfort*: Since SIPS consist of a core of expanded polystyrene (EPS) insulation that adheres to two exterior structural skins of oriented strand board (OSB), the technology provides a superior level of "whole-wall" R-value. The resulting tight building envelope provides energy savings and facilitates the downsizing of the building's HVAC equipment. It also provides a quieter, more comfortable indoor environment.

A sample cross-section of the SIPs used in the roof.

[1] Insulation is rated in terms of thermal resistance, called R-value, which indicates the resistance to heat flow. *The higher the R-value, the greater the insulating effectiveness*. The R-value of thermal insulation depends on the type of material, its thickness, and density. Installing more insulation in a building increases R-value and the resistance to heat flow. (Source: http://www.ornl.gov/sci/roofs+walls/insulation/ins_02.html).

- *Strength*: SIPS structural characteristics are similar to a steel I-beam. The outer layers act like the flanges of an I-beam, and the rigid core provides the web of the I-beam configuration. This composite assembly yields stiffness, strength, and predictable performance.
- *Reduced Labor and Job Site Waste*: Cutting and fabrication of SIPS is done at manufacturing plants based on the needs of each individual project. This reduces site labor, the amount of time building materials are exposed to the weather on the job site, and the amount of job site waste.
- *Fire Safety*: Since SIPS have no air within their solid core of rigid foam insulation; fire cannot run up the structural cavity as it can in traditional stud-framed buildings with fiberglass insulation.

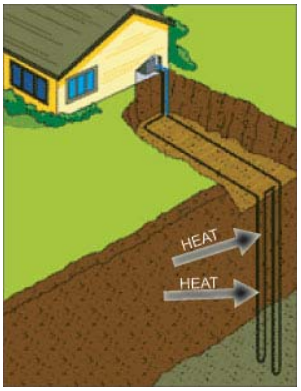
Source: Structural Insulated Panel Association, www.sips.org

Heating, Ventilating and Air Conditioning (HVAC) Systems

A geothermal heat pump system serves both the heating and cooling needs of the building. Unlike conventional furnaces that burn fuel to produce heat, heat pumps work by moving heat from one place to another. A geothermal heat pump uses the relatively constant temperature of the earth as a heat source in the winter and a cooling source in the summer.

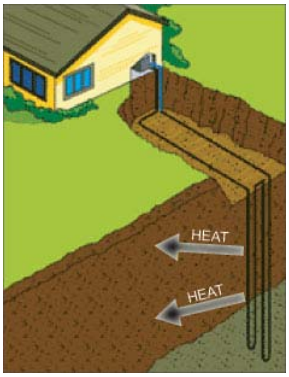
At the GRWECC, two wells were drilled for the geothermal system, one on each side of the building. Each well extends to a depth of 1200 feet and possesses a submersible pump. Well water is pumped into the building at temperatures which range from 45-65 degrees. The heat pump system uses an electrically driven vapor-compression cycle to concentrate the relatively hot or cold temperatures from the well water (depending on the season) to heat or cool the building. During the winter, when the temperature below ground is higher than the air temperature, the wells function as a heat source. The GRWECC uses twelve water-to-air heat pumps to distribute hot or cold air throughout the building. In the summer, the wells function as a heat sink, removing heat from the building.

Winter



During the winter, the heat pump absorbs heat from the ground and uses it to warm the air in the building.

Summer



In the warmer summer months, the processed is reversed, taking heat from the building and transferring it back into the ground.

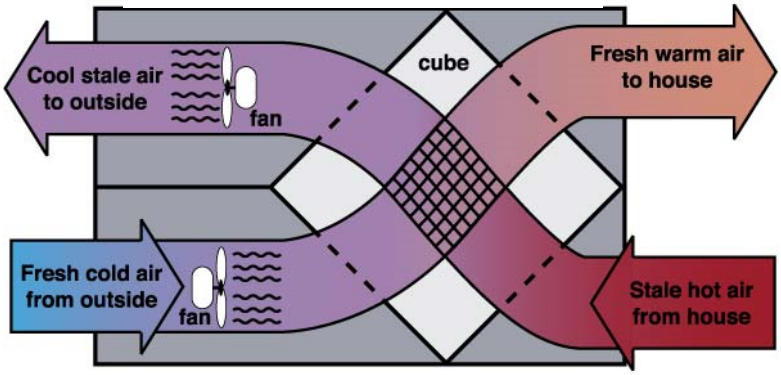
(Source: www.epa.gov)

The geothermal heat pump system has delivered both financial and environmental benefits. By using the highly efficient geothermal heat pump system to heat and cool the building, the building avoids the air emissions that would result from an oil or gas-fired heating system. It also eliminates the need for a conventional cooling system. Geothermal heat pump systems

are also quieter and more aesthetically pleasing than conventional HVAC systems because they do not require outdoor cooling equipment. These features of the geothermal system are particularly well suited to the GRWECC's location on a wildlife sanctuary.

The cost of the geothermal system was equivalent to that of a similarly zoned conventional HVAC system. Geothermal heat pump systems also save money by requiring limited maintenance.

Energy Recovery Ventilator



Source: Toolbase Services (http://www.toolbase.org)

Another innovative HVAC technology employed in the GRWECC is an Energy Recovery Ventilator (ERV). An ERV uses the temperature and humidity levels of the building's exhaust air to pre-condition fresh incoming ventilation air. Because the GRWECC was constructed with such a tight building envelope, very little air leaks in and out through walls and cracks. While this is great for energy efficiency purposes, it could result in unhealthy indoor air if ventilation rates were not properly maintained. By using an ERV, the GRWECC can bring in plenty of fresh outside air without losing all the energy that remains in the exhaust air. For example, during the cold winter months, the heat and humidity from the building's exhaust air is exchanged with the cool dry incoming outdoor air to limit the amount of energy the building's other HVAC equipment will need to expend to bring the incoming air to the proper temperature and humidity level.

The energy required for building ventilation was further reduced by using energy efficient fans, and by providing operable windows that allow for natural ventilation.

The building's temperature is regulated with an electronic Direct Digital Control (DDC) system. A central computer workstation is equipped to control the temperature and ventilation needs for the building.

Sanctuary Director, Julie Brandlen, uses the workstation that controls the building's temperature and ventilation.

Other heating and cooling-related features:

Solar water heating panels provide hot water for the kitchen and bathrooms.

A vine trellis along the south wall of the office area provides shade, reducing cooling loads during the summer.

On-Site Power Generation

Photovoltaic (PV) roof shingles located on the south-facing slope of the exhibit hall roof convert sunlight to electricity. The difference in appearance between the slate roofing and the PV roofing system is almost undetectable. The 2.7 KW system will generate approximately 3,500 kWh per year. This represents about two percent of the building's total annual electricity needs, or a little more than half of the electricity used by an average home. While it is unfortunate that the system produces a limited percentage of the building's electricity, the system demonstrates that buildings can use sunlight to produce electricity! This building serves to educate the general public about alternatives to centralized power plants that run on coal, oil, natural gas or nuclear energy sources.

There are many benefits associated with PV power that go beyond just the energy produced. First, PV-produced power emits no air pollutants! The PV system at the GRWECC will avoid over 41 tons of climate changing CO_2 emissions during its lifetime. This is equivalent to keeping 87 barrels of oil from being burned, or taking eight cars off the road for a year.[2]

[2]Source: http://www.usctcgateway.net/tool/.

Emissions Avoided Due to PV Power Production		
Pollutant (lbs)	Annual	Lifetime*
SO_2	7	139
NO_x	3	51
CO_2	4,138	82,766
**Assumes 20 year life of system*		

Because it is generated at the place where it is used, it avoids the losses that would occur when electricity is transported from a power plant to its point of use (over 10 percent of power is lost when it travels from the power plant to the end user). In addition, the distributed nature of PV power generators helps boost our nation's energy security. Unlike centralized power plants, PV will keep delivering power even if our transmission or distribution lines were damaged, and if one PV system were to go down, it would not have a major impact on the rest of the system.

Photovoltaic shingles replace slate shingles on a portion of the roof. This building-integrated feature helps minimize the aesthetic impacts of PV and reduce material use.

An educational kiosk found in the exhibit area allows visitors to learn more about the PV system and monitor its real-time electricity production.

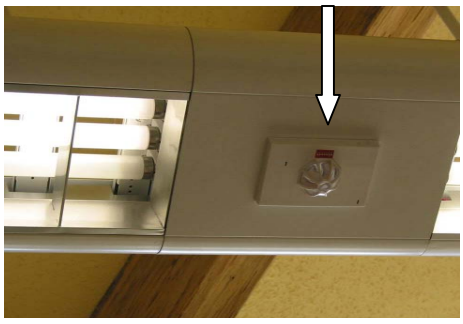
The PV system is interconnected with the electric grid which provides utility power to the GRWECC. All the power produced by the PV system is usually consumed right at the building, but if the PV system were to produce more power than the building is using at any given time, that power would flow back into the electric grid.

The PV system is connected to a data acquisition system which records energy output and related weather variables such as temperature, wind speed, and solar intensity and displays this information at a kiosk in the lobby.

Lighting Design

The building was designed to maximize the availability of natural daylight and to minimize the need for artificial light. A number of design elements help achieve this goal:

- The building was oriented so that the maximum amount of window area would face south. This increases the amount of natural light that can enter the building in addition to improving the potential for passive solar heating.



Above, light sensors adjust light output depending on the amount of available daylight.

- Advanced lighting controls use motion sensors to avoid lighting unoccupied spaces, and dim automatically when there is enough natural light available.

- Many fixtures provide both “direct” and “indirect” lighting, taking full advantage of light output by reflecting light off of the ceiling.

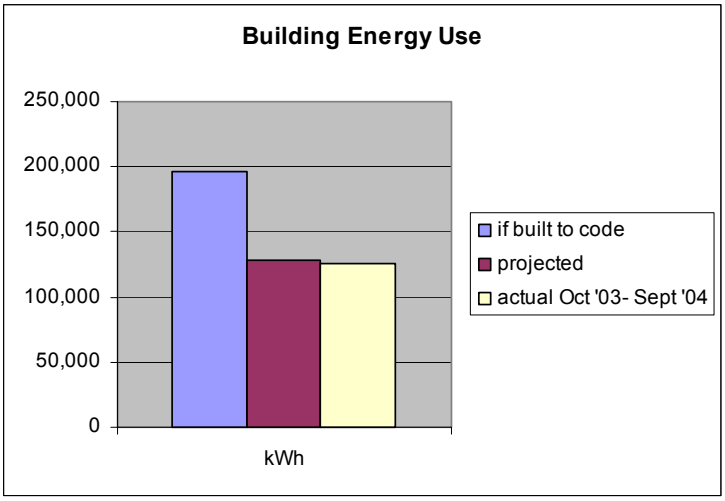
- Horizontal white panels, or “light shelves” (shown on the right) are positioned just below the clerestory windows located along the south facing wall of the administration area. The light shelves reflect light onto the ceiling to extend the reach of natural light into the room and further reduce the need for artificial lighting.

- Solar powered lighting is used in the parking lot. In addition to the benefit of using renewable energy as a source of power for lighting, the solar powered lights eliminated the need to run electrical wiring to the parking lot.

The extensive use of natural “day lighting” saves energy by dramatically reducing the need for artificial light. In addition, the use of natural light improves the quality of the visual environment for building occupants.

Energy Performance

The building was designed to use 30-35% less energy than a conventionally designed building of similar size. Since the building uses no gas for heating or appliances, the only energy utility Mass Audubon pays for is electricity. The building’s engineers anticipated that the GRWECC would use12.6 kWh per square foot annually, or a total of approximately 128,000 kWh, without factoring in electricity generated by the building’s photovoltaic system. Based on the building’s first year of electricity bills, it is using slightly less electricity than expected.[3]



[3] This refers to the first year after the building was fully tuned and operational- the year starting October 1, 2003.

Materials and Resources

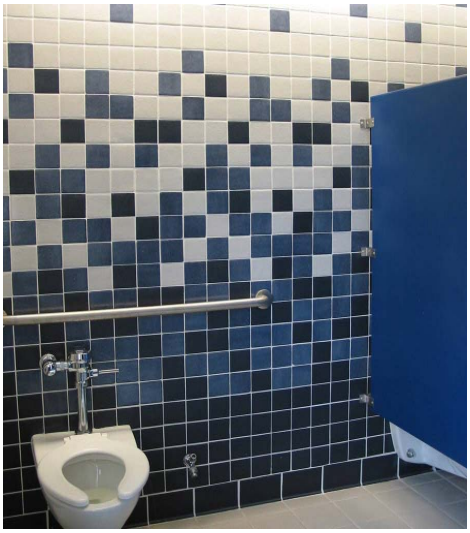
Building materials, furnishings and finishes, were chosen with careful consideration given to their environmental impacts. Potential materials were evaluated based on their embodied energy (the amount of energy associated with production, delivery, use and disposal of a material) and durability, as well as the effects they would have on indoor air quality and the solid waste stream.

Indoor Air Quality

Paints and adhesives that emit negligible amounts of harmful air pollutants, called volatile organic compounds ("VOCs"), were used throughout the building. The paints used meet the requirements of the "Green Seal" program. All insulation used in the building is formaldehyde-free. Fiberglass insulation (used in the walls) also consists of natural and recycled materials such as sand and recycled windows and bottles. In addition, carpeting used throughout the building meets the Carpet and Rug Institute's Green Label Indoor Air Quality Test Program.

Recycled Content

Building components ranging from carpets to office furniture were chosen for their high recycled content. Ceramic tile in the bathroom, for example, contains 55% recycled glass, a portion of which is from discarded airplane windshields. The bathroom partitions are made from a plastic material that consists of over 30% pre-consumer recycled content. The carpet used consists of 54% recycled content (32% post-industrial and 22% post-consumer). The carpet backing includes 100% recycled vinyl composite material. Another benefit of the carpet used in the building is that it comes in modular "tiles" so that pieces can be replaced without having to re-carpet an entire area.



Ceramic tile is made from 55% recycled glass, with 48% derived from airplane windshields.

Toilet partitions are made of 30% pre-consumer recycled plastic goods.

The building uses recycled steel and Parallel Strand Lumber (PSL) manufactured from wood fibers normally wasted in the milling process.

Carpet tiles contain 54% recycled content and contribute to a healthier indoor environment by emitting only low levels of Volatile Organic Compounds (VOCs).

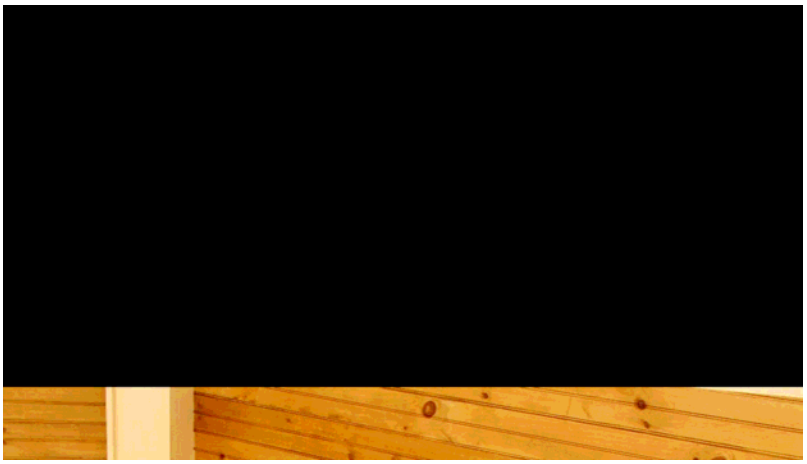
Local Resources

The building also makes use of local resources. For example, the entryway pillars use Roxbury Puddingstone which was salvaged during the demolition of buildings in a nearby neighborhood.

Puddingstone Column

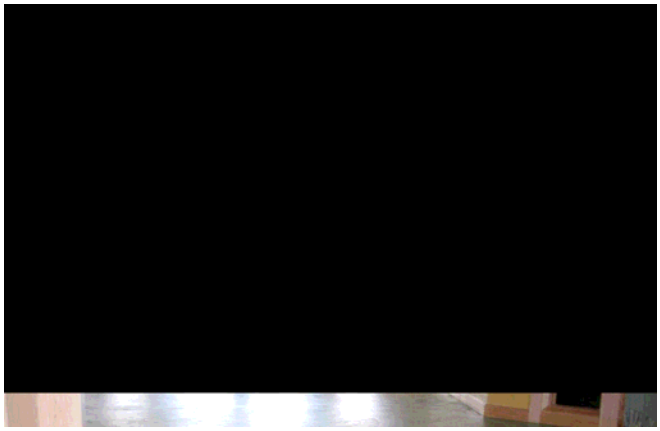
Other Innovative Features

Wood used for shingles, trim and framing is certified as sustainably-harvested, and the wood I-beams that are used consist of wood from young, rapid-growth trees.



The ceiling of the exhibit hall uses wood from a forest certified for its sustainable harvesting practices.

Natural materials were used wherever possible. For example, ceramic tile was used in the bathrooms, and linoleum was used in the classrooms, corridors and workrooms. Linoleum consists of natural materials such as wood, cork, and linseed oil and can be composted when it is removed from the building.



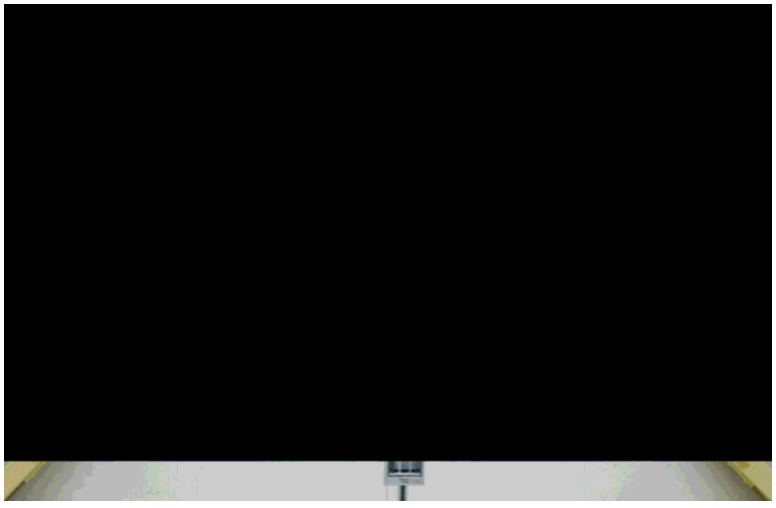
Concrete and granite flooring (above) and linoleum flooring (right) demonstrate the building's extensive use of natural materials.

Diversion of Construction and Demolition Waste

During the construction process, waste materials were sorted and, when possible, sent to an appropriate recycling facility.

Indoor Environmental Quality

The GRWECC was designed to take advantage of passive solar energy for both heating and lighting. Features such as clerestory windows and light shelves ensure that natural daylight is dispersed through the entire building to provide a visually comfortable indoor environment for employees and visitors.



Operable clerestory windows with shades provide natural light and ventilation.

As described previously, low VOC paints and adhesives were used throughout the building to maintain high indoor air quality. The GRWECC also uses carbon dioxide monitors to monitor and regulate indoor air quality, and allows fresh air into the building for natural ventilation whenever the outdoor temperature permits.

Water Efficiency

The building's designers considered using waterless toilets as well as a greywater system that would reuse waste water on site for watering plants and other purposes. The Boston Inspectional Service Department did not allow the use of a greywater system. The design of the building prohibited the use of waterless toilets as they require space beneath the floor and there is no basement below the bathrooms. The building does use water-efficient toilets and fixtures, and a composting toilet is being used in the educational gazebo located a short distance from the main education center.

Lessons Learned

Mass Audubon and the George Robert White Fund are pleased with the GRWECC and its green features. With its abundant natural daylight, Mass Audubon staff find the building to be an incredibly comfortable and pleasant work environment. As one of the first green buildings to be constructed in the region, the GRWECC provided valuable experience to the design and construction team that they can apply to their future work. The experiences of the project team, as well as those who have occupied the building since it opened in October 2002, can provide valuable lessons for those undertaking future green building projects. Following, in no particular order, are a number of lessons learned and potential areas for improvement for the GRWECC.

1. Green Buildings are Affordable, Comfortable and Achievable.
The GRWECC project demonstrated that when green design concepts are incorporated from the beginning of the design phase, green features do not have to cost extra. With proper planning and research, one can find products and strategies that achieve the environmental goals of a green building without adding to the cost. For example, the geothermal heat pump system cost the same as a standard HVAC system, and the recycled wooden beams used in the building cost less than a comparable product made from virgin materials. In fact, the entire project cost amounted to approximately $190 per square foot, which is comparable to the George Robert White Fund's non-green construction projects. An added investment came in the form of time spent by the design and review team.

With its clean, simple lines, airy openness and naturally lit spaces, Mass Audubon staff can attest to the findings of green building studies which have found that green buildings provide more comfortable and productive working and learning environments.[4] In addition to the many

[4] A number of studies document the productivity improvements and benefits to childhood learning that result from green buildings including: 1) Fisk and Rosenfeld, 1998, "Improved Indoor Environment Could Save Billions of Dollars"; 2) Nicklas and Bailey, "Analysis of the Performance of Students in Daylit Schools," Innovative Design, Raleigh, NC, www.innovativedesign.net; 3) Hathaway, Hargreaves, Thompson, and Novitsky, 1992, "A Study Into the Effects of Light on Children of Elementary School Age - A Case of Daylight Robbery," Policy and Planning Branch, Planning and Information Services Division, Alberta Education, Canada.

educational programs conducted by Mass Audubon staff, the GRWECC has become a popular location for City events.

While some green buildings employ technologies that are cutting edge, like fuel cells or advanced equipment control systems, the technologies and concepts used in the GRWECC are tried and true and readily available in the marketplace today. What is unique about the building is that it pulls together a variety of smart, environmentally-friendly technologies in one place. With careful planning and a well-qualified design and construction team, the results of the GRWECC are replicable.

2. Train Construction Industry in Green Building Concepts

A lesson gleaned from the experience of the building's architect, Liviu Brill, relates to the GRWECC as well as other green buildings. Mr. Brill believes that it is critical to target and train building contractors and subcontractors in the concepts of green buildings. While architects and engineers have been deeply engaged in the green building movement, other building trades have received little exposure to the concepts of environmentally sustainable design and construction. You can have a flawlessly designed green building, but if it is not constructed and maintained properly, it will not perform to its full potential. Given that green buildings tend to require a high upfront investment in energy-saving technologies and materials, their proper function is critical in order to deliver energy savings and occupant comfort over their lifetimes.

Training building contractors and trades people in green building concepts should also help reduce the cost of constructing green buildings. When building contractors are asked to do things outside of the norm, their tendency is to charge a higher fee. If contractors and trades people were more knowledgeable about the principles of green buildings, they might recognize that many green building concepts are just part of doing high-quality construction. In addition, if a greater portion of the industry were familiar with green building concepts, contractors would eventually have to become more competitive in their bids to serve "green" clients.

3. Building Commissioning is a Valuable Investment

Since the building employs a number of state-of-the-art energy systems, it is important to carefully monitor the performance of these systems to understand them better and to determine whether they are in fact delivering the promised energy savings for the building. Even if a piece of equipment is in perfect condition, if it is installed or adjusted improperly, it will not likely perform as projected. The process of commissioning a building upon the completion of construction, and then again at future intervals, is an effective way to ensure that all systems are functioning properly. The GRWECC was not commissioned when it was first built due to cost concerns. However, after over two years of operation, Mass Audubon staff and the George Robert White Fund believe that commissioning the building would be a valuable investment.

4. Enhance Functionality of Energy Management System

While a central computer station enables building staff to monitor the performance of the geothermal heat pump system in real time, and to adjust temperatures in each of the building's twelve separate zones, it does not appear that this control system is being used to its full potential as an energy management tool. The system should alert building staff when any equipment failures occur so that maintenance can be performed immediately and other potential damage can be avoided. Furthermore, the building should be equipped with metering devices so that the control system can be used to track and report on the long-term performance of the geothermal system and other energy-related equipment such as the Energy Recovery Ventilator, and solar hot water and PV systems.

Mass Audubon is lucky to have both a Property Manager and a Sanctuary Director who are willing to embrace the technology used in the building. However, they sometimes have to play detective to explore whether the equipment is working properly and to identify the source of problems. It is critical to make sure that the control system clearly communicates important information in a user-friendly way so that current and future staff can monitor and manage the building effectively.

5. Facilitate Building Maintenance

The building's heat pump system is located and configured in such a way that it is difficult to access and maneuver around. This makes maintenance a challenge. Since the long-term performance of the building depends on the proper function of its equipment, maintenance is incredibly important. Mass Audubon recognizes the importance of maintaining a long-term service contract with a knowledgeable and trust-worthy engineering firm to ensure that the energy systems retain their performance integrity over time. However, finding an engineering firm that possesses these qualifications can prove challenging since GRWECC's equipment is not mainstream.

6. Solar Hot Water: Educational Benefits, but Not Ideal Application

The value of the solar water heating system is questionable for this building. It is interesting from an educational perspective to see a variety of renewable energy systems in action, and solar hot water can be one of the most cost-effective renewable energy technologies. However, solar water heating systems are most appropriate for buildings with a significant demand for hot water. The GRWECC only uses a very minimal amount of hot water for hand washing in the bathrooms and in the kitchen, which gets limited use. Since there is such a long piping run from the solar tank to the bathrooms, it takes a while for the water to get hot during hand washings.

A variety of "green" alternatives may have been more appropriate for serving the hot water needs of the GRWECC. A technology that would directly address the need for immediate delivery of hot water is "on-demand" water heaters that could be located right in the bathrooms and kitchen. By only heating the small quantities of water that are used, this technology would serve as both an energy and water efficiency feature for the building.

Alternatively, waste heat from the geothermal heat pump system could be used to heat water for the building. Using something called a "desuperheater" geothermal heat pump systems are often used for water heating purposes. They can typically serve 100% of summer water heating needs and can dramatically reduce water heating needs during the winter as well.

Given that the solar water heating system is already in place, the GRWECC should take advantage of the system as an opportunity to demonstrate the technology. Staff should explore the possibilities of metering and monitoring the temperatures produced by the solar panels and perhaps making use of these data through the educational kiosk that currently serves the PV system.

Learn More

Visiting

The GRWECC is open Monday through Friday, 9 a.m. to 5 p.m., Saturday, Sunday, and holidays, 10 a.m. to 4 p.m. Boston Nature Center's trails are open every day, dawn to dusk. The Center is located at 500 Walk Hill St. in Mattapan, MA.

Directions are available at
http://www.massaudubon.org/Nature_Connection/Sanctuaries/Boston/index.php

For more information, contact:

Boston Nature Center
500 Walk Hill St.
Mattapan, MA 02126
617-983-8500
GRWECC@massaudubon.org

Boston Nature Center Contacts

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617-983-8500 x-6901

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One City Hall Plaza, Room M-5
Boston, MA 02201
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Information Resources

www.massaudubon.org/Boston
www.BostonGreenBuilding.org
www.usgbc.org
www.masstech.org

Contractor Contact Information

Trade/Service	Company Name	Phone/Fax
Architect	Primary Group Inc.	(617) 451-3333
Co-Architect, Building Systems Consultant	Steven Winter Associates	(203) 857-0200
Landscape Architect	Halvorson Design Partnership	(617) 536-0380
Mechanical / Electrical Engineer	SAR Engineering, Inc.	(617) 328-9215
General Contractor	Peabody Construction Co. Inc.	(781) 848-2680
Bathroom Partition, Projection Screens, Cork, Whiteboards	Sanahart International	(781)-455-6656
Concrete Suppliers	Tresca Bros.	(508) 326-8829
Construction and Demolition Waste Management	Jet-Away	(617) 541-4000
Doors and Hardware	Hardware Specialties	(413) 734-6487
Earthwork	ODF Company	(781) 442-5069
Electrical Contractor	Griffin Electric Company	(508) 429-8830 ext. 1320
Flooring; vinyl, carpet, slate, tile	Unicon Systems	(508) 675-3974
Glass (all except casework doors)	Glass Construction	(781) 255-0007
HVAC	Mechanical Advantage Company	(508) 747-6300
Millwork and Casework	Padco	(508) 753-8486
Paints	Northeast Interiors	(508) 951-2852
Photovoltaic Design	Solar Works, Inc. www.solar-works.com	(802) 223-7804
Photovoltaic Shingle Installation	Copper and Slate Company	(781) 893-1916
Plumbing Contractor	Dowd Plumbing Company	(781) 821-1212
Puddingstone	Bostonian Masonry Company	(617) 954-8700
Roof Panels / Structural Insulated Panel Systems	Branch River Products	(401) 232-0270
Shades / Blinds	Papas Company	(617) 964-8700
Thermo Well Drillers	D.L. Maher Co.	(781) 933-3210
Thermo-well Pumps	Wilmington Pump	(978) 658-9111
Windows	Littleton Lumber	(978) 597-6892
Wood Framing Materials and Roof Shingles	Cape Cod Lumber	(781) 261-7120

Summary of Products and Materials

A number of environmentally-friendly products were used throughout the GRWECC. A listing of some of these products is provided below. For further details, please refer to the complete building specifications which are available in the GRWECC Resource Library. For complete descriptions of "green" product criteria, refer to the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Rating System, available at www.usgbc.org.

Note that the manufacturers and products referenced below were active at the time of the GRWECC construction (2001-2002). Since the green building industry is constantly evolving,

the manufacturers and products listed here may no longer be representative of the current state of the industry.

Product	Manufacturers	Descriptions/Trade Names
Carpet	Interface	low emission materials, high recycled content
Ceramic Tile	Terra Green Ceramics	fabricated from recycled glass
Concrete Floor	Skookum Floor Concepts	
Engineered Lumber	Louisiana Pacific	Laminated Veneer Lumber
	Georgia Pacific Corp.	Oriented Strand Board
	MacMillan-Boeldel Ltd.	Parallel Strand Lumber
		Structural Composite Lumber (all lumber from certified sustainably harvested forests)
Exterior Paints	Benjamin Moore	low emission/VOC
	Devoe and Raynolds	formaldehyde-free (all
	Pratt and Lambert	”hospital paints” comply)
	Sherwin Williams	
Interior Paints	Benjamin Moore: “*Pristine Eco-Spec*”	low emission/VOC formaldehyde-free (all
	Sherwin Williams: “*HealthSpec Low Odor Coating*”	”hospital paints” comply)
Lamps	General Electric	T4, T5 and T8
	Phillips	
	OSRAM	
	Sylvania	
Lighting Ballasts/Controls	Osram Sylvania	high frequency electronic
	Magnetek	automatic motion sensing
Linoleum	Forbo Industries	Marmoleum Real
Windows	Marvin Windows	high performance, Low”e”
	Eagle Window and Doors	argon filled
	Pella Corporation	
Solar Exterior Lighting	Selux Corporation	
Structural Insulated Panel Systems	Branch River Products	
Toilet Compartments	Santana	solid plastic polyethylene from recycled plastic goods
Walkway Materials		wood fiber over crushed, local Roxbury puddingstone

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