CASE STUDY

"Big Green" Ottoville Schools' geoexchange HVAC system sets a new standard for energy efficiency

Nicknamed "The Big Green" years ago for their successful athletics program and the color of their uniforms, Ottoville Local School District, Ohio, can boast of another big, green achievement. The new K-12 building, which opened in September 2003, features an energy-efficient geoexchange system for heating, ventilating and air conditioning (HVAC). This system, which relies on the earth's stable temperature for its energy-efficiency, not only saves the school district significant energy costs. It also influenced the standards of the Ohio School Facilities Commission and has convinced other schools to use similar HVAC systems that are efficient and cost-effective.

From the very first plans, school officials required one major upgrade over the old building. The new school had to be fully air conditioned. The older building was only partly air conditioned; plus, the boiler-steam heating system was costly to operate. Knowing that a bigger school and complete HVAC system had the potential to boost energy costs significantly, officials sought a system that would mitigate projected cost increases. They based their solution on a life-cycle cost analysis that estimated significant utility cost savings and a relatively short payback period compared to a conventional central air handling system.

The new geoexchange system relies on 88 McQuay water source heat pumps to deliver heating or cooling to individual classrooms or other spaces. "It's a cost effective solution particularly for schools, where spaces are not in constant use," said Jeff Stringham, senior mechanical engineer, JDRM Engineering, Inc. "Water source heat pumps can deliver either heating or cooling to only those classrooms that are in use. The advantage is that you don't have to condition the entire school during periods of partial occupancy."

Digging deep for energy savings

Currently, Ottoville School has a student body of 590 in grades K-12, with a capacity for 850 students. When the small community in northwest Ohio voted to fund 17 percent of the new school's cost via a bond levy, their investment paid for a one-story, 131,000 square foot facility with over 50 classrooms, a media center, multi-purpose "auditeria," and two gymnasiums. It also paid for one of the most energy-efficient HVAC systems available at a cost comparable to a traditional system.

Geoexchange systems can reduce energy consumption– and corresponding emissions – by over 40 percent compared to electric resistance heating and standard air-conditioning equipment. Their

simplicity further reduces costs. Geoexchange systems do not require chillers, cooling towers, or boilers, and the closed loop water circulating system requires very little maintenance.

Ground water temperatures remain stable at about 50 degrees F year around, greatly reducing the energy required for heating or cooling. Plastic polyethylene supply/return tubes within 184 wells, each 305 feet deep, circulate and deliver the fluid needed to heat and cool the school. During cold months, heat is transferred from the ground via the closed loop circulating system to individual McQuay water source heat pumps. During warm months, heat is transferred out of the school and absorbed into the ground.

Most of the McQuay water source heat pumps are ceiling-mounted units, varying from one to six tons, which serve classrooms on an “as needed” basis. Larger vertical floor-mounted units serve the gymnasiums, auditeria and media center. Each space has a separate thermostat; direct digital controls manage the entire system.

Life-cycle analysis sways the Commission

Despite the energy cost-saving advantages of a geoexchange system, it was not one of the four HVAC systems recommended by the Ohio School Facilities Commission (OSFC), which provides funding, management oversight and technical assistance for the construction and renovation of all of Ohio's schools. Traditionally, the OSFC only approved systems with 1) central station air handlers with heat recovery and VAV (variable air volume) terminals; 2) central station air handlers with heat recovery and fan powered terminal units; 3) dual duct systems; or 4) heat pumps utilizing boilers and cooling towers.

“We conducted a life-cycle cost analysis, and the results convinced the Commission to give us a variance to build the geoexchange system,” said Stringham. “The analysis estimated that the new school's geothermal system would save $15,000 per year in utility costs compared to a conventional air handling system. The utility costs are primarily for propane and electricity, as natural gas was not available in the area at the time of the analysis.” Stringham added that the relatively short four-year payback period also helped win the variance. “At the time, we estimated that the additional $60,000 for the system, primarily due to the additional cost required to drill the well field, would be paid off in four years by the utility cost savings,” said Stringham. “We are currently estimating the system, including the well field, to be approximately the same cost as a conventional system.”

Actual cost savings for operating the system far exceed expectations. According to Mike Ruen, treasurer and chief financial officer with the Ottoville Local School District, the school district paid $0.55 per square foot in utility costs (electricity and propane gas) during the 2005-2006 school year, or approximately $75,000. In comparison, OSFC estimates that an Ohio school district can expect to pay between $1.50 and $1.75 per square foot in utility costs for a new building that does not use geoexchange systems. “In other words, it is possible that we are saving in excess of $150,000 per year,” said Ruen.

Ruen also compares the costs of the new building with the previous building, and the original goal of keeping costs down. “Our complete utility costs (electric, propane gas, water and sewage) in the second full year in the new building were 10 percent greater than the last year in the old building – and we're working with a building that's 33 percent larger than the older building.”

He added that a more accurate comparison would be to compare Ottoville with a similar, new building in the area. For example, from March, 2005 through February, 2006, Ottoville Schools spent $74,500 for electricity and about $1,900 for propane, which is also used to heat an adjacent bus garage. By comparison, a smaller school in the Ottoville area, which doesn't use a geoexchange system, spent $100,000 for electricity and $77,000 for propane during the same period.

Setting a new standard pays off for the Big Green

Ottoville Schools did more than mitigate energy cost increases with the new, larger school. Since opening its doors, Ottoville Schools' energy-efficient HVAC system is recommended by the OSFC and is an example for other schools looking for quiet, energy efficient systems.

“It's really the best of both worlds now,” said Tim Kimmet, maintenance manager at Ottoville Schools. “The heat pumps are quiet, so we don't get complaints from the teachers because of mechanical noise, and we're saving money because we're using a geoexchange system.”

Kimmet estimates he gives at least one tour every couple of weeks to representatives from other school districts who want to see first-hand how Ottoville is saving so much on energy costs. A recent symposium, sponsored by Ohio electric co-operatives, brought 200 school administrators, engineers and architects from across the state to learn about the advantages of geoexchange systems. “From experience, we know that geothermal systems are cheaper to maintain and operate, and we don't have to worry about the seasonal spikes in energy costs. We're happy to be leading the way.” It's just one more victory for the Ottoville Big Green.