Direct-use Geothermal Resources in British Columbia, Canada

Catherine Hickson, PGeo, PhD

Yuliana Proenza, PGeo, MEng

Our independent earth science enables informed resource management decisions and attracts investment that creates jobs

Webinar Modules

WEBINAR INDEX

MODULE 1	Introduction & Report Overview
MODULE 2	What is, Where is and Why Geothermal?
MODULE 3	Geothermal Power, Direct-use and GeoExchange
MODULE 4	Development Steps
MODULE 5	Environmental Considerations
MODULE 6	Permitting Overview
MODULE 7	Economic Considerations
MODULE 8	Funding Options
MODULE 9	**Case Studies**
MODULE 10	Summary of Follow-up Project

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Webinar Modules

Case Studies

(Module 9)

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Webinar Modules

Case Studies
OUTLINE

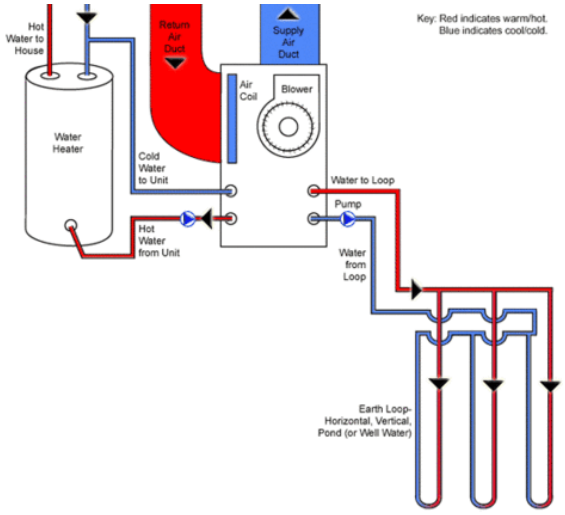
- Hot Spring Resorts throughout BC
- Current project areas in development for Direct-use and/or Power:
  - Sloquet Creek – Douglas-Xa'xtsa First Nation BC
  - Canoe Reach – Valemount BC (Borealis GeoPower)
  - Lakelse Lake – Kitselas BC (Borealis GeoPower)

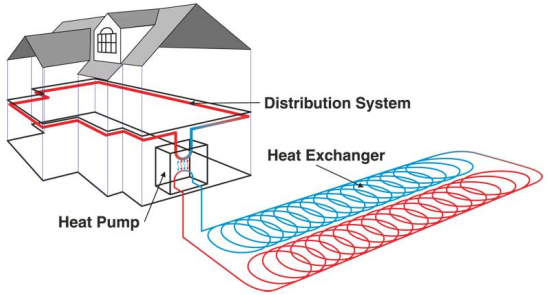
- **The capabilities of GeoExchage for Direct-use projects**
  - Alexandra GeoExchange District Energy Utility – Richmond BC
  - Gibsons District Energy Utility – Gibsons BC
  - Chapman Creek Hatchery – Sechelt BC (aquaculture)
  - Fairfield Propagators, Chilliwack BC (greenhouse heating)

Case Studies

Definition and Capabilities of Geothermal Direct-use Projects

- **HEAT PUMP SYSTEMS (GEOEXCHANGE)**
- **CAN ALSO BE USED FOR HEATING/COOLING AND HOT WATER USE AT A RESIDENTIAL, COMMERCIAL AND DISTRICT ENERGY SYSTEM SCALE**
- **The "SIMPLEST" geothermal system**
- Referred to as GeoExchange by Canada Geoexchange Coalition, a.k.a. ground-source heat pumps (GSHPs), geothermal heat pump, earth-coupled system, earth energy system
- Essentially a ubiquitous energy source, can be used for cooling/heating
- depending on location, at depths of 5-10 m a constant temperature is maintained of about 10-15° C
- Natural Resources Canada and US Environmental Protection Agency state that GeoExchange is the most:
  - energy-efficient,
  - environmentally clean, and
  - cost-effective space conditioning system available on the market





Case Studies

Definition and Capabilities of Geothermal Direct-use Projects

- **HEAT PUMP SYSTEMS (GEOEXCHANGE)**
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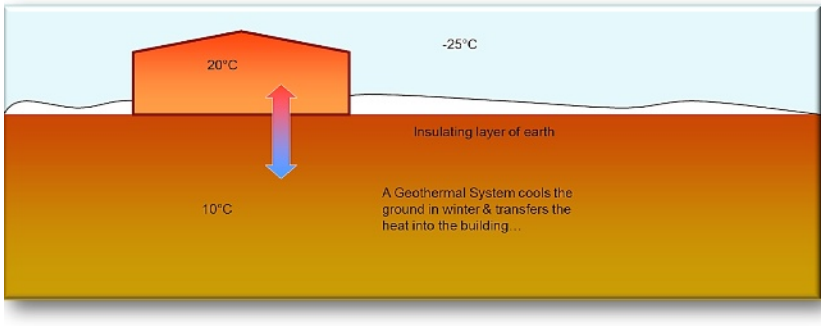
- **The "SIMPLEST" geothermal system**

District GeoExchange Systems
The earth is a heat source in winter

The temperature of the earth a few meters below the surface is very constant. In southern Ontario, the temperature of the earth in winter is about 10°C even though the air temperature may be -25°C.

It's a good heat source for a heat pump.

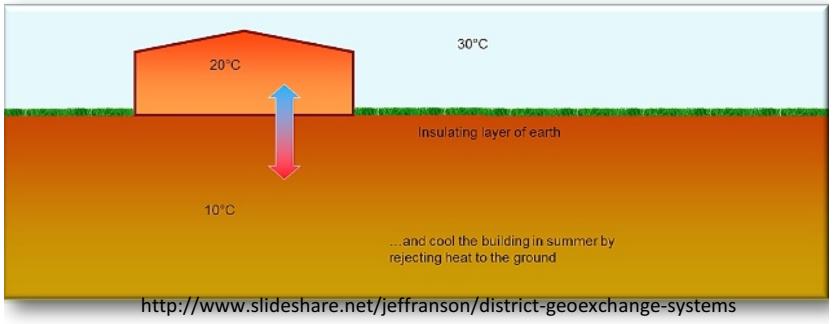


Green Building Festival – Evergreen Brick Works, Toronto, ON – October 11 & 12, 2012 Slide 2

District GeoExchange Systems
A heat sink in summer

In summer, even though the air temperature may be 30°C, the temperature of the earth is still 10°C.

It's a good place to get rid of heat removed from a building…much more efficiently than trying to reject heat to an air cooled condenser.



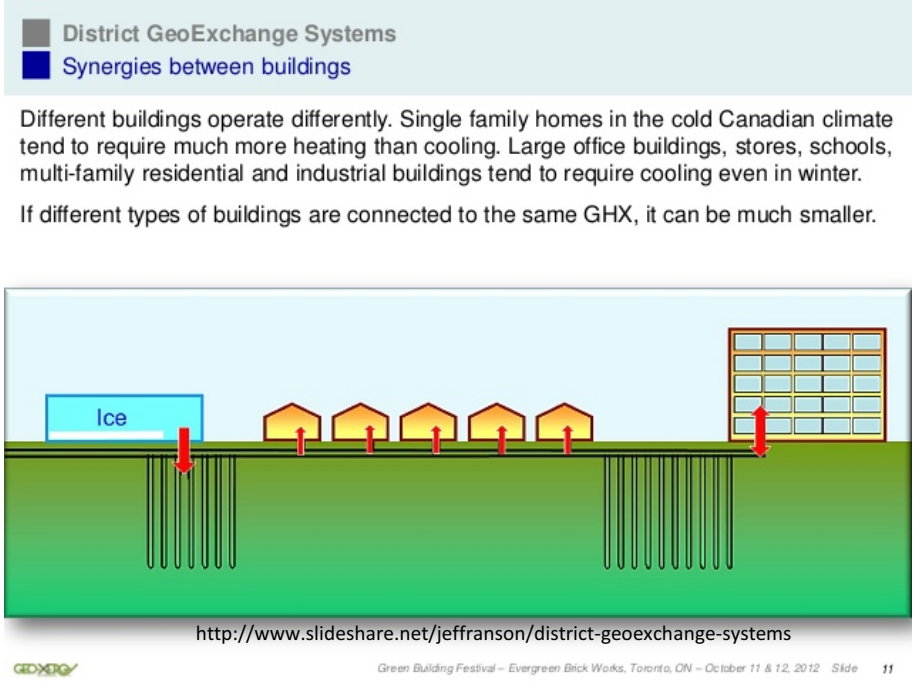
http://www.slideshare.net/jeffranson/district-geoexchange-systems

Green Building Festival – Evergreen Brick Works, Toronto, ON – October 11 & 12, 2012 Slide 3

Case Studies

Definition and Capabilities of Geothermal Direct-use Projects

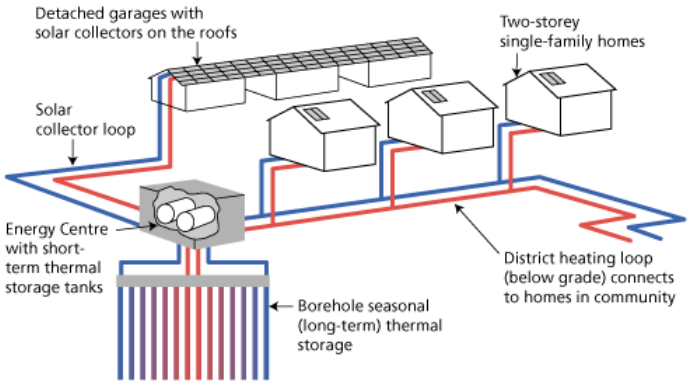
- **HEAT PUMP SYSTEMS (GEOEXCHANGE)**
- Heat pumps utilize the ground as a heat source/sink, but interconnected parts of a district energy systems can also be used as energy source/sinks
- Commercial buildings can provide heat for homes in the evenings (in addition to the heat rejected to cool certain commercial buildings)
- Community ice rinks can be a source of heat for a system
- Electricity is required to run the heat pump but the "fuel" is essentially free
- The basic element is the movement of heat from high temperature location to a low temperature location



Case Studies

Definition and Capabilities of Geothermal Direct-use Projects

- **HEAT PUMP SYSTEMS (GEOEXCHANGE) CAN ALSO BE USED FOR HEATING/COOLING AND HOT WATER USE AT A RESIDENTIAL, COMMERCIAL AND DISTRICT ENERGY SYSTEM SCALE**
- Can be utilized at temperatures at much lower temperatures than Direct-use applications
- Heat pumps "assist" by raising the intake temperature to more desirable levels of 40-60^{o}C by coupling with a working fluid and more favorable thermal properties (phase changes from liquid to gas at lower temperatures)
- Innovative solutions are being used that utilize (warm) wastewater, ocean water, hybrid systems with solar, hydro and other alternative technologies



Drake Landing solar-thermal community in Okotoks, Alberta at 1,084 m elevation.

52-house subdivision

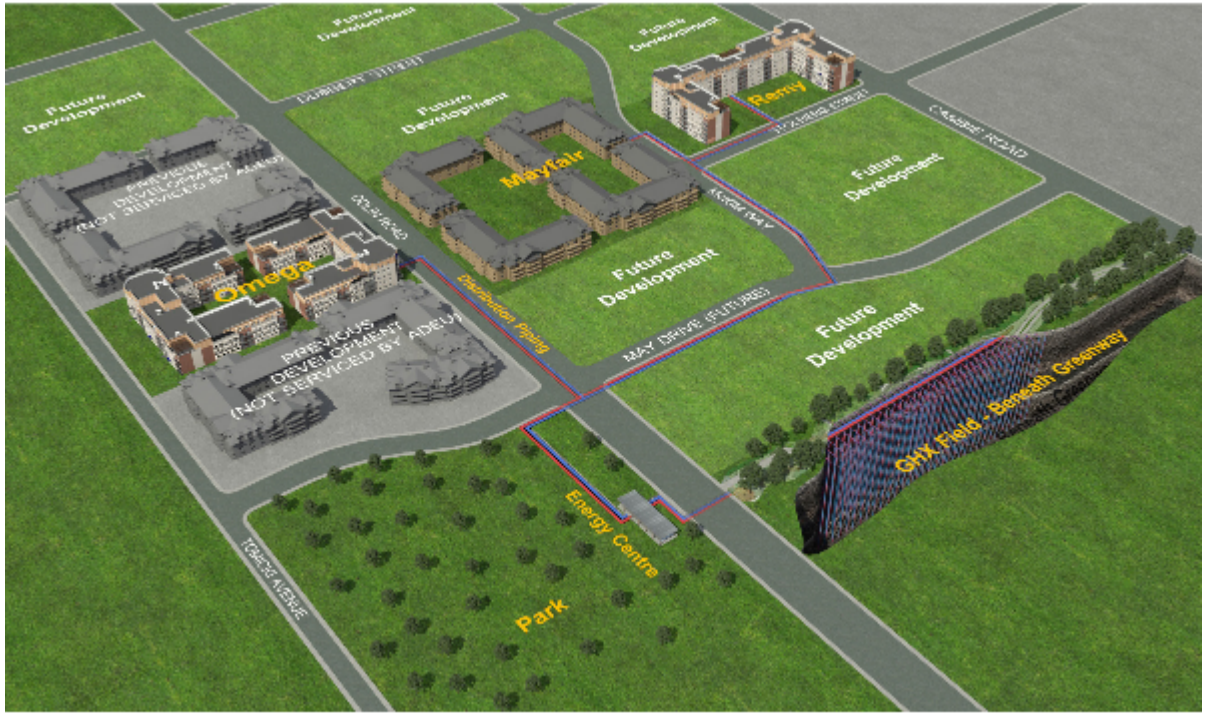
Winter low temperatures are -33^{o}C, summer high temperatures 28^{o}C

Won the 2011 Energy Globe World Award

Case Studies

Alexandra District Energy System

GeoExchange: Alexandra District Energy System, Richmond BC



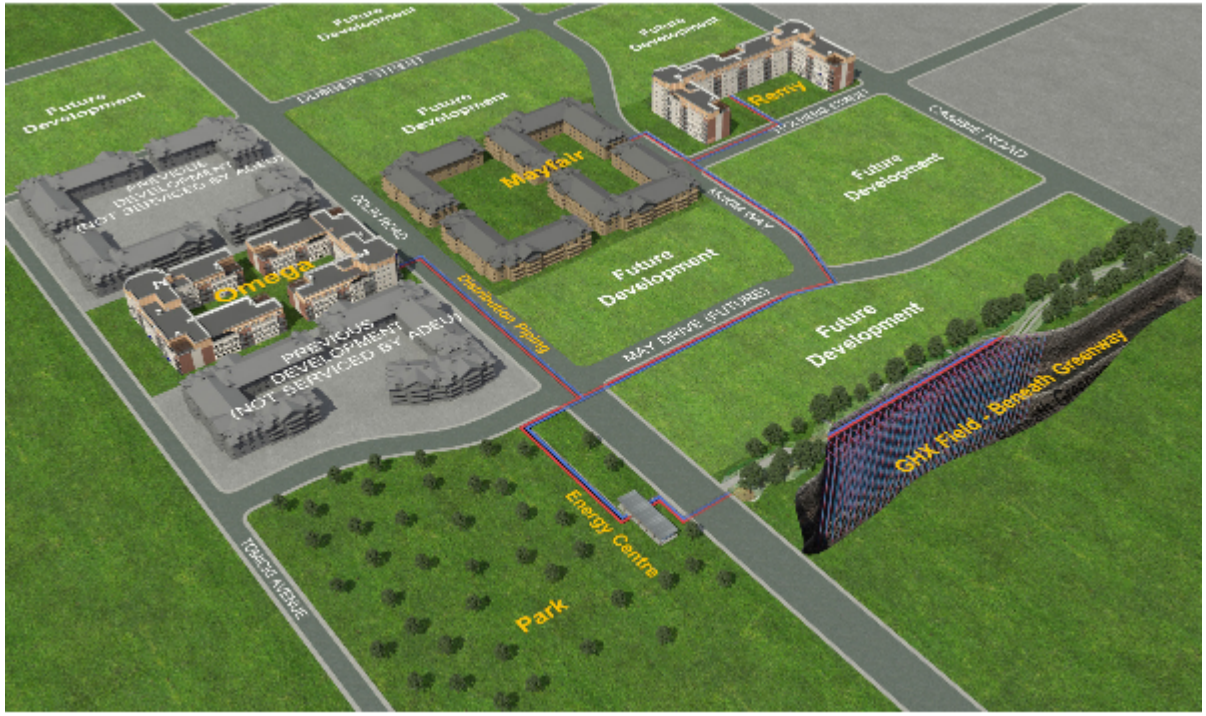
Source: http://www2.canadianconsultingengineer.com/awards/pdfs/2013/E8_AlexandraDistrictenergyGeothermal.pdf

- 1st phase of the District Energy Utility renewable energy system
- uses ground source heat pump technology to extract heat (geothermal energy) from ground via network of vertical pipe loops
- Designed for expansion as neighbourhoods develops and demands require more supply
- Phase 3 expansion completed Dec 2015 and now provides energy to 5 residential buildings equaling almost 1,200 units and 1 institutional building
- Phase 4 will expand system to service large commercial development in neighborhood (fall 2016)

Case Studies

Alexandra District Energy System

GeoExchange: Alexandra District Energy System, Richmond BC



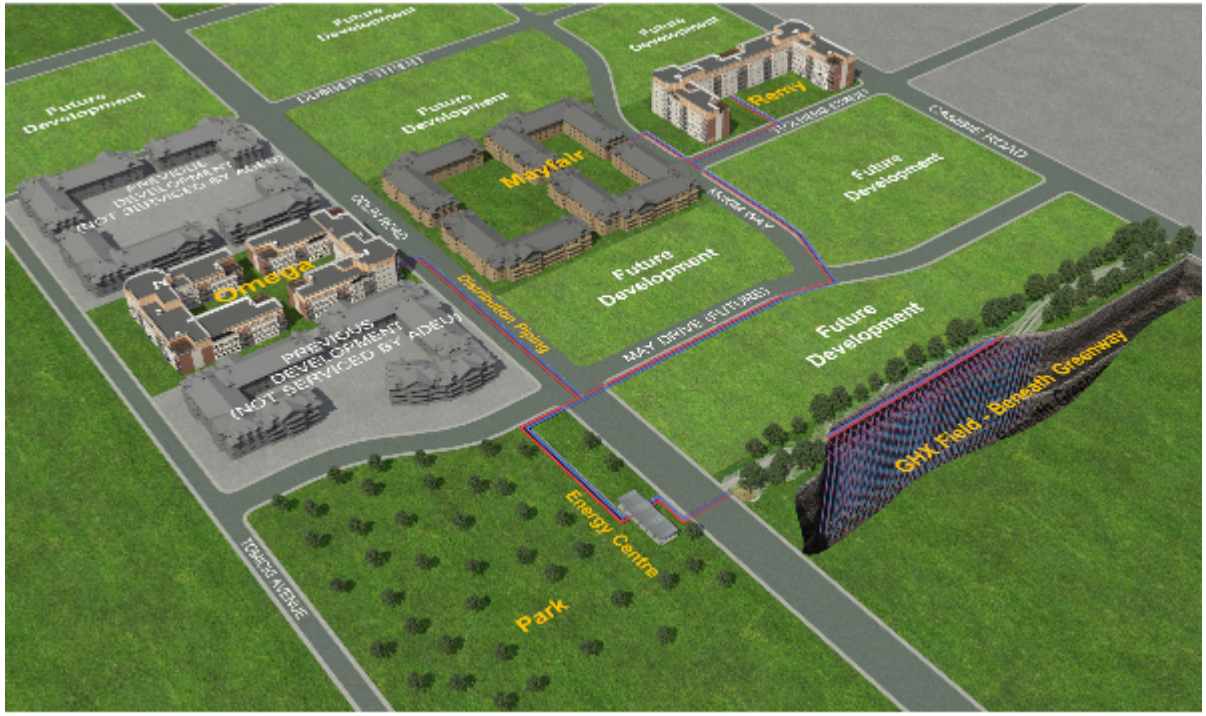
Source: http://www2.canadianconsultingengineer.com/awards/pdfs/2013/E8_AlexandraDistrictenergyGeothermal.pdf

- Provides space heating, cooling, domestic hot water
- 1,200 units, daycare, 1 institutional building
- Safe, clean, reliable external energy source, reducing GHG emissions
- 385 boreholes
- 76 m deep
- Drilled in a GeoExchange field beneath a city greenway corridor
- 1.3 km of 20” diameter, high density polyethylene pipes distribute water to and from the geothermal field.
- Heat pump units in each building elevate water temperatures for heating or rejects heat into system for cooling

Case Studies

Alexandra District Energy System

GeoExchange: Alexandra District Energy System, Richmond BC



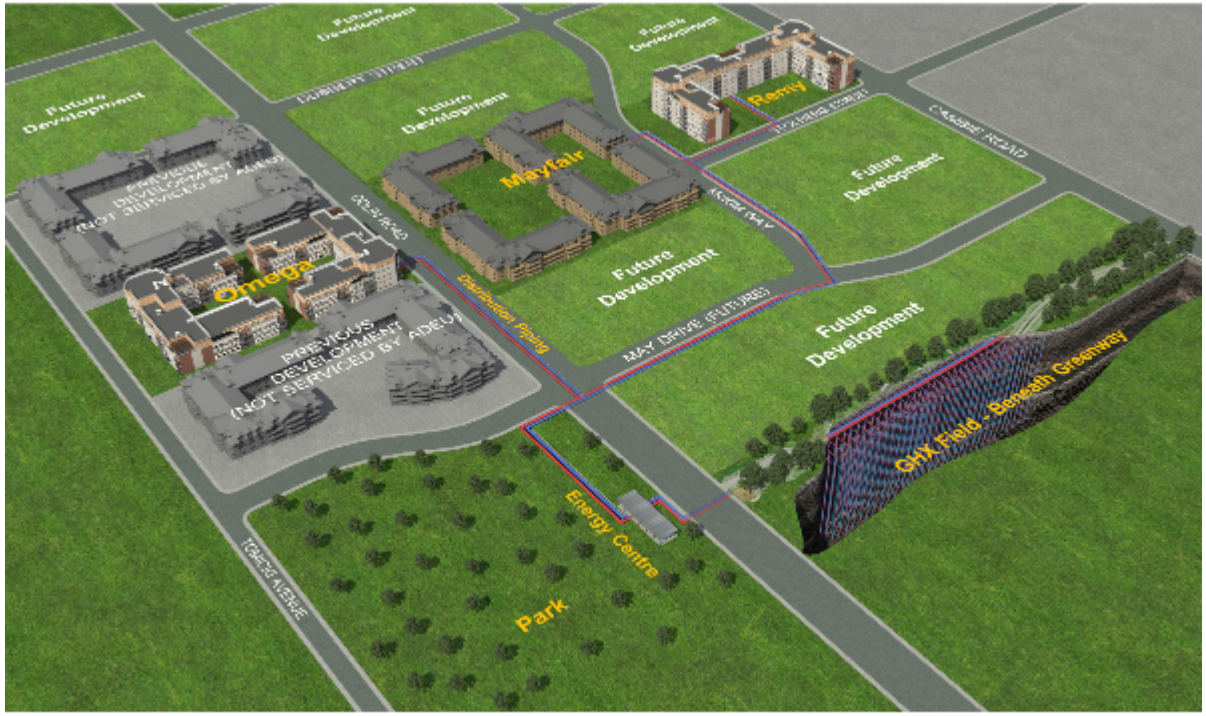
Source: http://www2.canadianconsultingengineer.com/awards/pdfs/2013/E8_AlexandraDistrictenergyGeothermal.pdf

- Designed to allow connection of additional residences and commercial buildings into system
- Allows heat recovery from commercial buildings to provide low-cost heating
- A 1 MW condensing, gas-fired boiler used as backup energy source and providing supplemental peak load heating

Case Studies

Alexandra District Energy System

GeoExchange: Alexandra District Energy System, Richmond BC



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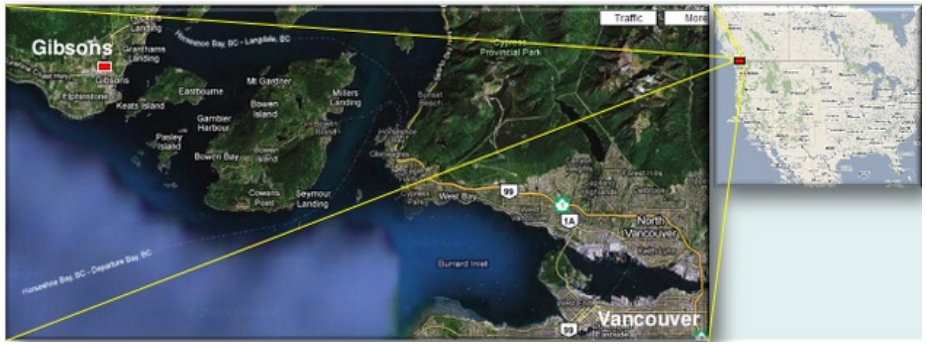
VIDEO: 3 MINUTES

Case Studies

Gibsons District Energy Utility

GeoExchange: Gibsons District Energy Utility



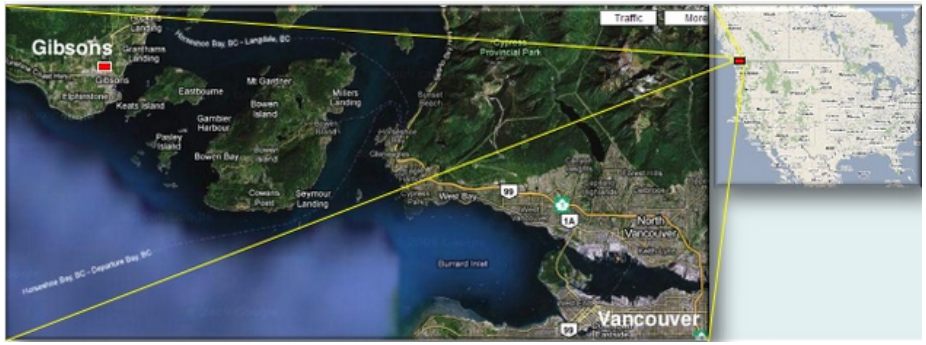
http://www.slideshare.net/jeffranson/district-geoexchange-systems

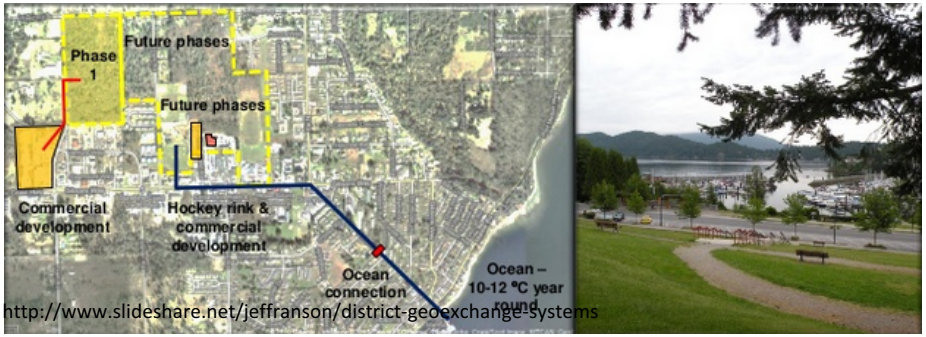
- New housing development
- Desire to minimize greenhouse gas emissions as much as possible and promote the use of geothermal systems
- As development grows, additional commercial space added to the system will help balance heating/cooling loads
- Heat rejected from cooling commercial buildings will replace heat extracted by homes
- Utilizing these interconnections within the system reduces the size and cost of the GeoExchange system

Case Studies

Gibsons District Energy Utility

GeoExchange: Gibsons District Energy Utility





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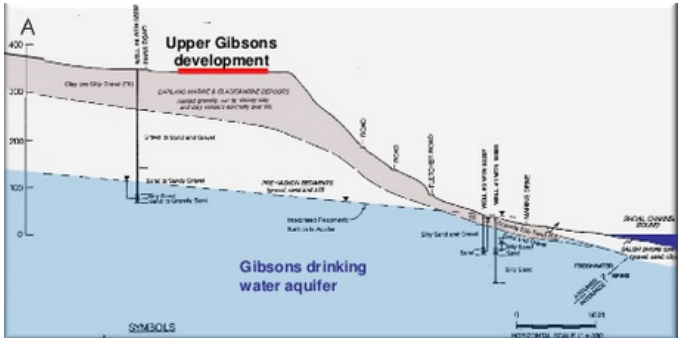
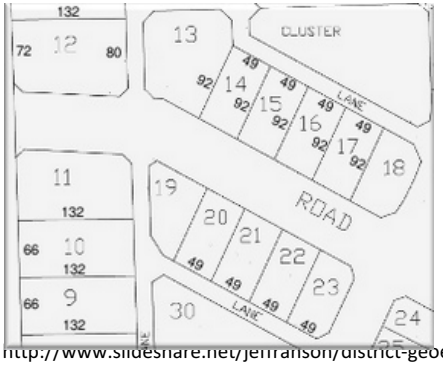
- Storm sewer servicing the development required rebuilding
- A connection to the ocean water can be installed at the same time
- Moderate temperature is used to ensure temperature of the GeoExchange system can be maintained at efficient operating temperatures

Case Studies

Gibsons District Energy Utility

GeoExchange: Gibsons District Energy Utility





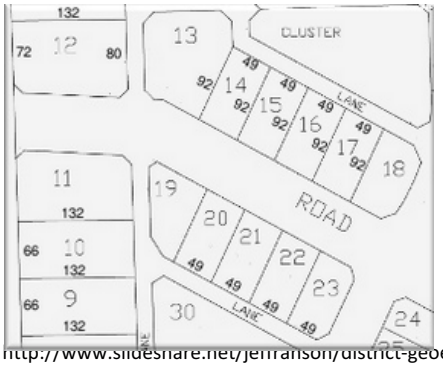
http://www.slideshare.net/jeffrahson/district-geoexchange-systems

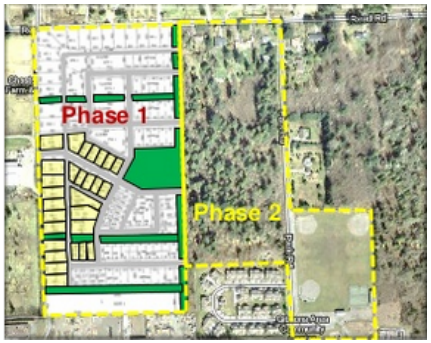
- Lot sizes are small
- Horizontal GeoExchange loop configurations were not possible
- However, the town of Gibsons did not want to drill into the aquifer directly beneath the proposed development
- Parks and greenways were used as the necessary space to install the horizontal ground loop configuration
- An additional 11 ground loop configurations can be connected and can serve ~250-300 additional homes as the development progresses
- Connections to a 2nd pump house and commercial development will provide load diversity and facilitate energy transfer between buildings

Case Studies

Gibsons District Energy Utility

GeoExchange: Gibsons District Energy Utility





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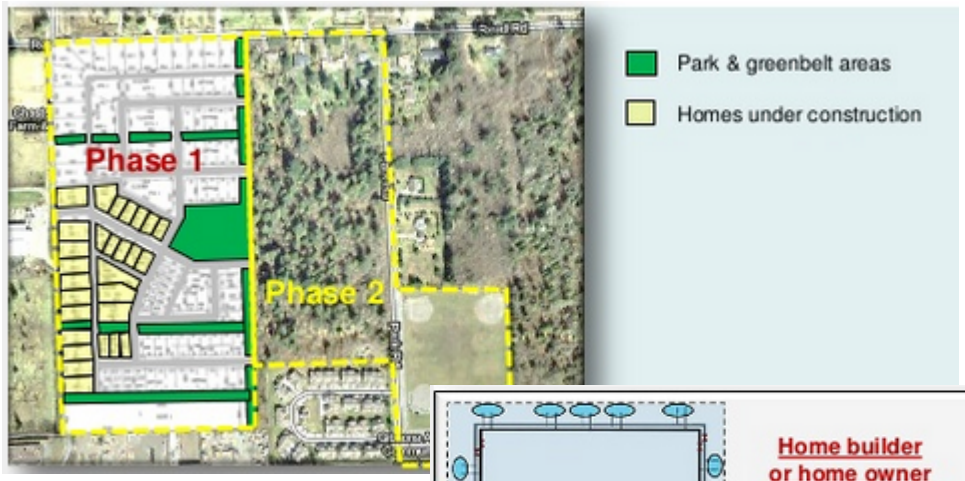
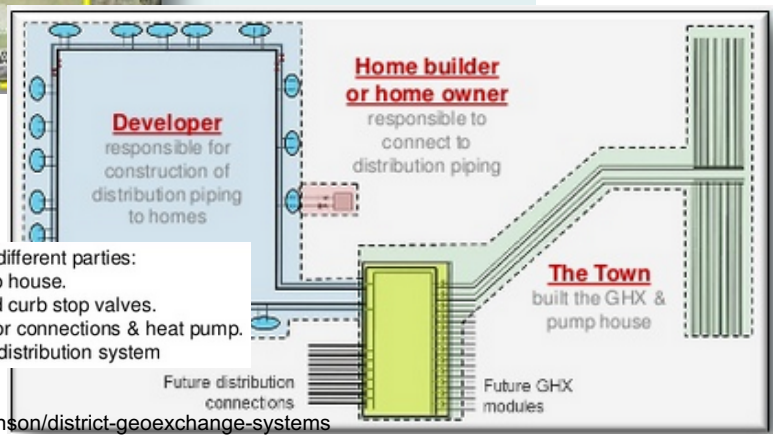




Components of the system are the responsibility of different parties:
- The Town of Gibsons installs the GHX and pump house.
- The Developer installs the distribution piping and curb stop valves.
- The home builder / home owner is responsible for connections & heat pump.
- The Town maintains the GHX, pump house and distribution system

Source: http://www.slideshare.net/jeffranson/district-geoexchange-systems

- Won 2009 Community Energy Association's Energy and Climate Action award: generates revenue while reducing GHG emissions
- First municipally-owned system of its kind in North America: 1st phase was 133 homes, duplexes and cluster homes
- 25mm pipes configured in series of coils ("flattened Slinky"), filled with ethanol/water mix, buried 2m beneath public greenspace
- 150mm supply-and-return lines distribute heat
- Heat pumps installed at each home
- Green Municipal Fund Webinar that discusses Gibsons DEU:
  - https://cullbridge.adobeconnect.com/_a782512023/p2k76wc5d6u/?launcher=false&fcsContent=true&pbMode=normal

Case Studies

Gibsons District Energy Utility

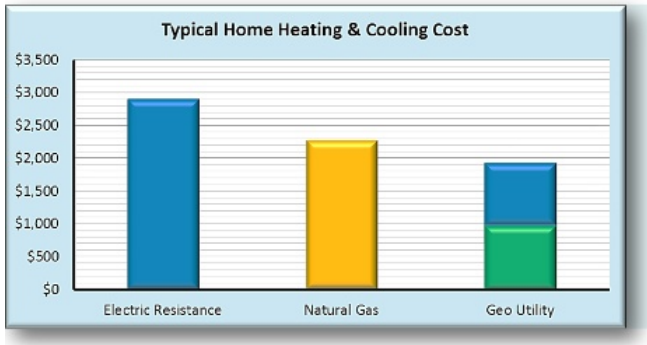
GeoExchange: Gibsons District Energy Utility

District GeoExchange Systems

Benefits to the homeowner

Monthly energy cost to the homeowner is approximately 35% less than electric resistance heating and 16% less than natural gas. In addition to energy cost savings, there is no outdoor air cooled condenser as with a conventional HVAC system.

The homeowner pays the electric utility for the electricity used to run the heat pump as well as a bill from the Town for the energy withdrawn or rejected to the district GHX.



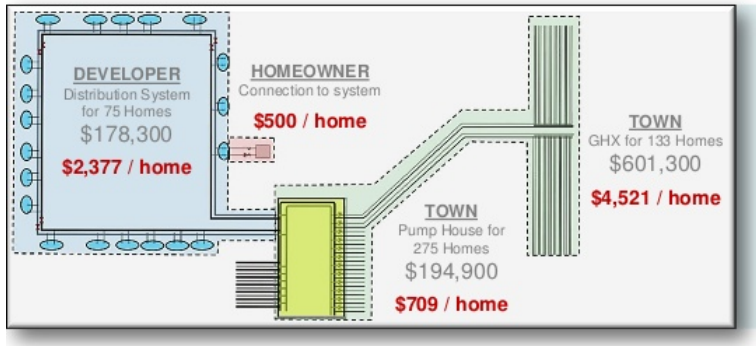
Source: http://www.slideshare.net/jeffranson/district-geoexchange-systems

District GeoExchange Systems

Responsibility for construction cost

- Town installs, owns and operates the GHX and pump house.
- Developer installs the distribution piping & curb stop valves, & turns it over to town
- Home builder / owner is responsible for connections mechanical system

The total cost of the energy source (GHX, pump house, distribution piping and connections to home is approximately $8,100…20% to 40% less than individual GHX.



Case Studies

Gibsons District Energy Utility

GeoExchange: Gibsons District Energy Utility

- Won 2009 Community Energy Association's Energy and Climate Action award: generates revenue while reducing GHG emissions
- First municipally-owned system of its kind in North America
- Estimated CO2 emissions will be reduced by 1,400 tonnes annually
- Investment in the system is expected to have an internal rate of return of approximately 15-20%
- Forward thinking and demonstrated concern for the environment to attract people and businesses to the community

Source:
http://www.slideshare.net/jeffranson/district-geoexchange-systems

Case Studies
Chapman Creek Hatchery

Aquaculture: Chapman Creek Hatchery run by Sunshine Coast Salmonid Enhancement Society

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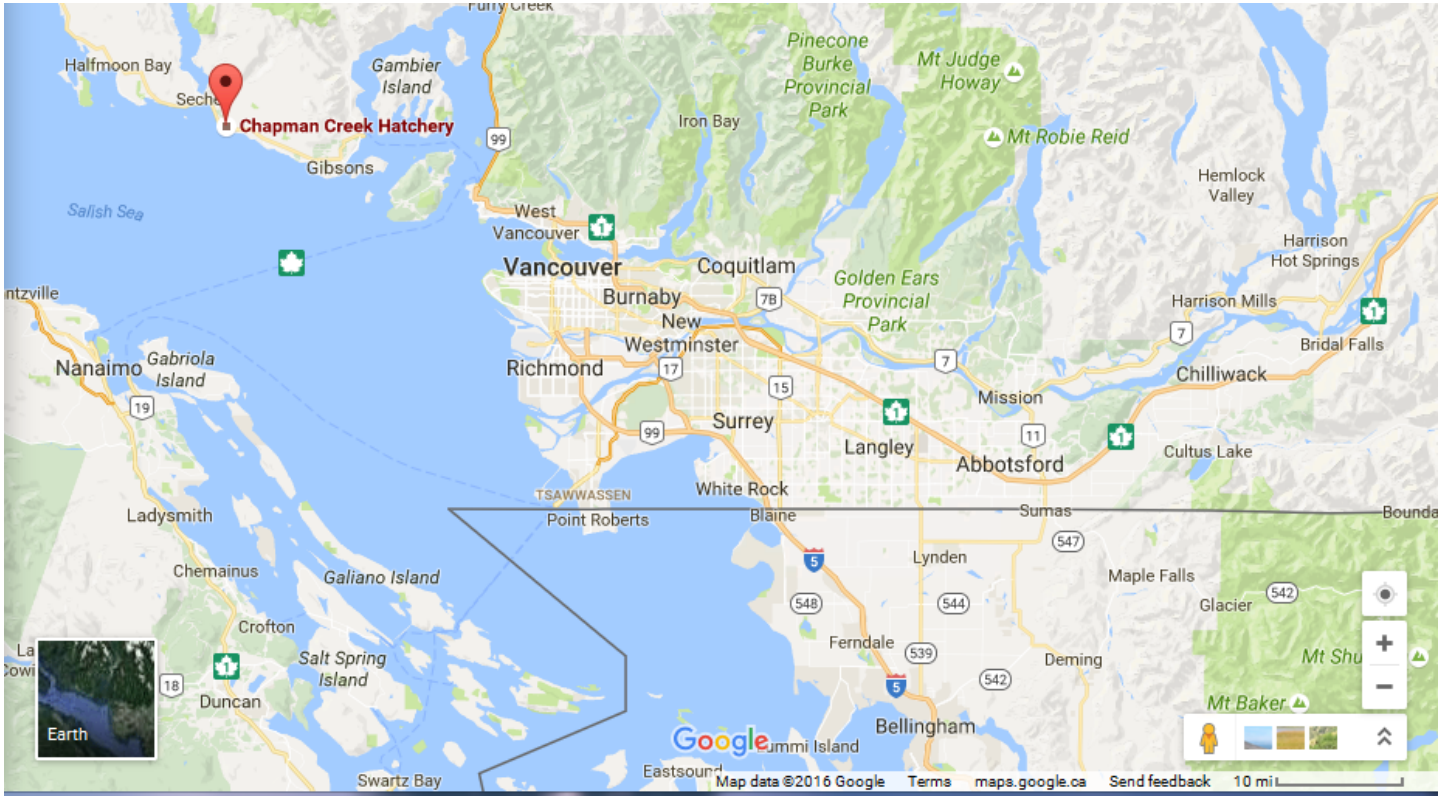
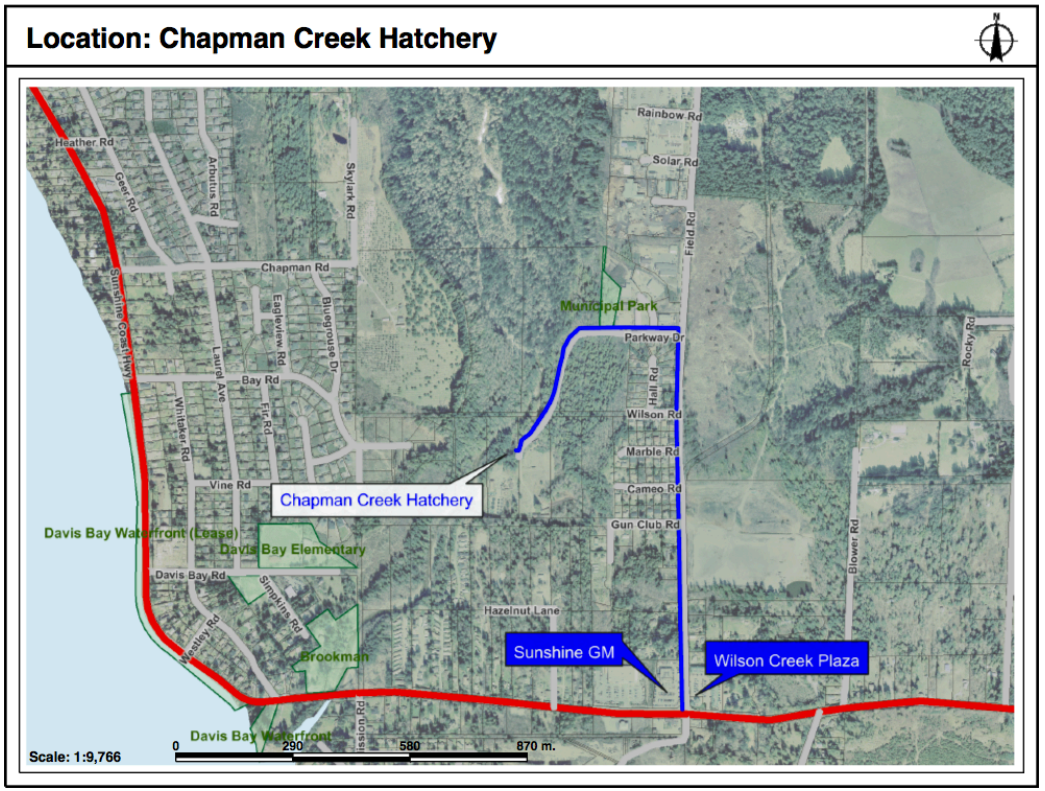


Case Studies
Chapman Creek Hatchery

Aquaculture: Chapman Creek Hatchery run by Sunshine Coast Salmonid Enhancement Society

- Fish hatchery operation in Sechelt BC
- Dedicated to sustaining and building salmon and trout stocks in local waterways, facilitating public education regarding salmonid habitat and life cycles
- HYBRID SYSTEM: Feasibility study and detailed engineering design of a 5 kW micro hydropower and 20 kW geothermal heating system for the facility
- Communication between the resource and demand minimizes energy waste



http://www.carnotechenergy.com/projects/the-chapman-creek-hatchery-2/

Case Studies
Chapman Creek Hatchery

Aquaculture: Chapman Creek Hatchery run by Sunshine Coast Salmonid Enhancement Society

- Fish hatchery operation in Sechelt BC
- Micro-hydropower is based on using exiting water-supply pipeline as penstock to utilize wasted head and flow without compromising required flow for hatchery's fish tank
  - Water that is already flowing through the hatchery tanks drives 3 micro turbines
- Open-loop geothermal system designed based on local hydrology to replace existing electrical heating of the facility
- Saves up to 75% on power consumption, reduces carbon footprint and operating costs
- Hydro generation is sufficient to run the geothermal heat pumps, making the facility 100% energy efficient
- Excess power sold: generates revenue stream

http://www.carnotechenergy.com/projects/the-chapman-creek-hatchery-2/

http://www.coastreporter.net/community/features/alternative-energy-project-started-1.996840

Case Studies
Other Potential Projects

Agriculture: Fairfield Propagators, greenhouse heating

- Fairfield Propagators: an 11-acre floricultural facility in Chilliwack, BC
- Comprehensive feasibility study and design for development of a 4MW geothermal heat pump system
- Project was awarded $1.3M government funds towards implementation
- Designed geothermal system reduces 70% of GHG emissions of the facility, improving energy economics and sustainability

http://www.carnotechenergy.com/projects/fairfield-propagators/