

The Geothermal Exchange Organization recently sponsored a scientific, peer-reviewed study to test the energy efficiency of geothermal heat pumps for heating and cooling. The findings?

**No Question About It...**

# Geothermal Heat Pumps Beat the Competition!



Annual Energy Use  
with Geothermal Heat  
Pumps Is 44% Less  
than with Variable  
Refrigerant Flow for  
Heating and Cooling  
of Commercial and  
Institutional Buildings

**American Society of Heating, Refrigeration and Air-conditioning Engineers International Headquarters Building in Atlanta, Georgia.**

With assistance from the Southern Company, the Geothermal Exchange Organization (GEO) contracted a research team from Oklahoma State University and Oak Ridge National Laboratory to evaluate the performance of ground-source—or geothermal—heat pumps vs. variable refrigerant flow heating and cooling systems installed at the American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE) International Headquarters Building in Atlanta, GA.\*

The ASHRAE building offered a perfect “living laboratory” for the GEO comparison study. When ASHRAE contracted a major renovation of their two-story, 31,000 square-foot building in 2008, they did so to offer the chance to evaluate commercial building energy and sustainability performance.

In addition to energy efficiency improvements such as lighting and insulation, the ASHRAE building employs a variable refrigerant flow (VRF) system for the first floor; a ground-source heat pump system (GSHP) for the second floor; and a dedicated outdoor air system (DOAS) for fresh air to both floors.

To facilitate efficiency studies like that performed by GEO, the renovation included an array of 1,600 sensors that monitor heating, ventilation and air-conditioning operations and conditions in each building zone.

Historical and current data from these sensors were available to the GEO research team, led by Dr. Jeffrey Spitler, Regents Professor of Mechanical Engineering at Oklahoma State University and his colleagues, Dr. Xiaobing Liu, Staff Scientist at Oak Ridge National Laboratory, and Laura Southard, Oklahoma State Mechanical Engineering MS candidate. Southern Company provided the services of a power engineer to assist with onsite data measurements. Their work was performed independently, with full cooperation of ASHRAE. Two technical articles describing the project published in the *ASHRAE Journal* were peer-reviewed by heating and cooling industry experts.

For two years, the research team studied the relative performance of the geothermal and VRF systems, determining energy consumption of each, and heating and cooling required by the building.

The researchers concentrated on determining actual heating and cooling provided by the geothermal and VRF systems, data analysis, and measured and experimental metrics. They collected two years of operational data (July 1, 2011 to June 30, 2013) for the heating, cooling and ventilation systems. Data points included operating mode, zone temperature, and discharge air temperature for individual fan coil units and heat pumps, as well as metered energy used by each system. The research team also gathered data on ground loop water supply, return temperatures and flow rates for the geothermal system.



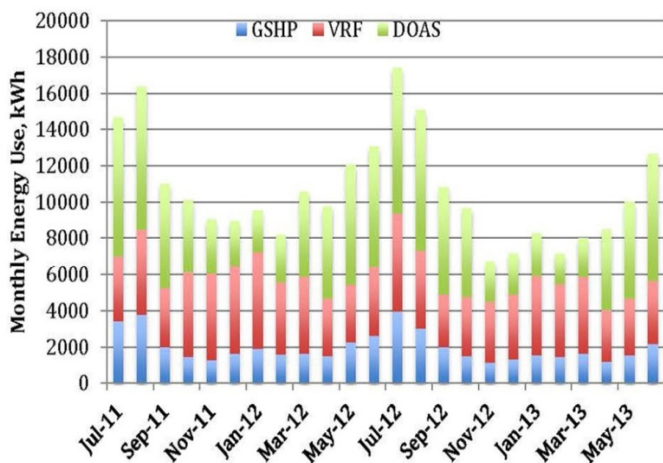
Raw data show that the VRF system used twice as much energy as the geothermal system during the two-year study period.”

Dr. Jeffrey Spitler

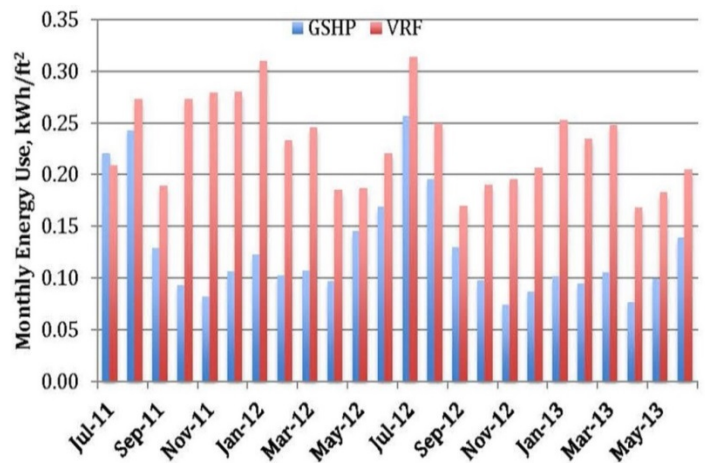
They found that the geothermal system used 29% less energy in the summer, and 63% less energy in the winter and shoulder seasons than the VRF system, while maintaining similar zone temperatures. During the two-year study period—with all variables accounted for—the GEO study proved that energy use by a geothermal heating and cooling system averaged 44% less than VRF. Why? Spitler explains that the answer is revealed by heat sink and source—ground vs. ambient air. “It is clear that ground loop water

supply temperatures were more favorable than ambient air temperatures for heat pump operation. This allows the geothermal equipment to operate at higher efficiencies.”

**LEARN MORE!** *Final Report, Performance of the HVAC Systems at the ASHRAE Headquarters Building* is available on the GEO website at [www.geothermal.org](http://www.geothermal.org), plus supporting information, a webinar recording, and links to peer-reviewed *ASHRAE Journal* articles.



Total monthly energy use by each HVAC system



Normalized monthly energy use per square foot

The geothermal system used 29% less energy in the summer, and 63% less energy in the winter and shoulder seasons than the VRF system, while maintaining similar zone temperatures.



GEO—the Geothermal Exchange Organization—is a non-profit 501(c)(6) trade association representing the interests of all businesses involved in the geothermal heat pump industry across the United States. GEO provides outreach for the industry to the public and government about the economic, national security, and environmental benefits of geothermal heat pump systems for residential, institutional and commercial applications. For more information and to **JOIN GEO**, please visit [www.geoexchange.org](http://www.geoexchange.org). Or contact us via email at [info@geoexchange.org](mailto:info@geoexchange.org). Phone: (888) 255-4436.

\*ASHRAE provided data for this study, but the organization does not endorse, recommend or certify any equipment or service used at ASHRAE International Headquarters.