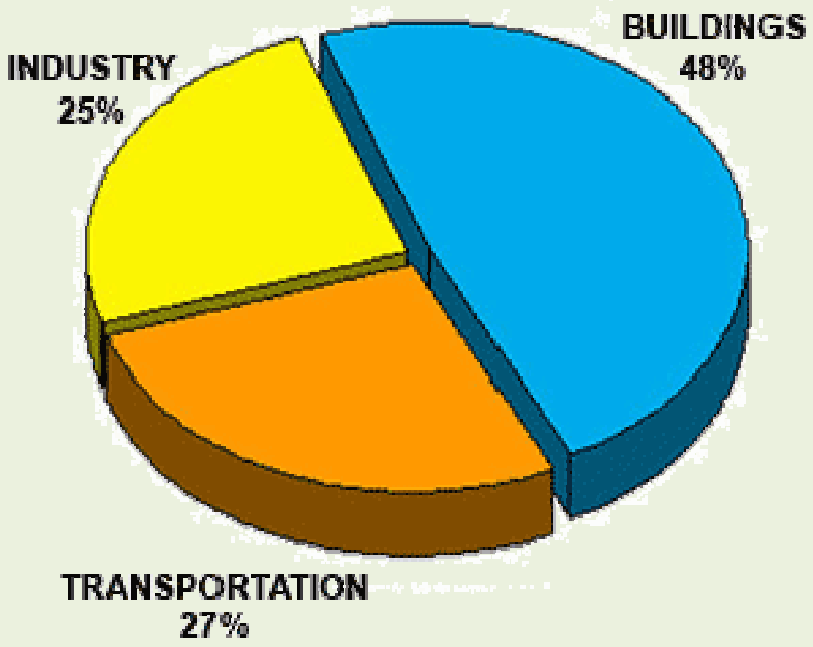

Newfoundland & Labrador
Water Well Workshop
April 7, 2009
What does global warming have to do with well drillers?

- Energy consumption in buildings
- **What do well drillers have to do with geothermal heating and cooling?**

Buildings consume about 48% of all energy used in North America. Heating and cooling is a large percentage of that use. Geothermal heating and cooling can reduce total energy consumption in buildings by half.

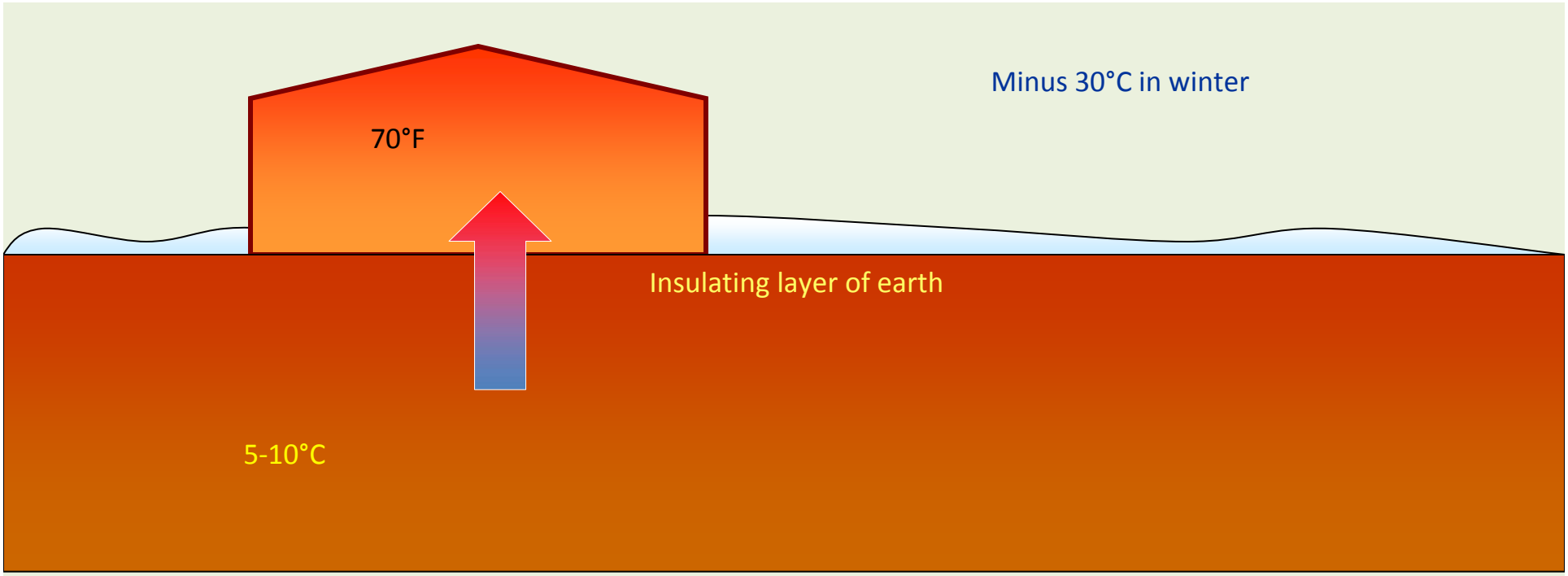
Geothermal systems transfer energy to and from the ground by burying pipe in it.



http://www.architecture2030.org

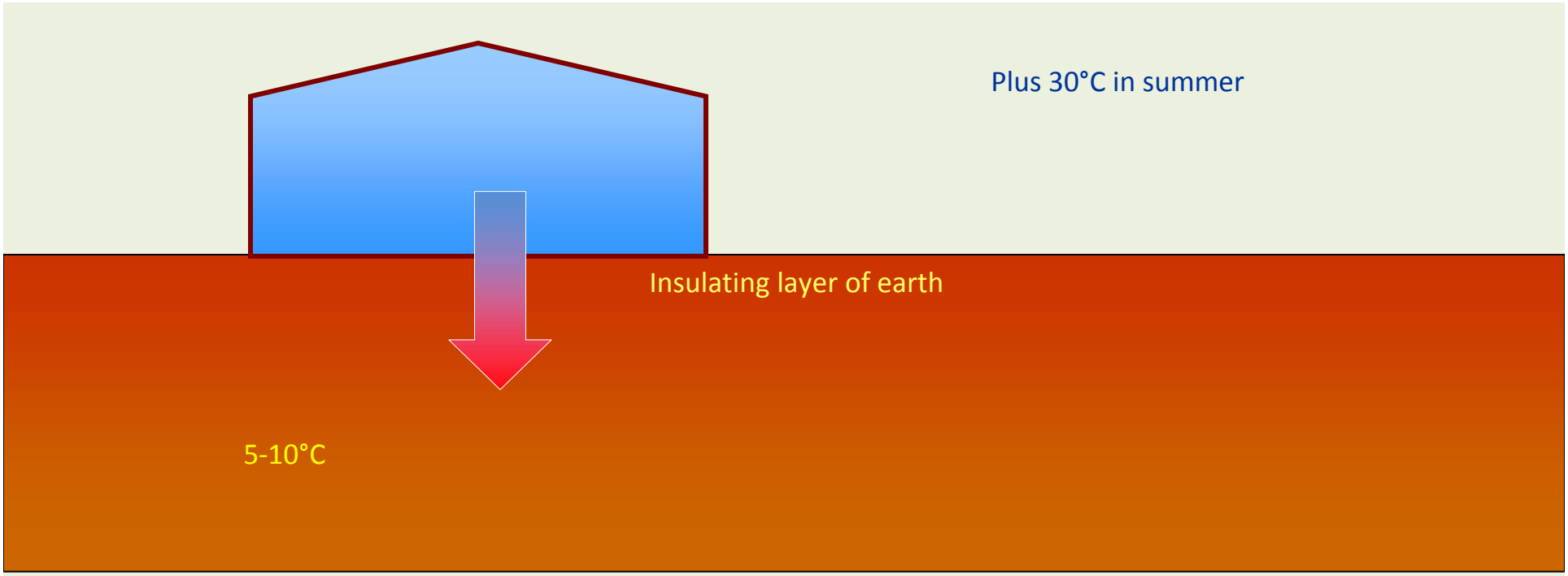
- What is geothermal heating and cooling?
- **A geothermal system moves heat to and from the ground**

In winter heat is extracted from the ground. The ground is usually about the same temperature as the average annual air temperature of the area. In Canada the ground temperature ranges from about 5°C to 10°C. That's a lot warmer than the winter air temperature.



- What is geothermal heating and cooling?
- **A geothermal system moves heat to and from the ground**

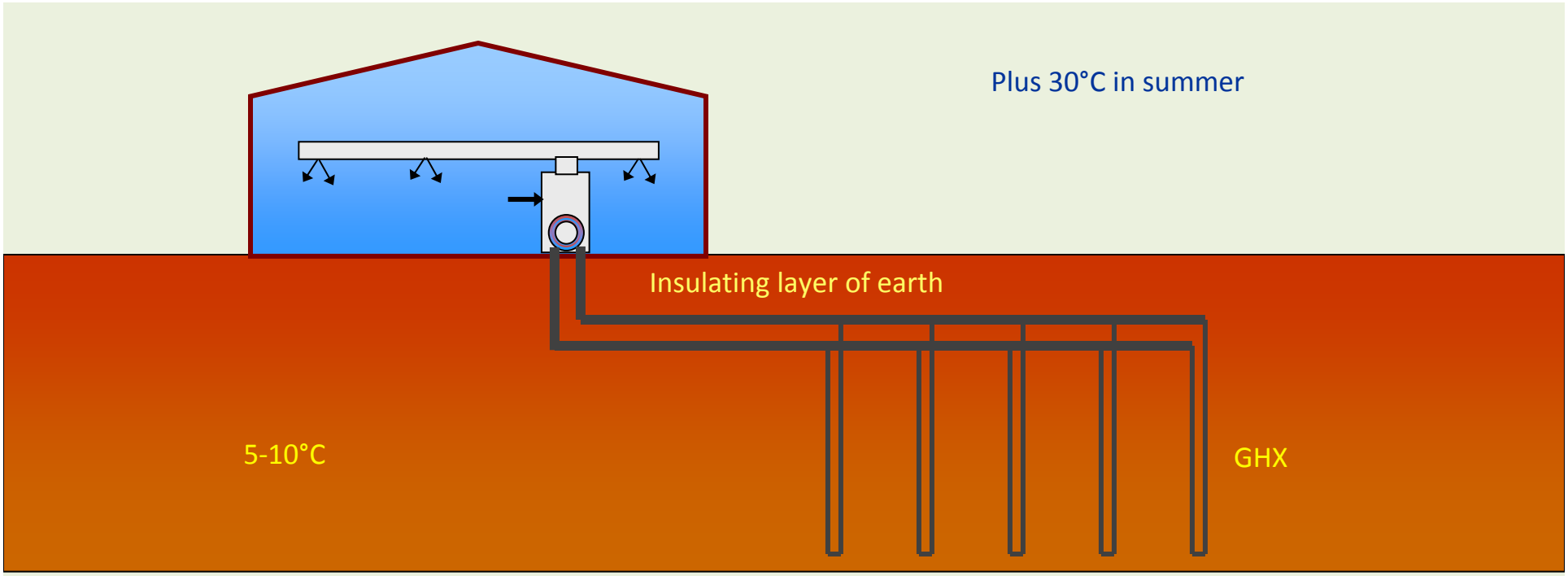
In summer, heat is taken from a home or building and is transferred to the ground. Since the ground is much cooler than the air temperature outdoors, it works more efficiently than a conventional air conditioner.



- What is geothermal heating and cooling?
- **A geothermal system moves heat to and from the ground**

Energy is transferred from a building by burying plastic pipe in the ground around it. Heat transfer fluid (water and antifreeze) is circulated through the pipe. A heat pump in the building either cools the fluid to heat the building or cools the building and heats the fluid.

This is referred to as a “ground heat exchanger”, or GHX.



- What is geothermal heating and cooling?
- **A heat pump works like a refrigerator**

A heat pump works exactly like a refrigerator. Heat is taken from food and milk you place in the fridge, keeping it cool. Heat is rejected into the kitchen through the coils at the back of the fridge. If you keep removing the cold milk and replacing it with warm milk, the fridge will heat your kitchen.

- What is geothermal heating and cooling?
- **What makes geothermal efficient?**

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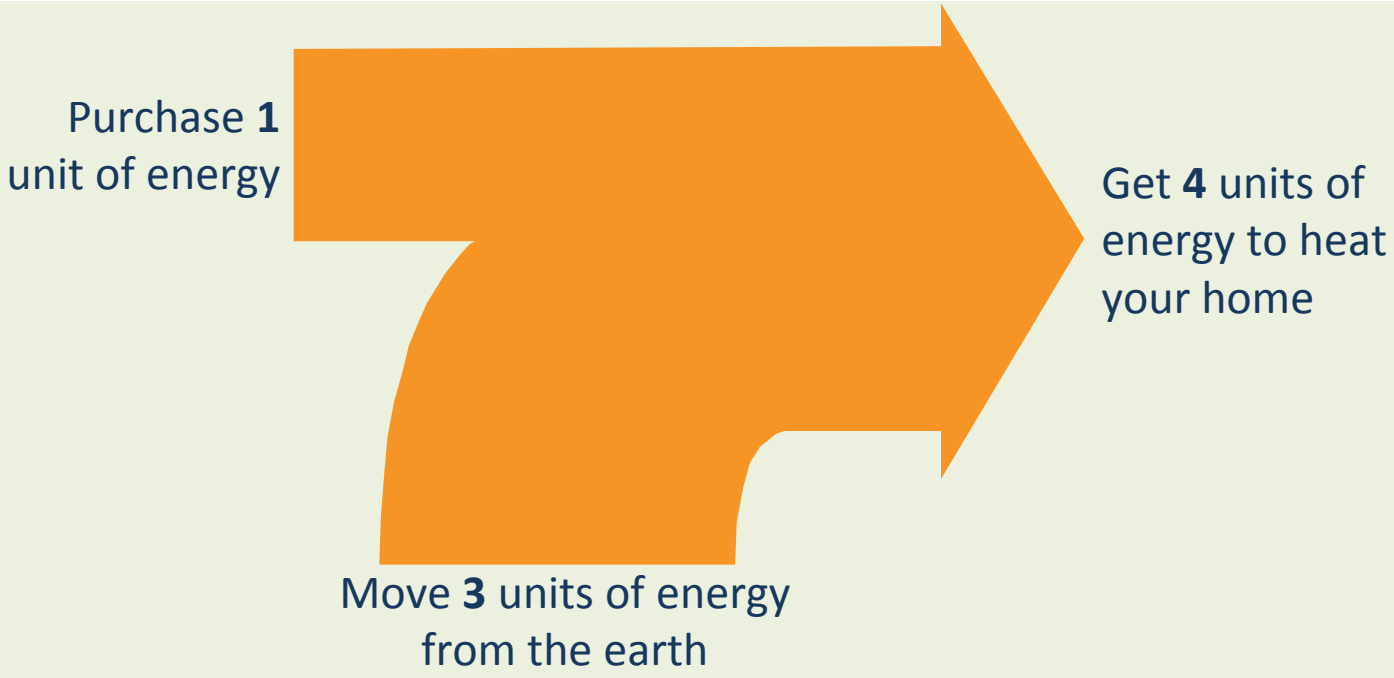


- How does geothermal affect drillers?
- **Lots of drilling in commercial projects**

Well drillers are becoming an important part of efficient heating and cooling of buildings across North America and around the world. This photo shows 5 drill rigs at work installing a ground heat exchanger for an IKEA store in Dublin, Ireland drilling approximately 600 boreholes to a depth of 150 m. For some larger projects, several drillers often partner to complete the borehole field in the time required.

- How does geothermal affect drillers?
- **Drilling under buildings**

The Manitoba Hydro Building in Winnipeg is heated and cooled with 280 boreholes 122 m deep…a total of 34,200 m (112,000’) of borehole.

- How does geothermal affect drillers?
- **All kinds of commercial buildings**

The Mission Centre Offices in Kelowna, BC, about 4,700 m2 (50,000 sq ft), includes 96 boreholes to a depth of 90 m (300’)

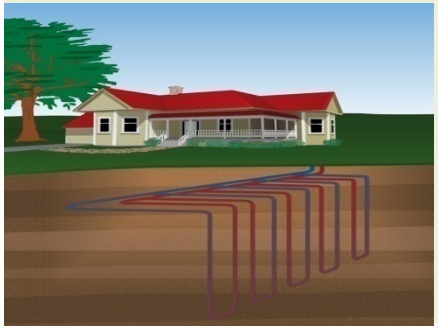
- How does geothermal affect drillers?
- **Homes**

A typical house will require 150 to 500 m (500’ to 1,600’) of vertical borehole to provide enough energy.

- Who are you competing against?
- **Many different GHX designs are available to a geothermal designer**

A geothermal system is more expensive to install than almost any other heating and cooling system. As a geothermal system designer, there are a variety of options that can be used as an energy source, and almost always the least expensive option to build is the option selected.

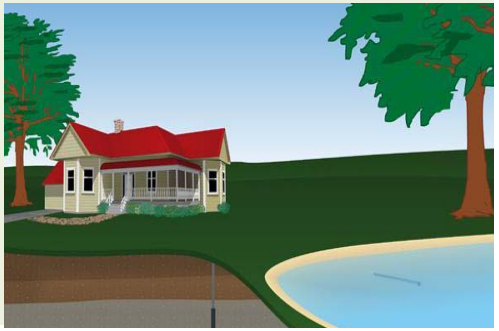
Vertical GHX



Horizontal GHX

Pond HX

Open Well



- Who are you competing against?
- **Horizontal trenching**

A horizontal GHX is installed simply by excavating a trench or series of trenches, laying HDPE pipe into the trench, and replacing the earth on top of the pipe.

If the land area is available, it is fairly easily installed. It can usually be installed for 25% to 60% lower cost than a vertical GHX.

- Who are you competing against?
- **Pond and lake HX's**

On some building sites a lake or pond, or even the ocean can provide a reliable energy source at a very competitive cost.

- What are the advantages of vertical GHX's?
- **Vertical GHX's**

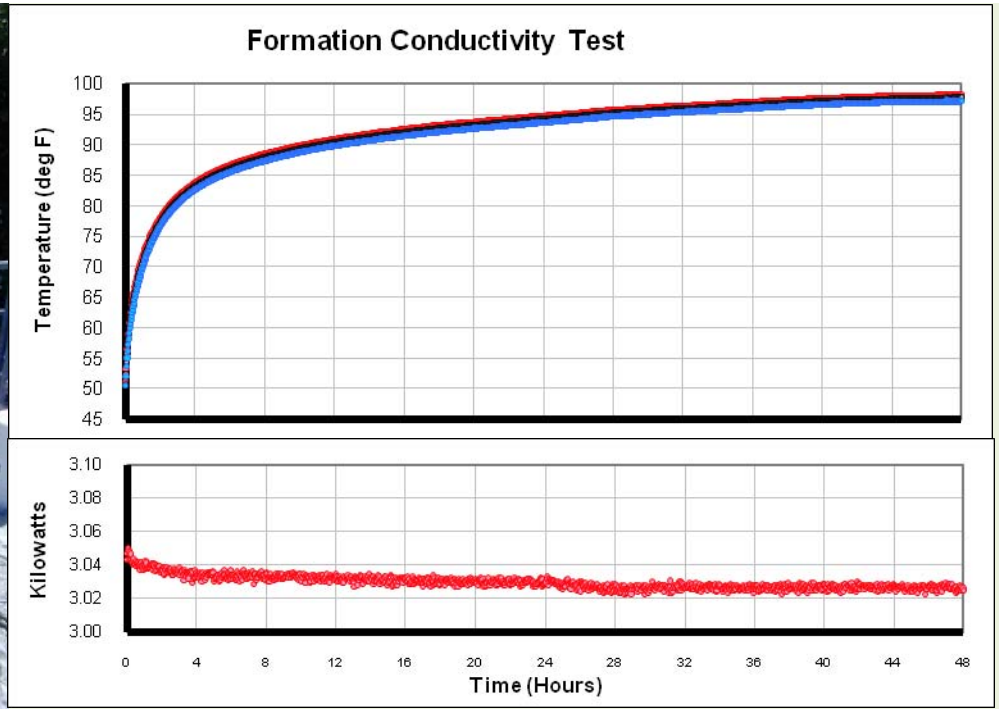
The advantage of a vertical GHX is that less land area is required. Many systems are being installed where the building is built on top of the borehole field.

- What does a driller have to do with designing a vertical GHX?
- **Determining the most economical drilling depth for a specific site**

As geothermal system designer, our job is to optimize the cost and efficiency of a geothermal design. We rely on drillers to tell us the optimum depth to drill to based on the equipment available in an area and the drilling conditions on a specific site. Large projects will often require drilling a test hole.

- What does a driller have to do with designing a vertical GHX?
- **Testing the heat transfer capability of the ground**

Larger geothermal projects often require drilling a test borehole, with a U-bend grouted in place, and a thermal conductivity test to determine the heat transfer capability of the earth on a specific site. Often drillers provide testing services to drill and log a borehole, install a U-bend and perform a thermal conductivity test that will help determine the feasibility of a geothermal system for a project.



- What's involved in installing a vertical GHX?
- **Drilling the borehole**

The advantage of a vertical GHX is that less land area is required. Many systems are being installed where the building is built on top of the borehole field.

- What's involved in installing a vertical GHX?
- **Drilling the borehole**

In some projects drillers have invested in the right equipment to allow drilling the boreholes inside the building. In this project an electric drill rig is powered by a generator outside the building.

- What's involved in installing a vertical GHX?
- **Inserting the U-tube**

The advantage of a vertical GHX is that less land area is required. Many systems are being installed where the building is built on top of the borehole field.

The borehole must be grouted for most projects to ensure contact between the earth and the pipe, to minimize the risk of cross-contaminating aquifers and to prevent contamination of an aquifer because of leakage from the surface.

In some projects it may be necessary to add silica sand to the bentonite grout to enhance the heat transfer between the pipe and the ground.

- What's involved in installing a vertical GHX?
- **Grouting the borehole**

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- What's involved in installing a vertical GHX?
- **Grouting the borehole**

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Note that specialized grouting equipment is required to pump high-solids grout into the borehole and with thermally enhanced grout (silica sand is added to the grout)

- What's involved in installing a vertical GHX?
- **Fusion welding & excavation**

Each borehole must be connected to supply and return piping runouts, which in turn are connected to heat pumps in the building to transfer the energy to and from the ground.

- What's involved in installing a vertical GHX?
- **Supply & return runout pipes between GHX & building mechanical room**

Heat transfer fluid is circulated between the heat pumps in the building, through supply and return pipes to the boreholes.

- What's involved in installing a vertical GHX?
- **Supply & return runout pipes between GHX & building**

In some projects the GHX contractor installs the piping through the building wall into the building.

Supply and return runout pipes are connected to the piping system in the building. In some cases it is the responsibility of the GHX contractor to install the pipes into the building.

- What's involved in installing a vertical GHX?
- **Connecting the GHX piping system to the building piping system**

Supply and return runout pipes are connected to the piping system in the building. In some cases it is the responsibility of the GHX contractor to install the pipes into the building.

Some projects may require the construction and/or installation of a "geothermal vault" and connection of larger pipes (6-12") into the building.

- What's involved in installing a vertical GHX?
- **Filling the system with heat transfer fluid**

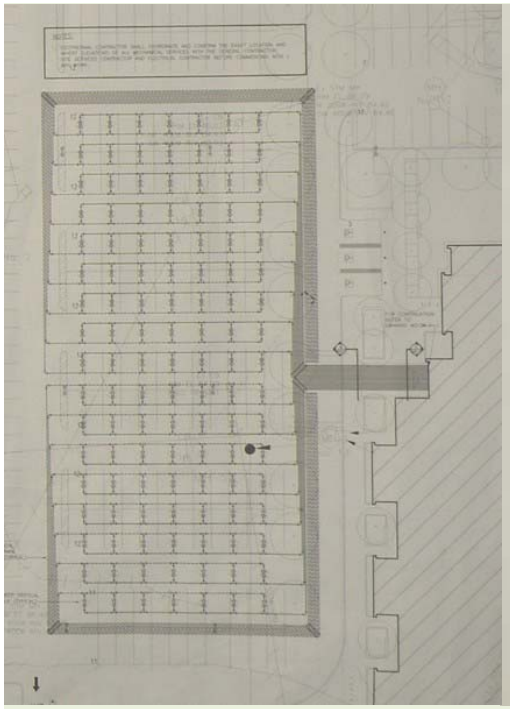
In many projects it is the responsibility of the GHX contractor to supply and install the heat transfer fluid. Three fluids are commonly used...methanol, ethanol or propylene glycol. The work will have to be coordinated between the GHX contractor and the building mechanical contractor.

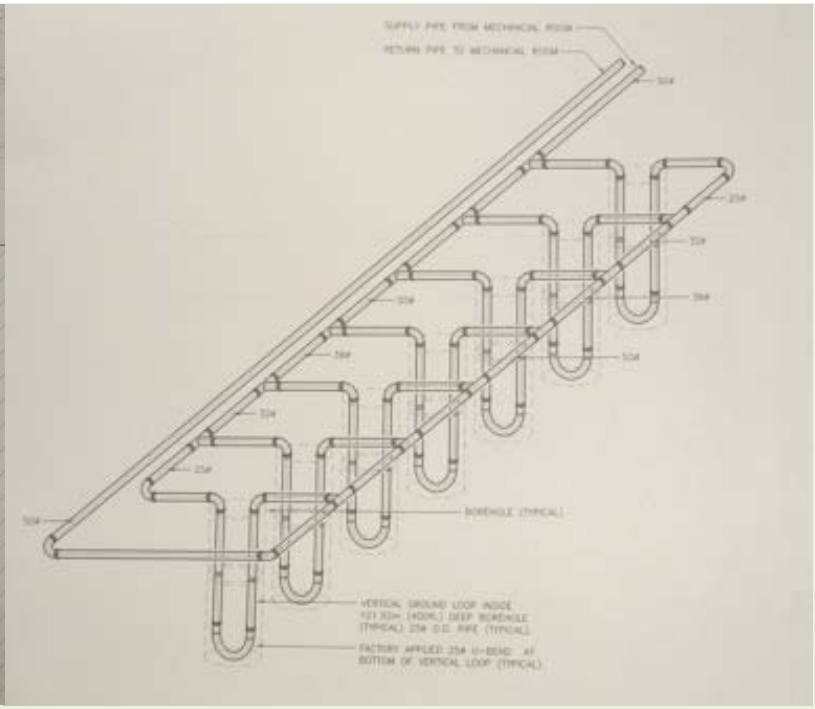
- What's involved in installing a vertical GHX?
- **Returning the ground to original condition**

In most projects it is the responsibility of the GHX contractor to level the ground over the borehole field. In some cases, the ground may have to be compacted to allow the construction of a parking lot or other structure above the borehole field.

- What's involved in installing a vertical GHX?
- **What will you be working with?**

A well designed geothermal project will provide detailed construction drawings showing where the boreholes are to be drilled, the drilling depth, borehole diameter, what size and type of pipe that is to be used, the type of grout to be used, etc.





- What's involved in installing a vertical GHX?
- **There is a CSA Standard – C448**

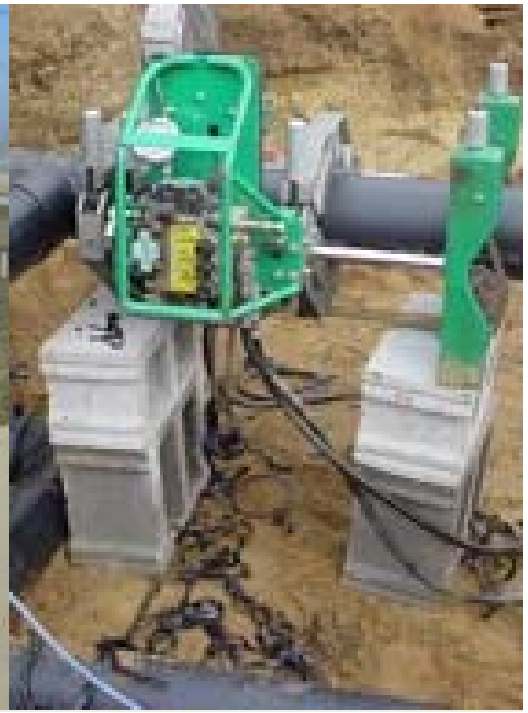
There is a CSA Standard for the design and installation of a ground heat exchanger that, as a driller, you should become familiar with. The standard addresses the need for test boreholes, grouting, piping material that is acceptable, etc.

- What's involved in installing a vertical GHX?
- **What equipment will you need?**

To install a GHX efficiently, some specialized equipment is required. This includes:

- Unit to insert U-bend into borehole
- Grout pump and mixing equipment
- Flush cart to fill GHX
- Fusion welding equipment (socket fusion, butt fusion, electro-fusion)





- What other opportunities are there?
- **Thermal conductivity testing equipment**

Large GeoExchange™ systems often require a “thermal conductivity test” while the system is being designed. The test requires a borehole with a U-tube installed and grouted. After a minimum of 5 days a heat source (usually a generator and electric elements) is connected to the U-tube and heat is injected for a minimum of 40-60 hours.

Drillers in many areas are providing these services to engineering firms.

- Quality assurance / quality control
- **Installing the borehole field as specified is important**

As a GHX contractor, you are building the energy source for a building. It’s important to ensure the amount of pipe required is installed. Specifications often call for pipe to be marked showing length markings and total length of each U-bend.

- Quality assurance / quality control
- **Installing the borehole field as specified is important**

The spacing between boreholes in a large borehole field can have a significant impact on the performance of the GHX. Depending on the building heating and cooling loads, installing the boreholes too close together will change the temperatures that the GHX will operate at over the long term, and can eventually cause the GHX to fail because it gets too hot or too cold for the equipment installed. Many specifications will require the driller to survey the borehole field or get a GPS location for each borehole.

- Quality assurance / quality control
- **The system must be kept clean**

Heat exchangers in heat pumps, valves and other system components can be sensitive to dirt in the system. It's important that dirt is kept out of the GHX piping. Often fusion welded caps or other hard to remove end caps will be specified for pipes that are not yet connected.

- Quality assurance / quality control
- **Grouting from the bottom up is important**

Grout connects the heat transfer fluid, through the pipe, to the earth. The system will not work if there is no connection. For most projects the specifications will require that the grout is installed with a tremie line from the bottom of the borehole. The heat transfer capability of the grout changes with the amount of solids and the amount of silica sand added. Geothermal system designers will often conduct random site inspections during drilling to ensure the boreholes are drilled to depth and the grouting is being done as specified.

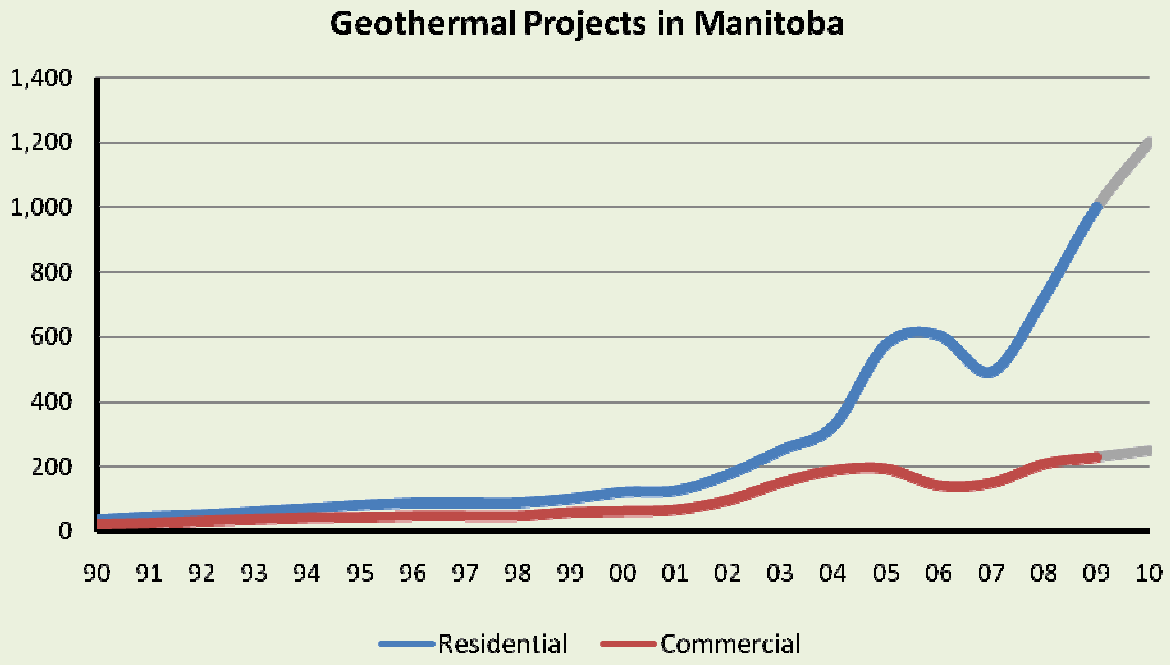
- Quality assurance / quality control
- **Quality of fusion welding is important**

High-density polyethylene must be fusion welded as specified to ensure the integrity of the GHX. Pipe and fusion equipment manufacturers provide fusion welding training for socket fusion, butt fusion and electro-fusion. Most specifications will require that people performing pipe fusion on a project must have current fusion welding certificates.

- Why should you give a damn?
- **It keeps your drill rigs busy**

The geothermal industry is growing rapidly for both residential and commercial systems. There is a growing market opportunity for drillers who can install a GHX. With significant incentives from the federal and provincial governments as well as financing and incentives from several utilities, the market can be expected to continue its rapid growth.

The LEED™ certification program also promotes the use of energy efficient technologies.



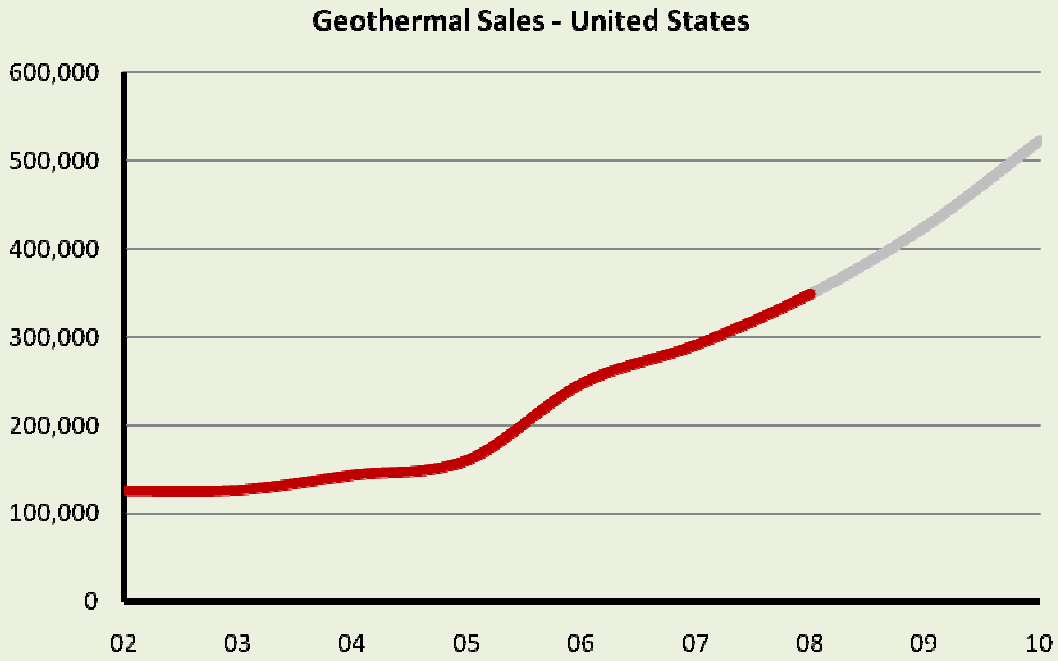
Note: many commercial projects have a large number of heat pumps in a project. A typical residential project will have one 5-ton heat pump, while a commercial project will have up to several hundred tons of equipment.

A residential project will have 250-300 m of drilling, while a large commercial project may have 3,000 to 10,000 m of drilling

- Why should you give a damn?
- **It keeps your drill rigs busy**

Various levels of government and electric utilities are heavily promoting geothermal systems. The federal government provides incentives of up to $5,100 for retrofit residential systems. Several provinces add their own incentives.

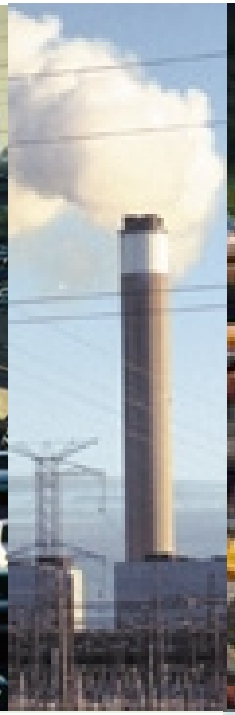
Electric utilities in several areas provide incentives or financing to encourage the installation of geothermal systems.



- Why should you give a damn?
- **It's good for the environment**

The geothermal industry reduces our impact on the environment. People are interested in "green". The geothermal industry in Manitoba alone is responsible for reducing CO2 emissions by 38,000 tonnes per year. That's the equivalent of taking 11,000 cars off the road.

When energy is taken from the ground the amount of energy that has to be shipped from across the country or halfway around the world is greatly reduced.



- Why should you give a damn?
- **It's good for the economy**

The geothermal industry reduces the consumption of electricity in Manitoba by an estimated 39,300,000 kWh per year...that's about $2,358,000 worth of electricity per year (at $0.06 per kWh.

Manitoba Hydro exports power not used in Manitoba. People with geothermal systems have more money to spend on other things.

- The geothermal industry & drillers
- **Questions or comments?**

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