New Construction Gold: Platinum dreams

This energy company's headquarters is a healthy building that generates its own power and cools itself using an on-site lake.

By Dawn Reiss, Contributing Editor -- Consulting-Specifying Engineer, 12/1/2008

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When it comes to saving energy, Great River Energy wanted its headquarters to be at the forefront of conservation. Located in Maple Grove, Minn., Great River Energy is the second largest electric utility in the state, based on generating capacity, and the fifth largest generation and transmission cooperative in the United States in terms of assets. It is a not-for-profit cooperative that provides wholesale electricity to more than 1.7 million people through 28 member distribution cooperatives in Minnesota and Wisconsin with more than $2 billion in assets.

When Great River Energy approached Minneapolis-based **Dunham Assocs**., it wanted a fully electric building that was as efficient and as environmentally friendly as possible.

“We were charged right out of the gate with something that has never been done before,” said Dunham's Randy Olson, PE, LEED AP, who served as project manager. “They wanted to be an example to their customers that sustainability is possible.”

Great River Energy also wanted a “healthy building” that generated enough power so that occasionally it wouldn't need an additional power source.

Dunham teamed with the architectural design firm Perkins+Will and McGough Construction on the project.

The process

Dunham began considering alternative power sources, including wind turbines, geothermal systems, and solar panels. More than 10 years ago, Olson studied sustainable practices in the United Kingdom. It was during that stay that Dunham learned about thermal displacement ventilation, an energy-saving concept that is commonly used across Europe. In a traditional air system, overhead diffusers use cooler air than a displacement ventilation system, and then mix the air in the room to a certain temperature, typically 72 F.

“Ninety percent of buildings in America use this,” said Olson, who has worked at Dunham since 1996.

With thermal displacement ventilation, cool air circulates in the floor, supplying 64 F air instead of the traditional 55 F air, which eliminates the need for very cold water in the coolant coils. Because heat rises, it creates a naturally self-balancing system that provides as much heat as needed.

Olson likens the system to a sweaty runner: “If you ran 3 miles and I was standing next to you, a lot more heat would come off your head. As that happens, cooler air would naturally be attracted to the heat to balance everything.”

An 18-in. raised floor assists with airflow and allows enough space for current electrical distribution and for future technology advancements.

Two outside air units contain energy recovery wheels that recover latent and sensible energy from building relief and toilet exhaust. An air-to-air plate exchanger provides free cooling and free reheat of supply air during dehumidification mode, but allows bypass when not dehumidifying to reduce fan static pressure.

The beauty of the system is its ability to allow 30% more outside air to enter the building than required by code.

In traditional geothermal systems, vertical wells typically 200 ft deep are used to exchange energy with the earth. But Dunham noticed the 6-acre lake on Great River Energy's property and thought about using that instead. Even though the lake was large, Olson didn't know its depth or temperature. To see if the lake could be used as a possible energy source, Lonnie Vande Kamp, Dunham's engineer of record, paddled a canoe to the middle of it in mid-August. He dropped a depth finder and thermometer for preliminary readings.

“It wasn't a very scientific starting point,” Olson said with a laugh. “But we had to see what we were dealing with.”

After discovering the lake's depth of 32 ft, Dunham commissioned a lake study to create a month-by-month temperature profile. The study showed the lake remained near 39 F during the winter and peaked at 60 F during the summer. Dunham considered a ground loop system but ultimately opted to use the lake since the study showed it offered hundreds of hours of free cooling from October through June, and the overall lake temperature would change only by a half degree.

Two heat transfer methods were then considered: metallic heat exchangers and polyethylene tubing. Ultimately, Dunham used more than 30 miles of rugged-yet-flexible polyethylene tubing instead of metallic heat exchangers, which have a limited history and raise concerns about maintenance and long-term performance. Since the flexible coils don't have joints and fittings, the ¾-in. coils were placed on top of a pallet. Twelve-inch concrete cinder blocks were attached under the pallet to elevate the piping slightly above the bottom of the lake, minimizing the lake bottom contact area to less than 1,200 sq ft. The 39 heat exchanger bundles were inflated with air and floated in raft-like fashion to the middle of the lake. The coils were then slowly filled with water to submerge the bundle. Each bundle has its own isolation valve so if a leak occurs, air can be blown into the tube to surface the raft and make repairs.

Chilled water is generated using the core water with water-to-water heat pumps that is then distributed throughout the 180,000-sq-ft building to air handling units.

Photovoltaic panels were installed on part of the roof, and a 166-ft-tall wind turbine was installed on the property to generate 15% of the building's energy. Interior fixtures are controlled by photocells that sense the available daylight and automatically dim the fluorescent lighting to maintain a minimum of 30 foot candles in offices and conference rooms.

Machine room-less elevator systems were used because they require less space, do not contain any hydraulic fluid, and consume 40% less electricity than conventional elevators.

Low-flow plumbing fixtures, along with dual-flush toilets and a 20,000-gal cistern that captures rainwater from the roof, were also installed. Native plantings that use very little irrigation, including northern climate apple trees, were planted.

The biggest challenge

Perkins+Will had already participated in a prototype “healthy building” study for the American Lung Assn. in 2000 that tested how to optimize indoor environmental quality.

“The concepts from that study and other energy studies demonstrated that daylight harvesting would be a huge step in saving energy,” Olson said.

To do so meant orienting the building in an east-west fashion to capture the maximum amount of sun. To allow the daylight to penetrate, there had to be narrow floor plans to optimize the daylight harvesting. This meant creating a set of four- and three-story buildings that connected with center atriums. The vast amount of glass created unique HVAC challenges, especially during the afternoon hours when the sunlight penetrated so deep into the building that some interior zones had to be treated like exterior zones because the temperatures would dramatically fluctuate.

As a result, five extra temperature control zones had to be added. While most floor diffusers, 964 to be exact, were adjustable, 113 were motorized in areas that experienced extreme temperature changes.

The end result

Great River Energy is one of less than 100 buildings in the world—and the first in Minnesota—to achieve U.S. Green Building Council LEED Platinum status. The building, which earned 56 LEED points, four more than the Platinum requirement, uses 45% less energy than a comparable facility built to state code requirements and 89% less water than a similarly sized corporate campus. It features an in-lake geothermal HVAC system, in-floor displacement ventilation, daylight harvesting, 72 kW of on-site solar panels, and a 200-kW wind turbine. Often, the building produces an excess of power that is then put back on the grid. It officially opened in April 2008, less than two years after construction began.

"We did things that were never done before," Olson said. "Not anywhere in the world."

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