PRI leads campus collaboration with ORNL geothermal energy technology

Urbana, IL— The Prairie Research Institute (PRI), Student Sustainability Committee (SSC), Facilities & Services (F&S), Illinois Water Resources Center (IWRC), Institute for Sustainability, Energy, and Environment (iSEE), the College of Agricultural, Consumer, and Environmental Sciences (ACES), and the Oak Ridge National Laboratory (ORNL) gathered on Feb. 27, 2023, to break ground on installing an underground thermal battery (UTB) at the Energy Farm in Urbana, IL.

“This is an essential step toward implementing and demonstrating an innovative, lower-cost geothermal energy technology at scale,” said Andrew Stumpf, a principal research scientist and geologist at the Illinois State Geological Survey (ISGS) at PRI, “We’ll be involved in the data collection and analysis with ORNL and provide the geological framework for the project.”

The successful installation and operation of the UTB serve to demonstrate the significant economic and energy efficiencies of this geothermal energy technology and help enable the commercialization of ORNL’s technology.

ORNL’s Xiaobing Liu, a senior researcher and the inventor of the UTB, said the device uses a water tank installed in the shallow subsurface to exchange heat with the ground. The UTB has a large thermal capacity and uses the relatively stable ground temperature to provide a heat sink or heat source with a more favorable temperature than the ambient air. A ground-source heat pump coupled with the UTB can heat or cool a building more efficiently than conventional air-source heat pumps or combined air conditioners and furnaces. Because the UTB is installed in a shallow borehole less than 25 feet deep, installation cost could be cheaper than a conventional borehole heat exchanger, which is usually installed at depths of more than 200 feet. In addition, the large thermal capacity of the UTB can be used for either passive or active thermal energy storage, which can help reduce energy costs by utilizing low-cost electricity during the day and shedding the demand for electricity during peak hours for the electric grid.

“This underground thermal battery can be coupled with a ground-source heat pump to heat and cool a home without any on-site emissions. It also reduces energy use and could be more cost effective than conventional ground-source heat pump systems,” Liu said. “It has the potential to transform how homes of the future are heated and cooled and can be installed to work in existing homes and commercial buildings, too. We look forward to receiving data from the University of Illinois field test to further prove the concept.”

This installation was supported through the collaborative efforts of the Illinois Geothermal Coalition, which was established on campus as a Living Laboratory workshop hosted by iSEE in 2018. The Illinois Geothermal Coalition is a collection of research, non-profit, and corporate partners dedicated to establishing Illinois as a leader in geothermal energy. Several students from the University of Illinois and other schools are members of the coalition. Student support also includes SSC funding to the UTB. SSC allocated $132,550 to the project since it began in 2018, collaborating with iSEE and F&S. The IWRC provided an additional $14,000 in 2023.

"The underground thermal battery at the Energy Farm sets a positive example for the community and, in line with SSC's charge, provides valuable experience for students involved in its design, installation, and research on this innovative technology," said Jack Reicherts, SSC chair and co-president of the Student Sustainability Leadership Council

The drilling and installation for the UTB will take several weeks and is expected to be fully operational by May. Researchers from PRI and ORNL will collect data from the UTB using flow meters, thermocouples, and a fiber-optic cable for one year to evaluate its performance and compare it with the current fossil fuel heating and air conditioning system.

Ehab Kamarah, associate vice chancellor and executive director of F&S, said,“The continued integration of geothermal projects across campus reflects the university’s commitment to the Illinois Geothermal Coalition and our Climate Leadership Commitments. This extraordinary site-specific research and academic collaboration will be a catalyst for the innovation and development of next generation energy storage, as well as sustainable heating and cooling resources, materials, and processes.”

Partnerships for this project include – Prairie Research Institute, Oak Ridge National Laboratory, Student Sustainability Committee, Facilities & Services, Institute for Sustainability, Energy, and Environment, the Illinois Geothermal Coalition, and the College of ACES. WSP was contracted by F&S to provide the engineering design and Connor Company directed the team on heat pump alternatives. Skinner Well Drilling and Durbin Geothermal installed the UTB and associated borehole heat exchangers.

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Photos and videos are available upon request.