**Why geothermal?**

Geothermal energy can be harnessed through various technologies but the most commonly utilized are geo-exchange systems, which have the potential to provide clean and highly efficient heating and cooling in a range of agricultural and food processing contexts. Geothermal systems provide greater independence from fluctuating energy costs and can significantly reduce carbon footprints.

While geothermal systems are costly up front, they also have significant associated savings and benefits. One of the primary benefits of geothermal energy is its efficiency. Geo-exchange systems produce 3 to 4 kilowatts of heat for every kilowatt of power provided to run the pumps. This “coefficient of performance” means reductions of energy usage of up to 75%.  

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1 Terasen Gas Energy Services
www.terasen.com/EnergyServices/GeoexchangeSystems

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Geo-exchange systems also have considerable flexibility in their design, heat pumps take up less space than conventional HVAC systems and can be installed new or when retrofitting. They provide increased options for heating and cooling various buildings or “zones” at different temperatures. Finally, heat pump systems are relatively durable and reliable (low maintenance) and underground pipes often have long term warranties (20–50 years).

**Defining geothermal energy**

The term “geothermal” commonly refers to the heat contained within the earth and the technologies that enable us to the capture and utilize this heat. A range of technologies are used to extract geothermal energy from large power plants to small heat pump systems. However, it is helpful to distinguish between direct use of geothermal wells and geo-exchange or earth energy systems. Both types of energy have been utilized in agriculture although neither is commonly used in Canadian agriculture.
Geothermal wells or reservoirs are only found in certain geographic locations – most commonly in tectonic fault lines or deep geological formations. The low to moderate geothermal water resources (20°C to 150°C) may be used for direct heating applications including in greenhouses and aquaculture tanks. Where water temperatures are particularly hot, geothermal energy is used to drive turbines and to generate electricity. In the western United States, particularly California and Nevada, this high heat geothermal power is utilized in large scale power plants.

In contrast, geo-exchange or earth energy systems use electricity and heat pumps to concentrate the low level heat that can be found close to the earth’s surface. This is actually solar energy captured and stored (even in cold temperatures) in the upper layer of the earth. Geo-exchange systems provide heating and cooling for buildings and do not require underground hydrothermal (water) resources. These systems are increasingly applied in residential and commercial settings. For agriculture they may have application in homes, barns and greenhouses.

Geothermal & geo-exchange in agriculture and food processing

Globally, the use of geothermal energy is increasingly common. In Canada, geo-exchange systems have become relatively common for residential and commercial use but adoption of this technology remains unusual in agriculture. There have been some limited application of geo-exchange systems in livestock barns – specifically poultry barns and dairy operations (see References & online resources section).

A pilot project is also underway to explore geothermal resources and costs for a large floriculture operation in BC (see References & online resources section). In this project, both potential for direct application of hot water resources to the greenhouse and electrical generation are being explored.

Internationally, geothermal systems are used for a number of agricultural and food processing purposes including: heating buildings or greenhouses, grain drying, food dehydration, mushroom cultivation and milk pasteurizing. Geothermal reservoirs of low to moderate heat are extensively utilized in the western United States.
According to the US Department of Energy, there are 38 greenhouses (both vegetable and floriculture) across eight western states that are using geothermal energy. The operators of the greenhouses estimate that they are saving about 80% of their fuel costs (approximately 5–8% of their total operating costs).

Another area of promise for agricultural application is incorporation of waste heat into geo-exchange systems. While the heat pumps in geo-exchange are used to extract underground heat, they can also harness waste heat. Waste heat can be recovered from sources in close proximity to the system, enabling this heat to be amplified, transported and used elsewhere. An innovative example of this type of agricultural use is a dairy in Alberta that utilizes waste heat from the cows (including respiration and heat captured from manure and milk) and re-purposes it to heat the barn.

Types of geo-exchange systems

Although there are various types of geo-exchange systems, they generally include three basic components: (1) underground pipes; (2) a heat exchanger; and (3) ductwork to distribute heat into the building. The pipes and can either be horizontal or vertical and are in close proximity to, or beneath, buildings. The two basic geo-exchange systems are closed loop and open loop systems.

Closed loop systems have pipes buried in a loop that circulate fluid (usually water with some anti-freeze) through the ground (or where possible a body of water such as a lake or pond). The fluid absorbs the heat which is then extracted and concentrated in the heat exchanger and transferred into the building. A heat pump controls the process and regulates the temperature. Alternatively, when cooling is required, the process is reversed and warm air is removed and transferred back into the loop (and into the ground).

Open loop systems require sufficient relatively clean water and must meet codes and regulations for groundwater discharge. In an open loop system, the heat exchange fluid is well or lake water which (as in a closed loop system) is then pumped up into the building where the heat is extracted. Following circulation through the system the water is returned to the ground.

Requirements for the technology

If a geothermal reservoir is used for direct heating, the underground thermal temperature will flow directly into the heat distribution unit. However, this approach
(commonly used for greenhouses in the western United States) requires that the temperature coming out of the ground is sufficiently hot (or cool) to meet the requirements of the business. This may not always be possible so in some cases a supplemental heat unit is required. This could be provided through a range of technologies including solar hot water panels or boilers operating on fossil fuels, biomass or electricity.

The heat pumps in geo-exchange systems require electricity to run their compressors and to circulate the fluid through the open or closed loop. A connection to the grid is important unless consistent alternative electricity generation is possible. However, considerably less energy is required than would be needed through an equivalent gas or electric heating and cooling system.

On the zoning and regulatory side, local approvals or permits may be required and a good first step is to contact the local municipality. Open-loop groundwater systems may also require Ministry of Environment involvement. Ensuring that an accredited installer develops a geothermal system will help to avoid numerous potential pitfalls including any applicable planning or regulatory issues. Both GeoExchange BC and the Canadian GeoExchange Coalition websites include a listing of accredited installers, designers and drillers (see References & online resources section).

Efficiencies & costs

Installation of geothermal technologies involve relatively high up front capital costs. The extent to which these costs can be offset partly depends on the potential for energy savings.

The cost of geo-exchange systems also depends on the type of system and the complexity of the accompanying trenches (for horizontal loop systems) or boreholes (for vertical systems). Horizontal loops are the less expensive option and although they require more space, this may not be a less significant issue for agricultural operations since following the installation of pipes the land can continue to be used for most agricultural purposes.

Opportunities to consider

Incentives & grants

There are currently limited incentives and granting opportunities associated with geothermal projects in BC. Periodically, the BC government offers funding for renewable energy projects through the Innovative Clean Energy Fund.
The federal government offers two taxation measures to encourage investment in energy efficiency and renewable energy projects. Class 43.1 in Schedule II of the Income Tax Act provides taxpayers an accelerated write-off on certain equipment designed to improve energy efficiency or produce renewable energy.

The Canadian Renewable & Conservation Expenses (CRCE) is a category of fully deductible expenditures associated with start-up of renewable energy and energy conservation projects. CRCE enables investors to fully write off (some) intangible costs associated with investment in renewable energy and energy conservation.

Environmental Farm Plan Program & Beneficial Management Practices

For farmers who have successfully completed the Environmental Farm Plan Program, there is an option to apply for cost sharing for changes to farm practices specified within the Beneficial Management Practices Program.

The eligible beneficial management practices (BMPs) now include some practices and technologies associated with reduction of greenhouse gas emissions and fossil fuel alternatives. For specifics regarding eligible activities and cost-share ratios contact the program manager (see References & online resources section).

Terasen Gas Energy Services

Terasen Gas builds, owns and operates geo-exchange systems for multi-residential, commercial and industrial developments – this can alleviate the capital costs and facilitates implementation of new systems.

Greenhouse gas emission offsets

There are both regulated and voluntary offset opportunities for producers considering fuel switching projects. There is particularly good potential for projects that involve transition from coal or fossil fuels to cleaner energy options. The Pacific Carbon Trust (a crown corporation purchasing offsets on behalf of the BC government) is committed to purchasing offsets generated within BC. More information on offset opportunities may also be found on the Climate Action Initiative website.

References & online resources

Guides and informational resources....

BC Agriculture & Food Climate Action Initiative

www.BCAgClimateAction.ca

Natural Resources Canada

Commercial Earth Energy Systems:
A Buyer’s Guide

Integration of renewable energy on farms

Earth Energy
www.farm-energy.ca/IReF/?page=earth-energy

GeoExchange BC

www.geoexchangebc.com

Canadian GeoExchange Coalition

www.geo-exchange.ca/en

BC Hydro Case Study

Serene Lea Farms – Geoexchange System
www.geoexchangebc.com/pdfs/CaseStudy_SereneLeaFarm.pdf
www.bchydro.com/powersmart/success_stories/commercial_offices_other/serene_lea_farms.html
The Climate Action Initiative is facilitating a proactive approach to climate change issues within the BC agriculture and food sector. By developing climate action resources, the Initiative raises awareness and assists the industry in meeting the challenges, and acting upon the opportunities, presented by climate change. The Initiative is led by an advisory committee made up of BC agriculture producers and food processors.

The Climate Action Initiative is a joint undertaking of BC Agriculture Council and the Investment Agriculture Foundation, with funding provided by Agriculture & Agri-Food Canada and the BC Ministry of Agriculture & Lands.

For more information about the Climate Action Initiative, please contact Initiative Coordinator, Emily MacNair at 250-356-1666 or Emily@BCAgClimateAction.ca.