ACKNOWLEDGEMENTS

Architects: Bray Associates Architects, Inc., Sheboygan, Wisconsin
Energy consultant: CDH Energy Corporation, Evansville, Wisconsin
Energy management system: J&H Controls, Inc., Fond du Lac, Wisconsin
General contractor: C.D. Smith Construction, Fond du Lac, Wisconsin
HVAC engineer: Thelen Engineering and Associates, Oconomowoc, Wisconsin
Loop installers: Loopmasters International, Indianapolis, Indiana
Plumbing and HVAC contractor: J.F. Ahren and Company, Fond du Lac, Wisconsin

Site visits to heat pump installations in Iowa and Indiana were made possible with a grant from the Energy Center of Wisconsin. Wisconsin Focus on Energy sponsored a showcase of the Fond du Lac geothermal system in January, 2002. Alliant Energy sponsored the GeoThermal Van and arranged financing for energy efficiency improvements. Emissions study was sponsored by the Wisconsin Focus on Energy Pilot program. DSARE, (Demand-Side Application of Renewable Energy) provided a grant for engineering and economic analysis as well as assistance with pond-loop design and installation.

GEOTHERMAL WORKS FOR SCHOOLS

Geothermal technology is a cost-effective heating and cooling technology for schools and other large commercial facilities. If your school is interested in a geothermal system, consider sending representatives to tour the Fond du Lac facility. Contact Jim Gescheidle at 1.920.929.2887 for more information.

FOR MORE INFORMATION

cdhenergy.com

CDH Energy Corporation provides up-to-date technical information on the performance of the Fond du Lac system. View pond loop temperatures, pump speed and other data related to heat pump and ventilation system performance.

focusonenergy.com

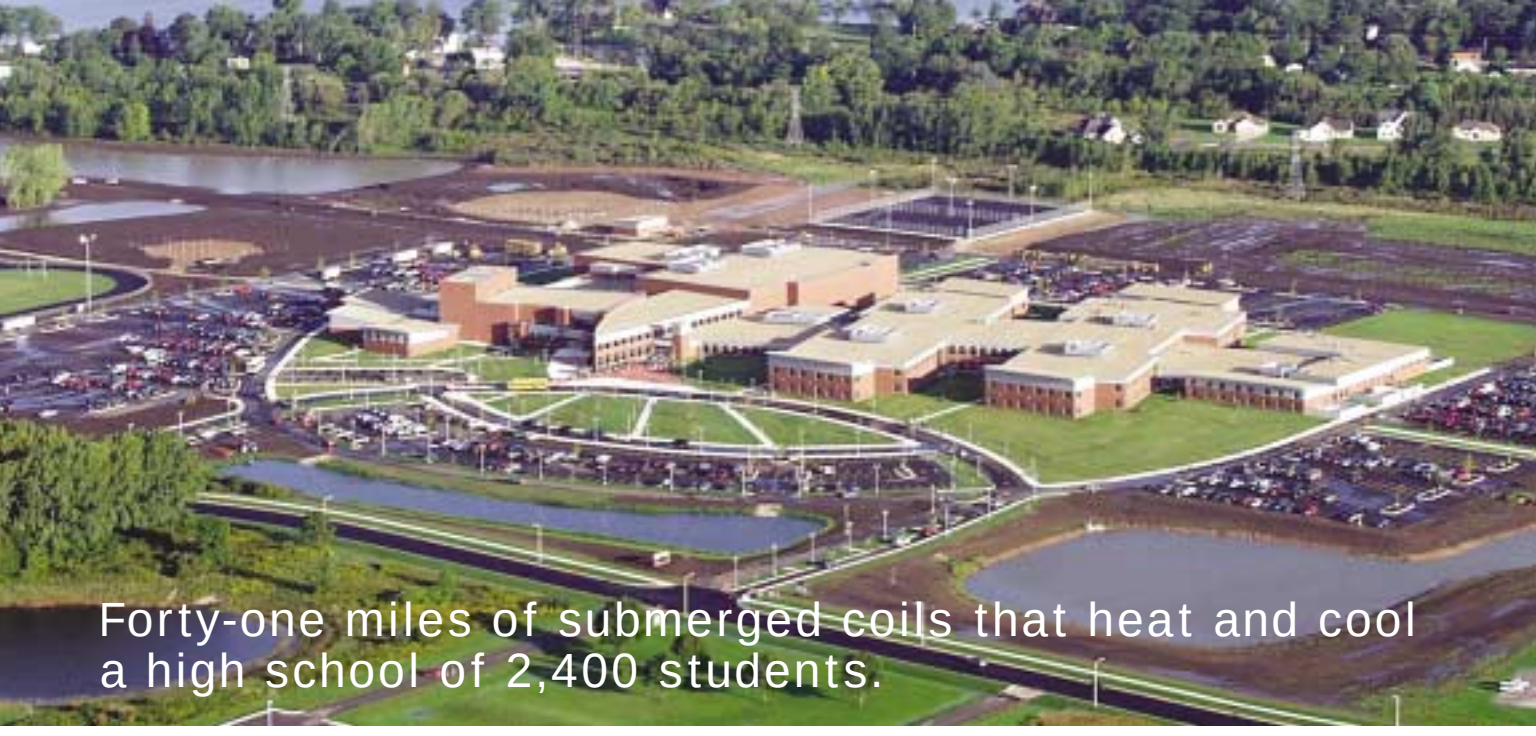
Focus on Energy is a public-private partnership offering energy information and services to energy utility customers throughout Wisconsin. The goals of this program are to encourage energy efficiency and use of renewable energy, enhance the environment, and ensure the future supply of energy for Wisconsin. For information about the Focus on Energy services and programs, call 1800.762.7077 or visit www.focusonenergy.com.

ALLIANT ENERGY

focus on energy
The power is within you.

ALLIANT ENERGY

focus on energy
The power is within you.



Forty-one miles of submerged coils that heat and cool a high school of 2,400 students.

In the fall of 2001, Fond du Lac High School opened its doors to students and began operation of the largest geothermal pond system in the United States. Using energy from the earth, geothermal technology provides a reliable and economical heating and cooling alternative for schools and other large commercial institutions.

As a result of its leadership, Fond du Lac High School enjoys $290,000 per year in avoided operating costs and is providing unparalleled comfort and reliability to its occupants. This brochure will take you on a tour of this innovative and environmentally friendly heating and cooling technology.

THE SCHOOL

Fond du Lac High School is a 400,000 square foot building with a capacity of 2,400 students. Using two, 6-acre ponds, the geothermal system heats and cools the building using well-established, reliable heat pump technology.

Science teachers originally brought the technology to the attention of Building and Grounds Supervisor Jim Gescheidle and the building contractors. In response, they decided to investigate the alternatives by visiting Alliant Energy's GeoThermal Van, which was visiting nearby Goodrich High School. This led to trips to Iowa and Indiana to visit geothermal systems that had been installed in commercial facilities.

"We came back very enthused about what geothermal technology could do for us," says Gescheidle. "Then we sat down with our contractors and they sharpened their pencils and we made it work."

Initially the community expressed some concern about the project because it was an unfamiliar technology. In response, the school district aired a video from the Wisconsin Geothermal Association about how geothermal heating and cooling was being used in schools. After learning about the benefits of the technology, concern was replaced by acceptance and the project went ahead as planned.

The school got financial assistance to help them investigate and install this unfamiliar but proven technology. For instance, the Wisconsin Focus on Energy Pilot program, DSARE (Demand-Side Application of Renewable Energy), provided a grant for engineering and economic analysis as well as assistance with pond loop design and installation. And Alliant Energy arranged financing that allowed the school to pay for improvements out of the resulting energy savings.

In addition to installing the innovative geothermal technology, Fond du Lac made other energy efficiency improvements to their new school, including low-emissivity windows, daylighting and a high efficiency lighting system.

THE BENEFITS

Fond du Lac High School has experienced numerous benefits since implementing heat pump technology—energy savings, comfort and maintenance savings chief among them.

Energy

- 20 percent energy savings compared to a traditional chiller/boiler VAV system
- Reduced peak demand charges due to more level seasonal energy usage

Environment

- 13 percent less production of CO_2
- Ponds available for student research

Comfort

- Individualized temperature control in each classroom (±2 degrees ºF)
- Plentiful fresh air from the dedicated ventilation system (twice code levels)
- Heat pumps are independent: Temperature adjustments in one area don't adversely affect comfort in other areas

Building savings

- Space for mechanicals reduced 50 percent—enough room for nine additional classrooms
- Less ductwork
- Floor-to-ceiling height reduced due to less ductwork (one course of cement block saved)

Reliability

- Heat pumps only require four filter changes per year
- Heat pumps are as reliable as refrigerators and last 20 to 25 years. Replacement can be gradual and only affects one room at a time
- Loop is sealed and comes with a 50-year warranty

THE SYSTEM

Pond

The energy source for the Fond du Lac High School geothermal system comes from two, 6-acre ponds. The ponds were originally intended to hold stormwater runoff and were built up an additional seven feet to bring them to a depth of 20 feet. A fluid-filled 41-mile loop consisting of 720 coils—the heat exchanger—covers the bottom of the ponds.

The loop moves heat from the pond into the school building during the heating season. During the cooling season, the loop moves heat from the building back into the ponds.

Thanks to nature, the ponds provide plenty of energy for heating and cooling. The geothermal system uses only a hundredth of the natural energy flow for heating and cooling. During normal system operation, the ponds deliver 39ºF water in the winter and 65ºF water in the summer.

Three factors help replenish the pond's energy. In the winter, a thick layer of ice insulates the pond from cold outdoor temperatures, while in the summer evaporation drives off excess heat. The ground stays at a near-constant temperature of 50ºF, which keeps the ponds at an even temperature.

1. Heat exchangers being assembled on the shore of the pond. Each coil provides one ton of heating and cooling capacity.

2. A heat exchanger being floated out to the middle of the pond. The unit will later be weighted and sunk.

3. "Pigtail" pipes coming from the individual heat exchangers join at the valve pit (lower left).

4. This box, called the valve pit, joins the heat exchanger pigtail pipes to the main feed lines for the school.

5. Header plumbing before being installed in valve pit.

6. Main feed lines coming to and from the school.

7. A heat pump in the classroom. The heat pump is located in a closet for easy maintenance.

In addition to supplying energy for heating and cooling, the ponds provide educational opportunities. Students have planted grasses along the shores, and thanks to a corporate grant, students are measuring the ponds' temperature and acidity. Two rowboats are available for research activities.

Loop

An insulated loop carries energy from the two ponds into the high school. An energy-efficient, variable-speed pump draws fluid through the loop. The speed of the pump varies as heat pumps in the classrooms turn on or off to maintain comfortable temperatures.

During the first year of operation the loop pump never exceeded 60 percent of full speed. This means that the heat pumps were never operating all at one time, indicating that system demand did not tax the units' capacity.

The loop is heat-fused at the joints to prevent leaks. To further ensure reliability, the loop is divided into independent circuits so that if one circuit fails it doesn't affect the entire loop. The loop fluid consists of non-toxic, food-grade propylene glycol, preventing freeze-ups.

Heat pumps

The mechanical heart of the Fond du Lac system is the 179 heat pumps that heat and cool the high school classrooms. Each classroom has its own heat pump, which is housed in a closet at ground level for easy maintenance.

The heat pump acts much like a refrigerator, extracting heat from the room and dumping it into the loop during the

summer. In the winter, it does the reverse, extracting heat from the loop to warm the classrooms.

The heat pumps only operate when needed to condition air. Each heat pump has its own thermostat, allowing occupants to adjust the temperature to individual comfort levels.

The heat pumps range in size from 0.8 to 15 tons. A typical 900-square-foot classroom uses a 2-ton unit. The only required maintenance is four filter changes per year.

Ventilation

Fresh air is constantly supplied to the classrooms by a dedicated system. Because only fresh air is supplied, the ductwork is smaller and less expensive than traditional systems that supply conditioned air to each room. The ventilation rate is 15 cfm per person, twice that required by code.

Heat is recovered from the exhaust air with a system of 26 heat-recovery wheels. The ventilation system preheats or precools outside air to bring it up to room temperature. Sixty-five to 75 percent of the exhaust heat is recovered, saving on heating and cooling costs.

Large spaces and auxiliary heating

A bank of 14 heat pumps in a central location preconditions ventilation air and supplies heating and cooling to the commons area, the auditorium and the fieldhouse. Four auxiliary boilers, each with a capacity of 1.6 million BTU/hr, are available to supply supplemental heating to common areas, vestibules and the loop if necessary. However, the backup boilers were never needed to heat the loop during the first year of operation.

SYSTEM FACTS AND FIGURES

Heat pumps and auxiliary heating equipment

- Water-to-air heat pumps (classrooms): 179
- Water-to-water heat pumps (common areas and ventilation air): 14
- Boilers (vestibules and backup heat): 4

Loop

- Heating and cooling capacity: 700 tons
- Composition: 41 miles of fused segments filled with food-grade antifreeze, 720 300-ft. coils in independent circuits joined to header plumbing
- Pumping: variable-speed drive

Ponds

- Number: 2
- Size: 6 acres, each
- Depth: 20 feet
- Delivers 39ºF water in the winter and 65ºF water in the summer

Ventilation

- Type: Dedicated system with heat-recovery
- Preconditioning equipment: 26 heat recovery wheels linked to 14 water-to-water heat pumps
- Ventilation rate: 15 cfm per person in class rooms (twice code levels), 7.5 cfm per person in common areas
- Heat recovery effectiveness: 65 to 75 percent

System cost

- Indoor HVAC equipment: $5.2 million
- Pond loop: $465,000
- Total cost: $12/ft^2