Imagine: Eliminating Natural Gas Use for Heating  
(and Reducing Energy and Water Use at the Same Time)

What better time to do a big project than during a pandemic, when you are not supposed to leave home, and no one is going to come over any see your mess anyway? Converting our home heating/cooling to geothermal was an idea I had had for several years, so to stave off cabin fever while stuck at home I decided it was the perfect time to tackle this project.

Geothermal heating/cooling is relatively simple and foolproof, using the thermal mass of the ground to heat/cool your house. The ground, after you go down from the surface a few feet, is a relatively stable temperature year-round. The concept is similar to having photovoltaic panels on your roof that directly produce electricity from sunlight, but in this case the sun indirectly moderates the ground temperature. A geothermal heat pump recirculates water deep underground and carries it up to a system (in our case located in our attic) that transfers the relative heat or coolness of the water to produce warm or cool air, which is then distributed through our regular ventilation system, depending on the home’s heating or cooling needs.

There are two main parts to the system:

1. Geothermal Bores – Needing to couple the ground with a building’s thermal needs, three vertical pipes were installed in the ground. These vertical borings, around 6” in diameter, were chosen over a horizontal piping loop which takes more land area, which was not available.

Three pipe risers (each having one water supply and one water return) extend into the ground 350 feet. The vertical pipes are connected together and water is circulated within them and then to a geothermal heat pump in the house, transferring ground heat (or relative coolness) to the house.

2. Geothermal Heat Pump – A geothermal heat pump is used in lieu of a natural gas furnace. Our furnace was nearing the end of its life, so something would need to be done in any case. This new heat pump is also multi-speed, offering output more efficiently matched to building thermal needs.

The heat pump provides both heating and cooling to meet the house’s needs –

- Heating – The heat pump converts the heat from the water that has circulated in the ground (coming back to the unit about 70F) into warm air (at a bit more than 100F). This warm air is pumped into housing duct work by a fan, exactly similar to your furnace system. But the key difference is that NO natural gas is used to heat the air, only heat extracted from the ground and the heat pump operation.
Cooling – The heat pump generates cooling much like a traditional AC system, but in lieu of an air-cooled condenser (typically located outside the house where its noisy operation is over-looked) it uses the ground for its condensing needs. This use of the ground makes the air-conditioning process much more energy efficient – using a mild, relatively constant ground temperature as opposed to a very warm and wildly fluctuating air temperature, such as on a 105-degree day.

So, this sounds rather simple. But it’s not that simple and you rarely see these installations on the West Coast (with a few notable exceptions). The execution is not for the faint of heart and most code officials need convincing that you know what you are doing as they are generally unfamiliar with this idea.

CHALLENGES ALONG THE WAY

- Finding an installer for the new heat pump who knows exactly what they are doing, minimizes time in your house (virus exposure), and knows every step of the process.

- Picture having a large military tank parked on your front yard, steel treads and all: The drilling rig that bores the holes into the ground for the geothermal piping is a truly formidable beast. The drilling rig also is accompanied by an armada of supporting equipment that creates a cacophony of diesel engines running constantly. Our driveway was taken over by a large storage tank for muddy water, used in the drilling process. Lasting weeks, our neighbors were initially quizzical, wondering if we had struck oil. They were excited to hear about the project, though, and very understanding (although I’m sure they were glad to see the rig go).
The only good thing was taking a rather idyllic-looking photo of the rig with fall leaves changing color – perfect for one's holiday card.

But think of having this armada visit you twice – which is what needed to happen because one of the vertical piping pairs unfortunately had a leak and an entirely new riser set had to be installed. The entire drilling contingent had to return to the front yard again, but the COVID surge also shut down driller operations, so the project had a temporary hiatus, returning to complete the job in February.

*The heat pump system, located in our attic where our furnace used to be*
Above, the flexible dual water pipes that run into the house, up through the walls, and into the attic to the heat pump system

- Crawling under the house or in the attic – one has to connect the geothermal bores outside with the new heat pump inside, and to save cost I did a lot of this myself. During a pandemic you don’t want outsiders in your house for an extended period of time and this jig-saw puzzle takes time and perseverance to pull new main piping in a tortuous path to where the heat pump is located. To double the fun, a new (high capacity) electrical feeder is also needed for the heat pump’s operation – so in my case this meant significantly more time in the attic.

- New front landscaping: After having a drilling rig on the front yard and then connecting the vertical borings with 4’ deep horizontal trenches reminiscent of a WW1 battlefield, the lawn was now a mud field and a new yard was mandatory. When it rained the trenches filled with water and the yard was an unbelievable quagmire of oozing, slick clay. We took the opportunity to eliminate grass and reduce water use in the new landscaping plan (this is the water part), and we couldn’t be happier with the result.
Trenches to connect the water from the three drill holes. If there was any doubt that our soil is impervious clay, let it now rest.

Imagine being done with the project and using no natural gas for heating; a much more efficient cooling system; a new and very attractive front yard that has reduced water usage without a lawn; a solution that adds value to the house, is a wonderful cocktail story, and will be running strong many decades to come.

Imagine looking at this every day…

In place of lawn, a reduced water-use landscape
I can imagine all of this, but I am glad this project is (almost) over too.

PS. Everything works great, by the way and exceeds my expectations. If you are considering this project, it qualifies for the lucrative solar tax credit, but do it soon in order to take advantage of the credit before it expires.

Clark Bisel - has more than 30 years of prior experience with a leading international mechanical, electrical, plumbing engineering firm. He now heads his own firm which counsels owners and design teams on new strategies for the built environment.

Mr. Bisel's completed design projects exceed 45 million square feet of space in various building types and systems. These encompass commercial developments, significant historic buildings, campus environments, central utility/co-generation plants, communication systems, energy efficient systems, sustainable facilities, phased design, and feasibility studies. Clark has historically been very active in international projects.

He is recognized as an industry leader in sustainable design. His projects have been recognized by their uniqueness in approach and for their energy performance results. These projects have promoted their inter-disciplinary nature required to result in environmental efficiency gains. He is a design advisor to several architects and developers to promote new, strategic thinking regarding energy performance in buildings.

Significant factors related to sustainable design:

- He was involved during the formation of the United States Green Building Council and his previous firm is one of the original founding members.
- He has been a committee member to establish LEED criteria for Core and Shell projects.
- He has numerous projects at Platinum, Gold, and Silver LEED certification levels.
- Several projects have received AIA Committee on the Environment Top 10 recognition.
- He has completed Zero Net Energy projects (ZNE), including one of the largest projects in the United States (net zero ready).