QUEST

Quality Urban Energy Systems of Tomorrow

Smart Communities in Cold Climates

November 18-21, 2012

Winnipeg, MB

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GEOXERGY SYSTEMS INC.

Taking advantage of diversity in Urban Environments

Jane Jacobs on diversity

In "The Death and Life of Great American Cities", Jane Jacobs said:

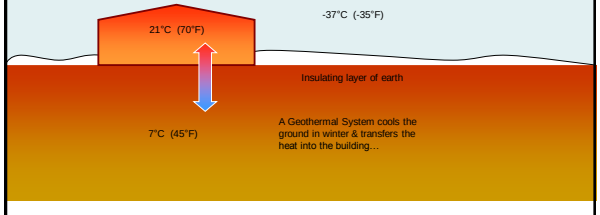
"This ubiquitous principle is the need of cities for an intricate & close-grained diversity of uses that give each other constant mutual support, both economically and socially."

The book was aimed at city planners, but the comment applies just as well to energy use & efficiency.

Taking advantage of diversity in Urban Environments

Energy stored in the ground can be extracted in the winter

The constant temperature of the earth provides a stable energy source for our buildings in winter. The ground a few feet down is a constant temperature even though the outdoor temperature drops to -37°C (-35°F)



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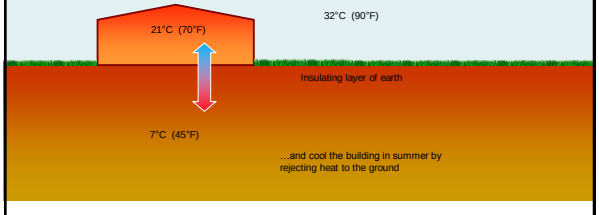
Energy from buildings can be rejected to the ground in summer

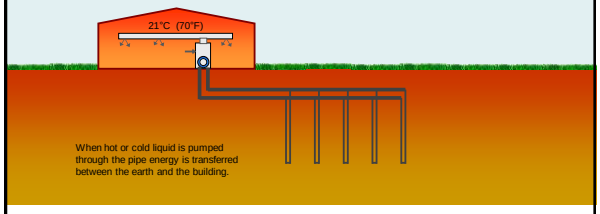
The temperature of the earth remains constant. When cooling is needed in our buildings the relatively cool ground easily absorbs heat removed from our buildings.



Taking advantage of diversity in Urban Environments

A ground heat exchanger (GHX)

By burying plastic pipe in the earth around our buildings and circulating liquid through it, we can access the constant temperature of the earth.



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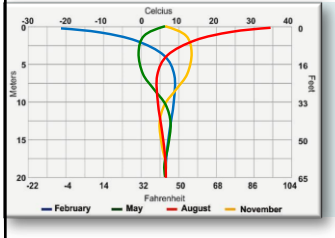
The ground can store energy

The temperature of the ground in most areas is about the same as the annual average air temperature. In Manitoba, that's about 7°C (45°F).

Near the surface the temperature changes with the seasons. Deeper, the temperature stays more and more constant.



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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.

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Ground heat exchangers

A ground heat exchanger (GHX) takes space, costs money and takes time to build.

This make it more difficult to implement ground coupled heat pump (GCHP) systems in dense urban environments, even though the energy cost savings & GHG emission reductions can be compelling.

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Building use determines energy loads

Retail spaces are used differently than office, residential and recreation spaces. Different times of day and different levels of activity, with different lighting levels and ventilation rates.

This makes heating & cooling needs much different from one building to the next.

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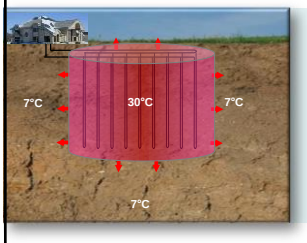
A GHX dissipates energy to the ground when the building is being cooled

The ground around the GHX heats up, and by the end of the summer heat pumps connected to it operate less and less efficiently.



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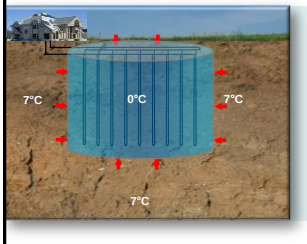
Energy is extracted from the ground as the building is heated

The earth around the GHX cools, and can freeze. As the temperature drops so does the efficiency of heat pumps connected to it.



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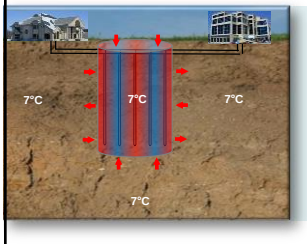
Taking advantage of building diversity with a GHX

If buildings with diverse heating and cooling needs are connected to the same GHX, one building may be rejecting heat to the GHX while the other is extracting energy.

The temperature of the GHX doesn't change as much, and systems in both buildings operate more efficiently…taking advantage of the diversity.



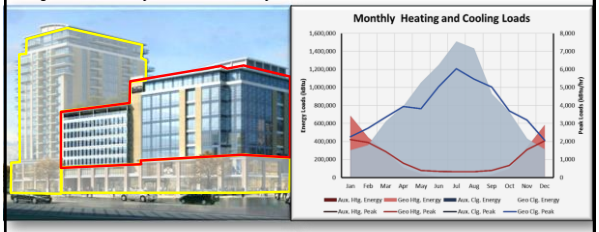
Taking advantage of diversity in Urban Environments
Mixed use development

Consider a mixed use development consisting of 74,350 m2 (800,000 square feet) of office, retail and residential space.

Taking advantage of diversity in Urban Environments
Commercial

Energy model show office space is cooling dominant because of:
- High occupancy during the day
- High lighting levels, computers, etc.
- Low ventilation rates when not occupied

These buildings are considered *"Cooling dominant"* because they reject more heat to the ground than they remove over the year.



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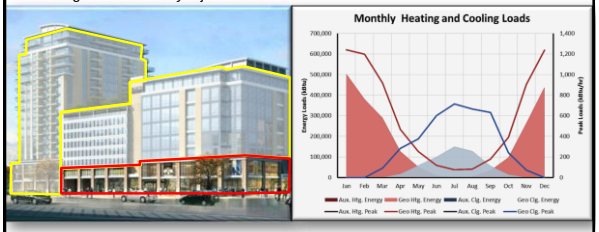
Retail

Energy loads show retail space is heating dominant because of:
- High traffic through doors
- Large glass areas
- Ventilation rates

These buildings are considered *"Heating dominant"* because the extract more energy from the ground than they reject.



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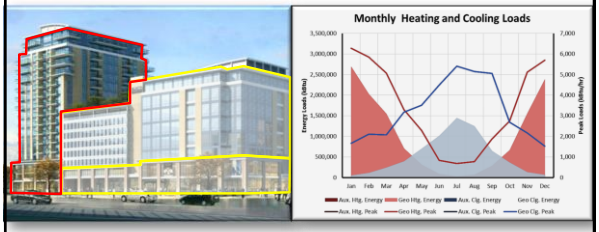
Residential

The cost of installing a ground heat exchanger (GHX) is typically the cost premium associated with a GeoExchange system. Reducing initial construction cost of the GHX is crucial to the acceptance of the technology.



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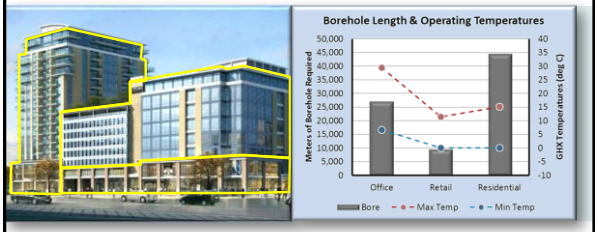
Separate ground heat exchangers

If a separate GHX is designed for the commercial, retail and residential spaces, the total length of borehole required is 81,000 m (265,900')



Taking advantage of diversity in Urban Environments
Architectural changes that can influence loads

- Glazing & orientation
- Operable windows
- Insulation specifications
- Roof specifications
- Lighting, lighting controls, day-lighting

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Mechanical system changes that can influence loads

- Distribution system design
- Ventilation strategy
- Thermal energy storage
- Domestic hot water strategy
- Snow melt to dissipate excess heat
- Auxiliary heating / cooling

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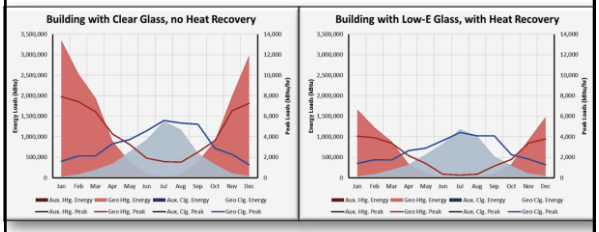
Impact of changes to building & mechanical systems

The impact the architect & mechanical systems designers can have on a building is enormous. In this example, changing glass and ventilation specifications reduces:

- Cooling energy consumption by: 10%
- Cooling peak load by: 21%
- Heating energy consumption by: 55%
- Heating peak load by: 48%



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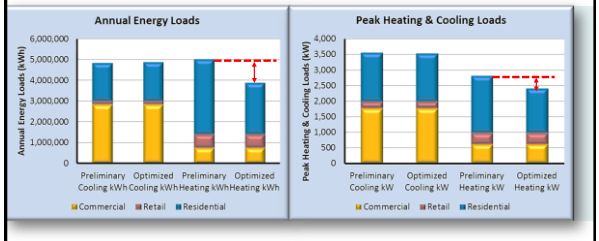
Using energy model to optimize loads for ground heat exchanger

Working with the owner & design team to optimize each building & the overall project to work well with a GHX:

- Reduces the size of the GHX
- Reduces the cost of the GHX
- Reduces energy consumption
- Ensures the long term, sustainable performance of the GHX



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Hourly energy modeling as a design tool

Using hourly weather data & detailed building schedules throughout the design process allows designer to understand the diversity & synergies in a project and to take advantage of them.

For example, building ice in storage tanks overnight produces heat that can provide space heating or hot water, while providing cooling for the building the following day.

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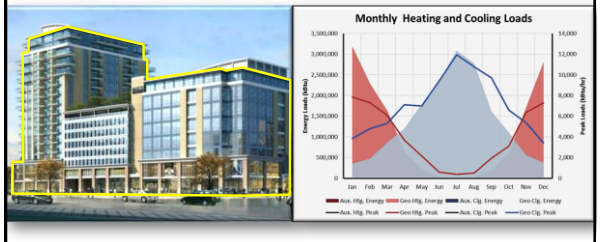
Integrated system loads

If we consider the project as a whole, the energy loads to & from the GHX become more balanced. This results in a GHX:

- That requires fewer boreholes & land area
- Is less expensive to construct
- Operates at more efficient temperatures
- Is more sustainable over time (will not overheat or freeze)



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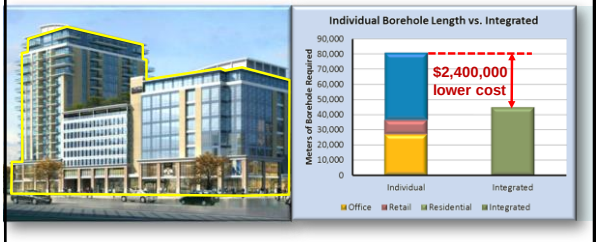
Integrated system ground heat exchanger

Taking advantage of diverse energy loads between buildings in this project reduces the amount of drilling from 81,000 m (265,900') to 45,000 m (147,600').

The 44% reduction in drilling reduces the cost of constructing the GHX by $2,400,000 or $3 per square foot on this project providing a better return on the owner's investment.



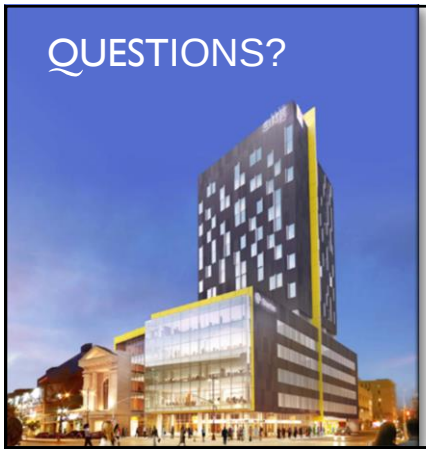
Taking advantage of diversity in Urban Environments
Land area requirements

Diverse loads from different buildings connected to a common GHX reduce the land area needed when compared separate buildings with their own GHX.

- More projects can benefit from the advantage of GCHP systems
- Logistical problems of building a GHX on crowded building sites are reduced
- More design options on a specific site can reduce GHX cost even further

Taking advantage of diversity in Urban Environments
Conclusions

- Detailed energy modeling, *used as a design tool throughout the design process* improves the feasibility of installing a GCHP system in a building
- Mixed use developments can benefit greatly if different components of the project are connected to a common GHX by moving energy from one building to another
- Taking advantage of energy loads from diverse buildings improves the energy efficiency of a GCHP system
- A GHX is an energy storage medium allowing energy storage on a daily and/or seasonal basis, allowing effective heat recovery and recycling of energy from a variety of waste heat sources



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