CASE STUDY

LEED-certified Westwood Elementary excels in its learning environment and cost savings with McQuay® Vision™ air handling units

When Elk River Area School officials set out to build a new elementary school for their fast-growing district, they specified two criteria: the school must qualify for LEED (Leadership in Energy and Environmental Design) certification; and it must be designed to help improve student achievement. The LEED Green Building Rating System® is a voluntary national standard for developing high-performance, sustainable buildings (www.usgbc.org/LEED). Completed in the fall of 2003, Westwood Elementary not only received LEED certification, it was the first school in Minnesota to be LEED-certified, and one of only four elementary schools in the nation to earn the distinction.

As for student achievement—studies show that students learn better in an environment with good indoor air quality. Westwood excels at bringing in fresh ventilated air and circulating it efficiently. Combine that with plenty of natural daylight and many other benefits, and Westwood provides the best learning environment a district can buy for its 500 students.

Yet the school cost no more to build than a typical elementary school. It even came in $500,000 under budget. And annual energy costs are 52 percent of the costs expected for a comparable-sized school—a savings of about $45,000 per year.

Energy recovery wheels contribute to savings

The school's air handling system contributes to the reduced energy costs and enhanced indoor air quality. Eight McQuay® Vision™ air handling units are installed; four of them deliver 100 percent fresh air throughout the school. Conditioning fresh air so that it circulates at the right temperature and humidity can be a significant part of any energy bill. Energy recovery wheels within these four air handling units help reduce this cost. Revolving slowly inside each unit, the wheels recover as much as 80 percent of the sensible (heat) and latent (moisture) energy from the exhaust air stream and transfer it to the supply air stream. The recovered heat and moisture are used to pre-treat the cold, dry outside air, helping to significantly reduce energy costs (see sidebar: Energy wheel beats summer and winter ventilation costs).

"We estimate that 75 percent of the total LEED points earned by Westwood can be attributed to the mechanical and electrical systems," said Russ Schumacher, P.E., project development manager and mechanical engineer of record, Johnson Controls. "The ventilation components contributed to LEED certification due to the energy recovery wheels."

Other energy-efficient mechanical systems contribute to the LEED certification. Displacement ventilation systems distribute conditioned air through the school. Typical circulation systems deliver conditioned air to ceiling-height ductwork and blow it into a space. Displacement ventilation distributes low velocity air at floor level through, in this case, Halton displacement diffusers. These diffusers are actually columns that run floor-to-ceiling, two per classroom, with air vents at floor level. The diffusers deliver air five degrees cooler than set point, because it warms as it rises. The low velocity and cooler air delivery both contribute to the school's reduced energy costs and increased ventilation effectiveness.

"The energy models project an annual electrical consumption reduction of over 280,000 kWH and a total building energy consumption reduction of 4,538 MMBTU over a code-based building," said Schumacher. A code-based building is designed to meet mechanical and electrical codes.

Westwood Elementary's ventilation system is, in fact, standard for new construction in the Elk River Area School District. The district received the 2004 Indoor Air Quality (IAQ) Tools for Schools Excellence Award from the U.S. Environmental Protection Agency for its district-wide approach to better IAQ, one of just 11 schools in the country to receive the award.

Elk River adopts the European model of sustainability

The decision to build an energy-efficient, sustainable building from the ground up was prompted by frustration, according to Dr. Ron Bratlie, director of special projects, Elk River Area School District.

Energy wheel beats winter and summer ventilation costs

"The cost to condition ventilation air is a major part of total energy costs for any school," said Russ Schumacher, P.E., project development manager and mechanical engineer of record, Johnson Controls. "Ventilation air can account for 30 percent of the total cooling load and 50 percent of the total heating load for a school building. Yet proper ventilation is a necessity for providing adequate indoor air quality to schools—that's why it's so important to install cost-effective systems."

Using an air-to-air energy-recovery device, such as an enthalpy wheel, is one way to reduce energy consumption and peak loads in schools. An enthalpy wheel—also known as a total energy wheel—can transfer both heat (sensible energy) and moisture (latent energy) from one air stream to another. This has the advantage of raising the temperature, as well as the humidity, of entering outdoor air during the winter and lowering it during the summer. The effect on first and operating costs of HVAC systems is significant.

Enthalpy wheels can recover approximately 75 percent of the energy from the exhaust air stream. Humidification can be expensive, because 1,100 Btu is required to evaporate one pound of water, regardless of the energy source. Enthalpy wheels can cut winter humidification energy costs by up to 60 percent, providing comfortable and affordable indoor air quality by transferring moisture from the return air to incoming outdoor air.

During the summer, enthalpy wheels help keep schools cool and dry. They transfer sensible and latent energy from the ventilation air to the exhaust air, lowering the temperature and relative humidity of the incoming outdoor air. Energy recovery wheels can cool outdoor air down to about 67 degrees wet bulb; standard recirculating air conditioners (such as heat pumps, unit ventilators, self-contained units and fan coils) can handle the rest of the conditioning.

Energy recovering devices are not new. They have typically been used in applications requiring high minimum outdoor air requirements. Given the savings they can generate, as well as improvements in indoor air quality, energy recovery systems make good sense for all schools to consider.

"I was at a school board convention, complaining to a consultant about building inefficiencies and IAQ," said Bratlie. "He suggested we visit offices and schools in Germany and Switzerland, which are models of efficiency and building sustainability. From that tour I learned that we could build schools here that are sustainable, efficient and within budgets. We proved that with Westwood. It's the best building we have in the district, and we're already building more like it."

The school district had worked with Johnson Controls, Milwaukee, WI, provider of facility management and control systems and services, for over 10 years, helping to install energy-saving measures such as HVAC upgrades, system upgrades, building automation strategies, and maintenance services at the various schools. When it came time to build Westwood, the district asked Johnson Controls to design a sustainable building that could be LEED-certified.

Integration is key to LEED approach

LEED certification and its concept of building sustainability—a building with low environmental impact both during construction and once it is occupied—is an integrated process. Although the mechanical systems contribute significantly to the reduced costs, all the building systems have to work together to achieve the goal.

For that reason, Westwood is designed from some basic principles: It is designed to support multiple community and school uses year-round; its clustered classrooms provide a small school atmosphere with the resources of a larger population; and future expansion is already built in.

Although 500 students in grades three through six currently attend Westwood, another eight-classroom wing can be added to accommodate 250 more students. Core systems for this expansion are already in place.

Further, the building is oriented to make the best use of solar and wind patterns. Large windows in the classrooms and other spaces help to maximize light collection; 95 percent of the building has a direct line-of-sight to the outdoors. Water ponds serve as natural water treatment alternatives for runoff, and the building is located close to the existing roadway to reduce the amount of required new hard surface. At 75,000 square feet, the school is a typical size, but its two-story design reduces its footprint and environmental impact.

Additional technologies within the school include photocell and motion sensors to automatically turn off lamps in unoccupied rooms and those with enough natural daylight. Infrared-controlled reduced water-flow faucets and bathroom fixtures control water usage to help save an estimated 600,000 gallons of water per year.

Mechanical systems designed for long-term durability and savings

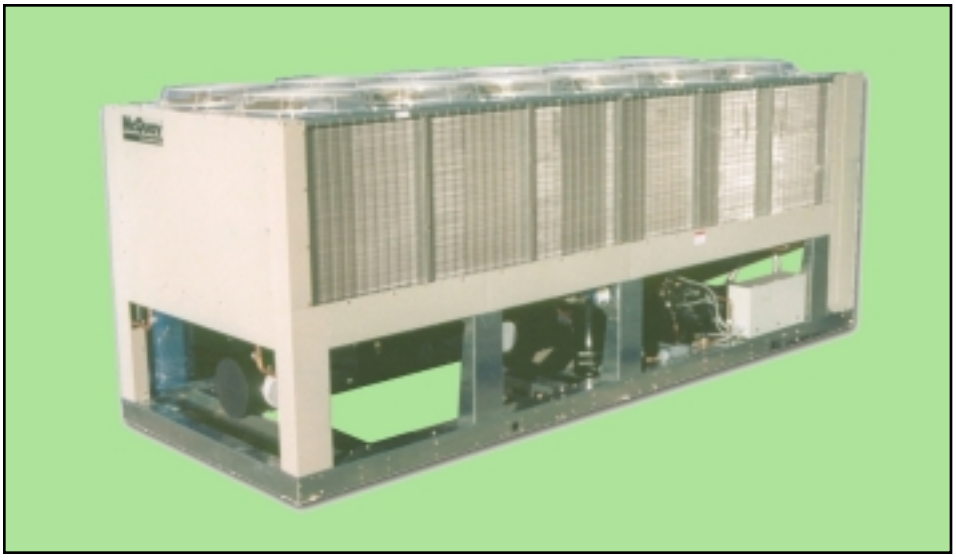
A single mechanical room houses a central system for the entire school. The McQuay 190-ton air-cooled screw compressor chiller features quieter operation than comparable chillers, as well as low energy consumption (part load EER up to 13.5 IPLV). Further energy control is delivered by Titus fan-powered VAV (variable air volume) boxes and Vulcan finned-tube radiation to each classroom or space.

The eight Vision air handlers are designed from a custom modular platform, meaning they could be specified to meet the school's exact requirements. In addition to the energy recovery wheels, the air handlers' efficient fan options and low-leak cabinets help to keep energy costs down.

The building's mechanical and electrical systems are all controlled by a Johnson Controls Metasys® building management system. McQuay Digital Ready™ controls on the air handling units, as well as MicroTech® controls on the chiller, allowed easy integration with the building automation system.

According to Bratlie, another reason for the school's success is not just that the mechanical systems are energy efficient; they are also "right-sized."

"Mechanical systems are often oversized," he said. "We saved money building Westwood because we put in mechanical equipment that was the size we needed. That savings allowed us to transfer costs from the mechanical equipment to the building envelope. We could beef up the insulation, windows and roof—which helped us build a more efficient building—at less cost than a typical building."



Elk River is one of the fastest-growing districts in the state. The district expects to enroll 400-500 new students each year for the next seven to 10 years. Two additional elementary schools are already being built, one of which will be submitted for LEED certification; the other will be built with the same sustainability approach.

Westwood Elementary's theme is migration. That's partly because the school is located next to the wildlife refuge, and students can walk from class to study migratory patterns of birds. The theme is reflected inside, too, through wildlife artwork on the school's floors, stairwells and walls. And perhaps there's another reason that migration is a fitting theme for Westwood. The school is "leading the flock" in sustainable development, a concept they have proven reduces costs and aids learning.

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