Earth Source Heat

Earth Source Heat (ESH) is Cornell's vision for a geothermal system that would use the Earth's abundant and consistent internal heat to warm the Ithaca campus without the use of fossil fuels. If successful, the system will not only revolutionize how Cornell heats its Ithaca campus, supporting efforts to achieve carbon neutrality by 2035, but also create a new, scalable, renewable energy source capable of sustainably meeting complex heating challenges in cold-climate regions across the globe.

ESH would harvest heat from the deep subsurface to meet baseload heating needs of Cornell's district energy system. It would rely on hot rocks deep underground to naturally heat water by injecting water in one well, letting it flow through cracks and fractures underground and then pumping that water back up in a separate well. A heat exchanger would then transfer the heat to a separate closed loop of pipes that would carry hot water to sustainably heat campus buildings.

Cornell University Borehole Observatory

The Cornell University Borehole Observatory (CUBO) – a nearly two-mile-deep geothermal exploration well drilled in 2022 – is a powerful tool for evaluating the technical feasibility of ESH, as well as supporting other subsurface research in the future. Cornell received approximately $8.18 million from the U.S. Department of Energy to install CUBO (estimated $14 million total cost for CUBO deployment).

Using an electric drilling rig to minimize noise and emissions, CUBO was drilled to a depth of 9,790 feet (1.85 miles). At the surface, the hole is approximately 36 inches in diameter, progressively narrowing to about 8.5 inches in diameter at the deepest point. Regions in the subsurface which may contain fresh water or natural gas were sealed behind multiple layers of steel casing and cement. The longest casing extends more than 200 feet below the deepest rock unit that is known in this region to potentially produce natural gas. The deepest portion of the borehole (greater than 7,808 feet or 1.47 miles below the surface) was left uncased to allow a variety of tests to be conducted within the rock layers of interest for geothermal development. To ensure well casing integrity and safe operating conditions of CUBO, proper permitting and rigorous design reviews were completed. Water-monitoring in wells and creeks and a network of seismometers were operational both prior to and during CUBO drilling to ensure minimal environmental impact. No changes relative to background conditions were observed.

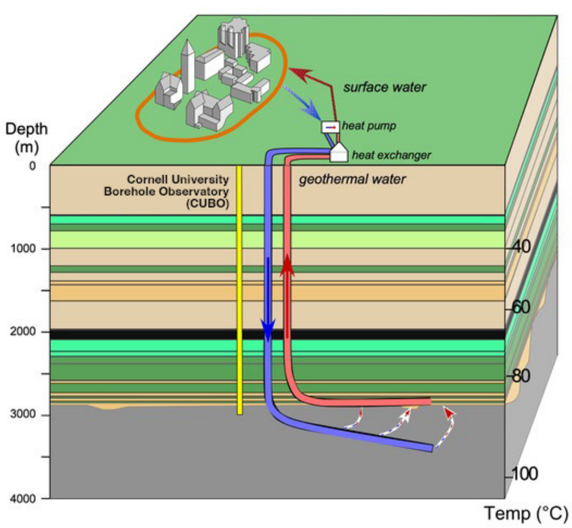
The CUBO borehole is not intended for heat production, but rather to enable our team of academic researchers, engineers and industry partners to gain a better understanding of the subsurface conditions that will guide development of an anticipated full-scale demonstration system. CUBO will also be used to deploy monitoring systems for use during future ESH project stages to support research and operations, and ensure that the methods used do not create unacceptable risks or unintended impacts. Cornell is committed to evaluating and addressing both benefits and risks in a thorough and transparent manner in order to develop best practices for the campus, the greater community and for others who might implement this technology to sustainably meet their heating needs.

What have we learned from CUBO so far?

Data from CUBO confirm that the temperature near 10,000 feet deep below Cornell is around 180°F (82°C), well within the range of temperatures useful for direct use in heating buildings.

CUBO has also provided information about networks of natural fractures present within the rock and the natural stress conditions currently acting upon them. These data will guide the design of future wells and efforts to establish connections for water to flow and be heated. Researchers are using rock samples and in-situ tests of the rock properties around the borehole to inform computer models that will estimate the thermal and hydraulic performance and lifetime of future ESH wells.

The existing natural rock permeability controlling how easy it will be to flow water between wells, as expected, is quite low (i.e., water does not easily flow through the rock). Consequently, enhanced geothermal system (EGS) technology – a current research focus of the U.S. Department of Energy – will be needed to efficiently utilize the heat within the rocks at these depths.



SCHEMATIC OF EARTH SOURCE HEAT AND THE CORNELL UNIVERSITY BOREHOLE OBSERVATORY

How would ESH use enhanced geothermal system (EGS) technology?

Using EGS technology, an area of bedrock could be hydraulically stimulated to create interconnected pathways through which water can flow between a pair of wells. Tests conducted elsewhere show that the permeability and connectivity of cracks and fractures in rocks similar to those beneath Cornell can be greatly increased using environmentally responsible methods. Once a connection between wells is established, careful hydraulic control will enable sustained production of heat in a safe manner.

In the next few years, if it is determined that Earth Source Heat has the potential to be safely and effectively utilized at Cornell, the next step would be to design, drill and test a separate demonstration well pair. A pair of wells would be drilled, and water would be pumped down the first injection well where rock would be hydraulically stimulated through EGS technology. Throughout drilling, stimulation and eventual long-term operations, monitoring equipment installed into CUBO will continue to enable insight into how the subsurface and environment respond and allow real-time operational adjustments if there is any indication of undesired effects.

If the demonstration is successful, the university would move to install additional wells using a phased approach that would create a full-scale system capable of supplying most of the heat needed by the Ithaca campus within the next 8 to 10 years.

Learn more at earthsourceheat.cornell.edu