GEO OUTLOOK

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Montrose Elks Civic Building Blends Technology and History

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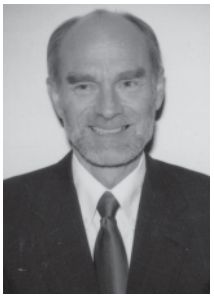
Directors' Forum

Notes from GHPC



By John Kelly
Executive Director,
Geothermal Heat Pump Consortium

Government is the largest facility owner and manager in the world. And in the United States, government is also the largest owner and operator of ground source heat pumps (GSHPs). There are good reasons for this.

First, governments at all levels (federal, state, county and municipal) are long-term owners who understand and appreciate the life-cycle cost of their buildings. They recognize the need to balance the initial capital cost of construction with the ongoing operation and maintenance expenses essential to accomplishing their public responsibilities.

Second, the public demands that governments set an example for energy efficiency and environmental stewardship. One way to meet these expectations is to assertively pursue opportunities to take advantage of proven efficient technologies and reliable renewable energy resources. No other technology can compare with GSHPs in their ability to accomplish these objectives.

Third, government agencies have excellent resources to assist them. The Federal Energy Management Program, Oak Ridge National Laboratory and the National Renewable Energy Laboratory all play leadership roles in GSHP technology.

Finally, Geothermal Heat Pump Super Energy Savings Performance Contracts allow federal agencies to take advantage of private funding to pay for GSHP projects with savings on their energy bills.

From office buildings, to research laboratories, to military operations, to remote sites in national parks and forests, government agencies lead the way in confirming the energy and environmental benefits of GSHPs.

Notes from IGSHPA

By Jim Bose
Executive Director,
International Ground Source Heat Pump Association

The United States Government use of ground source heat pumps has grown beyond military housing into the General Service Administration (GSA) where applications are becoming more popular in the many types of facilities under their jurisdiction. The GSA, which can be described as the government's landlord, has the responsibility to do all prudent things to combat rising energy costs.

The January 2007 Office of the Secretary of Defense Report to Congress on "Ground-Source Heat Pumps at Department of Defense Facilities" has so much good information that persons interested in the GSHP market should make an effort to give it a look. The one section that I found most informative from IGSHPA's point of view was the section in *APPENDIX D - DOD GSHP Lessons Learned*. Four general categories are presented: Financing, Design, Installation, and Performance and Energy Savings. If you were one of my students, I would place Chapter D.2 "Lessons Learned as Reported by DOD Field Personnel" as required reading. I have yet to find any document where so many crucial aspects of this industry are covered. Our IGSHPA training programs will be revised to include many of the recommendations found in this document.

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Water Energy Distributors, Inc.

Carl Orio started his involvement with geothermal heat pumps (GHPs) in 1974 as founder and president of WESCORP. Now Water Energy Distributors, Inc. is,one of the largest and oldest designers and suppliers of GHPs in the northeastern United States, involved in well over 10,000 GHP installations and providing equipment and consulting to more than 70 electric utilities and 200 installers, architects and engineers. Orio is a Certified GeoExchange Designer and IGSHPA Accredited Trainer, as well as a past IGSHPA Advisory Council member and sub-committee chair. He has also been active in ASHRAE, ARI, ACCA and NGWA, and has delivered countless presentations to both technical and nontechnical audiences.

Orio has a Bachelor of Science in Physical Chemistry from Holy Cross College and a master's degree in Systems Engineering from the University of Texas.

Mike Kapps

Vice President of Loop Operations
WaterFurnace International, Inc.

Kapps began his career in the geothermal heat pump industry in 1983 when he joined WaterFurnace as the general manager of LoopMaster International Division. He left in 1997 to pursue other endeavors and then returned in 2005 as the manager of business development of WaterFurnace Loop Services. In 2006, he earned his current position of vice president of Loop Operations. In between stints at WaterFurnace, Kapps served as the general manager of Precision Comfort Systems, one of WaterFurnace's largest dealers in Westfield, Ind. He also was the director of geothermal market development at a large geothermal heat pump manufacturer in which he traveled the world from Europe to Asia to discuss international opportunities for geothermal applications.

Kapps has received the following certifications and training: IGSHPA CGD, IGSHPA Accredited Trainer, Applied Project Management Training, Suretrack Project Schedule Training, PACT Training andFederal Contract Training

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The former Elks ballroom was restored and now serves as the city council chambers

Geothermal Blends Technology & History

By Marie Kadavy

Some might consider modern technology a threat to history. New innovations may make life easier, but they often take away the chance to relive and learn from the past. Today, keeping up to date can conflict with a building's beauty. However, in Montrose, Colo., modern geothermal technology blends seamlessly with a building of historic significance, both inside and out.

A Historic Approach

In 2004, the National Register of Historic Places named the Montrose Elks civic building a historic building due to its local significance. To qualify, the building had to represent the work of a master architect, represent a time period or method of construction, contribute to significant events or add to a historic district within the city of Montrose. The National Register recognized the building for its social history and mixed architecture, which includes Mission Revival, Pueblo Deco and Late Gothic Revival influences and elements.

The nearly 13,000 square-foot building was designed in 1926 by architect J.H. Antrobus and built in 1927 by White and Okey as a lodge for the Benevolent and Protective Order of the Elks for just $34,600. Since that time, the building has housed Colorado Western College and Montrose County Department of Social Services. In 2003, the city acquired the building and the restoration process began.

Completed in July 2007, the newly renovated building now serves the city council, planning commission and city staff and includes council chambers, a municipal court and community development office. "This building is an important public building that is used by many citizens of Montrose as well as the staff that serve them," Virgil Turner, a city official, said. "One of the important design concerns for the project was to provide a comfortable space for all that use the building."

The building was remodeled to meet the city's needs, and the renovation included structural upgrades, fresh finishes, new electrical, mechanical and plumbing systems, and asbestos abatement. The original porch

Photo courtesy of the City of Montrose.

Photo courtesy of the Brent Wilson.

Photo courtesy of the Elizabeth Hallas, Elks.

The Montrose Elks civic building was built in 1927 and restored by the City of Montrose 80 years later in 2007.

and ballroom, which had been turned into office space, were also restored. The ballroom now operates as the city council chambers. Additional seating, new technology and an elevator enable citizens of Montrose to more actively participate in their local government through easy access to open public meetings.

Elizabeth Hallas of Andrews & Anderson Architects in Golden, Colo., served as the project's architect, and Brent Wilson of Architectural Engineering Consultants (AEC) in Vail, Colo., provided engineering consultation. Working with a historic building posed a challenge for the team and meant special considerations needed to be made.

"You just need to be very sensitive to the existing building, and any alterations need to be compatible with the style of the building." Hallas said. One reason a geothermal system was chosen for the project was because it would not have a negative aesthetic impact.

"It really had minimal visual impact, so that's great for a historic building," Hallas said. "We were able to put some of the equipment in the basement of the building, but as far as the loop field goes, nobody knows it's there." The system's loops were buried underneath the building's adjacent parking lot, hidden from view.

As the architect for the renovation, Hallas' main concern regarding heating and cooling was the system's effect on the building's historic integrity. With the ability to hide the loop field under the parking lot and the equipment in the basement, geothermal made sense, Hallas said.

"It really was a work of art retrofitting all the ductwork and equipment into the basement, but due to the high degree of communication between all parties, it worked out well," Wilson said.

For the citizens of Montrose and the city itself, the savings were a huge benefit. Originally, the city evaluated both geothermal and conventional systems and discussed the options with the local power authority. "Our local electric cooperative, Delta Montrose Electric Association has been a leader in our community in pro-

Photo courtesy of the Brent Wilson.

moting ground source heat pumps," Turner said. "This assisted the decision makers in this project since there was a certain level of comfort with the proven nature of the technology."

During the design phase, the city requested a geothermal system, and Terry Proffer of Major Geothermal conducted a feasibility study to determine the payback period. "I believe it was an estimated 8-year payback," Hallas said. "For a municipally owned building, that was something that was attractive to the city, so they decided to make the investment."

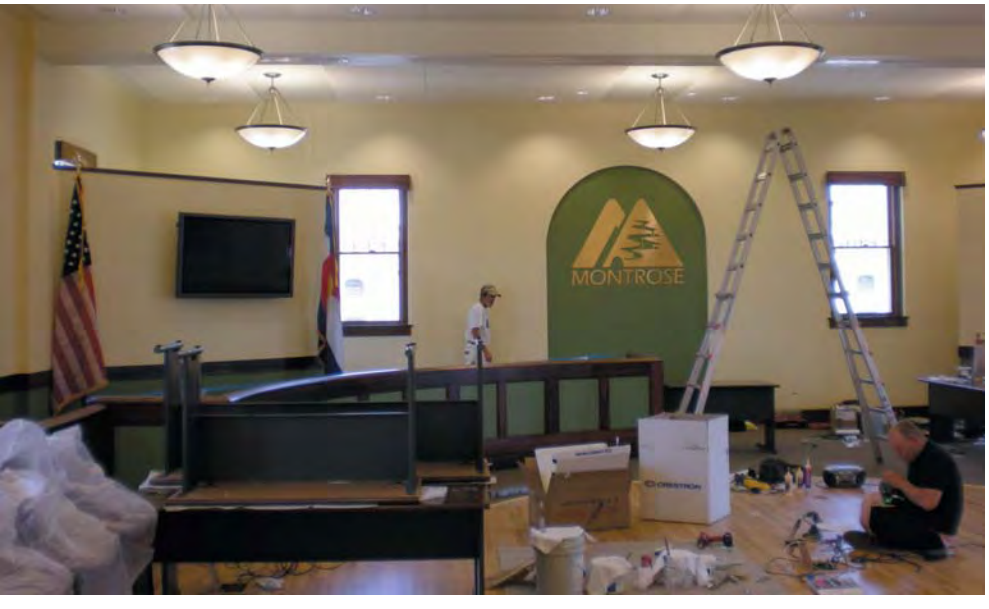
Although a lot of planning was involved in maintaining the building's historic integrity, few constraints affected the design and installation of the system. "They did give us a little bit of a confined area, but we were able to fit the loop field in OK," Proffer said. "We had to make some allowances for some things that couldn't be touched."

Proffer, a former resident of Montrose who put in some of the first systems in the area with local contractors, designed the loop field and helped size the circulation pump for the project. He also advised on the heat pump selection. Can-America Drilling installed the loop field, and Par Mechanical installed the seven water-to-air ClimateMaster units to meet the zone requirements and one water-to-water heat pump for the building's domestic needs.

"We utilized desuperheaters to supplement the hot water needs and streamlined some of the outdoor air heat losses and gains with energy recovery ventilators," Wilson said. A 30 percent propylene glycol solution circulates throughout the closed-loop system's 18,000 feet of 1 1/2-inch high density polyethylene pipe. The 32-ton system required 24 300-foot boreholes. "Loads were pushing for the loop field to be a little larger than what we thought we'd need, so we made the holes a little bit deeper," Proffer said. "We balanced the header pairs to cut down on our pressure drop to help lower pump exhaustion."

A Sustainable Preservation

"By definition, preservation is sustainable because we are reusing the resource of an existing building with all of its materials," Hallas said. "All the infrastructure is getting reused for a good purpose rather than tearing it down and starting over." Hallas worked to preserve as many of the building's historic qualities as possible, reusing trim and bathroom doors and refinishing the wood floors that had been covered with carpet.



The ballroom's maple wood floor was refinished to accompany its original windows, doors and trim.

Hallas recognized the city's effort to invest the taxpayers' money thoughtfully, she said, and Turner emphasized that the short payback was the city's primary reason for going geothermal. Turner felt that as a municipal government, the city of Montrose should take a leadership role in the use of renewable energy, he said.

"Since the building was a historic masonry structure, it was important that we provided enough heating and cooling capacity to compensate for the reduced energy effi-

Photo courtesy of the Brent Wilson.

The geothermal system's equipment was hidden in the basement and does not disrupt the building's historic feel.

ciency that the historic structure would provide," Turner said. A geothermal system was an excellent way to preserve the important building and still provide a comfortable environment, he said.

"It was the city's decision to blend their values of retaining a historic building as well as to be as sustainable as possible," Hallas said. "It is an extension of their preservation ethic of being sustainable, being good stewards of the building and being responsible to the taxpayers as far as spending the money wisely that they have."

A Happy Ending

Although the building's restoration included lighting and window upgrades and additional insulation, Wilson estimates the geothermal system is saving 30 percent on energy bills. These energy-efficient improvements along with the geothermal system combined for substantial savings. "The estimates for energy savings were about 30 to 50 percent depending on which angle you look at it," Wilson said.

Turner believes the building's energy use is less than the original energy cost analysis projected, and he thinks the energy savings are on target to meet the predicted payback period of 7.4 years, he said. In addition to the savings and short payback period, the city received a $5,250 GeoExchange rebate from Tri-State Generation and Transmission Association Inc. Colorado Preservation Incorporated also recognized the building for excellence in historic preservation, awarding it a 2008 State Honor Award.

Because of the project's success, city officials are considering geothermal systems for other city buildings as well. "We have had virtually no problems with the system," Turner said. "We are happy with our decision to install a building control system that allows us to operate the heating and cooling in an efficient manner, leading to additional energy savings."

Hallas said the citizens of Montrose are excited about the results of the remodeling effort, too. "I think the city is especially proud of the way the rehabilitation turned out," Hallas said. "It became a real focal point for the town rather than just a vacant downtown building."

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Profile to Success:

Phil Rawlings

By Marie Kadavy

Phil Rawlings has 30 years experience in the geothermal industry.

Phil Rawlings was in the right place at the right time. With a background as a mechanical designer in the electric power distribution, aircraft and computer hardware industries, he was fortunate to be working for Jim Partin in 1978 just as Partin, Jim Bose and Carl Ledbetter were developing and installing the first geothermal systems off of the Oklahoma State University campus.

"I had no background in heating and air conditioning or anything like that, and I was fortunate enough to come to Stillwater, Okla., and be involved with the people who developed and started this industry," Rawlings said. "Once that happened, just by shear presence, I was in it from the get go."

Rawlings dove into the industry and helped establish its first successful ground source heat pump "one-stop-shop" for system design, equipment, components and accessories. He worked in geothermal sales and service at Command-Aire Corp. and ClimateMaster before starting his own consulting company, The Rawlings Company, in 1996.

As a founding member of the International Ground Source Heat Pump Association (IGSHPA) and the Geothermal Heat Pump Consortium (GHPC), Rawlings values education in the industry, he said. "Designers and installers have to know what they need to do to correctly design and install the systems or we have problem jobs, and that is not good for the industry." Rawlings is active in industry education, training, speaking at conferences, revising manuals and writing for *Geo Outlook*.

Since his days in Stillwater, Rawlings has installed or designed systems in every state in the U.S., every province and territory in Canada, and 17 foreign countries. With eight patents to his name and a long list of firsts, it's easy to see why Rawlings is in love with what he does. "I feel like I am stealing when I get my paycheck because the industry is so much fun," he said.

Currently, he is working on approximately $20 million in geothermal projects on various military bases across the country as the director of geothermal services at TRC Energy Services-Geothermal. As for the future, Rawlings hopes to be in the industry for the rest of his life, he said. "I'm going to be doing earth coupling until I really am earth coupled."

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By Land or By Sea

By John Kelly

Whales leaping out of the water, dozens of tour boats carrying thousands of sightseers, ocean-going merchant vessels making a crossing. What do all these things have to do with ground source heat pumps (GSHPs)? The answer is the Stellwagen Bank National Marine Sanctuary.

Stellwagen Bank, at the mouth of Massachusetts Bay, is a feeding and breeding area for whales.

National Marine Sanctuaries

Just as national parks and wilderness areas are managed to balance competing uses of irreplaceable environments on land, the National Oceanic and Atmospheric Administration's (NOAA) National Marine Sanctuaries serve as the "trustee for the nation's system of marine protected areas, to conserve, protect, and enhance their biodiversity, ecological integrity and cultural legacy while facilitating compatible use." So it makes sense that an environmentally sound approach would be used in evaluating the replacement of the heating and cooling system for the headquarters of the Stellwagen Bank National Marine Sanctuary.

Stellwagen Bank

The Stellwagen Bank National Marine Sanctuary encompasses an area about the size of Rhode Island, 842 square miles at the mouth of Massachusetts Bay, covering most of the area 25 miles east of Boston from Cape Ann to the tip of Cape Cod. The bay's most prominent submerged feature is the kidney-shaped plateau called Stellwagen Bank, which lies at the bay's eastern edge. Stellwagen Bank is a shallow, primarily sandy feature, about six miles wide by 19 miles long, overlain by water between 65 feet and 600 feet deep. Now an important feeding and breeding area for whales and other aquatic species, it was once above sea level and roamed by mastodons and mammoths.

The headquarters of the sanctuary is in Scituate, Mass., about halfway between Boston and Plymouth. Originally constructed in 1938 as a Coast Guard station, the three-story headquarters building housed up to 40 Coast Guard personnel. After the Coast Guard moved out, the sanctuary staff of 14, along with the South Shore offices of the Massachusetts Environmental Police and the Massachusetts Coastal Zone Management Office, moved into the building.

A ground source heat pump system replaced the natural gas furnace at the sanctuary's headquarters.

Headquarters Restoration

"The building interior was designed for living and bunk space was not appropriate for office space, and there was a certain degree of disrepair," Deputy Superintendent Ben Cowie-Haskell said. The existing natural gas furnace was at the end of its useful life. Cowie-Haskell was successful in securing funds from a federal PAC grant for a restoration project for the building.

A 25-year life-cycle cost analysis was conducted to determine the most economically feasible replacement heating, ventilating and air conditioning (HVAC) system. The analysis included initial construction cost, ongoing operating and maintenance costs, and planned equipment replacement costs. Alternatives considered included a GSHP system and various configurations of natural gas heating with or without conventional air conditioning. While the initial cost of the GSHP system was higher than the other alternatives, it had the lowest operation and maintenance costs and provided the most efficient heating and cooling equipment. The GSHP also offered the advantages of no noisy exterior equipment to detract from the historical aesthetics of the Colonial Revival architecture and lower maintenance requirements due to the absence of equipment exposed to the weather and coastal salt air environment.

Once the decision was made to take advantage of the energy and environmental benefits of the GSHP system, the system was designed by PACE Collaborative, PC, of Virginia Beach, Va., and installed and maintained by Preferred Mechanical of Pembroke, Mass.

Cowie-Haskell explains: "The facility was the third NOAA building in the nation to incorporate a geothermal heating and cooling system. This HVAC system reduces dependency on fossil fuels by using the earth as a heat source in the winter and a heat sink in the summer. The subsurface soil, groundwater (salt and fresh), and bedrock maintain a constant temperature of around 54 degrees Fahrenheit. What drives the system is the difference in temperature between the 54-degree earth and the ambient air. In the winter, the system draws heat from the ground and transfers it to the building space through water source heat pumps. In the summer, it extracts heat from the building's interior and transfers it to the ground. In our case, we utilize the earth's energy source through two 740-foot wells, which are tapped into deep saltwater

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veins. Submersible pumps pump the 54-degree water into the building."

This is where the workhorses of the system, the water source heat pumps, take over. Their basic function is not to create heat but to move it from one place, the earth, to another, the building. Similar to a refrigerator, they do this by pumping an environmentally friendly refrigerant through a closed loop. However, the difference is that the heat pumps have a reversing capability – valving between the built-in evaporator and condenser coils allows their function to be reversed - so that they can take heat from a warm area and exchange it to a cooler area and vice versa. The refrigerant transfers heat, extracts it in the winter and discharges it in the summer, from the saltwater to the forced air, which is then circulated throughout the building via air ducts.

The bottom line is that the geothermal HVAC system is 50 to 70 percent more efficient at heating and 20 to 40 percent more efficient at cooling than a conventional air conditioner and fossil fuel fired system.

Environmentally friendly refrigerant circulates through pipes in the system's two 740-foot wells.

When the sanctuary conducted a life-cycle cost analysis, the ground source heat pump system had the lowest operation and maintenance costs.

Stellwagen Bank National Marine Sanctuary Programs

So, how do whales and other sanctuary resources benefit from this innovative heating and cooling system? The lower energy bills and reduced maintenance and associated costs of the GSHP system allow the sanctuary staff to focus their attention and resources on their mission to increase public awareness of America's marine resources and maritime heritage by conducting scientific research, monitoring, exploration and educational programs.

Stellwagen Bank is home to numerous aquatic species. While the four different varieties of large whales attract the most attention from tourists, other species include dolphins and porpoises, seals, sea turtles, fish, lobsters, scallops, sponges, starfish and squid, not to mention sharks and 34 species of seabirds. It is also the site of a number of nationally significant historic shipwrecks.

Both commercial and recreational fishing are allowed in the sanctuary, and it is open to all forms of vessels, from sailboats to the largest ocean-going freighters. The sanctuary strives to protect its living and non-living resources, while facilitating compatible uses of the ocean.

The sanctuary is one of the world's premiere sites for nature viewing from May through October, with an estimated visitation of approximately 1 million whale watchers per year. The World Wildlife Fund listed the area as one of its top 10 sites for viewing whales, and the readers of Offshore Magazine voted it the No. 1 location for wildlife watching in the northeast.

Whale population and migration studies demonstrate that numerous humpback whales have been returning to the sanctuary since the mid-1970s. Because they can be identified by unique markings, individual whales have been identified and given names, including Wizard, Tornado and Buzzard. Many of them are females, who can be counted

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on to bring their new calves up to Stellwagen Bank from the Dominican Republic. It is in the sanctuary that the mother whales feast on nutritious sand lance and teach their offspring to hunt.

Reducing Collisions Between Whales and Ships

The sanctuary is a critical seasonal feeding area for right, humpback, fin and minke whales, who feed in sanctuary waters despite the fact that large ships are an ever-present threat. It is also the area in which large commercial ships converge to enter the Port of Boston. More than 200 large commercial ships ply the waters of the Stellwagen Bank every month. Projections from extensive whale population studies in the sanctuary indicate the threat of ship strikes may be reduced significantly by moving the Boston shipping lanes several miles northward to an area with a historically lower whale sightings record. Rerouting this traffic may reduce risk of ship strikes to endangered right whales by 58 percent and to all baleen whales by 81 percent, while adding minimal additional transit time for the vessels. Sanctuary researchers continue to study the amount and type of vessel traffic that passes through the region and how that traffic might be better managed to protect marine mammals in sanctuary waters.

Sharing the saltwater of Massachusetts Bay, the aquatic species of the Stellwagen Bank National Marine Sanctuary and the GSHP heating and cooling system may provide us with a model to both utilize and protect the natural wonders that surround us.

◆

Photos and graphics courtesy of NOAA.

Approximately 1 million whale watchers visit the sanctuary each year. The area is a World Wildlife Fund top 10 site for viewing whales.

A Big Fish in the HVAC Residential Market

by Dara McCoy

If the consumer market for the ground source heat pump (GSHP) industry were compared to a pool of fish, the federal government of the United States of America would be the prize catch. It is the largest user of domestic energy, spending $17 billion a year to power 500,000 facilities, operations and vehicles throughout the country. Federal agencies spend nearly $10 billion per year on energy-using products.

"While this represents only 1 to 2 percent of total U.S. sales, it makes the federal government as a whole the largest buyer in the world for almost any product," according to the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy's (EERE) March 2008 Selling Energy Efficient Products to the Government publication. If deep pockets weren't enough reason for the GSHP industry to set bait for this big fish, the considerable slice of market share pie the U.S. government holds should be.

Green isn't some wussy, tree-hugging thing. Green is patriotic. Green is strategic. Green is the new red, white and blue.

—Thomas Friedman, New York Times columnist

According to the DOE's Web site, the end of the Cold War marked a shift in the department's focus from nuclear weapons and research to environmental clean up and energy efficiency and conservation. This shift was noted by legislation and executive orders like the Energy Policy Act of 1992, The Greening of the Government Executive Orders mandated by Bill Clinton in the late '90s, the Energy Policy Act of 2005 (EPAct), and in January 2007, President George W. Bush's Executive Order 13423: "Strengthening Federal Environmental, Energy and Transportation Management."

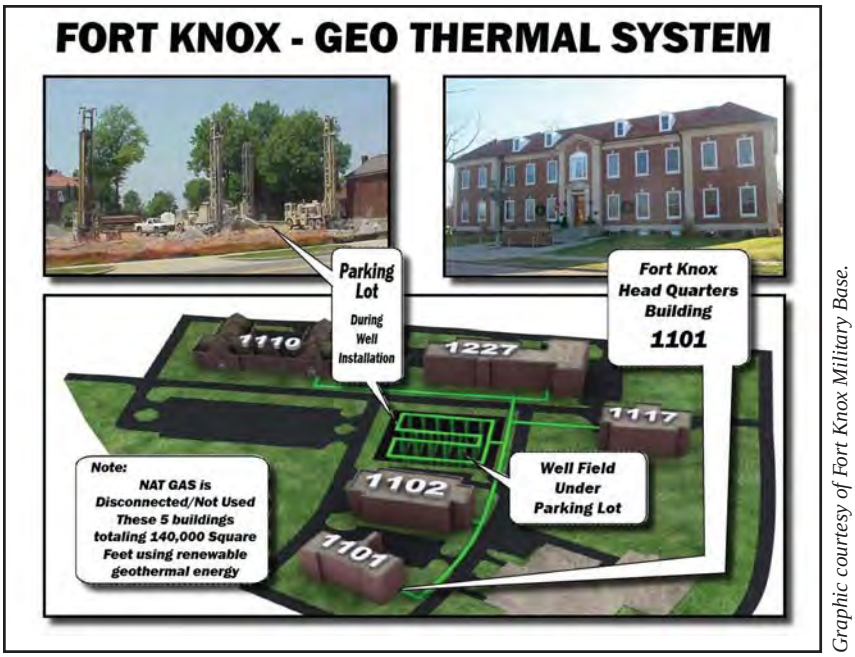
Agencies and branches of the federal government are pressured to utilize energy-efficient and environmentally safe products by more than just environmental stewardship. They follow direct orders from the commander-in-chief to do so. Executive Order 13423 from President Bush has put the onus on government agencies to reduce energy consumption 30 percent by 2015.

At Home on the Fort

While certainly not the beginning of a consumer relationship with the federal government, the 1996 GSHP project of 4,000 heat pumps and more than 8,000 boreholes at Fort Polk, La., for 4,003 military personnel housing units was a milestone in the GSHP industry's efforts

to secure a place in the government's energy efficiency crusade. Fort Polk remains one of the largest GSHP installations in industry history and, by saving 23.3 million kilowatt hours annually, serves as an excellent example of how GSHP technology can help federal agencies achieve mandated efficiency standards.

Today, GSHP systems are installed in both commercial and housing projects on U.S. military bases around the country, often becoming a standard component of a fort's energy reduction plan. That is the case at Fort Knox, Ky., where Base Realignment and Closure (BRAC) brought significant growth to the base, said Brandon Marcum, Trane representative in Louisville, Ky., and part of the Nolin-Trane energy team that has been working at Fort Knox since 2001. "The energy team was challenged to make sure that the new housing fits Fort Knox's preferred design, which is geothermal," Marcum said.



Graphic courtesy of Fort Knox Military Base.

Photo courtesy of Brandon Marcum, Trane and Nolin Energy Group.

The retrofit of 10 barracks at Fort Knox is broken into two pods, each served by a central well field.

In March 2007, Fort Knox began construction on the ECO-75 project, which called for the retrofit of 10 barracks totaling 300,000 square feet. The project breaks the 10 buildings into two pods, each pod served by a central well field. The fields were also designed to provide heating and cooling for nearby office buildings and take advantage of the load diversity between the two types of buildings, Marcum said.

One pod operates from a field with 200 wells at 500 feet deep. Its system totals 550 tons of heat pumps that serve the single soldier quarters and three office buildings. The other pod operates on a 165-ton system and a 60-well geothermal field connected to the multiple-occupancy Balcombe Barracks and one office building. "A barracks building has a load throughout the day, predominately peaking at night, whereas the offices have a heavy load during the day," said Marcum of the

Photo courtesy of Brandon Marcum, Trane and Nolin Energy Group.

Trenching work in progress for the ECO-75 barracks, which will house 900 soldiers at Fort Knox.

strategy to take advantage of peak loads between the two types of buildings. ECO-75 is projected to be complete in February 2009 and will serve the housing needs of approximately 900 soldiers.

The second housing-related project Marcum's team is undertaking is an Interim Brigade Combat Team (IBCT) project. The IBTC is a completely new barracks complex designed to meet the additional housing needs caused by the influx of soldiers to Fort Knox from BRAC. Completed in April 2008, the IBCT complex provides 539,000 square feet of GSHP heated and cooled housing for more than 1,400 soldiers.

ECO-75 and IBCT are just two of many GSHP residential projects at Fort Knox since the Nolin-Trane energy team was selected to help the base meet energy efficiency standards in 2001. GSHP made a big impression when the energy team utilized the technology in a retrofit of the base's childcare facilities, one of a few buildings on the base that presented Fort Knox with maintenance problems, Marcum said. "It was almost magic for them to have a system that actually saved money and fixed their maintenance problems at the same time," he said.

That experience and the GSHP systems installed since that time have made the technology a high priority when plans for renovation or new building construction begin. In fact, 100 percent of the barracks facilities at Fort Knox have GSHPs, which represents 40 percent of the total housing on base, Marcum said. In all, more than three million square feet of buildings at Fort Knox utilize GSHP technology. "Energy security is important to our country and to our military," Marcum said. "They do not take energy conservation lightly, and that's one reason why they're so firm and committed to proving out technologies and supporting them everywhere they can use it."

The Nolin-Trane energy team, which also does on-site maintenance for the base, is bound by contract to achieve a payback period of about 10 years. Their con-

tract with Fort Knox runs through 2011. "We've tracked ongoing energy consumption from their master meter that shows the decrease that Fort Knox has seen over time, and their decrease is amazing," Marcum said.

GSHPs Take a Walk in the Park

It's easy to correlate government housing to military housing when the military is installing 4,003 GSHP heated and cooled housing units at a time, but there are federal agencies beyond the U.S. military that need to provide housing for government employees. These agencies are under the same executive orders for energy efficiency. One such agency is the National Park Service (NPS) at Yosemite National Park in California. In March 2007, the NPS completed the Curry Village project, consisting of 180 studio units and a wellness center for more than 200 park employees.

This project was the first GSHP installation at Yosemite and, as such, had to jump through a few hoops before being selected. "We did a rigorous value analysis of other types of heating and cooling systems that resulted in our considering GSHP to be the best environmental alternative for Yosemite," said Mike Wichmann, NPS project manager at Yosemite.

GSHP technology was placed head-to-head with a water-cooled chiller and boiler system and conventional air-to-air heat pumps, as well as heating-only systems such as radiant floor and gas furnaces. Yosemite's cooler climate made the consideration of heating-only systems somewhat feasible, but further research showed employees did have air conditioning needs. A decision to provide heating-only systems could have resulted in the unsightly addition of window units, which occurred with Yosemite's current employee housing, said Steve Guttmann, a principal of Guttmann and Blaevoet Consulting Engineers. In the end, GSHP technology's limited water usage, superior temperature control, lack of local emissions, minimal visual and noise impact to Yosemite's natural setting earned it a recommendation for Curry Village.

The 27 residential buildings and wellness center required a well field of 178 boreholes, drilled to a depth

Photo courtesy of David Wakely Photography.

Selection Factors

HVAC System Alternatives	Site Disturbance	Visual Impact	Outdoor Noise	Emissions	Chemical Discharges	Water Usage
Ground-source Heat Pump	• Uses parking lots as location for majority of piping (reducing overall area of site disturbance) • Eliminates central plant building	• Less buildings • No mechanical equipment located outdoors	• No noise from outdoor mechanical equipment	• No air pollution emissions in valley • High energy efficiency (reduced electricity usage)	• Closed system—minimal discharge from maintenance activities • Treatment chemicals more benign (due to lower operating temperatures	100 gallons per year
Water-cooled Chiller/ Hot Water Boiler	• Additional building(s) to house central mechanical equipment required • Amount of trenching required to distribute utilities to residence buildings	• Adds buildings & enclosures • Cooling tower located outdoors • Steam plume from cooling tower & boilers	• Cooling tower noise (75 dB @ 20 ft; similar to the noise level of a typical factory)	• Nitrous oxides, sulfur oxides & carbon monoxide emitted from boiler • Lowest energy efficiency (highest power plant emissions)	• Continual discharge of chemicals from cooling tower water treatment system • Closed system, but boiler system treatment chemicals have more environmental impact	400,000 gallons per year
Air-cooled Chiller/ Hot Water Boiler	• Additional building(s) to house central mechanical equipment required • Amount of trenching required to distribute utilities to residence buildings	• Adds buildings & enclosures • Large air-cooled chiller located outdoors • Steam plume from boilers	• Air-cooled chiller noise (105 dB @ 20 ft; similar to the noise level of a jackhammer)	• Nitrous oxides, sulfur oxides & carbon monoxide emitted from boiler • Lowest energy efficiency (highest power plant emissions)	• Closed system, but boiler system treatment chemicals have more environmental impact	200 gallons per year

GUTTMANN & BLAEVOET CONSULTING ENGINEERS

Curry Village Employee Housing, Yosemite National Park
Comparison of Potential Mechanical Systems

ARCHITECTURAL RESOURCES GROUP
Architects, Planners & Conservators, Inc.

Ground source heat pumps will result in a 25 percent reduction in annual utility costs for the park

of 280 feet, but the well-field installation inside a national park required a few more steps than the traditional installation. Work had to be done around trees as the entire project was designed to retain as many trees as possible. To assist the driller, ground penetrating radar equipment was brought in to map boulders and tree roots in the geo-field site. "The ground penetrating radar only goes about 20 to 30 feet deep," Guttmann said. "When we're drilling 280 feet, it doesn't tell us everything, but it certainly tells us a lot."

NPS officials weren't only concerned with saving trees from construction demolition. Arborists wanted assurance that the geothermal field's presence in the ground wouldn't negatively affect tree health. "We did some fairly extensive analysis on the field to make sure the drift, the field and the impact on soil temperature was going to be fairly small," Guttmann said. With a soil temperature impact of less than two degrees, the system passed the arborist's test.

GSHP technology's immediate impact, or the lack thereof, to an environmentally protected area like a national park was appealing to NPS officials, but long-term benefits were abundant too. Curry Village's design, which included other environmentally-conscious products like low-E windows, performed 31 percent better than requirements in California's 2001 energy code and earned a $40,000 Pacific Gas and Electric utility

Photo courtesy of David Wakely Photography.

Curry village provides housing for 200 National Park Service employees at Yosemite National Park in California.

Photo courtesy of David Wakely Photography.

Ground source heat pumps were selected for Curry Village because of their low visibility impact to the scenic surroundings of the park.

incentive. The GSHP system uses less than 100 gallons of water per year compared to the 400,000 gallons per year needed for water-cooled chiller and boiler systems and is projected to save 156,000 kilowatt hours and avoid 50 tons of carbon dioxide emissions per year.

NPS also managed to get its GSHP system for a cost that did not create too much of a disadvantage when compared to the other HVAC technologies, Guttmann said. “The premium cost came out to be very small,” he said. “It’s something on the order of a $25 million project, and I think the premium for the GSHP was $150,000.” Guttmann explained that the cost of putting boilers in all 28 buildings to provide hot water and gas furnaces increased the building footprints and added to the cost of other systems. Central boiler systems would have required more building area, as well as expensive buried insulated piping systems. “The buildings got smaller when we went to GSHPs, the site distribution was cheaper, and it just worked out,” he said.

A lower premium cost was a nice bonus for the GSHP technology, which typically doesn't win a lot of contests on first cost. Life-cycle cost is where the technology usually shines, and it was no different for Curry Village. Guttmann said the GSHP system is projected to save the park $55,000 year, a 25 percent reduction in annual utility costs, and reach payback in about nine years. "My feeling is that the geo-field shines whenever your life-cycle cost horizon is long enough," Guttmann said. "For the government, they build these buildings for 50 years, and that's a time horizon where geo-field just hands down wins the life-cycle cost battle."

Landing the Big One

From Fort Polk to Curry Village, the GSHP industry has put considerable effort into reeling in government projects and is reaping the rewards in places like Fort Knox, where GSHPs have become a standard. Yet, as the "green" movement continues to pick up steam, new technologies will always be challenging the industry and vying for a place in government projects. There are roadblocks that GSHPs have not completely overcome and considerations when approaching a government project.

One example is the skepticism owners have on whether or not a ground loop will work in their specific geographic area despite documented success in other areas. Even Marcum noted that Fort Knox benefits from Kentucky's geology, providing an "ideal place for geothermal" with thermal conductivity that ranges from 1.5 to 2.5, but Phil Rawlings, director of geothermal services for TRC Energy Services-Geothermal, said geography shouldn't be much of a concern for the overall success of a GSHP system.

"The bottom line is, I've got installations from Saudi Arabia to inside the Arctic Circle, and you can't get much worse than that on this rock," said Rawlings, whose experience with government commercial and residential projects include Fort Sill, Okla., Camp Lejeune Marine Corps Base in North Carolina, Charleston Naval Weapons Station in South Carolina and Military District of Washington, to name a few.

"The true benefit is the benefit of heat transfer capabilities of water versus air," Rawlings said. Rawlings compared the difference to the heated air of an oven versus the heated water on a stovetop. "You can reach into the oven and take out cake when the oven is set at 425 F and, as long as you don't touch the metal, you're fine," he said. "At sea level water boils at 212 F, if you touch the boiling water, the water will transfer the heat to you instantaneously and burn the fool out of you."

Government projects can hold a myriad of different challenges and opportunities compared to traditional commercial or residential projects, but few present situations in which GSHPs cannot be utilized. Wichmann summed up the main difference with government projects as "tighter specs," but as with Curry Village's location in a national park, some government projects have special needs or historic preservation status. For military projects, Rawlings said GSHPs sometimes prevent a "target of opportunity" on a base by eliminating the need for big storage tanks of heating fuel.

Rawlings said the GSHP industry should be working toward the day the technology enters the "so-what category," when the technology is no longer special or new, but as common as it has become at Fort Knox or Fort Sill. "It does tremendous things for you, such as keeping you comfortable, making hot water and saving you energy," he said. "It happens to be this wonderful invention, but it's a machine. It's a simple system, and it doesn't need a lot of maintenance or upkeep."

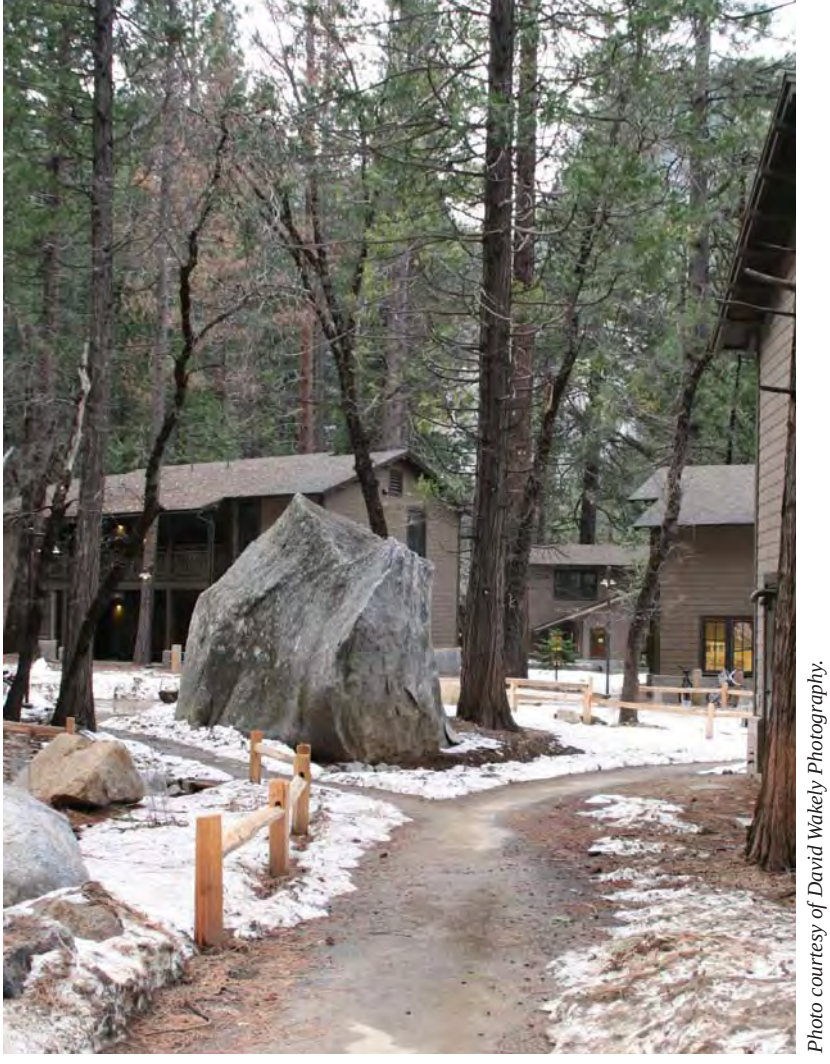


Photo courtesy of David Wakely Photography.

Drillers were faced with the challenging job of installing well fields around boulders and trees to meet a mandate of minimal site disturbance.

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Future House USA

By Megan Wible

Future House USA will show the world what America has to offer in energy efficiency.

More than 50 countries will attend the 2008 Olympic Games this summer. Each of these countries will come together to share the common goal of taking home the gold. However, 10 of these countries have another goal in mind: showcasing green technology to the world.

Almost 2 billion people currently live in China, the Olympics' host, and it has been predicted that with its emerging middle class and global economic purchasing power, China will need 100 million more residences in the next decade just to accommodate its growth. Because of this significant rate of economic development, there is now great concern surrounding the nation's environmental pollution. As China works to meet its growing needs, it plans to integrate environmentally friendly technologies into its housing market. One of the ways China is accomplishing this is through the Future House community project.

The Future House project consists of 10 demonstrative homes built by 10 different countries, with each country exhibiting its latest environmentally friendly technologies. The homes will be on the world's stage, as they open for tours during the 2008 Beijing Olympics and remain on public display for six years. The United States is taking part in the project, although they are the only country that doesn't have government or corporate financial sponsorship.

"This truly began as a grass roots effort," project director George Bialecki Jr. said. "Even though, in the beginning, we had not received government economic support, we knew the importance of such a global initiative. We knew that the United States must not only participate but also lead the way toward energy independent and environmentally nontoxic solutions." Instead, Future House USA (FHUSA) is represented by both Learn Green, which was founded by Bialecki, and Florida International University (FIU).

Although FHUSA still hasn't received financial support from the U.S. government, several politicians are behind the project, including 2008 presidential candidate Barack Obama. "As worldwide energy consumption in the coming decades continues to grow, a significant part of our strategy must include greater efficiencies and energy conservation practices, and that poses an important challenge in the design and construction of our homes," Obama said in a letter of support. "Future House demonstrates that these goals are not impossible, but achievable in a manner that is cost competitive with conventional building practices."

Dr. Yong Tao, third from left, and George Bialecki, Jr., second from right, participate in the groundbreaking ceremonies for Future House USA in Beijing,China.

How It Got Started

The United States was asked to be a part of Future House when the Chinese government saw a solar house designed by students in FIU's college of engineering for the "Solar Decathlon." Sponsored by the U.S. Department of Energy, FIU won first place in the international competition for the energy balance category. The Chinese government then contacted Dr. Yong Tao, an engineering professor at the university, and FIU was officially on board as the academic sponsor. Tao was asked to find a U.S. builder and had seen articles about Bialecki and his work with green technology through his foundation, Learn Green.

Learn Green, formerly known as the Alternative Energy Living Foundation, is a not-for-profit organization that built the first ENERGY STAR assisted living and adult community in the United States. Since then, Learn Green has built more than 50 non toxic, high-performance homes. The organization is fronting most of the costs of FHUSA, serving as the principle managing sponsor. "China really wanted the U.S. to be a part of this project," Bialecki said. "No matter what the image of the U.S. is around the world, people still admire the United States. It's a melting pot of everybody from around the world. We've always been leaders in whatever we've done and I truly hope through sustainability,

During construction an American flag was proudly draped over Future House USA.

The ground source heat pumps and other construction materials were shipped from the United States to China. Future House USA is an all-American home on Chinese soil.

ground source heat pumps (GSHPs) and other features in green housing, that we can continue to be leaders."

The Future House project was commissioned by China's Ministry of Science and Technology and the Ministry of Construction. Other countries participating in the Future House project include: China, Germany, Spain, Italy, Sweden, Norway, England, South Korea and Japan. The project will expand to take place in six cities around China with Shanghai being the next as they host the 2010 World's Fair. "The most unique part is that it's a global initiative and an international collaboration," Bialecki said. "It's not as much a competition as it is a collaboration for folks around the world to be able to view the different sustainable

Centennial Plastics manufactured the 3,360 feet of high density polyethylene pipe that was shipped to Beijing.

methods and products now available worldwide."

The Green Details

The house is 4,500 square feet and features four bedrooms and four bathrooms. No one will ever live in FHUSA, but it will serve as a demonstration facility to the public for six years. It will also serve as an educational tool, as its advanced monitoring and logging system tracks the effectiveness and savings of the home's green features. The data will be accessible to students worldwide through the Learn Green FHUSA blog.

The monitoring and logging system will help the house reach Zero Net Energy (ZNE), which means it will produce just as much energy as it uses. The actual state of ZNE for FHUSA is expected to be reached through a process of continued development of the systems within the house during the first two or three years of operation. This will be accomplished, in part, by a ground source heat pump (GSHP), which will take advantage of the energy stored in the ground below FHUSA. "My (assisted living) communities, stateside, are all geothermal," Bialecki said. "There's so much energy underneath our feet that we're not taking full advantage of yet. The nice thing about GSHPs is that it's there for us, underneath our feet, no matter where we are, no matter if it's sunny or windy. It may be one of the most consistent of the renewable energies."

A specialized geothermal system was needed for FHUSA because of the different electrical standards in China. Industry consultant Jack DiEnna recommended contacting ClimateMaster to help with the project. ClimateMaster brought their technical team together for FHUSA. The geothermal system design was carried out under the supervision of Dr. Xiaobing Liu, an invaluable member of the FHUSA design team, who brought his geothermal expertise to the project, project developer Lewis Demetri said. It is a closed-loop, vertical system with nine boreholes drilled 230 feet deep.

Another unique aspect of FHUSA is that there are two modes–normal and demonstration. During the normal mode, which is described as a family of four, two 3-ton water-to-air heat pumps provide both heating and cooling for the house. However, since FHUSA will mainly be used as a public display, the home must accommodate an occupancy of 40 people. This puts a burden on the geothermal system, so three 1-ton water-to-air heat pumps were added to the house for the demonstration mode. Three energy recovery ventilator (ERV) units will also be incorporated to reduce the heating and cooling load and provide air filtering by minimizing dust and pollen, according to the Web site. "We have found that if you're saying ZNE, you're pretty much saying heat pump," Demetri said. "FHUSA is designed to demonstrate the GSHP system at its finest, in terms of both optimized performance and install appearance."

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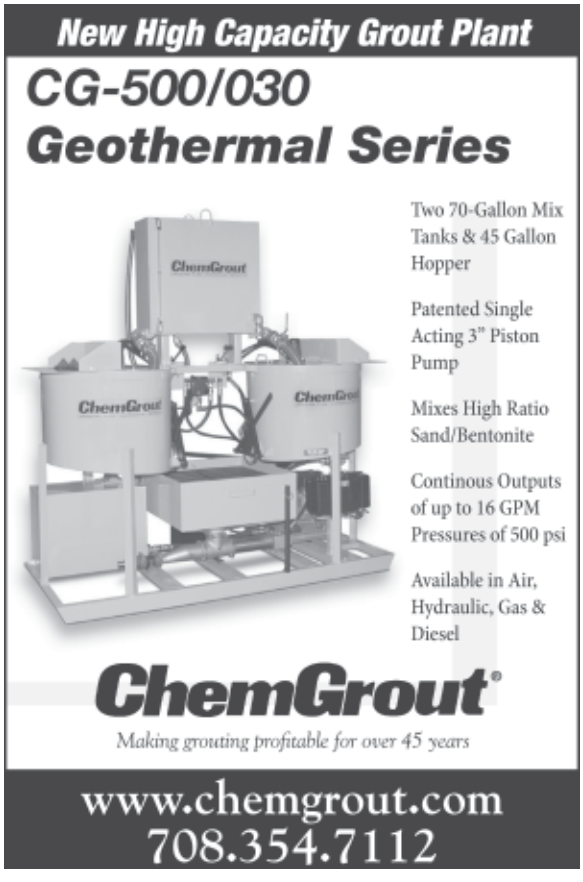
The Future Is Now

FHUSA is using an advanced building practice that Bialecki has termed Home Biology 101. This practice integrates the latest technology advancements in energy efficiency, water conservation, storm water management, indoor air quality, localized power production and storage, and recycling management. As it continues on the path to ZNE, FHUSA starts out with a reduced carbon footprint. Once ZNE is reached, it will have a zero carbon footprint as it creates all of the energy that it uses. The house will only use non toxic materials and will integrate products that eliminate off-gassing. It will also incorporate the architectural styles of Frank Lloyd Wright and the Chinese practice of Feng-Shui, according to the Web site.

FHUSA is showing the world what America can offer to help better the environment. The goal of FHUSA is to bring together a variety of technologies to create a fully integrated, sustainable "made in the USA" house. After completion in June, final touches will be made for the ribbon cutting, which will coincide with the Olympics' opening ceremonies. Bialecki hopes people learn from the project above all else. "This is really a demonstration project–it's a classroom," he said. "Not only are we part of this project, but our team goal is for the United States to lead the way. Through FHUSA, we are presented an opportunity to show that we are a great country and that we are really concerned about our collective future. It's very important that we look at the environment in a new way that's different from the past and present. Otherwise, what will be left for the next generation?"

Photos and graphics courtesy of Future House USA.



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 or via e-mail to igshpa.news@okstate.edu.

Geothermal and the U. S. Military

Since the '90s, various U. S. government and military facilities have utilized geothermal heat pump systems because they save energy, reduce maintenance, and are a "green" and "renewable" technology. Initially, through the "Super" Energy Savings Performance Contract (ESPC), bases such as Fort Polk in Louisiana and others converted thousands of military base family housing units from air source heat pumps, air conditioners and fossil fuel furnaces/boilers or resistance heating to high efficiency geothermal heat pump units. Other bases, such as Fort Bliss in Texas, built and continue to build new family housing stocks with geothermal. The use of geothermal by the military has spread through all branches, both in the USA and overseas.

A good example is Fort Sill near Lawton, Oklahoma. The new construction housing they have constructed is designed to be energy efficient, with superior envelopes, Energy Star appliances, and Energy Star geothermal heat pumps. Commercial facilities are similar, designed and constructed to LEEDS Silver requirements.

Over the last few years Fort Sill has used vertical ground heat exchanger geothermal heat pump systems on:

- Renovation of some "commercial" class facilities,
- 2 new construction phases of family housing (310 dwellings)
- Renovated historical family housing stocks (128 dwellings), and
- Are currently constructing several new "commercial" class facilities

Other bases, such as Camp Lejeune in North Carolina, have taken advantage of privatization programs. Large home builders with a regional or national presence take over housing stocks, providing renovation upgrades to existing units, new housing units, maintenance, and management of family housing over the long term. These companies are to be congratulated for the improvements they have made in existing military family housing stocks and the quality of new housing they are building. More and more of these contractors are also using geothermal for the long term benefits. This is particularly significant and they are to be complimented since the reduced operating costs benefit the USA's military families who occupy these houses and pay the utilities.

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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