Geothermal Heating & Cooling in Health Care Applications

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Intro to Geo

- Why Geothermal?
  - Future outlook for Geothermal in Ontario

- What is Geothermal?
  - Overview of the technology
  - How it is applied

- Applications
  - Specific examples of healthcare facilities
The Future for Geo Looks Bright

- Provincially funded programs – Multiple Branches of Government
- Investment from both public and private sector
- Exponential growth in multiple sectors
  - Residential new construction and retrofit
  - Multi family and condo market investment
  - Institutional, educational and healthcare investment
  - Indigenous community investment
- Geothermal heating and cooling will be the fastest growing technology in the province of Ontario over the next 5 to 10 years.
Common Misconceptions

- Geo is very expensive and doesn’t give me a return on my investment
- Geo is very time consuming during construction and interrupts the construction schedule
- Geo systems never work properly
What is Ground Source Energy?

(not geothermal)
Ground source captures indirect solar energy

- 19% absorbed by water vapor, dust
- 4% absorbed by clouds.
- 17% reflected by clouds.
- 6% reflected by surface.
- 47% absorbed by ground

Ground temperatures are similar to the average annual air temperature
Average Ground Temperature

- Near the surface the ground temperature varies with the air temperature.
- At greater depths the soil temperature becomes more stable throughout the year.
- Approximately 50°F (10°C) in southern Ontario
Ground Source Heating

- The earth provides a stable and renewable energy source to supply the energy required to heat the building.
- The low temperature heat can be utilized using standard refrigeration units.
- The refrigeration process is 3 to 7 times more efficient than combustion heating.
Ground Source Cooling

- In cooling the ground easily absorbs heat removed from our buildings.
- Cooling equipment is functionally identical to standard refrigeration units
- It is 30% to 40% more efficient for the system to reject heat to a GHX buried in 45°F (7°C) earth than air at 90°F (32°C)
Ground Heat Exchanger (GHX)

- Energy is transferred by circulating fluid through plastic pipe buried in the ground.
- Pipes can be below the building or adjacent below a field or parking lot.
Ground Heat Exchanger options
Vertical GHX

- Boreholes are typically drilled to a depth of 250 to 650 feet (76 to 198 m) deep
- A pair of HDPE pipes with a U-bend connection are inserted into the borehole and sealed with a cementitious grout mixture
- Requires minimal footprint and can be located beneath the building
Horizontal GHX

- Installed by excavating trenches 6 to 10 feet (2 to 3 m) deep and laying HDPE pipe
- Alternatively can be done with horizontal directional drilling.
- If the land area is available, it can often be installed for 25% to 60% lower cost than a vertical GHX
Lake or Pond GHX

- A lake, pond, or river can be used as a consistent and effective energy source at a much lower cost than other GHX options
- Requires special installation to prevent seasonal damage
- May require permitting from provincial or federal agencies
Some projects connect a common GHX to a number of buildings.

Instead of piping hot and chilled water through insulated pipes in a conventional district arrangement, ambient/ground temperature fluid is circulated.

Greater diversity of loads offers numerous financial and operational advantages.
Design Process
Feasibility

Client desires GeoExchange system

- Develop energy model
  - Monthly peak loads
  - Monthly energy loads
  - Annual energy balance
- Mechanical system impact
  - Equipment efficiency
  - Distribution design temp
  - Fresh air system
- Site & geology
  - Land area for GHX
  - Geological conditions
  - Regulations for GHX

- Vertical GHX
- Horizontal GHX
- Pond/lake HX
- Open well
- Standing column

Hybrid options - boiler, fluid cooler, energy storage, etc.

Work with team to modify loads & energy balance

Confirmation

- Confirm geology of site for GHX performance
  (TC or pump test if warranted)

Design

- Design ground heat exchanger (GHX)
- Design mechanical system
- Specifications and drawings

Implementation

- System construction
- Quality control, commissioning, operator training

Design conventional HVAC system if capital cost and/or site unsuitable for Geo-Exchange system
Energy Modeling

- In order to design the GHX we must know the peak and annual energy loads to and from the building.
- Requires detailed analysis of the building and mechanical systems
Energy Modeling

- Basis of design and critical for any project
- Has become very common in the industry but with varying intents:
  - Compliance
  - Incentives
  - Design
  - Predictive
A GHX works best, and it’s size can be reduced if loads are balanced over the year.

Many large buildings in Canada will have a greater demand for cooling than heating.

Supplementary systems can significantly reduce capital costs without large impacts on operating costs.
Energy Requirements and Balance

- Based on energy model we can predict the long term GHX temperature profile.
- This must be stable, otherwise the GHX will prove unusable over time.
- Simple adjustments to the building construction and/or building mechanical systems will balance the energy loads and stabilize the temperature profile.
Iterative Process

• Proper modeling allows us to assess the profile of the base building systems
• Adjustments can be made to balance the energy loads
• Our process includes sensitivity analysis to anticipate problems such as improper operation or dramatic changes in weather patterns

![Cooling Dominant](image1)

![Balanced loads](image2)

![Heating Dominant](image3)
What if I don’t want to use heat pumps?
Any hydronic based system can work
How do we make all of this work?
Hybrid Systems

- Supplementary heating sources (i.e. combustion boiler) are very common
- Supplementary cooling (i.e. fluid cooler) is much more expensive
- Ideally done with other efficiency and renewable sources
Technology options

- There are a number of options for energy balancing:
  - Snow Melt/Heat Rejection Pad
  - Active window shading
  - Domestic Water Preheat
  - Hybrid Makeup Air Systems

- Also options to reduce peak energy:
  - Thermal Energy (Ice) Storage
  - Co-Generation Plants
  - Biomass/Fuel Boiler
INTEGRATION

- Design mechanical equipment and systems to optimize the ground source asset
- Install the controls equipment required to operate the system effectively
- Commission the systems to ensure they operate as intended from initial occupancy
- Monitor the system performance to ensure it continues to operate as designed for the life of the building
Peel Memorial Centre
Systems Installed

- 100 vertical boreholes - each 600’ deep - installed adjacent to building in parking lot
- Connected to heat recovery chiller plant
- Supplies base load heating and cooling year round
Selkirk Regional Health Centre
Systems Installed

- Horizontal directional drilled system installed in three modules below adjacent parking spaces
  - Almost 200,000 feet of pipe installed
- Connected to central heat recovery chillers to supply 100% of cooling load and ~70% of heating load
Pine Falls Primary Health Ctr
20 vertical boreholes installed 400’ deep in adjacent parking area

Connected to central heat recovery chiller to serve new addition and existing building
THANK YOU...

QUESTIONS?

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