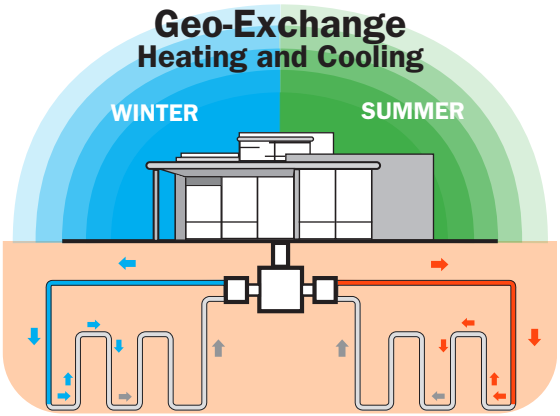
What is Geo-Exchange?

January, 2024

Think of geo-exchange as a thermal piggy bank. During summers, we take heat out of buildings and store it in the ground using geo-exchange bores to slightly warm the rock below campus. During winters, we use the same geo-exchange bores and warmed rock as a heat source for our buildings. Most bores will be about 850' deep and eventually there will be over 2,000 bores under campus in borefields.



The geo-exchange bores are used in our climate, with cold winters and hot summers, to exchange heat and maximize energy-efficiency year round. The geo-exchange system uses a heat pump to store and retrieve 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 installing *geo-exchange* bores and not *geothermal* wells. Geothermal and geo-exchange are often used interchangeably, but the underlying technology is very different. Geothermal heat is **extracted** from the earth but **not returned**.

Geo-Exchange vs. Geothermal?

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.

Why Geo-Exchange?

As part of our goal to achieve a zero carbon footprint, NetZero by 2046, Princeton University is investing in geo-exchange technology, both logistically and financially. The immense scope of projects to create and convert systems to geo-exchange technology (see other side), with enough capacity to serve the entire campus, will **enable Princeton to phase out nonrenewable energy sources**, including natural gas burned today to produce steam heat and electricity. Drilling bores, installing new pipes and converting old building systems can be noisy and dirty. The drilling will end, we promise, and our commitment to geo-exchange will bring us closer to NetZero, and be a model of what's possible.

Where is Geo-Exchange on Campus?

Geo-Exchange heat pumps

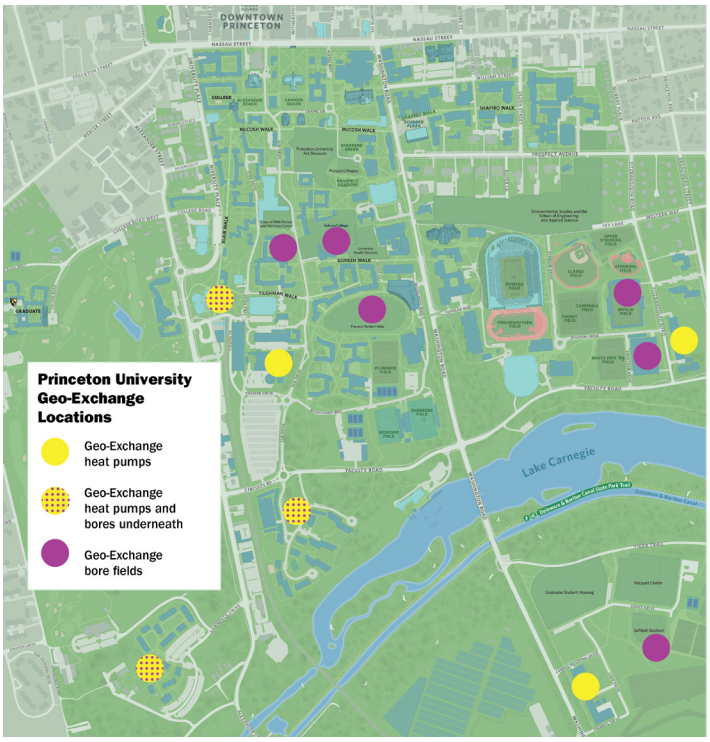
- CUB*^
- TIGER*
- West Plant*
- Lakeside Apartments**
- Lawrence Apartements**
- Lewis Center for the Arts**

Geo-Exchange borefields

- Under East Garage
- Under Hobson College^
- Under Meadows Softball
- Under Poe Field^
- Under Roberts Stadium
- Under Whitman Lawn

* Central district heating & cooling
** Building district heating & cooling

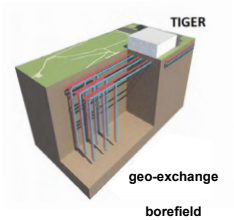
^ in progress as of Jan. 2024



Geo-Exchange Projects

Geo-Exchange Borefields

We have drilled over half of our 2,000 planned geo-exchange bores to expand the use of geo-exchange technology campus-wide. Lewis Center for the Arts, Lakeside Graduate Housing, Lawrence Apartments, Bloomberg, Butler College, New College West, and Yeh College are already using this technology today.



TIGER & CUB

These new buildings will house the heat pumps and electrical equipment necessary to expand our geo-exchange heating and cooling systems. Rather than back-of-house service buildings, TIGER (Thermally Integrated Geo-Exchange Resource) and CUB will be integrated into campus and support Princeton's commitment to sustainability. Two thermal energy storage tanks (TES) near each building are used to store hot and chilled water.

Converting to District 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 and new systems will enable every campus building to use geo-exchange heating and cooling.

Converting Princeton's Chilled Water Plant

We have converted 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. Cogen 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.

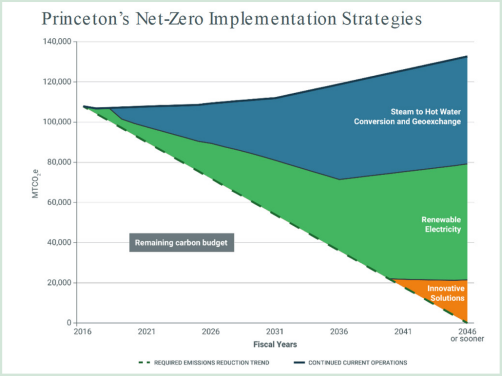
Converting Building Systems

An important step in completing geo-exchange 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, saving millions of dollars annually.

Advancing Sustainability Goals

Net Zero CO_2e by 2046 (300th Anniversary)

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



Solar Technology

Taking advantage of above ground space, new solar panels have been installed above parking lots, parking garages and in fields. Over the last two years our Solar Expansion project has added 16 Megawatts AC of new solar photo-voltaic systems. This expansion has **tripled our capacity to satisfy campus electrical needs** through solar power, from approximately 5.5% to 20%.

Campus in Three Dimensions (3D)

Campus planning, especially sustainability planning, considers all three dimensions of our campus footprint. One piece of land has the potential to be used on three levels: below ground, ground level and above structures. Buildings with a green roof take advantage of two dimensions. A parking garage with geo-exchange bores underground, parking spaces at and above ground level, and solar pv panels above the roof use all three dimensions of the land. Projects with layered land use include: Roberts Soccer Stadium, Poe Field, Hobson College, Meadows Softball Field and Meadows Drive Garage.

For information on campus impacts, visit *construction.princeton.edu*. Contact us with concerns or questions, 609-258-8023.