

Expanding Geo-Exchange Technology at Princeton University

As part of our goal to achieve climate neutrality by 2046, Princeton University is advancing our use of geo-exchange technology. Investing in geo-exchange projects, with enough capacity to serve the entire campus, will enable Princeton to phase out nonrenewable energy sources, including natural gas used today to produce steam heat. We are proud of these geo-exchange projects, excited to explain the technology, and what this means for the University.

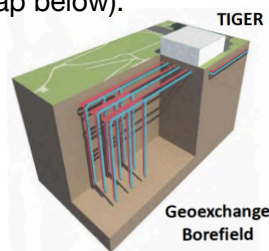
Geo-Exchange Projects on Campus

Geo-Exchange borefields

We are drilling over 700 new geo-exchange wells to expand the use of geo-exchange technology campus-wide. Lewis Center for the Arts, Lakeside Graduate Housing and Lawrence Apartments already use this technology today (see map below).

TIGER

This new building will house heat pump and electrical equipment. Rather than a back-of-house service building, TIGER (Thermally Integrated Geo-Exchange Resource) will be fully integrated into campus and signal Princeton's commitment to sustainability. Two thermal energy storage tanks (TES) to store hot and chilled water will be 40 feet tall, thanks to community feedback, revised engineering and sinking a portion of the tanks below ground.



Converting to Hot Water

We are installing over 13 miles of new underground hot water distribution pipes to convert from steam to hot water heat. The piping design needed for hot water is different than what is currently used for steam distribution, as is the science behind the two technologies. Eventually new hot water pipes will connect every campus building to geo-exchange heating and cooling.

Converting Princeton's Cogeneration Plant

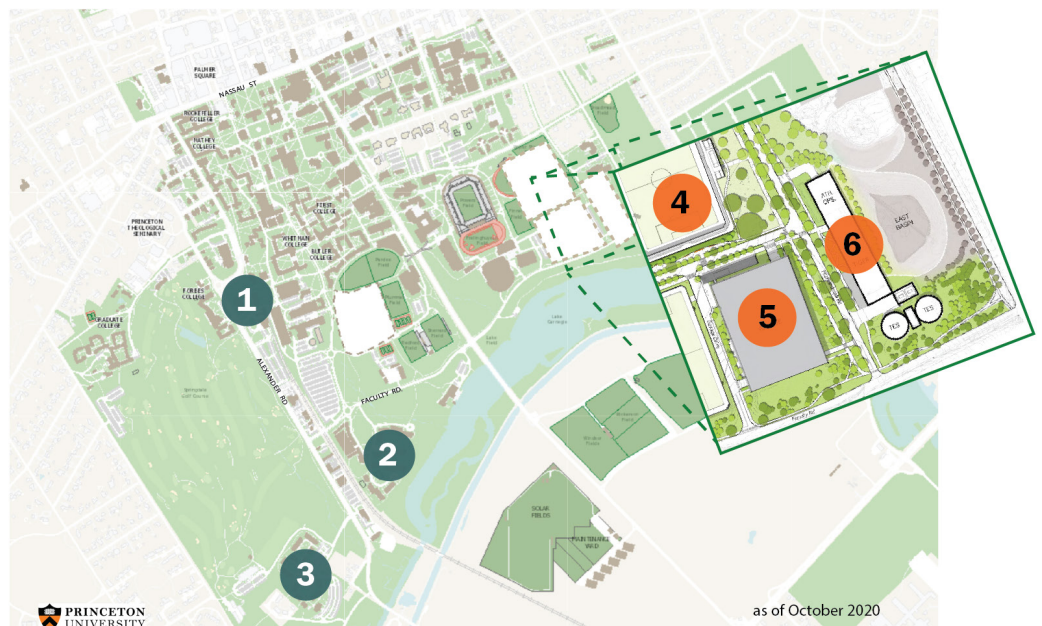
We will convert our Cogen Plant, already well known for its reliability and energy efficiency, from a chilled water plant and combined heat and power (CHP) steam plant to a renamed West Plant with hot water geo-exchange technology. After Cogen is converted it will operate together with TIGER to efficiently (economically and thermally) meet the campus heating, cooling, and partial electric load needs. The two plants will also be interconnected so each plant can partially backup the other for campus heating and cooling.

Converting Building Systems

An important step in completing geo-exchange technology on campus will be converting the heating and cooling systems in existing campus buildings. These conversions will take place over many years. When fully converted, the university will use geo-exchange systems to heat and cool over 180 buildings and save millions of dollars annually.

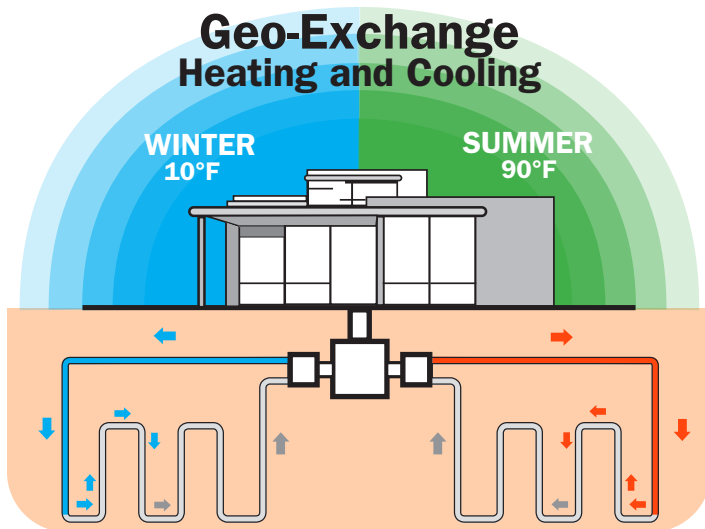
Geo-Exchange at Princeton University

- Geo-Exchange systems in operation
 - 1 Lewis Center for the Arts Complex
 - 2 Lakeside Apartments
 - 3 Lawrence Apartments
- Geo-Exchange wells and technology in the future
 - 4 Under Roberts Stadium
 - 5 Under East Garage
 - 6 under and inside TIGER



How does Geo-Exchange work?

We are installing *geo-exchange* wells. They work like a thermal piggy bank. We'll take heat out of the campus buildings all summer and store it in the ground, using geo-exchange wells to slightly warm the rock below campus. During the winter, we will use the same geo-exchange wells and warmed rock as a heat source for our buildings. Most wells will be about 850' deep and eventually there will be over 1000 wells under campus in borefields. The geo-exchange wells are essential in our climate, with cold winters and hot summers, to effectively use geo-exchange technology year-round. The geo-exchange system uses a heat pump to store and extract the heat from the Earth, often called a *ground-source heat pump*. A conventional furnace burns a fossil fuel to produce heat, a geo-exchange system **transfers heat** from one place to another.



We are NOT installing *geothermal* wells. Geothermal is an extractive technology. Geothermal and geo-exchange are often used interchangeably, but the underlying technology is very different. *Geothermal* wells tend to be a mile or more deep to reach depths where the rock itself is much hotter (sometimes hot enough to boil water). That heat is **extracted** from the earth but **not returned**. This is not what we are doing with our geo-exchange wells and systems.

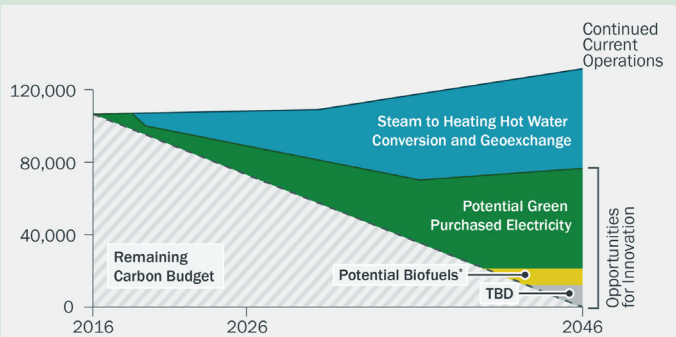


For information on campus impacts, visit construction.princeton.edu. Contact us with concerns or questions, 609-258-8423.

Advancing Sustainability Goals

Net Zero CO₂e by 2046

In addition to geo-exchange technology, TIGER will be partially or fully powered with renewable electricity with the intent of significantly reducing the University's carbon footprint. TIGER will significantly reduce water use needed for the University's energy systems due to the reduction in cooling tower water requirements.



*Biofuels require rigorous study to be confirmed as verifiable sustainable alternatives to fossil fuels.

Solar Technology

Taking advantage of above ground space, new solar panels will be installed above our parking lots. Over the next two years we will add solar PV panels to satisfy more electrical needs, increasing our ability to satisfy campus electrical needs from 6% today to approximately 15% in the future.

Campus in 3D

Campus planning considers three dimensions, below ground, ground level and above buildings. For example, our new parking garage will have hundreds of geo-exchange wells below ground, hundreds of parking spaces above ground, and rows of solar pv panels on the roof.

Geo-Exchange Terminology

Geo-Exchange: uses the ground (*geo*) as a renewable heat source in winter and heat sink in summer (*exchange*).

Geo-Exchange borefield: collection of boreholes in the ground to contain closed ground heat exchange piping loops.

Geo-Exchange system: Three part system: ground-source heat pump, closed ground heat exchange piping loops, and distribution pipes to deliver heating, cooling and hot water to buildings.

Thermal: of, relating to, or caused by heat.

Geothermal: heat (*thermal*) within the earth (*geo*), used as a renewable source of heat by extraction.