Major Benefits of Earth-Energy Systems

Efficiency

In Canada, where air temperatures can go below –30°C, and where winter ground temperatures are generally in the range of –2°C to 4°C, earth-energy systems have a coefficient of performance (COP) of between 2.5 and 3.8.

A ground water EES installation in southern Canada will have a heating seasonal performance factor (HSPF) of between 10.7 and 12.8, compared with an HSPF of 3.4 for electrical-resistance heating. Similarly, a closed-loop EES in southern Canada will have an HSPF of between 9.2 and 11.0, with the higher value achieved by the most efficient closed-loop heat pump available.

Energy Savings

Earth-energy systems will reduce your heating and cooling costs substantially. Energy-cost savings compared with electric furnaces are around 65 percent.

On average, an EES will yield savings that are about 40 percent more than would be provided by an air-source heat pump. This is due to the fact that underground temperatures are higher in winter than air temperatures. As a result, an EES can provide more heat over the course of the winter than an air-source heat pump.

Actual energy savings will vary depending on the local climate, the efficiency of the existing heating system, the costs of fuel and electricity, the size of the heat pump installed, and its coefficient of performance at CSA rating conditions. Later in this booklet, heating energy-cost comparisons will be made between earth-energy systems and other sources.

Domestic Hot Water Heating

EESs also provide savings in domestic hot water costs. Some have a desuperheater that uses some of the heat collected to preheat hot water; newer designs can automatically switch over to heat hot water on demand. These features can reduce your water heating bill by 25 to 50 percent.

Maintenance

EESs require little maintenance on your part. Required maintenance should be carried out by a competent service contractor, who should inspect your unit once a year.

- As with air-source heat pumps, filter and coil maintenance has a dramatic impact on system performance and service life. A dirty filter, coil or fan can reduce airflow through the system. This will reduce system performance and can lead to compressor damage if it continues for extended periods.

- The fan should be cleaned to ensure that it provides the airflow required for proper operation. The fan speed should be checked at the same time. Incorrect pulley settings, a loose fan belt or incorrect motor speed can all contribute to poor performance.
- Ductwork should be inspected and cleaned as required to ensure that airflow is not restricted by loose insulation, abnormal buildup of dust or other obstacles, which occasionally find their way through the grilles.
- Be sure that vents and registers are not blocked by furniture, carpets or other items that would impede airflow.
- In open systems, mineral deposits can build up inside the heat pump's heat exchanger. Regular inspection and, if necessary, cleaning by a qualified contractor with a mild acid solution is enough to remove the buildup. Over a period of years, a closed-loop system will require less maintenance because it is sealed and pressurized, eliminating possible buildup of minerals or iron deposits.

Service contracts are similar to those for oil and gas furnaces.

Operating Costs

The operating costs of an earth-energy system are usually considerably lower than those of other heating systems, because of the savings in fuel. Qualified heat pump installers should be able to give you information on how much
electricity a particular earth-energy system would use.

However, the relative savings will depend on whether you are currently using electricity, oil or natural gas, and on the relative costs of different energy sources in your area. By running a heat pump, you will use less gas or oil, but more electricity. If you live in an area where electricity is expensive, your operating costs may be higher. The payback on an investment in an earth-energy system may be anywhere up to a decade or more. Later in this booklet, operating cost estimates are provided for EESs.

Life Expectancy and Warranties

EESs have a life expectancy of about 20 to 25 years. This is higher than for air-source heat pumps because the compressor has less thermal and mechanical stress, and is protected from the environment.

Most ground-source heat pump units are covered by a one-year warranty on parts and labour, and some manufacturers offer extended warranty programs. However, warranties vary between manufacturers, so be sure to check the fine print.

The SolarCity of Geothermal

Geothermal heat pumps also have the economic potential to deliver that same value proposition: hassle free installations, and reliable savings from day one. But if the industry is to achieve this potential, several things have to come together:

- A single company responsible for the entire installation, from engineering to installation to maintenance.
- Reliable monitoring of heat production from the ground loop.
- A financing tied to the geothermal installation itself, to allow a lease-like structure which allows homeowners to see the benefits from day one.

We already have the corporate and financial structures to bring the solar lease model to GHPs. In fact, it takes little stretch of the imagination to see a solar lease company acquiring or partnering with GHP installers and offering a geothermal lease along with the solar lease to its customers. In cold climates not known for their sunny winters such as the Northeast US, the underlying economics of GHPs are far superior to those of solar photovoltaics. These economics should enable very attractive GHP leases, as soon as the other pieces are in place.

First, the homeowner and the geothermal lease company would have to have a reliable, objective way to monitor the performance of the GHP system.

Geothermal Monitoring

Ground Energy Support is tackling this problem with its GXTracker, which monitors the heat output of the ground loop and monitors or models the electricity consumption of the pump itself. Heat production monitoring lets everyone know if a system is operating as designed, and helps diagnose the problem when it is not.

Of the 30 GHP systems Ground Energy Support has been monitoring for the last two and a half years, 60% have had some operational, maintenance or mechanical issue. Most of these were minor maintenance issues or improper settings which caused only minor drops in performance, but which would have gotten worse if undetected. But 17% of the systems had significant design or installation problems. A third of these were oversized systems which can lead to higher energy costs but were likely the result of homeowner preferences. Another third were easily fixable and not the fault of the installer: a failed heat pump (covered under warranty), and an air duct which was left open to an unfinished garage. The rest (high pumping penalty caused by too large a pump or too small pipes, and an undersized ground loop) could have been avoided if the homeowner had been able to vet the installers' track records - another potential benefit of ubiquitous monitoring.

- **February 21, 2017**

by Joseph Zwilling and Mercedes Lopez Blanco

SAINT PATRICK'S CATHEDRAL ANNOUNCES THE LAUNCH OF A STATE-OF-THE-ART GEOTHERMAL PLANT

St. Patrick's Cathedral inaugurated the final phase of the restoration with the full activation of a state-of-the-art geothermal plant this month. The February launch of the geothermal plant is the first in a series of upgrades slated for 2017 intended to adapt one of New York's earliest and most impressive landmarks to the structural and environmental standards of twenty-first century urban life. The innovative engineering plan for the plant was carried out by the Cathedral's design team, Murphy, Burnham, & Buttrick ("MBB"), Landmark Facilities Group, and PW Grosser, who developed and repurposed the existing infrastructure to harness clean, renewable power from an underground system of wells in order to regulate the temperature of the Cathedral and adjoining buildings with increased efficiency and a considerable reduction in CO2 emissions.

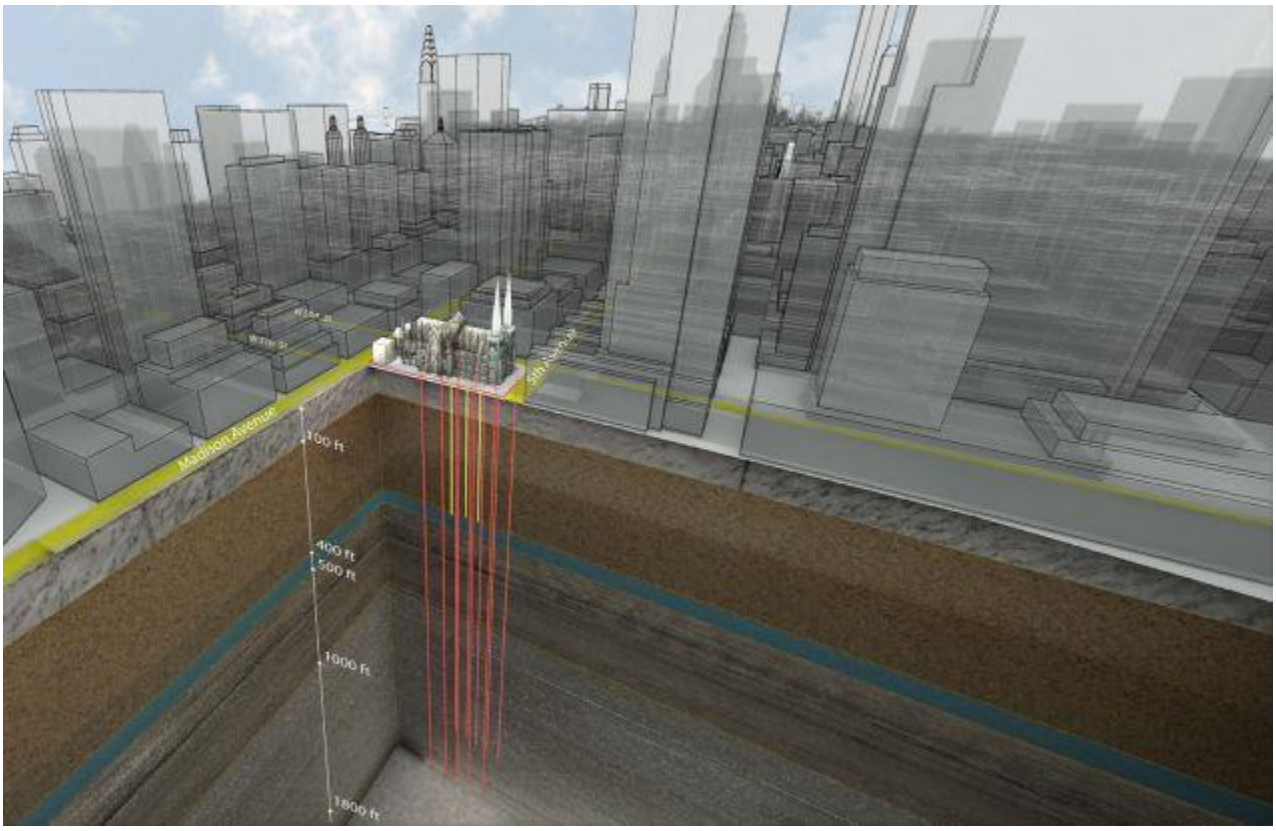
The Cathedral's newly active geothermal plant is comprised of ten wells which have been drilled along the north and south sides of the Cathedral to a depth of up to 2,200 feet. This prodigious drilling project, which included four wells on New York's 51st Street and six wells on 50th Street, was overseen by the prominent construction management firm, Structure Tone of New York. At the heart of the system is a Dedicated Heat Recovery Chiller which extracts thermal energy from the underground system of wells and distributes it throughout the campus for heating and cooling purposes. This is accomplished through a standing column hybrid open loop system. Structure Tone worked with Lane Associates to oversee the installation of the heat pump, as well as the sophisticated distribution network of heat exchangers, air handlers, and fan coils that extract and redirect heat through the 76,000 square feet of space. While most geothermal plants alternate between their warming and chilling functions, this plant is designed to automatically split its cooling and warming functions in order to simultaneously heat or cool the diverse areas it services. When fully activated, the central plant will be able to generate 2.9 million BTU's per hour of air conditioning and 3.2 million BTU's per hour of heating.

The engineering and design team of MBB, Landmark Facilities Group, Silman, and Langan Engineering, in close collaboration with Zubatkin Owner Representation, LLC and the construction manager, Structure Tone, Inc., were tasked with installing a comprehensive geothermal heating and cooling system while maintaining the rigorous standards for the historic preservation of one of New York's most iconic structures. "At the outset, we evaluated a conventional HVAC system, but determined it would pose too many challenges for this historic building," says Richard A. Sileo, Senior Engineer with Landmark Facilities Group. "We conducted a feasibility study and found that a geothermal system let us meet our goals with the smallest impact." Work on the project commenced with the drilling of the wells in June 2015. The plant was finalized and ready to launch by February 2017.

The Archdiocese of New York and St. Patrick's Cathedral saw in this project the opportunity to lead by example in choosing a sustainable energy solution. The geothermal plant represents not only the cleanest and most cost-effective long-term option for power, but also the most responsible. Cathedral Rector Monsignor Robert T. Ritchie noted, "A consistent *ethic of life* does not compartmentalize these issues. It prioritizes life and the preservation of life at every level. One of the most basic ways in which we are called to do so is through responsible stewardship of our natural resources." The decision on the part of the Trustees of St. Patrick's Cathedral and the Archdiocese of New York to pursue the geothermal option articulates a vision of restoration and preservation that extends beyond the celebrated walls of America's Parish Church; one that will, hopefully, encourage business leaders and institutions to also consider renewable energy solutions.

Warming Trend: Why New York Needs to Invest in Geothermal

By Zephyr Teachout • 01/14/16 10:00am



St Patrick's Cathedral – rendering of the new geothermal heating system for the church (Photo: © Murphy Burnham & Buttrick Architects

New York City has nearly 1 million buildings and nearly all of them (roughly 900,000) could be heated and cooled by the earth without burning any fossil fuels.

A recent report found that New York City was the most wasteful megacity in the world, and its buildings consume two-thirds of the energy we use. Over half of that energy is for space heating alone. Fossil fuels burnt for that purpose cause nearly 40 percent of CO2 emissions in America.

Solar, wind and hydropower are all necessary if we're going to provide electricity without accelerating climate change, but none of these are great for heating and cooling buildings. The leading technology for this is called ground source heat pumps, which use energy from the sun's heat trapped just below the earth's surface. As air temperature fluctuates wildly throughout the year, the ground 20 feet below the surface stays steady, between 50 and 60 degrees.

A ban on fossil fuel systems would spur a geoexchange explosion.

Ground source heat pumps are exchange systems. In the winter, they absorb the heat from the earth, concentrate it with a heat pump, and deliver it throughout a building by ductwork. In the summer, they absorb the heat from the building and release it to the cooler earth.

Currently, they have high upfront costs due to drilling and installation. But a recent study of the cost to switch in New York City showed that they quickly pay an impressive return-on-investment, breaking even within three to 12 years depending on what kind of system they replace.

You might assume that such projects of this scope are unworkable in a dense city like New York, but there is massive, glorious proof of the possible in the very center of the city. St. Patrick's Cathedral recently drilled and installed a new geothermal heating and cooling system. St. Patrick led the snakes out of Ireland—perhaps St. Patrick's can lead the fossil furnaces out of New York.

Once geothermal technology gains more attention, Bob Wyman, a local energy consultant, forecasts a tipping point, where the city bans the construction of new fossil fuel furnaces (a policy just enacted in Denmark). Such a ban on fossil fuel systems would spur a geoexchange explosion, as architects learn about the systems and financers capitalize on the long-term opportunity. The state can lower the barriers to acceptance of the technology by offering subsidies to homeowners and landlords. But the biggest motivation will come from high heating and cooling costs, as well as the unbearable cost to the city from climate change.

Bill Nowack is the executive director of NY-GEO, and an expert in geothermal energy. According to one estimate he shared with me, between 80 and 90 percent of buildings can be heated by ground source heat pumps. It is not for every part of the city and will be easiest to incorporate in the outer boroughs and more residential areas without existing underground infrastructures. An estimate by John Rhyner—a licensed professional geologist—showed that almost all of Staten Island, 70 percent of Queens, and half of Brooklyn residential footage could be heated with this technology.

According to Mr. Nowak, the installers are already doing brisk business as word spreads, but the lack of governmental support for the technology has made progress far slower than it could be. Last year,

Gov. Andrew Cuomo vetoed two bills that would have done the most toward jump-starting the geoexchange revolution. His support for the ground source heat pump future will be critical.

We have the breakthrough technology; all we need is breakthrough politics to build a city of the future, harvesting the steady heat of the earth.

New York City is an island city. It is one of the most vulnerable cities in the world to climate change. The city we love will drown if we don't lead the world in clean energy. It is time to dig deep.

Zephyr Teachout is an associate law professor at Fordham Law School.

What the Federal Budget Means for Geothermal - a Brief Explanation

The March 22nd federal budget announcement on geothermal was the culmination of several years of work by CanGEA and the benefits to the industry will be immediate. The budget announced that:

"Geothermal energy is one renewable energy source with the potential to reliably meet a portion of Canada's heating and electricity generation needs, including in northern and remote communities, where reliance on fossil fuels remains high.

To encourage greater use of geothermal energy, Budget 2017 proposes to:
Extend accelerated capital cost allowance [ACCA] to a broader range of geothermal projects and expenses. Expand the range of geothermal energy project expenses that are eligible as Canadian renewable and conservation expenses [CRCE], which can be fully deducted in the year incurred."

Today, I will be discussing the implications of this decision, as outlined by the above text, and the budget supplementary document.
Before March 22nd, for geothermal to qualify as a "renewable energy source" under the *Canadian Renewable Conservation Expense* (CRCE) and the *Accelerated Capital Cost Allowance Class 43.1/43.2* (ACCA), all production had to be allocated for electrical generation.

The expansion of the CRCE and ACCA to include geothermal heat seems small, but it is the exclusion of heat that has proven a huge challenge to the Canadian geothermal industry. Other Canadian subsurface resource developers enjoy exploration de-risking through the *Canadian Exploration Expense* (CEE) and require it to gain financing. The exploration expenses of a CEE qualifying project are tax deductible. These tax deductions reduce the risk of exploration and is one part of what is often talked about as fossil fuel subsidies; renewable energy qualifies for the CEE by being eligible for the CRCE. Geothermal requires the same exploration de-risking to secure financing, because the energy is several kilometres below the surface, but before March 22nd geothermal did not have assured access to the CEE (via the CRCE). The asymmetry in risk due to different levels of government industry support has made it functionally impossible to finance a geothermal development because capital has rationally favoured

better secured investments. By making all geothermal projects (heat, power and co-generation) eligible for exploration de-risking geothermal projects have a much better investment prospect.

Furthermore, and related to CRCE and CEE geothermal developers can now offer investors flow through shares(FTS). The FTS work by allowing tax deductions earned by an eligible corporation to pass to its investors. FTS are extremely important to the Canadian sub-surface resource development industries and now geothermal can offer its backers access to these attractive investments, further improving the investment potential for geothermal.

Lastly, it is just good news that Canada has recognized the value of geothermal heat and will allow geothermal to heat district heating systems. Geothermal supplied district heating systems are used around the world to provide affordable heat and offset fossil fuel use but until March 22nd, such systems that used geothermal did not qualify as eligible renewable energy projects for favourable tax status in Canada.