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NOTES FROM IGSHPA
By Roshan Revankar
Training Program Manager: IGSHPA

Residential Systems

The ground source heat pump (GSHP) industry was initiated by the residential market. With improvements in design and performance of GSHP’s, it is now possible to install a residential system at much lower costs than before. This success would not have been possible without continuous research support provided by pioneer institutions and manufacturers to develop high efficient water source heat pumps.

This third quarter issue of the Geo Outlook conscripts few success stories in the residential sector with the focus being high efficiency yet affordable homes. Well-designed systems, either new or retrofits are essential to reduce first costs and provide a quicker return on investment. Al Wallace is one such designer and innovator featured in this edition. Al specializes in integration of geothermal with solar thermal and radiant heating and cooling.

Our writers are keen to digest your experiences pertinent to GSHP performance. Success stories should not go unnoticed. If you have been a part of any such successful project, contact us and we will publish it for you.

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Industry Profile—Al Wallace
By Janet F. Reeder

Energy Environmental Corporation’s Al Wallace, founder and president of the Centennial, Colorado veteran-owned small business, has the kind of experience in the industry that allows him to be both an innovator and a designer of high-performance energy systems.

Wallace started EEC in 2006, following the operation of another firm, Eagle Ridge Engineering for the previous eight years. His expertise is in the integration of solar thermal, geothermal and radiant in-floor hydronic heating and cooling high performance systems in low energy buildings.

EEC’s patent-pending solutions incorporate commercial scale highly reliable controls for superior comfort, indoor air quality, and energy efficiency. For EEC, the common theme is planet-friendly elegant architecture.

This architecture evolved based on Al’s training and experience in the military and working for software technology companies. Starting his career as an Air Force F-15 pilot, he remarks that designing an integrated heating and cooling system is similar to flying, as it requires you to keep things simple, “push the stick forward and the houses get bigger, pull it back and the houses get smaller.”

The secret to simplicity is designing systems with an underlying architecture which provides interoperability. The current practice of disparate piping systems and standalone controls for geothermal, solar thermal, and other renewable technologies violate this premise.

Applying lessons he learned in the mid-90’s developing command, control and intelligence systems for Oracle, Sybase, and Cisco Systems, Al has been able to implement complex yet simple integrated solutions.

The company’s design/build projects have won numerous regional and national awards and have been featured in national publications. While most clients are mid-sized custom homeowners, the company has installed systems in retrofit and new homes as small as 700 sq. ft. and as large as 30,000 sq. ft. These projects have “pressed the edge of the envelope”, comments Al, “presenting formidable business and technical challenges.”

On one project for a production home builder, EEC installed a geothermal heat pump in a net zero energy home for under $10,000. At the other end of the spectrum, EEC has designed and installed systems in a 30,000 sq. ft. retreat in the Texas hill country utilizing radiant floor cooling and heating across 99 radiant zones, forced air for 20 zones, and digital controls for 18 ground-source heat pumps which provide heating, cooling, domestic hot water, for wine cellars, and pools.

The most recent project EEC has completed is a community center club house adjacent to a golf course with a spring-fed lake. A geothermal pond loop and heat pumps provide heating and cooling, domestic hot water, and heating for the indoor and outdoor pools and spa, and is integrated with a high-efficiency boiler delivering snowmelt during
the winter and pool heating in the summer. He is currently working on the design for a large custom home in Aspen that utilizes 50 tons of geothermal capacity for a 10,000 sq. ft. residence with 8,000 sq. ft. of snowmelt. While energy efficiency is important, Al’s goal is to provide comfort and indoor air quality for his clients.

There were two perspectives which lead him to this objective: a background in enterprise computing, and extensive exposure to HVAC technologies implemented in Western Europe. Having flown in Germany while in the Air Force, he was aware of the emphasis on energy efficiency and sustainability. While working on a Masters in Architecture in 1999, Wallace trained at the Master Builder Gewerbe Akademie, Rottweil, Germany.

A few years later he completed software modeling training with Vela Solaris in Winthur, Switzerland, based on integrated systems developed by the Institute for Solar Technologies SPF of the University of Applied Sciences Rapperswil (HSR), Switzerland.

He began to realize that architects in general would rather design form and spaces, rather than mechanical systems. In residential structures within the U.S., these HVAC and hot water systems lack any structured design as most contractors rely on rules of thumb when implementing systems.

In Europe, compact designs of integrated system and controls were available off-the-shelf from manufacturers. It was not uncommon to have one hydronic heating and domestic hot water unit with advanced controls. In addition, EU standards mandated tight building envelopes and low energy construction.

Al Wallace believes that contractors offering building science consulting along with geothermal, solar thermal and radiant hydronic systems have a competitive advantage within traditional HVAC trades. In that light, he has delivered seminars and conducted training to encourage builders to construct low energy building envelopes, and contractors to adopt these technologies.

Wallace is past president of the Colorado Heat Pump Association, has served as a HERS rater and as a director of E*Star Colorado, a group tasked with developing strategies to improve residential energy efficiency in Colorado. He serves on Uponor Corporations’ North American Radiant Advisory Council and on the City of Centennial Building Code Board of Review.

He is a member of the American Society of Heating and Refrigeration and Air Conditioning Engineers (ASHRAE), an associate member of the American Institute of Architects, a Certified GeoExchange Designer (CGD) by the Association of Energy Engineers, and an IGSHPA Accredited Trainer and Installer. He has earned the LEED for Homes Accredited Professional designation from the U.S. Green Building Council.

Wallace currently holds Advanced Building Science Master’s Certification, and is a certified contractor for Tridium’s NiagaraAX enterprise control software. He is a 20 plus year member of the Timber Framer’s Guild, where he is a regular contributor to their international newsletter, writing on sustainable design and systems. He is an adjunct instructor within the Renewable Energy program at Red Rocks Community College in Lakewood, Colo.

In the past three years, he has promoted energy efficiency and renewable energy technology to over 1,000 design professionals and building trades’ contractors.

Al holds a Bachelor of Science degree in Aeronautical Engineering from the U.S. Air Force Academy, a Master’s degree in Business Administration from Golden Gate University in California, and duel Master’s degrees in Architecture and Landscape Architecture with certificates in Design/Build and Historic Preservation from the University of Colorado at Denver.
Two of the ZEBRAliance homes in the Crossroads at Wolf Creek subdivision in Oak Ridge, Tenn., were equipped with the foundation heat exchanger technology.

(Photo courtesy Piljae Im-ORNL)
Energy efficient ground-source heat pumps are on the way to becoming both more affordable and increasingly more desirable options for residential use, thanks to new facts gained from a collaborative research project called ZEBRAAlliance. That project’s research has recently been completed on four Tennessee homes, two of which were built with the goal of decreasing the cost for residential ground-source heat pump installation.

The project’s goal is to show consumers how affordable and appealing highly energy-efficient homes can be. Schaad Companies, co-founder of the ZEBRAAlliance, built four homes; each equipped with different energy-saving strategies, in an Oak Ridge, Tenn., subdivision.

ZEBRAAlliance, a public/private partnership, was formed by the Department of Energy’s Oak Ridge National Laboratory (ORNL) and Schaad Companies in 2008. ORNL provided project management, technical expertise, industry partners and the research on the homes.

The project looked at the efficiency of two technologies to reduce the cost or improve the performance of ground-source heat pump systems: a foundation heat exchanger (FHX) and a ground-source integrated heat pump (GS-IHP). Many other experiments were conducted in the homes, including the evaluation of four building envelope strategies: structural insulated panels (SIP), optimal value framing, a double wall system, and an exterior insulation and finish system (EIFS).

The primary sponsor of ZEBRAAlliance project research was the Department of Energy Building Technologies Office. However the Tennessee Valley Authority also provided funding for the ZEBRAAlliance project, as well as participating in the design process. David Dinse, who works in Technology Innovation at TVA and is on IGSHPA’s advisory council, participated as a design team member. Dinse says being on the design team included work on both mechanical system design and the building envelope.

“The project demonstrated the thermal performance of four different

John Shonder of ORNL, Jeff Spitler of OSU, Simon Rees of De Montfort University and Dan Fisher of OSU, worked together on the ZEBRAAlliance project’s research and model development for the FHX.

(Photocourtesy Piljae Im-ORNL)
building envelope designs for enhanced thermal performance,” Dinse said.

“TVA has worked with ORNL for many years,” Dinse said. “This is a part of a continuing effort by TVA over many years promoting the wise and efficient use of electricity. The foundation heat exchanger concept used in ZEBRAffiliation houses one and two was first tried on one of the Habitat for Humanity homes in Lenoir, Tennessee but we wanted to see how the concept would work in full-sized homes.”

ZEBRAffiliation homes one, two and three had variations of ground-source heat pumps, while home four had a standard air-source heat pump. The initial GSHP systems in homes one and two were replaced with the GS-IHP prototype during the study.

The homes were vacant during the research phase, but occupancy was simulated for research purposes. After a 30-month research period, the homes were equipped with standard market heat pumps (excluding the fourth home, which kept its standard air-source heat

(below) The mechanical room in the basement of house 1 (SIP house), shows the GSHP system for space conditioning, water-to-water heat pump system for water heating which is also connected to the FHX, and the hot water tank connected to water-to-water heat pump.

(Photo courtesy Piljae Im-ORNL)
pump) and put on the market for interested buyers.

For the foundation heat exchanger model development, ORNL put together a team led by Jeffrey Spitler, a Mechanical Engineering professor at Oklahoma State University. His team was made up of three students and Simon Rees of De Montfort University in the UK. Spitler and his team developed the models for the loops and the construction excavations.

“We developed the models as ORNL collected data and we compared as we went,” Spitler said. “In the end, we developed models that were validated against Oak Ridge’s experimental data.”

Spitler worked to get the models into Energy Plus, a building energy simulation program used to model energy and water use in buildings.

“The results are promising for the parts of the country with a moderate climate,” Spitler said. “It could be implemented in quite a few places, but if you were going to test the boundaries farther north, more research homes would be needed. One of the last things we did was a map of the U.S. showing where loops in construction excavations would work well and maybe where it would be a little more difficult.”

According to Patrick Hughes of ORNL, the ZEBRAAlliance project came about at an opportune time when the residential housing market had slowed.

“Schaad Companies was interested in using that slow time to learn a new product for their home building business,” Hughes said. “We had some technologies and industry partners that were ready to put some new things in and essentially field test them in homes.”

“Having learned about ORNL’s research in residential building technologies and Tennessee Valley Authority’s interest in energy efficiency, Schaad initiated a collaboration that resulted in a win-win-win for all involved,” Schaad’s CEO, Jennifer Banner said.

Schaad brought in Barber McMurry Architects to design the four test homes to be built in the Crossroads at Wolf Creek subdivision in Oak Ridge, Tenn. Schaad leased the homes to ORNL for $1 a day for 30 months. Banner says ZEBRAAlliance was Schaad’s first major endeavor to improve energy efficiency in its residential product offerings.

Each of the four homes had different combinations of energy efficient strategies to be tested. House one used
an FHX system, as opposed to the traditional method of drilling boreholes for loops, and was built using the SIP envelope. House two also used an FHX system, but was built with the optimal value wood framing as the building envelope. Houses one and two both had walkout basements. House three used the conventional vertical loop ground-source installation and a double-wall building envelope. House four was equipped with a top-of-the-line standard air-source heat pump and was built with an EIFS envelope. Houses three and four were two-level buildings over crawlspaces.

The FHX was developed to go along the foundation of the house and in utility trenches, reducing the need for traditional trenching or drilling and thereby cutting the cost of installation. Research shows that this installation may reduce the installation cost in this region by up to $1,000 per ton. The average cost in this region for traditional vertical-loop and six-pipe-per-trench horizontal-loop systems is $3,000 per ton and $2,250 per ton, according to the ORNL Final Report.

ORNL worked with ClimateMaster during the study to develop a ground-source integrated heat pump to eliminate the need for multiple heat pumps. The GS-IHP is used for both space conditioning (heating and cooling) and water heating. Houses one and two were initially equipped with ClimateMaster standard geothermal heat pumps and after a year of baseline research on the original units, they were replaced with the GS-IHP. ClimateMaster donated all the heat pumps used in the project, according to Climate Master Product Engineer Shawn Hern.

“ORNL took our current, high-end standard heat pump to get a baseline while we were still working on the integrated heat pump,” Hern said. “After we had the GS-IHP installed and running, ORNL provided us with feedback and data on performance and other issues that could be improved upon.”

Smith and Associates Geothermal was responsible for the installation of the ground-source systems. Houses one and two were both 3,700 square-foot and they started out with a 2-ton

About 100 feet of the six-pipe heat exchange loop was placed along the basement and the remaining loop was placed in utility or additional trenches. (Photo courtesy Piljae Im-ORNL)
water-to-air heat pump for heating and cooling and a 1.5-ton water-to-water heat pump for water heating. The heat pumps were later replaced with the newly designed GS-IHPs.

House one and two both used the horizontal loop installation method with 3/4-inch pipe and six pipes (three circuits) per trench. The loop fluid was 20 percent propylene glycol solution. About 100 feet of the six pipe heat exchange loop was placed along the basement walls and the remaining loop was placed in utility or additional trenches. Around 60 percent of the excavations used were already required for construction, according to ORNL’s final report.

House three used the vertical loop installation method with 320-foot deep vertical boreholes. It was equipped with a 2-ton water-to-air heat pump and a 1.5-ton water-to-water heat pump. House four had a 2-ton high-efficiency air-source heat pump.

The research done on building energy-efficient homes has shown immediate results. Schaad has already begun using the energy-efficient building techniques tested during the ZEBRAAlliance project in their residential homes.

House 2 in the project was built using the OVF building envelope and the FHX system. (Photo courtesy Piljae Im-ORNL)

“The project transformed our entire residential business line,” Banner said. “All of our residential product offerings now meet or exceed Level III Energy Star standards and achieve HERS ratings in the low 50’s.” Energy Star and HERS are industry standard rating systems that measure a home’s energy efficiency.

ClimateMaster has introduced the Trilogy Series from the GS-IHP that was developed for the project. The Trilogy 40 Q-Mode™ won the heating category of the 2013 AHR Expo Innovation Awards and gold for the second year in a row at the 2013 Dealer Design Awards. Recently Trilogy 40 Q-Mode was also recognized with a 2013 R&D 100 Award.

“The product itself was first announced about the middle of 2012, but it wasn’t available until the end of 2012 in limited supply,” Hern said. “So far they have been well received.”

Editor’s Note: Oak Ridge National Laboratory is a multiprogram science and technology laboratory managed for the U.S. Department of Energy by UT-Battelle, LLC. The research from the ZEBRAAlliance project is available on their website under the heading “Whole-Building Integration Research” near the bottom of the publication list found at http://w-web.ornl.gov/sci/ees/etsd/hbic/publications.shtml.
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Installers as System Integrators
By Albert R. Wallace
In every economic environment—but especially in a recession as deep and prolonged as this one—developing new sources of business becomes the lifeblood of any firm. The best and most profitable way to cultivate these revenue streams is to provide current customers with more services and to offer new clients services that are difficult to find from any one contractor.

Heating and air-conditioning contractors can grow their bottom lines today using lessons learned from the high technology computer industry. How? By becoming “system integrators.”

Integrated systems are the combination of cutting-edge comfort technologies—radiant heating and cooling, solar hot water and geothermal heat pumps—that complement one another in ways that achieve greater energy efficiency than stand-alone systems can.

An integrator understands how to give clients—consumers, builders or building owners—the comfort, energy efficiency and indoor air quality they want. Currently to achieve the type of energy savings industry leaders feel are possible, multiple contractors are generally needed. For instance, it is not uncommon to have an installer for the geothermal system, another for the radiant floor heating and a third for solar photovoltaic panels. And the list can go on and on. While everyone wants the benefits of these new technologies, no one wants the migraine of multiple contractors and multiple points of contact when something doesn’t work.

For you, as an HVAC contractor, to become a sole-source system integrator, your thinking process needs to move beyond the usual trade boundaries: plumber does this, solar guy does that, and so forth. Why? System integration is what your customers will pay you to provide. This value for the consumer translates to higher profit margins and expanded market share to the integrator.

The value today is in the higher-priced, fully integrated computerized “package.” In our HVAC world, the value professionals like us can provide encompasses sustainable design, energy efficiency and unprecedented comfort that customers will enjoy for decades to come.

How do you achieve this? By looking at systems holistically and finding similarly minded folks in those trades to partner with, or by expanding your own staff to include these disciplines. At a 2010 Uponor seminar, I used as a case study my own experience with the Uponor Climate Control Network.
(CCN) as an enabling technology to provide systems integration.

Some of you may be asking, “Who is this guy Al Wallace, and what qualifies him to tell me how to grow my business?”

This is a fair question. Like most critical lessons in life, I came to understand the importance of becoming a system integrator the hard way.

On Thanksgiving Day 2007, a fire engulfed and destroyed our home in Centennial, Colorado. I am a long-time proponent and practitioner of sustainable design, and this tragedy provided my family an opportunity to design and build an energy-efficient and environmentally friendly home, capable of achieving a Platinum LEED rating from the United States Green Building Council.

Built atop the old foundation and basement, the new 3,300-sq-ft., two-story residence took more than two years to complete. The integrated systems provide unparalleled comfort and indoor climate.

The combination of passive solar design, a high-quality building envelope, and advanced digital controls delivers net-zero energy for heating and cooling the structure; that is, our new home produces more energy than it consumes over time. By itself, the home is 80 percent more efficient than a similar structure of comparable size, using standard construction and conventional control systems.

Researching and designing an integrated renewable energy system that manages heating, cooling, hot-water production and ventilation takes time. When you also include radiant cooling, the task may be daunting. I looked to my experience with enterprise software companies for the answer. Inherently, systems integration requires sophisticated off-the-shelf technologies to maximize interoperability, performance and savings.
For example, the major components of our new home’s integrated system include two ground-source heat pumps (GHPs). Although only the water-to-water unit is required for heating and cooling, we use the water-to-air unit for ventilation and to test the performance of hydronic systems over a ducted forced-air system.

The integrated system also includes four rooftop solar-thermal collector panels, a six-kilowatt solar photovoltaic array, and an energy recovery ventilator (ERV). In addition, space heating and cooling is furnished throughout most of the home with a high-mass radiant system in which PEX tubing has been installed in the floor and covered in concrete gypcrete.

So what are the functions of all these components? The first GHP—a three-ton water-to-water two-stage compressor unit from Enertech—augments the rooftop solar collector panels to maintain a constant temperature in the hot-water tanks that supply the radiant system and provide all of our domestic hot water needs. Combining this technology with advanced controls enables the GHP to run at 60 percent of peak load consumption, thus increasing the heat pump’s coefficient of performance while reducing the overall energy consumption.

The second GHP, a three-ton, water-to-air unit from Water Furnace International, operates with its own electronically commutated motor fan blower that works in conjunction with an ERV that helps maintain indoor air quality by refreshing the indoor air while minimizing energy loss to the exterior. The ERV and GHP, precisely controlled by the CCN, provide whole-house ventilation, using less than 100 watts of power.

Your key to success as a systems integrator depends on how easy it is to design, implement, and maintain the controls to achieve peak comfort and efficiency. Ideally the controls should be plug-and-play, yet customizable for specific applications. In the end, the controls are king. They rule the systems and ensure the results you and your customer want.

We could not have achieved the functionality described in my home using traditional technology. There would be one control box for solar hot water, others for the heat pumps, mixing, snow melt and anything else. All would be built by a different manufacturer, and all unable to talk to one another.

With two years’ experience in our home and at a handful of client sites, the best system I’ve found for managing all the components—even in the most complex systems—is the...
Climate Control Network from Uponor. Using the CCN, I am able to monitor and control components in my home via thermostats, a touchpad interface or through my laptop when I am away. I can monitor or troubleshoot and make instant changes to any of the settings by looking at real-time data. The system can send me an email or text message when something is out of the parameters for alarms I’ve set.

While it is possible to achieve this same objective using direct digital controls (DDC), that approach is costly and time-consuming for the contractor and the homeowner. For most residential clients, the DDC system’s up-front and maintenance costs are too expensive. Yet, without complex functionality, we would be limited in what we could deliver as a systems integrator.

With the CCN, we are able to outperform DDC capabilities using commercial off-the-shelf software modules provided by Uponor. Troubleshooting a complex system with DDC-controlled mechanical relays would be extremely difficult. Using the CCN controls, we are able to troubleshoot and isolate a component failure in several minutes.

For me, the clear choice is the new generation of HVAC controls like the CCN that can detect all the available heating devices in a home and automatically select the one with the lowest possible energy consumption.

Take the time to investigate the opportunities to learn a new way of doing business that will greatly enhance the value of your services to your customers.

**Editor’s note:** At this publication, Wallace notes that Uponor has discontinued the Climate Control Network from their product line. He says other manufacturers are coming out with similar controls. His company, Energy Environmental Corporation, also has a patent pending on a low cost integrated control that provides the functionality described in this article. This article is reprinted with permission of PHC News.
Architect’s Prairie Home Honors Family History

By Linda Allen
We call our piece of quiet on the Oklahoma prairie the Home Place. That’s the name my great-grandfather, Harry Liebhart, gave the 160-acre tract near Drummond after he claimed it in the Cherokee Strip Land Run of 1893. His fiancée, Norma Cox, joined him later from Kansas. Together they fulfilled the five-year requirement to settle and improve the land. From dugout to a little house on the prairie, they built and cultivated the raw prairie into productive wheat and cattle land. Their pioneer lifestyle was eco-friendly and sustainable as a means of survival.

The original house dated from at least 1903, which is the first photo of it on the treeless prairie. The white frame house had three bedrooms, kitchen, pantry, dining area, and parlor – all small by today’s standards. The bathroom was detached – i.e. – an outhouse. My grandmother and mother grew up in that house. My sister and I spent summers there enjoying the fresh air and sunshine while helping with the chores.

When my husband, Don, and I decided to build on the Home Place, only sheds and the wash house remained. Cattle had occupied the land – and occasionally the structures for more than 40 years. We had to tame the land, much like my grandparents had done.

Don is a career architect. This opportunity would allow him to design our dream home using LEEDS and green concepts. I have written for Geo Outlook for several years. This was my opportunity to test the reality of the research, reputation and return on investment of a geothermal system.

The land is designated a Centennial Farm, which requires that it be a working farm producing income and still owned by the original settling family. We wanted our home to tell our family’s story on the land by including family artifacts with modern amenities while being as eco-and budget-friendly as possible.

Finding a builder in rural Oklahoma who would step out of his comfort zone to work with Don’s design, green features and our salvaged and repurposed materials proved to be a three-year challenge. Jeff Tebow, owner of Tebow Construction in Lamont, Oklahoma, met our requirements. Founded in 2000, quality craftsmanship and onsite construction management are Tebow’s trademarks, which made the project run smoothly. Most of his business comes from referrals and reputation, which was another endorsement.

Don designed the house to continue the green living and sustainability practices that have always been my family’s lifestyle. “Energy efficiency and livability drove the design. The energy envelope started with the site.

Lang Well Drilling drilled six 200-foot deep boreholes in the side yard adjoining a wheat field. (Photos by Linda Allen)
orientation. Each feature complements the others for an efficient, economical and comfortable house,” he said.

We chose low-e, dual pane windows with composite frames made with recycled sawdust to provide natural lighting and views of the prairie throughout the house. On mild days, we open them to allow the wind to cool the house. Ceiling fans circulate the air.

Two-by six-inch exterior walls with sprayed foam insulation and a metal roof help keep the house at a comfortable 78 degrees in the summer and 68 degrees in the winter. “We added an extra inch of foam to maximize the insulation,” said Don.

A ground source heat pump (GSHP) is the workhorse for heating and air-conditioning. We chose geo because it is environmentally friendly and will provide both an ecological and economic return on investment far into the future.

IGSHPA member, Tim Lang, of Lang Well Drilling in Enid, Oklahoma, did the ground work for the closed loop system. Lang has been in business 11 years with 120 geo installations. He and Tebow have partnered on several residential installations. Both are strong advocates of the technology. “It’s the only way to go, in my opinion,” Tebow said.

Lang agreed it is great for new construction. “We work to give our customers a quality installation for great results,” he said.

Lang described our project as small with no installation problems. The geo field measures 20 by 35 feet with two rows of three wells spaced 15 feet apart – both rows and wells. The wells are 200 feet deep. One-inch HDPE pipe carries water through the system.

A Bosch 5.5 ton, two-stage heat pump powers the system. The mechanical room has easy access under the stairwell with ample storage space. A desuperheater provides free hot water during the summer.

“With no condenser like a conventional system would have, we had fewer concerns with vandalism and copper theft, which are concerns with construction in rural areas,” said Don. “We also enjoy quiet, summer evenings outside without the noise of a condenser switching on and off.”

The true test of the energy system is the comfort, livability and economics of the house. We are conservative energy consumers, so our utility bills are one

The master bath looks out over century-old trees, wetlands and prairie grasses. (Photo by Janet F. Reeder)
Utility costs for the 3300-square foot, total electric structure averaged $89.59 over the 16 months we’ve lived here, with a high of $135.93 during the summer of 2012 when Oklahoma experienced the hottest summer on record since 1934. Our highest winter bill was $102.80.

Total cost for the system was $32,000, which included drilling, equipment and installation. It qualified for the federal tax credit of 30 percent and a $375 per ton rebate from OGE Energy Corporation.

Additional green features include low-flow plumbing fixtures, Energy Star appliances, salvaged and repurposed materials, man-made stone, EIFS exterior and native landscaping.

The interior showcases salvaged and repurposed materials from the original house, the wash house and a shed plus Low-e windows provide natural lighting and ventilation and frame expansive views of the prairie throughout the house.

A compact 5.5 ton Bosch heat pump fits easily into the mechanical room under the stairs, with ample space for maintenance and storage.

(Photo by Don Allen)

(Photo by Don Allen)
materials Don collected during his career. As we worked on the house, my siblings gave us pieces and parts of the original house that had been stored in their attics and garages to repurpose in the house. Other family members contributed mementos from my grandparents.

The front door of the original house is now the door to the powder room; parlor doors and their decorative plinths open to the office which features antique roll top and writing desks and chairs.

We salvaged as much material from the wash house as we could. The interior bead board was repurposed as the kitchen ceiling, cooking island base and wainscoting in the powder room. Old paint from the doors and bead board was removed by soda blasting, which is more eco-friendly than sand blasting and easier on old wood.

Cedar studs from the wash house were repurposed to create the fireplace mantel and benches for the guest bath and the plant room. Exterior boards have become rustic picture frames. Brick from the wash house, Don’s remodel jobs, his dad’s collection and ones salvaged from a burned building make up the interior entry and exterior walkways. Light fixtures from the dorms where we lived while we were dating in college and salvaged glass blocks have become conversation pieces in their new setting.

Family artifacts from the past add character to our home and remind us of our ancestors’ stories as they settled the land. While my great grandparents’ green and sustainable lifestyle was one of survival on the unsettled prairie, our lifestyle 120 years later continues their practices to protect the land and its resources for future generations. As we settle into the house and the ways of the land, I believe my grandparents would be proud of their long-term return on investment in the land.
Geothermal Rides Out Sandy on Long Beach Island

By Dara McCoy
When Dan and Marilyn Nichols bought beachfront property to build their ideal retirement home in Long Beach Island, New Jersey, they dreamed of a house large enough to accommodate their four children and seven grandchildren. They dreamed of oceanfront views and sandy beaches mere feet away from their back door. They didn’t dream about Hurricane Sandy hitting their state and home during its construction.

Dan Nichols, a retired pharmaceutical company executive, and his wife made a North Beach vacation home their primary residence after Nichols’s retirement. When a coveted beach front property came open, they made the purchase in October 2010.

While living in their original North Beach home, the Nichols went about a “labor of love” to design and build their ideal retirement home, said Nichols. They demolished the 1942-era home that sat on their new property, but were still constrained to building within that home’s footprint by the State of New Jersey’s Coastal Area Facility Review Act (CAFRA).

“I wanted a home that was big enough for all my grandchildren, big enough that each child could have a room, their own identifiable space,” said Nichols. “It would be on the ocean and big enough for everybody to enjoy.” Nichols contacted his architect, Jay Madden, and builder, Dean Harkness, to create a design that stayed within the CAFRA guidelines, but still maximized the size of the home on a 150 by 400-foot lot.

Where the home couldn’t expand out, it went up. The Nichols’ managed to build a 6,000-square-foot home by utilizing three floors. Nichols describes the design as “reverse living,” where some of the most-used spaces in a home are placed on the top floor. The kitchen, dining area, living/entertainment room, master bed and bath, a hobby room for Marilyn and an office for Dan are all located on the top floor.

The second floor is dedicated to the Nichols’ descendents: five bedrooms around a large “gathering room,” complete with refrigerator, microwave, and entertainment center. “All the kids and grandkids can do what they want in there, and won’t be keeping us up all night,” said Nichols. The ground floor is half three-car garage and mechanical room, with the other half split between a home gym and a game room large enough for a pool table, dart board, and television.

The Nichols weren’t only thinking about future generations when sizing their home, they also felt that adding solar panels and a ground-source heat pump system were responsible elements to include in their home. Prior to moving in, the Nichols had already accumulated 3,000 kilowatts from 78 rooftop solar panels. “It’s fun to watch the meter go backwards,” said Nichols. “We tried very hard to make it as green as we could. That’s one of the reasons why I loved the geothermal and the solar.”

The Nichols managed to work around CAFRA regulations that limited the footprint of their residence by designing a three-story home.

(The Nichols managed to work around CAFRA regulations that limited the footprint of their residence by designing a three-story home. (Photo courtesy of Robbins Water Service, Inc.)
geothermal heating and cooling technology for their home. He invited the Nichols to visit another one of his homes where geothermal was utilized. “From the visit, I was very impressed with how quiet everything was when it was operating. My current house has central air, and you hear it all the time. It’s loud. It’s noisy,” Nichols said. “You had to work to hear this thing.”

The Nichols further investigated the technology by talking with Jeff Jaekel at J&F Mechanical, a driller—Robbins Water Service, Inc., and doing their own research on the Internet. As they learned more about the economic, environmental, and aesthetic advantages of geothermal, they were sold on using it in their home.

Their home’s beachfront location created an additional cost savings advantage for geothermal over traditional heating and cooling. Exterior condensers common to central air systems have to be replaced every three to five years for these beachfront homes, Nichols said. “We’re literally on the ocean, 150 feet from the water,” said Nichols. “There’s a lot of wind at times, lots of ocean spray and salt in the air. It just beats the heck out of anything metal.” In contrast, geothermal systems have components buried underground, with closed-loop systems typically expected to last 50 years, and mechanical equipment is installed inside the home, safe from the corrosive elements.

While the Nichols and their descendents may enjoy plenty of space in their new home, John Robbins, who supervises drilling operations for the family business, Robbins Water Service, Inc., did not enjoy such a luxury while drilling on the Nichols’ lot. “It’s a

(Photo courtesy of Robbins Water Service, Inc.)
congested area,” Robbins said. “Most of the houses encompass two-thirds to three-fourths of these lots. That’s probably the biggest challenge of drilling in shore resorts like this.”

Robbins’ team came into the project early in the construction phase to bring in the equipment needed for drilling. To operate on a site that, at times, had merely three feet of clearance for their truck, Robbins Water Service utilized smaller drilling rigs, like a DrillMax 350. “We can maneuver it around sites easier, and it’s a lighter piece of equipment. It leaves less of a footprint in the yard,” Robbins said.

Robbins also used a vacuum truck on the site to reclaim the drilling fluid and cuttings. There was no room on the site for cuttings or run off in any direction. Robbins said owners who invest the money in geothermal systems deserve not being left with a big mess. “They don’t want their yard to look like a bomb exploded,” Robbins said. “We’re talking about multi-million dollar houses on top of each other, that’s not going to fly here.”

As discrete as Robbins Water Service attempted to be during the four-day drilling process, the beach resort neighborhood wasn’t quite accustomed to a drilling rig set up in their midst. The crew drew some attention while they worked. Robbins said he tried to greet anyone who walked up so he could explain what was going on. He said many ended up showing interest in the technology.

With space constraints overcome, Robbins Water Service drilled eight, 350-foot deep vertical boreholes for the ground-source system using mud rotary method and keeping a careful eye on the boreholes. “Salt water does tend to do some funny things with your drilling mud, breaking it down,” Robbins said. “That was definitely something we had to stay on top of and use certain additives to keep that from happening. If your drill mud gets broken down too much, you run the risk of having the hole collapse.”

The drilling was done and the Nichols’ house about 75 percent complete when a very unwelcome guest hit the northeastern coast of the United States. According to the National Oceanic and Atmospheric Administration (NOAA), Sandy made landfall near Brigantine, New Jersey, on October 29, 2012. In the U.S., Sandy killed 72 people, 12 in New Jersey, damaged or destroyed about 650,000 homes and left 8.5 million people without power, according to NOAA. The National Hurricane Center estimated property damage from Hurricane Sandy at $65 billion. Sandy became the second costliest and deadliest hurricane in U.S. history, behind only Hurricane Katrina.

Nichols said many of his neighbors—some no more than 50 yards from Buried below ground, geothermal’s outdoor components are protected from corrosive salt water and the dangerous impact of hurricanes. (Photo courtesy of Robbins Water Service, Inc.)
his new home—lost their entire ground floors to water damage, when high water broke through the sand dunes and rushed through the resort community. “If you were not fortunate enough to have a decent sized dune, you just got water rushing right through your house,” Nichols said. “There was a stretch of 10 homes further south that were all destroyed. Water came up 20 or 30 feet over the top of the dune and broke through. Hundreds of people are out of homes. It’s just scary.”

While the Nichols and their neighbors followed the mandatory evacuation and stayed out of harm’s way, their homes were left to face the storm. Dean Harkness, their builder, stayed on the island and gave updates until the Nichols were able to return to the island three weeks after Sandy hit. “We had a lot of sand come onto our deck, right up against the windows, 150 feet wide and two feet high of sand that went from house to ocean,” Nichols said. “We had to move all of that, but that was the extent of the damage. We were very, very fortunate.”

For the Nichols, the threat of just such a scenario had always been a plus for geothermal.

“When you’re on a barrier island like this, you always worry about this kind of thing happening,” Nichols said. The closed-loop ground-source system rested safely underground, while Hurricane Sandy raged above it.

“It’s very well protected,” said Robbins. “We have multiple installations on the island and not one of the ground loops was negatively impacted by the storm, which further proves their durability.”

By June 2013, the sand was long gone and the Nichols were “spindles on a stairway” away from occupancy. Meanwhile, many of their neighbors are still rebuilding from the damage.

When touring another home with GSHP technology, Dan Nichols was immediately impressed with its quiet operation when compared to conventional central air systems. (Photo courtesy of Robbins Water Service, Inc.)
Hurricane Sandy wrought. Many of them had expressed interest in the Nichols’ ground-source heat pump system, but upgrades come second to repairing damage. “Sandy got in the way of everybody doing everything,” said Nichols. “You’re reassessing your home location and your whole life because of Sandy.”

Fortunately, the Nichols still envision a house full of kids and grandkids, beautiful ocean views, and plenty of beach time. Nichols is excited about the many benefits of using sustainable technology in his home. For them, there is no second-guessing their home location, design, or use of geothermal technology.
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SkillsUSA Taking GSHP to the Next Level

By Janet F. Reeder
The geothermal heat pump industry is stretching to meet the needs for trained technicians and installers as the energy efficient and ecologically friendly technology expands into new markets.

By partnering with IGSHPA, universities, colleges, trade and technical schools and other educational entities are including GSHP training to add to the workforce and help meet those increasing needs.

SkillsUSA®, a national organization with more than 300,000 member students and educators partnering with business and industry to ensure a well-prepared skilled American workforce, has taken notice. Formerly called Vocational Industrial Clubs of America or VICA, the organization is active in more than 3,700 member chapters, 206 of which are colleges, in all 50 states, DC and three U.S. territories. All of these schools are comprehensive high schools with career and technical curricula, regional career and technical education centers, and two-year colleges.

“The great thing about SkillsUSA is actually in the definition of SkillsUSA. It is a partnership between students, business and industry. The three working together,” SkillsUSA Oklahoma State Director and Oklahoma Department of CareerTech Program Specialist, Darren Gibson, says.

“Geo is a good example of how the industry is directing the schools,” he says. “The training is one-hundred percent industry driven.”

SkillsUSA has the active support of more than 1,100 corporations, trade associations, business and labor unions at the national level and is active at local, state and national levels. The organization’s programs also teach leadership, citizenship and character development to complement technical skill training. SkillsUSA emphasizes respect for the dignity of work, ethics, workmanship, scholarship and safety.

In a local SkillsUSA chapter, trained student officers organize and help member students carry out a ‘Program of Work’ under the guidance of a teacher-adviser. The ‘Program of Work’ includes employability and leadership skills development, competitions, community service, chapter fund raising, social activities, public relations and employment while in school.

Assistant State Program Manager of Trade and Industrial Education with Oklahoma CareerTech, Jim Bullington, has been phasing in geothermal technology and heat pumps “over the last five years,” in Oklahoma’s programs. Bullington has been able to include at least a basic understanding of GSHPs in the state’s HVAC training efforts by helping his instructors to build training stations.

Oklahoma has an outstanding CareerTech network, that includes HVAC programs in 20 Technology and Skills Centers. Bullington says that the industry is supportive of the effort and is quick to show that support by donating equipment to be used in CareerTech’s Skills Centers. He is always on the lookout for tools and geothermal units that can be used by his instructors to increase the opportunity for their students to work on a variety of
models from different manufacturers. Bullington has also been writing and polishing curriculum to expand the GSHP training segment in the state’s HVAC offerings and hopes to see it adopted soon. Currently, in Oklahoma, the technology is briefly mentioned in HVAC texts and finds additional support from the initiative of instructors who try to include information and hands-on situations. Some programs take students to dealers or manufacturers to see products demonstrated.

At the state level this year, Oklahoma’s SkillsUSA competition included a station for ground-source heat pumps with a fusion demonstration, sponsored and manned by IGSHPA and McElroy. The GSHP station testing was not scored in this year’s state event.

Other stations and their sponsors included: Station 1- brazing project by the Pipe Fitters Union; Station 2 - electric heat problem by Lennox Industries and Sam Kinder; Station 3 - air flow calculation for gas or electric furnace or for cooling by O’Connor Inc. and Greg Westerman; Station 4 - gas heat station with mechanical, electrical problem or procedure by York; Station 5 - heat pump station with mechanical or electrical problem or procedure by Carrier and Ray Fletcher; Station 6 - air conditioning, mechanical or electrical problem or procedure by AAON; Station 7 - refrigeration, mechanical or electrical problem or procedure by United Refrigeration; Station 8 - ground-source heat pump by IGSHPA.

SkillsUSA national program has also recently incorporated ground-source heat pump stations in their national competition, the SkillsUSA Championships.

Both Bullington and Gibson admit Oklahoma’s CareerTech students have a home court advantage. With the state holding such a strong manufacturing and distribution base for the geothermal industry, students here have greater opportunity to both learn about and eventually work in the industry. Those who compete and do well at the Oklahoma SkillsUSA competition stand out and are recruited by industry reps.

“They are the best in the state of Oklahoma,” Gibson says. “Pretty prestigious. Oklahoma is recognized as the best in the country. So they would be the best of the best.” But winning carries more than prestige.

“They also many times walk away with several hundred dollars worth of equipment and tools, as well as scholarships,” Gibson said.

SkillsUSA state and national competitions judge high school participants and adult participants separately. First place winners in this year’s Oklahoma SkillsUSA competition came from Canadian Valley Technology Center in El Reno, and Red River Technology Center in Duncan. High school category first place winner was Benjamin Biorato, from CVTC; and adult category first place winner was Stewart Gibson, from RRTC.

HVAC Instructor Howard Griffin at CVTC in El Reno has reason to be proud of Biorato, although he says he is proud of all of his students.

Griffin, who started adding GSHP to his program last year, is in the process of completely rebuilding his teaching lab. On May 31, this year, an EF5 tornado barreled through El Reno leaving a path of death and destruction behind. Griffin’s class and lab area, as well as the entire Canadian Valley Technology
Center, was hit hard. Before the tornado, Griffin had begun preparing Biorato for the national competition.

“We weren’t able to get together and study and practice because of our building,” he said. “Ben still placed sixth in the nation. I have no doubts he would have placed in the top three nationally if he could have practiced,” he said.

The Washington Post declared the El Reno tornado at 2.6 miles, the widest ever measured on Earth. With winds measuring nearly 300-mph, the tornado killed 18 people, including four storm chasers.

“Our whole campus is relocating for a couple years to an old Chevrolet dealership in Yukon,” Griffin says. He says it is going to be interesting.

“It’s like going from a three-X shirt to an extra small shirt,” he says. “But we can make it work.” Griffin displays an amazingly positive attitude. “We will be okay. We will get through it and we will be fine.”

Griffin’s program lost equipment and says that most of what he needs to start school in the fall is coming in from manufacturers and donations from other areas, including IGSHPA.

“Is everything going to be up and running? No. But that is what I am planning on students being able to do—help us set up equipment,” Griffin said. His program typically sees 18 morning students and 18 afternoon students, with a fairly even split between high school age and adults.

“Right now we kind of have some catching up to do,” Griffin said. “If there are guys that want to check on us to see where we are in getting set back up—they could call.”

Students who complete Griffin’s program and the others around the country are looking at what he calls “a wide open field.” He says participants in the program are looking for an occupation that offers a good career choice for them. Veterans make good students, he says.

“Some students have gone to college for a year or two and decided that wasn’t their cup-of-tea. With the training that CareerTech provides, they can go out there and be successful in this industry,” Griffin says.

“Geo is up and coming and the students are glad they can get their hands on it,” he says.

Timothy Savage takes advantage of the IGSHPA and McElroy sponsored fusion testing station set up as a demonstration for SkillsUSA contestants.

(Photo by Janet F. Reeder)
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First, to be sure, increased piping in a trench or borehole does enhance the ground heat exchanger’s ability to transfer heat. Whether it is multiple pipes in a trench or borehole, spacers in a borehole to maintain separation between single or multiple U-bend pipes, larger diameter concentric vertical heat exchangers, large diameter vertical concentric heat exchangers with means to enhance turbulence within the heat exchanger, large diameter vertical heat exchangers with thermal barriers between the supply and return flow paths, etc. there have been significant claims about performance increases – so why are the old tried and true approaches not being replaced?

Drilling cost is not the issue; ground heat exchanger cost is the issue. With the rare exception of when some naturally occurring condition prevents drilling to the depths desired, there is no reason to go with shorter boreholes unless it carries a cost benefit. Don’t get me wrong – I’m for anyone that can provide new GHEX alternatives that improve performance and reduce system costs. Unfortunately, I’ve evaluated many of them and they all claim to improve performance – cost is the silent issue. For example, let’s consider a single U-bend against two U-bends in the borehole – does the limited improvement in performance offset the cost of the additional U-bend plus materials and labor to connect both to the headers, regardless of whether or not they are connected in series or parallel before that connection?

Considering the concentric or other large diameter pipe applications, they require a larger diameter hole (even if a hammer is not being used in heavy rock drilling) and take increased time and materials to assemble, install, and connect to the headers. Remember, it’s not the cost of the heat exchanger inserted into the borehole, it’s that cost plus the cost of labor and materials to fully connect the heat exchanger to the headers and any other difference between that system and the conventional U-bend system’s total installed cost.

So, it’s all in the math. If you save $1,000.00 on drilling but spend an additional $1,500.00 on labor and materials, what have you accomplished? What happened to your profit? I’m not for or against any technology; I’m for profit and industry growth. Do the math — it’s your money....

Mr. Rawlings has more than 35 years experience in the geothermal industry. He is the Director of Geothermal Services for Trison Construction, a Certified GeoExchange Designer (CGD) and an IGSHPA Accredited Installer and Trainer.
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The three day event featured Mark Hunt, WILO-USA’s corporate trainer, who explained the principle of ECM technology which powers WILO’s high efficiency Stratos pump. Topics covered were system evaluation, pump sizing, wiring, and how to extract the operating parameter of working pumps using an infra red device which downloads all the information to a Windows based lap top. All of this information was supplied in the context of geothermal systems.

Event attendees were some of the leading geothermal contractors and distributors from across the country, traveling from Texas, Kentucky, Ohio, Indiana, Michigan, Tennessee, and Wisconsin. The reaction from the event was so positive that we were asked to provide this training opportunity for the second time this year! The next Flow Center Products / WILO-USA ECM geothermal training event is scheduled for October 22 - 24, 2013.

For more details or to register for this event, contact Flow Center Products at 866-364-9460 or email rlklaty@flowcenterproducts.com.
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