IDEA Innovation Award 2023

Markham Springwater Geoexchange District Community

Markham, Ontario, Canada

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Statement of Confidentiality

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Executive Summary

(In 700 words or less, summarize the project /program, demonstrating the key aspects of what was done and the overall benefits.)

The Markham Springwater Geoexchange Community Project ("Springwater") is an innovative solution to the challenges of providing sustainable, energy-efficient, and market-competitive heating and cooling to urban communities. Located at the northwest part of Markham, Ontario (See Figure 1 in Section: Project Figures and images), the Springwater project is the first of its kind in Canada, This project was developed collaboratively between the City of Markham, Mattamy Homes, and Enwave Energy Corporation to leverage the earth's natural energy to serve as both a heat source and a heat sink for over 300 homes. The system consists of 144 boreholes drilled to a depth of 259m each. These boreholes provide primary space heating and space cooling source for the homes in the community. The district piping, which connects the boreholes to the homes and to each other, spans over 2.9 km and ensures efficient delivery of heating and cooling throughout the community.

The homes in the Springwater project were built to a more stringent building standard (EnergyStar) and are net-zero ready. The EnergyStar standard is a voluntary program that focuses on improving energy efficiency and reducing greenhouse gas emissions in homes. By meeting the EnergyStar standard, the homes in the Springwater project have undergone rigorous testing and inspections to ensure they meet strict energy efficiency guidelines. This means that the homes in this community are designed and built to be highly energy-efficient and are ready to become net-zero buildings with the installation of a renewable energy system.

The key aspects of the project included:

- Extensive research and analysis of the potential benefits of the different types of geoexchange systems, including lifecycle costs, energy efficiency, and environmental sustainability.
- Development of a comprehensive geoexchange system that leverages advanced technology and engineering expertise to provide efficient and reliable heating and cooling to homes in the community.
- Testing the market and proving commercial viability of the solution and creating a transferable model that can be replicated in other locations.

Overall, the project has delivered significant benefits, including:

- Enhanced environmental sustainability: By leveraging the earth's natural energy, the geoexchange system has reduced greenhouse gas emissions by eliminating use of a natural gas furnace.
- Reduced energy consumption and cost savings: The geoexchange system has significantly reduced the energy consumption and cost associated with traditional heating and cooling systems, for the community as a whole.
- Supporting the Green Economy: The project contributes to the growth of the green economy by promoting long-term investment models and supporting the development of a skilled trade network for geoexchange systems. This approach redirects the focus from the traditional solely on capital cost towards a more holistic approach that considers the total life cycle cost of sustainable solutions.

- Enhanced reliability: Ground source heat pumps are more reliable and have a longer operating life than typical air conditioners/furnace systems. A Natural Resource Canada study showed a life expectancy of 20- 25 years for the ground source heat pump[1] compared to the estimated 15 year for central air conditioners[2]. Additionally, geoexchange boreholes and district piping infrastructure that provides the heating and cooling sources are expected to last at least 50 years (and likely over 100 years).
- Noise reduction: The project will also reduce noise within the community. Since air conditioning units are no longer necessary in the community, the outdoor unit for the air conditioner is no longer required, effectively reducing noise pollution during the cooling seasons.

The Markham Springwater geoexchange community project serves as a testament to the power of collaboration between industry leaders, government bodies, and energy companies in achieving a more sustainable future. We are proud that the Springwater project can serve as a successful model for sustainable, energy-efficient heating and cooling solutions in urban communities around Canada, and we look forward to continuing to innovative and drive positive change in the industry.

[1] Natural Resources Canada, "Heating and cooling with a heat pump," Energy Star Canada, 2019. [Online]. Available: https://natural-resources.canada.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/heating-and-cooling-heat-pump/6817.

[2] Natural Resources Canada, "Air conditioning your home," Energy Star Canada, 2018. [Online]. Available: https://natural-resources.canada.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/air-conditioning-your-home/6051.

Innovative and Unique Aspects

(In 300 words or less, explain how the project/program is innovative and unique.)

The Springwater project is a truly innovative and unique system that showcases the potential of collaboration and technology in addressing the challenges of incorporating sustainability into large-scale single-family home developments. One of the key features that sets this project apart is the use of a single-pipe, low-temperature ambient system with distributed geoexchange boreholes (See Figure 2 in Section: Project Figures and Images). This approach is particularly noteworthy because it allows for energy sharing within the community; for example, by the extraction of waste heat from one home that is used as a heat source for other homes within the community.

The geoexchange boreholes are distributed in clusters connected to geo-vaults within the district. The geo-vault directs the flow from the ambient loop to the geoexchange boreholes. These geo-vaults use the boreholes to provide energy to the ambient loop serving a series of homes adjacent to the geo-vaults. The geo-vaults are spaced intentionally along the district loop to ensure sufficient energy is provided to each segment of the loop, ensuring that the fluid temperature across the segment and the loop is consistent.

The in-suite heat pumps are located at the basement of the homes and are connected to the district through a dedicated connection directly to the ambient pipe. When energy is required in a home, the district water is pulled into an individual heat pump through an integrated flow center pump. The energy is either extracted from or rejected to the fluid and is returned downstream in the district ambient loop. This process is illustrated in Figure 3.

This distributed geoexchange design is also unique because it helps prevent overheating or over extracting of the geo field by spacing the borehole clusters far apart. By doing so, the system reduces the seasonal balance issues that typical geoexchange systems may encounter. It also ensures that the boreholes do not interfere with each other and concentrate energy within the ground.

Project Energy Efficiency Benefits

(With supporting data, demonstrate the improved energy efficiency benefit offered by the project/program, in 250 words or less.)

The Markham Springwater geoexchange community project has shown a significant improvement in energy efficiency compared to traditional heating and cooling systems. Enwave's recent analysis of operating data from September to December 2022 (illustrated in Table 1) reveals that the geoexchange system has reduced energy consumption for space heating and cooling by over 75% compared to conventional systems. The closed-loop system of the GSHPs also significantly reduces greenhouse gas emissions, contributing to a more sustainable community.

Table 1: Energy Consumption and Greenhouse gas Emissions Comparison (September – December 2022)

Summary of Results				
	Energy Consumption (kWh)		GHG Emissions (tCO_2e)	
Base Case Scenario		454,444		80
District Geothermal System		99,380		8
Calculated Impact	-	355,065	-	72
Percent Reduction		-78%		-90%

The system utilizes a distributed borehole design with a one-pipe ambient loop (all installed within the public right of way) in combination with ground source heat pumps, which allows the system to share energy within the community, combined with geoexchange energy and a ground source heat pump. During the winter, heat is extracted from the ground and upgraded using water-to-air heat pumps. During the summer, the system rejects heat back into the ground for cooling. This closed-loop system minimizes the amount of energy required to heat or cool homes, resulting in substantial energy savings and reduced greenhouse gas emissions.

The district geothermal system reduced energy consumption by 355,065 kWh and greenhouse gas emissions by 72 tCO2e, representing a reduction of 78% and 90%, respectively, compared to the base case scenario during the period between September to December 2022. See Figure 4 and Figure 5 on the expected modeled energy savings and GHG emission reduction. The project's success demonstrates the potential for large-scale deployment of GSHPs and other sustainable technologies, which can have a significant impact on reducing energy consumption and greenhouse gas emissions.

Project Financial Advantages

(With supporting data and graphics, explain the financial advantages of this project/ program in 250 words or less.)

The Springwater project not only offers significant energy efficiency benefits but also financial advantages. The distributed borehole design of the GSHPs, combined with the closed-loop system, resulted in lower operating costs, which can lead to significant cost savings for the community.

According to Enwave's financial analysis model prepared in 2019, the community is expected to see over $7 million in energy savings for the homeowners over the next 20 years (See Figure 6 for expected energy saving costs for next 30 years). This is due to the significant reduction in energy consumption achieved by the geoexchange system, which reduced the amount of electricity and natural gas required for heating and cooling.

Furthermore, the project has received funding and incentives from various government agencies, including the Federation of Canadian Municipalities, Natural Resource Canada and The Atmospheric Fund. This funding has not only helped to offset some of the upfront costs of the project but also supported research, experimentation, and additional engineering costs.

Overall, the Springwater project has been designed to be at minimum cost-neutral, but likely provide a cost benefit for the community over the long term. While there is a slight premium on the capital cost for the net-zero ready homes, the overall cost of the project has been carefully managed to ensure that the financial burden on the homeowners is minimized. The project's reduced energy consumption, combined with government funding and incentives, results in cost savings for the community and demonstrates the economic feasibility of sustainable technologies such as GSHPs.

Project Challenges

(In 250 words or less, please provide any additional information about the project/program (what challenges did you face? What plans do you have for the future? How did your customer base or community react? Etc.))

Despite facing several challenges during its implementation, the Springwater project has been a success in promoting sustainable and environmentally friendly housing options. One of its major challenges was the high capital cost associated with this project, but funding from various sources was secured to overcome this challenge. This investment was necessary to develop a reliable, efficient, and sustainable heating and cooling system that could provide long-term benefits to the community.

During the project, there were some technical challenges such as issues related to the control and operation of the ambient pumping system, and occupancy starting later in the year when the ground temperature was colder than we'd prefer for winter operation. However, with the Enwave team's experience, the team was able to address these issues.

There were also some issues with the supply chain during the 2020-2021 pandemic, which resulted in a mismatch between the window SHGC value on the constructed building and the original design. These issues could have been avoided if alternatives had been designed and communicated in advance.

Even though there were many challenges, the response from the customer base and community has been overwhelmingly positive. Residents appreciate the sustainable and cost-effective benefits of the geoexchange system. We aim to expand our operations to other communities and help promote sustainable and environmentally friendly housing options across the province. Our ultimate goal is to demonstrate that sustainable housing options can be energy-efficient, and environmentally friendly, and we are committed to leading the way in this important area.

Project Figures and Images

(Please provide 3 to 5 attachments as images, diagrams, or photographs in jpeg format with identifying captions.)

Figure 1: Location of the geoexchange community

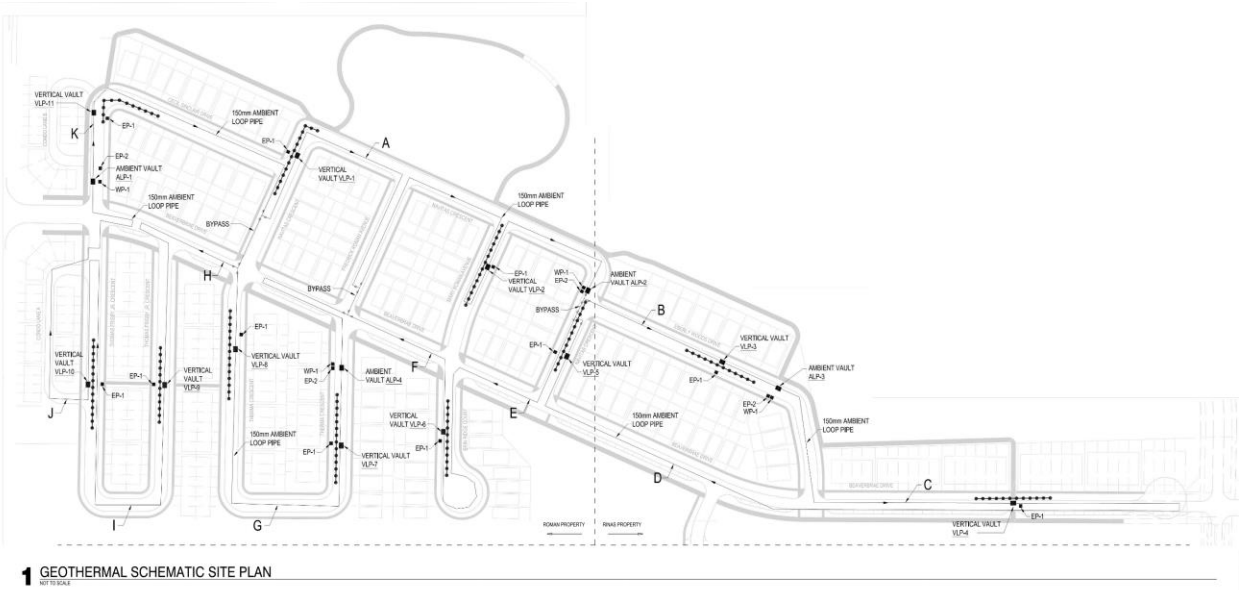

Figure 2: Geoexchange System Distribution Schematic

Figure 3: How geoexchange works

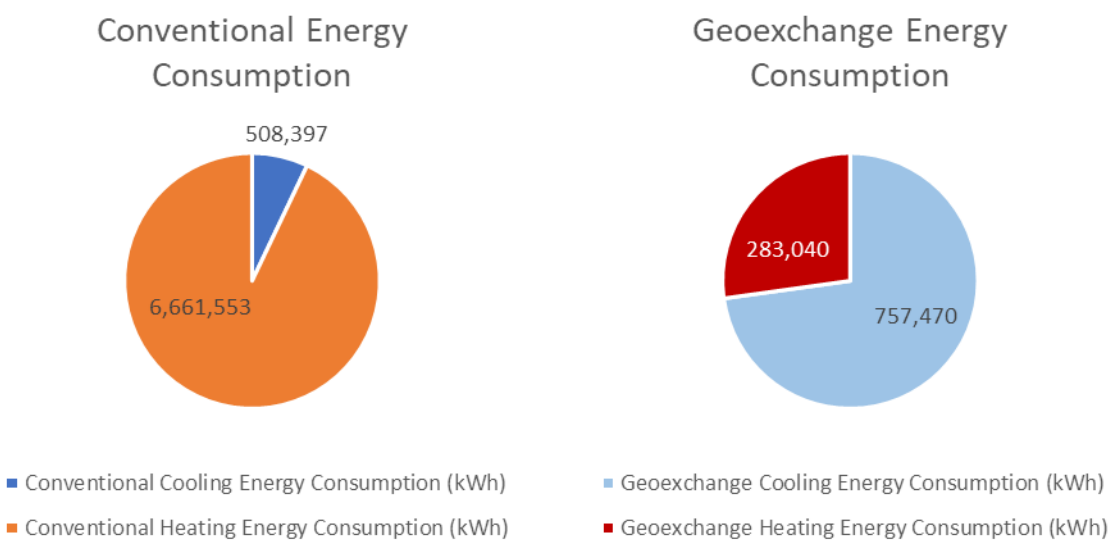

Figure 4: Energy Consumption Comparison

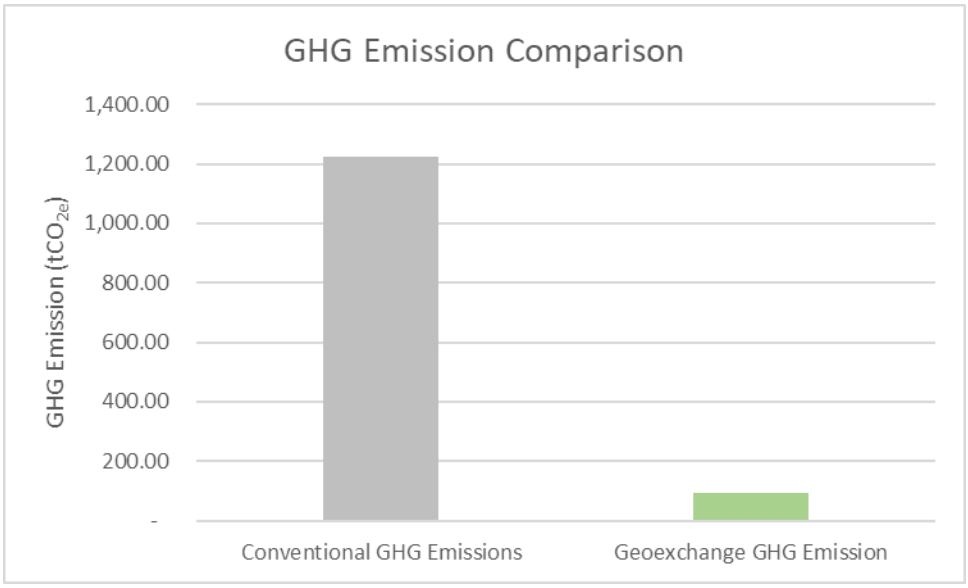

Figure 5: GHG emissions comparison between conventional system and geoexchange system

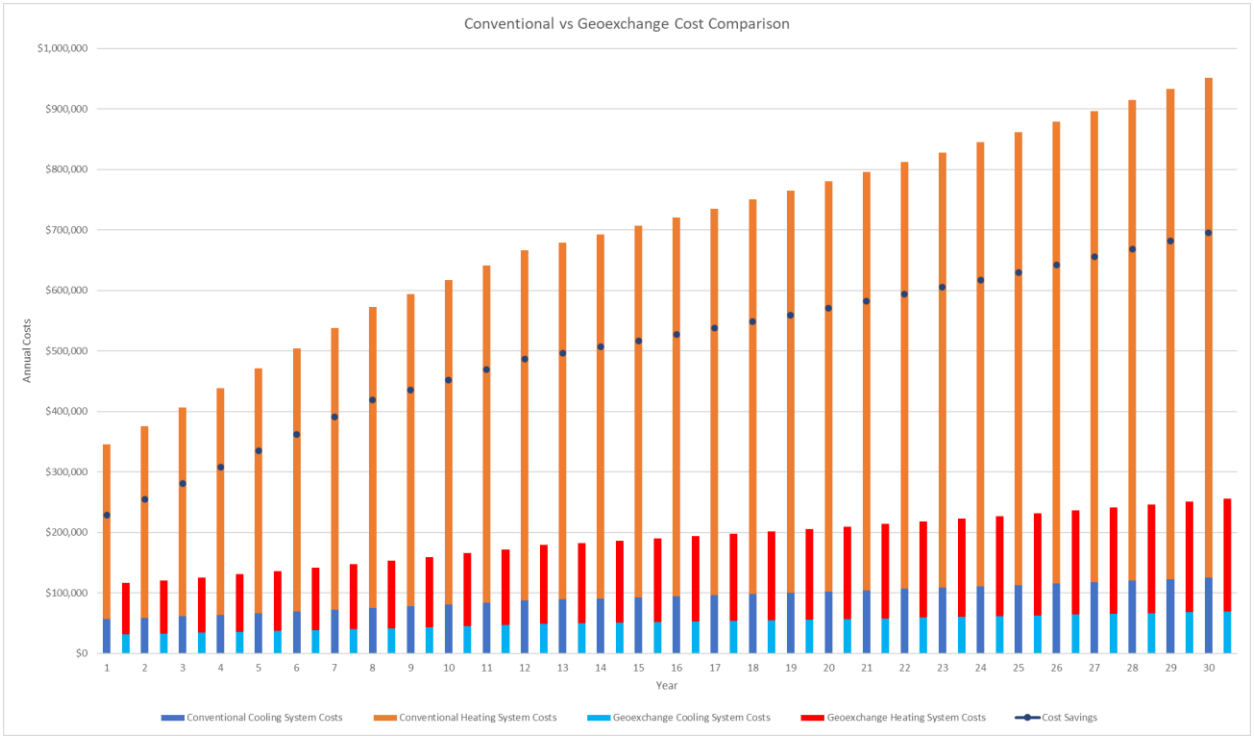

Figure 6: Conventional Vs Geoexchange Cost Comparison