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THE GEOTHERMAL HEAT PUMP CONSORTIUM'S NATIONAL EARTH COMFORT PROGRAM

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PROJECT BACKGROUND AND STATUS

In 1990, DOE identified Geothermal Heat Pumps (GHPs) as a major renewable energy technology that offered the nation significant energy savings. In 1993, the U.S. Environmental Protection Agency concluded that geothermal heating and cooling technologies represented a major opportunity to reduce air pollution through use of renewable energy. EPA also found that geothermal technology was becoming increasingly competitive and provided excellent comfort, reliability and aesthetic amenities. EPA and DOE recommended the formation of a national, utility-based consortium to take advantage of this opportunity for cost-effective pollution prevention.

The U.S. Department of Energy immediately began laying the groundwork for such a market mobilization as part of Action 26 of President Clinton's Climate Change Action Plan of October 1993. DOE worked with the Edison Electric Institute, EPA, the Electric Power Research Institute (EPRI), International Ground Source Heat Pump Association, the National Rural Electric Cooperative Association and industry to incorporate the Geothermal Heat Pump Consortium (GHPC) in late 1994 to implement the National Earth Comfort Program.

The GHPC has recruited over 300 utilities as participants through 52 dues-paying holding companies, generation and transmission (G&T) cooperatives, and power administrations (Bonneville Power Administration and Tennessee Valley Administration). In addition, 467 manufacturer and trade allies are now part of the Consortium, as well as 13 national organizations and 28 international organizations. 1997 represents the third year of implementation of GHPC's **National Earth Comfort Program.**

PROJECT OBJECTIVES

Geothermal heat pumps substantially reduce heating, cooling and water heating bills, typically have lower maintaintence costs, and cause less pollution than other available heating and cooling technologies. Residential geothermal systems usually have higher capital costs than conventional technologies while geothermal systens in commercial size buildings are often very competitive on first cost. However, consumers and commercial facility managers know little about them, and lack a clear understanding of their benefits. Contractors, architects and engineers seldom promote them. The Geothermal Heat Pump Consortium is a partnership of utilities, geothermal manufacturers, HVAC vendors and public agencies whose objective is to overcome these market barriers and increase market penetration of geothermal heat pumps tenfold to 400,000 per year by the turn of the century.

Technical Objectives

- Reduce cost of loop installation by 25-50% by the end of this decade through development of new loop, drilling and trenching technologies.

- Increase number of architects, engineers, HVAC contractors and builders that are trained in the design and installation of geothermal systems, develop advanced design software, incorporate energy efficienct building envelope designs to reduce energy load, and design for refrigeration, icemakers and freezer applications where feasible.

- Effectively demonstrate the economic, environmental, comfort and reliability benefits of geothermal systems to consumers, architects, engineers, commercial facility managers, and public officials/opinion leaders.

- Develop and implement "technology transfer" of effective market-pull mechanisms to be employed by utilities, manufacturers and vendors.

Expected Outcomes

- Advance current loop designs or develop new loop systems that reduce installation time and cost and perform as well or better than today's prevalent loop configurations.

- Develop improved loop installation procedures, drilling and trenching equipment that reduce installation time and cost.

- Successfully demonstrate and document geothermal system reliability, lower maintenance costs, and energy performance in a variety of residential, commercial and public-sector applications.

- Develop at least 5 regional training centers that utilize the most up-to-date training facilities and curricula, and successfully train thousands of technicians in the effective sale and installation of geothermal systems.

- Stimulate improvement and benchmarking of residential and commercial geothermal design tools.

- Demonstrate and transfer effective market-pull technologies and strategies for utilities through Model Utility Geothermal Program demonstrations.

- Achieve widespread recognition of geothermal as a viable, desired heating and cooling technology among homeowners, landlords and facility managers.

- Increase employment opportunities in the drilling and excavating industries.

APPROACH

Analysis of the HVAC market identified three major types of barriers to the increased market penetration of geothermal heating and cooling systems in the U.S. As a result, three Operating Committees were formed within GHPC to formulate, coordinate and implement aggressive responses to each of these areas.

First Cost Competitiveness

Geothermal systems cost as much as $2000-$5000 more than conventional heating and cooling systems in a typical residential application. Similarly, in most commercial applications geothermal costs more than conventional technologies, although in some applications geothermal systems can have similar or even lower first costs. Thus, even though their low operating and maintenance costs lead to lower overall *life cycle* cost compared to conventional technologies, the first cost premium associated with most geothermal systems constitutes a significant market barrier. The First Cost Competitiveness (FCC) Committee's approach to reducing the capital cost of geothermal systems involves documentation of new, improved loop configurations, installation techniques, drilling/trenching equipment and developing innovative financing packages. It also is supporting technical work to improve the understanding of soil conductivity, grout performance, and advanced (hybrid and integrated) system design and performance.

Infrastructure Strengthening

Today there are insufficient numbers of distributors, contractors, architects, engineers, builders and Realtors who know and recommend or install geothermal systems. The Infrastructure Strengthening (IS) Committee's goal is to create a market infrastructure of trained and experienced contractors, developers, architects and engineers sufficient to achieve GHPC's annual sales goal of 400,000 units by 2001 with advanced residential and commercial design tools, competitive pricing, a high degree of installation quality and reliability, and support from a rational framework of environmental, licensing, building code and other regulations.

Technology Confidence Building

A key barrier to geothermal technology is the fact that, even though it has been technically proven through the installation of over 250,000 systems to date, it is still unknown and unproven to end users in many markets. The goal of GHPC's Technology Confidence Building (TCB) Committee is to help build a self-sustaining market for geothermal by effectively communicating its benefits to all important market stakeholders. TCB's approach is to provide cofunding for Model Utility Geothermal Program Demonstrations and Pilots and to provide direct assistance to utilities designing and implementing regional geothermal programs. Through support for innovative utility program design, demonstration and transfer, GHPC will help its member utilities learn which program designs, communication and public education strategies are most effective in yielding demand for geothermal systems. In return, cofunded utilities will provide their own significant resources to the effort, and share program designs, deliverables and lessons learned. GHPC will complement this with a national effort to increase awareness about geothermal among key market influence groups, such as commercial building developers, real estate professionals, home builders, appraisers, contractors, architects and engineers.

RESEARCH RESULTS

During 1996, GHPC began full-scale implementation of the National Earth Comfort Program. The following tasks were carried out:

Field Demonstration of New Loop Technologies: During 1995, GHPC initiated a field demonstration of a patented, "multiple parallel" loop configuration technology for both vertical and horizontal ground loops. Developed by ClimateMaster, this technology has the potential for reducing loop installation costs by 25% or more without compromising performance, while lifting much of the responsibility for on-site

design and fabrication from the installation contractor. ClimateMaster is carrying out laboratory and computer studies of performance and manufacturability. They also installed the loop at several sites during late 1995 and 1996, and are monitoring its performance.

GHPC also entered into contracts with member utilities to assess other innovative ground heat exchange technologies. With the support of both GHPC and the Electric Power Research Institute (EPRI), Virginia Power is collecting field data to assess the use of fly ash, a by-product of burning coal at power plants, as a flowable fill component for horizontal loop fields. Results are expected in 1997. Another GHPC member, Pennsylvania Power & Light (PP&L), is collecting performance data on a plate frame collector that transfers heat between a large commercial building and a non-potable source (water treatment plant effluent stream). Results of this demonstration could help proliferate low-cost GHP systems in urban areas where non-potable sources of water (such as rivers, sewage streams, etc.) are available. Data collection will continue through 1997.

Data Collection and Commercial Case Study Development: Analysts throughout the geothermal industry have identified the commercial sector as a major opportunity for growth in market penetration during the late 1990's. Geothermal heating and cooling systems usually have lower life cycle operating and maintenance costs than conventional technologies; in some cases, they have comparable or even lower first costs. However, information to educate customers and practicioners in commercial markets has been insufficient. Thus, in 1996 GHPC intiated several projects to close the informational gap. Caneta Research was engaged to collect available high-quality data and produce detailed case studies targeted at architects, engineers, and commercial facility managers. At the end of 1996, GHPC moved to expand this work to include an analysis of maintenance costs at existing installations. GHPC expects delivery of the Caneta research by late Spring 1997.

GHPC also initiated contracts with two firms that specialize in field performance monitoring (CDH and AIL) to select and begin full-year monitoring of a number of commercial installations. These projects will produce high-quality performance and monitoring data leading to effective case studies for strategically-selected commercial installations in a variety of locations, some of which will evaluate innovative ground heat exchanger and mechanical system configurations. GHPC will begin publishing research results soonn after the end of each location's performance monitoring, in 1998.

ASHRAE Study on Antifreezes: In 1995, GHPC partnered with ASHRAE in studying the environmental impacts of loop antifreeze materials. The report was finalized at the end of 1996, and is expected to provide valuable guidance to ground water regulators and the loop industry. It will also be a major input to a national consensus-building process to determine voluntary, industry loop installation guidelines, which is being launched by the National Ground Water Association with GHPC support (next page).

Compilation of State and Local Codes and Regulations: In 1994 EPRI and the National Rural Electric Cooperatives Association (NRECA) initiated research at University of Idaho to compile and analyze state drilling regulations. GHPC has expanded this effort by providing on-line access to regulations at GHPC's World Wide Web site; by extending the research to include local jurisdiction regulations and open-loop borehole regulations; and by compiling and analyzing state and local building codes for their treatment (if any) of geothermal systems. Test of all regulations is found on the University of Idaho World Wide Web page, which is hyper-linked to GHPC's home page.

Model Practices for Vertical Ground Heat Exchangers: During 1996, GHPC initiated a contract with the National Ground Water Association (NGWA) for it to conduct a consensus-building process and publish model practices for vertical ground heat exchanger installers. This would emulate past work performed by NGWA in partnership with EPA on model water well drilling practices, which resulted in a document that became a solid foundation for both installers and regulators. NGWA plans to have the process completed by mid-1997.

Research on Pumping Pressure and Head Loss: Lack of information on the pressure drop associated with geothermal loop components (the pipe, pipe joints, and fittings, such as U-bends and tees) can lead to gross oversizing of circulating pumps, thereby increasing capital cost and reducing operating efficiency. GHPC and Phillips Driscopipe, a manufacturer of geothermal loop pipes, cofunded work at University of Alabama that led to publication of that vital information for commercial geothermal system designers.

Improved Residential Design Tools: During 1996, GHPC conducted several subcontracts to strengthen treatment of geothermal heating and cooling systems in residential design tools. Wrightsoft (formerly Wright Associates) was engaged to plan the design of a residential software suite that combined geothermal system performance estimation with its popular existing residential software packages (Right-J,. Right-Loop). By the end of 1996, Wrightsoft was entering the stage of implementing the plan in its proprietary software packages. A second subcontractor, Architectural Energy Corporation (AEC), was engaged to integrate a geothermal heat pump module in REM/*Design* and REM/*Rate* software. By the end of 1996, AEC was running the latest edition of ESPRE software to develop the modules needed.

Modeling Long-Term Thermal Effects on Loop Fields: Long-term thermal buildup in large, closed-loop commercial installations is a significant design issue for geothermal system designers. Obviously, the objective of commercial designers is to ensure long-term stability of ground temperature (and therefore system performance), without grossly oversizing the loops. This work is to be completed by March 1997.

Expansion of Technical Training: GHPC conducted several subcontracts to initiate or improve geothermal system training at several sites during 1996. The International Ground Source Heat Pump Association (IGSHPA) was awarded a subcontract to improve CAD-based training in its existing program. Stockton State University in New Jersey and South Dakota State University were engaged to expand and improve their training efforts. In addition, several new regional training centers were established: the Geothermal Energy Association's center in Davis, CA; the Keystone State training program at four vocational schools spread out across Pennsylvania; a new geothermal training curriculum at the existing Alabama Power Company Heat Pump Training Center in Alabama; a new geothermal training center developed in partnership with the Air Conditioner Contractors Association (ACCA) at Ferris State University, MI; and the Alternative Energy Corporation's new training center in Raliegh, NC. Some of the training centers started offering training in 1996; all are expected to be in full operation during 1997.

Public Awareness and Education: During 1996 GHPC formulated a strategy for a national and regional public awareness and education campaign. The objective is to raise awareness about geothermal among consumers, installers, designers, architects, engineers, builders and other key groups. The first need identified was for a single, national brand name for the techology, which is known by a confusing array of terms currently. By year's end, GHPC was completing that task, as well as preparing a large number of information products and deliverables for use by its utility and trade ally members.

Cofunded Utility Model GHP Program Pilots and Demonstrations: During 1996 GHPC expanded the number of cofunded utility programs designed to implement and disseminate new and innovative program designs and strategies. Many new projects emphasizing innovations in system financing, providing technical demonstrations of geothermal applications, or targeting key market segments were initiated. These projects were at different stages of start-up or implementation by the end of 1996. A summary table of the GHPC utility projects follows:

Geothermal Heat Pump Consortium Pilot Projects

Utility	Project Description	GHPC Cofunding	Utility Cofunding	Total Project	Utility/GHPC Funding Ratio
Duke Power	Residential New Construction w/out Rebates	$200,000	$510,591	$710,591	2.55
East Kentucky Power	Schools; Implemented by ESCO	$165,000	$345,000	$510,000	2.09
Gulf Power	Target Commercial Market; Demonstrate Technical Feasibility	$134,500	$424,200	$558,700	3.15
KCP&L	Community Revitalization/Special Tax District with Sustainable Development	$87,700	$128,550	$214,250	1.50
Minnesota Power	Geothermal Convenient Store/Gas Station/Car Wash; Integrated Loop	$40,000	$40,000	$80,000	1.00
Niagara Mohawk	Residential Subdivision Demonstration	$154,000	$384,364	$502,364	2.26
Northeast Utilities	Geothermal as Centerpiece of Energy Crafted Homes w/ Phased-Out Rebates	$81,000	$161,000	$242,000	1.99
PP&L	Buried Treasure: Pre-install Loops at Time of Initial Home Site Preparation	$23,500	$49,802	$73,302	2.12
PP&L	Target Commercial Segments (Schools, Hotels, Office Buildings)	$175,037	$200,014	$375,051	1.14
Plumas-Sierra REC	Loop Lease Program	$58,830	$97,250	$156,080	1.65
PEPCO	Target Military Bases & Other Federal Facilities	$195,000	$1,200,000	$1,395,000	6.15
Viginia Power	Target State-Owned Facilities	$179,000	$509,037	$688,037	2.84
Totals		**$1,491,567**	**$4,013,808**	**$5,505,375**	**2.69**

Geothermal Heat Pump Consortium Demonstration Projects

Utility	Project Description	GHPC Cofunding	Utility Cofunding	Total Project	Utility/GHPC Funding Ratio
Oglethorpe Power	Residential & Commercial Technology Demonstration and Public Education	$557,760	$2,690,891	$3,248,651	4.82
Pacific Gas & Electric	Residential & Commercial; Build up Infrastructure and Demonstrate Tech.	$495,000	$1,560,000	$2,055,000	3.15
The Southern Co.	Residential & Commercial Technology Demonstration and Public Education	$583,100	$4,315,960	$4,899,060	7.40
Totals		**$1,635,860**	**$8,566,851**	**$10,202,711**	**5.24**

FUTURE PLANS

During FY97, GHPC will complete or make substantial progress in all of the above projects. Benchmarking reports and research findings will be reported fully to all GHPC members, and summaries will be made available through GHPC's National Information Resource Center and Web Site. In addition, the Operating Committees plan to initiate the following projects:

First Cost Competitiveness

- Field tests of innovative loop designs in addition to projects already underway;
- Continue to acquire residential and commercial field data and prepare case studies;
- Complete compilation of model geothermal vertical ground heat exchanger installation practices;
- Analyze long-term heat build-up effects on system performance and the environment, leading to improved system designs;
- Develop low-cost ways to determine thermal conductivity of soils;
- Evaluate loops that are integrated with other building components; and
- Improve understanding of heat transfer in hybrid commercial systems.

Infrastructure Strengthening Committee

- Continue support for the six GHP Regional Training Centers (RTC) fund in PY 1997. RTCs will are required to work towards self-sufficiency and will be supported until that status is achieved based on performance and meeting their goals and objective;
- Provide technical and design assistance as well as general information through RTCs;

- Establish Training Feedback Mechanism: Multiple means will be established to provide feedback/cross fertilization between training centers, including site visits, teleconferences, and other means;
- Institute a periodic trainers workshop to provide a working forum for the dissemination of "lessons learned" from training centers and other training activities;

- Training Workshops and Seminars: Other trade allies, such as realtors, builders, facility operators, etc. will be targeted through specialized seminars or conferences (an example is the Geothermal Heating and Cooling for Federal Facilities workshop December 9-10, 1996 in Anaheim, California);

- Enhance Commercial Design Tools: Major efforts to support commercial building design tool software enhancement and confidence building will be initiated, building on existing capabilities where possible. RFPs will be issued to compare existing design tools with standard data sets and suitable existing research model outputs; and

- Develop model ground heat exchanger design and drilling regulations, update information on State laws and regulations, and make this information accessible via the GHPC Web Site on the Internet.

Technology Confidence Building Committee

- Formulate recommendations and business plans for "model" GHP programs that respond to the needs of utilities in the current market and result in significant market penetration ;

- Conduct regional outreach to initiate local partnerships between utilities, manufacturers and trade allies;

- Initiate 3 to 7 Utility Geothermal Program Pilots and Demonstrations;

- Implement early stages of national and regional public awareness campaigns.

INDUSTRY INTEREST AND TECHNOLOGY TRANSFER

Organization	Type and Extent of Interest
300+ Electric or Dual Utilities	Dues-paying members in 1995
467 Manufacturers and Trade Allies	GHPC non-dues paying members and participants on GHPC committees
28 International Organizations	GHPC non-dues paying members
International Ground Source Heat Pump Association (IGSHPA)	Board member; provides advice and guidance from perspective of research community and industry
Electric Power Research Institute (EPRI)	Tailored collaboration arrangement for members; cofunding of research efforts and teleconferences

Organization	Type and Extent of Interest
Edison Electric Institute (EEI)	Strong support for GHPC; Board Member. 50% cost share for development of geothermal analysis in MECCheck Model Energy Code compliance software
National Rural Electric Cooperative Association	Resources for various R&D projects
ASHRAE	70% cost share of antifreeze environmental study; cosponsorship of Professional Development Series
National Ground Water Association	Cosponsorship of model drilling practices development and GHPC's Environmental Advisory Committee
American Institute of Architects (AIA)	Cosponsorship on teleconference for architects and engineers
ClimateMaster	Greater than 75% cofunding of new loop technology commercialization
Phillips Driscopipe	60% cost share of head loss algorithm study
Philadelphia Electric Company	Cofunding for video and case study for geothermal redevelopment project
Geothermal Energy Association	66% cost share for regional training
Keystone Geothermal Heat Pump Training Consortium	40% cost share for regional training
Ferris State University	66% cost share for regional training
South Dakota State University	50% cost share for regional training
Alabama Power Company Heat Pump Training Center	88% cost share for regional training
Alternative Energy Corporation	56% cost share for regional training
Wrightsoft	90% cost share for development of a designers software suite

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