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Report

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Market Assessment of
New Heat Pump Technologies

September 1996

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REPORT

146-1

Market Assessment of New Heat Pump Technologies

September 1996

Prepared for

595 Science Drive
Madison, WI 53711-1076
Phone: 608.238.4601
Fax: 608.238.8733
Email: ecw@ecw.org
www.ecw.org

Acknowledgments

Research by:

CDH Energy Corporation
P.O. Box 641
132 1/2 Albany Street
Cazenovia, NY 13035

Center for Energy & Environment
The Butler Square Building
100 North 6th Street, Suite 412 A
Minneapolis, MN 55403-1520

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Abstract

Residential heat pumps can provide heating and cooling more efficiently—and at lower operating costs—than conventional air conditioners and furnaces. But they are associated with relatively high installation costs and perceptions of poor reliability, and they have not achieved widespread use in Wisconsin. New heat pump technologies have surfaced in recent years, which could make them more competitive with conventional heating and cooling technologies. Based on qualitative information collected from utilities, heating and cooling contractors, equipment dealers, manufacturers, and builders from Wisconsin, the rest of the United States, and Canada, this study assesses the market potential for new heat-pump technologies in Wisconsin. The study reports how a variety of people and organizations view heat pumps and how some have attempted to promote them. Currently the best markets for electric ground-source heat pumps in Wisconsin appear to be new construction in areas where natural gas is not available. Gas-engine air-source heat pumps appear less viable. To expand the market for heat pumps, distributors, dealers, and contractors need to be made more aware of and knowledgeable about the technologies. Setting quality standards and organizing bulk installations to lower costs have helped in other states. Consumer perceptions that heat pumps are unreliable and that natural gas is always the best alternative need to be addressed. Because Wisconsin's regulatory policies discourage electric heating, territories of unregulated utility cooperatives could be the most promising markets to develop. If heat pumps are considered to use renewable energy sources, they may qualify for an exception to the Wisconsin building code that requires more insulation in electrically heated homes.

Report Summary

Ground-source heat pumps (GSHPs) use the earth for heating and cooling. During the winter, when the ground is warmer than the air, heat pumps move heat from the ground into the home. During the summer, they move heat from the home back into the earth, providing cooling. GSHPs, which are electrically powered, are much more efficient than conventional heating devices because they extract heat from the earth, rather than burning fossil fuels.

GSHPs have lower operating costs and environmental benefits, such as decreased greenhouse gas emissions, compared to many alternatives. Although GSHPs have been successful in Canada and other parts of the northern U.S., they have not had widespread use in Wisconsin, partly because of high initial costs and their association with air-source heat pumps (ASHPs), which performed poorly in northern climates. A new type of air-source heat pump technology—the gas-engine heat pump (GEHP), which uses engine heat for supplemental heating—has performed better.

This study assesses the potential market in Wisconsin for GSHPs and GEHPs. We investigated equipment, costs, and successful programs by conducting in-depth interviews with utilities and heat pump manufacturers, distributors, and dealers. We focused on identifying the market for GSHPs in Wisconsin and suggesting ways to overcome barriers to market growth.

Equipment

There are two kinds of GSHP systems—closed-loop and open-loop. Closed-loop heat pumps exchange heat with the earth using a buried loop filled with fluid. Open-loop heat pumps exchange heat with well water. About half of GSHPs have variable speed operation, and this is an increasing trend. Most are single package, closed-loop systems with backup electric resistance heat and built-in supplemental water heating. Only one manufacturer makes air-source GEHPs. In general, the equipment has been reliable.

Successful Programs Outside Wisconsin

Outside Wisconsin, we found that utility GSHP programs have focused on increasing electric sales and flattening utility load shapes. Most programs have targeted existing homes with electric resistance heat or new homes.

The primary market barriers outside Wisconsin have been high initial cost and lack of consumer awareness. Many consumers believe that heat pumps are new, unproven technologies or that they don't work in northern climates. Other problems have been low sales volumes for distributors and lack of training for contractors. Programs have also had difficulty competing with natural gas because it is the cheapest alternative. The most important success factors have been developing infrastructure, using incentives, and increasing consumer awareness.

One of the most promising marketing approaches has been mass construction of loops in subdivisions. Not only does this bring down costs, but including the cost of the GSHPs in the mortgage provides convenient 30-year financing. To increase sales, some dealers emphasize low operating costs, even heat, less expensive insurance, and safety (no chimney or flame). Some utilities have found that installations in schools and churches interested people in buying heat pumps for their homes. Although many rebate programs have been successful, most utilities plan to reduce incentives.

Wisconsin Programs

We found that sales in Wisconsin have been small (only 1000-2000 total installations, mostly of open-loop GSHPs). Wisconsin programs have focused exclusively on GSHPs, rather than GEHPs. The Wisconsin programs face most of the barriers that programs in other states reported. In addition, Wisconsin utility regulations discourage promotion of GSHPs; regulations don't distinguish between electric-resistance heat and electrically driven systems like heat pumps. Furthermore, the building code requires more insulation for electrically heated homes.

Wisconsin distributors face the high cost of keeping inventory, training staff, small volume, and lack of profitability. Dealers face a need for special skills, tools, and inventory; difficulty finding loop contractors; lack of contractor awareness; and lack of marketing expertise.

Costs

The following table shows the estimated range of incremental equipment costs, operating cost savings, and paybacks for GSHPs compared to propane or oil furnaces, and GEHPs compared to natural gas furnaces.

Heat pump cost comparison

System	Additional Cost	Annual Savings	Payback*
Closed-loop GSHP			
Horizontal loop	$3500-5500	$300-500	7-18 years
Vertical loop	$5500-7500	$300-500	11-25 years
Open-loop GSHP	$1000-2500	$300-500	2-8 years
GEHP	$2800	$100	28 years

*Simple payback on incremental cost. Low payback assumes greatest savings with least cost; high payback assumes least savings with greatest cost.

Open-loop GSHP systems have the shortest payback, but they can only be installed where there is a well and adequate drainage. (Some people also say that using water this way is wasteful.) Closed-loop systems are more practical, because they can be installed anywhere, but the paybacks are longer. GEHPs have the longest payback. Their main advantage is that they don't face any regulatory barriers.

Conclusions

Because of long paybacks, the market for air-source GEHPs in Wisconsin is poor. This study suggests that the best market for GSHPs is new construction in areas that don't have natural gas available. Customers who buy GSHPs tend to be wealthy, energy conscious, and technically minded. If costs can be lowered, other markets can be developed. However, in addition to lowering costs, Wisconsin heat pump programs need to:

- Develop market infrastructure.

  Educate and work with distributors, dealers, and contractors. Successful programs outside Wisconsin have promoted heat pumps to distributors and dealers, trained contractors and loop installers, established trade organizations, developed quality standards for loop installations, made deals with loop installers to lower costs, given sales leads to hand-picked contractors, and distributed heat pumps directly.

- Increase consumer awareness.

  Marketing programs need to overcome the perception that natural gas is always the best heating alternative. They also need to distinguish ground-source units from air-source models that have performed poorly in Wisconsin.

- Overcome regulatory barriers.

  Wisconsin's regulatory policy discourages electric heating. Because the unregulated cooperatives do not face this barrier, their service territories make promising markets. The building code requires more insulation for electrically heated homes, but a clause in the building code that credits renewable energy sources (ILHR 22.21) may offset this requirement.

Introduction

Heat pumps are receiving increasing national attention as a way to improve the energy efficiency of home heating and cooling. In some parts of the United States, electric air-source heat pumps have become a well-established heating and cooling option, but they have not met with success in Wisconsin or other places with colder climates. Promising new technologies such as electric ground-source heat pumps and gas-engine air-source heat pumps perform substantially better than electric air-source heat pumps.

This market assessment is the first phase of a two-phase study aimed at assessing the potential for applying these new heat pump technologies in Wisconsin. The second phase will involve technical case studies of up to ten heat pump installations.

New Heat Pump Technologies

Heat pumps heat or cool enclosed spaces by exchanging heat between the enclosed space and the outside environment. They are more efficient than other heating and cooling systems because they use energy only to run fans, pumps and compressors, not to generate heat. Many heat pumps installed today use the outside *air* as the heat source and sink, and are therefore called air-source heat pumps (ASHPs). This study focuses on two new heat pump technologies: electric ground-source heat pumps (GSHPs) and gas-engine air-source heat pumps (GEHPs).

GSHPs—also known as ground-coupled or geothermal heat pumps—use the earth as the heat source and sink. They are more efficient than ASHPs because the ground retains a relatively constant temperature year round. During the winter, the ground is much warmer than the air and therefore a better source of heat. During the summer, it is cooler and therefore a better sink.

This market assessment considers two kinds of GSHPs: closed-loop and open-loop. Closed-loop GSHPs exchange heat with the ground by constantly recirculating the same water or other fluid through a buried collector loop. Open-loop GSHPs exchange heat with a continuous supply of well water, which is then reinjected into the ground or drained at the surface. Open-loop systems are less expensive, but they require an existing well that can supply six to 15 gallons per minute, the ability to drain that much waste water, and local laws that permit such a use of well water. Some authors restrict the term GSHP to closed-loop systems and call the open-loop systems "ground-water heat pumps" (GWHP) or "well-source heat pumps."

GEHPs use natural-gas engines instead of electric motors to run their fans and compressors. The only GEHP commercially available for home use is the York

Triathlon, which became available in 1994. It has an engine-heat-recovery system that makes heat from the gas engine available to heat the enclosed space. The outdoor version of the Triathlon also has a small boiler that can provide supplemental heat. This GEHP uses air as a heat source and sink.

Marketing Efforts

Several entities are planning national marketing efforts for heat pumps. These include the U.S. Environmental Protection Agency, U.S. Department of Energy, the Consortium for Energy Efficiency, the Geothermal Heat Pump Consortium (an organization whose voting members are electric utilities), and the York Triathlon Consortium (an organization of the gas industry). Utilities have successfully promoted ground-source heat pumps in cold-climate areas, but up to this time, substantially fewer new-technology heat pumps have been installed in Wisconsin than in the most active areas of the United States and Canada.

In a 1993 report, the EPA concluded that GSHPs and GEHPs could reduce consumers' operating costs and reduce carbon dioxide emissions and environmental costs compared to same-fuel conventional systems. The Geothermal Heat Pump Consortium is working to increase the annual sales of GSHPs from 40,000 to 400,000. That goal represents about 12 percent of the residential heating, ventilation, and air conditioning market. The DOE has made a provisional award of $35 million to the consortium as part of the Climate Change Action Plan. The EPA is providing additional support and has created an Energy Star program for GSHPs. The Consortium for Energy Efficiency has developed a model incentive program for GSHPs in collaboration with the Geothermal Heat Pump Consortium, and the York Triathlon Consortium is developing a market for the York GEHP. This consortium's short term goal is to sell 25,000 Triathlon units in three years.

Objectives

This project has two primary goals: to determine how the heat pump market in Wisconsin can be improved; and to develop the technical information necessary for utilities and contractors to help customers make decisions about heat pump installations with regard to design, installation technique, technology performance, and consumer economics.

To meet these goals we address four key issues:

1. What are the residential markets for new heat pump technologies? Which of these markets are most promising for Wisconsin utilities and installers?

2. What are the barriers to acceptance of these technologies by trade allies and to their promotion in Wisconsin? How can these barriers be overcome?

3. How will incremental changes in the installation costs of heat pumps change customer and utility economics?

4. What next-generation heat pump technologies are on the horizon and what technical information will be needed to assess their applicability in Wisconsin?

Method

We conducted the market assessment by discussing perceptions and issues in depth with manufacturers, utilities, trade allies, and state agencies in the heat pump market. We also reviewed government documents and other relevant literature and conducted an economic analysis based on information obtained through the interviews and literature review. Survey instruments are presented in Appendix A.

Exploratory Interviews

We began by conducting exploratory interviews with a range of industry players on the national level. The primary purpose of these interviews was to identify key issues before conducting more structured interviews with manufacturers, utilities, and key players in Wisconsin. An additional objective was to identify strategies and activities that national organizations are pursuing or plan to pursue to promote heat pumps.

Interviews with Manufacturers

We interviewed heat pump manufacturers to identify equipment features, sizing and installation practices, and technical and market trends. We asked the manufacturers about the nature of their distribution infrastructure, contacts and activity level in Wisconsin, the features of equipment they currently offer, anticipated next-generation technologies, and the loop and heat pump sizing practices they recommend. We also asked the manufacturers about markets with significant activity in Northern climates, key contacts in those markets, perceived factors in high market acceptance, and good early markets for heat pumps. This information was intended both to provide an overview of new heat pump technologies and markets, and to provide information needed to select technologies and establish site criteria for technical case studies.

We collected data in three phases. First we identified U.S. and Canadian manufacturers who produce certified ground source heat pumps (closed loop or open loop) by contacting the Air Conditioning and Refrigeration Institute and the Canadian Standards Association. We contacted U.S. manufacturers of ground-source heat pumps to identify their Wisconsin representatives and distributors. We then conducted interviews in depth with eight selected manufacturers.

We identified 18 U.S. and one Canadian manufacturer of GSHPs through consultations with the Air Conditioning and Refrigeration Institute (ARI) and the Canadian Standards Association (CSA). Table 1 lists these manufacturers.

Table 1: ARI- and CSA-certified manufacturers of electric ground-source heat pumps

	ARI-Certified		CSA-Cetrified	
	Closed Loop*	Open Loop*	Closed Loop**	Open Loop**
Addison Products Co.	X	X		
Amtherm, Inc.		X		
Bard Manufacturing Co.		X		X
Carrier Corp.[1]	X	X		
Climate Master Inc.	X	X	X	X
Command-Aire[2]	X	X	X	X
Crispaire		X		
DeMarco Energy Systems of America, Inc.		X		
Econar Energy Systems Corp.			X	X
FHP Manufacturing	X	X	X	X
Heat Controller	X	X		
Hydro Delta	X	X	X	X
Mammoth[3]	X		X	
Maritime Geothermal Ltd.			X	X
Tetco		X		
Thermal Energy Systems Inc.		X		
Trane	X	X	X	X
Walmer Supply, Inc.		X		
WaterFurnace International, Inc.	X	X	X	X

* ARI Directory of Certified Applied Air Conditioning Products, Effective June 1, 1994-November 30, 1994

** CSA fax dated 1/9/95

[1] Manufactured for Carrier by Climate Master

[2] Bought out by Trane. Trane still sells product with both Command-Aire and Trane labels. According to the manufacturer, the Command-Aire label has the same CSA certifications as Trane label.

[3] Updated information provided by manufacturer.

We contacted 17 of the 18 U.S. manufacturers of ground-source heat pumps to identify their Wisconsin representatives and distributors. We were unable to locate Amtherm.

We selected eight Wisconsin representatives for further interviews. The manufacturers represented and the rationale for including them are as follows:

Climate Master Florida Heat Pump Trane & Command Aire Water Furnace	Identified through exploratory interviews as the largest U.S. manufacturers of GSHPs (order is alphabetical, not by market share).
Carrier*	Major HVAC manufacturer
Econar	Identified through exploratory interviews as having a product targeted to northern markets that should be considered in this area
Tetco Hydro Delta	Also known to have had some activity in Wisconsin

*We dropped Carrier from the sample after leaving messages with the product manager.

The only GEHP commercially available in the U.S. is manufactured by York International. We also interviewed York. The other ARI- or CSA-certified companies appeared to be minor players or not active in Wisconsin. We did interview some of them about certain issues relating to the variety of equipment available.

Interviews with Wisconsin Utilities, Trade Allies, and State Agencies

To assess present market conditions in Wisconsin, we screened utility programs and identified those that had included electric ground-source heat pumps or gas engine heat pumps. We interviewed staff from eight utilities with successful programs to determine their goals and results, their past and present activities, and their current and future interests in new heat pump technologies. We also sought to identify perceived market barriers, regulatory barriers, and how they built successful programs.

We also interviewed 12 Wisconsin utilities to determine what they have done to promote or test ground-source heat pumps and gas-engine heat pumps for the residential market.

We interviewed trade allies working in these utilities' service territories. We asked them about market conditions, market barriers, marketing strategies, incremental costs, perceptions of utility programs, and regulatory barriers. We interviewed distributors and contractors regarding perceived market conditions and market barriers for ground-source heat pumps and gas engine heat pumps in Wisconsin.

We interviewed staff at Wisconsin state agencies to assess the accuracy of utilities' and trade allies' perceptions of possible regulatory barriers.

Interviews with Utilities and Trade Allies Outside Wisconsin

To assess the possible results of improving the heat pump market in Wisconsin, we examined utility and trade ally activity in areas of the United States and Canada where the technologies have already achieved high market acceptance.

We asked the national organizations and manufacturers we interviewed to identify utilities in areas of the country with high acceptance of ground-source heat pumps and gas-engine heat pumps.

We conducted screening interviews with 20 utilities in areas with high acceptance of GSHPs to determine which of their programs to explore in depth. (Most of the utilities initially identified but not screened were just getting started or were small.)

We conducted more detailed interviews to further examine six of the twelve programs with the most GSHPs installed. We based our selection on number of installations, utility type, and climatological and other similarities to Wisconsin. The selected programs included four investor-owned utilities, one government utility, and one cooperative generation and transmission utility. Only one of these programs has ended.

We interviewed the selected utilities about their programs, and we also interviewed trade allies operating within the utilities' service territories. We selected one heat pump supplier (distributor or manufacturer's representative) and one heat pump contractor or dealer in each territory by asking utilities, GSHP manufacturers, and other trade allies for referrals. We also interviewed a developer or builder in those areas where the utility had focused at least part of its marketing on these players.

Analysis of Customer Economics

We analyzed equipment and operating cost data to assess customer economics for ground-source heat pumps and gas engine heat pumps in Wisconsin.

Previous studies have analyzed the economics of heat pump systems (Carlson, 1994; Energy Center of Wisconsin, 1994; L'Ecuyer, 1993). These reports proceed from detailed definitions of systems, costs, and operating environments to arrive at first costs and operating costs. Our approach is to show sensitivity to changes in these parameters by using ranges for seasonal load, efficiency, and costs.

Past market assessments have defined prototype houses in Wisconsin with annual cooling loads ranging from 10 to 13 million BTUs and annual heating loads ranging from 80 to 120 million BTUs. We chose to look at a house with a heating load of 90 million BTU and a cooling load of 12 million BTU. A three-ton heat pump would be appropriate for this application. We compare ground-source heat pumps with propane furnaces and oil furnaces, their primary competition in Wisconsin. We compare gas-engine heat pumps with natural gas furnaces with electric air conditioning.

Equipment, Trends, and Markets

Equipment Available

We give detailed descriptions of specific equipment available from selected manufacturers in Appendix B. This information includes equipment capacities, coefficients of performance, capacity modulation features, water heating options, and configurations. In this section we attempt only to characterize the range of equipment and features available.

For most GSHP manufacturers, the largest certified closed-loop system available has a heating capacity of 45,000 to 56,000 Btu/h. But Florida Heat Pump and Climate Master have units with capacities of 100,000 and 85,000 Btu/h respectively. The heating coefficients of performance of the largest units range from 2.5 to 3.4. Among open-loop systems, the largest certified units available are typically 54,000 to 64,500 Btu/h. But three companies have larger units: Climate Master (116,000 Btu/h), Florida Heat Pump (131,000 Btu/h) and WaterFurnace (114,000 Btu/h).

The York Triathlon GEHP is currently available in only one size, a nominal 3 ton unit. The unit is subject to ANSI Standard Z 21.40. A 3.5-ton unit and a 4 ton unit are planned.

Capacity Modulation

About half of the GSHP manufacturers have multiple-speed compressors or dual compressors for their larger units. The manufacturers who have offered models with capacity modulation capabilities for some time report that they account for a third to half of sales. Manufacturers who have only recently offered such models report that they represent a small but rapidly growing fraction of sales. In general, manufacturers who offer them said they are more efficient and provide better summer humidity control in climates like Wisconsin's. Other manufacturers said the humidity problems with single-speed systems are not serious.

The York GEHP's compressor is driven by an internal combustion engine and therefore has an inherent ability to vary speed. It controls speed with a proportional integral controller that determines how close the temperature is to the setpoint and how quickly the setpoint is being approached. The controller varies the speed in 16 steps from 1,200 rpm to 3,000 rpm.

Quite a few GSHP manufacturers use multiple-speed or variable-speed fans. Manufacturers that offer variable-speed fans typically report that less than half of the units sold have them, but the proportion is reported to be growing. The York GEHP fan speed varies with the gas engine speed.

Water Heating

Only Hydro Delta currently offers a single machine that performs the three functions of heating, cooling, and water heating. Several others offer or are about to introduce dedicated ground-source heat pumps for water heating. They prefer this approach to a triple function machine because the controls are much simpler. For most manufacturers, 65 to 90 percent of units sold have water heating capability, but two manufacturers reported that less than half of the units they sell are sold with water heating capability.

Pump Configurations and Applications

GSHP manufacturers indicate that they sell primarily *single-package* equipment to the residential market. In other words, the heat pump equipment (except the collector loop) is usually contained entirely within a single cabinet located inside the home. The manufacturers also sell *split systems,* which divide equipment between two cabinets, one indoor and one outdoor. But most of these go into retrofit applications, dual-fuel applications, or zoned applications. The split systems have to be field charged, which may increase warranty concerns, especially in cold climate areas where residential contractors do not have extensive refrigeration system experience. The York GEHP is a split-system unit.

Sizing and Backup Heat

There are two strategies for selecting the size of a heat pump. It may be sized large enough to provide all of a home's heat or only a portion, with backup equipment installed for use on the coldest days. We summarize recommendations for sizing practices and backup heat by ten GSHP and GEHP manufacturers in Table 2.

Several GSHP manufacturers indicated that they suggest a sizing strategy based on the local utility's situation and goals. Four indicated a preference for 100 percent sizing regardless of climate and two indicated a preference for sizing at less than 100 percent. It appears that most units are installed with fairly large resistance heaters for back-up, even when the GSHP is sized for 100 percent of the design heating load.

GEHPs are available in only one size at this time. The Triathlon has a 64,000 Btu/h gas-fired back-up boiler. Because the Triathlon has a capacity of only 30,600 Btu/h at 7° F and 25,600 Btu/h at 0° F, the back-up system would be needed in most Wisconsin homes.

Loop Configurations

Most GSHP manufacturers reported that closed-loop systems account for 60 to 90 percent of sales. Even those who formerly sold only open-loop systems reported a trend toward closed loops. This may be driven by customer and utility preferences based on the perception that open-loop systems are wasteful, by regulations in some states, and by lower long-term maintenance costs. Several contacts noted that Wisconsin has a higher proportion of open loops than the United States as a whole.

Most manufacturers use vertical, horizontal, and horizontal slinky loops, depending on the site. Vertical loops are used on sites that are shallow to bedrock and for commercial installations where a horizontal loop would require too much area. Slinkies are used when space is limited. Vertical closed-loop systems appear to be used in a minority of residential closed-loop applications. Some manufacturers feel slinky placement is up to the contractor, but more recommend flat placement for better thermal contact with the soil and greater average depth.

Nearly all manufacturers have decided not to pursue DX systems (those in which the heat pump's refrigerant evaporator-condenser is the ground loop itself, instead of merely being coupled to the loop through a heat exchanger) due to concerns with refrigerant migration, oil return, and corrosion or mechanical failure of copper pipe. The exception is WaterFurnace, which is currently testing DX technology.

Table 2: Equipment sizing practices for heat pumps*

Manufacturer	Sizing Recommendations for Northern Climates (for up to 100% of heating load)	Supplemental Heating
Bard	Depends on what installer thinks is best for the job.	No information available.
Climate Master	Depends on what the utility wants, needs.	40 to 50% or more sold to northern climates are sold with back-up heat. (Recommended?)
Command-Aire/Trane	Typically recommend sizing for 70 to 80% of calculated load. Utility rebate structures can affect this.	Almost always provide for back-up.
Econar	In general try to size for 100% of heating load. There isn't a lot of cost savings in undersizing. And when consumer buys an expensive heating system they don't expect to have to run another source.	Less than 20% are sold with back-up heat but it is available from other vendors so may go into more units than that. They've gotten more in favor of the idea because it can be helpful in the event of a service call.
Florida Heat Pump	Depends on the utility's situation.	Even when sizing for 100% of the load they recommend emergency resistance back-up. For a 4 or 5 ton unit, recommend 10 to 15 kW of staged backup heat.
Hydro Delta	Depends on local utility's goals. Nationally perhaps 10% sized for 100% of load. Personal opinion that the best strategy for homeowner is to size for less than 100% but at least 80% of load. Significant first cost savings and pumping savings and not much increase in energy use.	Normally recommend some backup, e.g., 10 kW for a 50,000 Btu/h unit in a building with 60,000 Btu/h load.
Mammoth	Try to size for 100% of load. Depends on utility situation.	Seeing less auxiliary heat. If it's there, it's there for emergency, and even for that they are seeing less of it. Isolated jobs in Canada have auxiliary heat.
Tetco	Size for 100% in most cases.	Almost insist on back-up heat, e.g. 15 kW for 5 ton unit. Size to provide 90 to 95% of design load, because customers will set back even though they are told not to, and then they want immediate recovery.
Water Furnace	Generally design for 70% of load in climates like Wisconsin's. Expense is significant to design for 100% and dollar benefit to customer is not that great. Only the utility benefits.	Their sizing software gives recommendations for the amount of required auxiliary heat (to meet design load) and for the amount of optional back-up heat.
York	With current capacity, heat pump itself could not meet 100% of heating load in most Wisconsin homes.	Integral 64,000 Btu/h gas-fired back-up boiler.

* All manufacturers produce electric ground-source heat pumps, with the exception of York, which produces an air-source, gas-engine heat pump.

Technology Trends

Several manufacturers suggested that use of capacity modulation (multiple compressors, multiple- or variable-speed compressors, or multiple- or variable-speed fans) for GSHPs would increase. Only a few vendors mentioned other possible trends such as increased use of dedicated ground-source heat pump water heaters, more triple-function equipment, or more vertical-loop installations. York intends to expand its GEHP product line to include more sizes.

Markets

We summarize traits of good markets for heat pumps, as identified by ten manufacturers, in Table 3. Manufacturers generally agree that the best markets for GSHPs are upscale households and those not served by natural gas. New construction represents the majority of current sales, but retrofits are also important. York reported that upscale new construction is also the best market for GEHPs.

Table 3: Good early markets for heat pumps

Manufacturer	Identified Traits of Good Early Markets
Bard	No information available.
Climate Master	Not served by natural gas. Upper middle income to upper income. All ages, for different reasons. New or retrofit equally.
Command-Aire/Trane	Gas not available (tends to be rural). Not speculative building but homes built to order. Mostly new construction.
Econar	No natural gas. Upscale. Somewhat more new construction than retrofit.
Florida Heat Pump	Hasn't looked at this too intently.
Hydro Delta	Not served by natural gas (typically rural). Upscale: 2 income family w/median income of $72,000 and a 2 story, $180,000 home. More new than retrofit.
Mammoth	Outside natural gas area. Higher income. The bulk of theirs are in existing homes, though this is not typical for other vendors
Tetco	Natural gas not available. New home, well insulated. Target combined income of $75,000. Households with incomes of $55,000 to $70,000 can afford a ground-water heat pump (homes 1,800 to 2,100 sq. ft.)
Water Furnace	Electric resistance customers, propane, oil, air source heat pump customers. Start mostly upscale but then move down to 2,200 sq. ft. and even 1,500 sq. ft. Mostly rural or suburban. Somewhat more new construction than retrofit. Working with builders to do whole subdivisions is a good approach. At least one installation in an area served by natural gas would be nice.
York (GEHP)	Higher end new construction.

Perceived Factors in High Market Acceptance

We asked manufacturers to identify areas of the U.S. that had enjoyed relatively high market acceptance of GSHPs and GEHPs. We used this information to compile and screen a list of promising utility programs.

We also asked GSHP manufacturers what they perceived to be the key factors in the high market acceptance of GSHPs in these areas. All identified the presence of utility programs as a critical factor. Nearly all agreed that some kind of utility incentive is necessary at this point to move the market. But a number of

manufacturers stressed that incentives alone are not sufficient, and that it is critical for utilities to:

- Use their credibility with customers to educate them and strongly promote the technology.
- Develop infrastructure through such activities as working with the manufacturers to identify and enlist good distributors and good dealers, offering subsidized local International Ground Source Heat Pump Association training for contractors, training/establishing loop contractors, or requiring equipment certification by the Air Conditioning and Refrigeration Institute.

Several manufacturers mentioned utility programs that had large incentives but had not been successful because they did not market GSHPs effectively. Some manufacturers expressed concern that there is a tendency for the market to disappear when utility rebates are eliminated. One manufacturer stated that he is opposed to rebates and would prefer that utilities put their money into aggressive marketing and customer education in areas not served by natural gas.

Future Strategies for Promotion of GSHPs

We also asked manufacturers what potential future strategies they foresaw to increase market penetration of GSHPs, given the changes in the electric industry.

One manufacturer suggested that utilities should treat GSHPs as an source of energy supply rather than a source of demand-side savings. He stated that GSHPs will produce a positive cash flow and a good return on investment if amortized over half the period used for a power plant. He suggested that utilities could pay for installation of loops, and then include them in the rate base as a capital investment, rather than treating them as a DSM expense. He also suggested that if the utility were to finance the loops over 30 years and the heat pumps over 10 years, the cost to the customer would be much less than for a gas system. A utility might be able to make more money installing and financing GSHPs than selling energy. It may also be possible to lock in customers through long-term leases of the loops.

Three other manufacturers also mentioned that financing could be an effective, lower-cost alternative to rebates, and named utilities that had been successful with this approach.

Several manufacturers mentioned that aggressive, effective marketing could provide good results with small incentives or no incentives. A number of the manufacturers were optimistic that the Geothermal Heat Pump Consortium could strongly drive the market for GSHPs in the next few years, although some also expressed concern that changes in the electric utility industry might undermine this effort.

Successful Programs Outside Wisconsin

Ground Source Heat Pump Programs

The utilities we interviewed (see Appendix C for details) had installed from 12 to 7,400 residential GSHPs. Eight had installed more than 1,000 units. This section is based on the results of interviews with representatives of the six utilities that had installed the most units. Five were cooperative or government-owned utilities. The program goals mentioned most often were strategic load growth and the retention or expansion of electric heating market share. Nearly all utilities said they offer cash incentives to decrease the incremental first cost of GSHPs. Only a minority offer reduced rates or financing.

The trade allies' responses are not statistically representative of trade ally perceptions either for specific utility programs or for the U.S. market as a whole. But the distributors and dealers interviewed had considerable experience with GSHPs, so their perceptions are valuable, particularly in those cases where similar responses were obtained from several individuals.

Program Goals, Target Markets, and Results

For the six utilities that had installed the most GSHPs, Table 4 summarizes program goals and target markets, along with the numbers of GSHPs installed. Five utilities set strategic load growth, load shaping, and increasing market share for electric space heating as primary goals. As a result, they target new homes and existing homes heated by other fuels. Three utilities also included conservation, efficiency, or reduced environmental impact in their goals, and two of these included existing electrically heated homes in their target markets. Ontario Hydro's sole stated goal was to reduce demand, but they targeted new construction as well as existing electrically heated homes.

None of the utilities provided definitive information on the impact of their GSHP programs on system peak demand or sales, but Ontario Hydro had completed an assessment while their project was still in progress. This analysis attributed a five-kW reduction in demand to each GSHP, regardless of whether the unit was installed in new construction or as retrofits.

Table 4: Program goals, target markets, and residential GSHPs installed

Utility	Goals	Target markets	GSHPs installed
Ontario Hydro	Reduce demand, especially winter peaks	New homes and existing electrically heated homes in areas not served by natural gas.	6500
PSI/Energy	Build electric space heat market share. More recently, increase efficiency.	New homes and existing homes with ASHPs.	>4900
Detroit Edison	Customer service - low operating costs. Build on EPA's interest, environment. Reduce summer peak, increase winter load.	New construction.	>1000
Utility X	Peak clipping and valley filling.	Target market has not been clearly defined. Residential new construction is limited in the service territory, so the target market should perhaps be existing oil heated homes, since that is the greatest area of conversions, and most are currently going to natural gas.	not available
Otter Tail Power	Improve system load factor, build off-peak load while slowing growth of peak. Conservation. Customer value - heating, cooling, and conservation.	Broad brush, with focus on new construction and replacement of existing electric heat.	350 to 420 residential; 300 commercial
United Power Assn.	Strategic load growth.	New homes and existing oil and propane heated homes.	550 residential; 550 commercial (at 35 facilities)

PSI/Energy and Utility X (anonymous) had completed formal assessments, but declined to make their results available. The other utilities had not completed formal assessments, but Detroit Edison and Otter Tail Power had analyses underway. The utilities were generally confident that their GSHP programs were having a positive effect.

The utilities did not have estimates of changes in the market penetration of GSHPs in the existing housing stock as a result of their programs, but several had quantified the impact of their programs on the new-construction market (see Table 5).

Table 5: Impact of utility programs on GSHPs in residential new construction

	Percent of new homes with GSHPs			
	All homes		Homes with electric heat	
Utility	Before program	After program	Before program	After program
PSI/Energy[1]		Peak of 10, now 2.4	26	42
Detroit Edison		1.6		about 100
Utility X		4-5		about 50
Otter Tail Power	4	< 6[2]		

[1] 1992 budget $5.3 million, 1995 budget $9 to $10 million. The project involves six headquarters staff and 45 field staff dedicated exclusively to this program.

[2] Otter Tail Power also reports that six percent of new commercial construction uses GSHPs.

With few exceptions, the trade allies interviewed considered utility programs in their areas to be successful. In areas where rebates have decreased or been discontinued, trade allies have noticed a significant impact on sales. Distributors also reacted negatively in the one area where the utility itself distributes GSHPs. Trade allies also mentioned other program features as key elements in success. These included working closely with builders, giving 20 percent of the incentive to contractors, maintaining consistency of program design and personnel, and one utility's "whole-building energy efficiency" approach to new construction.

Market Barriers

We summarize utility perceptions of GSHP market barriers in Table 6. Utilities cited high first cost most often as the primary market barrier to increased sales of GSHPs. Some also mentioned lack of awareness, but others said they believed they had overcome that barrier.

Table 6: Perceived market barriers to increased use of GSHPs

Utility	Market Barriers
Ontario Hydro	Cost. Lack of awareness.
PSI/Energy	Cost. Pro-gas atmosphere in the market (e.g., realtors). Initially, bad reputation of ASHPs and lack of awareness.
Detroit Edison	For builders, price. For homeowners, comfort and awareness.
Utility X	First cost. Lack of awareness. Inadequate infrastructure (distribution, qualified HVAC contractors and loop installers).
Otter Tail Power	Cost. Acceptance by customers and professionals (especially architects and engineers).
United Power Association	Cost. Shortage of highly qualified contractors. Initially, awareness.

Trade allies also identified cost and customer awareness as primary market barriers. Distributors cited the difficulty of finding contractors who can sell GSHPs well, the reluctance of builders to work with new HVAC contractors instead of their regular contractor, lack of utility support, and unavailability of proven equipment and proven installation practices.

Five of the six distributors we interviewed said that it is profitable for them to sell GSHPs. One commented that he can maintain a higher margin on GSHPs than conventional HVAC equipment, but this is offset by the additional effort and time required to get a sale. Another said that it was more profitable before the utility became a distributor. A distributor who said GSHPs are not profitable said the equipment is priced too high to make much of a profit, and that questionable installation practices have caused expensive callbacks.

All of the dealers interviewed find it profitable to sell GSHPs, although one said they are less profitable than fossil-fuel equipment. All of the builders found GSHPs indirectly profitable because they are a good selling point for a home. In addition, two said utility programs made the actual cost to them about the same as a standard system, while the third said that the utility's incentive for all electric-homes increased his profit, because he was not required to pass it on to the customer.

We asked trade allies what factors they consider most critical in achieving significant sales of GSHPs. Many referred to cost and awareness. Cost factors included utility rebates or financing, increasing volume to bring down costs, and focusing on selling GSHPs in areas where they are competitive (such as where competing fuels are expensive or when the customer needs to drill a well anyway). Customer awareness and perception issues included utility endorsements (which give customers confidence in the product), and overcoming the perceptions that heat pumps don't work in northern climates and that GSHPs are a new and unproven technology. Other factors mentioned included the need to get more HVAC contractors involved with GSHPs and to train them on how to sell GSHPs, the need to have the contractor and manufacturer back the equipment and take care of problems, and the need to assure customers that other homeowners are satisfied with their GSHPs.

We also asked trade allies what barriers prevented them from getting involved with GSHPs. Many distributors mentioned the low volume of sales and the difficulty of selling a product for which there is no existing demand. Distributors also mentioned their own lack of experience and training, the need to find and train dealers who can effectively sell GSHPs and do good installations, the need to get utilities involved in order to increase dealer and user confidence in the product, and availability of quality equipment. Contractors mentioned technical barriers, including the need for training and expertise on refrigeration, control wiring, sizing, and other issues, and the need to stock more equipment, tools, piping, fluids, etc. Contractors also mentioned price, the lack of a ready-made market, and the need to overcome their own fears that GSHPs are not dependable and that GSHP manufacturers will not be around long term. Barriers identified by builders were cost and the need to find contractors capable of installing GSHPs.

Key Factors in the Programs' Success

Table 7 shows what factors utilities say are important for a GSHP program's success.

Table 7: Key factors in GSHP programs' success

Utility	Key Factors
Ontario Hydro	Incentives were the driver. Targeted promotions were a key facilitator.
PSI/Energy	Comprehensive Smart Saver program carefully designed to address customer concerns, perceptions and needs. Creating awareness, rebates.
Detroit Edison	Efforts of sales people in selling the benefits of GSHPs.
Utility X	Having the infrastructure in place, specifically, enough qualified contractors to respond promptly to leads and to effectively sell GSHPs. Market transformation approach based on high quality installations, e.g., certified contractors, Duct Blaster tests to reduce duct leakage to a minimum.
Otter Tail Power	Aggressively pursuing the school market -- schools are high profile, and have significant spillover effect on residential. Good contractors who actively sell GSHPs.
United Power Association	Rebates. Total commitment of coop staff to selling GSHPs.

PSI/Energy had designed its successful Smart Saver program only after investigating why customers were not buying heat pumps. The program was designed to respond to customer concerns and perceptions. It also identified customer motivations in selecting heating systems.

PSI/Energy incorporated a comfort guarantee into the program. This committed the utility to replace a GSHP with a system of the customer's choice, if the customer is not satisfied after one year. The utility also used Refrigeration Service Engineers Society-certified contractors, room-by-room heat-loss calculations, and extensive inspections that include checks of room air flow, duct insulation, and GSHP model numbers.

Utility X found GSHPs difficult to sell. The utility reported that a good infrastructure was needed because customers require quick service from a contractor once they decide to consider GSHPs. Both the HVAC contractors and the loop contractors need to understand the technology, as well as how to sell it and how to make a profit on it.

Utility X has a long-term strategy of market transformation. Like PSI, it bases its success on high-quality installations. Utility X works closely with the Contractor's Heat Pump Association, which has been instrumental in achieving quality. The utility ensures that duct leakage is reduced to a minimum before giving any rebates.

Otter Tail Power indicated that the most important thing the utility has done is to aggressively pursue the school market. High-profile installations in schools expose a lot of people to the technology. Initially, Otter Tail had difficulty getting architecture and engineering firms to consider GSHPs, so they made efforts to sell the concept to school boards. This created demand that pressured architecture and engineering firms to analyze GSHPs. The school boards' faith in Otter Tail, developed through a consistent presence at state school board association meetings, offers of financing, and the utility's long-standing close relationship with its customers made this possible. The school installations had a spillover effect on the residential market, but more importantly, they opened the commercial market and completely turned around some architecture and engineering firms.

Infrastructure Development

All six utilities said they had helped train HVAC contractors and loop installers. Most required them to be certified to participate in their programs. Ontario Hydro and Utility X were also actively involved in establishing trade organizations in their areas, the Canadian Earth Energy Association and the Contractor's Heat Pump Association, which are involved in training on technical issues and marketing. CEEA also provided the mandatory inspections and handled the mandatory warranties. Otter Tail Power helped establish an IGSHPA-certified GSHP training program at South Dakota State University at Brookings. Some utilities had also encouraged contractors to attend training sessions conducted by IGSHPA or by manufacturers, sometimes covering costs for tuition and travel expenses. But at least two utilities still suffer from a shortage of qualified contractors.

Detroit Edison initially had a problem with poor follow-up on leads generated by their customer information center and given to contractors. They solved this by giving the leads to their own sales people and letting them decide which dealers to give the leads to, based on their confidence that the dealer would follow up, represent the product well, and not end up trying to sell the customer a gas system. This has improved the rate of follow-ups from 20 percent to 80 percent and significantly decreased promotion of non-GSHP alternatives to these customers.

Two utilities said that a small fraction of the contractors receive training and then do a large fraction of the total work. Ontario Hydro said that raising the qualification requirements could reduce program costs while maintaining adequate coverage and without significantly affecting program results.

United Power Association had difficulty getting adequate supplies of closed-loop GSHPs from active, financially sound distributors. As a result, the utility decided to distribute one brand of GSHP itself. This was relatively easy because the utility already had a distribution business in place, handling electric thermal storage heating equipment. United Power reported that this has given it good

access to a quality product manufactured in their state and has assured that installing contractors get good field support from the distributor. The utility reported that although this has angered some distributors and manufacturers, other vendors' interest in and ability to serve the market has improved, and the utility will cease distribution as soon as it is not needed.

To improve infrastructure for GSHPs, distributors most often recommended building customer awareness and confidence. Several mentioned training classes and seminars for contractors. Two mentioned efforts utilities had made to assure that their front-line people could provide good information and support. One distributor said it was important for the utility to identify quality contractors, although another said that utilities should *not* dictate which contractors and equipment to work with.

In Table 8, we summarize items mentioned by dealers as the most important things utilities had done to develop infrastructure for GSHPs in their areas.

Table 8: Important utility activities in developing infrastructure (dealer perspectives)

Utility	Activity
Ontario Hydro	Providing leads. Endorsing GSHPs at home shows.
Detroit Edison	Investigating every request for new service to see if there is potential for a GSHP. Festive and informal field days that get customers, contractors, distributors, A&E firms together at an installation or display.
Utility X	Forming Contractor's Heat Pump Association. Offering contractor training. Should require contractors to be association members in order to receive rebates.
Otter Tail Power	Installing GSHPs in their own building and having open houses to show them off. Getting schools to install GSHPs.

Builders most often mentioned the utilities' efforts to work directly with them, including educating them, providing technical support, lining up contractors, and setting up programs that work for the builder, as well as simply courting them through luncheons, dinners, and trips.

We also asked trade allies what the utilities could do to have more impact. They made the following recommendations:

- Keep programs going and keep the momentum going.
- Continue programs and keep them consistent.
- When rebates are discontinued, continue to endorse the product.

- When programs are discontinued don't lose the expertise and knowledge base of the utility personnel.
- Participate in the Geothermal Heat Pump Consortium efforts to promote heat pumps, set up regional information centers, etc.
- Don't restrict programs to subdivisions only; this upsets existing customers.
- Do more with the retrofit market—low interest financing, more education.
- Identify good manufacturers of the product.
- Give contractors part of the rebate.
- Do not try to reduce the price to the point where contractors can't make money selling GSHPs.
- Provide referrals for people interested in GSHPs.
- Systematically study how well GSHPs will work in the customer's area through installations and monitoring. Don't just shove the technology down consumers' and contractors' throats.
- Don't sell GSHPs directly.
- Help builders work with city officials in urban settings to connect GSHPs to the city water system.

Two trade allies said that if programs are not maintained without changes for several years, dealers become cynical and don't want to participate. They find it frustrating to repeatedly learn new program features. Also, a new home can take three to six months from the initial customer contact to the date construction starts, so they must try to promote GSHPs based on a program that may change before the house is built. Trade allies also said that changes in utility personnel require them to retrain the utility staff.

Most trade allies identified at least one missing element in market infrastructures. Several distributors said that there are not enough HVAC contractors, loop contractors, and drillers, or that the HVAC contractors do not yet have sufficient technical and sales capabilities. Two dealers and one builder also mentioned either high loop costs or the lack of sufficient loop or drilling contractors. One contractor also mentioned poor-quality installations by other contractors. One builder said that a single individual should control installation of both the equipment and the loop, so that there is a single point of contact and responsible party when problems arise.

Several distributors mentioned ways in which utilities fail to provide adequate support for GSHPs. One said that inconsistency in utility program design and staff and lack of continuous marketing hurts the GSHP market. Another said that utilities don't support GSHPs enough in territories adjacent to that of one utility with a successful program. The distributor in Ontario Hydro's area said he had been hurt when the utility discontinued its program, but the manufacturer

he works with is developing a marketing strategy and sales support system that will help distributors in areas without utility programs.

Activities Undertaken to Bring Down GSHP Costs

Only PSI/Energy and Detroit Edison said they had attempted to bring down costs. PSI/Energy developed a subdivision program in which closed loops were installed en masse before construction of the homes. The Electric Power Research Institute (1990) reported that the utility's first subdivision project achieved costs of $1502 for horizontal loops and $2860 for vertical loops, 34 percent less than the costs of loops installed one at a time. PSI/Energy said the cost to install loops is about $450 per ton when done in quantity and $600 to $700 per ton for an individual job if the customer negotiates it, even with a cost-conscious contractor.

PSI/Energy entered contracts in which a loop contractor worked for a lower price in return for a guaranteed number of jobs. The utility hoped that after the completion of a number of jobs, prices would come down due to volume and competition, but few additional contractors entered the market, and the first contractor raised prices after the expiration of the initial contracts. PSI/Energy also reduced costs through volume purchase of GSHPs in the initial subdivision project. The utility is now working with EPRI to experiment with the slinky loop—including the use of slinkies with flowable fill—but so far these efforts have not been very successful.

Detroit Edison also guarantees a volume of work to a contractor, a well driller who installs vertical loops. The utility pays the difference between the actual volume installed and the guaranteed volume. Vertical loops are the most common system installed in the Detroit Edison's service territory. The utility targets the subdivision market, where open loops cannot be used, and wants to sell GSHPs in homes on 60 foot by 100 foot lots, where horizontal systems are difficult to site. The guarantee program has decreased the installed cost to between $800 and $1000 per ton. The contractor now performs most loop installations, and the utility is helping to increase its volume capability.

Contractors said the approximate incremental cost of a GSHP relative to heating and cooling equipment they typically sell is $1000 to $3000 with a median of $2000 for open-loop systems, and $3000 to $9000, with a median of $6500 for closed-loop systems. All estimates are before rebate.

We also asked contractors and builders what they had done to reduce the installed cost of GSHP systems. Most contractors said they had worked to improve their speed and efficiency, but they could not get much faster without cutting corners. One subcontracts some duct work and loop installation to assure a fixed cost; another switched to slinky loops; and one started purchasing components at lower prices from a new vendor. One builder said that the price of equipment has continually increased. Another said that the well driller he

uses bought a rig that drills to 300 feet, compared with 100 to 200 feet previously. This reduces setup time and the number of loops required. Three contractors said that equipment and material costs have gone up continually, and one said that the cost of installing loops has gone up.

Dealers said that equipment prices seem higher than they should be, considering the components and construction; that costs go up every year; and that if major residential HVAC manufacturers got involved and mass produced GSHPs, the unit price could be reduced considerably.

One contractor suggested that manufacturers could decrease installation time and cost by making a packaged unit with a preassembled, pressurized loop. Another suggested that increased marketing by manufacturers and utilities would help reduce costs. But another expressed a concern that if costs are reduced too much, it will attract "fly-by-night" contractors who are "here today and gone tomorrow."

Marketing

Participant Characteristics

We summarize utility-program participant characteristics in Table 9. The typical GSHP installation goes into a large new home purchased by a high-income household. PSI's and Detroit Edison's high proportion in new construction reflect their programs' emphasis on the subdivision market. Utility X's low new construction share reflects the small new construction market in their area. PSI, which promotes both ASHPs and GSHPs, reports a greater proportion of GSHPs in the northern part of Indiana than in the southern part.

Marketing Strategies

Utilities have used many of the same marketing strategies to promote GSHPs that they have used nationwide over the past decade to promote demand-side management measures to the residential sector. This section focuses on the more unusual approaches.

PSI/Energy has made marketing to builders a major strategy for GSHPs. The utility began a subdivision program in 1988. If a developer agreed to commit 100 percent of a subdivision to GSHPs, the utility would pay to install the loops and provide an advertising allowance for the subdivision. Sometimes the utility gave an equipment incentive as well. The loops were installed en masse before home construction. The first subdivision in this program, and probably the first subdivision in the country entirely heated by GSHPs, was the Walden Pond Project, a 126-lot patio home subdivision built from 1988 to 1991. The project was a marketing tool for the developer, who wanted something to differentiate his development from others. Home buyers preferred GSHP heating and cooling to other choices, and the first phase sold quickly. The project generated

considerable free publicity, with headlines such as "Indiana Leading Nation in Geothermal Energy Systems."

Table 9: Characteristics of participants in GSHP utility programs

Utility	Percent In New Construction	Income	Home Size	Fuel Availability	Other
Ontario Hydro	60	High	Typical > 2000 sq. ft.	Areas not served by natural gas, by design.	Rural, by design. Younger.
PSI/Energy	Not quantified, but "most."	Upper middle			More in northern part of state (ASHPs in south).
Detroit Edison	85	At least $40,000	--	70 to 75% in areas with gas at least at the road.	
Utility X	30 (Limited new construction in territory.)	High	Larger.		More educated, early adopters.
Otter Tail Power	--	--	--		--
United Power Assn.	60	Middle[1] and high	--	More in areas not served by natural gas.	

[1]GSHPs go into middle-income homes in areas where the coops promote them well and give more than $1,000 in incentives.

After Walden Pond, five other subdivisions with 324 lots signed up in five or six months. By 1992, 34 subdivisions with almost 1,000 lots were involved. By 1993, 500 builders were involved with the program (The Results Center, 1993). These projects were sold almost exclusively through one-on-one contacts by the utility's sales reps, with support from the corporate office as necessary. An unusual part of the marketing strategy was that the utility offered free loops to builders for their own homes.

Detroit Edison has developed a subdivision program similar to PSI/Energy's. If the builder commits to provide all heating and cooling with GSHPs, the utility pays for the subdivision's advertising and works with an advertising firm to develop a comprehensive promotional plan. The program has been successful despite incentives much smaller than those used by PSI/Energy.

Detroit Edison also works with an insulation company that guarantees heating and cooling costs for three years. If the actual costs exceed the estimated costs, the company pays half the difference. This preserves the customers' incentive to

control energy use. The insulation company has only had to pay six customers in six years. Detroit Edison is considering offering this guarantee themselves. The utility also hopes to incorporate an "energy-efficient mortgage" into its program, using the mortgage to encourage builders to commit their subdivisions for GSHPs and to encourage homeowners to buy in these subdivisions. The mortgages would also be available to individual customers. The utility also installed a geothermal system in the home of one builder who has 13 active subdivision projects, as well as in a demonstration house that he built.

United Power says it's easier to promote GSHPs to the new construction market by working with selected dealers who effectively market GSHPs to builders.

Utility X has shifted from a "market-push" strategy, focused on developing infrastructure, to a "market-pull" strategy based on advertising to customers. The utility gives its advertising budget for the retrofit market to the Contractor's Heat Pump Association (some other regional utilities do the same). The association operates the marketing campaign, but the utility influences the message.

Several trade allies said that marketing to builders, contractors, and customers were the most important things utilities have done to market GSHPs. They mentioned specific activities such as:

- Utility representatives working directly with builders to crack the new construction market
- Having one-on-one contacts with customers and builders
- Utility representatives stopping at construction sites to talk to builders or customers about GSHPs as an option
- Knowledgeable field representatives talking to people about using GSHPs.
- Training internal staff thoroughly so they can talk positively and informatively with customers (more important than rebates)
- Hosting dinner meetings for contractors for presenting awards, giving pep talks on sales, and providing information

Trade allies also identified more conventional marketing activities such as cooperative booths with builders at home shows, television and radio advertisements, and bill stuffers.

In areas where utilities had discontinued programs or had reduced program staff, marketing activity, or incentives, trade allies said that the utilities should have maintained their programs.

Many trade allies also suggested new activities to make GSHPs more competitive, such as rebates, special utility rates, application of existing special rates to an entire bill rather than to the GSHP only, using financing or leasing to convert

high first costs to a manageable monthly payment, free loop installation, and low-interest financing so that the people who need GSHPs the most can afford them. Trade allies also mentioned bill stuffers, promoting products generically via TV, radio, and newspapers, encouraging the customer to go to a certified dealer, and teaching GSHP technology as an alternative HVAC system at the college level. One distributor, however, cautioned that if his utility did any more, it would take over the installations and cut out the contractors.

A few distributors undertook their own marketing activities, such as home shows and contractor training. Two distributors working with the same manufacturer said they are cooperating with contractors to improve sales—by setting up a one-stop service for contractors through which the manufacturer provides heat loss/heat gain calculations, compares operating costs, designs the loop, and even provides a price quote. The distributors are also setting up a centralized service to follow up on leads from trade shows and other sources. The service fields general questions and sends out information. A week or two later, a phone call ensures that the potential customer received the information and asks if the customer wants to set up an appointment to speak with a dealer. The distributors are also working to increase the dealers' sales ability. They are active in dealer open houses and home shows and are doing direct mail marketing. In addition, they are developing new financing plans for customers and working to get greater utility cooperation.

Another distributor said he runs regular radio and television advertisements, including coop ads with dealers and utilities. He also conducts field days with PSI, in which customers observe a loop installation at an otherwise completed site. The distributor said this was an effective way to demystify the technology.

Contractors described only minimal GSHP marketing efforts. Builders mentioned including GSHPs in the advertising for their homes, providing videos and pamphlets about GSHPs, promoting at home shows, showing the GSHP to potential buyers when they visit a home, and word of mouth.

To convince customers to choose a GSHP over other HVAC equipment, five of six contractors said comparing annual operating costs or payback was the most important selling point. One said features were the most important; two said features were a secondary selling point. The features they emphasize include even heating, cheaper insurance, a certified duct system, and the absence of outdoor equipment, chimneys, and flame. One contractor said that he uses testimonials and gives phone numbers of satisfied customers. He also said he sells his years of experience and builds the customer's trust.

Contractors said that from the customer's point of view, the decision to buy a GSHP is based on operating costs, first costs, or payback. Contractors also said that their customers were well educated and informed, that they like being on the leading edge of technology, that they want the newest, most efficient thing, or that they like having no gas in the house and view GSHPs as simpler and

safer than the alternatives. But contractors also said that customers were nervous about high first cost and the newness of the technology.

Incentives

Table 10 summarizes the way the utilities use incentives.

Table 10: Utility incentives for promoting GSHPs

Utility	Rebates	Financing	Special Rates
Ontario Hydro	$2000 (average size is about 2.5 tons—about $800/ton)	$1000 cash plus loan up to $12,000	None
PSI/Energy	Initially, free loops (valued at about $450 to $700/ton), advertising allowance for builder, some equipment incentives. $450/ton for 5 homes or more, flat $700 for single home, $100 adder for desuperheater water heater. Rebate to builder or dealer, who decides whether to pass it on to customer.	Under development	Smart Saver rate for total envelope & equipment package is $0.029/kWh vs. regular rate for same block of $0.047. Differential is intended to drop to 20 percent.
Detroit Edison	For energy-efficient air conditioning, rebates are $50, $75, $125, and $150 per ton for SEER 12, 13, 14, and 15 respectively. There was a specific GSHP incentive available in 1993, providing $300 to $500/ton.	Developing "energy-efficient mortgage" for new construction and credit services for existing homes. Provides increase in allowable dept ratio from 36% to 39-40%, and possibly lower interest rates.	Experimental electric space-conditioning and water-heating rate averaging ~$0.04/kWh, which they want to be a permanent rate, vs. regular rate averaging $0.096/kWh.
Utility X	Varies with efficiency and capacity, with additional incentives for desuperheating water heater and variable speed operation.	Available for all conservation measures. GSHPs are one of the main measures financed through program.	None
Otter Tail Power	$12.50/kBTU (~ $150/ton).	No formal program. Financing is offered to commercial customers on a case by case basis.	Nearly all GSHPs installed with back-up and on dual-fuel rate of ~$0.033, vs. regular rate of $0.050 to $0.052.
United Power Association	1994: $1,000 loop rebate. 1995: $750 (average size is about five tons—about $150/ton).	Maximum $7500. Interest rate: formerly 6%, recently 8%.	GSHP rate: ~$0.05, vs. regular rate ~$0.08.

Note that only one utility offers a rate specifically for GSHPs, and one of the utilities without special rates at all has the highest GSHP rebate level. Detroit Edison had reasonably good success with low rebates their experimental rate became available in 1994, but for many years, the lack of a special rate was reportedly the utility's biggest problem in marketing GSHPs.

Most trade allies said that utility incentives had been important in creating an initial market for GSHPs and in increasing sales over time. Many said that they would not be involved in GSHPs were it not for the utility's incentives. Only two trade allies indicated that the utility endorsement is more important than incentives. Trade allies did not always seem to be aware of the special rates and financing options the utilities offered, and usually were not able to offer meaningful comparisons of the relative value of rebates, rates, and financing.

Competing with Natural Gas

Two utilities reported difficulty competing with natural gas. Ontario Hydro said it had stopped targeting areas with natural gas when gas prices decreased and electric prices increased because GSHPs could not compete. This may be due in part to Ontario Hydro's lack of a reduced electric heating rate. United Power Association said that it has found much slower acceptance of GSHPs in areas where natural gas is available, despite the fact that it offers a GSHP rate. Most GSHPs in their territory are going into propane areas.

Otter Tail Power, which offers a dual-fuel rate and encourages GSHP customers to install a dual-fuel system, said it does not see access to natural gas as a major impediment to GSHPs. PSI/Energy said that the availability of natural gas had been a major barrier at one time, but not any more, partly because of the utility's Smart Saver rate. Detroit Edison said that 70 to 75 percent of its installations were in areas where gas is available at the road, if not at the house. This may be due to the utility's focus on installing GSHPs for entire subdivisions.

Some utilities said that natural gas companies have competed aggressively to retain markets. Utility X said that natural gas companies sometimes inhibit competition unfairly in the new-construction market. PSI/Energy said that natural gas companies run service to all new developments of any size, and that in areas without natural gas, they urge people to choose propane and tell them they can switch to natural gas later. One natural gas company in Detroit Edison's area advertises to counter Detroit Edison's GSHP advertising. Several utilities reported that it is easier to compete against natural gas in the commercial market.

Relationship of GSHPs to Other Strategies for Electric Residential Space Heat

Table 11 summarizes how utilities promote other electric HVAC options.

Table 11: Other residential electric HVAC technologies promoted

Utility	Air-source heat pumps	Electric Thermal Storage	Dual Fuel Systems
Ontario Hydro	Yes. Part of the GSHP program, with lower rebates based on demand savings.	No (even though time-of-use rates are offered in some areas).	Yes. ASHP with backup, part of the GSHP program, with lower rebates based on demand savings.
PSI/ Energy	Yes. Part of the GSHP program. Utility began promoting ASHPs when their reputation improved recently. Bigger proportion of market in southern Indiana than northern.	No. No time-of-use rates.	No. Balance point is often set so high that they are in essence only air conditioners.
Detroit Edison	No. Used to promote mostly add-on ASHPs. Not enough AC hours to justify customer cost.	No.	No.
Utility X	Yes. Part of the GSHP program with the same rebate schedules.	No. No time-of-use rates.	Encourages ASHP add-ons for customers wanting central AC that have good existing furnaces . Not actively promoted because of concern about possible spillover effects—customers wanting ASHP/furnace combinations for new homes, instead of using only heat pumps combined with good insulation.
Otter Tail Power	Yes. Rebate is half that for GSHPs because utility believes GSHPs are superior.	Yes. Rebates are smaller than for GSHPs.	Yes. Promotes dual-fuel rate for use *with* GSHPs.
United Power Assn.	Yes. Targeted to affluent and warmer part of service territory as an alternative to central AC for customers who want AC and a gas furnace. Most are *not* on dual-fuel rate.	Yes. Targeted to new construction and retrofit in areas where natural gas is not available. For customers who don't want to use other fuels or invest in a second heating system.	Yes. 20,000 dual fuel customers, usually electric resistance with wood, propane or oil backup, are targeted as an economical option in retrofit market in areas not served by natural gas. Not promoted to GSHP customers to keep these customers all electric.

PSI/Energy said that recent reductions in their Smart Saver incentives have led to increased use of ASHPs relative to GSHPs. The utility is now evaluating whether GSHPs have enough load-shape advantage to justify the additional incentives required to move them.

Only the Minnesota utilities—Otter Tail Power and United Power Association—market electric thermal storage. United has found that GSHPs and off-peak heating compete with each other: sales of electric thermal storage

systems have decreased as GSHP sales increased. Four utilities promote or have promoted dual-fuel systems, but only three do or did so actively.

Regulatory Barriers

The utilities interviewed had encountered no regulatory barriers to GSHP incentives. Detroit Edison, United Power Association, and Ontario Hydro, and PSI/Energy said they were not required to seek regulatory approval for GSHP rebates. PSI/Energy said that regulatory reviews have been favorable, partly because PSI/Energy had worked out its demand-side management plan with its major intervenors. Utility X said that the Public Utility Commission closely monitors its actions to ensure that activities assumed to be demand-side management efforts are not load-building efforts in disguise. But Utility X said it had not had a problem with GSHP activities. Detroit Edison said it recently began charging direct GSHP program costs (but not labor) to shareholders rather than to ratepayers, but not because of regulatory prompting.

The only utility that said it had been challenged on the issue of load building was Otter Tail Power. The stated policy of the Minnesota Department of Public Service is to evaluate demand-side management programs that may involve fuel switching in terms of total annual source-energy use. Its initial recommendation was to approve the project, but allow rebates for ASHPs only in communities where natural gas is not available, and to allow rebates for GSHPs only in new construction and in retrofits replacing electric, oil, or propane systems. Otter Tail said it made two arguments in response to the recommendation: first that electricity is often the energy of choice for customers for reasons other than operating costs (cleanliness, reliability), so limiting rebates might lead customers that want electric heating to choose a less efficient option; and second that restrictions would limit advertising opportunities and increase the administrative costs of determining customer eligibility.

Eventually Otter Tail's program was approved with no limits on eligible customers. The utility expects to continue to include it in its rate-based demand-side management program for customers considering other electric options. Other cases, including most commercial applications, may be treated as fuel switching or load building and handled separately. An evaluation currently underway will determine what proportion of GSHPs installed are appropriate for inclusion in the rate-based demand-side management program.

Detroit Edison has had difficulty getting regulatory approval for an electric space-conditioning and water-heating rate. The experimental rate approved for 1994 is a high-efficiency rate (as was PSI/Energy's Smart Saver rate). The utility wants to make this a permanent rate, but anticipates difficulty doing so.

The utilities reported few problems with environmental regulations. PSI/Energy said that some municipalities in its service territory regulate against open loops in subdivisions, and that a few municipalities require a municipal inspector on

site when closed-loop vertical systems are being grouted, which can result in costly delays. The utility said it had not attempted to reverse these requirements.

Utility X said it does not discharge water from open systems above ground, but uses reinjection wells extensively. The issue of thermal pollution from reinjection came up some years ago, but the utility successfully argued that the net annual change in thermal energy from GSHPs is close to zero. The state's department of environmental protection now favors GSHPs.

Problems Encountered

PSI/Energy said that it had discovered after the first year of its Walden Pond project that operating costs were higher for the homes with GSHPs than for those with ASHPs. They found that this was due to deficiencies in the homes' insulation. Twenty percent of the homes had no insulation over half the ceiling area, all had large attic bypasses near the chimney, and all had uninsulated or poorly insulated flex duct in the attics. The utility fixed these problems in some of the homes and then began to require quality improvements through their Smart Saver program. These requirements applied to ASHPs as well.

Utility X said it had a consistent problem with leaks when using potassium acetate (GS-4) as a loop fluid. The utility had to replace the GS-4 with methanol in some systems, and as a result, does not recommend using GS-4. It also encountered problems in existing homes with defective duct work.

United Power Association said that five or six homes involved in its program had problems maintaining temperature due to improper heat-loss analyses, lack of return air ducts, or other problems not related to the GSHPs. Only one unit had to be removed, in a home that did not have return air ducts.

The three other utilities reported no problems.

Dealers and builders reported few problems with heat pumps. Dealers had primarily technical problems, such as leaks and corrosion in systems using GS-4. One had problems with air in the closed loop. Another had tried DX loops but found they were expensive and did not perform well. He was concerned about refrigerant in the loop and said that water was more flexible. Others had problems with other contractors who don't do quality work—one in bidding against them and one in correcting their errors. One dealer said that the utility had made overoptimistic savings estimates, which led to a few dissatisfied customers.

Builders mentioned problems related to management and communications, including the need for a single point of contact to handle all service calls, whether related to the loop or the indoor equipment. They also cited damage to GSHPs by a sprinkler contractor, and children closing the valves to the heat

pump loop. One builder said that landscaping is more complicated when working around GSHP loops.

Activity with Commercial GSHPs

Several utilities discussed how they promote GSHPs in the commercial sector.

Otter Tail Power and United Power Association said that it is easier to compete against natural gas in the commercial sector than in the residential sector. They said the incremental first cost of commercial GSHPs is lower because commercial HVAC systems tend to be more expensive. In addition, they said GSHPs save a significant amount of expensive floor space, as a GSHP requires a small area where the piping comes into the building and a conventional system requires a large mechanical room. They said that designers can take advantage of the diversity in building loads to further reduce costs. If some zones of a building are in heating mode while others are in cooling mode, the system can be smaller and will operate efficiently. They also said that commercial buildings have a higher intensity and longer duration of cooling loads, which further improves the comparative economics. They said commercial installations have a beneficial effect on the residential market because many owners and occupants of commercial facilities also own homes, and many commercial installations are high-profile public buildings such as schools.

At the 1994 ASHRAE Winter Meeting, Conn Abnee of East Kentucky Power Cooperative presented 20 year life cycle cost data showing a GSHP system to be 14 to 21 percent cheaper than three other conventional systems for schools in their area.

Otter Tail Power said its efforts to promote GSHPs started in the residential market, but the commercial market had grown because of better economics, while the residential market has remained relatively flat. The utility said that schools, banks, and churches are typical commercial GSHP customers. To date Otter Tail Power has installed about 300 GSHPs in commercial sites. Often a commercial installation includes a large number of small (2 to 5 ton) GSHPs, so a single site can account for many GSHP installations.

Otter Tail Power said its success came from working with consumers to generate demand. The contact said that engineers and architects were reluctant to try out the new technology, and that in some cases the school boards installed GSHPs over the objections of the architect or engineer. The utility has done well competing against natural gas in schools, and currently has 14 schools completed, under construction or committed, as well as a large juvenile detention center.

United Power said it had learned that the residential market for GSHPs in its service territory is a narrow niche market in upper-income homes where natural gas is not available. The utility said it had seen minimal growth. Partly for this

reason, it expects to emphasize the commercial market in the future. It sees increasing interest from commercial customers, contractors and architects, and has already installed about 550 GSHPs in 35 commercial facilities. They see the school and church market is an attractive subset of the commercial and industrial market. Schools are a particularly good market because they are not open in the summer, so their impact on summer electricity demand is low.

Detroit Edison said it is entering the small commercial market with GSHPs. It installed 100 tons of commercial GSHPs in 1994, and had three apartment building installations in progress.

Jim Bose of IGSHPA said that a number of utilities are having more success in the commercial sector than in the residential sector. Schools were a promising market for GSHPs and effective installations had been done from Texas to Minnesota and into Canada. He also noted that the first cost of GSHPs is competitive with that of other alternatives for schools, and that integrated heating, cooling, and service water heating systems are the most economical.

The Future Heat Pump Programs

Three of the six utilities we interviewed said they would be affected by changes relating to wholesale and retail competition. Ontario Hydro, which had terminated its heat pump program, said that it had undergone a dramatic change. With 74 percent of its revenues from municipal utilities and ten percent from direct industrial customers, Ontario Hydro is positioning itself for wholesale open access and assessing how to be a good supplier. Ontario Hydro intends to concentrate on customer service instead of sales of demand-side management measures. The utility no longer offers incentives except to customers it might lose and those in geographic areas where it needs to add capacity. It is focusing its marketing on large commercial and industrial customers.

Ontario Hydro also said that utilities need to better communicate with customers during transitions. Customers were wondering why the heat pump program had been terminated, and perhaps thinking that the technology had failed. Doug Cane of Caneta Research said that in 1993, the Canadian Earth Energy Association had 350 members, but by early 1995, they had only 75. He said there is a lesson here: that utilities must manage the turndown of these programs if they don't want to destroy the industry.

PSI/Energy said it too is preparing for competition. It had already competed against gas utilities for market share, but the prospect of competing with electric utilities means that decisions must be made on the basis of each program's net present value. It has decreased incentives and eliminated almost all advertising for its heat pump program, but it increased program goals in 1995 and will probably increase them again for 1996. The program includes both GSHPs and ASHPs, and the utility expects that ASHPs will play a bigger role due to the decreased subsidies. PSI/Energy is currently recalculating avoided costs, and

may increase GSHP incentives again with the hope that the national effort will finally bring the costs down and create a self-sustaining market. PSI/Energy said that incentives may now be too low to cause builders to use GSHPs, even when they are interested in using GSHPs to create a market niche for themselves. The utility is looking for less expensive ways to move the market. The representative we interviewed said he was concerned about the impact of the utility's program modifications on long-term relations with trade allies. He said that builders and contractors don't understand why the utility is cutting incentives, and infer that the utility doesn't support GSHPs any more.

Utility X said it is assessing which market segments to pursue and how. It will continue to offer rebates for GSHPs for now but has long-term plans to eliminate incentives and rebates. The goal of its GSHP program is market transformation, and it will consider that goal met when installed costs are reduced and customers are willing to pay some incremental cost because they understand the benefits.

United Power Association has already reduced GSHP incentives and expects to reduce them further. It is shifting the focus of its GSHP program to the commercial market, and reevaluating the need to distribute GSHPs.

Detroit Edison said its management had consistently backed its GSHP program, and that it hopes to move up to 2,000 residential units per year. Detroit Edison views demand-side management incentives as a beneficial load shaping tool, and wants to continue to recover demand-side management incentives through rates. The representative he did not anticipate gross changes in their GSHP program unless the Public Service Commission discontinues recovery of demand-side management dollars through rates. Detroit Edison is starting to enter the commercial market and has begun installing GSHPs at an Air Force base.

We discussed with trade allies how national trends in the electric utility industry may make it more difficult for utilities to offer large incentives or special rates for GSHPs, and how the Wisconsin utilities might look for less expensive ways to increase the market for GSHPs. To help utilities expand the GSHP market without large incentives or special rates, distributors often focused on more effective marketing, cooperative efforts with manufacturers and dealers, financing and leasing, and targeting areas where GSHPs are easier to sell. Their recommendations were:

- Build awareness and sell GSHPs with smaller incentives and reasonable rates.
- Train utility representative to educate customers on the savings and efficiency of GSHPs.
- Combine direct mail and bill stuffers with a systematic process for following up on leads—large incentives are not necessary, just good marketing.

- Do cooperative advertising, training, and marketing with manufacturers.
- Establish a process that enables contractors to make money without giving them money directly, such as hand holding, marketing, and generating leads.
- Train and motivate dealers to sell.
- Offer financing and leasing to make heat pumps more affordable.
- Keep the special rates.
- Compete with natural gas mostly in areas where GSHPs have good economics and are easier to sell.

Some contractors also mentioned marketing and endorsement, saying:

- It is important to bring down the cost of loops
- Utilities should train and promote loop contractors, keep a list of certified loop contractors, work with a set group of loop contractors at set prices, or hire one contractor to do all loops at a bulk price.
- Utilities should work with manufacturers to develop a packaged unit with a prepressurized loop that would decrease the installed cost.
- Finance the GSHPs on the electric bill
- Install a separate meter for the GSHP has helped make customers realize how much they are saving, because it allows them to distinguish between their HVAC costs and their costs for lights and other electrical appliances.
- Training contractors in sizing, layouts and design

Some contractors said GSHPs could not be sold effectively without rebates or special rates.

Dealers said utility incentives tended to attract contractors who weren't really qualified, leading to dissatisfied customers and damaging the reputation and marketability of GSHPs in the area. Some builders said that utilities could expand the market without large incentives by focusing on marketing, building customer and builder awareness, bringing down the cost of the unit (by working with manufacturers or by increasing demand and competition), and by bringing down the cost of loops (perhaps by installing the loops).

Gas Engine Heat Pump Programs

The York Triathlon air-source GEHP became available commercially in the fall of 1994. We found that Southwest Gas Corporation and Northern Indiana Public Service Company have sold these units, and we conducted brief additional interviews with these utilities. We did not interview GEHP trade allies.

Program Goals, Target Markets, and Results

Southwest Gas Corporation said its goal was to increase gas sales while serving customers' interests. NIPSCO said its goals were to build summer gas load and retain or increase gas market share. NIPSCO is a combination gas and electric utility, but most of its service territory is gas only, and it is structured so that the gas and electric sides compete. Gas is the preferred heating fuel in both utilities' service territories.

Both utilities focus exclusively on the new construction market. Southwest said it targets large, high-end homes. NIPSCO said it is avoiding the retrofit market because payback is better on incremental cost than full cost, and because cash flow is more favorable when the cost is included in a 30-year mortgage. The contact also said retrofits may face problems with inadequate ductwork.

Southwest had installed about 10 GEHPs, but had 960 more committed to be installed in three subdivisions under construction by a single builder. The builder planned to install the first GEHPs in the model homes in these subdivisions by July 1995 and to install all 960 by February 1996. NIPSCO had installed 10 or 12 units and anticipated having 50 to 60 installed by the end of the 1995. The utility had just under 200 units committed, including two subdivisions.

Key Factors in the Programs' Success

Southwest said the key factor in its success with the Triathlon was a long-standing good working relationship with builders. NIPSCO cited a partnership formed with York dealers, the York regional office, and the York territory manager. NIPSCO said its sales staff and the territory manager talk frequently with dealers, and that they all work together to sell the product to builders. NIPSCO let York select the contractors, which assured that they involved only the best dealers. The dealers were willing to offer a good price because they expect NIPSCO to send them business. NIPSCO also said that its executives strongly supported the product from the first day. The utility held a press conference for the first installation, and this sent a message that the product was important and of high quality.

Market Barriers

Southwest said that the equipment size has presented a barrier more often than price. The typical home in their area has a 3.5- to five-ton cooling load, and the Triathlon has only been available in a three-ton capacity. Southwest is using two units in each of the 2000-square-foot homes in its subdivision projects. Other barriers stem from the trade allies. The manufacturer and distributors sell both gas and electric air conditioning and heat pumps, so they don't have a strong motivation to support the GEHP. Some of the dealers want to charge the same percentage margin as they do for other work, which leads to a high margin in dollar terms. The utility has to struggle to convince them that it takes a while to build a market for the product, that they will make a good profit at a lower percentage margin, and that it will be worthwhile in terms of later sales. NIPSCO said it had markedly greater success in the portion of their service territory served by a York territory manager. In the other part of their service territory, there is a York distributor but no territory manager. The distributor appears to have little incentive to push the Triathlon because he distributes so many HVAC products.

Marketing Strategies and Incentives

Southwest said it had marketed the Triathlon through print media but works primarily through its relationship with trade allies. Local sales people are in daily contact with York dealers, doing coop advertising, joint sales calls, and getting feedback from dealers about obstacles to selling the unit. Southwest also markets the Triathlon to builders, drawing on a long-standing working relationship. Once the utility gets initial units installed, it will invite the industry to inspect them. In Arizona, the utility focuses on national accounts—builders who operate on a national or multistate level.

Several things helped Southwest's first project move forward. The utility was able to sell the GEHP to the builder without incentives because the builder saw advantages to the consumer in energy costs and comfort, as well as advantages to himself from using these selling points. The utility said the builder would save money on construction by eliminating venting, roof jacks, and combustion air intakes for an indoor furnace and by reducing electrical service requirements and wiring runs for air conditioning and strip heat. In addition, the dealer and distributor for the project understood that Southwest was trying to seed the market and that a good project could be the source of future work. As a result, they were willing to accept a lower percentage margin than they would normally make, though it is at least equal on a dollar basis.

NIPSCO said it sells the GEHP primarily through one-on-one contact between sales representatives and builders. The York territory manager often participates in these sales calls, and this significantly increases builders' confidence in the product. NIPSCO also said its marketing approach ignores price and focuses on benefits: savings for the homeowner, excellent comfort, and an extended

warranty. They have found that builders are not very concerned about price. The builders find it easy to add $5000 to the mortgage when operating cost savings will pay for it. NIPSCO provides them with an energy analysis they can show to prospective homeowners to demonstrate that total monthly costs for the mortgage and energy use are lower with the Triathlon than with a conventional 80-percent AFUE furnace and 10 SEER air conditioner. But the utility said that builders make money on upgrades such as cabinets and carpeting and are concerned that customers will divert upgrade dollars to the Triathlon. NIPSCO works to show the builders that they can use the Triathlon and still spend money on other upgrades, because the Triathlon will pay for itself. Builders use cost savings and comfort as selling points for their homes, and they like the York extended warranty, which helps them avoid expensive callbacks.

Both utilities said that incremental costs for the Triathlon are about $5000 in new construction. Southwest said it does not offer financing or a rebate beyond the money given to the manufacturers through the York Triathlon Consortium. The utility offers a special air-conditioning rate in Arizona, but not in Nevada where the three subdivisions are committed. Under the air-conditioning rate, the customer pays a lower price per therm for all gas used throughout the year but also pays a demand charge based on highest winter use. Southwest is planning to apply for a similar rate in Nevada. In the area where the subdivisions are committed, the utility sells natural gas at $0.051/therm, and the electric rate is $0.062/kWh. In Arizona, the competing electric utility has a residential rate of $0.13/kWh.

NIPSCO offers a rebate of $1,000 in addition to the $1,200 given to the manufacturer through the Consortium. The utility does not consider this a necessary measure to make the unit's costs acceptable. If the consumer comes to the builder requesting a Triathlon, the consumer gets the rebate. If the builder builds an all-GEHP subdivision or gives the homebuyer the choice, the builder receives the rebate.

Regulatory Barriers

Southwest said its regulatory commission prohibits demand-side management activities that promote fuel switching, but promoting the Triathlon might be permitted because it is an efficient gas heating technology. Southwest said there might be concern if the utility asked to include GEHP incentives in its rate base, but it hadn't promoted GEHPs from a demand-side management perspective yet.

Problems Encountered

Southwest said it had not encountered problems with the Triathlon. Units installed in their area have performed extremely well and provided exceptional comfort. The variable-speed operation also minimized start-stop noise.

Wisconsin Utility Programs and Demonstration Projects

Table 12 summarizes Wisconsin utility programs affecting GSHPs, and Table 13 identifies key features of four of those programs. We found no Wisconsin programs for GEHPs. None have joined the Geothermal Heat Pump Consortium (see Appendix D), nor had any of the investor-owned utilities had an incentive program targeted specifically at GSHPs.

Dairyland Power Cooperative reported that most of their member coops have attractive dual-fuel rates, and that some of the coops have had GSHP rebates that have come and gone. The member coops do not promote GSHPs heavily because they can't sell as much power for GSHPs as for storage heat, plenum heater add-ons, ASHPs, and other technologies, but the Eau Claire Coop reported that they are promoting GSHPs virtually to the exclusion of all other electric heat technologies.

Table 12: Wisconsin utility program activity related to GSHPs

	Program Type	Start	End	Number of GSHPs	Marketing for GSHPs
Investor-Owned Utilities					
Madison Gas & Electric Company	Custom	~1991	Dec. 1994	1 to 3	No
Northern States Power Company	Custom	early 1994	ongoing	0	No
	High Efficiency AC	?	?	~25 to 50	No
Wisconsin Electric Power Company	Custom	1990	June 1995	~100	Yes
Wisconsin Power & Light Company	Custom	1994	ongoing[1]	5 to 10	No
Wisconsin Public Service Corporation	Custom[2]	mid-1993	ongoing	33 in 1994[3]	Yes
Cooperative and Municipal Utilities					
Adams Columbia Cooperative	GSHP	July 1992	ongoing	90	Yes
Eau Claire Electric Cooperative (Dairyland Power Cooperative)	Dual Fuel	1985 or earlier	ongoing	~200	Yes
Sun Prairie Water & Light (Wisconsin Public Power, Inc.)	none				

[1]not currently being marketed

[2]GSHPs would have been eligible for high-efficiency AC and heat pump water-heater programs, but they were not marketed for GSHPs.

[3]Total sales through program not available.

Table 13: Features of utility programs affecting GSHPs

	Wisconsin Electric Power Company	Wisconsin Public Service Corporation	Adams Columbia Cooperative	Eau Claire Electric Cooperative
Rebates	Through 1994, $0.12/kWh saved in the first year[1].	GSHP: $800 desuperheater: $50 water coil[2]: $200	$500	$200 ($450 at one time)
Special Rates	none	none	none	$0.036/kWh vs. $0.071/kWh for general purpose.
Financing	In 1995, up to $5000 at 10%.	(Only through separate program, not available with rebate: prime + 1.5%, 5 year term).	1% over utility's cost	none
Target Market	Electric heat customers only (1% of customers).	Propane, oil or electric resistance customers.	All customers.	All customers.
Marketing	1 or 2 mailings per year.	Personal contact with builders, contractors; none direct to customers.	Direct mail, radio, print, one-on-one to new customers.	One-on-one to new customers, TV, radio, print, direct mail, word of mouth.
Goals for GSHP Portion of Program	Energy efficiency for electric heat customers.	Electric sales for oil, propane customers, customer retention for electric resistance customers	Build winter load, compete against LP, increase number of all-electric homes.	Build controllable load.

[1]Trade allies report incentives of $1500 to $5500.

[2]once-through cooling using groundwater in the coil rather than vapor-compression cooling

Only WEPCO and WPSC have specifically marketed programs for GSHPs. WEPCO's program targets only electric-heat customers, and WPSC's program targets customers without access to natural gas. Both offer substantial rebates, and both have seen significant participation.

Northern States Power Company estimates that they have paid modest rebates ($120 or less) for 25 to 50 GSHPs through their high-efficiency air conditioning program. The utility also reported that it received applications for GSHP rebates through its custom program, but all were dropped either because the applicant didn't provide enough information or because the calculated rebate was less than that available through the high-efficiency air conditioning program.

Both of the retail cooperative utilities we interviewed market their programs actively to all customers to build load and improve load shapes, and both have

achieved significant participation. Adams Columbia offers a larger rebate, and also offers financing. Financing appears to be an important component because 40 to 50 percent of the installations are financed. Adams Columbia had difficulty getting dealers involved, and had installed all GSHPs themselves. Eau Claire offers a favorable dual-fuel rate. It promotes GSHPs for both dual-fuel and electric-only applications. Thirty percent of the GSHPs in its service territory are not on the dual-fuel rate, including half of those installed in new construction. Eau Claire has joined in a shared-services program with four other Dairyland Power Cooperative customers that offer similar programs (Buffalo, Jackson, Oakdale and Trempeleau). The group is cooperating on activities such as advertisements for GSHPs.

Demonstration Projects

None of the utilities said they had done formal research projects on GSHPs, but several had done demonstration projects. We summarize these projects in Table 14.

Table 14: Utility GSHP demonstration projects

Utility	Dates	Sites	Types	Purpose	Outcome
WEPCO	1990-92	8	open loop, closed horizontal or vertical loop	Test various types of systems.	Performance good, all customers very pleased, kept units. Customers found it hard to get prompt service. Results were to be used for further marketing but this was not done due to changes in the industry. A final report was completed.
WPS	mid-1980s	not available (several)	open loop, DX	(Not a systematic project but a number of installations.) For open loop systems, determine water use, electric use, estimated savings relative to other systems. For DX system, test performance.	Open systems are reliable, are able to meet loads, have lower operating costs than high efficiency gas systems, but have substantial incremental cost. Applicability is limited by need for adequate water supply and for pond or permeable soil for discharge. DX test site atypical, results not transferable. One or more reports were completed.
Dairyland Power Cooperative	~1992	20	vertical closed loop	To determine whether vertical closed loop systems could be installed cost-effectively, since horizontal systems require large hole.	In their area, costs ran $12 to $13/ft due to shallow depth to bedrock, pockets where drillers lost drilling fluid, etc. This was about twice the cost they needed to achieve for the system to be economic. No formal final report due to negative results.
Sun Prairie W&L for WPPI	1994-95	1		Compare installed costs, seasonal performance and operating costs vs. natural gas. Document installation, operational and maintenance procedures and issues.	Not yet completed.

The demonstrations found reliable, comfortable performance and high customer satisfaction, but did not lead to significant marketing efforts for GSHPs. The reasons for this included changes in corporate strategies, high installed costs, and limited applicability of the GSHPs. Most utilities reported only a few isolated problems with the GSHPs installed through their programs, but one noted a more consistent problem—fouling of heat exchangers for open-loop systems.

Only Wisconsin Natural Gas has completed a demonstration of the Triathlon GEHP. We describe this project along with several incomplete ones in Table 15.

Table 15: Utility GEHP demonstration projects

	Dates	Sites	Purpose	Outcome
NSP	early 1995	1	Phase II prototype installed by contractor in his office with NSP contribution to York. No formal monitoring.	Unit works well.
NSP	current	1 planned	Demo installation in Parade of Homes or similar setting.	Site not yet selected.
WNG	1994-95	1	Obtain experience with the Triathlon prototype re: ability to meet heat load, comfort, efficiency.	Heating energy use was reduced 45%. Unit met heat loads and customer was very impressed with comfort (reduced temperature swings, improved dehumidification). However, problems with vibration of the refrigerant lines and with stalling of the engine in heating mode required an inordinate amount of trouble-shooting. WNG was dissatisfied with manufacturer and distributor support. The customer exercised his option to replace the unit with a 90+% AFUE furnace and high SEER air conditioner.
WPS	1995	1	Monitoring and demonstration.	No results yet.

While Wisconsin Natural Gas found good energy savings, good comfort, and sufficient capacity, they had reliability problems which caused them to have serious concerns about future use of the product. Northern States Power and Wisconsin Public Service are just beginning demonstration projects. None have launched any substantial program for GEHPs. Only Northern States Power and Wisconsin Natural Gas are currently members of the York Triathlon Consortium (See Appendix D). NSP does not have any plans for extensive marketing of this program or for direct incentives to the customer. Wisconsin Natural Gas is unlikely to do any marketing and unlikely to provide a customer rebate due to concerns about reliability raised by their prototype demonstration.

Relationship to Strategic Objectives

We asked the utilities how GSHPs and GEHPs fit into their strategic plans. The investor-owned utilities indicated that they usually do not consider GSHPs in strategic planning because:

- All the investor-owned utilities either provide both electric and gas service or are owned by holding companies with both electric and gas utilities in Wisconsin. In other states, competition for residential heating market share has been a significant motivator in electric utilities' GSHP marketing efforts. Utilities said that where gas is available, GSHPs are not the best option, a

view not shared by the electric-only utilities with successful GSHP programs.

- The restructuring of the electric utility industry and anticipation of retail competition are causing utilities to de-emphasize residential and small commercial customers. GSHPs are so low on the priority list that they are not receiving any attention.
- Wisconsin utilities cannot promote GSHPs broadly because regulatory policy prohibits electric sales activity using ratepayer funds.

Utilities said that the high first cost of GSHPs makes them impractical. Other factors mentioned by utilities were that a large part of their electric service territory is urban where GSHPs are not practical, and that the company's electric load factor is high due to high industrial load, so modifying residential load is not a concern.

The electric coops said that GSHPs provide an opportunity to build winter load, build controllable load, and free some summer capacity for sale to other utilities. They also said that GSHPs provide a tool to compete against liquid propane, for space heating and for other end uses such as water heating, clothes drying and cooking, where fuel choice may be influenced by the fuel choice for space heating.

Some investor-owned utilities showed more interest in GEHPs than GSHPs, but in most cases their interest was still modest. They said that GEHPs fit the utilities' strategies when the company's gas load factor is poor or the gas service territory is rural. In the latter case, GEHPs could add summer gas load, decrease summer electric peak, and retain or add overall gas load in their gas-only areas. They also said that GEHPs could fit utilities' strategies because the first cost is high but not as extreme as for the GSHP, and because it is on the gas side.

Other investor-owned utilities did not perceive much strategic interest in GEHPs. Several had doubts about their reliability, either due to experience with the York unit, experience with earlier residential gas-cooling equipment, or the lack of a track record for the product. Some stated that the incremental cost may be too high for the unit to be cost-effective to the customer, especially where electric costs are not high.

Others said their gas load is fairly level already thanks to summer storage, and it may not make sense to drive air conditioners with gas engines on site when this can be done more efficiently and cleanly with electricity from a central plant.

Anticipated Activities

Most investor-owned utilities said they had no plans for further activities relating to GSHPs in the near future. Several said they might reconsider if installed costs decrease and the infrastructure develops further, or if fuel prices change. The two investor-owned utilities that have actively promoted GSHPs are dropping or scaling back their efforts. WP&L is phasing out its custom program that covered GSHPs. WPSC says it will continue its financing and possibly its custom rebates for GSHPs in the short term, but is moving away from rebates. WPS expects to continue providing information about GSHPs. NSP, which had given rebates for some GSHPs through its high-efficiency air conditioner program, is also moving away from incentives and toward information-only programs.

Adams Columbia and Eau Claire Electric Cooperatives say they expect to continue their current programs for the foreseeable future. Dairyland Power Cooperative says it has interest in further activity but no well-defined plans. Sun Prairie is waiting for the results of its demonstration and to see what happens with deregulation.

None of the investor-owned utilities have plans for any significant activity relating to GEHPs in the near future, even though two are members of the York consortium. They plan to follow developments related to GEHPs, and possibly get involved later. Several mentioned that they are reducing demand-side management expenditures and moving away from incentives generally.

Regulatory Barriers

Several investor-owned utilities said they are not allowed to actively promote electric use with ratepayer dollars, there is a regulatory bias toward natural gas for heating applications, and regulatory agencies would not allow special rates for electric heating, energy-efficient electric homes, or GSHPs specifically.

These statements are generally accurate according to the Public Service Commission of Wisconsin. The PSC had investigated electric promotion in the early 1980s, leading to an Environmental Impact Statement. It found that electric sales promotion would eventually lead to a need for increased capacity and therefore increase the long-term costs of generating electricity (Public Service Commission of Wisconsin, 1984). The PSC concluded that electric sales promotion should not be funded with ratepayer dollars. Neither the utilities nor the commission staff mentioned any utility regulatory barriers for GEHPs.

The PSC articulates guidelines for fuel switching in an appendix to their Advance Plan 6 (Public Service Commission of Wisconsin, 1992). The guidelines call for electric utilities to provide information on life-cycle and societal costs and benefits when providing information to customers on fuel substitution, and to develop this information jointly with gas utilities. The guidelines also state that incentives for electric demand-side technologies "should not exceed those offered to encourage gas use for the same end use." These principles are less stringent than the requirements of past Advance Plans. The PSC has consistently opposed electric-heat rates for more than a decade, finding that they cannot be justified based on analysis of cost of service. The municipal utilities in Wisconsin are subject to rate regulation by the PSC.

Cooperative utilities are not regulated by the PSC except with regard to siting of power plants and transmission lines. The PCS may require cooperatives to conduct demand-side management activities as a condition for approval of a power plant. In general, however, the cooperatives are free to set rates and promote the use of electricity as they wish.

Utilities identified two items in the building code that impact GSHPs. The first is that homes with permanently installed electric space-heating equipment having a total input of three kW or more are required to meet the more stringent envelope heat-loss requirements for electric space heat (Uniform Dwelling Code, ILHR Chapter 22, Subchapter V), rather than those for nonelectric space heat (Subchapter IV). One utility indicated that a coalition is forming to amend this portion of the code, while another said that it is completely unenforced in their area and has not been a problem for them.

A section in the Department of Industry, Labor, and Human Resources' Commentary to ILHR Chapter 22 Subchapter VII, "Buildings Utilizing Solar, Wind Or Other Non-Depletable Energy Sources," describes a credit for "groundwater heat pumps" that may reduce the difference in envelope requirements in many cases.

One utility raised a second issue regarding the Uniform Dwelling Code, stating that the code requires 100-percent backup heat for any heat pump. This may be an incorrect interpretation of the code (ILHR 23.04 (2) Heat Pump Appliances).

Utilities and trade allies mentioned a number of requirements of the Wisconsin Department of Natural Resources that they believe affect GSHPs, primarily regulations relating to water supply and waste water. In general, the utilities and trade allies said that the DNR's regulations were appropriate and desirable. But individual respondents considered a few of the requirements to be problematic.

One said that DNR grout requirements were stringent and had necessitated the purchase of a $4000 pump by one contractor the utility had worked with, and that the DNR requirement for higher pressure-rated piping in vertical closed-loop systems deeper than 150 feet was unnecessary. The utility had exchanged

several letters on this point but had not succeeded in changing the DNR's position.

Another utility stated that Wisconsin regulations requiring an initial drainage field and a replacement drainage field for residential septic systems may limit the space available for horizontal closed-loop systems.

One contractor said that GSHP costs could be reduced if the DNR allowed the use of ponds as a heat source and sink without requiring DNR approval. One distributor said that current GSHP installation procedures and materials are not approved, and that this could be a problem later. He said he would like to be sure that the DNR has no objections to the loops and antifreeze products being used now, rather than find out later that they don't like what is being done.

Trade Ally Perspectives

Based on contacts with most of the GSHP distributors and contractors in Wisconsin, we estimate that 1000 to 2000 GSHPs have been installed in Wisconsin. Most are open-loop systems. WaterFurnace and Tetco are the most popular brands, with over 500 units installed each. There are about 90 Econar units installed, and lesser numbers of units by Hydro Delta, Florida Heat Pump, and Bard.

Only about three GEHPs have been installed in Wisconsin to date, so we did not contact GEHP trade allies.

We interviewed four contractor-dealers and one utility dealer. These had installed 13 to 500 GSHPs each. We also interviewed two distributors and a contractor-distributor. Two had sold hundreds of units, and the third had sold very few.

We also interviewed contractors who install the equipment of manufacturers that offer GSHPs (either GSHP manufacturers or major residential HVAC manufacturers), but have done very few GSHP installations (0 to 20). We focused on the reasons they had not gotten more involved in the GSHP market.

Market Conditions and Profitability

Most of the active distributors and dealers described the current market for GSHPs in Wisconsin as fairly slow and soft. Two described it as more or less nonexistent. One distributor said that sales had slowed down considerably since the middle of 1994. Two dealers said that their sales have leveled off. But one dealer said that sales are increasing, and another stated that the market was strong.

Those who said the market was slow or soft attributed this to lack of consumer awareness, slowness of contractors to take on a new product that they don't understand, misconceptions about GSHPs, a general conception that natural gas is the only economic choice, difficulty competing with gas and liquid propane at current prices, the high cost of equipment, bad installations by poorly trained contractors, and insufficient promotion by electric utilities. Those who felt the market was strong or increasing attributed this to utility activity.

One distributor reported that it is currently profitable to sell GSHPs. The other active distributor said he has yet to reach his break-even point for sales, and the inactive distributor has not marketed GSHPs actively because he isn't convinced he could make enough profit to justify the additional staff and training.

Four of the five dealers stated that selling GSHPs is profitable for them, with the fifth indicating that it sometimes is. However, most indicated that they rely more on other kinds of work to carry their business, that they have to keep their margins tight to compete with cheaper systems, or that they are doing this more because they believe in the product than because it is profitable.

Market Barriers

All of the distributors agreed that the primary market barriers to increasing the market for GSHPs in Wisconsin were lack of consumer awareness and lack of awareness, training, and support for the product on the part of contractors. Distributors also mentioned the first cost and uncertainty about Department of Natural Resources approval of installation procedures and materials.

Barriers at the distributor level were the cost of keeping inventory and training staff, the small volume, and the lack of profitability.

The primary market barriers identified by dealers were the high first cost of the equipment, the low cost and ready availability of natural gas, extensive long-term marketing to the effect that gas is the best, most efficient heating option, the idea that heat pumps don't work in northern climates, the idea that heat pumps are bad (based on experience with air-source heat pumps), and lack of good contractor training.

Barriers at the dealer level included the need to do a good job to avoid problems, lack of a ready market or demand for the product, and the need for training and knowledge in many areas including furnaces, duct work, air conditioning, electrical work, plumbing, pumps, wells, excavation, and loop installation. Dealer barriers also included the need for special tools, the need to find contractors to install loops, the cost of loop installations, and the need for special inventory (dealers reported that they only stock standard equipment, so they do not stock heat pumps). Dealers also cited misinformation about GSHPs—that they don't work well, or don't work in northern climates—and a

lack of awareness of benefits of GSHPs, how to set prices, how to sell them, and how they can be profitable for contractors.

We asked active trade allies what is missing in the market infrastructure. Most respondents said that contractors were the weak link. Some mentioned that contractors lack skills needed to install GSHPs, are more interested in installing gas furnaces (which require less skill and have plenty of demand), have a tendency to shy away from refrigeration work due to changes in regulations governing refrigerants, lack confidence in GSHPs, and lack interest in selling them.

Two trade allies said that builders and general contractors need more information and are very resistant to installing GSHPs unless the customer talks them into it. One said greater acceptance by utilities was needed.

Most of the dealers not actively involved with GSHPs described themselves as very familiar with them. Three of the five companies had sent one or more people to GSHP training offered by manufacturers or the International Ground Source Heat Pump Association. A fourth company had a technician who had installed 25 units while at a previous employer.

The reasons given most often for not getting more involved in selling GSHPs were the high up-front cost, the niche character of the market, the lack of utility rebates, and the lack of consumer awareness. Other reasons included the need for the right site (very clean groundwater, adequate conditions for dumping water, large enough lots for horizontal loops), well drillers' unwillingness to install vertical loops, uncertainty about what groundwater conditions will be encountered at each site, high maintenance requirements, softening of the market, and termination of involvement with a specific builder.

Marketing Strategies

Distributor marketing strategies varied widely. One distributor, who had sold hundreds of units, had undertaken many different marketing activities, including home shows, energy fairs, participation in utility seminars and symposia, cosponsorship with the utility and others of a field day featuring an installation, installation of GSHPs at a high-profile site, participation in radio call-in shows, direct mail to dealers, provision of demonstrator units, videos and slide presentations for use by dealers, magazine and newspaper ads, and provision of dealer training. Another distributor, who had also sold hundreds of units, focused on calling on dealers. The third distributor has been intentionally inactive.

Dealers said that the selling points they use for GSHPs include low operating cost, the long life of the unit, relatively quick payback (supporting with data from previous customers), environmental benefits such as the absence of pollution from fossil fuels on site, reduction of oil imports, and the idea that

GSHPs provide "heat from the earth." They also point to safety (because of the absence of combustion), low noise, and high comfort, and argue that GSHPs represent the best choice when natural gas is not available.

When asked what information customers want about installed costs, operating costs, or other financial comparisons with other products, nearly all of the dealers said that operating cost is important to customers and a key selling point for GSHPs. Two said that up-front costs or overall owning costs are very important, but others did not mention these factors, saying that this was not a great concern for the typical upper-middle-class customer, or that the key point for customers is whether other customers have installed GSHPs and are satisfied with them.

Dealers reported that a variety of factors can generate a customer's initial interest in GSHPs. Some customers are looking for a cutting-edge technology, but they will balk if the product seems too untested. Customers are also often looking for something that is very efficient, or is environmentally sound, or has a very low operating cost. They respond positively to the argument that the GSHP uses renewable energy. Often, customers who show initial interest in GSHPs are those in areas where natural gas is not readily available. In the service territories of the cooperative and municipal utilities, the unique relationship of members to their utility has engendered interest when the utility promotes the technology.

According to dealers, the typical GSHP customer tends to have a higher income, be very energy-conscious, and be technically minded, gadget-oriented, college-educated, professional, or a number cruncher.

Dealers said that many customer concerns about GSHPs arise from impressions of air-source heat pumps, and concerns about groundwater use, comfort, and reliability. Dealers reported problems with the poor image of heat pumps, previous problems with ASHPs, lack of understanding of the difference between ASHPs and GSHPs, concerns about the durability of heat pumps, and the idea that heat pumps are only for use in the South. Some dealers respond to these concerns by calling the product a "geothermal unit" or a "WaterFurnace" instead of a heat pump.

Dealers also reported that customers were concerned about wasting, contaminating, or using up well water; that customers want concrete proof that the system works and is reliable; and that customers have a hard time accepting that they can get winter comfort from a system that uses cold water from the ground. All of the dealers said that customers have environmental or other concerns about discharge of water from open-loop systems. They said that customers' concerns are that the unit will cause their well to dry up, that it is wasting water, or that it is contaminating the water.

Dealers use various approaches to address these concerns, including explaining that they are in an area with abundant groundwater, responding that it is not being wasted because it is being used to heat the home, asking whether they feel more comfortable burning natural gas or dumping water, explaining that it does not pollute their well, and asking them to consider where oil comes from versus where water comes from—making the point that oil is not local or renewable—and which they would rather use in their system. Dealers also say they tell customers that the DNR does not object to open-loop GSHPs, which usually satisfies them because the DNR is perceived to be very strict. Dealers also say they sometimes simply sell the customer a closed-loop system instead.

Many of the contractors interviewed said they had limited budgets for marketing. They said they had relied primarily on home shows and activities like the Parade of Homes. Some have done newspaper, television, and radio advertisements. Most have done some activities with utilities, including cooperative advertising and open houses.

Incremental Costs

We summarize dealer estimates of incremental costs for GSHPs in Table 16. We discuss these costs in more detail beginning on page 65, "Customer Economics."

Table 16: Dealer estimates of incremental costs for GSHPs in Wisconsin, prior to rebates, if any

Dealer	Open Loop	Closed Loop
A	$1000*	$3000*
B	30 percent more than a 90+percent AFUE gas furnace and 12 SEER AC	
C	$1000 to $1500	$4500 to $5000 more than a 90+percent AFUE gas furnace and 12 SEER AC
D		$4500 to $5500
E	$2500	$1300 per ton of AC

*For a split-system heat pump installed in new construction with dual fuel, the cost is an additional $2500 to $3000

To reduce the installed cost of GSHP systems, one dealer said he had not been able to do anything because the problem is the cost of the equipment itself. Another said he had not reduced prices but now installs a better system because of improved familiarity with GSHPs. A third dealer said he had concluded that

the best way to reduce costs was to reduce the cost of closed-loop systems. Others reported ways to reduce costs such as installing open-loop systems, keeping low margins, shopping to find lower prices, using plastic pipe instead of copper, using insul-duct to eliminate the need for a sheet metal worker, doing their own electrical work, and doing their own digging. Most dealers also said that the cost of the equipment could come down if the volume sold increased and the market expanded beyond a high-priced niche. Several contractors mentioned the need to decrease loop costs. One dealer who now installs many open-loop systems said he anticipates closed-loop systems will eventually take over more of the market due to regulatory pressures, so reducing the cost of closed-loop systems is important. Another dealer also said that if he could use ponds without a special DNR permit, he could reduce loop costs considerably.

Problems Encountered

Most dealers reported few or no problems. One had problems with the closed-loop heat-exchange fluid potassium acetate (GS-4), both in performance and in manufacturer support. One reported that closed-loop GSHPs are the most trouble-free system you can buy, but that open-loop systems frequently have problems with wells, pumps, or valves. Two reported some problems with scaling in open-loop systems in areas with high iron content. One reported some ground settling on a closed loop system, but said this was expected and was fixed. One reported problems with a particular brand, which were solved by switching to another brand.

Perceptions of Utility Programs

The trade allies we interviewed had experience with some of the utility programs for which GSHPs were eligible, including programs offered by Wisconsin Electric Power Company, Wisconsin Power & Light Company, Wisconsin Public Service Corporation, Adams-Columbia Cooperative, Dairyland Power Cooperative, and various other cooperatives.

One trade ally reported that WEPCO's rebates had been very helpful because they were high enough to jump-start the market and could be reduced later as the market takes off on its own. He also said that their time-of-day rates were helpful, that the utility showed a real interest in GSHPs, and that that company's customer service representatives were knowledgeable. Another trade ally said that the program could have been successful but was not marketed enough.

One trade ally said that WP&L's rebate program had not been sufficiently publicized. Another was not aware of WP&L's custom rebates, but reported that their rebate of up to $150 for high SEER air conditioning was not enough to help the GSHP market. Two trade allies had found WPS's program significantly helpful in selling units, and one had also found their off-peak rate helpful. Another trade ally said that the rebates were not well publicized.

Some trade allies said they did not like Adams-Columbia's current efforts and DPC's previous efforts to sell units directly to customers because the utilities, they said, sell the units at such low prices that it ruins the local market. Dealers said they do not want to install GSHPs because they can't make a profit, and they don't want to service units they didn't install.

One trade ally reported that a $600 per ton rebate offered by DPC for vertical-loop systems had spurred some interest, but the market returned to its original state when the rebate was withdrawn. The trade ally said that rebates generate a false market, and the market stagnates when they end.

Several said the various small cooperatives' promotion, financing, and rebates were helpful.

Regarding utilities' incentives, marketing, and infrastructure development activities, most trade allies said that rebates got people's attention and were helpful, but only one thought they were the most important utility activity. Most said that informational activities were more important. They mentioned participation in trade shows, informing dealers about GSHPs, advertising to build confidence and awareness, and conducting new-home seminars that reach a focused set of customers at the decision point. One trade ally preferred financing to rebates. Two gave utility activities credit for 75 to 85 percent of their sales.

To increase utility impacts, the trade allies suggested that utilities better inform customers and customer representatives. They also suggested that utilities could offer short-term (five-year) low-interest (five-percent) financing, increase the hours covered by off-peak rates, offer rebates, or continue current programs rather than ending them.

We asked trade allies to consider that national trends in the electric utility industry may make it more difficult for utilities to offer large incentives or significantly lower rates for GSHPs, and that the utilities in Wisconsin might look for less expensive ways to increase the market for GSHPs. We then asked them to suggest what utilities might do to expand the market for GSHPs in the absence of large incentives or special rates.

Two said that rebates are just a way to prime the market and can be dropped once the market is established and customers have seen that the technology is cost-effective. One compared this to the rebates for 90-percent or greater AFUE gas furnaces that transformed the market in Wisconsin. Others commented that rebates are not necessarily the best approach because they are short-term and tend to generate a false market. Some said that rebates make customers skeptical about the product, and that utilities can generate more sales with the same amount of money through seminars to a targeted audience, such as new-home buyers. Trade allies repeatedly stressed the need for customer and dealer education.

Customer Economics

This section broadly characterizes the customer economics of new heat pump technologies. We discuss first incremental cost and operating cost.

First Incremental Costs

The first incremental cost includes the cost of purchasing and installing a system.

Closed-Loop Ground-Source Heat Pumps

Based on the information we collected from interviews, the installed incremental cost of a closed-loop GSHP in a northern climate ranges from $3000 to $9000 (see page 28). The installed incremental cost for a typical house in Wisconsin ranges from $3500 to $5500 (see Table 16).

The largest portion of the incremental cost is for the loop. Loop cost includes coverage for risk assumed by the contractor when quoting fixed prices because of the many unknowns in excavation or drilling. This is especially important in vertical-loop installations. Most contractors with vertical installation experience tell of difficult or unforeseen drilling obstacles that lead them to set their prices high or to avoid vertical loops altogether.

Horizontal loop costs vary. The lowest-cost horizontal loops in Wisconsin are just above $3000. This includes excavation, pipe, labor, and markup. These low-cost loops are installed in one day using a wide-bucket (four-foot) tracked backhoe; all pipe is installed at o single depth so that the excavation can be backfilled in a single operation. Excavation usually takes eight to 10 hours, and excavation contractors usually charge $80 to $120 per hour, giving costs ranging from $640 to $1200. Loop installations usually require 1800 to 2400 feet of polyethylene at $0.20 per foot, giving costs from $360 to $480. This could make it difficult to reduce costs below $3000, as nearly half is accounted for in pipe and excavation costs.

Other contractors use multilayered loop design (considered the industry standard) and use more pipe per ton. They use a smaller backhoe with a two-foot bucket. These loops cost about $4000.

Vertical-loop generally cost several thousand dollars more than horizontal loops. At one site the contractor used a smaller drilling rig than usual to install a four-ton, four-bore loop in ideal soil conditions (mostly clay) for just over $4000. A more typical cost for a vertical loop is $5500 for a three-ton loop, based on $1000 for mobilization plus $1500 per ton. The variability of the soil

and rock conditions in Wisconsin could keep vertical installation costs higher than those for horizontal loops.

A smaller portion of GSHP incremental cost comes from a heat-pump equipment premium of $500 to $1000. Dealers from Wisconsin and elsewhere said they charge the premium because they sell a lower volume of the product. Several dealers said they felt squeezed by increasing heat-pump equipment costs. Greater volume could leads dealers to reduce or eliminate the premium.

Fifty to 70 percent of the GSHPs in northern Wisconsin are installed as add-ons, often operating in conjunction with liquid-propane furnaces. Using GSHPs this way adds from $2000 to $3000 to the incremental costs cited above, but many electric cooperatives in the region encourage this option by promoting a dual-fuel electricity rate at about half the standard electricity price. Under this rate, electric-heating equipment is on a separate circuit that can be radio controlled by the utility. Typically the load control option is exercised four to six times a year for about four hours.

The extra cost of using GSHPs in a dual-fuel setting is the cost of a high-efficiency condensing furnace. This premium unit serves during load-control periods and supplements the heat pump capacity at about 10 to 15 percent of the annual heating load. Many of the dual-fuel installations are in upscale homes where owners want better quality equipment and seem willing to pay for it. Also, venting a condensing furnace with PVC pipe costs as little as $50. Costs for venting an 80-percent efficient gas furnace with high temperature pipe start at around $250, and increases for vertical vents. One contractor noted that the venting costs offset a large portion of the high-efficiency furnace premium.

Open-Loop Ground-Source Heat Pumps

The lowest-initial-cost option for GSHPs is the open-loop configuration using an existing well. The incremental cost ranges from $1000 to $2500 (see Table 16). A large portion of this cost is the dealer's premium for the heat pump. The predominance of open loops in Wisconsin is typical for a market that doesn't support the initial costs associated with a closed loop. Wisconsin has a relatively high abundance of clean water, so the fraction of open-loop systems could remain higher than the national average as the market develops.

Gas-Engine Heat Pumps

The York Triathlon air-source heat pump has an installed cost of $6800, which is $2800 above the typical $4000 cost of a gas furnace with air conditioning. But 1995 is the initial year of commercialization, with 2,000 units planned for production. The price could still reflect contractors' lack of experience with installation and low volume, so that future costs could drop.

Table 17 compares the average capital costs of installing heat pumps and conventional furnaces equipped with air conditioning.

Table 17: Capital equipment costs

Market	System	Cost ($)
New Construction	Ground-source closed-loop heat pump	8000
	Gas furnace with add-on heat pump	5100
	Condensing gas furnace with AC, 10-12 SEER	4800-5000
	Air-source heat pump, 10-13 SEER	4200-4700
	Non-condensing gas furnace with AC, 10-12 SEER	4000-4400
Replacement	Condensing gas furnace with AC, 10-15 SEER	3100-4200
	Air-source heat pump, 10-16 SEER	2800-3800
	Gas furnace with add-on heat pump	3700
	Non-condensing gas furnace with AC, 10-15 SEER	2400-3500
	Oil furnace with AC	3000

Operating Costs

We present the range of operating costs for various systems in Tables 18 to 22. We derived energy use from seasonal efficiency ratings. Ratings of GSHPs were taken from past assessments and include auxiliary heat (Oak Ridge National Laboratory, 1994). The GEHP seasonal efficiencies assume gas consumption only for both engine and boiler and were derived from past field data and assessments (Gas Research Institute, 1992, 1993). We obtained electricity and gas prices from 1994 statewide utility revenue and consumption data by rate class. We propane and oil prices are based on rates in the Eau Claire area during the winter of 1994-1995. The tables show the relative importance of operating-cost savings in cooling, water heating, and heating.

Cooling

Because of Wisconsin's short cooling season, the expense for cooling is minimal. Less than $30 of the GSHP savings are from cooling as shown in Table 18, which assumes a seasonal load of 12 million BTU. GEHP cooling costs are similar to electric cooling costs.

Table 18: Energy cost comparison for cooling

	Energy units	Price per unit ($)	BTU per unit	Seasonal efficiency (percent)	Cost per million BTU of cooling ($)	Seasonal cost ($)	Annual savings ($)
Electric air conditioner (11 SEER)	kWh	0.070	3413	322	6.36	76	base
GSHP (16 SEER)	kWh	0.070	3413	469	4.38	53	23
GEHP	therms	0.650	100,000	110	5.91	71	5

Water Heating

GSHPs use a heat exchanger called a desuperheater to supply free hot water when cooling in the summer, as long as the hot-water tank temperature is below the desuperheater's maximum operating temperature. Cooling operation is infrequent, typically less than 350 hours in a season. During the heating season the desuperheater takes heating capacity from the heat pump. The desuperheater is locked out whenever the electric resistance auxiliary heat energizes or the hot-water tank temperature is above the maximum desuperheater operating temperature. There is currently no hot-water option available for the gas engine unit.

We found it difficult to estimate hot-water costs accurately. Table 19 summarizes estimates based on the assumptions shown. It shows that a GSHP providing 100 percent of the hot water load at its heating efficiency would cost $128, but this is not realistic because the heat pump will not always operate when the hot-water tank needs heat. The "realistic case" assumes half of the load is met by the electric water heater and half is met by the heat pump desuperheater. With a propane water heater instead, the savings are lower. With a dual-fuel rate (a half-price electric heating rate) savings are also reduced. When natural gas is available, desuperheaters are typically not cost-effective.

Table 19: Energy cost comparison for water heating, seasonal load = 20 million BTU

	Energy units	Price per unit ($)	BTU per unit	Seasonal efficiency (%)	Cost per million BTU of hot water ($)	Percent of seasonal load	Seasonal cost ($)	Annual savings ($)
ER	kWh	0.070	3,413	95	21.59	100	432	base
GSHP	kWh	0.070	3,413	320	6.41	100	128	304
GSHP	kWh	0.070	3,413	320	6.41	50	64	
ER	kWh	0.070	3,413	95	21.59	50	216	
Total (ER + GSHP)						100	280	152
Liquid propane	gallons	0.750	92,000	70	11.65	100	233	base
GSHP	kWh	0.070	3,413	320	6.41	50	64	
LP	gallons	0.750	92,000	70	11.65	50	116	
Total (LP + GSHP)						100	181	52
ER (dual-fuel rate)	kWh	0.035	3,413	95	10.79	100	216	base
GSHP	kWh	0.035	3,413	320	3.20	50	32	
ER	kWh	0.035	3,413	95	10.79	50	108	
Total (ER + GSHP)						100	140	76
Natural gas	therms	0.650	100,000	80	8.12	100	162	base
GSHP	kWh	0.070	3,413	320	6.41	100	128	34

Heating

Heating-cost savings depend on energy price, load, and system efficiencies. We show a comparison based on one set of assumptions in Table 20.

Table 20: Energy cost comparison for space heating, seasonal load = 90 million BTU

	Energy units	Price per unit ($)	BTU per unit	Seasonal efficiency (%)	Cost per million BTU of heating ($)	Seasonal cost ($)	Annual savings ($)
Fuel oil furnace	gallons	0.850	140,000	65	9.34	841	-
LP furnace	gallons	0.750	92,000	85	9.59	863	base
GSHP	kWh	0.070	3,413	320	6.41	577	286
GSHP with dual-fuel rate	kWh	0.035	3,413	320	3.20	288	575
Natural gas furnace	therms	0.650	100,000	85	7.65	688	base
GEHP	therms	0.650	100,000	120	5.42	488	200

The savings for the GEHP do not account for electricity requirements of the outdoor unit. If the outdoor unit operates for 3000 hours annually at 500 Watts at a price of $0.07/kWh, the savings are reduced to about $100. The GEHP also requires additional annual maintenance for the engine, including changing the oil, spark plug, and air filter after 4000 hours of operation or one year. York presentation literature states that the typical cost is $125. This reduces the expected savings by at least $50.

Combined total energy-cost savings for the GSHP are about $330 without desuperheating and close to $400 with desuperheating compared to liquid propane. The savings compared to a system including electric hot water approach $500. The total savings for the GEHP of around $100 come mainly from heating. These savings estimates are meant to provide a relative break-down between the heating, cooling, and hot-water savings for the particular load and system efficiencies.

The cost estimates in Table 20 are based on a single set of assumptions about load and system efficiency. To establish cost ranges, we also made estimates based on slightly larger and smaller heating loads accompanied by extremes in system efficiencies. We present the case with the smallest differential in operating costs in Table 21; it assumes a lower load, higher furnace efficiency, and lower heat pump efficiency. Table 22 shows the case with the largest differential, which assumes a higher load, lower furnace efficiency, and higher heat pump efficiency. The first case reduces GSHP savings by about $75, and the second case increases GSHP savings by up to $150. The second case could be optimistic because increasing the seasonal load for a given heat pump size tends to increase supplemental heating and therefore decrease seasonal efficiency.

For the GEHP, savings could be increased or reduced by $100 with the variations specified in the table. Again with a larger seasonal load it is likely that more supplemental heat would be required and seasonal efficiency would drop.

Table 21: Energy cost comparison of heating: smallest differential, seasonal load = 80 million BTU

	Energy units	Price per unit ($)	BTU per unit	Seasonal efficiency (%)	Cost per million BTU of heating ($)	Seasonal cost ($)
Fuel oil furnace	gallons	0.850	140,000	80	7.59	607
LP furnace	gallons	0.750	92,000	90	9.06	725
GSHP	kWh	0.070	3413	320	6.41	513
GSHP w/ LP furnace	kWh	0.035	3413	320	3.20	256
Natural gas furnace	therms	0.650	100,000	90	7.22	578
GEHP	therms	0.650	100,000	110	5.91	473

Table 22: Energy cost comparison for heating: largest differential, seasonal load = 100 million BTU

	Energy units	Price per unit ($)	BTU per unit	Seasonal efficiency (%)	Cost per million BTU of heating ($)	Seasonal cost ($)
Fuel oil furnace	gallons	0.850	140,000	60	10.12	1012
LP furnace	gallons	0.750	92,000	80	10.19	1019
GSHP	kWh	0.070	3413	350	5.86	586
GSHP w/ LP furnace	kWh	0.035	3413	350	2.93	293
Natural gas furnace	therms	0.650	100,000	80	8.13	813
GEHP	therms	0.650	100,000	130	5.00	500

Discussion of Economics

Annual savings from horizontal closed-loop GSHPs are about $300 to $500 with incremental costs at about $3500 to $4500 for horizontal-loop systems. More than half of the savings are from space heating. Only about 10 percent of the savings are from cooling, and water heating accounts for 15 to 30 percent, depending on whether propane or electricity is replaced. Savings from open-loop systems are similar with substantially reduced incremental costs, often below $2000. Closed vertical loops typically increase the incremental cost by

about $2000 over a horizontal loop. GEHP savings are less than $100 per year for an incremental cost of $2800.

These estimates suggest that payback periods for these systems are generally at least 10 years. To perceive these systems as cost effective, target markets must rely on long-range planning such as life-cycle costing. Homeowners who arrange for custom construction have the opportunity to consider financing options that give heat pump technologies positive cash flow. But homeowners who buy on the speculative market do not. Market forces do not now reward speculators for choosing technologies that can only be justified with life-cycle costing. Therefore speculators are unlikely to choose to install GSHPs unless a home rating system or similar practice is introduced.

Besides the homeowner there are at least two other players with a stake in new heat pump technologies: the utility and society. For the utility, both GSHPs and GEHPs offer seasonal load valley filling. GSHPs provide an electric space heating option while GEHPs provide a summer gas cooling option. For society the ability to retain dollars in the local economy rather than spend them on energy resources might justify the long-term investment in efficiency. Additionally, emissions trade-offs between energy sources and geographic location might also point toward long-term investment.

If utilities and society are going to reap benefits from new heat pump technologies, the main barrier is the short-term financial planning horizon of most residential consumers. Customers in the upper-income, custom-construction niche market already consider installing GSHPs and GEHPs, in part because heating-system costs generally represent a smaller percentage of the total house cost for these customers. But even in this market, heat pumps are probably not reaching their full potential because many potential buyers lack information about them.

For the rest of the market some mechanism is needed to prevent shorter planning horizons from blocking long-term benefits. National organizations have proposed positive-cash-flow financing options as one solution. But this may be insufficient unless provisions are added to make it easier for consumers to cash out of the investment early. The housing market does not currently place a premium price on low-operating-cost houses, so those who invest in new heat-pump technologies can only recoup if they continue to occupy their houses for the entire payback period.

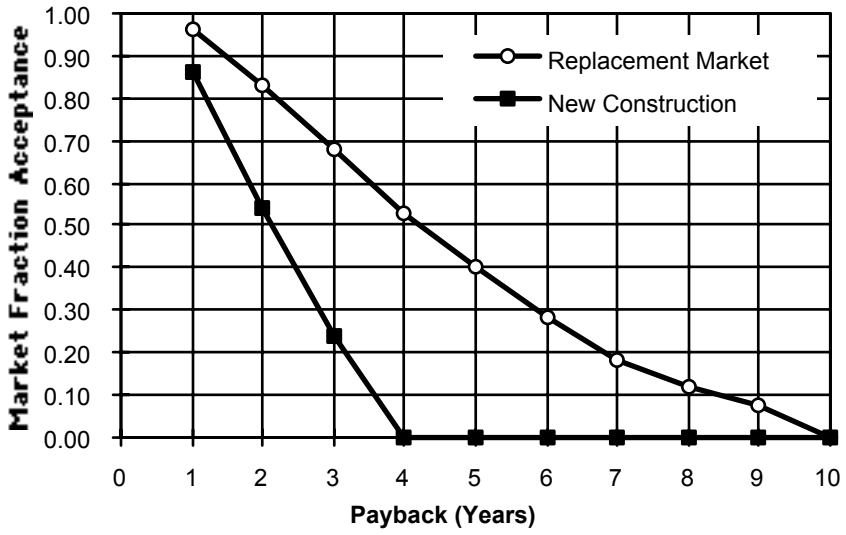
This characterization of the present market suggests that an appropriate strategy for promoting GSHPs and GEHPs would begin by seeking to saturate the current upper-income, custom-construction niche market. It is relatively easy to reach the new-construction market because there are fewer developers and builders. The possibility of generating a positive cash flow with an ordinary long-term mortgage gives builders a valuable selling point. Several subdivision developers have successfully promoted GSHPs on the basis of their lower

operating cost. This strategy would also prepare the way for new heat pump technologies in other housing markets if they look to the upscale market for new ideas.

To reach the existing housing market, GSHPs and GEHPs face the same hurdle as any efficiency improvement—cost-effectiveness for the buyer. It is possible to use no-down-payment financing to create positive cash flow from these technologies that result in a monthly credit after nothing more than acceptance of the project by the owner. By tying debt service to the meter rather than the owner, utilities could give buyers the ability to favorably cash out of the investment before the payback period. The owner still assumes the risk of not achieving the savings. One possible pitfall related to resale is that the repayment would probably be explicitly stated on the utility bill, but operating costs savings are less obvious. Because the market doesn't now value lower operating costs, this explicit charge for lower costs might discourage installation of heat pumps.

During the early 1980s Oak Ridge National Laboratory (1982) sought to quantify the willingness of the housing market to accept higher-first-cost, lower-operating-cost technologies. Figure 1 shows his market acceptance curves for the new and replacement markets. The difference between these two curves might be explained by a difference in who is making the decision, owner or builder.

Figure 1: Market acceptance curves



The figure indicates that payback periods of about eight years in the replacement market and 3.5 years in new construction would allow a new technology to reach 12-percent market share—the goal set by the Geothermal Heat Pump Consortium. Closed-loop GSHPs saving $300 to $500 could support incremental costs of $2400 to $4000 in the replacement market. The current incremental cost is already near the high end of this acceptable range. The GEHP cost premium would have to drop to near $800 to reach the same target penetration. The figure suggests that the new-construction market is less willing to accept longer-term investment, allowing only a $1050 to $1750 cost premium for the ground-source heat pumps and $350 for the gas engine heat pump. These examples support the argument for concentrating on niche markets rather than trying to sway the market as a whole.

Discussion and Recommendations

Our qualitative studies involving manufacturers, trade organizations, government agencies, utilities, and trade allies in Wisconsin and elsewhere in the United States and Canada, together with our economic analysis, give insight into the nature of the heat pump market. In this section we present our recommendations for promoting heat pumps in the residential market.

The best early markets for both ground-source heat pumps and gas-engine heat pumps appear to be upscale households in areas not served by natural gas.

Information from GSHP manufacturers suggests that this has been the best market in the United States and Canada. Manufacturers said they consider new construction somewhat more important than retrofits. Utilities with successful programs found that the majority of their program participants were upper-income households with relatively large new homes. Some but not all utilities said the majority of their GSHP installations were in areas not served by natural gas. Manufacturers and utilities reported that upscale new construction provides the best early market for GEHPs as well.

Our analysis of the consumer economics in Wisconsin points to the same target market for GSHPs. In upscale, custom homes, the prospective owner is directly involved in decision-making. Typical 30-year financing will provide a positive cash flow for a GSHP. And the installed cost of a GSHP will be a smaller percentage of the total mortgage for a custom home than for moderate-income housing.

The new construction market is also easier to reach than the existing construction market because there are fewer developers and builders. Indeed, many of the most successful utility programs for both GSHPs and GEHPs have focused on marketing to builders, and specifically on getting the builder to use the technology in an entire subdivision. Lower operating costs give builders a selling point that can distinguish them in the market.

Competition in the speculative housing market is largely driven by first costs. This market is unlikely to favor new heat pump technologies unless a home energy rating system or similar vehicle is used to increase the importance of operating costs in builders' and buyers' decision making. Such a rating would also place a premium on houses with low operating costs which would allow homeowners to recoup their investment if they sell their homes before the end of the heat pump's payback period.

To compete in the existing-home market, GSHPs must become cost-effective for the buyer. Long-term, no-down-payment financing would partially achieve this by generating positive cash flows. At least one private financing program already operating offers fully assumable loans with terms of up to 15 years for

GSHPs. This program is not being marketed directly to consumers, but to utilities, manufacturers, large distributors, and contractors who would sponsor the program but would not have any bad debt risk. Another positive cash flow alternative would be for utilities to provide financing directly. Utility financing could be structured to give homeowners the ability to recoup their investments if they sell before the end of the payback period. In either scenario, the owner still assumes the risk that the heat pump will not save money.

With an incremental cost of $2800 and savings of less than $100 per year, we did not identify any promising markets for the GEHP in Wisconsin.

Market Barriers

Substantially fewer new-technology heat pumps have been installed in Wisconsin than in the most active areas of the U.S. and Canada. Based on interviews with distributors and contractors, we estimate that fewer than 2500 GSHPs have been installed in Wisconsin. Only a handful of GEHPs have been installed since their introduction in 1994.

We found that the primary barriers to increased market penetration of new heat pump technologies in Wisconsin are:

- Poor customer economics
- Lack of sufficient infrastructure
- Lack of consumer awareness and confidence
- Disinterest on the part of investor-owned utilities
- Regulatory policies that discourage electric space heating

Customer Economics

Annual operating cost savings for GSHPs are about $300 to $500 at average Wisconsin electric rates, when compared with a liquid propane or oil furnace, liquid propane or electric water heater, and a central air conditioner with a SEER of 11. If a natural gas furnace is substituted in the base case, the operating-cost savings are about $200 less.

Incremental costs are about $3500 to $4500 for a horizontal loop system, and about $5500 to $6500 for a closed vertical loop. Open-loop systems have lower incremental costs, often less than $2000, but they lack consumer acceptance because of the need to discharge water and the perception that this use of ground water is wasteful.

Operating cost savings for GEHPs are less than $100 relative to a gas furnace with 85-percent AFUE and a central air conditioner with a SEER of 11, with an incremental cost of $2800.

The payback periods for all of these systems except open-loop GSHPs are generally 10 years or longer. Other studies have indicated that paybacks of eight years in the replacement market and 3.5 years in the new-construction market would be required to achieve an industry goal of 12 percent market acceptance.

Infrastructure

Utilities and trade allies say there is inadequate infrastructure to distribute, sell, and install GSHPs in Wisconsin. There are few qualified, experienced GSHP installers in the state. Perceived problems in Wisconsin include lack of contractor awareness, insufficient training on technical and marketing aspects of GSHPs, and inadequate contractor support of the product.

The GEHP, as a recently-introduced design that is available from only one manufacturer, faces even greater obstacles in infrastructure development.

From distributors' points of view, the major barriers to getting involved with GSHPs are:

- Cost to inventory the equipment and train staff
- Small volume
- Lack of profitability

From dealers' points of view, the barriers include:

- Need for skills
- Need for special tools and inventory
- Need to find loop contractors
- Lack of a ready market
- Lack of marketing expertise
- Lack of awareness among contractors

Utilities with successful GSHP programs outside Wisconsin have found it critical to actively develop the market infrastructure. Their activities have included promoting the technology to distributors and contractors, training contractors and loop installers, establishing trade organizations, establishing strict quality criteria for installations, executing contracts with loop installers that guarantee a certain volume of work at a specified price, distributing GSHPs themselves, and hand-carrying leads to contractors.

Because Wisconsin's infrastructure for heat pump technologies is so meager, further development is critical. Without utility involvement, manufacturers may find that the responsibility for infrastructure development falls heavily on them.

Consumer Awareness

Trade allies and Utilities with successful heat pump programs identified lack of consumer awareness as a significant barrier to increased market penetration of new heat pump technologies. In addition, many have found that marketing for GSHPs must differentiate them from air-source heat pumps because of the perception that ASHPs perform poorly or do not work in northern climates. In addition, Wisconsin trade allies say they must overcome past marketing to the effect that gas is the best, most efficient heating option.

As a new product, the GEHP will face many of the same awareness and perception barriers as the GSHP.

Aggressive utility promotion has been a key factor in building consumer awareness of and confidence in GSHPs elsewhere. Trade allies say it is tremendously valuable for utilities to use their strong credibility with customers and actively endorse GSHPs. Many trade allies also said that all front-line utility staff should be able to provide complete accurate information to customers. Trade allies say this is more important than financial incentives in building the market for GSHPs.

In the changing utility environment, it may be more realistic for utilities to actively promote GSHPs and GEHPs than to provide incentives. But even promotion requires expenditure of funds and staff resources that may be in short supply.

Utility Activities and Strategic Interests

Aggressive, effective utility marketing, combined with incentives, attractive rates, or both, have been critical elements in nearly all areas of high market acceptance of GSHPs and GEHPs.

In Wisconsin, however, none of the investor-owned utilities has had an incentive program targeted specifically at GSHPs. Several have had custom programs for which GSHPs were eligible, but only two have marketed these programs for GSHPs. The most successful programs have had about 100 installations. Some of the retail electric cooperatives have promoted GSHPs more actively, and at least one has had about 200 installations. By contrast, successful utility programs elsewhere in the United States and Canada have achieved 1000 to 7400 installations. Nationally 75 electric-utility operating companies have joined the Geothermal Heat Pump Consortium, but none of the investor-owned utilities or cooperatives in Wisconsin has joined.

No Wisconsin utility currently has a program for GEHPs, although several are members of the York Triathlon Consortium. The two leading utilities in other states each have about ten to twelve units installed, but have firm commitments from builders to install 200 to 1000 more.

The investor-owned utilities in Wisconsin said that GSHPs are not important in their strategic planning. Among the most important reasons for this are:

- All of the investor-owned utilities either are combination electric/gas utilities or are owned by holding companies that own both electric and gas utilities in Wisconsin. In other states, load-building and competition for residential heating market share have been primary motivators in electric utilities' GSHP marketing efforts. Although the Wisconsin companies' electric and gas service territories are not completely congruent, they overlap enough to significantly reduce the motivation to compete for market share with other suppliers.
- The restructuring of the electric utility industry and anticipation of retail competition is causing utilities to de-emphasize residential and small commercial customers and shift resources to commercial or large C&I customers.
- Wisconsin utilities cannot promote GSHPs broadly because regulatory policy prohibits electric sales activity using ratepayer funds.

Most Wisconsin investor-owned utilities said they had no plans for further promotion of GSHPs, but some indicated that they might reconsider if installed costs decrease, if the infrastructure develops further, or if fuel prices change. The two investor-owned utilities that have more actively promoted GSHPs in the past are dropping or scaling back their efforts. Of the six utilities outside Wisconsin whose successful GSHP programs we examined, four have scaled back or terminated their incentives because of concerns about competition, specifically the need to reduce costs and to re-evaluate and refocus customer services. These changes appear to represent a significant trend that runs counter to the Geothermal Heat Pump Consortium's efforts.

Four of the utilities outside Wisconsin noted that they are increasingly interested in promotion of GSHPs for commercial customers. Some have observed that the commercial market has a beneficial spillover effect on the residential market, and that it may be easier to penetrate the commercial market first. It is possible that commercial applications could be more valuable to Wisconsin investor-owned utilities than residential applications.

In contrast with the investor-owned utilities, the Wisconsin electric cooperatives incorporated residential GSHPs into their strategic plans. For them, GSHPs provide the opportunity to build winter load, to build controllable load when installed as part of a dual-fuel system, and, for those that generate electricity, to free valuable summer capacity for sale to other utilities. In addition, they provide a tool to compete against liquid propane, not only for space heating, but also for other end uses for which fuel choice may be influenced by the fuel choice for space heating. These cooperatives say they intend to continue their current programs indefinitely.

Some Wisconsin investor-owned utilities said they had more strategic interest in the GEHP than in the GSHP, but in most cases the interest was modest. These utilities said that the GEHP could offer the ability to improve gas load factors, add summer gas load, retain or add gas load in gas-only areas, and reduce summer electric peaks. They were also more interested in it because the first cost is not as high as for the GSHP and it is a gas rather than electric technology. Some of the investor-owned utilities that did *not* have much strategic interest in the GEHP were uncertain about its reliability, and others said that the incremental cost may be too high for the unit to be cost-effective for the customer, especially where electric costs are low or moderate. None of the investor-owned utilities plan any significant near-term activity to promote GEHPs. They plan to follow developments and possibly get involved later.

One promising strategy to improve the market for new heat pump technologies in Wisconsin is to build on the retail electric cooperatives' success with GSHPs. Further analysis and testing of commercial applications of GSHPs and GEHPs would be valuable to give the investor-owned utilities a better basis for evaluating the strategic value of these technologies.

Regulatory Policies

Strategic load-building and competition for residential space heating market share have been primary goals for most of the utility programs successfully promoting GSHPs in other areas. Only one of the six utilities we contacted had encountered any significant regulatory challenges to their promotion of GSHPs. By contrast, policies established by the Public Service Commission of Wisconsin form a negative regulatory context for GSHPs. These policies may be appropriate, but they are a barrier to increased market acceptance of new heat pump technologies.

An Environmental Impact Statement (Public Service Commission of Wisconsin, 1984) found that electric sales promotion would increase the long-term costs of generating electricity and should not be funded with ratepayer dollars. An appendix to Advance Plan 6 (Public Service Commission of Wisconsin, 1992) presents guidelines that, though less stringent than the requirements of earlier plans, inhibit utility activities that promote fuel switching. Furthermore, the commission has consistently opposed electric heat rates for over a decade, finding that they cannot be justified based on analysis of cost of service.

The municipal utilities in Wisconsin are also subject to rate regulation by the PSC, and generally would not be able to get approval for electric sales promotion rates. Their demand-side management activities are also subject to approval, but the commission generally gives them more latitude than the investor-owned utilities. If the municipal utilities could show that a program to promote or provide incentives for GSHPs passed the revenue requirements test, they would probably be allowed to operate it.

These policies contribute to utility disinterest in GSHPs, and presumably are responsible at least in part for the fact that the two investor-owned utilities with the most successful GSHP programs targeted them only to electric-heat customers or customers without access to natural gas. The cooperatives that have had successful programs are not subject to regulation by the PSC.

Building codes and water-supply and waste-water regulations in Wisconsin have some marginal impact on the economics of GSHPs, but do not appear to be major impediments to increased market penetration. There are no significant regulatory barriers to GEHPs.

It may be worthwhile for regulators to reassess the societal benefits of new heat pump technologies, to determine whether any modifications in policy would be appropriate.

Impact of Incremental Changes in Costs and Savings

Utilities and trade allies in Wisconsin and elsewhere identified high first costs as one of the key barriers to increased market penetration of heat pumps. Clearly, one way to improve customer economics and broaden the cost-effective market is to decrease installed costs. But we found that incremental costs for GSHPs in Wisconsin are comparable to those in areas with the most successful utility programs. This is in spite of the relatively small number of installations in Wisconsin to date. The poor market penetration of new heat pump technologies in Wisconsin relative to these areas can not be explained by incremental cost alone.

The Geothermal Heat Pump Consortium hopes to bring down GSHP costs by increasing volume on a national level. Contractors said GSHP equipment costs seem high given the components and construction, and that these costs might be expected to decrease as volume increases. But the equipment cost premium only accounts for about $500 to $1000 of the incremental cost of GSHPs. Loop-installation costs account for a much larger part of the incremental cost, and most contractors, manufacturers, and utilities do not anticipate dramatic decreases there.

In areas where loop costs have decreased, utilities have either sponsored mass installation of loops in subdivisions prior to construction or arranged contracts with loop installers that guaranteed a certain volume of work in return for a certain price.

Prices for single unit sales of GEHPs are not likely to decrease in the near future because the York Triathlon Consortium has already lowered installed cost to a level near the mature market price through substantial direct payments from gas utilities to the manufacturer. Some gas utilities are working with customers to

achieve lower prices by encouraging volume purchases for installation in subdivisions.

Trade allies in Wisconsin also identified the low cost and ready availability of natural gas as a significant market barrier to GSHPs. GSHP economics can be improved if utilities offer lower electric rates and thus increase operating cost savings. Some utilities offer special energy-efficiency rates, dual-fuel rates, or ground-source rates to encourage GSHPs. In Wisconsin, the dual-fuel rates offered by some cooperatives increase the heating-cost savings provided by GSHPs from $300 to nearly $600. But the PSC has been reluctant to grant electric-heat rates to regulated utilities. Gas-cooling rates could improve the economics of GEHPs, but these have not been common in Wisconsin.

Equipment Trends

Manufacturers did not identify any coming revolutions in GSHP technology, but they anticipate evolutionary changes including increased use of multiple compressors, multiple-speed compressors, variable-speed compressors, and multiple- and variable-speed fans, which will improve load-matching capabilities. For Wisconsin, this will allow contractors to size systems close to the design heating load without raising concerns about short-cycling and loss of humidity control in summer. Systems like these are already available commercially, and their performance can readily be examined.

Only a few vendors identified other trends, including increased use of dedicated GSHP water heaters, triple-function equipment (which provides all water heating, as well as space heating and cooling), and increased use of vertical-loop installations. One manufacturer is pursuing DX systems—those in which the heat pump's refrigerant evaporator-condenser is the ground loop itself, instead of merely being coupled to the loop through a heat exchanger. Nearly all other manufacturers have discarded this technology. Triple-function GSHPs are available from one manufacturer, and GSHP water heaters from another. These may warrant field tests to determine whether they increase operating-cost savings more than installed costs.

The GEHP warrants further testing in Wisconsin because Wisconsin utilities and regulators appear receptive to gas heating technologies. The maintenance costs and electrical consumption are critical to its overall economics, but are poorly quantified. Some also raise questions about its reliability.

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Appendix A: Survey Instruments

Open-Ended Interview Guide for Ground-Source Heat Pump Manufacturers

I. Characteristics of available equipment, and equipment typically used in northern climates.
   A. Sizing relative to design heating/cooling load.
      1. Recommended practices.
      2. Percent of units sold that are sized to meet 100 percent of load, vs. less than 100 percent.
      3. Percent of units sold with electric resistance heating.
   B. Availability of water heating capability (desuperheating, triple function, or other) and percent of sales.
   C. Availability of multispeed compressors and fans and percent of sales
   D. Percent of sales hydronic or hydronic/air systems.
   E. System configurations available (single package, split system) and percent of sales.
   F. ARI listings — relationship of their GSHP, GWHP, WSHP products to each other.

II. Typical loop configurations — northern climates.
   A. Percent of sales open vs. closed.
   B. Percent of sales by closed loop type (horizontal, vertical, slinky, DX).
   C. Slinky placements recommended/used (upright, flat).
   D. Aware of any movement toward in-situ loop testing?

III. Design tools and other support provided to or recommended to distributors/ contractors.
   A. Heat loss/gain calculations, equipment sizing procedures.
   B. Loop sizing.
   C. Duct sizing.
   D. Economic analysis: operating costs, payback, life cycle costs, other.

IV. Trends in equipment and loop configurations, anticipated next generation technologies.

V. Most promising early markets for GSHPs and GWHPs (competing fuels, demographics, new/retrofit etc.).

VI. Geographic markets with significant activity in Northern climates, and key contacts in those markets (utilities, reps, distributors).

VII. Perceived factors in high market acceptance in those areas.
   A. Fuel choices and rates.

B. Utility role.
C. Distribution infrastructure.
D. Contractor role.
E. Customer characteristics.

VIII. What do they foresee as future strategies to help market share of GSHPs and GWHPs given changes in electric utility industry?

IX. Participation in national mobilization.

X. Distribution infrastructure, contacts, and level of sales in Wisconsin.

XI. Perceived barriers (including regulatory) to regional and Wisconsin market acceptance.

XII. Cost data (list price, estimated installed cost).

XIII. Technical and marketing product literature.

Capacities and COPs of equipment currently available are determined from ARI or CSA certified ratings.

Screening Interview for Utilities

Introduction: Working with the Wisconsin Center for Demand-Side Research on a project on enhanced heat pump applications. WCDSR is a consortium of electric and gas utilities. They are looking at ways to improve the market for geothermal heat pumps in Wisconsin, and want to learn from the experience of utilities that have had successful GHP programs.

- Goals: Why they got involved with residential GSHPs. How does it fit into their overall strategy? (E.g., are they doing it for load building? To retain electric space heating shares? To reduce peak demand from residential space heating?)
- When did the program start?
- When did it end (if it has)?
- How many residential GSHPs/GWHPs have been installed through the program?
- What type and amount of financial incentives do they offer (rebates, loans, special rates)? If special rates, get regular residential rate, too. If incentives have changed, get history.
- What do they perceive as the key factors in their program's success?
- Have they had any experience with GHPs competing against natural gas space heating?

- Are there other utilities they feel have particularly successful programs that we should talk to?
- Do they have any information describing their program that they would be able to send?

We may contact them for further information within the next month. Thank them for their help.

Open-Ended Interview Guide for Utilities with Successful Programs

Goals

Purpose of GHP/GEHP program.

How GHPs/GEHPs fit into the utility's overall DSM/marketing objectives.

How GHPs/GEHPs compare with/relate to other options for meeting these objectives, such as residential thermal storage, dual fuel heating, air source heat. Pumps, high efficiency furnaces, superinsulated buildings.

Results

Number of GHP/GEHP units installed in service territory.

Absolute.
As an percent of new and existing customers.

Estimated system impact.

Increased sales.
Decreased demand.

Does the company view the program as a success? Has it been worth it?

Baseline Market Conditions

Preprogram saturation and new construction market share of various heating fuels in service territory and trends.

Program start date.

Overview of Perceived Market Barriers

Primary market barriers to GHPs/GEHPs .

Factors viewed as most critical in achieving significant market penetration.

Incentives Offered

Rebates offered.

Special rates offered.

Financing offered.

Leasing programs or other incentives.

Perceived incremental cost relative to competing technologies in their area.

Comparison of special rates with regular residential rates.

Rates for competing fuels in their area.

Infrastructure Development

Perceived infrastructure needs.

Which infrastructure-related activities have been most important?

Activities undertaken to bring down installed costs - installation techniques, other.

Equipment and Installation Characteristics

Heat pump sizing relative to design load.

Use of and control of back-up heat.

Marketing

Activities undertaken to market GHPs/GEHPs (build awareness, build sales).

- To distributors.
- To builders.
- To HVAC contractors.
- To customers.

Which of these activities have been most important?

Characteristics of residential customers installing units:

- New/retrofit.
- Urban/suburban/rural.
- Fuel options available.
- Income.
- Other.

Best residential market niches for GHPs/GEHPs.

Regulatory Barriers

How was the program presented to regulators when first proposed?

How was this program viewed by regulators when initially proposed?

Were there regulatory barriers (utility and environmental)?

How these were overcome.

Regulatory incentives, if any.

As operated, how is (was) the program viewed by regulators?

Problems Encountered

Problems encountered with GHP/GEHP installations (e.g., loop and duct sizing, supply air temperature, reliability).

Problems encountered with trade allies and other parties viewing GHPs/GEHPs as competitive threat.

Other problems.

Program Costs and Staffing

Program costs — total, annual, whatever they will provide.

Staff requirements: central staff, customer service reps, other.

Future Plans

Future plans for the program.

Perspective on role of GHP/GWHP in an increasingly competitive utility environment.

Thoughts about less expensive ways to achieve significant market penetration.

Supporting Documentation

Can they send us anything?

Further Contacts

Key reps, distributors, contractors, builders.

Open-Ended Interview Guide for Distributors/Manufacturer's Representatives, Contractors/Dealers, and Builders in Areas with Successful Programs

Introduction: Calling on behalf of WCDSR, consortium of utilities in Wisconsin, because we understand they are or were involved in (utility's) program for geothermal heat pumps (ground source heat pumps, groundwater

heat pumps) and want to get their perspective on the technology and on the utility's program.

Results

How many GHPs has your company sold (distributors) or installed (dealers)? How many homes with GHPs has your company sold (builders)?

Is it profitable for you to sell GHPs (homes with GHPs) currently? If not, why not?

In your view, is (was) the utility's program successful, worthwhile? Why or why not?

Problems Encountered

(Dealers, builders) What problems have you encountered with GHP installations, in terms of loop installation, loop fluids, equipment installation, loop and duct sizing, reliability, customer satisfaction, or any other problems?

Overview of Perceived Market Barriers

What do you see as the primary barriers to increasing the market for GHPs?

What factors do you view as most critical in achieving significant sales of GHPs?

Marketing

(Dealers, builders) What is the approximate incremental cost of a GHP relative to the type of heating and cooling equipment you would more typically sell to the same customers? (Clarify whether this is including the rebate, if any, or not.)

What activities has your company undertaken to market GHPs?

(Dealers, builders) How do you think your customers look at the decision to buy a GHP rather than some other heating and cooling equipment?

(Dealers, builders) How do you sell a customer on choosing a GHP rather than other heating/cooling equipment? (Product features, other benefits, sales tools such as testimonials, etc.)

(Dealers, builders) What information do your customers want about installed costs, operating costs or other financial comparisons of the GHP to other options?

(Dealers, builders) What have you done (if anything) to reduce the installed cost of the GHP systems you sell?

(Dealers, builders) Is there anything else you think could be done to reduce installed costs?

Which of the utility's incentives (rebates, special rates, loans, leasing, other) is (was) most important and how important are these incentives in selling GHPs?

Of the things that the utility has done to market GHPs, which have been most important, successful?

What else could the utility do (have done) or what could they do (have done) differently to have more impact?

Infrastructure Development

For a (distributor, builder, contractor) what are the barriers to getting involved with GHPs?

Looking at the whole market infrastructure, including manufacturers, distributors, loop contractors, HVAC contractors, builders and lenders, what specific things are needed to get GHPs off the ground in a new area?

In your area today, what pieces of the market infrastructure are still missing or inadequate, from your point of view? (More distributors, more loop contractors, more GHP installers, more training, more tech support, energy efficient mortgages, home energy rating systems, other.)

Of the things the utility has done to build up the infrastructure for GHPs, which have been most important?

What else could the utility do (have done) or what could they do (have done) differently to have more impact?

Future Plans

National trends in the electric utility industry may make it more difficult for utilities to offer large incentives or significantly lower rates for GHPs. The utilities in Wisconsin are looking for less expensive ways to increase the market for GHPs. What suggestions would you have for ways they could expand the market without large incentives or special rates?

Interview Guide for Activities of Wisconsin Utilities Relating to Enhanced Heat Pumps

I. What activities has your company undertaken relating to electric geothermal heat pumps (ground source heat pumps, ground water heat pumps) and gas engine driven heat pumps?

- A. Programs:
  1. start date
  2. end date
  3. goals
  4. number of GHPs installed
  5. incentives (rebates, rates, financing)
- B. Research
  1. dates
  2. purpose
  3. number of sites
- C. Demonstrations
  1. dates
  2. purpose
  3. number of sites
- D. Information programs
  1. dates
  2. what was done
- E. member of GHPC?
- F. member of York GEHP consortium?

II. How do GHPs and GEHPs fit into your company's strategic plans for the future?

III. What activities do you anticipate your company doing in the future relative to GHP and GEHP technologies, if any?

IV. If more or less activity than in the past, why the change?

V. In your electric service territory, what percent of residential customers have electric space heat?

Is this increasing or decreasing?
What percent of residential customers in your electric service territory have access to natural gas provided by your company?
What percent have access to natural gas provided by another company?
What percent do <u>not</u> have access to natural gas service?
How many customers is this?
In your electric service territory, what fuels does electricity compete against for space heating?

VI. In your gas service territory, what percent of residential customers have gas space heat?

Is this increasing or decreasing?

What percent of residential customers in your gas service territory are served by an electric utility other than the one owned by your company?

In your gas service territory, what fuels does gas compete against for space heating?

VII. Are there any specific state or local regulatory barriers that inhibit the growth of the market for GHPs or GEHPs in Wisconsin, including regulations governing utilities?

Open-Ended Interview Guide for Wisconsin Distributors and Dealers

Introduction: Calling on behalf of WCDSR, consortium of utilities, government agencies in Wisconsin, because we understand they are or were involved in sales of geothermal heat pumps (ground source heat pumps, groundwater heat pumps) and want to get their perspective. Working with Steve Carlson, of CDH Energy, who talked with them previously. Would like to first ask them some questions about their views on the technology, and then on activities of Wisconsin utilities.

Overall

How would you describe the current market for GHPs in Wisconsin?

Results

How many GHPs has your company sold (distributors) or installed (dealers)?

Is it profitable for you to sell GHPs currently? (If not, why not?)

Problems Encountered

(Dealers) What problems have you encountered with GHP installations, in terms of loop installation, loop fluids, equipment installation, loop and duct sizing, reliability, customer satisfaction, or any other problems?

Overview of Perceived Market Barriers

What do you see as the primary barriers to increasing the market for GHPs in Wisconsin?

Marketing

What activities has your company undertaken to market GHPs?

(Dealers) What is the approximate incremental cost of a GHP relative to the type of heating and cooling equipment you would more typically sell to the same customers? (Clarify whether this is including the rebate, if any, or not)

(Dealers) In your experience, what causes a particular customer to be interested in GHPs initially?

(Dealers) How do you sell a particular customer on choosing a GHP rather than other heating/cooling equipment? (Product features, other benefits, sales tools such as testimonials, etc.)

(Dealers) What information do your customers want about installed costs, operating costs or other financial comparisons of the GHP to other options?

(Dealers) What other concerns (if any) do customers have about GHPs?

(Dealers) In your experience, do customers have any environmental or other concerns about discharge of water from open loop systems? How do you address this?

(Dealers) What have you done (if anything) to reduce the installed cost of the GHP systems you sell?

(Dealers) Is there anything else you think could be done to reduce installed costs?

Infrastructure Development

For a (distributor, contractor) what are the barriers to getting involved with GHPs?

Looking at the whole market infrastructure, including manufacturers, distributors, qualified loop contractors, qualified HVAC contractors, builders, financing, training, or anything else, what specific things are still missing or inadequate to get GHPs off the ground in Wisconsin at this point?

Regulatory Barriers

Are there any specific state or local regulatory barriers that inhibit the growth of the GHP market in Wisconsin?

Utility Programs

What programs offered by WI electric utilities to promote GHPs have you participated in?

In your view, is (was) each of these utilities' program successful, worthwhile? Why or why not?

Of the incentives, marketing, and infrastructure development activities undertaken by Wisconsin utilities that you of worked with, which is (was) most important and how important are these program features in selling GHPs?

What else could the utilities do (have done) or what could they do (have done) differently to have more impact?

Future Plans

National trends in the electric utility industry may make it more difficult for utilities to offer large incentives or significantly lower rates for GHPs. The utilities in Wisconsin will probably be looking for less expensive ways to increase the market for GHPs. What suggestions would you have for ways they could expand the market without large incentives or special rates?

Appendix B: Heat Pump Equipment

Below are detailed descriptions of specific equipment available from selected manufacturers. We summarize this information and discuss additional aspects of the equipment in Equipment, Trends, and Markets. The additional discussion includes the manufacturers' recommendations for heat pump sizing and loop configuration, the manufacturers' views of technology trends, and the manufacturers' experience marketing new heat pump technologies.

The only gas-engine heat pump currently available for residential use, the York Triathlon, comes in only one size, a nominal three-ton unit. The unit is subject to ANSI Standard Z 21.40. A 3.5-ton unit is expected in July 1995, and a four-ton unit is also planned. We present the current model's characteristics at selected rating points in Table B-1.

Table B-1: York Triathlon GEHP capacities and coefficients of performance

	Heating	Cooling
outdoor temperature	7° F	95° F
heat pump output, Btu/h	29,800	35,600
gas input, Btu/h	28,100	40,000
electrical input, W	not available	not available

integral back-up boiler capacity = 64,000 Btu/h

source: York product literature

There is a much wider range of ground-source heat pump equipment available today. We summarize the sizes of equipment available from nine manufacturers in Tables B-2 and B-3. In Tables B-4 through B-6, we describe the capacity modulation capabilities, water heating options, and heat pump configurations and applications for both GEHP and GSHP equipment.

Table B-2: Closed-loop GSHPs: maximum capacities and corresponding coefficients of performance (certified product only)

		Cooling		Heating	
Manufacturer/models	Configuration	maximum capacity	corresponding EER	maximum capacity	corresponding COP
Carrier					
Carrier	HSP-GS	60.0	10.6	43.0	2.6
WeatherMaker GT	HSP-GS	60.0	10.6	43.0	2.6
WeatherMaker GT-X	HSP-GS	71.0	14.2	52.5	3.4
Climate Master					
Geo-Thermal	HSP-GS	116.0	10.5	85.0	2.5
Geo-Thermal	HRCU-GS-CB	58.5	10.5	41.5	2.6
Geo-Thermal Ultra TR	HSP-GS	71.0	14.2	52.5	3.4
Command-Aire/Trane[2]					
Command-Aire	HSP-GS	70.0	14.0	50.5	3.0
Trane	HSP-GS	70.0	14.0	50.5	3.0
Econar					
Econar (?)	not specified	47.0	12.4	45.0	3.0
Florida Heat Pump					
Super Xtra Efficiency[1]	HSP-GS	74.0	11.1	53.5	2.7
Super Low Temp	HSP-GS	119.0	11.4	100.0	3.2
Super Low Temp	HRCU-GS-C	62.0	11.7	49.0	3.1
Hydro Delta					
Hydro Heat - Horizon	--	--	--	--	--
Hydro Heat - Extended Range	HSP-GS	65.0	12.8	56.0	3.0
MegaTek - Dual Comp.	HSP-GS	67.0	14.1	45.5	3.2
Mammoth[3]					
Hydrobank	HSP-GS	130.0	12.1	101.1	2.7
(unknown)	HRCU-GS-CB	66.0	13.8	51.0	3.0
Tetco					
Tetco[2]	HSP-GS	58.5	11.4	52.0	3.0
WaterFurnace					
Extended Range	--	--	--	--	--
Extended Range	--	--	--	--	--
Premier Series	HSP-GS	48.0	16.0	33.0	3.4
Premier series two-speed	HSP-GS	73.0	10.6	52.0	2.8
Spectra Series	HSP-GS	68.0	12.0	52.0	3.0

Table based on ARI Directory of Certified Applied Air-Conditioning Products, Effective June 1, 1994-November 30, 1994, if available. All capacities in 1000 Btu/h, EER in Btuh/Watt, COP dimensionless. Where ARI ratings were not available (Econar only), listing was based on CSA Listings for Energy Efficiency Verified Ground and Water Source Heat Pump Manufacturers, fax dated January 9, 1995. For products rated at both 230 and 208 V, only the 230 V rating is shown.

[1]Certified part load ratings also available

[2]More recent information provided by the manufacturer.

[3]More recent information from the manufacturer and ARI December 1, 1994 - May 31, 1995 directory. Mammoth also has closed loop units as large as 264,000 Btu/h cooling and 204,000 Btu/h heating, but these exceed the size limits of ARI's certification program.

Table B-3: Open-loop GSHPs: maximum capacities and corresponding coefficients of performance (certified product only)

		Cooling (low temp)		Heating (low temp)	
Manufacturer/model	Configuration	maximum capacity	corresponding EER	maximum capacity	corresponding COP
Carrier					
Carrier	HSP-GW	68.0	12.3	60.0	3.0
WeatherMaker GT	HSP-GW	68.0	12.3	60.0	3.0
WeatherMaker GT-X	HSP-GW	77.0	17.8	63.5	3.5
Climate Master					
Geo-Thermal	HSP-GW	127.0	11.7	116.0	3.0
Geo-Thermal	HRCU-GW-CB	68.0	12.1	60.0	3.0
Geo-Thermal Ultra TR	HSP-GW	77.0	17.8	63.5	3.5
Command-Aire/Trane					
Command-Aire	HSP-GW	79.0	18.3	59.5	3.2
Trane	HSP-GW	79.0	18.3	59.5	3.2
Econar					
Econar (?)	not specified	52.5	15.9	55.0	3.3
Florida Heat Pump					
Super Xtra Efficiency	HSP-GW	82.0	13.1	68.0	3.0
Super Low Temp	HSP-GW	139.0	13.9	131.0	3.3
Super Low Temp	HRCU-GW-CB	65.0	14.2	61.0	3.2
Hydro Delta					
Hydro Heat - Horizon	HSP-GW	49.5	15.3	42.0	3.4
Hydro Heat - Extended Range	HSP-GW	72.0	14.4	64.5	3.4
MegaTek - Dual Comp.	not specified	73.0	17.7	60.0	3.6
Tetco					
Tetco	HSP-GW	67.0	14.2	57.5	3.2
	HRCU-GW-CB	36.0	13.7	32.4	3.4
WaterFurnace					
Extended Range	HSP-GW	131.0	11.8	114.0	3.2
Extended Range	HRCU-GW-C	66.0	12.3	56.5	3.2
Premier Series	HSP-GW	52.0	18.1	39.0	3.7
Premier Series Two-Speed	HSP-GW	77.0	12.0	64.5	3.0
Spectra Series	HSP-GW	73.0	14.0	63.0	3.2

Table based on ARI Directory of Certified Applied Air-Conditioning Products, Effective June 1, 1994-November 30, 1994, if available. All capacities in 1000 Btu/h, EER in Btuh/Watt, COP dimensionless. Where ARI ratings were not available (Econar only), listing was based on CSA Listings for Energy Efficiency Verified Ground and Water Source Heat Pump Manufacturers, fax dated January 9, 1995. For products rated at both 230 and 208 V, only the 230 V rating is shown.

Table B-4: Capacity modulation for GSHPs and GEHPs

	Multispeed or multiple compressors	Multispeed fans	
	Available	Available	Control
Bard	No.	2 or 3 speed.	??
Climate Master	Dual compressors in 2.5, 3, 3.5, 4, 5 and 6 capacities	Variable speed.	
Command-Aire/Trane	Two-speed compressor for 4- to 6-ton capacities available August 1, 1995	Variable speed available August 1, 1995.	"In-field programmable." Will generally be set up with 3 heating speeds and 4 cooling speeds (standard and dehumidification speeds for low and high speed compressor operation). Control monitors and maintains static pressure.
Econar	Dual compressors for 8- and 10-ton commercial only. Current R&D for residential.	3 speed.	Left at one speed for both heating and cooling - set when installed.
Florida Heat Pump	Two.	At least the SX has variable speed	Speed set when installed (not sure if same for heating and cooling) and then it maintains CFM
Hydro Delta	Dual compressor - MegaTek.	MegaTek has variable speed.	Fan speed changes depending on whether one or two stages are running. Set desired air flow (=static pressure) when installed - control maintains this static pressure.
Mammoth	Dual compressors for 6-ton and larger capacities.	3 speed with optional solid state speed control.	Left at one speed for both heating and cooling selected via field wiring when installed. Option for low speed continuous fan-only operation for 50% air flow with no cooling or heating operation active.
Tetco	No.	Variable speed on their closed-loop GSHP, not open loop.	Set for desired CFM when installed. Unit then maintains torque to maintain CFM.
Water Furnace	Two speed available for 3 tons and up.	Variable speed on the Premier line, single speed on Spectra.	"in-field programmable." Commonly set up with 4 heating speeds, very low when compressor is off (if continuous fan is desired), low for single stage heating, high for second stage of heating, and highest for resistance heating. Lower in cooling mode to give desired dehumidification. Control monitors and maintains static pressure.
York (GEHP)	Inherently variable speed — 16 speeds.	Yes — standard.	Varies with speed of gas engine.

Table B-5: Water heating options for GSHPs and GEHPs

Manufacturer	DHW Type	Northern Climates	DHW Control	Comments
Bard	Desuperheater.	Recommended regardless of climate.	?	
Climate Master	Desuperheater. Separate GS water heater.	?	?	Company prefers separate heat pump for DHW to triple function — less complex and costly.
Command-Aire/Trane	Desuperheater.	Recommended regardless of climate.	On when compressor is on, unless astat is satisfied.	
Econar	Desuperheater. Separate GS water heater.	Not a problem. Recommended unless there is a utility preference against it (e.g., off-peak DHW program).	?	
Florida Heat Pump	Desuperheaters. About to introduce separate GS water heater.	Poorest application is in central states with long periods requiring neither htg nor cooling.	On when compressor is on, unless astat is satisfied.	The most cost-effective accessory available on a GSHP. Separate DHW is less complicated than triple function.
Hydro Delta	Desuperheater. Triple function, "on-demand hot water."	Recommended in southern U.S. only. Cuts heating capacity too much in northern climates.	?	Only ARI-certified manufacturer that offers triple function, commercially available since 1988. DHW has priority unless temperature falls more than 2 degrees F below setpoint.
Mammoth	Desuperheater.	Recommended regardless of climate.	Pump turns on when compressor turns on, shuts off if astat is satisfied or if the system is on auxiliary heat.	
Tetco	Desuperheater. Separate GS water heater.	Strongly recommended regardless of climate as highly cost-effective.	On when compressor is on unless astat is satisfied.	Company introduced triple function in 1984, but currently sell separate DHW instead.
Water Furnace	Desuperheater. About to introduce separate GS water heater.			Company once had a triple function product on the market but took it off.
York (GEHP)	None.	NA	NA	NA

Table B-6: Equipment configurations and applications for GSHPs and GEHPs

	Certified products available			
Manufacturer	Closed loop	Open loop	Configurations (single package vs. split)	Hydronic applications
Bard	See note 1	X	Offer both but sell single package except for retrofit. Split system serves a niche - dual fuel in retrofit applications or cold climates.	
Carrier	X	X		
Climate Master	X	X	Offer both but sell splits only in special circumstances. E.g., the air-handling unit is in the attic, inaccessible to water lines. Split is field-assembled and charged, so greater potential for problems.	
Command-Aire/Trane	X	X	Offer both but sell primarily single package to residential.	Not nearly as popular as air systems. Typically limited to specialty applications such as heating-only or snow melting.
Econar	X	X	Single package only. Stopped selling split due to warranty concerns — field assembled and charged.	
Florida Heat Pump	X	X	Offer both, sales breakdown not available.	Application in its infancy. Have done successful residential installations, some commercial (e.g., heat floor of a garage, cool office with fan coil units, melt snow).
Hydro Delta	X	X	Single package only. They offer a "water split" system — run hot or chilled water to fan coil.	
Mammoth	X		Offer both but sell mostly single package.	Limited to special applications.
Tetco	See note 2	X	Offer both but most residential sales are single package. Split system most commonly used when zone control is desired — e.g., downstairs on single package unit and upstairs on split system.	Hydronics are a significant minority of their sales. Used with floor panels, fan coils, swimming pool heaters, etc.
Water Furnace	X	X	Offer both but don't see a lot of split systems at this time, partly because when they do retrofits they do total retrofits (fussy about CFM). May see more as closed-loop GSHPs get added on to existing well-designed HVAC.	Not a significant proportion of the market. Used for radiant floor heating, often with fan coil cooling. Works especially well in areas with low cooling load. Attractive to upscale customers.
York	GEHP	Split system only.	Not designed for hydronic applications at this time.	

[1]As of early January, Bard was working on certified ratings for a closed-loop GSHP line and expected to have them by sometime in February 1995.

[2]As of mid-February 1995, Tetco was working on certified ratings for closed-loop GSHPs and expected to have them within 60 to 90 days.

Appendix C: Utility Programs

We conducted screening interviews with 20 utilities in areas with high acceptance of ground source heat pumps to select subjects for the in-depth interviews described in Successful Programs Outside Wisconsin.

The 20 utilities screened were selected from a list derived from interviews with national organizations and manufacturers. The 30 utilities on the initial list were identified as being in areas of the country with high acceptance of ground-source heat pumps. Most of the 10 utilities initially identified but not screened were just getting started or were small.

We summarize features of the screened utilities' programs in Table C-1. In Table C-2, we summarize the factors in program success identified by the interviewees, along with remarks on the utilities' experience competing with natural gas, and other comments.

Table C-1: Screening interviews of utilities with ground-source heat pump programs: program features

Utility (utility type, location)	Start date	End date	Goals	Residential GSHPs installed	Incentives
Associated Electric Coop (coop G&T, MO)	~1986-87	ongoing	Improve load factor.	7408	$250/ton. Some member coops offer additional rebates.
Ontario Hydro (gvt, ONT)	1990	1993	Decrease peak demand. (Target electric heat in non-gas areas.)	6500	$2,000 cash, or $1,000 cash plus loan up to $12,000.
PSI/Energy (now CINergy) (IOU, IN)	1988, 1990	ongoing	Reverse decline in residential electric space heating market share.	>4900 (10% of new construction market at peak, now down to 2.4%.)	Initially, free loops plus advertising allowance. Currently, $450/ton for 5 homes or more or flat $700 for single home, plus $100 for desuperheater water heater. Rebate is given to builder or dealer, who decides whether to pass it on to customer. Smart Saver rate for total envelope & equip package = $0.029/kWh vs. regular rate for same block of $0.047. Differential will drop to 20% soon.
KAMO Power (coop G&T)	1986?	ongoing	Improve load factor. Improve electric market share for heating and cooling. Strategic load growth.	2831	$250/ton from KAMO. Some member coops offer an additional $100/ton and some have discount loans. (Prior to 1989, a flat $250 rebate)
Michigan Coop Association (coop assn., MI)	??	ongoing	Load building and load management. Retention (e.g., of customers with electric hot water)	Unknown for coops. For one manufacturer in MI, 10,000.	Varies by coop. Could be a reduced rate (e.g., $0.055 vs. $0.09) or low interest loan (0 to 5%). Previous rebate program (flat $300) was not effective.
Buckeye Power (coop G&T, OH)	??	ongoing	Winter peak load reduction (winter peaking utility). Summer load building. Compete with natural gas	1562	All member coops offer flat $600 rebate. They can offer additional incentives such as below market loans or interruptable rates for the electric resistance back-up heat. Rebate used to be $400, raised 1 year ago to increase GSHP penetration.

Table C-1: continued

Utility (utility type, location)	Start date	End date	Goals	Residential GSHPs installed	Incentives
Detroit Edison (IOU, MI)	late 1980s	ongoing	Provide customer service (least expensive heating/cooling/ DHW option in service territory). Protect environment (EPA interest). Reduce summer demand and increase winter load.	>1000 in past 5 to 7 years. Plan 450 for 1995, hope to increase to 2000 per year.	For energy efficient AC, either alone or through efficient home program, ranging from $50/ton for SEER of 12 to $150/ton for SEER of 15. Experimental electric space conditioning and water heating rate averaging $0.04/kWh. Planning "energy-efficient mortgage" for new construction and credit services for existing homes. Had an incentive program for 2 months in 1993, $300 to $500/ton, but were concerned market would disappear with incentives.
East Kentucky Power Cooperative*	1991	ongoing	(not stated)	3540 residential and commercial	(not stated)
Utility X (IOU)	mid 1992	ongoing	Peak clipping and valley filling	Not available, but believed to be substantial.	Rebate varies with efficiency and capacity. Details not available. A loan program is available for any conservation measure, and GSHPs are one of the main measures financed through this program.
Pennsylvania Power & Light (IOU, PA)	~1992	ongoing	Reduce peak demand. Promote energy efficiency.	~800	$1000 for closed-loop GSHP, plus $100 for desuperheater or $300 for fully integrated DHW.
Otter Tail Power (IOU, MN)	~1988	ongoing	Improve system load factor. Strategic load building. Conservation (EPA, DOE backing). Customer value.	~700, including residential and commercial. 350 to 400 are residential.	About $150/ton rebate. Nearly all GSHPs installed with back-up and on dual fuel rate of ~$0.033, vs. regular rate of $0.05 to $0.052.
United Power Association (coop G&T, MN)	~1989?	ongoing	Build load with good load shape.	1100 to 1200 residential and commercial, including 550 residential	$1000 loop rebate ($750 starting 1995). GSHP rate: ~$0.05, vs. std rate ~$0.08. Low interest financing; was 6%, now 8%, up to $7500.
Tennessee Valley Authority* (gvt G&T, TN)	1987	ongoing	(not stated)	several hundred	Loans at 1% over TVA's cost of money (up to 10 years). Also a one-time special promotion in which TVA paid for loop piping and fittings (avg. $500) and distribution utilities paid for installation (avg. $900). This program appears to have accounted for most installations.

Table C-1: continued

Utility (utility type, location)	Start date	End date	Goals	Residential GSHPs installed	Incentives
Jersey Central Power & Light	??	ongoing	Load management, strategic load building (fill in winter valleys).	in 1993, 50 in 1994, 100 projected 1995, 250	equipment rebate $180/ton loop rebate $400/ton desuperheater $100 additional Also Good Cents Home rebate over and above this. $0.80/sq. ft. Currently submitting proposal to regulators for energy-efficient rate ($0.091 instead of $0.111).
Pennsylvania Electric (IOU, PA)	last 2 years have been main thrust	ongoing	Better competitiveness, viable DSM option, increase market share.	in 1993, 50 in 1994, 67 in 60 homes	$600 grant. Homes installing more than one can get an additional half grant. Extra $600 for developments if get 5 or more lots.
Southwestern Illinois Electric Coop (COOP, IL)	started about 1 year ago	ongoing	Load building for the winter to fill valleys. They are summer-peaking — June through September.	75	(1) 17-year lease where payment is collected with electric bill (high efficiency homes only). Lease is transferable to the next resident or can be paid off without penalty. Lease arrangements are figured at 5% interest where during the heating season (Oct - May) a $0.038/kWh charge is added to the $0.044/kWh reduced rate (over 1000 kWh). (2) 7% five-year loan with collection through the electric bill. (3) Literature shows 5% loan not mentioned in interview. Power supplier offers additional flat $500 rebate for heat pumps. New homes built to high efficiency standard receive an additional $500. High efficiency rate for GSHP and ASHP installed in efficient home, $0.044/kWh after the first 1000 kWh, compared with regular residential rate of $0.1085 for first 2000 kWh and $0.085 over 2000 kWh. Any all-electric home is eligible for a load-controlled rate, $0.1085/kWh for the first 800 kWh and $0.057/kWh over that.
Black Hills Power and Light	1993	ongoing	Load building, total electric living (marketing), efficiency (DSM).	41 so far	$250/ton (not clear if customers are also eligible for regular heat pump rebates). According to interview by WCDSR, HP rate of $0.02/kWh vs. regular rate of $0.07/kWh.
Northern Indiana Public Service (IOU elec/gas, IN)			No GSHP program. Energy efficient house program with option for ASHP or closed-loop GSHP.	about 40	$150/ton for 10 SEER, ASHP or closed-loop GSHP. (Reduced from 12 SEER some time ago.)

Table C-1: continued

Utility (utility type, location)	Start date	End date	Goals	Residential GSHPs installed	Incentives
Public Service of Oklahoma (IOU, OK)	??	Officially not ended, but no plans to do more.	Encourage the marketplace, create infrastructure, eliminate difference in incremental cost.	~12	Paid for drilling of wells up to $2500. Good Cents rate for efficient homes, not related to GSHPs specifically.
Virginia Power & Light (IOU, VA)	1994	Pilot. May continue.	Peak clipping and valley filling.	20 test sites with different loop configurations	Not specifically for GSHPs. Finance up to $15,000 at 6% for units with SEER of 16 In discontinued energy-efficient new construction program, paid the incremental cost of installing a GSHP.

* information from presentation at ASHRAE winter meeting

Table C-2: Screening interviews of utilities with ground-source heat pump programs: factors in success, competition with gas, other comments.

Utility, utility type, location	Perceived key factors in success	Experience competing against natural gas	Other
Associated Electric Coop (coop G&T, MO)	Get in early, educate consumers about the rebate and create a relationship with HVAC dealers.	Have competed well against natural gas.	Different coops are involved in different ways. Some install loops, others sell the equipment.
Ontario Hydro (gvt, ONT)	Rebates were the driver. Targeted promotions were a key factor.	Avoided areas served by natural gas. Given current rates, GSHPs can't compete with natural gas in this area.	Strategy was to involve industry associations, manufacturers, contractors and dealers. Broad promotion of many types.
PSI/Energy (now CINergy) (IOU, IN)	Smart Saver program, which addressed customer concerns through a comfort guarantee and a compressor protection plan. Creating awareness and providing rebates.	No longer see availability of natural gas as a major factor. GSHP can compete with gas on operating costs in this service territory, partly because of Smart Saver rate.	Free loops contingent on contracts committing builder to 100% GSHP subdivision. Strong promotion. Early poor performance due to inadequate home insulation, bypasses, uninsulated ducts led to quality assurance through Smart Saver.
East Kentucky Power Cooperative*	(not stated)	Competes well against natural gas at $0.52/therm.	Units installed in homes of president and chairman of the board were helpful. 30% callbacks due to unqualified contractors.
KAMO Power (coop G&T)	Service reps of member coops helped develop infrastructure (contractors and drillers) and relationships with realtors and builders. Advertising helped spur consumer demand. KAMO also helped develop infrastructure.	Gas has proven to be a tough competitor not because of rates but because of first cost. Competes better against propane.	
Michigan Coop Association (coop assn., MI)	Building awareness in the market, especially testimonials. Referral process works best.	Low gas rates make it difficult. First costs are a problem for the GSHPs.	
Buckeye Power (coop G&T, OH)	Customer education, by far.	Most customers are in rural areas not served by gas, but where service territories overlap, GSHPs can compete.	Have set up a subsidiary that sells WaterFurnace to dealers, to allow them to get GSHP for their own customers.

Table C-2: continued

Utility, utility type, location	Perceived key factors in success	Experience competing against natural gas	Other
Detroit Edison (IOU, MI)	Sales people selling the benefits of GSHPs.	Have been successful and feel they are slowly changing mentality that automatically chooses natural gas heating. 70 to 75% of GSHP installations in areas where natural gas `s available at the road.	Work actively with builders.
Utility X (IOU)	Getting the infrastructure in place, specifically, having enough contractors to respond quickly to leads, and having contractors who understand the technology, as well as how to sell it and how to make a profit on it. The company is using a market transformation approach, basing their success on high quality installations. The contractors' heat pump association is instrumental in achieving this quality. Reducing duct leakage to a minimum is a key part of that quality.	Economics favor GSHPs in long term perspective. Markets better comfort and air quality relative to gas. Says natural gas companies in area unfairly inhibit competition in the new construction market. If one home in a subdivision is considering GSHPs, they may not provide service or may charge for connecting the development, rather than providing service free.	
Pennsylvania Power & Light (IOU, PA)	Training of contractors, both HVAC and loop installer, open houses for contractors, loop training made into a media event.	For most customers GSHPs are a better option because of the good infrastructure they've built up.	
Otter Tail Power (IOU, MN)	Aggressively pursued school market, which has opened commercial market and had spillover effect on residential market. Residential success occurs in pockets because of good contractors who push GSHPs.	Natural gas has not been a big impediment to GSHPs. Market has stagnated but more due to low level of new construction in service territory.	Economics. of GSHP better in commercial, and they have been successful there. Had to overcome A&E resistance by working with customers to generate demand.
United Power Association (coop G&T, MN)	Rebate, plus total commitment of member coops' staff in selling GSHPs.	Much slower acceptance if natural gas is available. Theirs are going mostly into LP areas.	Very involved. Promote heavily to customers, contractors. Became a distributor to address lack of infrastructure. Have greatly increased awareness. Typically size for 100% of load. Also, success in commercial market, expect to emphasize this more in the future.

Table C-2: continued

Utility, utility type, location	Perceived key factors in success	Experience competing against natural gas	Other
Tennessee Valley Authority (gvt G&T, TN)	For their HP program as a whole (not just GSHPs), the low interest loans, and inspection of every job. For the GSHPs, their special free loop promotion. Also, providing loop flush carts and fusion tools on loan to first-time contractors has been helpful. Distribution utility promotion is essential to growth of the market.	The distribution utilities that provide both gas and electricity are often not interested in GSHPs, depending on their gas rates.	
Jersey Central Power & Light	Stress recruiting and training of HVAC and loop installers in hopes of bringing costs down.	Very tough, due to first cost, primarily the loop. They try to do cash flow analysis with customers.	Only recently have begun to market again due to sensitivities around Three Mile Island incident.
Pennsylvania Electric (IOU, PA)	Infrastructure. Need well drillers and loop installers at reasonable costs, good installations. Training important. Mentioned IGSHPA support several times.	Going to be a long road. Primary target is oil in outlying areas, not gas. First cost big problem against gas, but have installed units in natural gas areas.	
Southwestern Illinois Electric Coop (COOP, IL)	Buy in quantity and get a good price, then sell to members at cost. They also have a list of preferred contractors available to do the installations.	Contact didn't have any information on this question.	The utility does the heat loss calculation and also does a system analysis check after installation.
Black Hills Power and Light	Long range energy savings. First cost is an obstacle.	Project still new, but total energy costs (heating, cooling, DHW) are 20 to 30% below natural gas.	
Northern Indiana Public Service (IOU elec/gas, IN)			Contact noted that they are not required to do DSM.
Virginia Power & Light (IOU, VA)	Still a pilot, but using the desuperheater makes GSHP an attractive option. (VA has only 3000 to 5000° F-days).	Almost all test sites in natural gas areas. Energy bills for GSHPs have been outstanding. Problem is the first cost; when loop price comes down, there'll be more installations.	
Public Service of Oklahoma (IOU, OK)	Not successful. First cost too high for market. Contractors talking against the program.	At $0.45/therm, it's a difficult market to penetrate.	Subcontractors were incompetent.

* information from presentation at ASHRAE winter meeting

Appendix D: National Activities

In the early phases of the market assessment, we conducted exploratory interviews with industry players around the United States and Canada. The primary purpose of these interviews was to assure that all key issues were identified prior to conducting the more structured interviews with manufacturers, utilities, and key players in Wisconsin. An additional objective was to identify the strategies and activities that national organizations are currently pursuing or plan to pursue to promote new heat pump technologies. We summarize these strategies and activities below.

Geothermal Heat Pump Consortium

The Geothermal Heat Pump Consortium, Inc. (GHPC) is a nonprofit corporation. (Geothermal heat pump is a synonym for ground-source heat pump.) It held the organizational meeting of its Board of Directors in November, 1994 and its first General Membership meeting in early February, 1995. Utilities are the voting members of the Consortium and are required to pay dues of $0.10 per residential and commercial customer up to a maximum of $50,000. (Members of the Electric Power Research Institute can pay for GHPC membership through EPRI's Tailored Collaborative program, which effectively cuts in half the cost of dues.) Nonvoting members include manufacturers, trade allies and utility organizations, and they do not pay dues. Manufacturers cannot serve on the Board due to antitrust concerns.

As of late May, 1995, the voting membership included about 75 electric utility operating companies. The group has formal liaisons with the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Consortium for Energy Efficiency.

The Executive Director of GHPC is Paul Liepe, formerly of Atlantic Electric. The GHPC has formed three standing operating committees to address the three primary market barriers for GSHPs:

- First Cost Competitiveness Operating Committee

  Dave Wadsworth, Duke Power Company, chair.
  This group will focus on alternative financing options, model DSM/IRP programs, R&D to reduce drilling and ground loop costs, and R&D to improve GSHP system performance.

- Technology Confidence Building Operating Committee

  Jerry Brandom, Public Service Company of Indiana (PSI), chair.
  This group will focus on "development of a model marketing program,

utility support services, demonstration programs, and consumer awareness activities." (*Earth Comfort Update*, Vol. 1, No. 1, November, 1994)

- Infrastructure Strengthening Operating Committee

  Nancy McMahen, National Rural Electric Cooperative Association, chair. This group will focus on technician training and certification, establishment of regional training centers, development of design tools, and legislation, regulations and standards.

In addition, there are two standing advisory committees:

- Technology Advancement

  This group will "provide input and advice on research and development, and technology advancements." (*Earth Comfort Update*, Vol. 1, No. 1, November, 1994)

- Allies and Manufacturers

  This group will "provide input to the Board of Directors and the Executive Director on technical, market, cost and legal issues." (*Earth Comfort Update*, Vol. 1, No. 1, November, 1994)

The GHPC's first major initiative is the National Earth Comfort Program, a "Geothermal Heat Pump Market Mobilization and Technology Demonstration Program."[1] The goals of the program are:

- To increase sales of GSHPs from 40,000 per year to 400,000 per year (from approximately 1% to 12% of the space heating market).
- To reduce greenhouse gas emissions by 1.5 million metric tons of carbon equivalents annually by the year 2000.
- To develop a competitive, self-sustaining industry to produce, market, install and service GSHPs on a national level.

Under this program, the GHPC and the U.S. Department of Energy (DOE) have agreed to provide $100 million in funding for GSHPs over a six year period, $35 million from DOE and $65 million from industry. DOE has already made a provisional award of $35 million, and will sign a legally binding contract (subject to annual Congressional approval) once the GHPC has completed a detailed work plan for the entire project.[2] The industry contribution consists of

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[1] National Earth Comfort Program Geothermal Heat Pump Market Mobiliation and Technology Demonstration Program: A Proposal for an Industry-Government Collaborative. GHPC, 1994.

[2] The DOE funding comes from funds for Action # 26 of the President's Climate Change Action Plan, which states that "The Department of Energy will form a collaborative with private industry to accelerate market acceptance of renewable technologies and to conduct industry cost-shared demonstrations of renewable energy technologies in multiple regions of the U.S. DOE will fund utility/independent power industry consortia

funds already being spent by industry—expenditures projected to total over $100 million based on 1994 trends were scaled back to a conservatively estimated $65 million. The National Earth Comfort Program proposal to DOE requested $5 million for 1995, focused on the technology confidence-building and infrastructure-strengthening activities. Although there are always uncertainties about federal funding, it appears that collaborative efforts with significant industry involvement are among those activities most likely to survive budget cuts, and that funding of the GHPC project is relatively secure.

As part of the same initiative, the GHPC has also submitted a proposal to the U.S. Environmental Protection Agency (EPA) for $1.4 million in funding from 1995 through 1997 to fill gaps in the DOE contract. Specifically, the EPA funding would focus on:

- National Information Resource Center

  The center would maintain a data base available to the public, builders, architects and engineers, and others covering such information as manufacturers, products, certified contractors, utility programs, and research and development activities. The information would be available through the Internet and through a toll-free telephone number. If funding is approved, EPA anticipates that the center might be operational by the end of 1995.

- Innovative financing mechanisms

  EPA funding would be used to examine strategies to minimize first costs or to spread the first costs over the life of the equipment to provide a zero or positive cash flow to the customer. A request for proposals would probably be issued to consulting companies, and promising strategies identified by the winning contractor would be tested in utility pilot programs.

As of late May, 1995, the EPA proposal had not been approved, but approval was expected by late June, 1995.

The overall strategy of the National Earth Comfort Program is to create a high-volume market, leading to reduced costs and increased awareness and confidence. The strategy will be implemented through coordinated regional and national activities. Within each of six regions, "training centers will be set up and demonstrations of marketing and deployment programs will be conducted. The model marketing programs will demonstrate how similar utilities can effectively promote GSHP technology, strengthen or establish the sales and service infrastructure, and influence product costs to ensure competitiveness. Alternative methods to increase volume will be tested and proved through these demonstrations." These may include "alternative financing techniques, ground loop installation configurations, advertising campaigns, and training and

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to pool purchases of nearly-commercial renewable systems. DOE will also join with these consortia and States in cost-shared demonstrations of larger renewable energy systems" (quoted in GHPC 1994).

certification schemes" (GHPC 1994). The national level activities will "support technology R&D to reduce costs, develop standards and generic tools, educate opinion leaders, and provide national-level visibility and credibility" (GHPC 1994).

As of the middle of 1995, the program's operating committees were preparing statements of work for requests for proposals to accomplish the early tasks in the program. DOE and EPA are expected to provide leadership, resources, and credibility. According to Liepe, continued federal involvement is essential to ongoing participation for some members of the Consortium.

U.S. Government Activities

The U.S. Department of Energy's primary activity relating to GSHPs at this time is funding of the GHPC's National Earth Comfort Program. DOE has also received $2.6 million from the U.S. Department of Defense to introduce GSHPs at defense facilities. The project is managed by Sandia National Laboratories and includes collaboration and cost-sharing with local electric utilities.

In addition to the GHPC, EPA is involved with several other GSHP initiatives. They launched an Energy Star program for GSHPs on April 10, 1995. The equipment specifications are shown in Table D-1:

Table D-1: Equipment specifications for EPA Energy Star ground-source heat pump program

	Through 12/31/96		After 1/1/97	
Product Type	EER*	COP*	EER*	COP*
Closed/open loop	13	2.8	16	3.4
Closed/open loop with integrated WH	13	2.8	14	3.0
Direct expansion	13	3.1	16	3.7
Direct expansion with integrated WH	13	3.1	14	3.3
a) GSHPs shall include a desuperheater or integrated water heating.				
b) GSHPs shall have a 2 year manufacturers limited warranty or 5 year warranty on major components.				

*Specifications in this table apply to single-speed models. Multispeed models may be qualified based on averaging the high-speed and low-speed efficiencies.

Manufacturers have agreed to provide training for distributors and contractors to assure proper installation and operation of the equipment. EPA will allow

manufacturers to use the EPA Energy Star logo in their advertisements. In addition, EPA will promote the program.

In late 1995, EPA expects to release a booklet providing guidance to code officials and state energy officials on environmental issues relating to GSHPs, including antifreeze, well boring, and discharge of water. EPA is also providing a grant to Stockton State College to assess the microbiological effects of changes in ground temperature due to GSHPs. The project is expected to be completed by spring of 1996. Findings from the Stockton State study will be incorporated in a revised version of the booklet in 1996. The manager of all of the EPA activity is Steve Offutt.

Consortium for Energy Efficiency

The Consortium for Energy Efficiency is an organization which seeks to create or expand viable markets for highly efficient technologies. By encouraging utilities to commit their support to incentive programs somewhat with standardized equipment requirements, the consortium's programs help to provide the necessary economic justification for manufacturers to produce and market these products. In cooperation with the National Earth Comfort Program, the consortium has developed a program for residential GSHPs which has as its goal expansion of production and installation of GSHPs to 400,000 units/year by the year 2000, as well as improvements in sales-weighted efficiency. The consortium believes that at that level of sales, the GSHP market should then become self-sustaining.

The program covers single-phase GSHPs with cooling capacities up to 135,000 Btu/h (about 11 tons). It allows inclusion of all ground-coupling methods, open loop, closed loop, and even direct expansion, once a test procedure is available. Highlights of the program's four components are given below[3]:

[3] From Version 4.1, November 22, 1994. The final version approved by the Board included a few changes to add flexibility or clarification, but this version was not available as of late May, 1995.

I. System Design Component

A. Installation of full backup resistance heat is not recommended. Resistance heat should be provided in situations where the building's design heat loss is so much greater than the design heat gain that sizing for heating has a significant negative impact on system economics or causes inadequate summer dehumidification. Use of multispeed systems which operate during the summer at low speed only should be considered as an alternative solution.

B. Heating and cooling loads must be determined using ACCA Manual J or an approved equal.

C. Equipment and ducts must be sized and installed according to ACCA Manuals S and D respectively. Equipment size must be within 15 percent of Manual J recommendations.

II. Equipment Efficiency Component

A. Equipment efficiency thresholds are based primarily on certified ARI ratings for EER and COP, with additional credits for water heating and variable speed operation.

B. Efficiency tiers for closed-loop GSHPs are shown in Table D-2.

C. Utilities are encouraged to use the same tier levels for other ground coupling methods (open loop, DX) but CEE recognizes that appropriate thresholds may be application or climate-specific.

D. In order to participate in the program, a utility must offer support for Tier G1 equipment and offer financial incentives of some type (rebates, loans, leasing, special rates) for Tier G2 equipment. Utilities are encouraged to offer progressively higher incentives for each of the three efficiency levels, as well as for water heating and variable-speed features.

E. The choice of whether to pay incentives to customers, dealers or manufacturers is left to the discretion of the utility.

F. Participating utilities are encouraged to commit to providing incentives through the end of 1999, to give manufacturers the confidence required to design and manufacturer higher-efficiency equipment.

III. Inside Equipment Installation Component

A. Utilities may adopt, reject or modify this component of the program at their discretion, although CEE encourages its adoption to provide consistency of program design and reductions in system energy use. The following requirements would apply if the component were to be adopted in full.

B. Each equipment installation crew must have at least one person who has completed an approved training course in heat pump installation. Installers should be trained through an RSES heat pump certification course or an equivalent program offered by a manufacturer.

C. In new duct systems, all ducts located outside the conditioned space must be sealed with mastic or mastic and tape, and duct leakage tests should show leakage less than 120 cfm at 50 Pascals. For existing duct systems, only the readily accessible ducts must be sealed.
D. Contractors must confirm that air flow meets the manufacturer's recommendations.
E. Filters and indoor coils must be readily accessible for replacement or cleaning.
F. Refrigerant systems must be properly piped, charged and leak-tested.
G. A number of requirements and recommendations are given for thermostat type, installation and adjustment.
H. Appropriate information on system operation and control must be provided to the customer.
I. Procedures for assuring compliance with the equipment installation specifications are to be established by the individual utilities.

IV. Outside Loop Installation Component

A. According to CEE staff, this component is optional.
B. Each crew must include at least one member trained and certified by an appropriate organization. For closed-loop installations, the crew member must be certified by the International Ground Source Heat Pump Association.

Table D-2: Consortium for energy efficiency ground source heat pump efficiency tiers

Tier	EER (Cooling)	COP (Heating)
G1	13.0-15.9	2.80-3.39
G1 as of 1/1/97	14.0-15.9	3.00-3.39
G2	16.0-18.9	3.40-3.99
Advanced	19.0 and higher	4.00 and higher
Premiums for additional features:		
Water heating (desuperheater or triple function)		
Variable or Multiple-Speed Blowers or Compressors		

As of late May, 1995, CEE had not yet begun to compile a list of utilities endorsing or adopting CEE's GSHP program. CEE expects the GHPC to be the main driver for increased use of GSHPs, with CEE's program serving a complementary role.

International Ground Source Heat Pump Association (IGSHPA)

The International Ground Source Heat Pump Association (IGSHPA), located on the campus of Oklahoma State University, was established in 1987 to advance GSHP technology. IGSHPA offers a wide range of services and tools, as outlined below:

I. Education and Training
   - A. Approximately Monthly Installer Certification Workshops (3 days)
   - B. Train-the-Trainer Workshops (5 days)
     Trains instructors working for manufacturers, utilities, universities, contractors or others to conduct certification training to prepare installers for the IGSHPA certification exam.
   - C. Annual technical conference and teleconferences.
   - D. Training videos, manuals, other publications, including
     1. Closed-Loop/Ground-Source Heat Pump Systems Installation Guide
     2. GSHP Systems: Flushing, Purging and Pressurizing (video)
     3. Grouting Procedures for Ground-Source Heat Pump Systems
     4. Layout, Fabrication and Installation of SLINKY Ground Heat Exchangers
     5. Proper Drilling and Trenching Procedures for GS-System Installations (video)
     6. Soil and Rock Classification for the Design of Ground-Coupled Heat Pump Systems: Field Manual
     7. Soil Identification for GS-System Installation (video)
   - E. Software
     1. CLGS-Ground Heat Exchanger Design Program
     2. PC-Programs for Dimensioning of Heat Extraction Boreholes
     3. Professional Ground Loop Heat Exchanger GLHEPRO software for sizing of commercial systems

II. Information Network
   - A. Quarterly newsletter
   - B. Clearinghouse of case studies
   - C. Member directory

III. Industry Standards
   - A. *Closed-Loop/Ground-source Heat Pump Systems Design and Installation Standards*

IV. GSHP Promotion and Publicity
   - A. News releases and articles disseminated to national newspapers and trade press.
   - B. Marketing materials and videos available at low cost to members.
   - C. Assistance in developing news releases and advertising.

V. Consumer Quality Assurance through the GSHP Registration Program
   A. Provides customers with industry support in case a manufacturer or contractor goes out of business.
   B. System specifications are permanently stored at IGSHPA in a confidential file.
   C. If owners cannot reach a particular dealer, IGSHPA will work through other association members and/or manufacturers to help the owner obtain service or warranty support.

IGSHPA's director, James Bose, is on the board of directors of the Geothermal Heat Pump Consortium. He expects IGSHPA's role in the National Earth Comfort Program to focus primarily on training and standards.

Air-Conditioning and Refrigeration Institute and Canadian Standards Association

The organization operating the certified rating programs for GSHPs in the U.S. is the Air-Conditioning and Refrigeration Institute (ARI). ARI publishes certified ratings for both closed-loop and open-loop applications. (Open-loop systems are also known as ground water heat pumps.) The primary difference between the standard rating conditions for the two applications is the entering fluid temperature:

I. ARI 330-93 for Ground Source Closed-Loop Heat Pump Equipment (GSHP)

   standard rating conditions, cooling:
      entering fluid temperature (loop): 77°F
   standard rating conditions, heating:
      entering fluid temperature (loop): 32°F

II. ARI 325-93 for Ground-Water Source Heat Pump Equipment[4] (GWHP)

   standard rating conditions, cooling:
      water source (high temperature):70°F
      water source (low temperature): 50°F
   standard rating conditions, cooling:
      water source (high temperature): 70°F
      water source (low temperature): 50°F

ARI publishes its ratings semiannually in the *Directory of Certified Applied Air-Conditioning Products.*

The Canadian Standards Association also publishes certified ratings for "Energy Efficiency Verified Ground and Water Source Heat Pumps" under Standard

[4] The low temperature ratings would be more relevant to open-loop ground-water source heat pumps in Wisconsin.

CAN/CSA C446. As of January, 1995, these ratings were available only in the form of a computer printout, rather than a prepared publication. Standard C446 is harmonized with ARI Standards 330 and 325, and ratings are published for the same fluid temperatures for closed-loop systems, and for the low-temperature water source only for open-loop systems.

ARI and CSA recognize each others' ratings. One difference between them is that ARI uses independent test labs, but CSA qualifies the manufacturers' own laboratories. For initial certification, ARI selects one unit at random from the manufacturer's stock or production line for testing by an independent laboratory. They then do scheduled random testing of 30 percent of models every year. The unit tested is again selected at random from the manufacturer's stock or production line. The manufacturers are supposed to do their own testing as well, but ARI verifies it using independent laboratories. CSA qualifies manufacturers' laboratories by reviewing their procedures or observing a test once or twice a year. They can at any time select a unit for testing by an independent laboratory, if they have reason to suspect the ratings.

Nearly all of the manufacturers included in the market assessment have ARI certifications for their products (see Equipment, Trends, and Markets) and many have CSA ratings as well. Econar has only a CSA rating. Some manufacturers feel that ARI certification should be required by utility DSM programs. They prefer the independent testing, and also feel that the fact that manufacturers make the investment in ARI certification ($10,000 to $20,000 per unit, according to one source) demonstrates financial stability and long-term commitment.

A number of manufacturers (interviewed later in the project) indicated that their ARI 330 models and their ARI 325 models are the same units, simply rated at different conditions (Bard, Econar, Hydro Delta[5], Trane, WaterFurnace). Others indicated that they are not the same. For example, Florida Heat Pump uses capillary tube expansion devices for their open-loop systems, but uses thermostatic expansion valves for their closed-loop systems, which operate over a wider range of conditions. Climate Master's closed- and open-loop systems units are also separate lines designed for different operating conditions. Tetco's closed-loop line (not yet certified as of January 1995) has a variable speed fan motor, while their open-loop line does not, but they were expecting to add this feature to their open-loop line eventually.

CSA has also published a standard for *Design and Installation of Earth Energy Heat Pump Systems for Residential and Other Small Buildings* (CAN/CSA-C445-M92). Ontario Hydro indicated that they were actively involved in the development of this standard (see Equipment, Trends, and Markets). The standard addresses "system design, equipment selection, minimum installation

[5] Hydro-Delta's GWHP has a freeze protection device that turns it off below 32□F, and this device is disconnected for their GSHP models. Otherwise, they are identical.

requirements, test protocol, and information to be provided to the user and the equipment manufacturer."

Environmental Financial Services

In late spring of 1995, Environmental Financial Services, of Richmond, Virginia, announced a major new financing program called "HELP 2000" (Home Energy Loan Program 2000). The company developed and is marketing the product. Capital is being provided by Saxon Financial, an affiliate of Resource Mortgage Capital, a New York Stock Exchange company. Loan origination and servicing is provided by Volt VIEWtech, an energy service company. Environmental Financial Services is marketing the program to utilities, manufacturers and large distributors, and contractors. It is a turnkey program designed to overcome the first-cost barriers to purchase of high-efficiency energy-consuming equipment. Additional services that can be provided include "certification and sales training for contractors and installers, marketing and promotional assistance, field inspection services, and information management." While it covers a broad range of energy-efficiency measures, it was designed in response to the first-cost problems of GSHPs. Loan terms vary depending on the measure, but terms up to 15 years are available for GSHPs. Loan amounts range from $2500 to $25,000. Rates are reportedly very competitive; with fixed rates set at 550 to 700 basis points over the rate for like-term Treasury Notes at the time of the loan. Utilities can buy down the interest rate for selected measures if they choose. The loans are fully assumable if the homeowner moves. According to the marketing materials, most loans are approved in less than a day, and the sponsoring organization (utility, manufacturer, etc.) has no bad debt risk. Up to $35 million per year is currently available. EFS is the first lender to be recognized with an EPA Energy Star. They also have an endorsement from the Edison Electric Institute. They expect to expand this program into the commercial and industrial market in the near future. This product appears to be very timely, given the large number of utilities that are reconsidering the wisdom of cash rebates in a deregulated environment.

York Triathlon Consortium

The York Triathlon Consortium was established in 1991 by the Gas Research Institute, York, and the American Gas Cooling Center. According to a September, 1994 consortium publication *Speaking About Triathlon,* the goal is to provide a "risk-sharing partnership for market introduction of the York Triathlon Gas Heating and Cooling System product line." The long mission of the Consortium is to build sustainable U.S. and Canadian markets for the Triathlon. The short-term goals are:

1. Sell 25,000 Triathlon units in three- and four-ton cooling-capacity sizes in three-year period.

2. Promote widespread gas utility market support for the marketing and sales transactions of Triathlon dealers.

Gas industry consortium members pay specified York factory market development support payments on units sold to their gas customers.

As of September, 1995, members of the consortium included the manufacturing team: York International, Briggs and Stratton, and Johnson Controls; 150 gas and gas-electric utilities and pipeline companies; and GRI, the American Gas Cooling Center and the American Gas Association. The Consortium has a Managing Committee chaired by an executive of Brooklyn Union Gas and composed of 16 Region Champions and representatives from the each manufacturer and each gas industry association. Each region of the country has a Region Champion, one of whose goals was to meet with all the gas utilities in their region and solicit their financial support. For the area including Wisconsin, the champion is Minnegasco, in Minneapolis, MN.

The financial support provided by utilities takes the form of a "market development support payment" to the manufacturers for each unit sold to their gas customers, for the first 25,000 units or so. These payments are intended to write down the initial high price of the units to something close to a mature market price. The dollar amount of the payment varies based on the total volume sold nationally. The three-year program started in August, 1994 when the units became commercially available. According to *Speaking About Triathlon,* the payment for the first 2000 units sold is $1200; the payment then decreases to $1000 for the next 8000 units and $270 for the next 15,000 units. In areas where the pipeline company is a member, the payment is generally split equally between the pipeline company and the local distribution company. The money is paid into a central fund and then is divided among the manufacturing partners. After 50,000 units are sold, the manufacturers will start paying back a royalty on each unit sold, which will go into the fund and then back to the utilities that contributed. York will sell the Triathlon to anyone, even if their utility is not in the consortium, but as there is no subsidy in such cases, the customer would be charged the full price.

The utility members agree to support the market introduction of the Triathlon, but there is no consistent marketing or incentive arrangement that all utilities must follow. Most utilities are not providing any rebate beyond what they give to the Consortium, unless it is the minimal amount (e.g., $100 or $150) that they provide for a high efficiency furnace but at least some utilities are giving rebates of up to $700 per ton. Some utilities offer lower gas rates. These are typically applied to the entire gas load during summer months, rather than to a separate meter that meters only the heat pump use. Other utilities are providing financing with no money down and zero percent interest, paying for up to 50 percent of

the unit cost for employee installations, paying for the optional five year labor warranty or providing other inducements. Utilities are also doing coop advertising with the York distributors.

The Triathlon is distributed through the regular York distributors, who recommend and train selected dealers. The units can only be installed by trained dealers.

According to the Gas Research Institute, 1500 units had been installed or committed by June, 1995, including 1000 units committed to the subdivisions of a single builder in the service territory of Southwest Gas.

Gas Research Institute

GRI is a member of the York Triathlon Consortium. In addition, they are working with York on continued research and development in three areas:

- Expanding the product line to larger sizes. This will involve identifying a larger engine (for capacities of five tons and up) that is qualified for service of 40,000 hours.
- Reducing NOX emissions.
- Investigating alternative refrigerants. The current Triathlon runs on HCFC-22, which is scheduled for mid-term phase-out.

At one time, GRI had also worked with a Japanese manufacturer to try to bring their unit to the U.S., but the exchange rate made the price prohibitive. In addition, the unit was designed for a ductless system, had no indoor air-handling unit, and had controls unsuitable for the American market.

GRI is also involved in research on a generator-absorber heat exchanger with the U.S. Department of Energy and Carrier.

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595 Science Drive
Madison, WI 53711
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Fax: 608.238.8733
Email: ecw@ecw.org
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