Is There a Future for Geothermal Heat Pumps in Southern New England?

Dinesh Bhagani, Northeast Utilities
Robert Wirtshafter, Wirtshafter Associates, Inc.
Russell Johnson, Northeast Utilities
Jonathan Weiss, Wirtshafter Associates, Inc.
Robert Bordner, Energy Market Innovations, Inc.,

ABSTRACT

This paper provides an in-depth look at the future market for ground-source geothermal heat pumps in New England. It is based upon interviews with manufacturers, installers, new home builders, real estate professionals, and an array of related market participants. Building upon research undertaken primarily in Southern New England markets, we examine and discuss the market factors that impede the diffusion of this energy efficient technology. Factors that have been explored and will be highlighted include: strong local economy and consequent tight home building market, geographic and climatic conditions, inconsistencies in local code enforcement, changes in codes and building practices, and past experiences with older heat pump technology.

Cost and performance trends are discussed, as well as feedback obtained from homeowners using ground source heat pumps. Homeowners with systems installed in the past five years are overwhelmingly satisfied with these systems. Importantly, however, the paper also explores critical market barriers that result from limitations in the installation infrastructure for this technology. Drilling companies for vertical loop systems, for example, are in short supply and services are costly. Finally, building upon this in-depth examination, the authors address a variety of market transformation initiatives that may be pursued by manufacturers and energy service companies to spur the development of this market in New England.

Introduction

The Energy Crafted Homes Program (ECH) administered by Northeast Utilities (NU) in Massachusetts and Connecticut was in existence since the early 1990's, and promotes the construction of state-of-the-art energy-efficient homes, with special emphasis on tight building construction, air ventilation systems, energy efficient lighting and appliances, and geothermal heat pumps (GHP). The program supported the installation of over 150 geothermal heat pump systems over the last seven years.

The Western Massachusetts Electric Company has joined other Massachusetts utilities - Boston Edison, New England Electric, Eastern Edison, and Commonwealth Electric - in discontinuing their GeoExchange rebate programs in order to focus on Energy Star Homes. Because the Energy Star Homes program is fuel blind and because it would be too confusing to have two utility programs with competing rating requirements, NU is also ending the ECH program, but wishes to continue supporting GHP. The Connecticut Department of Public Utility Control fully supports the Company's geothermal activity; it has directed the Company

to install 70 GHP systems in 2000, significantly more than in previous years. Several options for what to do with GHPs have been discussed, and these options are analyzed at the end of this paper.

As background to that discussion, this paper first discusses the GHP technology. We follow that with a discussion of monitored performance results. This paper also provides results of interviews with homeowners who have lived with the systems for the last five years. Finally, the detailed market discussion is presented.

Background on Geothermal Heat Pumps

A geothermal heat pump extracts heat from the earth to heat a building, and delivers heat back to the ground for cooling. Because the ground is so much warmer than outdoor air in winter, and so much cooler in the summer, geothermal systems are much more efficient than standard heat pumps and air conditioners. Geothermal systems that use a buried pipe loop are called "closed-loop" systems, and those that use well water are referred to as "open loop". Closed loop systems recirculate a heat transfer fluid (typically water and antifreeze) through piping in the ground. They can be further distinguished by how the loop is installed in the ground: horizontally in trenches or fields, or vertically in bore-holes. Open loop systems take ground water from a well (or a pond or lake), extract or dump heat, and then dump the water back into the ground. They can either pump back into the same well (standing column system), into another well (two well) or into some other water reservoir or storm water system.

The Geothermal Heat Pump Market in New England

There are four major manufacturers currently selling GHP in New England: Systems are distributed by a combination of manufacturer representatives and HVAC distributors. Our interviews with distributors suggest that total geothermal installations are somewhere between 500 and 1,000 units per year for all of New England and upstate New York.

The market for GHPs has been growing slowly over the past few years in New England. The fundamental economics and market barriers for GHP in New England are more challenging than in the Midwest or Southeast, where GHP markets are much more developed. This is due to a number of factors. First, the heating and cooling loads are less balanced in New England so the system must be sized much larger to meet the heating loads. Second, the ground is very rocky which makes both well drilling and loop trenching more difficult. And third, electricity rates are higher in New England, leading to a low market penetration by traditional (air-source) heat pumps. While these factors combine to keep New England somewhat on the back burner for the major GHP manufacturers, none are sufficient to exclude a New England market.

Our experience has shown that the GHP market is a niche market, with most of the purchasers either technologically- oriented or "green" consumers. The customers tend to be in their mid-30s through their 50s, relatively affluent, and well educated. Market demand seems to rest more on GHP's reputation as high quality rather than high efficiency. The improved comfort levels resulting from GHP's steady, low velocity airflow is a major selling point.

A significant barrier to the expanded adoption of GHP in New England is the high installation cost for the ground loop systems. Water well drillers typically undertake such

work. The total system cost for an installation in New England typically runs between $15,000 and $20,000 (or around $5,000 per ton). This includes drilling (at $12 to $15/foot - $1600 to $2000/ton) or excavating (for $1200 to $1400/ton), laying piping in the ground, the packaged unit, and a high quality ductwork installation. Costs can vary dramatically, however, largely based on the type of looping configuration that the site permits. Closed loops are generally more expensive than open loops and vertical drilling is generally more expensive than horizontal trenching or excavating. Costs could run as high as $30,000 for a large house with a vertical closed loop and difficult soil.

Performance Monitoring in ECH Homes

Between 1994 and 1997, Northeast Utilities monitored the performance of twelve GHP systems. The sample was non-random, as "interesting" sites were recommended by program administrators. Sites were also chosen on the basis of geographic convenience and owner's willingness to participate in a test. A variety of water heating systems, including several desuperheaters and heat pump water heaters (both air- and water-source), were included. Three brands of geothermal heat pumps were represented. Sites were monitored for at least a full year. Instrumentation cost was in the range of $1000 to $2000 per site. Metering consisted of the following:

- Kilowatt-hour meters were installed on circuits feeding the heat pump (compressor), the backup resistance heat (usually including fan power), and on the domestic water heating system.
- BTU meters (consisting of a flow meter, two temperature sensors, and related electronics) were installed on the geothermal loop and on the domestic water heating system.
- Temperature loggers were deployed outdoors, and max/min digital thermometers were placed near the thermostat indoors.

Instrumentation varied according to the site; a few early sites did not have BTU meters. Participants read meters and filled out data sheets weekly, and mailed them to the utility. Analysis was done in a spreadsheet for each site. The major findings include:

- Annual heating energy used by the heat pumps was between 3,700 and 17,000 kWh; median usage was 6,300 kWh per winter.
- Normalized to floor area, annual heating energy usage ranged between 1.5 and 2.0 kWh / square foot of heated floor space; median use was 1.7 kWh / ft^2. House sizes ranged from 2,300 to 4,700 ft^2. The local climate has around 5,500 to 6,500 degree-days (base 65).
- Seasonal heating COP measurements ranged from 2.6 to 3.5; average among eight sites where COP was measured was 2.8. As one would expect, seasonal COP is lower than ARI-rated COP. Heating COP was defined as the ratio:

  COP = (electricity used + thermal energy taken from the loop) / (electricity used).
- Shell heat loss rates were in the range of 2.1 to 3.7 Btu/ft^2/deg ΔT. (ft^2 = heated floor space, not wall area.) Average loss among these 12 sites was 3.0 Btu/ft^2/deg ΔT.
- Owners are comfort-oriented. Thermostat settings were generally left at around 70 to 72°F through the winter, with occasional lower settings. Owners generally did not implement night setback.

- Cooling energy use for most sites was minimal, with usage ranging between 350 and 2,000 kWh / season. Air conditioning usage correlated poorly to weather conditions; it appeared to depend more on occupant discretion than outdoor temperature. A representative cooling COP could not be identified.
- Base use of these houses (non-HVAC, non-DHW use - useful in models for estimating internal gain) averaged around 24 kWh/day, or about 6.6 kWh/day per 1,000 ft^2 of floor area. Base use can be roughly estimated from the area and occupancy of the house.
- Backup resistance heat was used in very moderate amounts at most sites (generally less than 4% of total heating electricity use). At two sites resistance backup use was as high as 10 - 12% of total electricity used for heating. One owner was concerned that his resistance backup heat ran frequently, using about 2,000 kWh during the heating season (*vs*. 14,000 for the compressor).
- Loop size ranged from about 250 to 1,700 ft per heating ton (1 ton = 12,000 BTU heating capacity). Median loop length was about 530 ft/ton. Horizontal and vertical loops were about equally popular among the test sites. Insufficient data were available on loop size vs. performance, except for one site, where the loop is probably undersized. Otherwise, loops appeared to be reasonably-sized for these installations.

Attitudes of Homeowners

Customer Satisfaction with ECH Program Homes

Interviews with 25 homeowners of Energy Crafted Homes with GeoExchange systems built in 1994 and 1995 indicate that the GHPs are operating at a high degree of reliability, and that customers are extremely satisfied with the energy efficiency and comfort of their homes. The homes, all of which use GHPs, have had few problems.

Homeowners are almost universally happy with their homes. On a scale of one to five, where one is 'not at all satisfied' and five is 'extremely satisfied,' homeowners on average rated the energy efficiency satisfaction at 4.48, and their comfort satisfaction at 4.75. Most recognize that the tightness of the home, along with the higher insulation level and the GHP, gives them a more constant and comfortable indoor temperature. Homeowners felt that NU and others did not adequately promote the ECH Program, and that that lack of promotion limited the potential for increased re-sale value.

The type of homeowner that was willing to buy a GHP during 1994-5 can certainly be classified as an 'early adopter' in the typical innovation adoption model. These people are older and more educated than the average homeowner. The data indicate that these homeowners are less likely to move than is the normal homeowner. Surprisingly, the homes in the analysis were not all large, expensive homes; the estimate of current home value averaged around $300,000, including land value. The median home value was $255,000 and six of the homes had values equal to or less than $200,000.

Homeowner Concerns with Geothermal Heat Pumps

The results indicate an exceptionally fine record of performance for the GHPs installed as part of the 1994-95 program. Five and six years after installation, all 25 systems are operating largely as they were intended. Homeowners were asked tom give an operation/

maintenance history regarding their GHPs. None of the issues raised represents a continuous, long-term maintenance issue. In fact, 17 (68 percent of the systems) operated continuously for the five-years without a single operational breakdown. Only three systems (12 percent) had multiple breakdowns. Of these, all of these could be characterized as start-up issues, and all homeowners are reporting that systems are now operating reliably.

It should be remembered as well that GHP systems were quite untested in 1994-95. First-time builders, HVAC contractors, and well diggers were installing most of the systems. Many of the sizing issues and installation practices followed today were not yet common knowledge among the industry. We would have expected that start-up and design issues would have been commonplace in the 1994-95 period. Yet they were not. Only six houses mentioned sizing looping design issues and these include systems that operate well, but whose owners feel that their systems might have undersized looping capacity, because backup heat operates more than they had expected. Another six mention start-up issues that were fixed by the installer or the manufacturer and have not continued. The rest of the issues raised can only be classified as minor in nature.

System sizing and loop design. The biggest issue relates to system sizing. Four of the six respondents noted that their system was not as big as they now wish. The looping size causes the system to operate below the homeowner's expectation. There is a trade-off between increased system size and installation cost on the one hand and the reliance on more expensive resistance heating on the other. A smaller loop size means that the overall capacity of the system is lower, and that the system must revert to a backup (normally, electric resistance) more often. Ideally, one wants to match the incremental costs of digging more well versus the benefits in reducing the backup load used. In a few cases here, the system loops are not big enough to carry the whole (design) load. Some installers may have purposely designed for a certain amount of resistance use, in the interest of saving loop cost. Others may have thought they had enough looping. (Several installers noted in their interviews that they have increased their rule-of-thumb looping sizes since 1994-95 because the smaller sizes proved to be an issue).

Homeowners have dealt with the inadequate looping in three ways: pay for the resistance heating that is needed; let the home drift to lower temperatures when extreme conditions occur, or install a gas backup system.[1]

Start-up issues: Six homeowners mentioned issues that involve operational problems that could be characterized as *mostly start-up issues*, these are defined as installation, equipment, or maintenance issues that surface almost immediately and are the result of a faulty piece of equipment, improper installation, or improper operation. Three households needed replacement equipment: two compressors and blower fan, all of which were covered under warranty. Some of these are attributable to the inexperience of the installers while others the poor communication to the homeowner about how the system is supposed to operate.

GHP Maintenance Issues

Homeowners were asked whether they were able to obtain quality maintenance for their systems, and how often scheduled maintenance was performed. Most of the systems do not receive (or require) routine maintenance other than changing filters or, in some cases,

[1] Propane backup systems can be expensive to install and operate.

lubricating motors and pumps. Four households have had maintenance performed once in five years, four households have it done once a year or once every other year, and two have it done twice a year. The others do the maintenance themselves.

At least five households noted problems in the past in getting maintenance. Several of these households had problems when their original installer terminated his GHP work and abandoned them as clients. Importantly, seventeen of the 25 households feel that they are now able to get quality maintenance for their GHP system. Only two persons noted that the lack of availability of a qualified maintenance firm was an issue. In both cases, they have found someone to fix the units, but would feel more comfortable if there was more than one option available to them. Most of the others could not answer the question because they have not yet had the need to look for maintenance. Of the 12 households that rated the maintenance they have received, all but two gave a rating of extremely satisfied.

Manufacturer and Utility Support for GHPs

Homeowners were asked if they had contacted either the manufacturer or the utility company to resolve any issues regarding their GSHPs. Nine households had had dealings with the manufacturer. While most manufacturers did honor their warrantees when applicable, there were three instances where the manufacturer was not willing or able to correct system issues. Three of the households had real concerns about the role the manufacturer played. In one case, the manufacturer could not even provide a contact living in the region. In two others, the manufacturers did not offer any help in fixing system problems.

Interviews with Manufacturers, Distributors, and Installers

The authors conducted extensive interviews with installers, distributors, and manufacturers. Most market actors felt the market has been growing, albeit slowly, over the past few years. Representatives of three different manufacturers provided sales figures for last year. **All interviewees asserted that the market is closely tied to utility programs.** Dealers and installers reported utility-related sales at anywhere from 60 to 90 percent of their GHP business. They said that a number of New York and Massachusetts utilities halted their GHP programs over the past few years and that this definitely cut into sales. However, general market growth, albeit slow, seems to be taking up the slack. Everyone interviewed also praised Northeast Utilities as playing a major role in stimulating interest in and demand for GHP. Most also recognized the Geothermal Heat Pump Consortium as a very good referral source. The Consortium forwards inquiries received by their web-site to regional distributors and also offers direct links to distributors' websites. Yet the interviewees all also say that broader promotional efforts would be welcome.

They also identify the GHP market as a niche market. These interviewees feel that **market demand seems to rest more on their products' reputation as high quality rather than its high efficiency.** They recognize the value of the "quality control" provided by utility programs; program requirements for careful duct system design and layout assure a high comfort level. The resulting steady, low velocity airflow contributes to comfort, and is a major selling point.

The First Cost Barrier

As has been seen throughout the ECH program, builders and homeowners alike are extremely satisfied with their GHP systems. When GHP dealers and contractors were asked

what drew people to GHP, they listed many positive attributes: energy efficiency, environmental benefits, lack of combustion inside the house, increased comfort, and inclusion of air conditioning. *The only item that keeps more people from installing them is the high first cost.* (While GHP costs are high, GHPs do avoid the need for a chimney and oil storage tank.)

No one interviewed felt that a larger New England market would bring down *manufacturing* or *marketing* costs. Most parties interviewed agreed that there is not a lot of potential cost reduction in the packaged unit or the ductwork. Ductwork cost is pretty consistent and the compressor and blowers are high-quality equipment comparable to high-quality fossil fuel of air conditioning equipment. The only potential technical improvements to the equipment would be in following general advances in compressor or fan motor technologies, such as using modulating compressors.

However, **all parties identified the drilling or excavating as the one area where costs could be brought down.** Many interviewed felt that *if the ground loop costs could be reduced, GHP would be fairly competitive with high quality fossil fuel systems that include central air*. (Some high-end fossil systems can be more expensive than GHP.) Ground loops are discussed further, below.

Opportunities for Growing the Market

If Northeast Utilities is interested in developing the geothermal heat pump market either inside or outside of the current ECH and Energy Star frameworks, there are three areas where they can focus energies:

- General Publicity and Marketing
- Developing New Incentive Structures
- Supporting Ground Loop Installation

General publicity and marketing. At present, demand for GHP systems is increasing in Northeast Utilities service territories largely due to NU's efforts. If demand is to continue to grow, NU will need to shoulder most of the burden for supporting the industry.

As mentioned above, the manufacturers seem to be satisfied letting the New England market develop at a slow pace without extensive market development support. A couple of the marketing representatives explained that they do not want the market to develop too quickly in New England. These equipment representatives want to make sure the infrastructure develops to support a broader market. If the market grows too quickly, it will lead to unqualified people installing systems and this could totally undermine the reputation of the equipment itself. The reps feel strongly that they have very high quality products and they want to maintain that reputation. A couple of individuals suggested that the market still has a little way to go before it is viable and they are therefore moving cautiously.

Another reason that GHP manufacturers limit marketing in New England is that they are too busy keeping up with demand in other parts of the country. One distributor reported that GHP has such a good reputation in the mid-West that customers are tearing out gas systems to put in GHP in Indiana.

The manufacturers do provide some limited funds for their distributors or reps, but they leave the marketing itself up to them. One contractor said that the manufacturers and distributors do not even provide him with free brochures; he has to buy them. He said that this is a marked contrast from mainstream air conditioning manufacturers such as Lennox and

Trane who flood him with materials. And even where manufacturers provide decent marketing budgets, the dealers and contractors do not have the infrastructure to launch large mass-media campaigns.

Limited marketing from the dealers also comes out of another market condition – the limited number of qualified installers. Dealers are very cautious about who they will sell to. The dealers interviewed all described the importance of close relationships between themselves and installers. They each have some sort of trial basis for new installers before they will sell them systems. One dealer said that he would not sell directly to builders or homeowners at all. He will only sell to HVAC contractors and only to HVAC contractors who regularly install air conditioning. This distributor further extends his market control through variable warranties. His full warranty for regular installers is 10 years parts and labor. If someone new wants to start installing his systems, he will offer them a 5-year warranty until they demonstrate their expertise in installing the systems. And in the one or two cases where people he did not know talked him into selling them a system, he only gave a 1-year parts-only warranty. Another distributor, who is also a general plumbing and heating wholesaler, also only sells to installers and he only brings on about one installer a year. This all points to the importance that these dealers place on maintaining their reputation for quality. This system also serves to protect the market *for* the good installers, and *from* bad installers. The relationship goes two ways with many homeowner inquiries coming to the dealer first and the dealer then recommending one or two installers. Most of the parties interviewed agreed that these relationships are the best way for the market to mature.

Two of the contractors, who both enjoy working with GHP, mentioned that they could barely keep up with their non-GHP work because of the booming economy in New England. Even if they wanted to do some GHP marketing, they would not have the time to do it.

New Incentive Structures. If NU decides to continue with its GHP support, the question becomes, *In what form should that support be given?* One issue is whether GHPs should be promoted in parallel with the Energy Star Home program, or an independent effort. There are numerous reasons that NU should avoid an independent program. The most important issue is that GHPs in New England are most economical in extremely efficient homes.

There should be consideration as to whether or not builders are the best targets for incentives. The ECH program trained a lot of builders; many build ECH homes, though some install fossil-fueled heating systems instead of GHP. There is only a limited pool of builders who will really promote GHP because most builders don't see how it will translate to their bottom line. Most builders, particularly large-scale builders, are more concerned with things like whirlpool baths and Corian™ countertops, which are more easily marketed and can bring more substantial mark-ups. Furthermore, GHP is more complicated than a standard fossil fuel system. Except for the rare cases, builders are unlikely to install GHP unless clients ask them to.

Furthermore, one distributor suggested that builders end up learning how to sell the rebates, but not the technology. He had a fear that builder rebates create an artificial demand that goes away as soon as the rebates go away. He said that he has seen this with other canceled utility programs in Massachusetts and New York. He, and others interviewed, agree

that *builder rebates are probably not the most effective way to make GHP a more broadly used technology*.

This year, the program is experimenting, at the DPUC's direction, with installing the loop *for* the builder, instead of giving him the rebate, and having him hire the loop contractor.

Another option would be for Northeast Utilities to subsidize installations through a leasing program. NU would help pay first costs and the customer would pay NU back for the system over time through a lease surcharge on their electric bill. This system could apply to the ground loop, to the equipment, or to both.

Southwestern Electric Power Corporation (SEPCo), a small cooperative electric company in Illinois, operated a program that incorporated varying incentive structures in the early nineties. SEPCo offered a lease-to-purchase program for geothermal heat pumps. SEPCo would provide and install the equipment and the customer would pay for it through a two cent per kWh surcharge on his/her electricity bills (7 cents per kWh vs. 5 cents per kWh). The customers paid for the ground looping themselves. After the lease period was completed, the customers took ownership of the equipment. They then received a discounted "High-Efficiency" electricity rate of 4.5 cents per kWh.[2] SEPCo enrolled somewhere around 500 or 600 customers through this program. The program was discontinued in 1996 because the market for GHP was strong enough that SEPCo did not need to offer an incentive for people to install systems. After the lease program was discontinued, SEPCo tried a $500 per installation rebate as a transition incentive, but SEPCo found that even this small incentive was not necessary. The GHP market is now very strong in SEPCo area: "The systems sell themselves". The engineering manager estimated that they have between 1500 and 2000 geothermal heat pump customers now.

It should be mentioned that one GHP dealer thought the builder rebate system was fine. He was looking to expand his marketing from installers to builders. He hopes to find a builder who is interested in doing a whole development of GHPs. (CL&P is doing the same, this year.) He thinks this could provide a lot of economies-of-scale in the groundwork and perhaps some bulk purchase savings from the manufacturer for the equipment. He suggested that an ideal situation would be to build a small development with one common ground loop. He is also looking into working with modular home builders as another route to economies-to-scale. In either case he would like to see NU provide support for him to market to builders.

Supporting ground loop installation. Neither broader publicity nor different incentive structures will ultimately make GHP a major market, however, without some reductions in the cost of ground loop work. This is where the largest marginal costs (over fossil fuel systems) lie and an area where Northeast Utilities might have a direct impact.

Four alternatives for supporting this work came up in our interviews.

- One was for Northeast Utilities to install ground loops themselves in lieu of a subsidy.
- A second was for NU to offer financing, possibly through their bill, to customers to have the groundwork done (this could also encompass financing the entire system).
- A third option is for NU to provide more technical support and equipment to ground loop installers.

[2] CL&P has for years offered the Residential Electric Heating Service rate (Rate 5) which gives a discount to electric heat customers (around 7% - 8%) vs. its standard Residential Electric Service rate (Rate 1).

- A fourth option would be for NU to contract with a driller to do all of the loops in the program, in exchange for a very low per-foot rate and guaranteed minimum number of jobs.

The most common approach to installing a ground-loop system is to hire a water well drilling contractor for this task, costing approximately $12 to $15/foot. Importantly, this approach uses equipment that is not particularly well suited for providing a optimal set of groundwater loop holes. This approach utilizes a $450,000 air hammer drilling rig with a 25 - 30' stroke capable of drilling 1500 - 2000' into the ground, for the purpose of drilling a hole that is only 100' to 300' deep. Moreover, water wells are typically 6" in diameter, whereas a hole suitable for a ground loop system can be significantly smaller in diameter (approx. 4"). The equipment utilized is cumbersome and not easily moved from one hole to another.

As a result of strong demand for new housing, water well drillers are reported to be quite busy throughout New England. For this reason, it may be unlikely for them to venture into new business areas that require a substantial investment and that may provide a less certain income.

One suggestion has been to work with what are termed "environmental drillers" to undertake this type of work[3]. Environmental drillers typically drill holes 20 - 40' into the ground, using a hollow-stem auger drilling rig. This type of equipment is also not particularly well suited for drilling deeper (over 100') required for groundwater loop systems. What is needed for this task is a smaller drilling rig, using rotary hammer technology and approximately 11' stroke[4]. This rig is more maneuverable than larger water well drilling rigs and, since the drills are smaller and weigh less, the system can be configured by hand. It is possible to retrofit existing environmental drilling rigs with air hammer equipment that is better suited to ground-looping installation. While the drilling equipment is only $10,000, the system also requires a 500 CFM / 300 PSI diesel compressor that may cost upwards of $50,000 new (used compressors are also available).

There is a possibility that environmentally related drilling (e.g., EPA-related work) may decline in the up-coming years. These drillers are used to setting up shop at a site to do multiple holes; they may not like setting up to do only 2 – 3 holes at a site. Moreover, as with many construction-related industries, all drilling firms have difficulty finding skilled labor. Therefore, given the uncertain economic returns and a boom economy, it appears unlikely that drilling firms are going to risk an investment to re-tool for groundwater loop installation.

Significantly, earth drilling requires a specialty-contracting license in Connecticut, the application for which requires letters of reference from already-licensed drilling contractors. This barrier is likely to inhibit the entrance of new businesses to fulfill this need for inexpensive vertical loop drilling. Equipment purchasing costs may also restrict the number of drillers, if some potential drillers are unsure of the long-term viability of the market. For example, the cost of some of the equipment for installing loops, such as "flush carts" and

[3] The geo-technical work engaged in by these firms involves obtaining core samples necessary for design and permitting of larger civil engineering projects. It was also noted that this type of work is a bell-weather indicator for local economic conditions since this is the first stage in any large scale development project.

[4] The Simpco 2800, for example, is a small rig that is well suited to this task but is not commonly in service in New England. There are other "long-stroke" machines that could possibly be retrofit but not as easily.

"fusion tools" is fairly expensive. NU could purchase these items and then rent or lease them to installers at a low first cost to encourage installers to use them. If they could try doing a few installations with rented equipment, it could convince them that this is a market worth pursuing.

In the mid-West horizontal ground looping is used more commonly than drilling. Here in New England it is also used, but the technology is not as advanced. The trenches can be dug with a basic backhoe. Training is necessary to install the loop itself and make sure it is sealed properly. And again, there is a shortage of people who are trained or willing to dig the trenches and lay in the piping. The utility and the International Ground Source Heat Pump Association (IGSHPA)[5] have offered "Loop schools" where contractors can learn how to layout and fuse loop piping. A couple of installers and dealers identified this as a very positive program.

One dealer suggested that these loop schools should be promoted to septic system excavators rather than well drillers. Leach fields for septic systems are very similar to the looping necessary for GHP loops. Septic system installers already have much of the equipment and experience to install ground loops. And there is usually already a septic system installer on most building sites (or at least on most sites that would be suitable for horizontal GHP loops). He said that the loop schools should be promoted to septic system installers or other excavators, rather than well drillers. Again, however, the strong economy keeps the septic system installers in demand. They might not be interested in expanding into an uncertain field without confidence that there would be enough business volume to justify it.

The fourth approach is for NU to contract with a single driller to provide the work for all program loops. While it may serve to accelerate activity in the short run, the promotion of a single firm may not be in the long-term interest of NU, the local GHP industry, or consumers. If the ultimate goal of the program is to develop a viable self-sustaining industry, then it is important that artificially restricting the number of well drillers seems counter productive.

We suggest that NU should look for ways to increase the number of well drillers interested in doing GeoExchange, instead of decreasing market participants by locking into a particular approach and company. This may best be done by continuing to increase the number of GeoExchange installations per year.

Summary

In summary, the authors feel that there is a strong future for geothermal heat pumps in New England, and particularly in the Northeast Utilities service areas, <u>if</u>

1. manufacturers continue to offer training and sales support to their distributors and installers, and warranty support through these players to owners
2. utility support continues until they are successfully transitioned to other formats
3. utilities help assure that loop design is adequate and appropriate
4. systems are installed in thermally-efficient dwelling structures
5. ground loop installation costs can be brought down to that of regions where GHP has become competitive with other HVAC systems.

[5] International Ground Source Heat Pump Association, headquartered at Oklahoma State University, Stillwater, OK, does training and certification of loop installers.

References

Harley, Bruce, 1999, “A Builder’s Guide to Geothermal Heat Pumps”, The Journal of Light Construction, October, 1999, pp 51-56.

Sutphin, S.E., 1994, Heat Pumps: Installation and Troubleshooting, The Fairmont Press,.

Wirtshafter, R., J. Weiss, R. Bordner, V. Kreitler, 2000, “Impact and Process Evaluation of Northeast Utilities’ 1997-98 Energy Crafted Home Program, Quakertown, PA, Wirtshafter Associates, Inc.

Northeast Utilities, “Measured Performance of Selected Geothermal Heat Pumps and Water Heating Systems in the Energy Crafted Home Program”, October 1997.