The Importance of Geothermal Heat Pumps as a Renewable Thermal Technology Under Connecticut's Comprehensive Energy Strategy

GEO – The Geothermal Exchange Organization

Connecticut Department of Energy and Environmental Protection (DEEP) Bureau of Energy and Technology Policy

Informational Meeting

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The Geothermal Exchange Organization (GEO) thanks the Connecticut Bureau of Energy and Technology Policy for the opportunity to comment on our support for geothermal heat pumps (GHPs) as a vital component of the state's Comprehensive Energy Strategy. GEO is a non-profit 501(c)(6) trade association representing the interests of all businesses involved in the geothermal heat pump industry across the nation (website: www.geoexchange.org).

GHPs are a widely available renewable heating and cooling technology that hare proven highly efficient in Connecticut for homes and businesses—as well as commercial, industrial and institutional buildings. With the Connecticut Geothermal Association, GEO believes that GHPs should play a greater role in state energy policy and planning because of their efficiency in reducing energy consumption and use of fossil fuels for the heating and cooling of buildings.

According to the U.S. Department of Energy (DOE), buildings are the largest single sector of total U.S. energy consumption, accounting for more than 40% of primary energy use.[1] Some 60% of energy used in buildings is for "thermal loads," including space heating, cooling and water heating. And a third of that load—3.2 quadrillion BTUs—is satisfied with electricity.[2] With greater adoption, GHPs can significantly reduce the energy demand of the building sector.

GEO believes that with the right level of encouragement from the state, GHPs offer a unique technology for heating and cooling that provides clean, efficient and renewable energy that can help Connecticut achieve its economic and environmental goals, both for now and in the future. The federal administration agreed in March 2015 with its Executive Order, "Planning for Federal Sustainability in the Next Decade," which recognizes GHPs as a clean source of renewable energy for the nation's future.

How GHPs Produce Renewable Energy Using a concept called "geothermal exchange," GHPs tap the clean energy naturally stored in the near-surface of the earth, where temperature is constant around 50° F depending upon latitude. GHPs transfer this free heat to buildings in winter and back to the ground in summer.

Most GHPs work by circulating water in a closed system through a loop of durable, high-density polyethylene pipe installed either horizontally or vertically in the ground beside or even beneath a building. Besides vertical or horizontal orientations, ground source heat exchangers can also be installed in water wells, lakes and ponds. Another example of a GHP technology is "direct exchange" (DX), in which a refrigerant circulates through copper tubes placed in the ground. The refrigerant exchanges heat directly with the ground through the highly conductive walls of the copper tubing. During the summer, GHPs provide cooling by rejecting unwanted heat from buildings back to the ground, using the earth as a heat "sink," and provide free hot water in the process. During the winter, GHPs transfer free renewable heat energy from the ground back to buildings for comfortable warmth.

Whether they are in heating or in cooling mode, GHPs offer significant savings in energy use and emissions compared to conventional heating and cooling equipment. Even though GHPs use a small amount of electricity to operate, they can completely eliminate the use of polluting fossil fuels like natural gas, fuel oil and propane in on-site heating applications for buildings.

Overcoming the Initial Cost Barrier Typical installation cost of a GHP system in a 2,000-square foot. home is ~$20,000, which is higher than most conventional heating and cooling systems. However, with 30-70% savings on energy bills after installation, the cost difference is typically recaptured in 3 to 7 years with federal tax credits for GHPs of 30% for residential applications and 10% for commercial jobs (plus accelerated depreciation). The credits are set to expire at the end of 2016, but GEO is confident that Congress will extend them for another 5 years, as they have already done for solar.

GHP Prevalence in Connecticut Though GHPs still represent only a fraction (2%) of the heating and cooling equipment market, tens of thousands of geothermal heating and cooling systems have been installed across the state over the past few decades in several types of buildings. The Great Recession slowed GHP installations everywhere, but current industry figures show that in 2014 and 2015 alone, some 5,000 GHP units were installed in all applications in Connecticut. With extension of federal tax credits for residential and commercial GHPs, GEO expects that number to increase, especially if the state takes a greater role in promoting and providing incentives to consumers to adopt the technology.

More GHPs Means More Well-Paid Jobs GHPs' attractive operating costs and environmental benefits have created a green industry in Connecticut. There are nearly 150 certified International Ground Source Heat Pump Association (IGSHPA) certified GHP installers in Connecticut, who utilize the services of hundreds of professionals and staff in the engineering, design, drilling and industrial equipment sectors. These are all well-paid, "home-grown" jobs that can't be imported.

Most Efficient for Heating and Cooling GHPs are widely recognized as the most efficient technology for heating and cooling homes, businesses and commercial/ institutional buildings. According to the U.S. Environmental Protection Agency (EPA), "Geothermal heat pumps are among the most efficient and comfortable heating and cooling technologies currently available." EPA's Energy Star program website says, "…qualified geothermal heat pumps are over 45% more energy efficient than standard options."[3]

In addition, EPA says that GHPs can reduce energy consumption and corresponding emissions up to 44% compared with conventional air-source heat pumps, and 72% compared with electric resistance heating with standard air-conditioning equipment.[4]

GHPs typically move 3 to 4 times more energy to or from the earth than is used to operate them. A GHP with a coefficient of performance (COP) of 4.0 uses one unit of energy (electricity) to transfer three equivalent units of renewable thermal energy from the ground to a building. Innovations in multi-stage and variable speed compressors during the past few years have significantly lowered the energy needed to power GHPs, resulting in COPs even greater than 5.0.

More importantly, says DOE, "The biggest benefit of GHPs is that they use 25% to 50% less electricity than conventional heating or cooling systems."[5] Even though GHPs run on electricity, they are only required to produce the difference between outside ground tempera-ture and indoor temperature. Conventional furnaces must combust oil, natural gas or propane to create heat, while geothermal systems simply transfer existing heat. Conventional air conditioners struggle to reject heat into hot outdoor air temperatures while a GHP easily transfers heat back to the earth.

A standard resistance electric heater can provide no more than 100% of the energy it uses, but GHPs in heating mode can offer efficiencies of 400% and even more. In cooling mode, GHPs claim significantly higher energy efficiency ratings than competing air-source heat pump systems. A recent working paper by Western Farmers Electric Cooperative (Anadarko, OK) describes dramatic drops in efficiency for air-source heat pumps struggling in air temperatures exceeding 95° F on hot summer days. In comparison, efficiency degradation of GHPs under the same conditions is negligible.[6]

GHPs a Dependable, Dynamic Technology GHP indoor components easily last 25 years, and the plastic pipe that comprises their underground heat exchangers is guaranteed to last at least 50 years. Ongoing improvements (i.e. variable speed compressors) that have increased COP set the stage for continuous expansion of market potential. Improvements are ongoing in drilling technologies that are expected to help bring down cost, and in grout to further improved already excellent efficiencies. And GHP manufacturers understand the need for intensive and qualified installation training that will further improve customer satisfaction and rates of adoption.

GHPs Produce "Negawatts" GEO believes that the lowest cost—and least polluting—unit of energy is one that is not used. A typical 4-ton residential GHP can reduce summer peak electricity demand by more than two kilowatts (kW).[7] Take that times 500 homes equipped with GHPs, and you have a peak power demand reduction of a megawatt. That's a megawatt of electricity NOT used, which creates what energy experts around the world call a "Negawatt."[8]

The idea of a Negawatt is cutting electricity consumption (and therefore production) with energy efficiency. Because they are a renewable energy technology, GHPs produce the thermal equivalent of a Negawatt at a fraction of installation cost compared to a megawatt of electricity produced by even renewable power sources let alone that produced by fossil fuels.[9]

Recent data from the Illinois Association of Electric Cooperatives and the American Heating and Refrigeration Institute confirm that an average 4-ton GHP reduces the peak load of an electricity provider by 2.6 kW.[10] Adding to that efficiency gain is the fact that distributed thermal energy producers like GHPs avoid the need for expensive transmission lines required by power plants.

GHPs Help Reduce Utility Stress GHPs can help lighten the load on our strained electrical grid. This is especially true on sweltering summer days when consumer demand for air conditioning and power generation spikes. As noted, GHPs can be up to 400%+ more efficient than conventional air conditioners, which lose efficiency as ambient temperatures soar. That's when efficiency is needed most—when electric utilities are straining to provide power to air conditioners that are cooling tens of thousands of buildings at the same time.

Flattening peaks in electrical load with GHPs at such critical times smooths out electrical generation use and lessens the power plant capacity that must be installed, saving utilities and rate-payers money while stabilizing the transmission grid. In addition to reducing summer peak demand, GHPs help build load (and power sales) during the winter—while reducing carbon emissions and saving the high cost of new power and transmission infrastructure.

GHPs are a big win for utilities. An excellent example is a PSEG-Long Island efficiency project in New York. According to utility PSEG-Long Island's Long Range Plan, "A typical PSEG-Long Island residential customer uses approximately 10,000 kilowatt-hours annually and has an average peak demand of 4 kW." The utility says that with a GHP system, their typical residential customer would slash total electric and fossil fuel consumption for space heating, cooling and water heating by an estimated 4,500-5,000 kW, while cutting peak demand by 1.5 kW.[11]

GHPs Slash Carbon Emissions Perhaps the most important benefit of GHPs is carbon emission reduction to help fight climate change. Continued growth in U.S. carbon dioxide (CO_2) emissions is a wakeup call telling us that more must be done to accelerate deployment of energy efficient, renewable energy sources like GHPs. A 2010 study[12] from Oak Ridge National Laboratory shows that aggressive retrofitting of all single-family homes across the country with GHPs would avoid the need to build up to 48% of new electric generation capacity that is projected nationwide by 2030. Such a deployment of GHPs would save $52.5 billion annually in energy expenditures, and slash projected CO_2 emissions by over 45%. The Oak Ridge research found that one ton of GHP capacity over a 20-year operating cycle avoids CO_2 emissions of 21 metric tons. A thousand homes retrofitted with 3-ton GHPs would therefore reduce carbon emissions by 63,000 metric tons over a 20-year period.

Conclusion GHPs must be a vital component of Connecticut's Comprehensive Energy Strategy. GHPs are a clean and dependable distributed renewable energy source. They are the most efficient and environmentally beneficial technology available for heating and cooling buildings. Reduction of both power generation and on-site fossil fuel use by GHPs should not be overlooked by state policy makers and regulators trying to balance economics with environmental protection.

GHPs already have a solid base of suppliers and installers in Connecticut. More widespread adoption of GHPs in the state will provide the economic benefits of additional high-paid jobs and lower energy bills for ratepayers. At the same time, greater use of GHPs by homeowners, businesses and institutions will lighten peak utility loads, reduce fossil-fuel use, cut pollution, and curb production of greenhouse gases.

GEO recommends that Connecticut's Comprehensive Energy Strategy make room for aggressive promotion of the many benefits of GHPs. We would also like to see the state adopt strategies for basic financial incentives for GHP installations. Finally, we urge the development of state- and/or utility-sponsored loan guarantee programs for GHPs. Such a program would allow ratepayers to more easily enjoy the comfort and economic benefits of the technology while making monthly payments that are less than the money they save on utility bills.

If you have any questions, please contact GEO.

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