CLIMATE CHANGE INNOVATION AND TECHNOLOGY FRAMEWORK

Awardee Summary

CCITF PROGRAM	Clean Technology Development
PROJECT TITLE	Refining the design approach for GeoExchange system
ORGANIZATION	University of Alberta
SECTOR	Energy Efficiency, Green Buildings
PROJECT LEAD	Wei Victor Liu
AI PROJECT ADVISOR	Maureen Kolla
GRANT AMOUNT	$37,560
START DATE	2018-09-15
END DATE	2019-09-15

PROJECT OBJECTIVE: A more explicit understanding on the complex thermal behavior of the borehole heat exchanger, and a refined analytical design approach for the GeoExchange system that leads to a more economically feasible design.

PROJECT PROFILE: In Alberta, new buildings have also been increasingly utilizing the GeoExchange system, which uses the shallow ground—mostly less than 150 meter—as an energy reservoir for space cooling and heating. The GeoExchange system provides a higher energy efficiency and a lower electricity consumption, resulting in a substantial reduction of GHG (greenhouse gas) emissions. According to the US Department of Energy, GeoExchange system is endorsed to be “among the most efficient and comfortable heating and cooling technologies.”

But the high capital costs—associated with drilling and installation—lead to a relatively long payback period (i.e., between <10 and 20 years), which impedes the application of GeoExchange system. To reduce the capital costs, one straightforward solution is to reduce the borehole length while maintaining the required heating/cooling capacity. This is because the drilling and installation costs depend on the borehole length—a shorter borehole length means lower capital costs. This reduction of borehole length can be achieved during the design of GeoExchange system, which can be refined by including the synergistic effect of groundwater on the borehole heat exchanger (BHE).

In the GeoExchange system, BHE is the most crucial component because the efficiency of the GeoExchange system relies primarily on the thermal interactions between BHE and its surrounding ground. Currently, the design approach of BHE is to use analytical solutions of heat conduction governing equations under the Laplace transform. However, these models do not consider the impact of groundwater flow on the thermal performance of BHE. This impact is beneficial because the advection of groundwater helps the dissipation of heat in the ground and therefore provides a synergistic effect on the performance of BHE under both cooling and heating modes. Consequently, this design length of BHE can be shortened, and the drilling and installation costs can be reduced substantially. To this end, we propose research collaboration between Revolve Engineering Inc. and the University of Alberta to conduct finite element method (FEM) modeling of the BHE by incorporating the co-simulation of groundwater and heat transfer. As a result, a more explicit understanding will be achieved on the complex thermal behavior of BHE, and the current analytical design approach will be refined for the GeoExchange system, leading to more economically feasible design. Since the GeoExchange system is increasingly popular across Canada, the outcome of this research can be directly used in other nationwide projects.

GHG EMISSION REDUCTION SUMMARY: