The Future of Space Conditioning Today 2011 Vol. 8, No. 1

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Saginaw Valley State University Utilizes Aqua Thermal System

New Hampshire School Sets Green Example

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Geo Outlook is published quarterly by Oklahoma State University and the International Ground Source Heat Pump Association (IGSHPA), 374 Cordell South, Stillwater OK 74078-8018. Send questions, story ideas, photos and comments to igshpa@okstate.edu, Geo Outlook, c/o IGSHPA, or call 800-626-4747. Visit our Web site at www.igshpa.okstate.edu.

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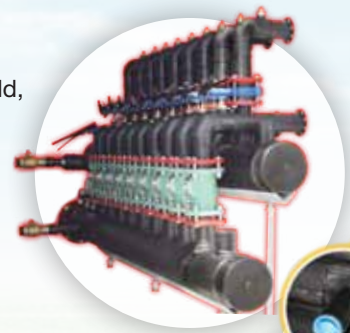

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DIRECTORS' FORUM

NOTES FROM IGSHPA

By Jim Bose

Executive Director:
International Ground Source Heat Pump Association

I've had the pleasure of working with many successful professionals over the years, and have benefited from their creative approach to applying geothermal heating and cooling in schools. Numerous industry leaders have generously provided examples that demonstrate ways of providing competitively priced, high efficiency systems that have essentially the same first cost as conventional 4-pipe systems. They have been able to accomplish this in spite of customer reluctance to accept what they consider to be new ideas.

Many designs take on characteristics of conventional cooling tower/boiler systems and all of their associated equipment with a ground heat exchanger substituted for heat rejection and energy source. Newer designs weigh heavily on multiple modular systems which allow commissioning to become routine, load matched pumping to individual heat pump units to minimize power usage. To reduce corrosion all plastic piping systems are used in both the ground heat exchanger and indoor piping. Multiple ground heat exchanger fields are designed to minimize thermal build up resulting from seasonal load imbalances.

At the IGSHPA Annual Conference in Denver, Don Penn discussed net zero schools and the approach taken to enter this market. He made a compelling argument. But more important than the argument, is the successful project acceptance and subsequent building construction.

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Geothermal Heat Pump Systems are emerging as one of the leading topics of discussions in the HVAC Industry. From Engineers, Contractors and Manufacturer circles to Facility and Building Operating personnel GHPS are being discussed and evaluated. Approaching 20 years in designing these systems we have seen a marked change in interest in the last 24 months. We have always breached the discussion with new or potential clients to educate them on the systems and the advantages; we are now seeing clients that previously declined now installing GHPS in their facilities and being strong advocates of the technology.

With the advent of LEED, Net Zero and other high performance Building models, GHPS are becoming more popular in these circles as well. GHPS are the foundational renewable resource of most of these higher performing buildings and are a great companion to Solar PV or Wind Energy systems. Paybacks on Solar PV in particular, can be cut in half when coupled with GHPS as the GHPS provides a significant energy avoidance thus minimizing the required investment in the Solar. When evaluated on a 20-year life cycle cost, the "system" payback (being the combination of Solar PV and GHPS) can be as few as 5 years and up to 11 years, depending on available incentives. Finding the "sweet spot" where the sizing of the Solar PV array and the GHPS meet yields an impressive Renewable Solution.

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COVER STORY

Photo courtesy of Tim Inman SYSU

SAGINAW VALLEY STATE UNIVERSITY UTILIZES AQUA THERMAL SYSTEM

BY DAVOD NEMATPOUR

Loops for the largest geothermal system in the state of Michigan are located under water on the campus of Saginaw Valley State University (SVSU). As the sustainability movement sweeps across the nation increasing numbers of people grow concerned with their carbon footprint, and businesses, organizations and higher education facilities struggle to meet the demands of their growing eco-conscious public. Facility managers, architects, contractors and engineers are also finding that the proven energy savings from geothermal technology has appeal in many different applications.

A picture perfect installation is evident in the mechanical area for Saginaw Valley State University's new geothermal system.

(Photo courtesy of Tim Inman-SVSU.)

Universities like SVSU are looking to decrease their operation costs while appealing to the environmental wants of their students and faculties. When SVSU planned construction of their Human and Health Services building, they wanted to cater to their university stakeholders' desire to utilize green design. Even more than that, they wanted to find a way to make it affordable to meet that desire and increase the school's energy sustainability stance.

SVSU had already taken steps within the last couple of years to decrease their carbon footprint. According to Steve Hocquard, SVSU Assistant Vice President of campus facilities, SVSU already has a lower per-square-foot BTU and electricity use on campus than many other similar size universities. To further decrease their carbon footprint, SVSU decided to install geothermal loops into retention ponds already on its campus and use that system to heat and cool their new Health and Human Services building.

The retention ponds on the SVSU campus have dual uses. While they are used to heat and cool the 95,000 square feet Health and Human Services building, they are also used for two other reasons.

"We have a big county drain ditch that runs through campus. And so in order to build parking lots and buildings we have to have a detention area," Hocquard said. "It was needed to bring storm runoff that was coming onto campus and then to have a place for it to go while it was waiting to dribble off downstream at a slower rate."

Hocquard also says that the retention ponds have been used to feed the on-campus lawn sprinkler system for the past two years. The ponds are fed by groundwater so this has enabled the university to take its sprinkler system off the city water system, thus saving money on their water bill.

Wayne Kerbelis of Peter Basso Associates, mechanical engineer for the project, says that most common geothermal heat pump systems he is familiar with use water to air heat for forced air systems. At SVSU water-to-water heat pump systems were utilized. The SVSU geothermal system includes 10 water-to-water modular heat pumps connected together. One end of the heat pump system provides chilled water for cooling the building, and the other end provides hot water heating. The 10 heat pumps can reverse cycle and can either heat or cool, depending on the load of the building. Hot water and chilled water from the heat pumps is supplied by variable flow to central variable volume air handling units. The radiant under floor heating system provides superior comfort control.

In all the system provides radiant floor heating, snowmelt, hot water heating to central variable volume air handling units, and heat to generate domestic hot water. The SVSU system also takes up less space than other systems and it is packaged in one spot. For a project this size to use a water-to-air heat pump, Kerbelis said it would need a heat pump virtually for every space heated or cooled in the building. Housing all of those heat pumps could present real space issues.

For the SVSU project, all 10 heat pumps that cool and heat the entire building, each sized a little bigger than a refrigerator, are housed in a central location. Climacool Inc. manufactured the project's water-to-water heat pumps. Bell and Gossett manufactured the water distribution pumps used for the SVSU system.

At SVSU, 28 skids of 14 coils each were sunk in the pond to provide geoexchange source water to the water-to-water heat pumps.

In the late fall, Kerbelis and others had to closely monitor the system and tune it in order to prevent freezing on the outside surface of the coils. Freezing could cause the coils to float to the top of the pond and become damaged.

Kerbelis said this is a concern for a week or two before the yearly ice caps form. Without the ice caps in cold weather, pond temperatures would range around 35 degrees top to bottom. With the ice caps the pond temperature stays at a steady 39 to 40 degree temperature. As the pond gets colder, the heat pump system has the potential to draw more heat out of the water and thus reject

Views of the SVSU aquathermal field during construction and installation

(Photos courtesy of Kerbelis.)

colder water (below 32 degrees F) back to the coils in the pond. This might cause the water around the coils to freeze, which would then allow them to float to the surface and risk damage to the system. But once the temperature of the pond is stabilized and the ice caps form, Kerbelis says likelihood of the freeze ups around the coils lessens and his concerns about the skids floating up is also minimized.

While SVSU was looking to save money from the energy savings of the geothermal system, they also were able to save money from the installation of the system itself.

"One thing we did get was a product donation from the Dow Chemical company," said J.J. Boehm, SVSU director of media and communications. "They are a Fortune 50 company that is headquartered in Midland, about 20 miles away, and they gave us 10,000 gallons of a product called Dow Frost. That's the glycol product in the tubing that is submerged in the retention pond." Dow's product donation helped with SVSU's overall cost.

The total building project was $28 million, including the geothermal system. Construction cost of the heat pump system was slightly more than the cost of a traditional boiler and chiller system, according to an information sheet provided by Peter Basso Associates Inc. The simple payback on the additional cost on investments was stated at approximately four years.

The geothermal system, while installed in a new part of the campus, has the added ability to benefit the whole campus, Boehm says.

"Up here in the snow bank area we find it nice to have indoor connections during the winter, so we attach quite a few of our buildings together." Boehm said. The new building that the geo-thermal system is in is attached to the older Regional Education Building, which in turn is connected to the university's campus wide chiller loop.

"What we have done is double the size of the heat pump system and the aqua thermal pond piping system for what is needed for just that building," Hocquard said. "We are finishing up the connection for our chiller loop so that the savings from this system not only enables savings for that building, but also handles other buildings that are attached." With this connection the university can also use the heat pump system in the wintertime to cool the campus's main computer lab, he said.

"Instead of running the chillers and that sort of thing and having troubles with that, we can run the heat pumps and it actually helps, cause if we are cooling something over here, it is helping us cool something over there," Hocquard said.

With both the chiller loops and geothermal systems working together to heat and cool the buildings, the university is expecting a return on investment of the price of the system in four years.

"I think, its set up on a four-year pay back on the difference. The difference to construct the first 350 tons for this system, and the difference to install aqua thermal versus the traditional system was about $350,000 extra for the aqua thermal system. The payback was under four years without counting the assistance of helping the regional center. The dollar amount is 37 percent, close to $100,000 a year, maybe less." Hocquard said.

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New Hampshire School Sets Green Example

By Kendra Mann

Deborah and Denis Gleeson had an idea for a special school where teaching could focus on nature and students could receive hands-on experiences to help them incorporate environmental science into all of their studies. Their idea has turned into a campus that offers childcare, pre-school programs and a private academy.

Second Nature Academy, in Nashua, N.H., is the first school in New Hampshire to become LEED® certified and the first non-residential building to receive LEED® Platinum certification.

A view of the mechanical area at the school shows heat pump installation area.

The sustainable school is located on 22 acres of farmland and forest complete with trails, wetlands, a bog and a pond, according to The Nature of Things website. The school uses a green curriculum to teach pre-K through grade six. It was important to the Gleesons that the school itself, located on a sustainable working farm, be able to support the curriculum used in the classrooms.

"When we first started building this, we gathered a group of experts together and we looked at a lot of different systems," Denis Gleeson said. "The Nashua Green Team was doing tours of buildings with green components and we went on a tour of a building with a geothermal system installed." Gary Maedl, president of Virstar Geothermal Energy HVAC Group, located in Hollis, N.H., led that tour and explained the system in greater detail to the Gleesons. "That is when we looked into doing geothermal on the school," Denis Gleeson said.

An open loop standing column geothermal heat pump system was installed in the first school building. A shroud was placed at the bottom of the well so all the water from the bottom would return to the top.

Roger Skillings, of Skillings & Sons Inc., located in Amherst, N.H., was responsible for drilling for all three geothermal systems on the property. The school utilizes two systems and the Gleeson's home uses a third.

The school's well is 1,200 feet deep with 4-inch PVC pipes and runs a 12-ton water-to-water heat pump.

"It has a heating capacity ranging from approximately 138 KBtu per hour with the desuperheater running to 158 KBtu per hour with the desuperheater not running. The cooling capacity is approximately 147 KBtu per hour," says Gary Maedl, president of Virstar Geothermal Energy HVAC Group, located in Hollis, N.H.

The school needed more than 140,000 BTUs per hour for cooling, Maedl said. One of the challenges he faced was finding a heat recovery ventilation system that could operate under harsh winter conditions without having to go into defrost mode.

"Most commercial HRV units have an efficiency rating in the 70 percent to 75 percent range. The exception is the Model 300 DDD and 500 DDD from Aldes, a German based company, which can have as high as a 95 percent efficiency but require a defrost at outside air temperatures under 20°F. However, we needed two HRVs with 1,200 CFM each that could operate down to at least 0°F without defrost and, ideally, have an efficiency of at least 90 percent. This was not available commercially that we could find," Maedl said.

Maedl read about a company in Canada that was producing a heat

Workers from New Energy Works Timberframers use a crane to position heavy framework during construction.

recovery ventilator (HRV) core with claims it could operate down to minus 20°F without defrosting. He bought the cores and designed and manufactured two custom 1,250 CFM HRV units. Using a dual core design in combination with high efficiency ebm-papst Inc. variable frequency drive (VFD) fans at a 1,250 CFM output, energy consumption was 108 watts, he says.

After putting the HRV core system into use, he measured an average of 90 percent efficiency at approximately 25°F outside air temperature.

Maedl also used Wilo pumps, special pumps from Germany that consume roughly one- tenth to one-fourth the energy of a normal pump.

The geothermal heat pump system, in combination with the high-efficiency fan coils and HRVs and the use of high-efficiency Wilo pumps are supported with other energy saving measures. Building construction includes R42 insulation in roof and walls, R20 slab insulation and triple-pane windows. Radiant floor heating is also used. Those efforts resulted in a building that was certified for energy efficiency by the Jordan Institute of Concord, N.H.

The Gleesons, Green Building Construction Group, KW Management, New Energy Works Timberframers, Virstar Geothermal Energy and the Jordan Institute planned,

Classrooms are open and inviting and incorporate bright primary colors and as much daylighting as possible.

coordinated and documented the construction of the school buildings. Those efforts were vital to the LEED® process as well.

Maedl says the Jordan certification shows total energy consumption for the first year was less than $0.45 per square foot. He says the building is an excellent example of how cost effective geothermal can be when it is designed with super efficient pumps, fans and fresh air ventilation systems. Jordan Institute's Paul Leveille, says in a March 16, 2010, press release announcing the school's LEED® certification, "Second Nature Academy's new school building is the most efficient building we have analyzed to date."

"Typical well pumps for continuous flow variable-speed pumping, will consume roughly $1,200 a year for a 4-ton system. Just to do water pumping for the geothermal system, the Wilo will only consume $340," Maedl said.

Maedl installed four of his own high efficiency fan coils, 3-tons each, on the first floor. Then he installed two Hydron Modules, at 4-tons each, with special variable speed blowers on the second floor.

Mark Weissflog, owner of KW Management Inc., located in Nashua, N.H., installed a 9.6 KW solar electric system, used to produce 13,100 Kwhr per year. Weissflog says it provides about half of the energy used for the first school building.

The construction of the sustainable school started when Debbie Gleeson, president of 2nd Nature Academy, decided to do her master's degree project on how to start a school. She also said she and Denis were both at turning points in their careers and were looking for something to do. The timing was right, she said.

"I also taught at other schools and saw things that I thought could be done better," Debbie Gleeson said.

Second Nature Academy is built on a 1970s contemporary ranch, which in its time had sustainable features such as solar heating.

"We renovated the house, giving it a farm house look and feel. We added a post and beam addition, installed a geothermal open loop heating and cooling system, insulated the structure with closed cell foam, installed a solar system and earned an ENERGY STAR® rating on the structure," Denis Gleeson, owner of the 2nd Nature of Things, said.

The building of the school was completed in phases. The construction of the first school building started in April 2008, and was completed in January 2009. The second school building was completed in October of 2010, Denis Gleeson said. The first building is 4,800 square feet and the second building is 10,600 square feet.

"Working with motivated owners who understood the true meaning of sustainability along with a very quick start to finish schedule made this project unique," Weissflog said.

Just recently the school was relocated to another building on the same land. The original school building is now used for administrative offices, an assembly hall and a science center. The second building, which is now the actual school, uses a closed loop geothermal heat pump system.

"Using an open loop geothermal system in the first building resulted in a 70 percent savings on cost. The second building, which has only been open for a few months is saving about 50 percent of the price we were paying before," Denis Gleeson said.

Geothermal systems were chosen for both buildings because the owners saw the cost savings, energy savings and comfort they provided.

"We didn't want the building to use fossil fuels. Also, we teach environmentalism and stewardship of the earth to the children. If we are teaching that to the kids we feel we need to practice what we preach," Debbie Gleeson said.

"Sixty percent of energy is used through the PV system and 40 percent is through wind power," Denis Gleeson said.

In addition, the owners bought renewable energy credits from wind power. No fossil fuels are used, eliminating potential indoor air quality concern and climate change potential, both important to the Gleesons and their school's mission.

The Gleesons and several employees were very active in the school's construction, insulating the slab and installing the radiant floor loops to the manifold, he said. Construction of the second building did not take as long because they knew a little bit more about how to construct the building and what they wanted.

Their site abuts 350 acres of conservation land owned and maintained by the Dunstable Rural Land Trust. Together, their goal is to teach the children the importance of preserving the land and its natural resources, according to the Nature of Things website at www.naturesacademy.com.

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After getting the first building finished, the Gleeson's and several of their employees found it was not nearly as difficult to do their part on the larger second structure. Their efforts help them to better understand and teach the school's green curriculum. They also have a first-hand understanding of what makes their school special enough to gain the coveted LEED® Platinum certification.

(All photos courtesy of Deborah and Denis Gleeson.)

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Schools Are Still Growing Market For GHP Technologies

By Janet F. Reeder

What Makes a School Great? –TIME magazine posed this question on the cover of one of their recent magazines. In that September 20, 2010 issue, focused on education in this country, the magazine article examines teacher quality and highlights a number of other areas in which our nation's public schools continue to face growing economic issues due to funding shortfalls.

Schools using ground source heat pumps are a growing segment of the industry, and have a good outlook for 2011. As information becomes increasingly more available about geothermal heat pump (GHP) – technology and the very real benefits it can provide to schools both planning new construction and looking to remodel or retrofit systems, adoption of the technology will continue to increase.

Don Penn of IEG Limited, Lisa Meline of Meline Engineering and Kirk Mescher of CM Engineering all have experience with school design work and geothermal systems. Each of them shared comments and information about how school districts and decision makers can get the right information to consider making the change to ground source systems for their schools.

Units in the mechanical area at Maus Middle School in Frisco, Texas, speak to the size of the system the school needed, and are easily accessible for inspection and maintenance. (Photo by Image Engineering Group, Ltd., Grapevine, Texas.)

All three said they would refer school board members, administrators or other professionals to their firms' websites and to the IGSHPA website www.igshpa.okstate.edu for good content and resources. All three also mentioned school districts and projects they would refer anyone interested in schools and geothermal to for verifiable information and contacts.

"We have slide video clips on our website explaining the system we use, budget information and audited results at www.cmeng.com," Mescher said. Lisa Meline has recently updated her site to make it more educational and informative at meline.com. Penn's website at www.iegltd.com likewise has a wealth of studies and real cost and energy data.

"Anyone of our school district clients with geothermal, but particularly Frisco ISD here in North Texas would be good to refer them to," Penn said. "They have almost 20 geo campuses all done within the last seven years. And they have an inventory of the similar prototype campuses done with other mechanical system types all within a few years of each other," Penn said.

"We have worked with a number of school districts," Mescher said. "I would refer them to McLean County Unit District #5, in Bloomington, Illinois. They have long operating systems with energy and maintenance cost records." Mescher added, "All of the schools we have retrofitted in this district have achieved energy star scores in excess of 90." He says they are all very simple designs with outstanding results. "All had installation cost under $22 per square foot, with many under $18 per square foot," Mescher says. "No fluid cooler assistance or boilers were used either."

Addressing Obstacles to Geo in Schools

One of the most apparent obstacles for schools adopting geothermal technology involves first cost. Mescher says that "tunnel vision" about first cost can also often become a factor. He adds that complicated designs with excessive first costs are at times the real barrier.

"Designers who follow a close prescriptive process where they properly evaluate the building energy requirements,

surrounding geology and drilling conditions and design a system that meets the performance requirements of the owner, have a great opportunity to install cost effective systems," Mescher says. "A proper presentation of the economic facts without bloating the installation budget generally results in an informed consumer who understands the investment and the benefits associated with the system."

Meline also mentions poor design and bad installations as other notable barriers for schools.

"In my part of the country there are certain engineering firms who are used over and over again by the school districts to do their designs," Meline said. "They have a relationship with the district or the facilities folks, but they don't know how to design geothermal. If the district can convince their engineers to design a geothermal system for their school, they usually approach it like a boiler-chiller project." Meline says the process can result in a poor design getting put out to bid and a low bidder getting the job.

"The engineer doesn't know how to set the right criteria for the contractors to bid the job, like requiring IGSHPA certification and that the technicians must be certified to fuse pipe. Then the inexperienced contractor realizes they are in over their heads. They either badmouth the technology and try to change the system design, or they start trying to reduce the costs by designing to the 200 ft/ton residential rule-of-thumb that they found somewhere on the internet," she said. "And then they wonder why geothermal doesn't work."

Penn says lack of education and information are also obstacles in adoption of the technology. "School district maintenance and operating personnel not being familiar with the systems shows a lack of education," he said. "The engineering community as a whole has not been receptive to geo, thus directing owners away, for again a lack of education," Penn said.

"As with any HVAC system or technology," Penn adds, "there are systems out there that have either been designed or installed improperly or both. Some circles judge too quickly without investigating the issue thoroughly." Penn also mentions high drilling costs in certain areas of the country as another possible barrier to adoption of the technology by schools.

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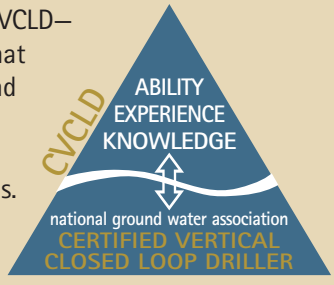

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Individual gauges and controls allow for monitoring and servicing of the geothermal system used at Maus Middle School, in Frisco, Texas.
(Photo by Image Engineering Group, Ltd., Grapevine, Texas.)

Advantages of Geothermal for Schools

Penn enumerates a long list of benefits schools can see from adopting geothermal systems. Efficiency is at the top of his list. "Energy costs are 30 percent to 50 percent less than other systems, and schools typically have the property around them to use geothermal," he says. "Maintenance costs are 25 percent to 60 percent less than other systems. And maintenance does not usually require a specialized technician."

"If the systems are properly sized and good engineering practices are used," Meline says, "the operating costs are reduced and the money the school saves each month can now be spent on other things like teacher's salaries, field trips and school supplies."

Mescher finds advantages for the schools in the simplicity and the long-term solution geothermal offers. "The cost of the well field is an asset which the school has for the duration of the building. No other mechanical system has an integral component with a virtually infinite economic life." He adds, "Flatly stated, the economic life and life cycle cost for geoexchange is unparalleled."

Penn says the systems also offer advantages in minimizing vandalism of systems, excluding damage from weather events like hail and wind, and fewer and smaller roof penetrations that help maximize envelope integrity.

"It is simply the right thing to do for the community, the district and future generations. It is a sustainable solution," Penn said.

He is also a big fan, he says, of zone systems and extols their advantages.

"Utilizing demand pumping in conjunction with individual classroom and zone units provides the maximum efficiency while providing the greatest user flexibility and comfort," Penn said. "There are other methods, but I feel this is the best solution and I have the data to support it."

Earlier Reports and Studies

Oak Ridge National Laboratory and Lincoln Electric System have documented Nebraska's Lincoln School District early adoption and involvement with GHP systems in a cooperative study in 1998. Lincoln's incorporation of geothermal heat pumps in four elementary schools–Campbell, Cavett, Maxey and Roper followed a comparison of estimated life-cycle costs for five alternative system designs that included: ground source heat pumps, water-source heat pumps, air-cooled variable air volume, water-cooled variable air volume and gas-fired absorption cooling.

The study used multiple sources of information including utility account data and 1996 and 1997 billing records, facility reports and equipment inventories from the Lincoln Public Schools to compare the energy use of the four Lincoln GHP schools with the other schools in the district. The physical characteristic such as floor space, age, expansions and improvements along with the type and age of HVAC system was also included.

Studying energy use of the GHP schools in comparison to the other 50 schools data was collected for revealed that the GHP schools came in as "exceptionally low energy users," according to the Geothermal Heat Pumps in K-12 Schools, Oak Ridge Report.

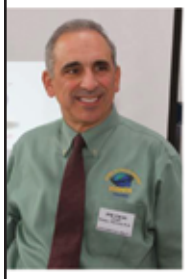
Saving energy costs was a definite plus for the Lincoln Schools, but the study also examined maintenance costs of GHP and other system types and life cycle cost of the GHP systems. Calculations arrived at through the study show that GHPs are the most cost-effective of the options examined for space conditioning of the schools. Figures revealed a 15 percent lower life cycle cost for GHP than for the next most economical system. Maintenance study results also showed that the four schools heated and cooled with vertical-bore GHPs had the lowest average annual repair, service and corrective maintenance costs per square foot in comparison to

the other 16 schools using three other conventional HVAC system types, when looking at total cooled space.

Site-monitored data from the Lincoln study was used to establish or ascertain the accuracy and consistency of commercially available software for the design of vertical borehole heat exchangers. The monitoring provided a body of information to assist engineers and designers efforts to establish life cycle costs that also promote the GHP technology.

The Department of Energy (DOE) has implemented other programs to aide schools in becoming greener and more energy efficient. The EnergySmart Schools program is a partnership offered through DOE's Energy Efficiency and Renewable Energy Building Technologies Program. Initiative goals are to upgrade new schools to 50 percent higher than current energy codes and to improve existing schools by 30 percent.

The EnergySmart Schools program also offers a wealth of information on preventative operations and maintenance with strategic retrofitting of existing buildings, quick wins and long-term facility management strategies that pay for them selves and save energy.



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In Maryland, the High Performance Buildings Act of 2008, requires all new schools for which the architectural/engineering proposal is issued after July 1, 2009 must achieve a rating of LEED Silver or equivalent from a nationally recognized accreditation entity.

An initiative, or actually a culture of innovation in school design and construction, has emerged in efforts known as sustainable design, green architecture and high performance schools. In an annual report titled the High Performance Building Initiative in Maryland Public Schools, the benefits

and attractiveness of high performance schools to local governments are spelled out.

The report also states that while the estimated pay back period for a geothermal ground-source heat pump system has been considered to be about seven years, "first costs for geothermal systems have dropped so rapidly in the lower Eastern Shore since 2006 that savings are reported to accrue as soon as the systems are put into operation." That cost change appears to involve contractors' increasing familiarity with the systems more than technology changes, the report also adds.

DOE hopes to see high-performance school building that will save $2 billion annually in energy costs, while also providing healthier schools with better lighting, air quality and temperature control. Current public school expenditure on energy is more than $8 billion annually, according to DOE.

Numerous other programs, initiatives and efforts by state and local educational groups are also moving toward adoption of energy efficiency in schools. In North Carolina, the Department of Public Instruction, in response to earlier state legislation regarding school design and construction, in March 2009, approved the North Carolina Public Schools Energy Guidelines For K-12 Public Schools, with the intent of providing direction for economical and energy-efficient school design, while maintaining local control of that process.

In Connecticut, the Connecticut Green Building Council launched their High Performance Schools Initiative in 2005, setting four tasks. The goals included conducting stakeholder process, increasing educational outreach efforts, inventorying current energy efficiency of all state public schools, and promoting high performance energy efficiency building standards through legislative action.

After collecting and evaluating energy use and cost data from a sample of 35 percent of Connecticut Schools and comparing it demographically to the larger picture of the state's schools, and then the national picture, Connecticut's schools did not stack up well. Like many other areas of the country, more than 90 percent of Connecticut's schools were built before 1978. And of those, 68 percent were put in service between 1950 and 1978.

ENERGY STAR, a comprehensive joint program of DOE and Environmental Protection Agency (EPA), designed to educate and facilitate the use of energy efficient products and practices, has also had large success with public schools.

Having enough room to drill a large well field is integral to the design for large school projects like this one for Maus Middle School, in Frisco, Texas. (Photo by Image Engineering Group, Ltd., Grapevine, Texas.)

Originally introduced in 1992, as a voluntary labeling program to help identify and promote energy-efficient products to reduce greenhouse gas emissions, ENERGY STAR has succeeded in helping with the greening of American schools through the promotion of best management practices that have included innovations in areas such as fluorescent lighting and power management systems. The trustworthy label on more than 60 product categories, including HVAC equipment and GHPs, has aided schools in managing tight energy budgets.

The top ten rated states and the number of ENERGY STAR certified schools include growing numbers of GHP installations. Those states and numbers include: California, 620; Michigan, 309; Wisconsin, 279; Florida, 225; New York, 212; Texas, 198; Colorado, 197, Indiana, 155; Pennsylvania, 142; and North Carolina, 130.

The adoption of geothermal heat pump systems in public schools in other states all around the country is increasing as well. An interest in taking control of both maintenance and energy budgets in an economic time when schools are seeing less funding and with that less ability to adapt to ups and downs like those fluctuating fuel costs create, will drive even more districts and school boards to research alternative measures to meet HVAC needs.

Another important driving factor that favors the GHP industry is that education facilities built decades ago are up for replacement or renovation. Many districts are studying the economics of tightening buildings where possible and replacing outdated boilers and rooftop units. Those who are looking at GHPs more efficient energy usage and maintenance reliability now have case studies and districts with success stories to guide them in the decision making process.

Large numbers of the nation's schools were built during a time of growth following World War II when building codes used minimal thermal standards that reflected the availability of cheap energy. Even though many have made renovations or taken initiatives to upgrade in areas such as lighting, budgets are continually stretched to meet the cost of inefficient HVAC systems in buildings with inadequate insulation and building envelope integrity.

The GHP return on investment for state schools makes the technology attractive to school boards, administrators, financial personnel and even parents, who understand that the energy savings and the expected payback are worthwhile–but that the same savings will continue for the life of the system, long after the installations have exceeded the initial investment cost.

In the near future, schools will be combining every available energy efficient technology in an effort to design and build new net-zero schools. The geothermal heat pump industry will be a leading component in that mix of wind, solar and other emerging renewable technologies. The marriage of GHP with these other resources is already well established. Expect to see the GHP industry continue to lead in efforts to be the most efficient choice in the mix for the immediate and long-term future for schools.

What is the Future for Geothermal in Schools?

"I'd say it is a lot brighter in states other than California," Meline said, of the future for the technology and schools in her area. She is currently involved in a small pro-bono project for a local district to help promote geothermal in schools. She mentioned the need to prove the technology to local architects and school districts, as well as utilities.

"Budgetary constraints for districts that simply do not have the money to spend, even though they know it is the right thing to do, is currently reducing the demand of geo-exchange systems in schools," Mescher says. "Programs with grant incentives help, however cash strapped districts are simply that, cash strapped."

"Geothermal heat pump systems are in their infancy," Penn says. "We are seeing a dramatic change in the number of owners interested in these systems as well as actually installing them. We are also seeing the engineering community slowly wake up," Penn says.

"When you look around at the LEED Platinum and Net Zero Buildings, at least 80 percent of them employ geothermal heat pumps. Owners are becoming more savvy about the systems and the ones that have been using geo for several years are getting phone calls from owners wanting to get educated," Penn said.

"We have not really tapped what this technology has to offer. There are applications and thermal resource concepts that have yet to be realized," Penn says. "With water becoming a more precious resource, geo offers the efficiency of water cooled equipment without the evaporation. This is a huge consideration that is only discussed in small circles."

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EARTH INSIGHTS

If you have a question about geothermal installation, design or troubleshooting, send it to Phil Rawlings in care of *Geo Outlook,* Oklahoma State University, 374 Cordell South, Stillwater, OK 74078

For several centuries, schools have taught their students the three "Rs" – Reading, wRiting, and aRithmetic. For the last 25 years or so, the closed-loop GSHP industry has been offering schools a new set of Rs – Reduced operating costs, Reduced maintenance costs, and Reduced capital replacement costs. Some have accepted, some haven't. Now, with reduced revenues and an emphasis on energy conservation, energy efficiency, and renewable (green) technologies, interest in closed-loop GSHPs is increasing in all levels of the education community – from public school districts to colleges and universities.

However, there has been resistance within this marketplace. First, you hear that it is a new and unproven technology – give me a break!! When closed-loop GSHP was introduced as a marketable technology I was 30 – now I'm 64. Enough of that excuse – just say that it isn't what you have always done and you don't want to change or try something you haven't done before – long term applications throughout North America and around the world with a proven history of satisfactory performance make the "unproven" argument look foolish.

Another is that closed-loop GSHP systems really don't save any energy (money). Properly installed system do save significant operating costs – from 30 to 70% annually. No, I'm not exaggerating!! They can and do save 30% or more than the most efficient "conventional" HVAC technologies available in today's marketplace and up to 70% or more against old, outdated systems. For example, a large project at Fort Polk, Louisiana saved 26,000,000 kWh of electricity (33% annually), 260,000 therms of natural gas consumption was completely eliminated (which also adds to the annual savings rate), and the Fort's demand was cut approximately 7.5 MW (43%). Now, two points – if you picked up that it only saved 33%, consider that a large number of the homes were previously heated with natural gas, so that portion was new electricity usage, and for you "unproven" skeptics, this system was installed in the mid '90s. A detailed bulletin is available that describes this project. The bulletin was developed by Oak Ridge National Lab for the Department of Energy.

There are also claims that the systems cost more to maintain or do not save anything on maintenance costs. Nothing could be further from the truth. Typical maintenance cost savings are 40% or more. The American Society of Heating, Refrigeration, and Air-conditioning Engineers (ASHRAE) provided their final report of ASHRAE Research Project 929. It illustrates in Table C-8a a comparison of various types of HVAC systems maintenance costs. Also, this isn't a head to head comparison of carefully maintained samples to prove a point, but multiple samples of most system types (GSHP has 41) from over 250 samples of various systems. Unfortunately, this study was done in the late '90s (another proven example for you "unproven" skeptics), so the dollar values are not representative, but the percentages of maintenance cost difference are.

Finally, closed-loop GSHP systems useful life is exceptional. Referencing ASHRAE again, the 2007 ASHRAE Handbook – HVAC Applications, Owning and Operating Costs section Table 4 indicated the service like of water cooled packaged air conditioners and water-to air heat pumps (geothermal heat pumps are in this category) to be greater than 24 years. And, that's only part of the story. The high density polyethylene (HDPE) piping material that is used for the closed-loop ground heat exchanger is typically warranted by the manufacture for approximately 50 years. Therefore, capital replacement costs are significantly reduced, and the safety, liability, vandalism/theft, etc. issues typical of outdoor equipment are gone – on a closed loop GSHP everything outside is underground.

Basically, they pay for themselves with these features in a very reasonable period of time. So, if you are planning retrofits, think GSHP. If you are planning new construction, think GSHP. Considering increasing energy costs, mandated energy efficiency and renewable technology requirements, as well as the availability of incentives, what are you waiting for?

Mr. Rawlings has more than 30 years experience in the geothermal industry. He is a Certified GeoExchange Designer (CGD) and an IGSHPA Accredited Installer and Trainer.

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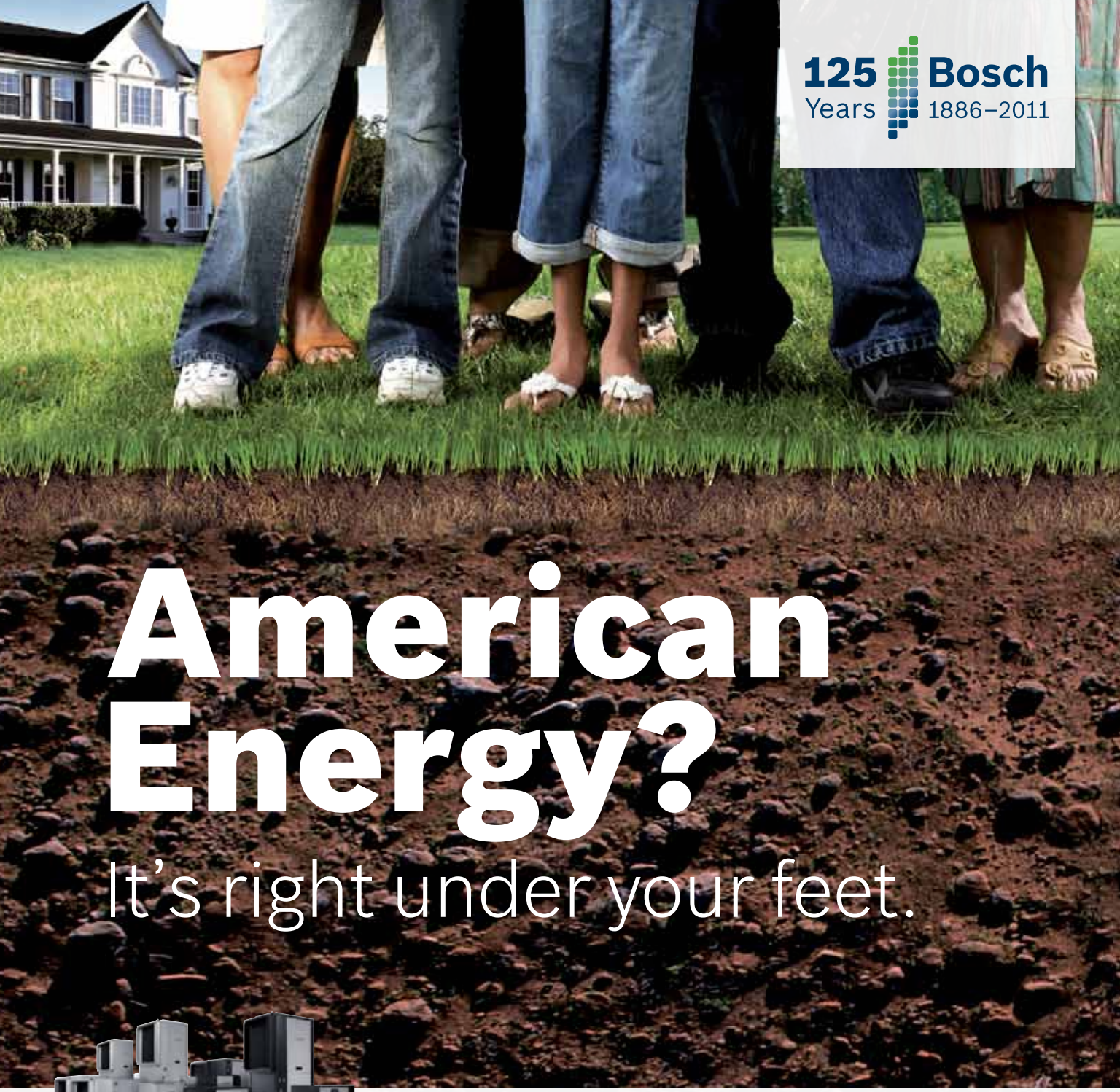

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