Comments on the U.S. Department of Energy Quadrennial Technology Framework Review

Submitted by

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The Geothermal Exchange Organization (GEO) respectfully submits the attached comments in response to the U.S. Department of Energy's Quadrennial Technology Review Framing Document, published in the *Federal Register* March 14, 2011.

GEO is a non-profit 501(c)(6) trade association representing the interests of the geothermal heat pump industry. Geothermal Heat Pumps (GHPs) use the earth's renewable energy, just below the surface, to heat or cool a building and to help produce domestic hot water, with efficiencies of up to 400% compared to fossil-fuel systems. The U.S. Environmental Protection Agency has said GHPs are, "the most energy-efficient, environmentally clean, and cost-effective space conditioning systems available today." GHPs can dramatically increase building energy use efficiencies.

GHPs, which are a renewable and clean energy source, are manufactured by 27 companies in the United States and installed by American workers. Installation of the GHP energy transfer component (the underground loop) creates additional well-paid jobs not found in the conventional Heating, Ventilating, Air Conditioning (HVAC) industry.

The Geothermal Heat Pump Industry is still nascent, with less than a five-percent market penetration for new building construction. Economic subsidies, both public and private, are helping to increase GHP market share but several barriers to industry expansion still exist. In consultation with the GHP industry, DOE has identified six primary market barriers:

- Consumer awareness and confidence in the technology;
- High Initial, or "First," Cost, primarily due to underground loop installation;
- Need to ramp-up qualified design and installation infrastructure;
- Need for builders, developers, realtors, lenders, and appraisers to value energy savings;
- No strong industry voice; and,
- No "Home" program at DOE.

The GHP industry has effectively addressed the fifth barrier with its support of GEO during the

past year as the new Voice of the Geothermal Heat pump Industry. We are now working on strategies to effectively reduce—and ultimately remove—the remaining barriers and increase GHP market share.

With the help of DOE, geothermal heat pumps have the potential to foster significant reductions in electricity consumption and the use of fossil fuels nationwide, helping to achieve other relevant policy and societal goals. With improved technologies and increased public awareness, GHPS can quickly become the consumers' renewable technology of choice, paving the way for:

- Efficiently lowering energy costs;
- Reducing pollution and greenhouse gas emissions;
- Creating well-paid, permanent jobs;
- Generating new tax revenues at all levels;
- Expanding the U.S. manufacturing export base; and
- Helping to enhance National Energy Security.

1) What do you think of the following mission statement for DOE energy research?
To facilitate the invention, refinement, and early deployment of meaningful technologies that enable options for scaling by the private sector toward national energy goals.

GEO agrees with and supports DOE's mission statement (above), and notes that several qualities inherent to Geothermal Heat Pumps (GHPs) are captured by it, including terms such as *invention, refinement; early deployment; meaningful technologies; scaling by the private sector;* and *toward national energy goals*. All are vital components of the many benefits of GHP development and installation.

The technologies used in the production of GHPs are American inventions which are under continual refinement to produce ever greater cost and energy efficiencies. Even so, it must be recognized that the GHP industry is still in an early stage of development in terms of cost reduction (primarily underground loop installation); measurement of operations and efficiencies over time; and consumer acceptance and market share.

GHP systems are meaningful technologies from both an energy efficiency as well as a renewable energy standpoint. They are scalable in nature, so can be used in small residential building up to large commercial structures for government, commerce and industry. GHPs are poised to play a critical role in national goals of reducing energy dependence; limiting the environmental impacts of energy production; and increasing U.S. competitiveness in the world marketplace.

2) How can DOE activities best support U.S. leadership in clean energy innovation? In clean energy manufacturing? In clean energy deployment? How do we balance international competitiveness against international cooperation?

To support the efforts of U.S. leadership in clean energy innovation, DOE should be involved in the debate over a Clean Energy Standard (CES) for the United States. In doing so, we hope that DOE will recognize and promote the unique contributions that GHPs could make if such

sweeping legislation were to become law.

GEO believes that to help meet its environmental, economic and security goals, CES legislation should recognize GHP demand-side thermal renewable energy technologies. If CES legislation is passed into law, inclusion of GHPs on a megawatt to thermal basis could be beneficial to utilities, because GHPs present few cost problems, permitting concerns or liability issues. GHPs could help utilities earn CES credits while reducing carbon emissions from displaced fossil-fuel combustion. GHPs are a cost-effective way to help utilities meet obligations under any potential CES.

According to DOE, 39% of total U.S. energy use is devoted to heating and cooling of buildings. GHPs are a distributed energy source, available for every home and business, eliminating the need to build new electric transmission systems. GHP thermal energy is available on-peak 24 hours per day, 365 days per year in every State.

Finally, we believe that DOE should embrace GHPs as a stand-alone component among their various programs. In doing so, the agency could better assist the GHP industry in overcoming price and technological barriers, while helping to fulfill its twin goals of increasing clean energy manufacturing and deployment in the United States. The GHP industry already has a significant export business that could only be increased by the positive contributions of DOE in raising efficiencies and reducing costs of its products.

3) What principles should the Department follow for allocating resources among technologies of disparate maturity and potential time to impact?

GEO believes that DOE should not only look at emerging energy technologies for their portfolio, but at technologies like GHPs that have passed the emergent stage, but still face significant hurdles to widespread and beneficial adoption (see above).

For GHPs, that means providing an independent Geothermal Heat Pump Technologies Program, funded adequately to support its headquarters and regional office teams, plus research at Oak Ridge and the National Renewable Energy Laboratory (NREL) as well as selected institutions. Current metrics for evaluation of projects are suitable for most GHP applications.

With a program that better allocates limited research and development dollars, GHPs could more quickly gain market share and help the United States meet a variety of societal and policy goals.

4) What are the optimal roles for the private sector, government laboratories, citizens and academia in accelerating technology innovation?

GEO would like to see a firm partnership of industry with DOE and the national laboratories, which recognizes the contributions of each and naturally leads to optimization of the work and product. A dedicated program and personnel who can effectively provide shared leadership and refine inputs for targeted results can accomplish the goals of cost reduction and data collection technologies. Both will ultimately help raise consumer confidence and increase GHP deployment.

Oak Ridge has traditionally led DOE research and development standards for GHPs; NREL's recently formed geothermal program has expressed great interest in working with the industry. One idea is "Smart Box" technology attached to installed systems (with owner consent) that over time would record and confirm GHP cost and efficiency claims. The ultimate goal of such a project is to build consumer trust, thus helping expand the market reach of GHPs.

5) What are principles and best practices in performing large-scale demonstration projects?

- **a) How close to commercial viability does a demonstration have to be? What are the optimal cost sharing arrangements? How might demonstrations be coordinated with DOE financing activities?**
- **b) How can demonstration projects better benefit all stakeholders beyond the immediate participants? How are lessons-learned best captured and promoted, and how is intellectual property best handled?**
- **c) How should DOE determine whether demonstrations adequately address technical and operation risks?**
- **d) What defines failure or success in the demonstration phase?**

The primary risks faced by energy decision-makers are the uncertainty of the operational performance of chosen energy infrastructure and the application of existing regulatory structure to emerging technologies. Demonstration projects can better benefit all stakeholders by incorporating and disseminating operational and performance metrics for each project. While numerous GHP demonstration projects have been accomplished in the past by DOE and the GHP industry, no centralized database of post-installation system performance has been made available to facility decision-makers or regulators. Demonstration projects should incorporate requirements for extensive collection and analysis of actual system performance and assessment of associated regulatory issues. Widespread dissemination of results of demonstration projects benefits all stakeholders beyond the immediate participants, and the Internet provides an efficient and effective media for communicating with a broad audience via publication of case studies.

Demonstration projects should be selected on the basis of the cost/benefit ratio of a technology in furthering the goal of DOE to accelerate the transformation of the nation's energy system to meet the challenges of Energy Security, U.S. competitiveness and environmental impacts. For example, the Oak Ridge National Laboratory report on *Geothermal (Ground-Source) Heat Pumps: Market Status, Barriers to Adoption, and Actions to Overcome Barriers* concludes that "GHPs have the potential to offset about 35 to 40 percent of the projected growth in building energy consumption between now and 2030." Those benefits would enhance energy security by displacing foreign energy imports and decentralizing U.S. energy infrastructure with distributed renewable geothermal energy located at each building site. U.S. competitiveness would be promoted by expanding U.S. manufacturing capacity of technology that is rapidly being adopted by other nations, and environmental impacts would be mitigated by reduced greenhouse gas emissions and avoidance of significant electric transmission system expansion.

Assessment of the benefits of demonstration projects should include their contribution to the expansion of design and installation infrastructure. For example, large GHP demonstration

projects at federal facilities have alerted federal facility managers and engineers to technology that provides them with tools to meet their mandates for renewable energy and energy reduction. The Federal Energy Management Program (FEMP) provides an effective vehicle for disseminating such information to a broad audience of federal employees and contractors. DOE should support FEMP programs to leverage the knowledge gained from demonstration projects. For example, the General Services Administration is required to accelerate the use of more cost-effective technologies like GHPs and would benefit significantly from lessons learned from other federal agencies.

6) A number of non-technical barriers - including federal, state, and local regulations, market failures, and non-technical risks - impact the rate of deployment of energy technologies. What, if any, role should the Department have in addressing these barriers?

DOE can have a great impact on non-technical barriers merely by its presence. The non-technical barriers impinging upon the market for GHPs are would be addressed indirectly by a DOE-dedicated program for the technology, which would constitute a much needed endorsement of GHPs. In addition, a Geothermal Heat Pump Program would necessarily have a public outreach component, which could efficiently provide information through State Energy Offices and other partners to a broad swath of public and consumer interests.

7) Have we correctly identified and structured these six strategies?

Yes, GEO believes DOE has correctly identified and structured the six strategies. GHPs clearly fit within the strategy developed for the demand side of clean, renewable and efficient energy policy. Our answer to question 2) briefly articulates how GHPs would fit into a Clean Energy Standard on the demand side. Our answer to question 8) demonstrates how GHPs drive down end-use costs and consumption for owners of buildings simultaneously flattening an electric utility's peak demand and reducing carbon emissions.

8) We welcome comment on the selection of these technologies and sources, as well as suggestions of alternate technologies and sources, and updated technology, cost, and forecast data, particularly in rapidly-moving fields.

GEO specifically addresses the strategy for 6.2 Stationary; the sub component of 6.2.1.1 Efficiency in Buildings and the key strategy for 6.2.1.1.3 HVAC and Water Heating.

We agree with DOE that residential and commercial buildings are responsible for approximately 40% of U.S. primary energy consumption and over 70% of electric consumption, and add that buildings are responsible for some 43% of U.S. carbon emissions. GEO also agrees with DOE's goals of reducing energy consumption of commercial HVACs by 80% by 2020 and reducing energy use for hot water service by 50% by 2015.
GEO hopes that DOE will recognize that GHPs can play a significant role in meeting those goals, and should be recognized for their ability to significantly reduce energy consumption for thermal loads while simultaneously reducing monthly peak electricity demand.

A unique experiment was developed in Edmond, Oklahoma to quantify the energy savings of a

GHP compared to a traditional HVAC system. Two commercial office buildings were built next store to each other with identical building designs and materials. One building was equipped with a conventional HVAC (VAV) system and the other building was equipped with a GHP system. On an annual basis, the GHP building used 47% less energy (kBtu) than the HVAC building and the GHP building reduced peak electric monthly demand (watts/sq/ft) by 35%.

This is a powerful experiment which demonstrates the unique characteristics of GHPs from both a supply and demand point of view. From the supply side, the GHP building reduced peak demand with the accruing benefit flowing back to the electric utility and reduced the strain on the electric grid. On the demand side, the GHP building reduced energy consumption, saved the consumer money and made the company more profitable. Additionally GHP buildings eliminate health and safety hazards of carbon monoxide poisoning and gas line/building explosions.