2010

# Retrofitting the Workforce: Report #2

## Geothermal Heat Pumps
## (Geothermal Heat Exchangers)

Good Company Associates

TEXAS FOUNDATION FOR INNOVATIVE COMMUNITIES

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# TABLE OF CONTENTS

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*This report is designed to offer useful information to Texas' workforce investment boards and community colleges about the availability and potential of green jobs in the geothermal heat pump industry in Texas as well as to provide details on the workforce training needs of employees in the industry.*

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# EXECUTIVE SUMMARY

Geothermal heat pump (GHP) systems, also commonly referred to as geothermal heat exchangers or geoexchangers, are proven energy efficiency technologies that have been successfully used for over 60 years. The U.S. Environmental Protection Agency (EPA) has labeled GHP as "the most energy efficient, cost-effective, and environmentally clean space conditioning technology available." [1]

Often confused with geothermal power production, which uses naturally-occurring heat to produce steam to drive a turbine to generate electricity, and other forms of direct-use geothermal heating that can only be found in select locations across the globe, GHP systems can be widely deployed almost everywhere in the world. The GHP industry has experienced significant and continued growth over the last few years, and that growth is likely to continue despite (and partially because of) current economic conditions. Training and education, coupled with financing mechanisms and/or additional incentives for consumers, could further accelerate industry growth.

Many businesses and occupations can potentially be involved in the GHP industry, including designers, architects, engineers, drillers, excavators, conductivity testers, heating and air conditioning contractors, electricians, plumbers, pipe fitters, mechanical contractors, sheet metal workers, manufacturers, suppliers, distributers, sales representatives, and software engineers. An inventory of companies involved in the GHP industry in Texas can be found in Appendix A. In practice, many of the firms that manufacture, design, install, maintain, or sell geothermal systems often cross-train their employees in many different disciplines to facilitate and simplify the process for customers and to provide higher-quality comprehensive services that provide them a competitive advantage. Much of this training could be provided by, or at, community colleges.

Trainings and accreditations from the International Ground Source Heat Pump Association (IGSHPA), located in Stillwater, Oklahoma at Oklahoma State University, are the current industry standard for most trainings and certifications specific to workers in the GHP industry. Other organizations with relevant occupational training and certification requirements for the GHP industry include the Association of Energy Engineers (AEE), North American Technician Excellence, Inc. (NATE), the National Ground Water Association (NGWA), the Geothermal Heat Pump Consortium (GHPC), GHP manufacturers, and the U.S. Department of Energy and EPA via the ENERGY STAR program. All of them collaborate with IGSHPA.

In terms of formal licensing in Texas, the only established license class specifically dedicated to geothermal technology by the Texas Department of Licensing and Regulation (TDLR) is the license for a geothermal water well driller. However, all heating, ventilation, and air conditioning (HVAC) contractors must have a TDLR license before performing air conditioning work. As the industry continues to grow, there may be some licensure issues that need to be addressed to ensure there is an adequate supply of appropriately qualified professionals in the field.

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[1] Environmental Protection Agency, Space Conditioning: The Next Frontier. Office of Air and Radiation, 430-R-93-004 (4/93).

In general, the skill and knowledge needed for workers in the GHP industry will require incremental training and experience to develop enhanced skills relevant to the industry, rather than training to transition workers to entirely new occupations. For example:

- Geothermal well construction generally uses the same equipment and requires many of the same skills used by water well contractors. However, some additional training is needed as well as new approaches to managing equipment.

- Plumbers and pipefitters for geothermal systems require additional training on heat fusion of high density polyethylene (HDPE) geothermal pipe and other fitting/grouting techniques, but leverage many of their existing skills.

- Capable HVAC/R and mechanical contractors should be able to easily learn about and service geothermal units since they are in many ways simpler than traditional units, but they still require additional training.

Therefore, a key market for any potential training to be developed should be for experienced workers in related fields, not just entry-level job-seekers. Additionally, since the development of enhanced skills carries relatively little risk, other than the financial and opportunity costs of attending the trainings, and could provide a competitive advantage for workers and companies in the industry, well-priced and relatively short courses on specific, relevant occupational skills and knowledge topics could do very well.

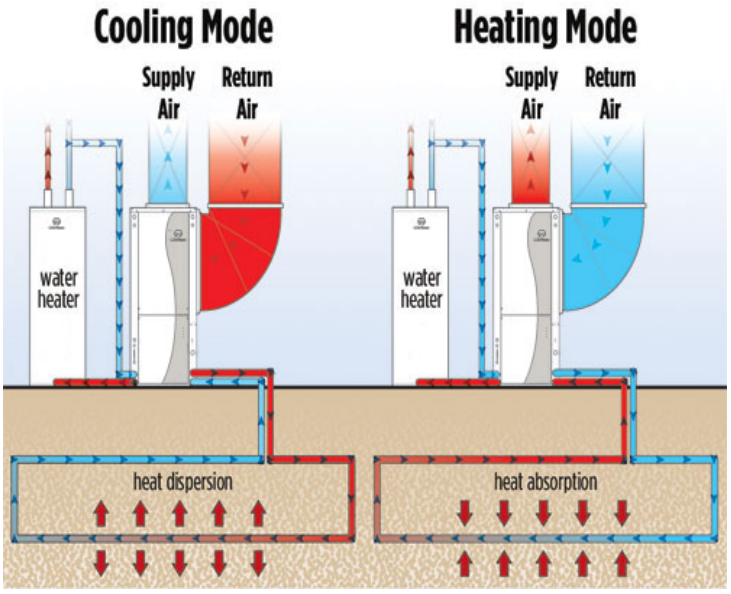
Community colleges, including ones in Georgia and Oklahoma, are currently working with IGSHPA to deliver these types of trainings. Texas colleges should consider doing the same. Important regional differences in topography, geology, climate, hydrology, and the designs that are effective in each area must be a component of any successful training. Since they differ by region of the state, community colleges are naturally an excellent delivery vehicle for these trainings.

Finally, while additional education is critical to workers in the GHP industry, classroom training alone will likely be insufficient to ensure success. Experience is also crucial, so there needs to be a mechanism for experienced local professionals to oversee/mentor/transfer knowledge to trainees. Therefore apprenticeships or other on-the-job trainings opportunities should also be explored, along with classroom learning.

# TECHNOLOGY OVERVIEW

Geothermal heat pump (GHP) technology, also commonly referred to as geothermal heat exchange technology,[2] can be used to help efficiently heat and air condition homes, businesses, and other facilities almost everywhere in the world by taking advantage of the difference in temperatures between the surface of the earth and the ground below it (or nearby water sources). GHP is often confused with geothermal power production (geothermal energy generation), which utilizes naturally-occurring heat within the earth at select locations in the world to produce steam to drive a turbine to produce electricity.[3] Although both have the term "geothermal" in their name and use renewable resources, GHP is not an energy generation technology, it is an energy efficiency technology that can be used ubiquitously throughout the world, especially throughout the United States, by all consumer classes. An overview of how the technology works follows.

Since the temperature of the earth 10-15 feet below the surface remains at a relatively constant temperature between 50 to 70 degrees Fahrenheit (F) year-round,[4] the ground can serve as an effective heat sink during hot summer months and as an effective heat source during cold winter months. On a 90° summer day in Texas, heat can be easily moved out of buildings and dispersed (i.e., sunk) into 65° earth. On a 40° winter day, heat can be readily absorbed from 65° earth and used for heating. Hot water can also be efficiently produced as a by-product of operation if a device called a desuperheater or a compressor is used. These processes, each performed by a typical GHP system, are depicted below.[5]




[2]Other terms include geoexchange, earth-source heat pumps, ground-source heat pumps, water-source heat pumps, earth exchange systems, earth-coupled heat pumps, ground-coupled heat pumps, water-loop heat pumps, and water furnaces. **In this paper, GHP will be used as an inclusive term.**

[3] GHP is also sometimes confused with the direct use of geothermal heat in which greenhouses, aquaculture ponds, and other agricultural facilities are heated using lower-temperature sources such as hot springs.

[4] Although if a heat pump is installed, there will be some ground temperature fluctuations by design.

[5] Image courtesy of WaterFurnace.

Geothermal heat pumps that exchange heat with a nearby lake, pond, well or other body of water utilize the same basic concept, although they typically rely more on evaporative or deepwater cooling than temperature differentials. In both cases the earth itself serves as a much more effective and efficient heat transfer mechanism as opposed to the air at the surface. Typically, the result is 50 to 70% higher efficiency than other heating systems and 20 to 40% higher efficiency than available air conditioners.[6]

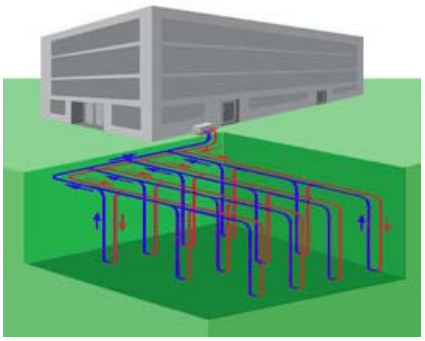
A typical GHP system has three main components: [7]

- ***1) The earth loop (i.e., the ground or water loop)*** – a series of pipes, typically constructed of high-density polyethylene (HDPE) that circulate a fluid between a geothermal heat pump unit and the earth to transfer heat. Copper pipes can be used for "direct exchange" GHP systems. The earth loop is also called a "heat exchanger" and can be installed in multiple configurations.
- ***2) The geothermal heat pump unit*** – an electric heat pump that exchanges heat between the fluid in the earth loop and the air that conditions the home/building.
- ***3) The air delivery/distribution system*** – standard ducts, controls, etc. that deliver conditioned air throughout a home or building.

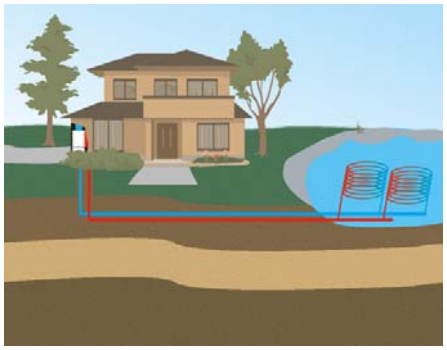
A "hybrid" GHP system may include a cooling tower to help reject waste heat or other components.

As mentioned above, earth loops for GHP systems can be installed in a few different ways. Most are "closed" loop systems, meaning that fluid in a loop is continuously circulated between the heat pump and the earth in pipes without loss of fluid. However some systems are designed as "open" loops to take advantage of local water sources. For example, a design could withdraw water from underground, pass it through a heat exchanger, and return the warmed/cooled water to an aquifer or well. Depictions of some representative closed earth loops are shown below.[8]

***Horizontal ground loop***



***Vertical ground loop***



***Coiled water loop***

Typical drilling for boreholes and trenches range from 100-400 feet. To facilitate heat transfer and prevent ground water contamination, boreholes for closed loop systems must be grouted and sealed appropriately. Adequate spacing between boreholes is also critical to avoid heat saturation.

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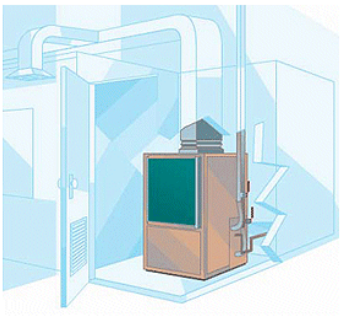
[6] http://www.igshpa.okstate.edu/geothermal/faq.htm, last accessed in February 2010.

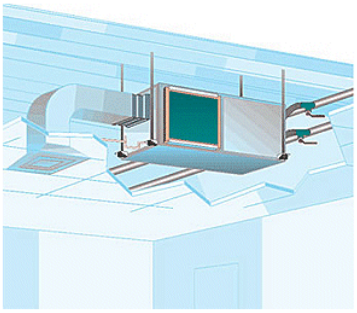
[7] Summarized from http://www.eia.doe.gov/cneaf/solar.renewables/page/ghpsurvey/ghpssurvey.html.

[8] Images courtesy of ClimateMaster, EnLink Geoenergy, and Gould Well Drilling.

Within a facility, the GHP units themselves can be installed vertically or horizontally, depending on the model and design needs, as depicted below.[9]



***Vertical mount in closet***



***Horizontal mount in ceiling***

***Console mount on floor***

GHP units are typically installed indoors, so unlike a traditional A/C unit that needs to be outside for the air-to-air heat exchange, a GHP unit does not need to be subjected to the elements, which reduces wear-and-tear and makes the unit less likely to be damaged or vandalized. GHP units also utilize standard ductwork and other air-delivery distribution components, which facilitates installation and maintenance. The comparable maintenance costs of a GHP system, on a national basis from ASHRAE statistics, are listed below.[10]

| | |
|---|---|
| All Electric | 28.9 ¢/sq. ft. |
| Propane | 27.0 ¢/sq. ft. |
| Air Source | 28.9 ¢/sq. ft. |
| Natural Gas | 27.0 ¢/sq. ft. |
| GeoExchange® | 23.9 ¢/sq. ft. |

Finally it should be noted that GHP is not a new technology. The first ground-source heat pump installation in the U.S. occurred in 1945 in Indianapolis when a 2.2 kW compressor was hooked to a direct expansion ground coil system in trenches to supply heat to a warm air heating system at the home of Robert C. Webber, an employee of the Indianapolis Power and Light Company.[11] Since then over 1,000,000 GHP systems have been installed in residential, commercial, and institutional buildings in the U.S. alone.[12]

The size of the GHP market, and its potential, will be addressed in the next section.

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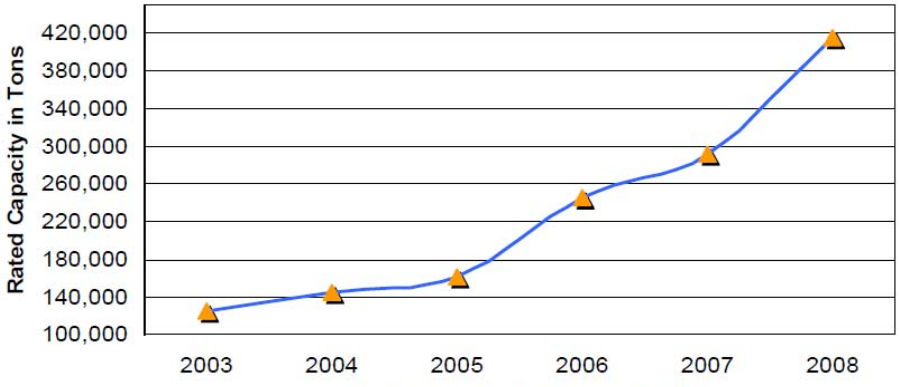
[9] Images courtesy of http://www.emt-india.net/equipment_tips/HVAC_refrigeration/Heat%20Pump.htm.
[10] http://www.actionmech.biz/geo.html#geoloop, last accessed February 2010.
[11] http://welldrillingschool.com/courses/pdf/geothermal.pdf, last accessed February 2010.
[12] Geothermal Heat Pump Consortium, Inc.. GeoExchange Fascinating Facts, available at: http://www.geoexchange.org/index.php?option=com_docman&Itemid=358, last accessed February 2010.

# MARKET OVERVIEW

## SIZE OF THE MARKET

According to a report released by the U.S. Energy Information Administration (EIA) in November 2009, total shipments of geothermal heat pumps increased more than 40% in 2008 to 121,243 units compared to 86,396 shipments in 2007.[13] The rated capacity of the shipped units grew 43% in 2008 to 416,105 tons of air-handing compared to 291,300 tons in 2007.[14] Of the 2008 shipments, 48% went to the residential sector, 50% went to the commercial and governmental sectors, and 2% went to the industrial sector.[15] As shown in the figure below, growth has been strong over the last five years.

**Geothermal Heat Pump Shipments, 2003-2008**




Source: Energy Information Administration (EIA)
Form EIA-902, "Annual Geothermal Heat Pump Manufacturers Survey."

Anecdotal evidence from conversations with leading GHP companies suggests that growth is even stronger in 2009 and 2010, as many of the generous federal tax incentives for GHP systems in the Emergency Economic Stabilization Act of 2008 and the American Recovery and Reinvestment Act of 2009 were not signed into law until October 2008 and February 2009 respectively. A June 2009 report by the Priority Metrics Group (PMG) estimates that the 2009 market for GHP in the U.S. was around $3.7 billion, including equipment and installation costs. PMG expects a high growth rate to continue for a few years and by 2013 they project the U.S. geothermal heat pump market to almost triple in value.[16]

To give some perspective on the penetration of GHPs into the broader air-conditioning and heating market, the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) reported that combined shipments of traditional central air conditioners and air-source heat pumps totaled 5,833,354 in 2008 (a 9% drop from the prior year), while shipments of gas-fired, warm-air furnaces totaled 2.3 million (an

[13] http://www.eia.doe.gov/cneaf/solar.renewables/page/ghpsurvey/ghpssurvey.html, last accessed February 2010.
[14] Ibid.
[15] http://www.eia.doe.gov/cneaf/solar.renewables/page/ghpsurvey/ghpssurvey.html, Table 4.11.
[16] "Energy Beneath the Backyard: Global Geothermal Heat Pump Market 2009." Priority Metrics Group. June 2009.

18% drop from the prior year) and oil furnace shipments totaled 59,255 (a 29% drop).[17] Clearly there is room for expansion in the market, with GHP shipments representing roughly 1%-2% of the reported AHRI shipments of traditional units, but it is notable that the GHP industry significantly accelerated its continued growth in 2008 despite the economic difficulties that slowed the traditional technologies.

Internationally, a December 2008 report on geothermal heat pumps published by Oak Ridge National Laboratory points out that although the U.S. was once the world leader in GHP technology and market development, European markets now absorb 2 to 3 times the number of GHP units annually.[18] Market growth rates in Europe, parts of Asia (China, South Korea), and Canada exceed those in the United States. In terms of installed base of GHPs, the United States still has the largest absolute number, but on a per capita basis many European countries are ahead.[19]

## Size of the Texas GHP Market

Texas accounted for 2.5% of the reported 2008 GHP shipments in the U.S. (10,207 of 416,105) and approximately 3% of shipments in 2007 (8,719 of 291,300). Traditionally the technology has been most prominent in the Midwest, where more defined seasonal changes make it easier to predict performance.[20] States receiving the greatest number of shipments in 2008, per the EIA, are shown in the table below.[21]

| State | 2008 Shipments | % of 2008 Shipments | | State | 2008 Shipments | % of 2008 Shipments |
|---|---|---|---|---|---|---|
| 1-Illinois | 26,599 | 6.4 % | | 9-Nebraska | 12,618 | 3.0 % |
| 2-Pennsylvania | 22,494 | 5.4 % | | 10-Florida | 12,439 | 3.0 % |
| 3-Ohio | 20,332 | 4.9 % | | 11-Maryland | 12,048 | 2.9 % |
| 4-New York | 19,589 | 4.7 % | | 12-Kentucky | 10,931 | 2.6 % |
| 5-Indiana | 18,199 | 4.4 % | | **13-Texas** | **10,207** | **2.5 %** |
| 6-Minnesota | 17,124 | 4.1 % | | 14-Tennessee | 10,144 | 2.4 % |
| 7-Michigan | 13,075 | 3.1 % | | 15-California | 9,522 | 2.3 % |
| 8-Iowa | 12,801 | 3.1 % | | 16-Oklahoma | 9,036 | 2.2 % |

One of the best markets in Texas has been school districts, given the availability of suitable land at these locations and their sensitivity to ongoing maintenance and operating expenses (which can be significantly decreased by GHP systems as shown in the case study on the subsequent page). GHP systems have been installed in over 600 schools in the U.S.[22] and in over 120 schools in Texas, including locations in Birdsville ISD,[23] Grand Prairie ISD, Frisco ISD, Lake Dallas ISD, Little Elm ISD, Gainesville ISD,

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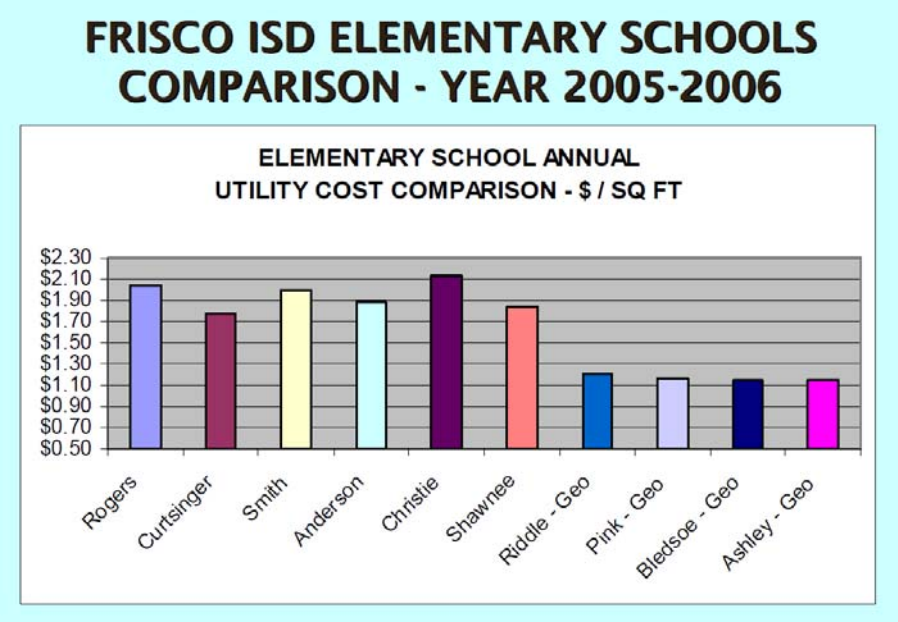
[17] AHRI December 2008 Heating and Cooling Equipment Shipment Data, available at: http://ari.org/Pages/ShowMeMore.aspx?src=single&lpk=848, last accessed February 2010.
[18] Hughes, Patrick. "Geothermal (Ground-Source) Heat Pumps: Market Status, Barriers to Adoption, and Actions to Overcome Barriers." Oak Ridge National Laboratory, December 2008 (ORNL/TM-2008/232). Page 1.
[19] Ibid.
[20] Van Hampton, Tudor. "Hot & Cold." The Construction Weekly Engineering News-Record (ENR). The McGraw-Hill Companies, November 2009.
[21] http://www.eia.doe.gov/cneaf/solar.renewables/page/ghpsurvey/ghpssurvey.html, Table 4.6.
[22] http://www.nrel.gov/analysis/pdfs/46022.pdf, last accessed Feb. 2010.
[23] http://www.trane.com/Commercial/CaseStudies/Tier3/BirdvilleHigh.aspx?CaseId=0&Id=102, last accessed Feb. 2010.

Keller ISD, Eagle Mountain ISD, Aledo ISD, and Dallas ISD.[24] Austin ISD has converted or built over 60 schools using the GeoExchange® System and has more than 6,000 loops in the ground.[25]

Comparative utility costs for elementary schools in Frisco ISD, based on a 2005-2006 study, are shown below.[26] The last four schools installed geothermal systems.




Tom Romberg of Action Mechanical Systems has performed many cost comparisons of GHP systems in Texas, including one for a typical home in Austin using Austin utility rates. His findings for that home are reprinted below.[27]

| | Heating | A/C | Hot Water | Yrly. Total | Percent |
|---|---|---|---|---|---|
| **All Electric** | 864 | 689 | 179 | $1732 | 100% |
| **Propane** | 832 | 689 | 138 | $1659 | 96% |
| **Air Source HP** | 465 | 723 | 179 | $1367 | 79% |
| **Natural Gas** | 418 | 689 | 75 | $1182 | 68% |
| **GeoExchange®** | 182 | 415 | 27 | $624 | 36% |

Additional case studies and cost comparisons can be found in Appendix B. Although the benefits of GHP can be more pronounced in other regions of the country, there are still significant savings available for the Texas market.

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[24] http://www.iegltd.com/html/projects.html, last accessed February 2010.
[25] http://www.actionmech.biz/geo.html, last accessed February 2010.
[26] http://www.iegltd.com/html/information.html, "IEG Geothermal Heat Pump Systems Slide Show Presentation." Slide 26, last accessed February 2010.
[27] http://www.actionmech.biz/geo.html, last accessed February 2010.

## MARKET BARRIERS AND DRIVERS

Oak Ridge National Laboratory published a comprehensive study in December 2008 that addressed the major barriers to the rapid adoption of geothermal heat pumps and identified some recommended actions to overcome them.[28] The key barriers were:

1. High first cost of GHP systems to consumers
2. Lack of consumer knowledge and/or trust or confidence in GHP system benefits
3. Lack of policymaker and regulator knowledge of and/or trust or confidence in GHP system benefits
4. **Limitations of GHP design and business planning infrastructure**
5. **Limitations of GHP installation infrastructure**
6. Lack of new technologies and techniques to improve GHP system cost and performance

The recommended actions to address the barriers and facilitate rapid growth of the GHP industry were:

1. Assemble independent, statistically valid, hard data on the costs and benefits of GHPs
2. Independently assess the national benefits of aggressive GHP deployment
3. Streamline and deploy nationwide Rural Electric Cooperative programs to provide GHP infrastructure
4. Develop and deploy programs to provide universal access to GHP infrastructure
5. Develop the data, analysis, and tools to enable lowest life-cycle-cost GHP infrastructure
6. **Expand geographic areas where high-quality GHP design infrastructure exists**
7. **Expand geographic areas where high-quality GHP installation infrastructure exists**

It should be noted that a key component in the term "infrastructure" above refers to employees with the requisite knowledge, skills, abilities, and experience. To expand the areas where design infrastructure exists, the report specifically states that the solution involves "**improving training materials and training more architects, commercial HVAC designers, and true residential system designers**." To expand the areas where more installation infrastructure exists, the report suggests "**improving training materials and training more drillers, loop installers, residential HVAC contractors, and commercial mechanical contractors and design/build contractors**."

The sentiments of the Oak Ridge findings are echoed in a 2009 American Council for an Energy-Efficient Economy report that states:

> "The greatest challenge to the acceptance of ground-coupled systems is information-related: few designers have the experience required to do a low-cost, low-risk system, and designers new to the field tend to insist on "bells and whistles" that raise costs and degrade performance. In most areas, there are too few contractors who are experienced at ground loop installation, and too little information about ground conditions, to get competitive bids with low risk of failure. Finally, all aspects of the system are simply unfamiliar to the decision-makers involved."[29]

Training and education, coupled with the increased availability of financial incentives and financing mechanisms, could go a long way in removing major industry barriers and would help rapidly grow the industry.

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[28] Hughes, Patrick. Geothermal (Ground-Source) Heat Pumps: Market Status, Barriers to Adoption, and Actions to Overcome Barriers. Oak Ridge National Laboratory, December 2008 (ORNL/TM-2008/232). It also provides a great history of the industry and technology.

[29] http://www.aceee.org/emertech/2009_Results.pdf.

## TEXAS-SPECIFIC BARRIERS

In addition to the items discussed in the Oak Ridge report, the following two issues warrant particular attention in Texas.

### *Waste Heat Rejection/Recycling*

Since Texas tends to have milder winters and different geology/hydrology than other regions of the country, GHP systems in Texas have been known to reject significantly more heat to the ground loop than they extract from it during the course of a year.[30] This issue is not prohibitive for the technology in the state, however it requires specific design considerations and possibly the addition of components that employ supplemental heat rejection techniques in certain instances.

For example, wider spacing between boreholes is typically required in Texas than elsewhere in the country to avoid heat saturation. In a more extreme case, cooling towers can be added to systems installed in commercial buildings as a supplemental means of heat rejection to avoid overheating the ground loop area, if necessary. In the fall of 2009, the University of Texas was awarded federal stimulus dollars to investigate the use of these types of "hybrid" systems and other supplemental heat rejection techniques that would increase deployment of GHP systems in hot and humid climates, like Texas.[31] Dr. Glenn Masada in UT's Mechanical Engineering department is overseeing that effort.

Despite problems with waste heat rejection in certain installations in Texas in the past, this issue has been overcome in most current installations with appropriate system design and installation.

### *Specific Soil Conditions*

A 2009 report from a group of researchers at the University of Texas investigating the viability of geothermal heat pumps in the state found that:

> "Texas is an applicable region for geothermal heating and cooling. Some regions are more favorable than others: San Antonio, Corpus Christi, Austin, and the lightly populated region of south central Texas. Other regions, such as El Paso and west Texas, should be given special consideration when sizing the ground loop for installation as the soil conditions are less favorable."[32]

As those of us in Texas know, there are significant differences between regions of our great state. Soil in El Paso is different than soil in San Antonio, which in turn is different than Amarillo and Houston. As with the waste heat issue discussed above, differences in soil conditions are not prohibitive for the technology in Texas, however it requires specific design considerations in each region and may affect project economics in certain regions.

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[30] http://welldrillingschool.com/courses/pdf/geothermal.pd, last accessed February 2010.
[31] Grant awards for geothermal technologies can be viewed at: http://www.energy.gov/news2009/documents2009/338M_Geothermal_Project_Descriptions.pdf, p.9.
[32] Dave Gramlich , Dylan Smith, and Sam Van Metre. Assessment of Ground Loop Performance in Texas. Mechanical Engineering Design Projects Program. The University of Texas at Austin. Austin, Texas. Fall 2009.

## FUTURE MARKET GROWTH

The future prospects for continued growth of the industry are very good, as concerns over the economy, the rising price of energy, governmental mandates, and significant incentives are likely to continue over the next few years, and each help drive the market for geothermal heat pumps. The EIA has stated that many savvy customers turned to geothermal heat pumps in 2008 as a more efficient way to heat and cool their buildings and homes through clean alternative energy sources as they became increasingly concerned with tighter budgets and/or the rising cost of energy. It also noted that significant long-term incentives in the Emergency Economic Stabilization Act of 2008 and other legislation helped fuel industry growth.[33] Presenters at the National Ground Water Association's 2009 Geothermal Diversification and Drilling Forum in December 2009 echoed those sentiments and stated factors unique to today have created a "perfect storm" of business opportunity for those willing to design and install GHP systems. Numerous anecdotal instances of geothermal work growing in the recession were cited.[34]

The increased adoption of green building standards and more stringent building codes, such as requirements for Leadership in Energy and Environmental Design (LEED) certified facilities, may also continue to fuel industry growth, as GHP is an effective method of exceeding the minimum efficiency criteria and obtaining LEED points.[35] Certain offerings from one manufacturer, for example, can provide 19 of the 26 points required for basic LEED certification.[36] Mandates for GHP systems in government buildings are also occurring. For example, in December 2007 the U.S. Congress directed the General Services Administration (GSA) to establish a program to accelerate the use of more cost-effective energy-saving technologies and practices in GSA facilities, starting with lighting and GHPs.[37]

In addition to federal mandates and incentives, state and local actions can also play an important role in continuing to grow the market. From a study by the Geothermal Heat Pump Consortium, the national non-profit trade association of the geothermal heat pump industry, an additional $2,000 state rebate on the purchase of a geothermal heat pump –or the availability of low interest loans– could generate an additional 200 heat pump sales every month in a typical state, or 2,400 geothermal heat pump unit sales at the end of the first year. Further, every 18 heat pump installations can, on average, support one new job. By the end of the first year that means 133 new green collar jobs could be created (2,400 units divided by 18 installations per job).[38]

In Texas, rebates for GHP are available at a number of utilities, including Austin Energy, Oncor, and CenterPoint. Oncor recently significantly increased its GHP rebates, which can now range up to $2,600 for certain models in certain programs. CPS Energy and others are in the process of evaluating and designing GHP rebate programs.

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[33] http://www.eia.doe.gov/cneaf/solar.renewables/page/ghpsurvey/ghpssurvey.html.
[34] http://www.ngwa.org/public/releases/pr2009/09-12-12-geoforum.release.aspx.
[35] Although it should be noted that there are many other ways to effectively obtain LEED points.
[36] http://www.climatemaster.com/index/leed.
[37] Hughes, Patrick. Geothermal (Ground-Source) Heat Pumps: Market Status, Barriers to Adoption, and Actions to Overcome Barriers. Oak Ridge National Laboratory, December 2008 (ORNL/TM-2008/232), p. 2.
[38] http://www.geoexchange.org/index.php?option=com_content&view=category&layout=blog&id=371&Itemid=368.

Other financing tools are also making it easier to reduce the upfront cost to consumers. Since 2007, rural electric cooperatives have been able to obtain long-term loans with terms of up to 35 years at the cost of government funds from the U.S. Department of Agriculture Rural Utilities Services (RUS) to provide the outside-the-building portion of GHP systems to customers in exchange for a tariff on the utility bill, which would be more than offset by the GHP system's energy cost savings. The Electric Power Research Institute (EPRI) and others have promoted these types of "loop lease" programs to encourage coops, other utilities, and developers to eliminate the upfront cost barrier for consumers and achieve cost savings through economies of scale by building a network of GHP piping in a "single dig" for all the homes in an entire community or subdivision, similar to the method that gas and water networks have been historically developed.[39]

Property Assessed Clean Energy (PACE) financing, a mechanism in which a city or county will provide the upfront costs for renewable energy and energy efficiency programs and receive repayment through multi-year property tax assessments,[40] is also proving to be an effective financing mechanism for GHPs and is under consideration by several Texas municipalities including San Antonio, Austin, Houston, and El Paso. Energy Efficient Mortgages (EEMs) also present opportunities for homebuyers to reduce the upfront costs of systems by rolling the costs of energy efficiency improvements into the underlying mortgage transaction.[41] Both PACE financing and EEMs are cornerstones of the Obama Administration's "Recovery Through Retrofit" initiative.[42]

An occupational overview of the GHP industry will be provided in the next section.

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[39] Additional information available at: http://mydocs.epri.com/docs/public/000000000010015476.pdf.
[40] Additional information available at: http://www.pacenow.org/.
[41] Additional information available at: http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.energy_efficient_mortgage.
[42] Additional information available at: http://www.whitehouse.gov/administration/eop/ceq/initiatives/retrofit.

# OCCUPATIONAL OVERVIEW

According to the Geothermal Heat Pump Consortium, the national non-profit trade association of the geothermal heat pump industry, every geothermal heat pump requires 24 hours of manufacturing labor and 32 hours of installation labor.[43] Once the combined employment effects are considered throughout the entire value chain, the Geothermal Heat Pump Consortium estimates that one job can be created for every 18 heat pump installations.[44] According to some experts in the field interviewed for this paper, both of these may be low estimates.

Many businesses and occupations can potentially be involved in the GHP industry, including designers, architects, engineers, drilling machine operators, excavators, conductivity testers, heating and air conditioning contractors, electricians, plumbers, pipe fitters, mechanical contractors, sheet metal workers, suppliers, distributers, sales representatives, and software engineers. In practice, many of the firms that manufacture, design, install, maintain, or sell geothermal systems often cross-train their employees in many different disciplines to facilitate and simplify the process for customers and to provide higher-quality comprehensive services that provide them a competitive advantage. Much of this training could be provided by, or at, community colleges.

An overview of industry occupations, organized by area of the GHP industry, follows.

**Manufacturing**

The four largest manufacturers of geothermal heat pumps, who account for over 80% industry sales, are (in alpahebetical order): ClimateMaster, Florida Heat Pump (part of the Bosch Group), Trane (a division of Ingersoll Rand), and WaterFurnace International, which are headquartered in Oklahoma, Florida, New Jersey, and Indiana respectively.[45] In 2008, there were 23 known domestic manufacturers of GHP systems, according to the EIA.[46] Manufactured components include the heat pumps themselves as well as heat transfer coils, pipes, fittings, grouts, vaults, valves, drill rigs, grout pumps, and many other components. If demand for GHP systems significantly increased, it is believed that manufacturers would be able to keep up with demand, so it is unlikely that there would be a backlog of product (like in the wind industry for turbines) or increased costs in raw materials (like in the solar industry). However since most items used in GHP systems are already mass produced to serve the broader HVAC/R and other markets, only modest downward pressure on pricing could be expected.[47] While an increased market for geothermal systems in Texas may lead to some increased manufacturing, the majority of jobs (and training needs) in Texas will likely come from the service industries associated with GHP systems.

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[43] http://www.geoexchange.org/index.php?option=com_content&view=category&layout=blog&id=371&Itemid=368.
[44] Ibid.
[45] The American Council for an Energy-Efficient Economy, "Emerging Technologies Report: Residential Ground-Source Heat Pumps July", (2007), p. 3.
[46] http://www.eia.doe.gov/cneaf/solar.renewables/page/heatpumps/heatpumps.html.
[47] Hughes, Patrick. Geothermal (Ground-Source) Heat Pumps: Market Status, Barriers to Adoption, and Actions to Overcome Barriers. Oak Ridge National Laboratory, December 2008 (ORNL/TM-2008/232), p. 19.

**Design**

Appropriate design of a geothermal heat pump system is just as important, if not more so, than the appropriate installation of a system. GHP design includes unit sizing and selection, loop sizing and design, and other factors that typically require a significant amount of computer simulation and modeling. If not designed properly, GHP systems can have unintended consequences, such as astronomical costs, increased energy use, and polluted groundwater.[48] A GHP system that is not well designed will never perform up to specifications and can lead to skepticism over the effectiveness of the technology itself. Bad designs, not faulty technology, have led to some mistrust of the technology in Texas in the past, although the substantial number of successful installations across the state in recent years is helping to change that. However, as more people enter this growing industry, the potential will rise for sub-par designs by architects, engineers or other designers with insufficient training and experience. This must be closely monitored by industry and regulatory authorities.

Texas is home to a few of the nation's leading geothermal designers, including Don Penn of Image Engineering Group (IEG) in Grapevine, Texas. His company has designed over 160 projects for school districts in Texas in addition to numerous other projects.[49] IEG employees are cross-trained in mechanical, electrical, and plumbing disciplines so that they can be a one-stop shop for geothermal design. Redding Linden Burr of Houston, Baird Hampton & Brown of Ft. Worth, Estes McClure & Associates of Tyler, and Trison Construction of Greenville also have renowned engineers and designers in Texas with particular expertise in geothermal systems. Texas is also home to some architecture firms that have recently begun to develop geothermal design expertise in-house, including SHW Group and Ware Architecture. Employees joining each of these companies could potentially find value in targeted trainings that could help cross-train them in additional disciplines. As will be discussed later, certified geothermal designers are in short supply in Texas.

**Installation**

The physical installation of a GHP system includes the mechanical, electrical, plumbing, duct, and control system work associated with connecting a GHP unit to a property and the earth loop. It also includes specialized drilling and piping work associated with the creation of an earth loop. In addition to the work done by field technicians, project managers and project "estimators" can also be involved in an installation. Some installation companies possess all of these skill sets, while some prefer to subcontract out a portion of the job, such as the drilling and piping. Ground water protection is a critical issue for installers, so the leading companies receive specialized training on proper borehole drilling, grouting, and pipe fusing.

Action Mechanical, Century Mechanical, Earth Tech, Loop Tech, and Trison Construction are examples of some leading GHP installation companies in Texas. Performance Pipe (a unit of Chevron-Philips), ISCO Industries, and Centennial Plastics are the largest HDPE pipe manufacturers, and Performance Pipe happens to be located in Texas.

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[48] Van Hampton, Tudor. "Hot & Cold." The Construction Weekly Engineering News-Record (ENR). The McGraw-Hill Companies, November 2009.

[49] http://www.iegltd.com/html/projects.html.

**Maintenance**

Regular maintenance for most GHP systems is fairly simple (changing filters, purging water from valves, etc.) and should not be a prohibitive factor from installing a GHP system. Many commercial and institutional installations of GHP systems are accompanied by multi-year warranties from the design and installation companies that put them in, therefore any substantial maintenance that might be required will likely be performed by the installers or designers. Institutions with their own maintenance staff, such as schools and universities, will likely not require much additional training to maintain GHP systems. Residential installations can typically be serviced by HVAC contractors or plumbers with familiarity of GHP systems, which currently provides an opportunity for differentiation by these companies—and their potential employees—who possess relevant training. If the technology becomes more widespread, it will be a competitive advantage for companies to be familiar with GHP technology.

Capable HVAC/R and mechanical contractors should be able to easily learn about and service geothermal units since they are in many ways simpler than traditional units, but they still require additional training. This training could be offered at community colleges. Continuing education courses for experienced HVAC/R professionals and "add-on" modules for existing HVAC/R curricula that address GHP technologies could be particularly useful.

**Sales**

Manufacturers typically do not directly sell to consumers. They typically sell to either wholesale distributors or installers. Therefore, sales representatives at companies offering GHP products require additional training to be able to educate consumers on technology and make the sale. To assist their distributors and other sales representatives, GHP vendors often make specialized training available to them. These trainings are often focused on particular products, but a significant number of the trainings are overview courses on GHP technology in general, which could be offered at community colleges.

***Additional information on specific occupational requirements can be found in a subsequent section of this document.***

***For reference, a partial inventory of the GHP industry in Texas has been included as Appendix A.***

# TRAINING, CERTIFICATION, AND LICENSING OVERVIEW

## OCCUPATIONAL TRAINING AND CERTIFICATIONS

Trainings and accreditations from the International Ground Source Heat Pump Association (IGSHPA), located in Stillwater, Oklahoma at Oklahoma State University, are the current industry standard for most trainings and certifications specific to workers in the GHP industry.[50] Other organizations with relevant occupational training and certification requirements for the GHP industry include the Association of Energy Engineers (AEE), North American Technician Excellence, Inc. (NATE), the National Ground Water Association (NGWA), GHP manufacturers, the U.S. Department of Energy via the ENERGY STAR program, and licensing/regulatory agencies in individual states. In October 2009, the national Geothermal Heat Pump Consortium (GHPC), along with IGSHPA and Oak Ridge National Laboratory, was awarded over $1M in federal funds to work to further develop formal national certification standards for all primary personnel involved in the installation of GHP systems.[51]

A summary of the leading occupational certifications, accreditations, and licenses for the GHP industry in Texas can be found in the table below.

| **Organization(s)** | **Name of Certification / License** | **Number Currently Listed in Texas** | **Training Offered by Texas Community College?** |
|---|---|---|---|
| IGSHPA / AEE / GHPC | Certified GeoExchange Designer (CGD) | 8 | No |
| IGSHPA / NATE | IGSHPA Accredited Installer with NATE Certification | 128 | No |
| IGSHPA / NATE | Accredited Driller (Accredited Vertical Loop Installer) with NATE Certification | 17 | No |
| IGSHPA | Train-The-Trainer | 4 | No |
| GHP Manufacturers | Vendor-specific training on equipment, installation, sales, etc. | Unavailable | No |
| NGWA | Geothermal driller designation within their Voluntary Certification Program *(under development)* | *N/A* | *N/A* |
| GHPC | Geothermal Technician *(under development)* | *N/A* | *N/A* |
| Texas Department of Licensing and Regulation | Closed Loop Geothermal Well Driller License | 766 | Not Specifically |
| Texas Department of Licensing and Regulation | Air Conditioning Contractors *(Note: not geothermal specific)* | 13,743 | Yes |

[50] For more information, please visit http://www.igshpa.okstate.edu/training/training.htm.
[51] http://apps1.eere.energy.gov/geothermal/projects/projects.cfm/ProjectID=120.

IGSHPA offers a wide range of courses both on-campus at Oklahoma State and off-campus at select sites throughout the nation, including Gwinnett Technical College in Lawrenceville, Georgia[52] and the HeatSpring Learning Institute in Massachusetts.[53] IGSHPA is also currently in the process of working with community colleges in Oklahoma to develop courses that could be offered at their campuses throughout the state. Detailed descriptions of the IGSHPA certifications/accreditations and their associated trainings can be found in Appendix C. Additional details on trainings and certifications, organized by area of the GHP industry, follows.

**Design**

Engineers and system designers can become Certified GeoExchange® Designers through the Association of Energy Engineers (AEE) with training provided by IGSHPA.[54] Eight certified designers are currently listed in the State of Texas in the IGSHPA business directory.[55] Certified designers must meet one of the following sets of eligibility criteria:

- Be an engineering graduate and/or Professional Engineer or Registered Architect with three years of verified, combined experience in geothermal heat pump design, heating, ventilation, and air-conditioning.
- Have a four-year, non-technical degree with five years of verified, combined experience in geothermal heat pump design, heating, ventilation, and air-conditioning.
- Have a two-year technical degree with eight years of verified, combined experience in geothermal heat pump design, heating, ventilation, and air-conditioning.
- Have ten years or more verified, combined experience in geothermal heat pump design, heating, ventilation, and air-conditioning.

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) provides the primary source of design information for HVAC systems in commercial buildings for engineers. Chapter 32 in the ASHRAE Handbook of Applications covers design issues associated with closed loop, open loop, and lake loop GHP systems for commercial applications. ASHRAE also publishes a design manual for GHP systems and numerous additional papers on GHP are also available.[56]

In the residential sector, the Air Conditioning Contractors of America (ACCA) publishes guidelines for sizing HVAC equipment in the ACCA Manual J Residential Load Calculation (Manual J) that includes best practices for GHP technology as well. Manual J enables contractors to estimate heating and air conditioning loads more accurately and also helps calculate heat loss from the building.[57] Usage of Manual J by contractors installing GHP systems is specifically encouraged in ENERGY STAR Guidelines.[58]

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[52] https://aceweb.gwinnetttech.edu/wconnect/ShowSchedule.awp?~~GROUP~GREEN~LEED+and+Energy+Conservation+Training.
[53] http://www.heatspring.com/index.php?id=catalog.
[54] For more information, please visit: http://www.aeecenter.org/certification/.
[55] http://www.igshpa.okstate.edu/directory/directory.asp.
[56] http://www.heatspring.com/downloads/intro/GeothermalSurvivalKit.pdf.
[57] http://www.toolbase.org/Technology-Inventory/HVAC/hvac-sizing-practice.
[58] http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/geothermal_heat_pumps/ES_V3.0_Geothermal_Heat_Pump_Specification.pdf.

**Installation (Non-Drilling)**

IGSHPA offers accredited installer training for anyone interested in what it takes to install GHP systems, including heating and air conditioning contractors, pipe fitters, plumbers, developers, architects, distributors, dealers, excavators, trenching/drilling contractors. Representatives from public utilities, private utilities, and rural electric cooperatives can also benefit from training. 128 accredited installers are currently listed in the State of Texas in the IGSHPA business directory.

As of January 1, 2010, North American Technician Excellence, Inc. (NATE) is administering the installer accreditation for IGSHPA, and successful IGSHPA-accreditation now also results in NATE certification. NATE is an independent, third-party organization that develops and promotes excellence in the installation and service of HVAC/R equipment by recognizing high-quality industry technicians through voluntary testing and certification. NATE is a coalition of many partners representing the variety of stakeholders in the HVAC/R industry, including AHRI, ASHRAE, ACCA, Electric Power Research Institute (EPRI), National Energy Management Institute (NEMI), and others.[59] NATE certifications are often more rigorous than certifications or accreditations offered by vendors or trade organizations.

**Drilling**

IGSHPA also offers accredited driller training, also administered by NATE, for drilling contractors, drilling company owners, excavators with drilling operations, drilling company project managers, and drilling administrators. 17 certified drillers are currently listed in the State of Texas in the IGSHPA business directory. IGSHPA-accredited vertical well installation training has also been offered from the American Ground Water Trust (AGWT), the National Ground Water Association (NGWA), and GHP vendors. NGWA and AGWT have been actively involved in requirements for borehole drilling, grouting, and pipe fusing to ensure ground water protection.

NGWA has recognized the need for separate standards for geothermal drilling and is in the process of developing a new designation for geothermal drilling within its Voluntary Certification Program. The designation will be subject to different examination requirements than a Certified Well Driller (CWD) or a Certified Pump Installer (CPI), and will be considered an independent designation. However, renewal requirements will be the same as those for the CWD and CPI.[60]

In December 2009, NGWA also unveiled its revised "Guidelines for the Construction of Vertical Boreholes for Closed Loop Heat Pump Systems". The technical guidelines cover loop field design, test holes and samples, borehole construction, piping, borehole grouting, loop field identification, and permanent loop piping decommissioning. It also includes appendices on heat transfer fluids, tables of related interest, a glossary of technical terms, and organizations with related interest. The document was mainly written for geothermal borehole contractors, geothermal borehole design consultants, government officials, educators, students, and consumers.[61]

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[59] A listing of partner organizations can be found at http://www.natex.org/HVAC_HVACR/cert_partners.html.
[60] http://www.ngwa.org/cert/contractor/certificationcorner.aspx.
[61] http://www.estormwater.com/Vertical-Borehole-Guidelines-Unveiled-at-NGWA-Ground-Water-Expo-and-Annual-Meeting--newsPiece19769.

**Sales and Maintenance**

Manufacturers of GHP equipment often offer specialized trainings to distributers, suppliers, and technicians of GHP equipment. It is a best practice in industry to use technicians who have been certified by the manufacturers, when applicable, but it is not a formal requirement.

**U.S. DOE and EPA ENERGY STAR Considerations**

One of the terms of the U.S. Environmental Protection Agency (US EPA) ENERGY STAR Partnership Agreement with GHP manufacturers is that manufacturers must:

> "Offer and encourage training to distributors and/or contractors on the following issues: proper equipment installation and hookup; distribution systems and their effect on performance; proper domestic water heater connection for desuperheater or demand water heating; code compliance; and proper use of the Manual J calculation, or other equivalent calculation, in order to encourage proper sizing of equipment. In addition, Partner should strive to use contractors or loop installers who have received training on the design and installation of the ground heat exchanger and who provide warranty protection for the integrity and performance of the ground heat exchanger for at least two years. Ground heat exchanger training may be provided by Partner **or a well-regarded training program**. Partner shall focus its ENERGY STAR marketing efforts in regions where contractors and loop installers have received training and provide warranties"[62] [emphasis added]

Because only ENERGY STAR products qualify for many of the federal tax credits that are often crucial to the economics of buying a GHP, manufacturers are likely to do their best to adhere to these guidelines and ensure that their distributors and contractors are appropriately trained in the requite areas. If they do not, the ENERGY STAR designation for their products may be at risk.

## Occupational Licensing

In Texas, the only established license class that is specifically dedicated to geothermal technology is the license for a geothermal water well driller. The Texas Department of Licensing and Regulation (TDLR) has established six designations of water well drillers, including a dedicated class for closed loop geothermal wells. The six designations are as follows: (W)-water well; (M)-monitoring well; (C)-closed loop geothermal well; (N)-injection well; (D)-dewatering well; and (A)-master well driller which includes all designations previously listed. Applicants must have at least two years of hands-on experience or have been a registered apprentice for a minimum of two years under a licensed driller who possesses the specific license(s) for which they are applying. To drill geothermal wells in Texas, an individual must possess at least a (C) license.[63] 766 individuals currently hold a (C) designation or above. Of the 766, 4 individuals hold only a (C) designation (i.e., are only licensed to drill closed loop geothermal wells).

It should be noted that there has been some interest by certain HVAC/R contractors in the GHP industry in Texas to become geothermal well drillers in an effort to offer more comprehensive services, however the requirement for geothermal well applicants to have at least two years under a licensed driller is

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[62] http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/geothermal_heat_pumps/ES_V3.0_Geothermal_Heat_Pump_Specification.pdf.

[63] For more information on TDLR requirements, please visit http://www.license.state.tx.us/wwd/wwd.htm.

proving prohibitive. There are very legitimate reasons, some involving groundwater protection, why strict standards should be in place for geothermal drillers, but further discussions by a broad group of industry stakeholders is likely warranted to determine what the licensure requirements ought to be.

Other occupations licensed by the State of Texas must obtain licenses and follow the appropriate state guidelines for their industry, such as air conditioning and refrigeration contractors, pump installers, plumbers, pipe fitters, and electricians; however, there is not currently a dedicated state license for a geothermal installer, designer or technician in Texas. Registered Architects, Professional Engineers, and other professionals must also adhere to the requirements of their licensing body, as applicable.

## TRAININGS AND CERTIFICATIONS FOR EQUIPMENT AND MANUFACTURING

**Equipment**

Most GHP products are tested and certified by the Air Conditioning, Heating, and Refrigeration Institute (AHRI) for their cooling capacities and operating efficiencies.[64] The International Organization for Standardization (ISO) approved standards for GHPs in 1998, which were subsequently adopted by both AHRI and ASHRAE. Direct exchange GHPs are not covered by these joint standards, although both AHRI and the Canadian Standards Association (CSA) offers separate performance requirements for them.

Most manufacturers also will be taking steps to ensure their products adhere to the US EPA ENERGY STAR equipment standards, as that is now a prerequisite for many of the federal tax credits that have been made available for the industry. Under Version 3.0 6 of the ENERGY STAR Program Requirements for Geothermal Heat Pumps, the following requirements apply:[65]

- Closed Loop Systems: Geothermal heat pump models shall qualify under rating conditions in accordance with ISO 13256-1 for water-to-air models or ISO 13256-2 for water-to-water models.
- Open Loop Systems: Geothermal heat pump models shall qualify under rating conditions in accordance with ISO 13256-1 for water-to-air models or ISO 13256-2 for water-to-water models.
- Direct Geoexchange Systems: Geothermal heat pump models shall qualify under rating conditions in accordance with AHRI 870.

In addition to standards for GHP units, a number of voluntary standards for piping, tubing, groutings, and fittings have been developed by ASTM International, originally known as the American Society for Testing and Materials (ASTM).

To help ensure GHP equipment is properly installed, ACCA's Quality Installation (QI) standard seeks to quantify the minimum elements that, if done correctly, will provide proper operation of a HVAC system. It is part of a larger initiative that covers quality installation, quality maintenance, and quality restoration (see www.acca.org/quality). It was originally thought that the QI standard addressed the issues related to the installation of unitary HVAC systems, including geothermal heat pumps, but a number of entities have been seeking to broaden the elements that can be verified in an HVAC system installation, such as the ground loop. ACCA hopes that the QI standard can be used to "certify" that a

[64] http://www.eia.doe.gov/cneaf/solar.renewables/page/ghpsurvey/ghpssurvey.html.
[65] http://www.energystar.gov/index.cfm?c=geo_heat.pr_crit_geo_heat_pumps.

GHP was installed correctly and has been working with the Geothermal Heat Pump Consortium to incorporate their QI standards into national GHP standards.

**Manufacturing**

Manufacturers of GHP products do not obtain any certifications specific to the geothermal industry, but most obtain ISO 9001:2000 quality management certification for their facilities like manufacturers of other products.

**Summary Table**

A summary of the leading certifications and standards for GHP equipment and manufacturing can be found in the table below.

| Organization(s) | Name of Certification/Standard | Description |
|---|---|---|
| ASHRAE/AHRI/ISO | 13256-1 GLHP (ARI-330) | Ground-Source Heat Pumps |
| ASHRAE/AHRI/ISO | 13256-1 GWHP (ARI-325) | Ground Water-Source Heat Pumps |
| ASHRAE/AHRI/ISO | 13256-1 WLHP (ARI-320) | Water-Source Heat Pumps |
| ASHRAE/ARI/ISO | 13256-2 | Water-to-Water and Brine-to-Water Heat Pumps |
| AHRI | ARI-870 | Direct Geoexchange Heat Pumps |
| CSA | C748-94 | Performance of Direct Expansion (DX) Ground Source Heat Pumps |
| ASTM | Multiple standards | Voluntary standards for piping, tubing, groutings, and fittings |
| ANSI/ACCA | 5 QI–2007 HVAC Quality Installation Specification | HVAC Quality Installation (QI) Standard |
| ISO | ISO 9001:2000 | Quality management certification for facilities |
| US EPA | ENERGY STAR | Designation for energy efficient products |

# DETAILED OCCUPATIONAL ANALYSIS

## O*NET "GREEN" OCCUPATIONS RELATED TO THE GEOTHERMAL HEAT PUMP INDUSTRY

O*NET is the Occupational Information Network. In 2009, O*NET published a paper entitled *Greening of the World of Work*, in which three occupational categories of green jobs were identified,[66] each with different effects from the "greening" of work.[67] All of these categories apply to the GHP industry and are important for educational institutions and workforce boards as **all could require new capacity and/or trainings be developed.** The three identified categories are:

(1) *Green New and Emerging (N&E) Occupations* - The impact of green economy activities and technologies is sufficient to create the need for unique work and worker requirements, which results in the generation of a new occupation relative to the O*NET taxonomy.

(2) *Green Enhanced Skills Occupations* - The impact of green economy activities and technologies results in a significant change to the work and worker requirements of an existing O*NET-SOC occupation. The essential purposes of the occupation remain the same, but tasks, skills, knowledge, and external elements, such as credentials, have been altered.

(3) *Green Increased Demand Occupations* - The impact of green economy activities and technologies is an increase in the employment demand for an existing occupation. However, this impact does not entail significant changes in the work or requirements of the occupation. The work context may change, but the tasks themselves do not.

A listing of occupations most relevant to the GHP industry in each of the O*Net categories follows.[68] Please note that attempts to categorize occupations are ongoing.

***New and Emerging Occupations***

- 17-2199.03 Energy Engineers
- 49-9099.01 Geothermal Technicians
- 11-2011.01 Green Marketers
- 17-3029.09 Manufacturing Production Technicians
- 17-3029.07 Mechanical Engineering Technologists
- 13-1199.05 Sustainability Specialists
- n/a Sustainable Design Specialists
- 17-2199.02 Validation Engineers
- 17-2051.02 Water/Wastewater Engineers

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[66] Dierdorff, Erich C., et al. (February 2009). O*NET points out "the need to shift the level of specificity from 'job' to 'occupation' when discussing the workforce implications of the green economy. The current literature focuses almost exclusively on green jobs –or simply green job titles– rather than taking a perspective more conducive to workforce development efforts: an occupational perspective."

[67] O*NET's definition of green jobs is as follows: "the green economy encompasses the economic activity related to reducing the use of fossil fuels, decreasing pollution and greenhouse gas emissions, increasing the efficiency of energy usage, recycling materials, and developing and adopting renewable sources of energy."

[68] From http://www.onetcenter.org/green/emerging.html. Please note that these are just the occupations most directly related with GHP; there are many other green occupations listed on O*NET.

**Enhanced Skills Occupations**[69]

- 17-1011.00 Architects, Except Landscape and Naval
- 47-4011.00 Construction and Building Inspectors
- 47-2061.00 Construction Laborers
- 11-9021.00 Construction Managers
- 17-3023.03 Electrical Engineering Technicians
- 17-2071.00 Electrical Engineers
- 17-3024.00 Electro-Mechanical Technicians
- 17-2072.00 Electronics Engineers, Except Computer
- 11-9041.00 Engineering Managers
- 17-3025.00 Environmental Engineering Technicians
- 17-2081.00 Environmental Engineers
- 13-2051.00 Financial Analysts
- 19-4041.02 Geological Sample Test Technicians
- 19-2042.00 Geoscientists, Except Hydrologists and Geographers
- 49-9021.01 Heating and Air Conditioning Mechanics and Installers
- 17-3026.00 Industrial Engineering Technicians
- 49-9042.00 Maintenance and Repair Workers, General
- 11-2021.00 Marketing Managers
- 17-2141.00 Mechanical Engineers
- 47-2152.01 Pipe Fitters and Steamfitters
- 47-2152.02 Plumbers
- 41-4011.00 Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products
- 47-2211.00 Sheet Metal Workers

***Increased Demand Occupations***

- 17-3011.01 Architectural Drafters
- 47-2051.00 Cement Masons and Concrete Finishers
- 27-1021.00 Commercial and Industrial Designers
- 15-1032.00 Computer Software Engineers, Systems Software
- 43-4051.00 Customer Service Representatives
- 51-4032.00 Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic
- 51-2022.00 Electrical and Electronic Equipment Assemblers
- 49-2094.00 Electrical and Electronics Repairers, Commercial and Industrial Equipment
- 47-2111.00 Electricians
- 17-3023.01 Electronics Engineering Technicians
- 49-1011.00 First-Line Supervisors/Managers of Mechanics, Installers, and Repairers
- 49-9098.00 Helpers--Installation, Maintenance, and Repair Workers
- 49-9021.02 Refrigeration Mechanics and Installers

As you can see, increased demand for GHP systems could potentially benefit many “green” occupations. The detailed occupational skill and knowledge requirements are addressed in the next section of this document.

[69] http://www.onetcenter.org/green/skills.html.

## Detailed Occupational Skill & Knowledge Requirements

In general, the skill and knowledge needed for workers in the GHP industry will require incremental training and experience to develop enhanced skills relevant to the industry, rather than training to transition workers to entirely new occupations. For example:

- Geothermal well construction generally uses the same equipment and requires many of the same skills used by water well contractors. However, some additional training is needed as well as new approaches to managing equipment.
- Plumbers and pipefitters for geothermal systems require additional training on heat fusion of high density polyethylene (HDPE) geothermal pipe and fitting, but leverage many of their existing skills.
- Capable HVAC/R and mechanical contractors should be able to easily learn about and service geothermal units since they are in many ways simpler than traditional units, but they still require additional training.

Therefore, a key market for any potential training to be developed should be experienced workers in related fields, not just entry-level job-seekers. Additionally, since the development of enhanced skills carries relatively little risk, other than the financial and opportunity costs of attending the trainings, well-priced and relatively short courses on specific, relevant occupational skills and knowledge topics could do very well. A more detailed look at the skills and knowledge potentially required follows.

***Detailed Requirements from O*NET's Geothermal Technician***

One of the particularly relevant occupations identified by O*NET was a "Geothermal Technician," which is listed as occupation 49-9099.01. Although O*NET did not create a different classification for a GHP system technician opposed to a geothermal power plant technician, the occupation does address the skills and knowledge required for both. As previously discussed, these skills and knowledge are rarely all possessed by one individual, rather they are typically handled by multiple people with specializations in design or installation or some combination of each, for example. However the identified tasks do provide useful insight into the detailed skills and knowledge required for workers in the GHP industry.

Specific tasks in the Geothermal Technician occupation applicable to the GHP industry include: [70]

- Install, maintain, or repair ground or water source-coupled heat pumps to heat and cool residential or commercial building air or water.
- Backfill piping trenches to protect pipes from damage.
- Calculate heat loss and heat gain factors for residential properties to determine heating and cooling required by installed geothermal systems.
- Design and lay out geothermal heat systems according to property characteristics, heating and cooling requirements, piping and equipment requirements, applicable regulations, or other factors.

[70] http://online.onetcenter.org/link/details/49-9099.01.

- Determine the type of geothermal loop system most suitable to a specific property and its heating and cooling needs.
- Dig trenches for system piping to appropriate depths and lay piping in trenches.
- Prepare newly installed geothermal heat systems for operation by flushing, purging, or other actions.
- Identify equipment options, such as compressors, and make appropriate selections.
- Install and maintain geothermal system instrumentation or controls.
- Perform pre- and post-installation pressure, flow, and related tests of vertical and horizontal geothermal loop piping.
- Place geothermal system pipes in bodies of water, weighting them to allow them to sink into position.
- Verify that piping placed in bodies of water is situated to prevent damage to aquaculture and away from potential sources of harm, such as boat anchors.
- Collect and record data associated with operating geothermal well fields.
- Determine whether emergency or auxiliary systems will be needed to keep properties heated or cooled in extreme weather conditions.
- Integrate hot water heater systems with geothermal heat exchange systems.
- Operate equipment such as excavators, backhoes, rock hammers, trench compactors, pavement saws, grout mixers or pumps, geothermal loop reels, and coil tubing units (CTU).
- Prepare and maintain logs, reports, or other documentation of work performed.
- Test water sources for factors such as flow volume and contaminant presence.
- Weld piping, such as high density polyethylene (HDPE) piping, using techniques such as butt, socket, side-wall, and electro-fusion welding.

***Detailed Requirements in Industry Certifications and Trainings***

Based on an analysis of the topics covered in the current industry certifications and other courses made available to industry workers, requirements for the following skills and knowledge also appear to exist. Additional information on these certifications and other relevant courses can be found in Appendix C.

*For Design Professionals:*

- Geothermal Heat Pump Design and Layout Basics, especially Site Surveys, Loop Field Identification, and Loop Field Design
- Earth Loop Design and Material Options
- Soil/Rock Classification and Conductivity
- Grouting and Piping Procedures, including HDPE Pipes and Thermal Enhanced Grouts
- Performance of Ground Source Heat Pumps
- Integration of Hot Water Heater Systems with Geothermal Heat Exchange Systems
- Computer Assisted Design (e.g., GeoDesigner Software, Commercial Ground Loop Heat Exchanger Software)
- How to Calculate the Optimum Operating Water Flow Rate for Efficiency
- How to Calculate the Amount of Heat Available in the Ground For Extraction/Rejection
- Heat Saturation Design Considerations and Supplemental Heat Rejection Techniques
- ACCA Manual J (Residential Design)
- ASHRAE Chapter 32 (Commercial Design)
- Applicable Building Codes and Code Compliance

*For Installation Professionals:*

- GHP System Design and Layout Basics
- Earth Loop Design and Material Options
- System Layout
- Soil/Rock Classification and Conductivity
- Grouting and Piping Procedures, including HDPE Pipes and Thermal Enhanced Grouts
- Trenching/Drilling Processes
- Air and Debris Purging
- Pressure Drop Calculations
- Pump and Fluid Selection
- Thermal Conductivity
- Applicable Building Codes and Code Compliance

*For Drilling Professionals:*

- GHP System Design and Layout Basics
- Earth Loop Design and Material Options
- Knowledge of System Materials, Flow Controllers, Parallel vs. Series Configurations, Header Design, Inside Piping, Vertical Loop Piping Installation & Testing, and Closed Loop Pressure Drop Calculations
- Thermal Conductivity
- Soil/Rock Classification and Conductivity
- Drilling Processes, including Test Holes and Samples and Borehole Construction
- Containment Procedures
- Ground Water Protection Techniques
- Grouting Concepts, including Thermal Enhanced Grouts
- Air and Debris Purging
- Flushing Procedures, Typical Flush Carts, Valve Positioning and Flushing, Antifreeze Selection & Charging, Pump Replacement Procedure
- Piping and Pipe Joining Techniques (i.e., Fusion)
- Permanent Loop Piping Decommissioning
- Applicable Building Codes and Code Compliance

*For Sales Professionals:*

- Customer economic analysis
- Job costing/estimating
- Project Bidding
- GHP tax incentives and financing options

***Requirements from US EPA ENERGY STAR Guidelines***

Also as previously mentioned, under the terms of the ENERGY STAR Partnership Agreement, GHP manufacturers must offer and encourage training to distributors and/or contractors on the following:

- Proper equipment installation and hookup
- Distribution systems and their effect on performance
- Proper domestic water heater connection for desuperheater or demand water heating
- Code compliance
- Proper use of the Manual J calculation, or other equivalent calculation, in order to encourage proper sizing of equipment

The current employment status in Texas, and forecasted needs, will be addressed in the next section.

# CURRENT EMPLOYMENT STATUS IN TEXAS AND FORECASTED EMPLOYMENT NEEDS

## CURRENT STATUS

Our inventory of the GHP industry in Texas, included as Appendix A, identified approximately 200 companies involved in the GHP industry in the state.

- Over 100 companies are involved in the design and installation of GHP systems in Texas. The majority of the companies were involved in installation, but the industry is also supporting dedicated designers and drillers. As previously mentioned, the State of Texas has 8 IGSHPA-certified designers, 128 IGSHPA-accredited installers, 17 IGSHPA-accredited drillers, and 4 IGSHPA-certified trainers listed in IGSHPA's Business Directory. The number of IGSHPA-credentialed professionals is a small percentage of the 766 TDLR-licensed drillers and 13,743 TDLR-licensed air conditioning contractors in the State of Texas, although the numbers are consistent with the 1%-2% penetration rate of GHPs into the broader HVAC/R market.

- At least 15 GHP manufacturers or product companies have a presence in the State, but no major manufacturers of GHP units are headquartered here. Texas is home to the headquarters of a major HDPE pipe manufacturer (Performance Pipe in Plano) and a major supplier of well drilling products (Baroid Industrial Drilling Products) and has a significant cluster of support companies in the drilling industry due to our incumbent oil & gas industry. A few GHP computer design firms and software companies are headquartered here.

- Over 80 additional companies, if not significantly more, are currently involved in sales and maintenance of GHP systems in Texas. These companies include dealers and distributors.

The companies are located throughout the state from El Paso to Brownsville to Texarkana to Amarillo, although there is a notable concentration in Central Texas, and the Dallas/Ft. Worth Metroplex in particular. These companies range in size from sole proprietors serving local communities to companies employing hundreds of employees statewide.

## FORECASTED NEEDS

As previously mentioned, the leading GHP companies in Texas have been seeing indications that industry growth will continue to be strong in 2010, as the generous federal tax incentives for GHP systems as well as other consumer incentives and educational efforts have helped to accelerate growth. Additional incentives at the local and state level –through utility incentives, low-interest loans or other financing options– and consumer education will further accelerate industry growth and increase workforce demands. Appropriately trained and experienced GHP designers and installers are in demand, with the greatest quantity of need, in terms of potential employees to hire, for installers with GHP expertise. Over time, the increased presence of GHPs will require additional skill sets for technicians.

## RESULTS FROM THE TEXAS GHP INDUSTRY SURVEY

TFIC and Good Company directly surveyed the GHP industry in Texas to provide additional data for this report. Notable results include:

- 77% of respondents expect to have more work over the next year and 14% expect demand to at stay the same.
    - Over 45% of respondents expect their workload to grow by at least 40% and approximately 20% expect their workload to double.

- 22% of respondents derive 90-100% of their company's revenue from work in the GHP industry while 48% of respondents only derive 0-10% of their company's revenue from GHP work.

- 86% of respondents had difficulty finding qualified GHP system technicians, 75% had difficulty finding certified geothermal designers, and 65% had difficulty finding HVAC/mechanical installation professionals.

- The greatest quantity of expected hires over the next year is in the installation area (both HVAC/mechanical and plumbing).

- Over 95% of respondents were interested in seeing both IGSHPA Installer and Designer trainings offered at Texas community colleges (71% had "great interest" in both). Approximately 83% would like to see IGSHPA Drilling training (61% had "great interest").

- Other potential course offerings with "great interest" were courses on:
    - Advanced Residential HVAC Systems (82% "great interest");
    - Commissioning (80% "great interest");
    - Residential "Green" Code Compliance (71% "great interest); and
    - Energy Auditing (59% "great interest").

- Other potentially popular offerings were courses on:
    - Construction-Green Building Management (67% "some interest" and 28% "great interest");
    - Green Codes, Regulations, and LEED Certification (50% "some interest" and 44% "great interest");
    - Green Building Fundamentals (61% "some interest" and 33% "great interest");
    - Advanced Commercial HVAC systems (47% "some interest" and 41% "great interest");
    - Green Construction Sales (53% "some interest" and 35% "great interest"); and
    - Solar Thermal Plumbing Systems (43% "some interest" and 43% "great interest").

- 77% would be interested in a program that provided apprenticeships or interns.

Respondents reflected a representative cross-section of the industry (i.e., manufacturers, designers, drillers, installers, and sales professionals) and served all customer sectors (commercial, residential, government/institutional).

Our major conclusions and recommendations are presented in the next section of this document.

# MAJOR CONCLUSIONS AND RECOMMENDATIONS

## Conclusions

- The GHP market has been growing rapidly and will likely continue to grow, even in spite of (or partially because of) the economic conditions in the country. Recently enacted long-term tax incentives and other efforts to encourage their usage nationally will facilitate industry growth. Additional state and local efforts could further accelerate industry growth and increase workforce demands. And although the benefits of GHP can be more pronounced in other regions of the country, there are still significant savings available for the Texas market, so the industry will likely continue to grow in Texas specifically as well.

- While an increased market for geothermal systems in Texas may lead to some increased manufacturing, the majority of jobs (and training) in Texas will likely come from the service industries associated with GHP systems (i.e., design, installation, maintenance, and sales).

- IGSHPA is, and will continue to be, the industry standard for certification and accreditation; however, there are important differences in regional topography/geology/hydrology/climate that should be taught at the local level. Information about GHP designs that have been proven to be successful in each region should be a component of any developed training. Since appropriate designs could differ by community, community colleges are naturally excellent delivery vehicles for these trainings.

- There is a significant opportunity to expand the number of IGSHPA certified/accredited individuals in Texas, and there appears to be great interest within the industry to do so. IGSHPA-certified geothermal designers are in particularly short-supply, although the greatest quantity of jobs are in accredited GHP installation (short-term) and maintenance (longer-term).

- A shortage of trained workers will be a limiting factor for GHP industry growth; however classroom training alone will be insufficient to overcome this obstacle. Experience is also crucial, so there needs to be a mechanism for experienced local professionals to oversee/mentor/transfer knowledge to trainees. Therefore apprenticeships or other on-the-job trainings opportunities should also be explored, along with classroom learning.

- Short-courses could be beneficial for design engineers and other experienced professionals.[71]

[71] The Oak Ridge study points out that "many developers and building owners (i.e., the owners) have established relationships with their individual independent and trusted design engineers, so even if the owner becomes interested in GHP the HVAC design engineer must be educated and convinced. Designers are wary of liability, and the industry's fee structure does not accommodate a lot of learning time, so off-the-shelf solutions from past jobs are common because they are safe." Additional professional training for design engineers to overcome this hesitancy would benefit the industry.

- Cross-training of employees in additional disciplines relevant to GHP is a significant opportunity (e.g., teaching plumbing techniques to a mechanical contractor).

**Recommendations**

- Texas community colleges should develop a relationship with IGHSPA and GHPC and should consider offering courses in Texas that lead to IGSHPA/GHPC accreditation/certification.

- Texas community colleges should work with the GHP industry in the state to ensure the most recent GHP equipment and materials are incorporated into courses and trainings.

- Since market penetration of GHP is low (1%-2% of the broader HVAC/R market) and may not currently support a significant influx of dedicated GHP professionals, colleges may want to start with add-on modules for HVAC/R technicians and other related occupations rather than a dedicated GHP concentration. HVAC/R technicians, even without GHP knowledge, are in-demand so attracting additional students to HVAC/R courses is not a risky proposition.

- Cross-training of current industry workers and/or the development of enhanced skills are opportunities not to be overlooked, so the creation of shorter-term courses should be considered to minimize the opportunity costs of leaving the workforce for potential participants.

- Each community college offering GHP trainings should work with local GHP professionals to develop components in courses that cover the specific characteristics of the region (e.g., geology, topography, climate, hydrology, soil, conductivity, etc.) as well as in regions throughout the state (for portability of skills). The trainings should be focused on designs that have been successful in the area(s) in the past.

- Apprenticeships or some amount of on-the-job training should be a mandatory requirement, as classroom training alone will be insufficient.

- Community colleges offering GHP trainings should work with local utilities, electric cooperatives, banks, and municipalities to develop incentives and financing options that reduce the upfront cost of systems and increase demand for GHP systems, and therefore GHP professionals.

    - Rural electric cooperatives should explore opportunities to obtain low-cost financing from U.S. Department of Agriculture Rural Utilities Services that is made available for GHP loop leasing.

    - Banks and municipalities should explore options for PACE financing and Energy Efficient Mortgages.

- Water well drillers, HVAC contractors, TDLR, TREIA, and others should engage in discussions over drilling licensure issues before the next session of the Texas Legislature.

# APPENDIX A: INVENTORY OF GHP INDUSTRY IN TEXAS

The following is a partial list of companies involved in the geothermal heat pump industry in Texas.

| NAME | TX LOCATION | NOTES | WEB SITE |
|---|---|---|---|
| **GHP Manufacturers** | | | |
| Carrier | Wylie, TX | IGSHPA Installer | www.carriergeo.com |
| ClimateMaster | Austin, TX | IGSHPA Installer & Driller | www.climatemaster.com |
| Efficiency Power (Freus) | Anthony, TX | | www.freus.com |
| Florida Heat Pump | | | www.fhp-mfg.com |
| Trane | Dallas, TX | | www.trane.com |
| WaterFurnace | Dallas, TX | | www.waterfurnace.com |
| Watermaster Geothermal Heatpumps | Henderson, TX | | |
| **Associated Products** | | | |
| Aaon Coil Products | Longview, TX | Coil products; IGSHPA Installer | www.aaon.com |
| Arbor Oaks Software | Dallas, TX | Software | www.arboroaks.com |
| Baroid Industrial Drilling Products | Burleson, TX | Drilling Products | www.baroididp.com |
| Elite Software-ECA | Bryan, TX | Software | www.elitesoft.com |
| Geo-Systems USA | Grand Prairie, TX | Pump modules | www.geosystemsusa.com |
| GeoPro | Bowie, TX | Grouting products | www.geoproinc.com |
| Hays Fluid Controls | Canyon Lake, TX | Flow valves | www.haysfluidcontrols.com |
| Performance Pipe (Chevron) | Plano, TX | Pipe | www.performancepipe.com |
| Preferred Pump & Equipment | Amarillo, Ft. Worth, San Antonio, Houston, Lubbock, Round Rock, Tyler, TX | Water well drilling and pump products | www.preferredpump.com |
| **Design / Installation / Drilling** | | | |
| Action Mechanical Services | Austin, TX | IGSHPA Installer | www.actionmech.biz/geo.html |
| Action Water Wells | Rhome, TX | IGSHPA Installer | |
| AirRite Air Conditioning Company | Ft. Worth, TX | IGSHPA Installer | www.airrite.com |
| All Year Heating & Cooling | Austin, TX | IGSHPA Installer | www.allyearaustin.com |
| Andrews & Foster Drilling | Athens, TX | IGSHPA Installer | |
| Associated Well Services | Stephenville, TX | IGSHPA Installer | www.associatedwellservices.com |
| Baird, Hampton & Brown | Ft. Worth, TX | IGSHPA member | www.bhbinc.com |
| Ball Drilling Company | Marble Falls, TX | | |
| Ballard Water Well | Willis, TX | IGSHPA Installer | www.ballardwaterwell.com |
| Benchmark Service | Irving, TX | IGSHPA Installer | www.benchmarkservice.net |
| Berger Engineering | Dallas, TX | IGSHPA Installer | www.berger-engr.com |
| Bishop Water Well – Geo Masters | Newton, TX | IGSHPA Installer | |
| Boyd's Services | Hurst, TX | IGSHPA Installer | |
| Brown-McKee | Lubbock, TX | IGSHPA Installer | www.brownmckee.com |
| C M Drilling | Midland/San Antonio/Victoria, TX | IGSHPA Installer | |
| CBS Mechanical | Denton, TX | IGSHPA Installer | cbsmechanical.com |
| Central North Drilling | Allen, TX | IGSHPA Installer | www.centralnorthdrilling.com |
| Century Mechanical Contractors | Ft. Worth, TX | IGSHPA Designer | www.centurymech.com |
| Comfort Built Engineering | Tyler, TX | IGSHPA Designer & Installer | |
| Darter & Darter | Iowa Park, TX | IGSHPA Installer | |
| Destiny Drilling | Houston, TX | | www.destiny-resources.com |
| E.D. Miller Service Company | Dallas, TX | IGSHPA Driller | |
| Eagles Wings Service Company | Duncanville, TX | IGSHPA Installer | |
| Earth Energy | Midland, TX | IGSHPA Installer | |
| Earth Power AC and Heat | Houston, TX | IGSHPA Installer | |

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|---|---|---|---|
| Earthtech | Frisco, TX | IGSHPA Installer & Driller | www.earthtechtexas.com |
| Employee's Mechanical Contractors | Weatherford, TX | IGSHPA Installer | |
| Erwin Water Well Drilling | Jacksboro, TX | IGSHPA Driller | www.erwindrilling.com |
| Estes, McClure & Associates | Tyler, TX | IGSHPA member | www.estesmcclure.com |
| Gajeske, Inc. | Houston, TX | IGSHPA Installer | www.gajeske.com |
| GeoTex Drilling | Grapevine, TX | IGSHPA Installer & Driller | www.geotexdrilling.com |
| Geothermal A/C Services | Mesquite, TX | IGSHPA Installer | www.geothermal.tx.com |
| Geothermal Advantage | Spring, TX | IGSHPA Installer | |
| Geothermal Drilling | Huntsville, TX | IGSHPA Installer | |
| GlennAire Company | Granbury, TX | IGSHPA Installer | www.glennairecompany.com |
| Geothermal Resource Technologies | Allen, TX | Conductivity | www.grti.com |
| GeothermalXperts | Houston, TX | IGSHPA Designer & Installer | www.geothermalxperts.com |
| H&F Waterwell Drilling | Seminole, TX | IGSHPA Installer | |
| Hardin Engineering | Ft. Worth, TX | IGSHPA Installer | |
| Harrison & Cooper | Wolfforth, TX | IGSHPA Driller | www.harrisonandcooperinc.com |
| Hill Country Ecopower | Austin, TX | IGSHPA Installer | www.hcecopower.com |
| Hidalgo Industrial Services, Inc. | Ft. Worth, TX | IGSHPA Installer | |
| HK3 | Houston, TX | IGSHPA Installer | |
| Holbrook Mechanical | Garland, TX | | holbrookmechanical.com |
| Humphrey & Associates | Dallas, TX | IGSHPA member | |
| Image Engineering Group | Grapevine, TX | IGSHPA Designer & Installer | www.iegltd.com |
| Imperial Electric | Mesquite, TX | IGSHPA Installer & Driller | www.imperialelectric.com |
| Jackson Drilling Services | Bridgeport, TX | IGSHPA Installer | |
| John Cook & Associates | Ft. Worth, TX | IGSHPA Installer | www.johncookgeothermal.com |
| Johnson Drilling | Blue Ridge, TX | IGSHPA Installer | |
| Johnston Water Wells | Tomball, TX | IGSHPA Installer | |
| K-Seven Corp. | Fairview, TX | IGSHPA Installer & Driller | |
| Klufa Enterprises | Pilot Point, TX | IGSHPA Installer | |
| Kober Construction | Manuel, TX | IGSHPA Installer | |
| Krismer Consulting | McAllen, TX | IGSHPA Installer | |
| Lake Flato Architects | San Antonio, TX | Designs homes w/GHP | www.lakeflato.com |
| Legend A/C | Kyle, TX | IGSHPA Installer | |
| Loop-Tech International | Huntsville, TX | IGSHPA Installer | www.looptech.net |
| Metroplex Air Solutions | Southlake, TX | IGSHPA Installer | |
| Meza Engineering | Dallas, TX | IGSHPA member | www.mezaengineering.com |
| Monte Moore Drilling | Lamesa, TX | IGSHPA Installer | |
| MPS Geothermal | Odessa, TX | IGSHPA Installer | |
| Next-Gen Solutions | Marble Falls, TX | IGSHPA Installer | |
| Polk Mechanical | Grand Prairie, TX | IGSHPA Installer | www.polkmechanical.com |
| Porter Mechanical | Cooper, TX | IGSHPA Installer | |
| Precision Drilling | Lubbock, TX | | brownmckee.com/precision-drilling.asp |
| Presage Environmental | Brownfield, TX | IGSHPA Driller | |
| Pryne Builders | Austin, TX | Designs homes w/GHP | austin-green-builder.com |
| Quality Air Conditioning | Tyler, TX | IGSHPA Installer | |
| Red Rock Group | Flower Mound, TX | IGSHPA Installer | |
| Redding Linden Burr Consulting Engineers | Houston, TX | IGSHPA Designer & Installer | rlbengineers.com |
| Renewable Utility Solutions | San Antonio, TX | | renewableutilitysolutions.com |
| RES Air Conditioning | Henderson, TX | IGSHPA Installer | www.resairconditioning.net |
| Richard Moore Drilling | Welch, TX | IGSHPA Installer | |
| Richardson Water Well Drilling | Alice, TX | IGSHPA Installer | |
| Rick Black, Architect | Austin, TX | Designs homes w/GHP | www.rickblack.net |
| Romine, Romine, and Burgess | Ft. Worth, TX | | www.romineinc.com |

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|---|---|---|---|
| SHW Group | Aus/Dal/Hou, TX | | www.shwgroup.com |
| SkiHi Enterprises | Ft. Worth, TX | IGSHPA Installer | www.skihi.com |
| Solid Structures | Brownsville, TX | IGSHPA Installer | www.solidstructures.org |
| Southwest Mechanical Services | San Antonio, TX | IGSHPA Installer | www.southwestgeo.com |
| South Texas Renewable Energy | McAllen, TX | IGSHPA Installer | www.south-texasre.com |
| Stan's Heating & A/C | Austin, TX | IGSHPA Installer | www.stansac.com |
| Stoner Drilling | Corsicana, TX | | |
| Summit Consultants | Euless, TX | IGSHPA member | www.summitmep.com |
| Sunbelt Industrial Services | Ft. Worth, TX | IGSHPA Installer & Driller | www.sun-belt.com |
| TD Industries | Ft. Worth, TX | IGSHPA Installer | www.tdindustries.com |
| T.L Endeavors | Plano, TX | IGSHPA Driller | |
| Techno Drill | Ft. Worth, TX | IGSHPA Installer | www.techdrillusa.com |
| Texas General Mechanical | Rowlett, TX | IGSHPA Installer | |
| Texas Geothermal | Ft. Worth, TX | IGSHPA Installer & Driller | www.texasgogeo.com |
| Texas Reps | Spicewood, TX | IGSHPA Installer | www.texasreps.com |
| Tim Adams Heating, Cooling & Refrigeration | Bowie, TX | IGSHPA Installer | |
| Tindall Mechanical | Cedar Hill, TX | IGSHPA Installer | |
| TMI Construction | Weatherford, TX | IGSHPA Installer | www.tmiconstruction.com |
| Tolle Drilling | Sanger, TX | | |
| Total Comfort A/C Systems | Tomball, TX, | IGSHPA Installer | www.tcacs.com |
| Tradesman Heating & A/C Services | Waco/Elm Mott, TX | IGSHPA Installer | www.tradesmanair.com |
| Tree, Inc | Frankston, TX | IGSHPA Installer | |
| Trison Construction, Inc. | Greenville, TX | IGSHPA Designer & Installer | www.trison.us |
| Utopia Sales & Service | Utopia, TX | IGSHPA Driller | |
| Willis Mechanical | Ft. Worth, TX | | |
| Yarbrough Mechanical | Seven Points, TX | IGSHPA Installer | |
| Ware Architecture | Dallas, TX | | www.warearchitecture.com |
| Whisper Energy | Lubbock, TX | IGSHPA Installer & Driller | www.whisperenergy.com |
| Whiting Well Drilling | Boerne, TX | IGSHPA Installer | |
| Wolverton Co., Inc. | Waxahachie, TX | IGSHPA Installer | |

**Sales and Maintenance**

| | |
|---|---|
| A C Engineered Systems | Houston, TX |
| A C Systems of Texas, Inc. | Sunnyvale, TX |
| A/C Contractors | Longview, TX |
| Aces A/C Supply–North | Carrollton, TX |
| Advent A/C | Lewisville, TX |
| Affordable A/C | Corpus Christi, TX |
| Airtrol Supply | SW Texas/Corpus |
| Allied Energy Systems | |
| American Geothermal | Austin, TX |
| Armstrong Mechanical Company | Lubbock, TX |
| Atlas Electic & A/C | Alton, TX |
| Aweb Supply | Southeastern Texas |
| Bill Joplin's Compressor Service | Mckinney, TX |
| Cannell Air Conditioning | El Campo, TX |
| Central AC & Plumbing | Texarkana, TX |
| C.H.E. Incorporated | Lubbock, TX |
| Comfort Zone One Hour A/C | Midland, TX |
| Control and Equipment Company | El Paso, TX |
| Crawford Services | Dallas, TX |
| Custom Aire | Texarkana, TX |
| Doug's A/C | Pineland, TX |
| EarthEnergy Distributing | NE Texas |

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|---|---|
| First Service A/C Contractors | Midland, TX |
| Foss Enterprises | Woodsboro, TX |
| Gene James A/C & Heating | Iowa Park, TX |
| Geo-Thermal A/C Service | Greenville, TX |
| Geothermal Distribution | Rockwall, TX |
| Greenland Energy | Addison, TX |
| Grifco Enterprises | George West, TX |
| Gulf Coast Air Conditioning | Houston, TX |
| Hess A/C | Alamo, TX |
| Indoor Comfort Specialists | Houston, TX |
| Jerry's A/C | Corpus Christi, TX |
| Keith A/C | Marshall, TX |
| McMillan James Equipment Company | Grapevine, TX |
| Mechanical Reps | San Antonio/Austin, TX |
| Miller Service | Dallas, TX |
| Mize Heating and AC | Bryan, TX |
| Paradise Air | Plano, TX |
| Platt Heating and Air Conditioning | Grapeland, TX |
| QuanAir Quality and Value | San Antonio, TX |
| Riley A/C | Livingston, TX |
| Shaeffer Air Conditioning | Buna, TX |
| Sims Home Center | |
| Southwest AC & Heating | Abilene, TX |
| Standard Renewable Energy | Farmers Branch, TX |
| Sullivan A/C | Corpus Christi, TX |
| Sumrall A/C & Heating | Nederland, TX |
| Texas Services  Air Conditioning | Arlington, TX |
| Thermal Enterprises | Southlake, TX |
| Thomas Matheson A/C | Rockport, TX |
| Tonne A/C | Corpus Christi, TX |
| Walker Heating & Cooling | Tyler, TX |
| Wendland A/C | Portland, TX |
| Whitehead Electric Heating and A/C | Crockett, TX |

## APPENDIX B: ADDITIONAL COST COMPARISONS AND CASE STUDIES

The following projects further demonstrate the benefit of GHP systems in this region of the country.

**Rogers Elementary in Frisco ISD, Texas** (From Earth Tech):

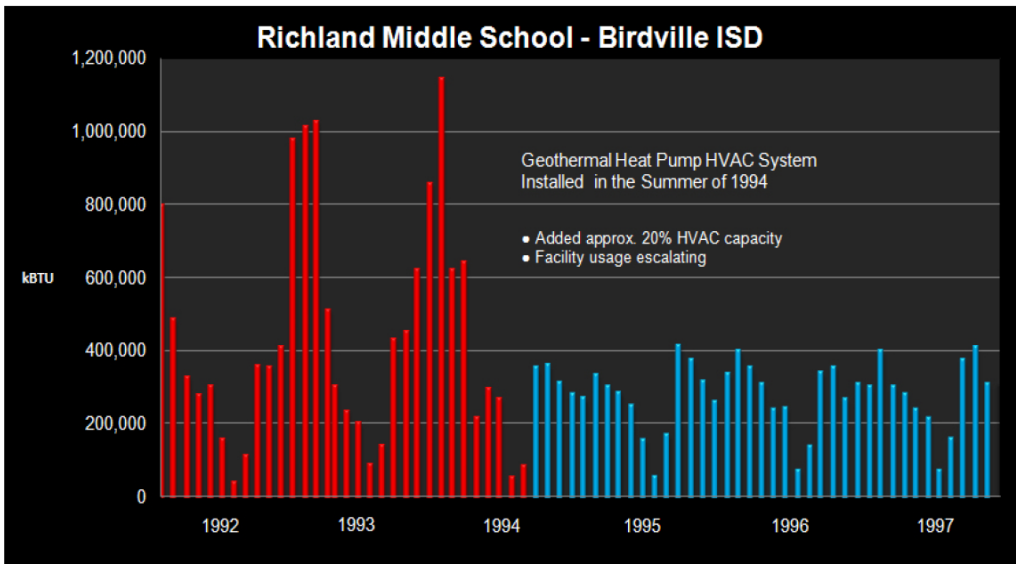
***Before GHP:***

| | | 2005 | | 2006 | |
|---|---|---|---|---|---|
| Roger Elementary | Electric (KWH) | 926,010 KWH | $110,826.50 | 922,140 KWH | $118,907.71 |
| | Natural Gas (CCF) | 8,099 CCF | $9,738.11 | 11,279 CCF | $10,375.07 |
| | Roger Elementary Subtotal | | $120,564.61 | | $129,282.78 |

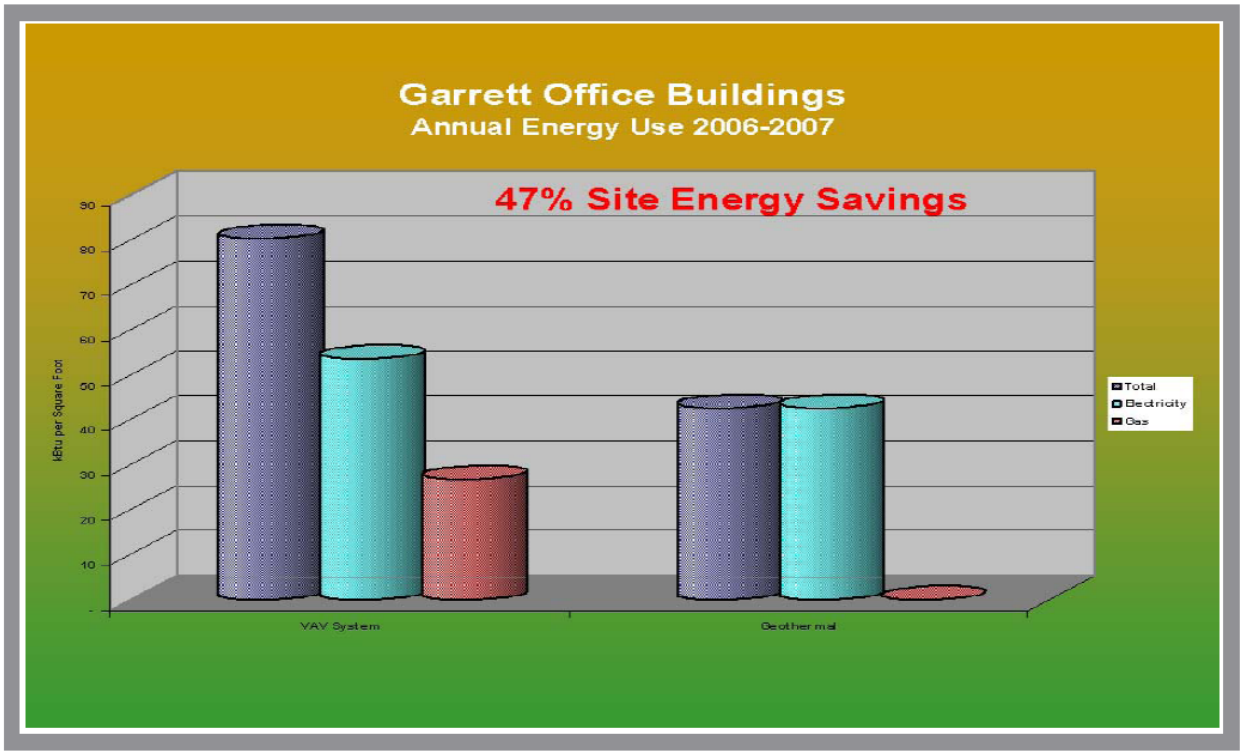
***After GHP:***

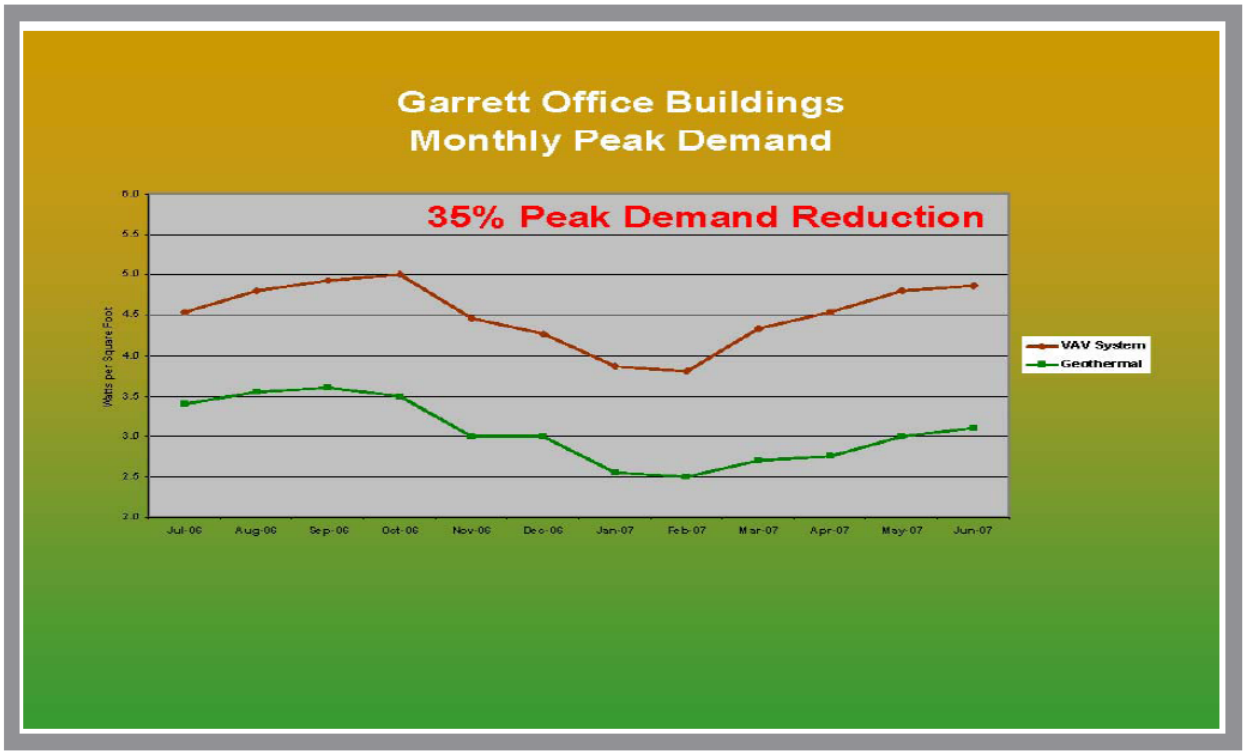
| 2007 | | 2008 | |
|---|---|---|---|
| 674,550 KWH | $86,723.38 | 608,085 KWH | $75,715.91 |
| 3,190 CCF | $3,536.17 | 2,941 CCF | $2,494.39 |
| | $90,259.55 | | $78,210.30 |

**Richland Middle School in Birdville ISD, Texas** (From Image Engineering Group):



**Garrett Office Buildings** (From Image Engineering Group):



**Case Study: Fort Polk - Louisiana**[72]

At Fort Polk, Louisiana, the space conditioning systems of 4,000 military family housing units, occupying 5.6 million square feet, were converted from air-source heat pumps (or, in some cases, central air/gas furnace combinations) to GSHPs with the help of an energy saving performance contract (ESPC).

A total of 6,600 tons of cooling was installed to supply the 4,000 units. Approximately 75% of the new GSHPs included hot gas desuperheaters to supplement domestic hot water heating. As is common with major retrofit projects, other efficiency measures, such as compact fluorescent lamps (CFLs), low-flow shower heads, and attic insulation, were installed along with the GSHPs. Including all these measures, the total cost of the project came to approximately $19 million.

An independent evaluation revealed that the project resulted in a 25.6 million kWh, or 32.4%, savings in electricity for a typical meteorological year. Peak electrical demand was also reduced, by over 6.5 MW, or just under 40% of the pre-retrofit peak demand. Natural gas savings average 260,000 therms per year. In addition, the ESPC allowed the Army to effectively cap its future maintenance costs for heating, ventilation, and air conditioning in family housing at about 77% of the pre-retrofit levels. The total value of all energy and maintenance savings is approximately $3 million per year, part of which is paid to the energy service company that financed and installed the retrofit equipment.

[72]From http://www1.eere.energy.gov/femp/procurement/eep_groundsource_heatpumps.html.

## APPENDIX C: INVENTORY OF EXISTING TRAININGS

Some leading occupational certification and accreditation courses for the GHP industry are listed in the table below. Descriptions of the courses can be found on the subsequent pages of this document.

| Organization(s) | Name of Certification / Training | Number Currently Listed in Texas | Training Offered by Texas Community College? |
|---|---|---|---|
| IGSHPA / AEE / GHPC | Certified GeoExchange Designer (CGD) | 8 | No |
| IGSHPA / NATE | IGSHPA Accredited Installer with NATE Certification | 128 | No |
| IGSHPA / NATE | Accredited Driller (Accredited Vertical Loop Installer) with NATE Certification | 17 | No |
| IGSHPA | Train-The-Trainer | 4 | No |
| Gwinnett Technical College | Multiple IGSHPA Installer and Driller courses | N/A | N/A |
| HeatSpring Institute | Multiple courses, including some IGSHPA courses | N/A | N/A |
| AGWT | Geothermal Vertical Loop Installer | Unavailable | No |
| GHP Manufacturers (e.g., ClimateMaster, Enertech, WaterFurnace) | Vendor-specific training on equipment, installation, sales, etc. and some IGSHPA courses | Unavailable | No |

## *International Ground Source Heat Pump Association (IGSHPA) Courses*

IGSHPA offers a wide range of courses both on-campus at Oklahoma State and off-campus at select sites throughout the nation. Descriptions of the four courses that lead to certification/accreditation follow. Additional information can be found at: http://www.igshpa.okstate.edu/training/training.htm.

### Description of Certified GeoExchange Designer Course[73]

Become a Certified GeoExchange Designer (CGD) with training brought to you through the combined efforts of the International Ground Source Heat Pump Association (IGSHPA), the Geothermal Heat Pump Consortium (GHPC), and the Association of Energy Engineers (AEE).

Take advantage of this opportunity via our new distance learning course option. You will receive all course materials, including lectures on CD, prior to attending a one-day Q&A/ review seminar. Having the lectures on CD ensures that you will have a professional instructor at your desktop for life! No more trying to remember exactly what the instructor said; instead, see for yourself by referring back to the lectures on CD. You should view all of the CD lectures, make notes, and record questions prior to attending the one-day Q&A/review that will be presented at various times and places throughout the year. Following your attendance of a review session, the certification exam will be available to take on-line at the student's convenience.

As an architect or engineer, you have specific questions about GSHP systems that you want answered. IGSHPA has designed a program to offer advanced training towards certification as a GeoExchange Designer (CGD). From an introduction to the technology to a complete review of the design process, participants learn the specific information they need to know. IGSHPA has entered into a cooperative endeavor with the Association of Energy Engineers (AEE) and the Geothermal Heat Pump Consortium (GHPC) to provide training for the Certified GeoExchange Designer Program. Participants will receive a copy of the Closed-Loop/ Ground-Source Heat Pump Systems Installation Guide, as well as other manuals in the CGD Notebook.

*Who should attend:* The Certified GeoExchange Designer course is designed for professional engineers, registered architects, installers, and contractors. This course is essential for individuals wanting advanced training and experience in designing GSHPs, and required for experienced individuals who wish to earn certification.

Topics:

- Ground Source Heat Pump Design
- Loop Systems, Open Systems
- Soil/Rock Classification and Conductivity
- Grouting Procedures
- Commercial Ground Loop Heat Exchanger Software
- Performance of Ground Source Heat Pumps in Housing Units

[73] More information available at: http://www.igshpa.okstate.edu/training/cgd.htm.

*Eligibility requirements:* Each candidate for certification must meet one of the following four sets of criteria:

- Be an engineering graduate and/or Professional Engineer or Registered Architect with three years of verified, combined experience in geothermal heat pump design, heating, ventilation and air-conditioning
- Have a four-year, non-technical degree with five years of verified, combined experience in geothermal heat pump design, heating, ventilation and air-conditioning
- Have a two-year technical degree with eight years of verified, combined experience in geothermal heat pump design, heating, ventilation and air-conditioning
- Have ten years or more verified, combined experience in geothermal heat pump design, heating, ventilation, and air-conditioning

*Certification process:* Certification is accomplished by application to AEE. To become certified the candidate must:

- Determine if eligible under the Eligibility Requirements listed.
- Register for and attend the IGSHPA CGD Workshop.
- Pass the IGSHPA CGD exam.
- Complete a separate application to be submitted to AEE, initiating the certification process.
- Certification will be awarded by AEE after the CGD Board's evaluation of the candidate's qualifications.

Attending the CGD Workshop and passing the CGD exam are only a part of the certification process and will not automatically lead to certification. Contact AEE at 1-770-447-5083, ext. 223 for additional certification information.

*Online Testing Procedures for Certified GeoExchange Designer Course:*

*Students Who Are Ready to Apply for CGD:*
If you have sufficient experience and are ready to make application for CGD, you must complete the long application form and submit it to the Association of Energy Engineers (AEE) after completing the CGD course. After you have made application, you need to contact the International Ground Source Heat Pump Association to obtain your online testing User ID and Password. You can email our Training Coordinator. After you pass the exam, the CGD board will review your application and make the decision for awarding certification.

*Students Who Are Not Yet Ready to Apply for CGD:*
If you do not currently have the experience necessary to meet the qualifications for the CGD, you can become a CGD in training. You need to complete the short application form and submit it to the Association of Energy Engineers (AEE) after completing the CGD course. Doing this will enable you to take the exam now and your results will be kept on file until you are ready to make full application. During the interim you will be designated as a CGD in training.

## Description of IGSHPA Accredited Installer Workshops[74]

Learning to install GSHP systems will keep you competitive in a market forced to deal with rising energy costs and resource depletion. Installer accreditation enables you to open new markets and offer customers a low-maintenance, economical, and environmentally friendly alternative for their space conditioning needs. With over fifteen years of experience teaching these workshops, accrediting thousands of installers, and setting the industry standard, IGSHPA has maintained close ties with Oklahoma State University, and pioneered training in GSHP installation.

*Who should attend:* The three day comprehensive Installation Workshops are designed for GSHP developers, architects, manufacturers, distributors, dealers, installers, HVAC contractors, trenching/drilling contractors, and anyone who desires a working knowledge of this innovative technology. Representatives from public utilities, private utilities, and rural electric cooperatives can also benefit from training. Information gathered from the workshops can help utility representatives serve as a source of information regarding money-saving concepts.

*Accreditation:* Upon successful completion of the workshop and passing the IGSHPA installer's exam, you will be issued IGSHPA accreditation as an installer of GSHP systems. You will receive an installer's card and a certificate. In most instances, you will receive a membership with IGSHPA after you have completed the Installation Workshop. Membership in IGSHPA is required to be an Accredited Installer and maintain accreditation.

Topics:

- Design and Material Options
- System Layout
- Pipe Joining Techniques
- Trenching/Drilling Processes
- Air and Debris Purging
- Pressure Drop Calculations
- Pump and Fluid Selection
- Thermal Conductivity

[74] Additional information available at: http://www.igshpa.okstate.edu/training/accredited.htm.

## Description of IGSHPA Accredited Drillers Training [75]

IGSHPA's Accredited Drillers Training—Applications of Production Drilling and Borehole Construction for GeoExchange Systems course. This new workshop will train individuals on proper construction and completion methods for vertical GeoExchange boreholes. Currently, drilling contractors searching for industry training on GeoExchange heat pumps must attend a full Accredited Installer workshop. Because certain topics covered within the Accredited Installer course do not pertain to drilling contractors, IGSHPA has formed this training course to provide drilling contractors with information that's unique to them on a GeoExchange job site.

*Who should attend:* Current Drilling Contractors, Drilling Company Owners, Drilling Company Project Managers, Drilling Company Administrators

*Accreditation:* Accreditation as an "Accredited Vertical Loop Installer" will be awarded with successful completion of the course and exam. You will receive a vertical loop installer's card and a certificate. In most instances, you will receive a membership with IGSHPA after you have completed the training class. Membership in IGSHPA is required to be an Accredited Vertical Loop Installer and maintain accreditation.

Topics:

- GSHP System Design and Layout Basics
- System Materials
- Pressure Drop Calculations
- Thermal Conductivity
- Drilling Processes
- Containment Procedures
- Grouting Concepts
- Air and Debris Purging
- Pipe Joining Techniques
- Project Bidding
- Partnerships

[75] Additional information available at: http://www.igshpa.okstate.edu/training/drillers.htm.

## Description of the IGSHPA Train-The-Trainer Course[76]

As ground source heat pumps capture more of the HVAC market, the need for competent installers increases as an integral part of the growing geothermal industry. Regional trainers are essential if the industry is to provide the necessary GSHP installation workshops for people interested in becoming IGSHPA-accredited installers. In IGSHPA's Train-the-Trainer Workshop, participants review all the skills involved in GSHP system installation and learn how to teach these skills to others. The five day comprehensive course is taught in conjunction with an Installers' Workshop.

The first and second days of the course will cover adult education principles, and program and lesson planning. During the remaining days, trainees will practice presenting lesson plans, and will present a lesson in an actual installation workshop. Participants are taught how to use IGSHPA training aids, such as manuals, videos, sample curriculum, and transparencies used in IGSHPA workshops. With successful completion of the program, participants will receive IGSHPA training accreditation and be able to instruct installation workshops in their home areas. Courses are taught by industry professionals with expertise ranging from GSHP system design to research. Each instructor is IGSHPA-accredited with years of teaching experience to share. Each participant will also receive a copy of the Closed-Loop/ Ground-Source Heat Pump Systems Installation Guide, a presentation manual, and handouts.

*Who should attend:* The Train-the-Trainer Program is designed for individuals who are already IGSHPA accredited installers, familiar with GSHP technology, and experienced in its installation and maintenance. Prospective trainers must be confident enough of their knowledge and skills to teach them to others.

*Accreditation:* Upon successful completion of the training program and passing the IGSHPA Installer's exam, you will be issued IGSHPA accreditation as a trainer of IGSHPA installation workshops. You will receive a trainer's card and a certificate.

TOPICS:

- Training Methods
- Adult Education Processes
- Design and Material Options
- Ground Heat Exchanger Design
- System Layout
- Pipe Joining Techniques
- Air and Debris Purging
- Soils and Rock Identification
- Pump and Fluid Selection

*Eligibility:* You must be an IGSHPA accredited installer to take the course.

[76] Additional information available at: http://www.igshpa.okstate.edu/training/ttt.htm.

## *GWINNETT TECHNICAL COLLEGE COURSES*

Gwinnett Technical College, which opened in 1984, is the State of Georgia's third largest technical college in terms of credit enrollment, and is the state's largest technical college when credit enrollment, continuing education enrollment and adult education enrollment are combined. Since 2000, Georgia has allowed technical institutes with proper accreditation to be designated as colleges.

Gwinnett offers more than 140 program options in areas such as Marketing, Business Management, Computer Information Systems, Early Childhood Education, Drafting, Health Sciences, Cosmetology, Criminal Justice, Automotive Technology, Visual Arts, and Fashion and Design. Many Gwinnett Tech students earn an associate of applied science (AAS) two- year degree. They also offer hundreds of certificate and diploma program options.

Gwinnett offers IGSHPA-accredited installer training and vertical well driller courses within their "LEED and Energy Conservation" Course group. Additional information can be found at: https://aceweb.gwinnetttech.edu/wconnect/wc.dll?acecode~CatalogList.

**Description of the IGSHPA Ground Source Heat Pump Accredited Installer Training**

**CEUs: 2.40 Hours: 24.00**

**Description:**

"Ground Source Heat Pump" (GSHP) systems will keep you competitive in a market forced to deal with rising energy costs and resource depletion. You will be able to offer your customers a low-maintenance, economical, and environmentally friendly alternative for their space conditioning needs. This three day workshop is designed for GSHP developers, architects, installers, HVAC contractors, trenching/drilling contractors, and anyone interested in this innovative technology. Topics covered include: design and material options, system layout, pipe joining techniques, trenching/drilling processes, air and debris purging, pressure drop calculations, pump and fluid selection, and thermal conductivity. Must be at least eighteen years of age to attend.

Upon successful completion of the workshop and passing the IGSHPA installer's exam, you will receive IGSHPA accreditation as an installer for GSHP systems. Participants that successfully complete this course and the final exam will have a three year membership/accreditation with IGSHPA. The course cost include the three year membership fee, the final exam testing fee, the IGSHPA study guide, and the IGSHPA text book developed for this program.

*Please Note: Class will be conducted on Thursday, Friday, and Saturday.*

| Meets | Fee |
|---|---|
| Th, F, Sa from 7:30 AM to 4:00 PM, 3 Sessions | 1150.00 |

**Description of the IGSHPA Vertical Loop Installer Certification Course**

**CEUs: 1.60 Hours: 16.00**

**Description:**

Tap into our drilling and borehole construction program for geoexchange systems.

This course is designed for those that do not wish to attend a complete geothermal accredited installer course, as they do not get involved with system connectivity or start-up. This is an excellent way for drillers, riggers, and borehole engineers to position themselves to bid on geoexchange projects without having HVAC credentials, or an IGSHPA System Installer credential. You will obtain IGSHPA Vertical Loop credentials after successfully completing the course and the final examination.

This accredited training program was developed by Oklahoma State University and is intended to prepare individuals for geothermal vertical loop installations in support of geoexchange systems. Those that wish to be certified for both Vertical Loop and Geoexchange System Installation must attend two workshops and will have dual certifications when successfully completed.

Participants that successfully complete this course and the final exam will have a three year membership/accreditation with IGSHPA. The course cost include the three year membership fee, the final exam testing fee, the IGSHPA study guide, and the IGSHPA text book developed for this program.

Topics:

- GSHP System Design and Layout Basics
- System Materials
- Pressure Drop Calculations
- Thermal Conductivity
- Drilling Processes
- Containment Procedures
- Grouting Concepts
- Air and Debris Purging
- Pipe Joining Techniques
- Project Bidding
- Partnerships

| Meets | Fee |
|---|---|
| F, Sa from 8:00 AM to 4:00 PM, 2 Sessions | 800.00 |

## *HEATSPRING LEARNING INSTITUTE COURSES*

HeatSpring Learning Institute is an education company headquartered in Cambridge, MA focused on providing clean energy training to building professionals. They have trained over 3,000 professionals across the United States on Geothermal Heat Pump and Solar Electric Systems. Additional information available at: http://www.heatspring.com/index.php?id=catalog.

### Classroom Courses

**Accredited Geothermal Installer Certification** - Offered in partnership with the International Ground Source Heat Pump Association (IGSHPA). Those who pass the open book exam become IGSHPA Accredited Geothermal Installers. Course also includes a hands-on pipe fusion training and certificate. Courses have been offered in CT, MA, MD, NJ, MN, and NY.

**Planning and Designing Geothermal Systems** - This class will allow you to evaluate designs, advise clients adeptly and design systems yourself. You'll have plenty of materials to reference later when you're on a project and need to resurrect all the learned best practices. Earn 16 hours of AIA approved continuing education credits while you're at it.

**Standing Column Well Geothermal Systems** - Learn about standing column wells from the industry's expert. This geothermal design course will address the fundamentals of what makes the Standing Column Well (SCW) different and compelling as a geothermal HVAC solution. It will investigate a number of SCW design applications, and review the key thermal and hydro-geological bases for good performance.

### Video Courses

- **Fundamentals of Geothermal Systems** - Topics covered include how heat pumps work; ground as a heat source and sink; system types; case studies; design issues; expected performance and the economics of a system.
  » Fundamentals of Geothermal Systems

- **Geothermal Short Courses** - Short courses offer condensed learning experiences for people curious about geothermal systems.
  - Geothermal Heat Pumps
  - Understanding Heat Pump Mechanics
  - Climate Change & Geothermal Heat Pumps

### Distance Learning

**Entry Level Geothermal Certificate Training** - This six-week interactive course uses reading assignments, video instruction, homework, quizzes, and a capstone lecture to give you a solid foundation for success in the geothermal industry. You can tailor the learning to your own needs by submitting questions to the instructor, and have access to the learning materials for a full 120 days. Passing the course earns you an Entry Level Geothermal Professional Certificate, and the course is pre-approved for CEUs (5 AIA HSW).

## *American Ground Water Trust (AGWT) Courses*

The American Ground Water Trust is a national not-for-profit public education organization. The Trust's mission is to:

- Promote efficient and effective ground water management
- Communicate the environmental and economic value of ground water
- Showcase ground water science and technology solutions
- Increase citizen, community and decision-maker awareness
- Facilitate stakeholder participation in water resource decisions

They offer a number of training courses and workshops throughout the year in coordination with GHP vendors and industry representatives on topics such as vertical loop installation, ground source heating & cooling for residential and commercial properties, and water well & pump performance. A description of the vertical loop installer course can be found below. Additional information on other courses and workshops can be found at: http://www.agwt.org/workshops.htm.

### Geothermal Vertical Loop Installer Course Outline

**Course Topics:**

- Drilling Methods for Geothermal Vertical Loop Installations
- Thermal Enhanced Grouts: Requirements and Procedures
- Learn how a Site Survey can Increase Your Profits
- How to Conduct a Site Survey and What Documentation is required
- How a Geothermal Heat Pump (GHP) Works
  - GHP System Components and How they Function
  - Learn about Basic Refrigeration - The Foundation of GHP Operation
  - How to Calculate the Optimum Operating Water Flow Rate for Efficiency
  - How to Calculate the Amount of Heat Available in the Ground For Extraction/Rejection
- Closed Loop Design Basics - How Is Ground Energy Transferred - Ground To Building and Back Again
  - Flow Controller
  - Parallel vs. Series Configurations
  - Header Design
  - Inside Piping
  - Vertical Loop Piping Installation & Testing
  - Closed Loop Pressure Drop Calculations
- Flushing the Earth Loop - In many ways the "Most important part of the Installation Process"
  - Learn the Proper Flushing Procedure and How It Can Make Your Job More Profitable;
- Typical Flush Carts, Valve Positioning and Flushing, Antifreeze Selection & Charging, Pump Replacement Procedure
- Computer Design Basics - GeoDesigner Software Overview

*Drillers Who Successfully Complete the Two-day Training May Obtain the Following Certifications / Recognition:*

- ClimateMaster Certificate of Participation (Test Required)
- Membership in ClimateMaster's Preferred Vertical Loop Installer & Dealership Network
- Inclusion on ClimateMaster's Find-a-Preferred Driller Website Listing
- Socket Fusion Certification
- Access to ClimateMaster's GSHP Loop Installation Experts

## *VENDOR TRAININGS: CLIMATEMASTER*

ClimateMaster offers a range of trainings throughout the year. Descriptions of representative courses have been included below. Additional information on commercial trainings can be found at: http://www.climatemaster.com/index/training_events. Additional information on residential trainings can be found at: http://www.climatemaster.com/index/res_training_events.

### Commercial Training: Commercial Sales Representative Training

Topics include:

Day 1:
- What is a Water Source Heat Pump?
- System Selling
- Product Overview
- Street Smart Specifications
- Geothermal Advantages
- Strategic Accounts

Day 2:
- LEED Update
- ClimaSize Overview
- EZ Order
- Sound
- Technical Services
- Customer Service

### Commercial Training: eQuest Software Training

### Residential Training: Residential Service and Install Training

Objective: Review of installation, operation and maintenance of ClimateMaster geothermal equipment and fundamentals of loop type and installation procedures.

Topics include:

- Review of basics and advantages of geothermal
- Components of a geothermal unit
- Basic refrigeration review: superheat/subcooling
- Unit performance
- Verification HE/HR
- Show slide rule calculator
- Begin going through IOM
- Install procedures
- Well water systems and closed loops
- Hot water generator
- CXM control board
- Product overview
- Auxiliary heat

## ClimateMaster IGSHPA Accredited Service and Installation Training

*Day 1 Objectives:* Discuss GSHP systems and proper sizing of equipment. Discuss soil and proper grouting procedures as well as designing and the ground heat exchanger

Topics include:

- Introduction and Overview of GSHP
    1. GS-System concept
    2. Energy source
    3. Basic heat pump system
    4. Heat pump configurations
    5. Heat pump operation
    6. Domestic hot water options
    7. System materials and components
    8. Economics, marketing and demand reduction

- Selecting, Sizing and Designing the Heat Pump System
    1. Design procedure for the heat pump system
    2. Determining building loads (heating and cooling)
    3. Load calculations procedures
    4. Performance of an air source heat pump
    5. Performance of a ground source heat pump
    6. Energy calculations

- Introduction to Grouting, Soils and Thermal Conductivity
    1. Importance of bore hole grouting
    2. Grouting materials
    3. Dry bore holes
    4. Grout placement methods
    5. Grout pumps
    6. Grout mixing
    7. Properties of soils
    8. Classifications of soils
    9. Field identification procedures for fine-grained soils fractions
    10. Rock classifications
    11. Thermal conductivity levels

- Designing the Ground Heat Exchanger
    1. Steps in ground heat exchanger design
    2. Ground heat exchanger configurations
    3. Standardized parallel system header
    4. Selection of heat exchanger
    5. Pipe selection
    6. Selecting the correct pump for the loop design
    7. Headers

*Day 2 Objective: Discuss proper installation and flushing procedures of the ground heat exchanger.*

Topics include:

- Installation of the Ground Heat Exchanger
    1. Site plan
    2. Excavating for different configurations of loops
    3. Back filling
    4. Testing loop before back filling
    5. Horizontal boring
    6. Vertical boring and types
    7. Pond and lake loops

- Flushing the Ground Heat Exchanger
    1. System flushing
    2. Air purging
    3. Verifying earth coil pressure/ flow design
    4. Error detecting
    5. Charging system with antifreeze and types
    6. Pressurizing the closed loop system

- Heat Pump System Startup and Checkout & Fusion of Loop Pipe
    1. Heat pump performance HE/HR check
    2. Looking up specifications of a particular unit to verify performance

- Socket Fusion Demonstration and Other Fusion Methods
    1. Slide show showing butt fusion and electro fusion
    2. Review socket fusion procedures
    3. Demonstrate a socket fusion in front of class

- Review and Test for IGSPHA Accredited Installers

## *VENDOR TRAININGS: ENERTECH*

Enertech offers a variety of training sessions are geared towards technicians, designers, or sales personnel, but none are currently offered in Texas. Descriptions of some representative courses can be found below. The courses would not typically be useful for building/home owners or individuals not in the HVAC industry. Additional information can be found at: www.enertechmfg.com/training1.

**Design & Application** A one-day seminar covering all aspects of design, selection, and application of residential geothermal systems. Topics include geothermal technology, introduction/application of products, ground loop options, sizing the heat pump/ground loop, preparing a list of components, and thorough instruction on how to use the GeoAnalyst software program. The training is intended for designers, sales personnel, and HVAC professionals wanting a better understanding of the technology. Cost is $99 per person.

**Installation & Service** This two-day seminar is geared towards installation and service technicians who already have a basic understanding of HVAC systems and refrigeration. Topics include packaged unit installation, split systems, water-to-water units, combination units, controls operation and troubleshooting, fl ow center installation and fl ushing, equipment start-up, performance checks, servicing the system, and refrigeration system/troubleshooting. Cost is $295 per person, and includes geothermal service tools, training materials, and **16 NATE CEH.**

**IGSHPA/NATE Certified Installer Workshop**

The three-day comprehensive Installation Workshops are designed for GSHP distributors, dealers, installers, HVAC contractors, trenching/drilling contractors, and anyone who desires a working knowledge of geothermal technology. Upon successful completion of the workshop and passing the IGSHPA/NATE installer's exam, IGSHPA/NATE accreditation as an installer of GSHP systems will be issued, which includes an installer's card and a certificate. Cost is $995 per person, which includes all course materials, a three-year IGSHPA membership, listing as an accredited installer on IGSHPA's website (once the exam has been passed), and a coupon for $200 off the purchase of GeoComfort/Hydron Module/TETCO equipment, accessories, promotional items, or tools.

## *VENDOR TRAININGS: WATERFURNACE*

WaterFurnace offers a variety of training sessions, including the modules described below. Some courses are offered in Texas. Additional information can be found at: http://training.waterfurnace.com.

***Module RT1 -*** Service and Installation (*3 days)*

Description: Designed for installers, service technicians and service managers, this course focuses on installation and service procedures. Topics include the basics of water-side analysis, troubleshooting, heat of extraction/rejection. Focus on Premier, E Series, Synergy3, Versatec & IntelliZone products. *Prerequisite: Understanding of heat pumps, refrigeration, electrical.*

***Module RT2 -*** Geothermal Piping Design (*4 days, 3 days if no loop is installed)*

Description: Designed for companies becoming loop installers, or HVAC contractors who design and/or install their own geothermal earth loops. This course thoroughly covers the design and installation of geothermal closed loop systems in residential applications. Topics include site surveys, soil classifications, header design, loop types, grouting vertical bores, fusion certification, building penetration, pressure drop, pump sizing, flushing and purging. If a local site is available, students will get hands-on experience applying classroom knowledge.
*Notes: This course is required for WaterFurnace Geothermal Services Contractor (GSC) status. Successful completion of the course allows the attendee to take the International Ground Source Heat Pump Association (IGSHPA) certification test.*

***Module RT3*** - Hydronic Applications (*1 day)*

Description: Designed for contractors using geothermal equipment in water-to-water applications. Includes theory of operation, refrigeration system, heat of extraction/rejection, and the various water-to-water units manufactured by WaterFurnace. Students will learn how to design a radiant floor heating system. Key controls and components required are discussed, along with installation procedures including pump sizing, buffer tanks, etc. Other applications using water-to-water units are also covered including ice melt, swimming pools, process water, outdoor air tempering, and fan coils.

***Module RT4*** - Introduction to Geothermal HVAC Systems (*2 hours + 4 hours for additional detail including water-side diagnosis)*

Description: Designed for the sales force and key managers of HVAC contractors who have little or no experience with geothermal heat pumps. Topics include explanation of geothermal technology theory and terminology, heat pumps and their key components, earth loop types, efficiency comparisons, variety of applications, advantages, disadvantages, and comparisons to other HVAC equipment.
*Note: This module is introductory in nature and is not intended as a substitute for modules RT1 and RT2.*