ESI’s new headquarters, Gateway West Sustainable I, is a one-story, 34,000 ft² leased building built for ESI in the 193-acre Gateway West Commerce Center in Brookfield, Wis., a Milwaukee suburb.

Sustainable Site Strategies
The project team reviewed sustainable design strategies on first cost, return on investment, life-cycle cost, and innovation with all of these considerations carrying equal weight. Site strategies include building orientation, native landscaping, a low-maintenance exterior and building features to encourage using alternative transportation.

To reduce energy demand for artificial lighting and maximize daylighting, the building team selected a north-facing orientation. Dimming ballasts and ambient light sensors automatically adjust artificial lighting levels as needed.

The use of native plants throughout the landscape design reduces maintenance costs and the need for pesticides and herbicides. A “natural prairie,” consisting of 100% native vegetation, makes up more than 50% of the building’s landscape. The prairie minimizes the disruption to the environmental habitat of the area. Shade trees are strategically planted to reduce the heat island effect.

The building exterior materials consisting of brick, core ten steel and aluminum trim require no maintenance other than washing windows. This reduces the potential for introducing harmful contaminants to the groundwater or emitting VOCs into the air and protects the health of workers.

More than 70% of all landscape maintenance is done with electric power, battery power or by hand. This reduces fossil fuel consumption and noise. Landscape waste removed from the site is composted or processed into mulch whenever possible.
alternative transportation. Nineteen percent of building occupants use alternative transportation, and the number is increasing.

**Water Efficiency**

The building uses 37% less water than the average building of similar use due to low flow water fixtures. Lower water use not only means savings in energy costs, but also reduces the impact on the environment. Water use is metered to detect leaks, and, when required, building maintenance procedures call for replacing fixtures with like kind to ensure that water use is kept to a minimum.

**Energy**

The building is performing better than predicted with an annual energy use of 41.8 kBtu/ft².

**Annual Energy Use Intensity (EUI)**
- **Site**: 41.8 kBtu/ft²
- **Natural Gas**: 25.9 kBtu/ft²
- **Electricity (From Grid)**: 13.6 kBtu/ft²
- **Renewable Energy (Solar PV)**: 2.3 kBtu/ft²

**Annual Energy Cost Index (ECI)**
- **$0.75/ft²

**Annual Source Energy**
- **75 kBtu/ft²

**Annual On-Site Renewable Energy Exported**
- **0.2 kBtu/ft²

**Annual Net Energy Use Intensity**
- **41.6 kBtu/ft²

**Savings vs. Standard 90.1-2004 Design Building**
- **41%**

**ENERGY STAR Rating**
- **99**

**Heating Degree Days (base 65˚F)**
- **6,569**

**Cooling Degree Days (base 65˚F)**
- **491**

**Average Operating Hours Per Week**
- **45**

**WATER AT A GLANCE**

**Annual Water Use**
- **65,000 gallons

**ENERGY USE COMPARISON**

JULY 2010–JUNE 2011

- **HVAC 80.7%**
- **Heating 69.4%**
- **Cooling 2.3%**
- **Ventilation 9%**

**Reasons why specific categories are unusually low or high:**

- **Lighting** represents only 12.3% of total energy use; well below the commercial building average of 26%, as defined by the U.S. Energy Information Administration in 2005.* Extensive daylighting in the form of high glazing percentage (45%), ceiling light tubes, energy-efficient bulbs, daylight dimming and zone control based on occupancy significantly reduce the lighting load.

- **Cooling** represents only 2.3% of total use compared to an average of 13%. The relatively short cooling season in Wisconsin does not require a lot of cooling energy as compared to an average U.S. building. Also, a central energy recovery system recaptures and returns heat to the building.

**Ventilation includes air-handling unit and energy recovery ventilator fan energy. At 9%, ventilation is 3% higher than an average building. The central energy recovery system that recaptures heating and cooling energy requires more ventilation energy (to drive the energy wheel) than an average building. Energy recovered greatly offsets this cost.**

**Plus, the lower percentages of cooling and lighting drive the ventilation percentage up. Since variable frequency drives are installed on the fan motors, ventilation energy use is still low compared to an average building.**


---

Above: All runoff water gathers in catch basins to remove solid debris before exiting the culverts. This design still allows vegetation to thrive and reduces erosion.

Top: The vegetation used in the island areas is native to the area and requires no potable water irrigation. Shade trees are strategically planted to reduce the heat island effect.

---

**QuickFacts**

- **Job Name**: Coventry Elementary School
- **Address**: Coventry, Vermont
- **Type of Application**: High efficiency boiler upgrade with building automation controls
- **iWorx Controls**: LCI, BILMC, DXU3

**Equipment Controlled**
- **800 MMBtu three-pass, cast iron boiler, fan coil units, and baseboard radiators.**

**Energy Savings**
- **iWorx and boiler installation qualified for incentive rebates from Efficiency Vermont based on the cost effectiveness of the project. Fuel savings of 52%.**

**Project challenge**

The original building management system inside the 120-student Coventry Elementary School had lost all control. The system was cantankerous, unreliable, and had lacked precision since Day One. Add to this an inefficient and unreliable boiler and you’ve got the makings of a mechanical nightmare.

**Project solution**

The existing, oil-burning demand of a boiler was replaced with an 800 MMBtu three-pass, cast iron boiler, controlled by a BILMC/Wax module. Five fan coil units, each of which was controlled by an iWorx DXU3 module.
High Performing Buildings Winter 2013

Vacant, and CO2 sensors control ventilation systems turn systems off when the rooms are not occupied. One of two classrooms. Occupancy sensors based on occupancy.

The energy model indicated that the building would perform 35% better than the baseline code (ASHRAE/IESNA Standard 90.1-2004) and after two years of operation, the actual performance is 41% better.

The control system keeps the building comfortable and an ENERGY STAR rating of 99.

Lessons Learned

- A high performance building envelope;
- Properly sized mechanical systems with heat recovery;
- Efficient lighting design including daylighting; and
- An integrated, open control system.

Motorized dampers have been added to the exhaust system and energy recovery unit to restrict outside air infiltration during morning warm-up. One variable air volume box was added to improve comfort without lowering discharge air setpoints.

Air metering stations are installed on outside air ducts, and return and exhaust ducts. A two-stage electric humidifier was part of the original installation, but has since been replaced with a variable control gas-fired humidifier (Lessons Learned).

This equipment provides improved occupant comfort. Despite higher first costs compared to conventional rooftop units, the lower life-cycle cost and increased efficiency of this design results in a favorable return on investment (Modeled Energy and Cost Savings table).

The lighting design provides a lower ambient light level in the open office with LED task lights for all individual workstations. All T-8 light fixtures in normally occupied spaces are dimmable and controlled based on occupancy and ambient light sensors. All scheduling of lighting controls is controlled by automated circuit breakers, which, in turn, are controlled by the building automation system and integrated with the access control system for unoccupied operation.
Because of the open office layout and the flexible work hours, the furniture layout is divided into zones and the lighting is circuited according to these zones. The access control system is programmed to know the zone location of the cardholder’s workstation, and when employees enter the building, only the lights in the zone they are assigned to is turned on.

The building is extensively sub-metered, and the HVAC, interior lighting and exterior lighting are separately metered. The metered data analysis shows that the exterior lighting accounts for nearly 50% of the total lighting load.

The optimal use of daylighting, the high level of interior lighting control through dimmable ballasts, and the use of access control to reduce lighting in unoccupied spaces all contribute to reduce interior lighting costs. Exterior lighting costs are high relative to indoor lighting costs for this reason and are augmented by the business park covenant that requires exterior lights to be on overnight every night of the week.

Also, all of the incandescent accent lights have been replaced as they burned out with LED lights. The LED lights reduce energy costs and lower maintenance costs due to their extended lamp life.

Vending machines are equipped with “energy mizers” and work is under way to install power over Ethernet (POE) switches for IP-connected devices such as phones, printers, etc.

The photovoltaic electrical system is comprised of 78 solar panels with an output capability of 18 kW that generates more than 6% of the building's annual energy use. The 18 kW array consists of 78 panels and is providing savings of more than $3,000 a year in energy costs and credits.
the building’s annual energy use. During some unoccupied days the array generates more power than the building uses, resulting in a credit from the utility company. This system is saving Gateway West more than $3,000 a year in costs and credits. Unlike the other measures implemented, all of which resulted in an eight-year simple payback or less, this feature has a 22-year payback, even when the local utility incentives are included. Despite the longer payback, the photovoltaic system was pursued for educational purposes.

To ensure that the building continued operating in the way it was designed, ESI pursued LEED EB.

**LESSONS LEARNED**

**A More Efficient Humidifier.** Continuous measurement and analytics showed that the electric humidifier was the single biggest contributor to the building’s electric demand. Total annual energy and operational costs of the existing electric humidifier were determined and compared to estimated costs of a new natural gas humidifier. The ROI analysis indicated a simple payback of just over two years. Even though the electric humidifier was in operation for only two heating seasons, it was replaced with the gas humidifier based on the ROI. Heating season utility bills showed a reduction in demand charges as expected.

**Reducing Landscaping Maintenance Costs.** To minimize ongoing landscaping maintenance costs, alternative native plants are being considered as replacements for some of the original plantings. Plantings used in the islands of the parking lot require more maintenance than expected and do not use that space effectively. These landscaping changes are expected to improve the appearance of the building’s exterior and lower costs by using plants that require less maintenance.

**Importance of Ongoing Measurement.** The most significant lesson is that after designing and constructing a building to the highest standards of efficiency and intelligence, the systems still require ongoing performance measurement and corrective action. A combination of technologies including analytics, a computerized maintenance management system, and a well-defined and managed process for corrective action provide the information necessary to keep buildings operating at peak efficiency and ensure a positive return on investment.

**Indoor Environmental Quality**

The building design incorporates exterior views and daylighting for all occupied spaces within the building through the use of full height windows with high visible light transmittance, daylight windows and light tubes toward the middle of the building. Low interior furniture partitions (54 in. with the top 12 in. being glass) help further extend the light into the building.

The energy recovery unit efficiently introduces greater volumes of outside air, which contributes to a high quality indoor environment. The outdoor ventilation rate for the air-handling unit is 30% above Standard 90.1–2004. Twenty-two VAV zones allow occupants to control their environment via local sensors, desktop Web browsers or mobile Web clients. Humidification is provided by a central humidifier to maintain proper indoor humidity levels for maximum occupant comfort. A double filter system (prefilter of MERV 8 and final filter of MERV 15) helps prevent potentially hazardous particulate contaminants from entering the building.

The use of low-emitting interior paints, adhesives, sealants, and carpet helped provide a higher quality of indoor air for the contractors and visitors during construction and help maintain this high quality for the building’s life. An annual occupant comfort survey confirmed that the systems and policies are meeting the needs of the occupants. One area that was lacking was the restroom facilities, specifically the shower areas, which were being used by occupants who required a private space for medical or other reasons. During the initial design and construction, the shower areas were not provided with a hand soap dispenser, hand towel dispenser, or appropriate waste receptacles for occupant needs; these amenities were added as improvements in those spaces.

The survey also indicated that the majority of people were satisfied with the cleanliness of the building. The cleaning audit, on the other hand, showed deficiencies in the cleaning processes that otherwise would have gone undetected for some time. As a result of this, vendors were directed to provide further training to the cleaning staff to ensure the building is receiving the quality of service expected.

**Financial Benefits**

Each design consideration had to meet the team’s criteria of an eight-year maximum simple payback and a positive life-cycle ROI. The selections of lighting design, built-up air-handling unit and boiler, building intelligence system, and types of glazing and insulation were each evaluated against a baseline model to determine if the selection and incremental cost met these criteria. The only exception to these criteria was the PV array, which had a simple payback of a little more than 22 years.

The results of these enhancements are summarized in Modeled Energy and Cost Savings table (Page 63).

**Conclusion**

In 27 months of operation, Gateway West Sustainable 1’s measured reduced energy use has saved more than $82,000 and avoided more than 550 tons of CO2 emissions compared to the Standard 90.1–2004 baseline model. The LEED system has prompted the creation of written policies and procedures for the building, which otherwise would have been lost or forgotten in the everyday process of doing business.

The building demonstrates the potential financial savings and performance that can be achieved through intelligently applied technology and well-defined processes. It also serves as an example for operating and maintaining buildings at a lower cost.

**About the Authors**

Mike O’Connor is manager of energy services at Environmental Systems, Inc. in Brookfield, Wis.

Mike Mittelsteadt is an energy engineer at Environmental Systems, Inc. in Brookfield, Wis.