



# GEOEXCHANGE

*Energy under foot*

## FACT SHEET



MAKING RENEWABLE ENERGY A PRIORITY

# You're standing on an untapped energy source

It's true. Almost half of the sun's energy is absorbed into the earth as geothermal energy and it's right beneath our feet. Geoexchange technology uses the relatively constant temperature (between 4°C and 10°C year-round) beneath the surface of the earth to heat and cool buildings. This heat energy from beneath the earth's surface can be captured using proven geoexchange technologies, and harnessed to provide space heating and cooling. Electricity is required to pump that energy out of the ground, but geoexchange systems are still able to produce three to four units of free thermal energy from the earth for every one unit of electrical energy used.

*“Geoexchange is the most energy efficient, environmentally clean and cost-effective space-conditioning system available on the market today.” - Natural Resources Canada*

**Geoexchange systems extract three to four units of free thermal energy from the earth for every one unit of electrical energy.**

## Geoexchange vs. Geothermal: What's the difference?

Geoexchange	Geothermal
Shallow (<250m/<1,000ft below surface)	Deep (>1km below surface)
Used for space heating/cooling and water heating	Used to generate electricity on a large scale
Smaller scale (residential, commercial, institutional buildings)	Larger scale (electrical utility power plants)
Available almost anywhere	Available in key regions where geothermal activity is present, such as along tectonic plates

### How many ways can you say geoexchange?

Geoexchange is synonymous with shallow geothermal, earth energy, low-temperature geothermal, and geothermal heating and cooling.

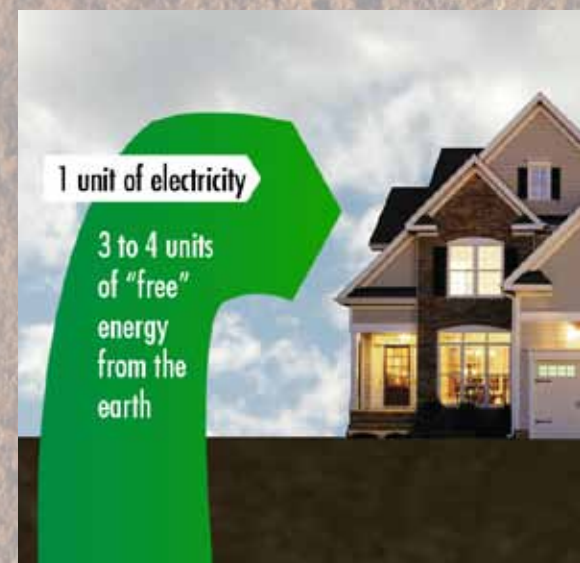
### Where to use geoexchange

**Residential:** single-family dwellings, multi-unit buildings

**Commercial:** retail/office space, hotels, recreation centres, pool heating, ice and curling rinks, farm operations, grocery stores, convenience stores, warehouses

**Institutional:** hospitals, schools, municipal buildings, universities and colleges

**Industrial:** manufacturing facilities



▲ Energy gains from geoexchange.

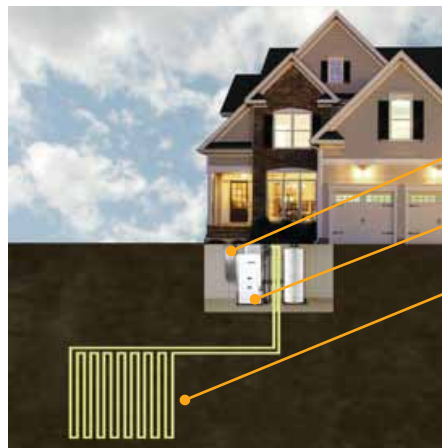
PHOTO: CLEAN ENERGY DEVELOPMENTS, A DIVISION OF ALTER NRG



# Benefits of geexchange

- Provides space heating/cooling and hot water generation.
- Three to four units of energy produced for every one unit used.
- Reliable, proven technology.
- Lower maintenance and operating costs than conventional systems.
- Quieter than conventional heating and cooling systems.
- No onsite emissions or indoor air pollutants.
- The potential to power the system using low-impact renewable electricity.
- Reduced space requirements where one system can be used for both heating and cooling.
- Private, provincial and federal subsidies to offset capital costs.
- Helps to achieve green building standards like LEED® accreditation.

## Anatomy of a geexchange system



### GEOEXCHANGE SYSTEMS HAVE THREE MAIN COMPONENTS:

A heating/cooling distribution system (ducts),

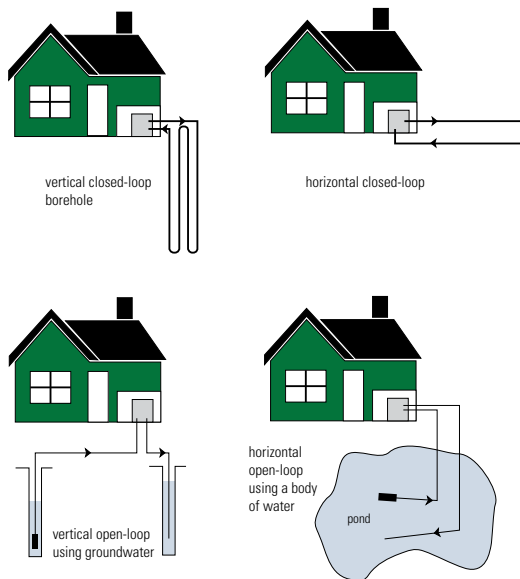
An electric ground source heat pump (GSHP),

Subsurface pipes called a ground loop.

◀ Geoexchange-equipped house.

PHOTO: CLEAN ENERGY DEVELOPMENTS, A DIVISION OF ALTER NRG

## The mechanics of geexchange



A ground loop, consisting of subsurface pipes, is buried underground or below the surface of a water body, filled with a heat-conducting, environmentally-friendly liquid. The loops may be closed, so that the same fluid circulates through the system continuously, or open, so they take in water from a pond or aquifer and release it into another water source. Loops may be oriented horizontally or vertically, depending on land area available as well as cost and ease of drilling into subsurface soil or rock. Geoexchange systems can be installed during new building construction or retrofitted to most existing heating and cooling systems.

## No need for a furnace or air conditioner

In Canada, geexchange systems are typically installed for heating purposes – the bonus is that nothing extra needs to be installed for air cooling to work as well! In the winter, the temperature six to ten feet below the surface is warmer than above ground, so the fluid travelling through the ground loops is warmed and circulated up to a heat pump that condenses the heat for use in the building’s distribution system. In the summer, the system is run in reverse where the heat is collected from the home or building and rejected back into the ground loop. A geexchange system essentially replaces the need for both a furnace and an air conditioner by providing heating and cooling in one unit.

*“Geoexchange is the lowest-hanging fruit on the carbon-reduction tree. It’s economically viable today, has little technical risk, and could – by itself – bring global carbon emissions down by a third.”*

– Tom Rand, Planet Traveler Hotel Owner

### CASE STUDY

#### Hotel breaks new ground

Planet Traveler was an abandoned building in downtown Toronto before it was converted into a low-carbon hotel. A geexchange system, using a closed-loop vertical borehole configuration, provides the majority of the heating and cooling necessary for the hotel. The geexchange pipes were the first to be buried under a public laneway in the City of Toronto. The installation of this geexchange system made history when a municipal resolution was passed due to the project, encouraging the use of Toronto’s public land for geexchange installations.



PHOTO: CLEAN ENERGY DEVELOPMENTS, A DIVISION OF ALTER NRG

▲ Planet Traveler Hotel equipped with geexchange, located in Toronto, Ontario.

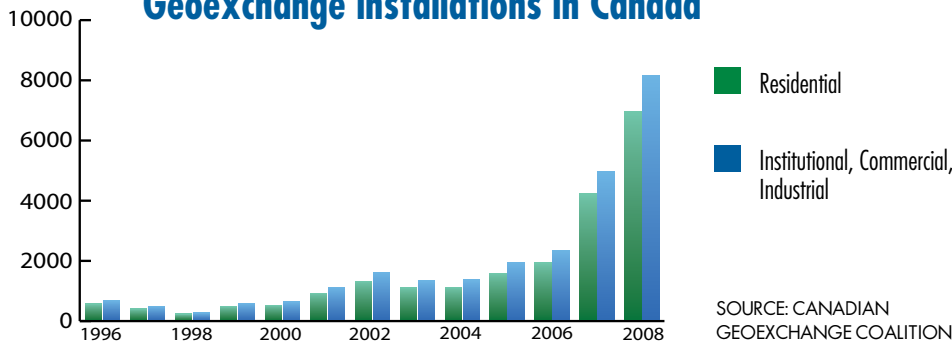
Installation cost	\$240,000
Hotel size	12,000 ft <sup>2</sup> , 4 ½ stories, 114 beds
Number of heat pumps	22
Annual energy delivered	6.8 MWh
GHG reduction	70% reduction
Month energy savings	\$2,500
Payback	4 years

## Adoption of geexchange

Global adoption of geexchange technology is expanding, with the majority of recent growth occurring in the United States, Japan and Europe. Sweden, a country that has embraced the technology with government support and industry standards since the 1980s, boasts an impressive 230,000 installed geexchange systems, which represents about 40 per cent of their residential market. Swedish government support of geexchange has boosted these systems to become the most common heating and cooling solution in the country.

The geexchange industry in Canada is in a growth phase with companies now just beginning to offer full turnkey solutions. Approximately 30,000 residential homes as well as 6,000 commercial and institutional buildings are equipped with geexchange systems, providing both heating and cooling. This represents only a small percentage of residential and commercial buildings, and the potential for growth is huge.

### Geexchange installations in Canada



## Typical costs and payback periods for various geexchange systems

System Type	Average Capital Cost		Applications	Typical Payback	Notes
	\$/ft <sup>2</sup> heated space	Total \$			
Residential home (2,500 ft <sup>2</sup> ) - horizontal	\$9 - \$11	\$20,000 - \$25,000	Residential homes	3 - 8 years	Payback typically shorter than vertical systems
Residential home (2,500 ft <sup>2</sup> ) - vertical system	\$15 - \$25	\$30,000 - \$40,000	Residential homes	5 - 10 years	Higher drilling costs could lead to longer paybacks
Commercial system - horizontal system	\$15 - \$25	Varies - depends on application and size of building	New multi-unit residential builds, warehouses, ice rinks, institutional buildings	Immediate - 8 years	Horizontal, open loop systems typically have the shortest payback. When integrated with payback waste heat recovery, can be immediate.
Commercial system - vertical system	\$30 - \$40	Varies - depends on size of building	New multi-unit residential builds, condos, commercial space, institutional buildings	2 - 10 years	Vertical systems most expensive but often required due to the lack of available space.

## Does it pay to invest in geexchange?

Although the initial capital costs of geexchange systems generally surpass conventional systems, the lifetime costs are typically less when you factor in the extreme efficiency, lower operating costs (fuel and maintenance) and a longer lifetime expectancy.

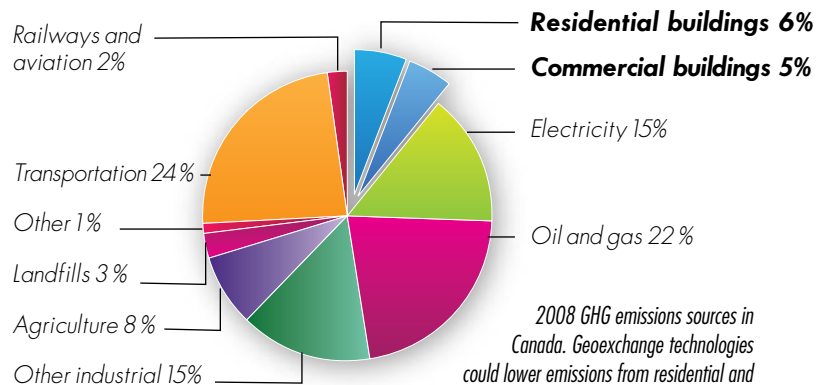
The financials for geexchange systems vary depending on several factors including the availability and cost of conventional fuels, system size and configuration, and electricity costs. Larger commercial systems that perform both heating and cooling, and utilize other technologies such as waste heat recovery can be very cost effective and have very short paybacks when considering the costs of conventional heating and cooling systems. Smaller residential systems typically have paybacks between three and ten years. The market price of conventional fuels is the most important factor affecting payback, meaning higher fuel prices equate to a quicker payback period. For example, in the North West Territories, where conventional fuels are priced higher, geexchange becomes a more attractive option.

*Geexchange systems consume only a fraction of the energy of conventional systems and this energy can be generated emissions free with renewable energy.*

## Geexchange could help Canada meet GHG reduction targets

Greenhouse gas (GHG) emissions from residential and commercial space heating/cooling and water heating in Canada are approximately 80 million tonnes of carbon dioxide and account for almost 11 per cent of Canada's national emissions. Analysis from the Pembina Institute's *Climate Leadership, Economic Prosperity* report shows that increasing residential geexchange installations from 0.5 to 1.5 per cent and commercial geexchange installations from 1.5 to 25 per cent is a realistic, cost-effective way to help Canada meet GHG reduction targets of 25 per cent below 1990 levels by 2020.

### GHG emission sources in Canada



2008 GHG emissions sources in Canada. Geexchange technologies could lower emissions from residential and commercial buildings.

## Incentives and financing options

While geexchange systems yield significant lifetime energy cost savings, installation requires considerable capital investment. Fortunately, a number of incentive programs and financing mechanisms exist across the country to assist homeowners, businesses and municipalities. These programs provide direct funding rebates from \$250 to \$3,500, sales tax exemptions, related electricity rebates, and both low-interest and interest-free loans.

### Contact the applicable provincial program for more information:

British Columbia	LiveSmart BC: Sales Tax Exemptions <a href="http://www.livesmartbc.ca/homes/h_tax.html">http://www.livesmartbc.ca/homes/h_tax.html</a> LiveSmart BC: Efficiency Incentive Program <a href="http://www.livesmartbc.ca/homes/h_rebates.html">http://www.livesmartbc.ca/homes/h_rebates.html</a>
Alberta	None available at this time
Saskatchewan	SaskPower Eneraction: Renewable Power Loan Program, Energy Efficiency for New Homes Rebate, PST Exemptions, Rink Retrofit Program <a href="http://www.saskpower.com/eneraction/">http://www.saskpower.com/eneraction/</a>
Manitoba	Green Energy Equipment Tax Credit <a href="http://www.gov.mb.ca/finance/tao/pump.html">http://www.gov.mb.ca/finance/tao/pump.html</a> Residential Earth Power Loan <a href="http://www.hydro.mb.ca/earthpower/">http://www.hydro.mb.ca/earthpower/</a> Manitoba Geothermal Energy Incentive Program <a href="http://www.gov.mb.ca/stem/energy/geothermal/incentives.html">http://www.gov.mb.ca/stem/energy/geothermal/incentives.html</a>
Ontario	Renewable Energy Initiative <a href="http://www.mah.gov.on.ca/Page127.aspx">http://www.mah.gov.on.ca/Page127.aspx</a> Building Owners & Management Association Retrofit Incentives <a href="http://www.bomacdm.com">http://www.bomacdm.com</a> Green Saver Multifamily Energy Efficiency Rebate <a href="http://www.meerontario.ca">http://www.meerontario.ca</a> Electricity Retrofit Incentive Program (ERIP) <a href="http://business.everykilowattcounts.com/com/programs-incentives-rebates.php?pir=ERIP">http://business.everykilowattcounts.com/com/programs-incentives-rebates.php?pir=ERIP</a> Better Building Partnership - New Construction, Existing Buildings <a href="http://bbptoronto.ca/resources/incentives/?bbp-incentives=1/">http://bbptoronto.ca/resources/incentives/?bbp-incentives=1/</a> Sustainable Energy Funds <a href="http://www.toronto.ca/energy/sef_info.htm">http://www.toronto.ca/energy/sef_info.htm</a> Ontario Home Energy Savings Program: Residential Geothermal Incentives <a href="http://www.mei.gov.on.ca/en/energy/renewable/?page=geoes_incentives">http://www.mei.gov.on.ca/en/energy/renewable/?page=geoes_incentives</a> Cool Savings Rebate Program <a href="http://everykilowattcounts.ca/residential/coolingsavings/index.php">http://everykilowattcounts.ca/residential/coolingsavings/index.php</a>
Québec	Hydro Québec Geothermal Energy Financial Assistance Program <a href="http://www.hydroquebec.com/residential/geothermie/appui.html">http://www.hydroquebec.com/residential/geothermie/appui.html</a>
Nova Scotia	Nova Scotia Power Rebates <a href="http://www.nspower.ca/en/home/energysavings/programs/energuidenew/nsprebates.aspx">http://www.nspower.ca/en/home/energysavings/programs/energuidenew/nsprebates.aspx</a>
New Brunswick	New Homes Program, Existing Homes Energy Efficiency Upgrade Program, New Commercial Buildings Incentive Program, Existing Commercial Buildings Retrofit Program <a href="http://www.efficiencynb.ca/enb/">http://www.efficiencynb.ca/enb/</a>
Prince Edward Island	Provincial Sales Tax Exemption <a href="http://www.gov.pe.ca/envengfor/index.php3?number=1012183">http://www.gov.pe.ca/envengfor/index.php3?number=1012183</a> Commercial Sector and Institutional Buildings Program for Energy Incentives <a href="http://www.gov.pe.ca/oee/csipei">http://www.gov.pe.ca/oee/csipei</a> PEI Energy Efficiency Grant Program <a href="http://www.gov.pe.ca/oee/index.php3?number=1020762">http://www.gov.pe.ca/oee/index.php3?number=1020762</a>
Federal	ecoENERGY Retrofit Incentive for Buildings <a href="http://oe.nrcan.gc.ca/commercial/financial-assistance/existing/retrofits/index.cfm?attr=0">http://oe.nrcan.gc.ca/commercial/financial-assistance/existing/retrofits/index.cfm?attr=0</a> Capital Cost Allowance Deduction (Commercial Buildings) from the CRA <a href="http://www.ic.gc.ca/eic/site/fte-fte.nsf/eng/00004.html">http://www.ic.gc.ca/eic/site/fte-fte.nsf/eng/00004.html</a>

NOTE: This information is up to date as of July 2010.

## Planning your geexchange project

*When considering how geexchange could be used for your building, be sure to consult relevant municipal authorities to determine requirements for compliance. Required approvals vary regionally and there are sometimes provincial requirements; CGC accredited installers should be able to help you determine which approvals apply to your project.*

## Growing the Canadian geexchange industry

The Canadian GeoExchange Coalition (CGC), formed in 2003, is focused on advancing the geexchange industry in Canada providing information such as market infrastructure, consumer awareness, education and confidence. CGC provides training and accreditation, and maintains a directory of geexchange professionals by province. There are approximately 360 CGC-qualified companies in Canada, and since 2007, the CGC has offered training and accreditation services.

## Further resources

Canadian GeoExchange Coalition: <http://www.geoexchange.ca>

International Ground Source Heat Pump Association: <http://www.igshpa.okstate.edu/>

Earth Energy Society of Canada: <http://www.earthenergy.ca/>

The Pembina Institute's *Greening The Grid Report*: <http://re.pembina.org/pub/1763>

The Pembina Institute's *Climate Leadership and Economic Prosperity Report*: <http://climate.pembina.org/pub/1909>

The Pembina Institute's Renewable Energy Website: <http://re.pembina.org>

### CASE STUDY

#### The WestJet Campus goes green



*WestJet built its new Calgary campus with energy efficiency in mind and a goal of meeting LEED® Gold standard. Their geexchange system provides simultaneous heat and cooling for the 315,000 ft² building. The system has reduced energy consumption by 35 percent and decreased the company's greenhouse gas footprint by 1,250 tonnes per year.*

▲ WestJet head office equipped with geexchange, located in Calgary, Alberta.

PHOTO: CLEAN ENERGY DEVELOPMENTS. A DIVISION OF ALTER NRG