The Evelyn Pease Tyner Interpretive Center (EPTIC) at Air Station Prairie in Glenview, Ill., blurs the distinction between inside and outside by using natural materials and colors that complement and mimic the prairie.

# Learning With Nature

**By Prem Mehrotra, P.E.,** Life Member ASHRAE

**The Evelyn Pease Tyner Interpretive Center (EPTIC) at Air Station Prairie in Glenview, Ill., includes exhibits and a learning center to help visitors understand the ecology of local prairies. The building is about 3,000 ft$^2$ (279 m$^2$) in net area and is located on the southeast corner of 32.5 acre remnant of a tall grass prairie.**

**The conceptual design process was begun in 2004. The project was inspired by Evelyn Pease Tyner, a local environmentalist and conservationist, and the facility. All the building systems, including construction materials and processes, were planned to harmonize with nature. The team of architect, engineers, owner, and all the stake holders met for several years on a regular basis. As the project evolved, the objective became to make the building self-sustaining for its energy use.**

**About the Author** Prem Mehrotra is president of General Energy Corp., in Oak Park, Ill.

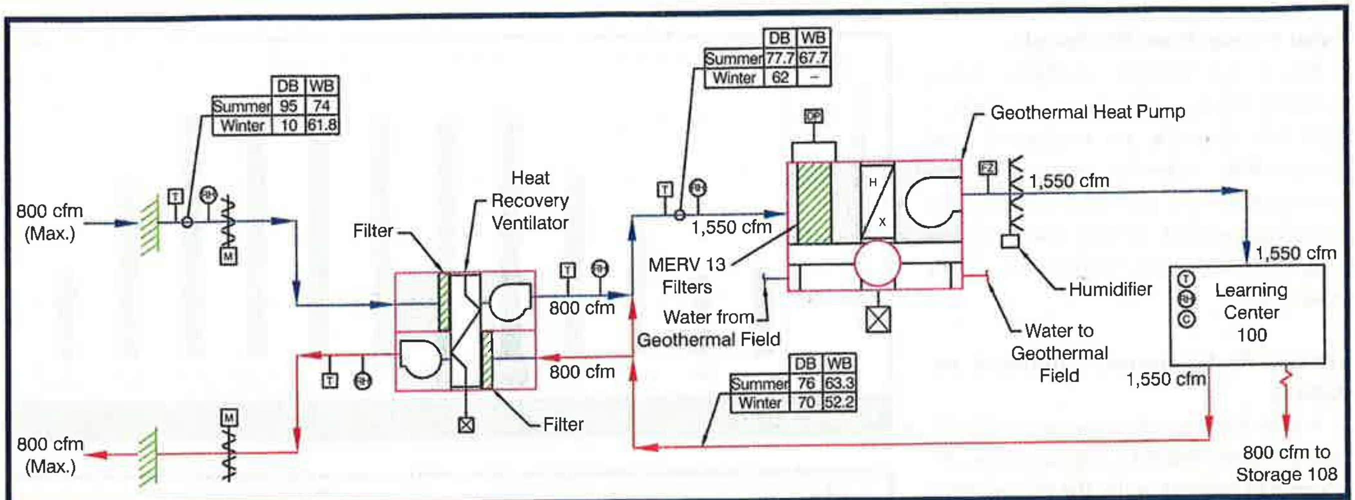


**Figure 1:** Energy recovery ventilator, geothermal heat pump for learning center.

The final design target was LEED Platinum certification and to use solar energy to power building systems. The project was somewhat delayed to acquire additional funds, and to obtain renewable energy grants.

The design engineers focused on maximizing LEED points for water efficiency, energy and atmosphere, and indoor environment. The architectural firm used exterior spaces for exhibits. This decision helped reduce the building's overall size, which created a smaller internal volume and helped contain costs and minimize the energy footprint.

### Orientation & Natural Ventilation

The building has an east/west orientation, and the solar gain was offset using large overhanging eaves on the south-facing façade and minimal eaves to the north. The 20 ft (6 m) high windows provide visitors incredible views of the prairie and allows for daylighting, saving energy. Operable windows in every space allow prevailing breezes to ameliorate temperatures without using energy. Careful attention to cross ventilation design means that the building is comfortable in the summer without mechanical systems running, despite being completely exposed on the prairie.

Two-thirds of the roof is vegetated with the other one-third used for photovoltaic panels. The roof has an R-value of 38. The walls are designed with a U-value of 0.039. A window shading coefficient of 0.25 is used.

### Geothermal Heat Pumps

Two geothermal heat-pumps are used for air-conditioning of the entire building. A typical heat pump system *(Figure 1)* has a cooling efficiency rating of 15.39 EER or 0.78 kW/ton and heating efficiency rating of 4.45 COP. The geothermal heat pumps were sized to meet the winter heating load to ensure that supplemental heating is not required during the winter. In the Chicago metropolitan area, heating requirements govern the size of heat pumps. Therefore, the project uses energy recovery ventilators (ERVs) to reduce the size of the heat pumps.

ERVs recover heat from exhaust air to preheat outside air during winter and precool outside air during summer before introducing the air to the heat pumps for mixing with return air. This helped reduce the size of the heat pumps, eliminated reheating requirements, and reduced the size of the geothermal loop. The heat recovery units are rated at 60% efficiency. Value engineering was an ongoing process during the design phase to stay within budget.

### Lighting and Daylighting

Every space within the building is lit with natural daylight and has a view to the prairie. Because of the amount of natural daylight in the building, electricity consumption for the lighting system is minimized.

The display cases and shelves embedded within the façade are transparent, allowing sunlight to penetrate. Also, visitors can see through the display and into the building.

The lighting in the learning center consists of indirect light with metal halide lamps. The metal halide lamps have two-step controls that use solar light sensors. The rest of the areas are provided with T8 lamps and electronic ballasts controlled by occupancy sensors. Outdoor spotlights are used to illuminate the exhibits to prevent direct proliferation of light to the dark sky. Solar bollards powered by solar light are used to illuminate the walkway to the building from the roadside.

## Building at a Glance

**Evelyn Pease Tyner Interpretive Center at Air Station Prairie**

Location: Glenview, Ill.

Owner: Glenview Park District, Illinois

Principal Use: Interpretive center

Includes: Museum and learning center

Visitors: More than 2,550 visitors annually

Gross Square Footage: 6,466

Conditioned Space: 3,000 ft$^2$

Substantial Completion/Occupancy: Oct. 2006/April 2007

### Solar Power from PV Panels

Based on energy analysis using building energy simulation models, a 16.9 kW capacity an integrated roof photovoltaic panel's power generation system was provided to meet the buildings annual energy consumption through net metering with utility power supply grid.

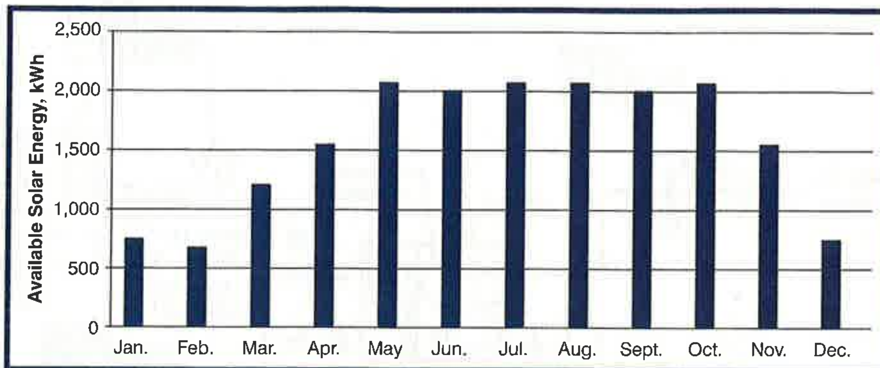


**Figure 2:** Monthly solar power generation.

### Energy Performance, Predicted vs. Actual

A part of the energy requirement for the totally electric building is provided by on-site power generation by the photovoltaic cells (PVs), and the balance of power is provided from the grid through a net metering arrangement with the utility.

The design building is 61.86% more energy efficient than the baseline building. The modeled annual energy requirement of 69,382 kBtu for the design building is 92% (64,120 kBtu) fulfilled by on-site solar power generation (*Figure 2*).

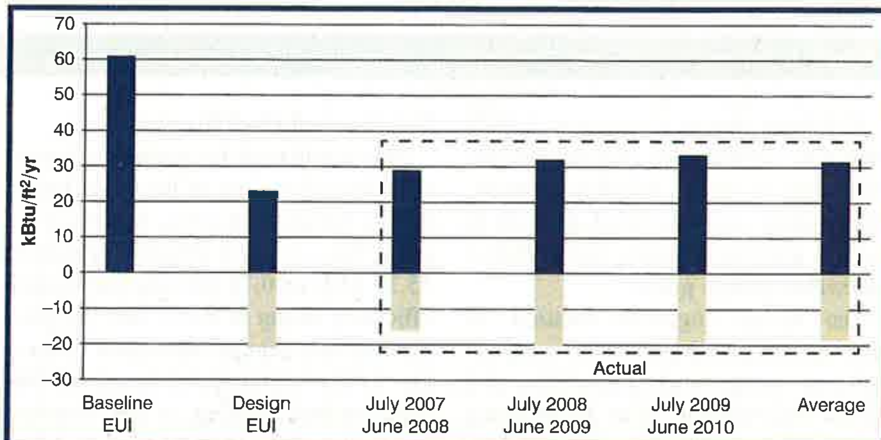


**Figure 3:** Summary of actual measured and modeled EUI.

The average electric power generated on site from PVs is 16,350 kWh annually compared to 18,787 kWh predicted by the model. This discrepancy appears to be partly due to accumulation of ice on the depression of the pagoda-shaped roof, and partly due to shading from the shape of the roof.

Visitors to the center have been increasing every year from 1,229 visitors in 2008 to 2,574 visitors in 2010. The building is used about 30% to 50% more than what was used in preparing the energy simulation model. This increased the EUI to 31.5 kBtu/ft$^2$·yr from a design EUI of 23 (*Figure 3*).

### Ventilation Effectiveness

The HVAC systems are designed to provide ventilation in accordance with ASHRAE Standard 62.1-1999. Demand control ventilation is provided with a carbon-dioxide ($CO_2$) monitoring system to monitor indoor and outdoor $CO_2$ levels. The monitoring system is equipped with three sensors. Two are used to monitor indoor conditions, and the third sensor is used to monitor outdoor conditions. Heat recovery ventilators operate to maintain space $CO_2$ levels of 530 ppm or below.

Displacement ventilation is used to maintain a high level of indoor air quality. This arrangement applies to the center. Diffusers are selected specifically to cover the entire room for proper throws and sound levels to provide good air diffusion performance index (ADPI) per *2001 ASHRAE Handbook—Fundamentals,* Chapter 32, Space Air Diffusion. Air is supplied at the floor level at a very low velocity and allowed to rise due to the thermal gradient in the room and then is exhausted near the roof level (*Figure 4*). Thermal comfort is designed based on ASHRAE Standard 55-1992.

The zoning is based on heating and cooling load characteristics of rooms/zones and the area thermostats are strategically located to ensure maintenance of comfort conditions for the entire zone. The temperature and humidity of each zone is monitored through the building management system.

### Water Efficiency

The rain that falls on this site is either intercepted or infiltrated by the 1) green roof; runoff that does leave the roof comes down rain chains into reestablished prairie areas; by the 2) biomass of native prairie, both existing and restored around the building; by 3) permeable pavers in the small amount of parking where rain filters into open graded aggregate, and 4) by the protection of in situ soils so that infiltration occurs where rain falls around the building. The water efficiency in the building is obtained through ultra-low flow toilets and electronic sensors on lavatories, and use of dual flush valves for ladies' washrooms.

### Cost Effectiveness

Value engineering was an important part of the engineering effort, and an energy model was prepared during the conception-of-design phase to evaluate envelope, fenestrations, building orientation, selection of the HVAC system and equipment. For example, ventilation heat recovery units were used with each heat pump to reduce the size of heat pumps and eliminate reheat requirements during the severe winter. This also helped reduce the energy footprint and the size of the photovoltaic cells required to provide on-site electric power through net metering to offset the power requirements.

The optimization of building envelope and HVAC equipment sizing had a domino effect of reducing equipment space required, smaller ductwork, and electrical power distribution, which helped in cost savings. A horizontal geothermal loop was used instead of a vertical loop, resulting in about a $7,000 reduction in cost by the drilling contractor.

The construction cost of the project was reported to be $2,550,097 plus $280,750 as soft costs. A grant of $104,310 grant for geothermal and photovoltaic systems was received from Illinois Clean energy foundation, a $120,500 grant was received from the U.S. EPA, and $140,000 from Catullus development.

Reduced operating costs from ground source heat pumps and photovoltaic save electric energy costs of $6,968 per year. Parking storm water drainage system was eliminated ($7,500) by using pervious pavers, and parking was reduced by sharing parking with an adjacent railroad station (10 cars at $2,500 = $25,000) for a total savings of $32,500.

**Environmental Impact**

Special care was taken during design and construction to minimize the impact on environment. Blurring the distinction between inside and out, the team used natural materials and colors that complement and mimic the prairie; harnessed renewable resources for energy needs; provided decks that "elevate" visitors onto the prairie; replaced lost land from the building's footprint with a green roof; interpreted the site and building with education panels; and augmented the remnant prairie with additional native landscape. Turning the building inside out reduced the building footprint, which reduced staffing and energy consumed.

Commuter rail parking lots and on-street parking offer shared parking opportunities, which allowed the project to reduce mandated parking stalls to a mere two stalls, two accessible stalls, and a bus lane.

By placing the building on a pin foundation, the entire footprint is elevated, creating minimal site excavation and disturbance. This engineering technique allowed the building to rest between two

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existing wetlands without compromising either one and allows water to fluctuate between the wetlands without harming the building.


The solar gain is offset using large overhanging eaves on the south-facing façade and minimal eaves to the north.

**Reduction in Green House Gases**

Energy efficient design and generation of clean electric power on site reduced annual emissions of GHGs. GHGs are expressed in terms of carbon dioxide equivalents ($CO_{2e}$), which is the sum total of carbon dioxide, nitrous oxide, and methane emissions normalized relative GHG impact of $CO_2$. Natural gas emits 11.7 lb of $CO_2$ per therm. Regionally, the average emission rate of electricity is 1.5 lb/kWh according to the U.S. Environmental Protection Agency's Emissions and Generation Resources Integrated Database. Based on the CBECS (Midwest) Energy Use Index (EUI), the saving in GHGs emissions are 118,311 lb/year.

**Conclusion**

The building opened in April 2007 and continues to receive positive feedback. The Interpretive Center and site are used to educate visitors in two major areas: green technology/sustainability and prairie ecology. A variety of programs are offered to school and scout groups, as well as group tours. The building is used about 30% to 50% more than was reflected in the data used in preparing the energy simulation model. Visitation is continuing to increase.

The project shows that an integrated approach in building systems design and involvement of all the stake holders from early stages of the project can help in cost controls and make the building energy efficient. ■



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