Del Ridge Homes

CASE STUDY

Geoexchange Series

GreenLife condominium in Miltron, Ontario, one of the first Net Zero condominiums in Canada.

SITE PROFILE

Building owner	Del Ridge Homes
Building location	Milton, ON
Building type and use	Multi-unit residential condominium complex
Net floor area (ft^2)	~673 to 1,400 per unit, ~140,000 for 160 units
Ground loop	The vertical loop is composed of 68 boreholes each 400 ft deep. Ground loop feeds 28 vertical risers each connecting up to 6 heat pump units in parallel.
Number of GSHPs	1 per unit
GSHP manufacturer and model	Climate Master Tranquility Series (TSV or TSH) models 006 to 042 water-to-air heat pumps
Total rated heating capacity (tons)	0.4 to 2.53 per unit
Total rated cooling capacity (tons)	0.56 to 3.3 per unit
Manufacturer rated coeff. of performance (COP)	3.4 to 4.0
Manufacturer rated energy efficiency ratio (EER)	18.1 to 20.0
Distribution system	Forced-air
Dominant use of system	Heating
Year installed	2012

ABOUT THE SITE

Del Ridge Homes is a leading developer of large scale residential and commercial facilities. Through its GreenLife Building Systems, Del Ridge has been on the forefront of the green building movement in the Greater Toronto Area. GreenLife facilities feature innovative technologies such as geoexchange for heating and cooling, grid-tied solar photovoltaics, thermally efficient windows, tight highly-insulated building envelopes and solar street lighting among others. The company recently constructed one of the first Net Zero Energy condominiums in Canada, GreenLife Condominium in Milton, Ontario.

RATIONALE AND PLANNING

Del Ridge's first geoexchange project was initiated in 2007. At this time, Del Ridge had set its sights on Net Zero Energy Building Certification and geoexchange was a move towards achieving this goal. At present, the company has developed a total of five multi-unit residential complexes served by geoexchange and a sixth is underway. Four of these buildings are condominium complexes and two are not-for-profit community housing. Feasibility assessments were not performed for each new geoexchange project. Instead, the team draws upon the lessons learned from past projects to streamline future system designs.

Figure 1. Ground loop manifold in basement parking garage of GreenLife Condominium.

GEOEXCHANGE SYSTEM DESIGN

The Net Zero Energy building, GreenLife Condominium, was constructed in 2012 in Milton, ON. The geoexchange system was part of the original construction of the facility, which is designed to high standards of energy efficiency. The ground loop is comprised of 68 vertical boreholes, each 400 feet deep. The geoexchange system is a decentralized system, meaning that each of the approximately 160 condominium units is fitted with its own heat pump. The ground loop supplies the heat transfer fluid to each condominium unit via vertical risers branching off from the main loop which connect up to a set of 6 units in parallel. Each unit contains Climate Master TSV water-to-air heat pumps ranging in size from 0.5 to 3.5 nominal heating tons. Decentralized geoexchange systems offers residents individualized space conditioning, providing greater efficiencies and improved thermal comfort.

MONITORING

To gain insight into the system performance, a single riser of 6 units was monitored from November 2012 to October 2013. Attached to the riser were a single Climate Master TSV 012 (1 ton nominal heating capacity) ground source heat pump (GSHP) and five TSV 006 GSHPs (0.5 tons nominal heating capacity). Power consumption was monitored for 3 of the 6 heat pumps. The flow rate through the riser was monitored as was the temperature of the supply and return. Malfunctioning flow rate sensors during the monitoring period prevented the calculation of system coefficient of performance (COP) and energy efficiency ratio (EER). The heat pump power consumption measurements became the primary focus of the analysis.

Geoexchange systems offer a range of design options. Systems can be centralized or decentralized. Centralized systems employ one (or more) larger heat pumps to heat and cool a whole building from a central location such as a mechanical room. In a decentralized system, a number of smaller heat pumps are installed throughout a building each sharing a common ground loop.

PERFORMANCE

Figure 2 shows the percentage of time each unit spends operating each month. On the coldest days of the monitoring period the units operated between 70% and 90% of the time.* Since they are operating the majority of the time on a design heating day, they are likely to be well-sized for the heating load without being prohibitively oversized. The benefit of the energy-efficient design of the condominium is clear from the low cooling loads evident in Figure 2. In any given month during the cooling season, the heat pumps, which are only half to one ton unit, did not have to operate more than 20% of the time.

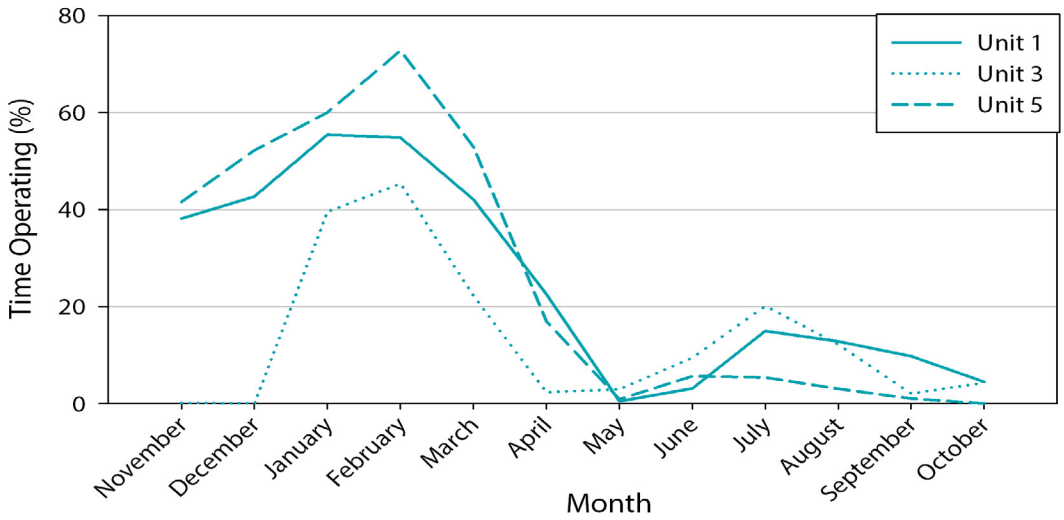

Figure 2. Monthly averages for the percentage of time heat pumps are operating in each unit.

* Note that Figure 2 displays montly averages, not daily values.

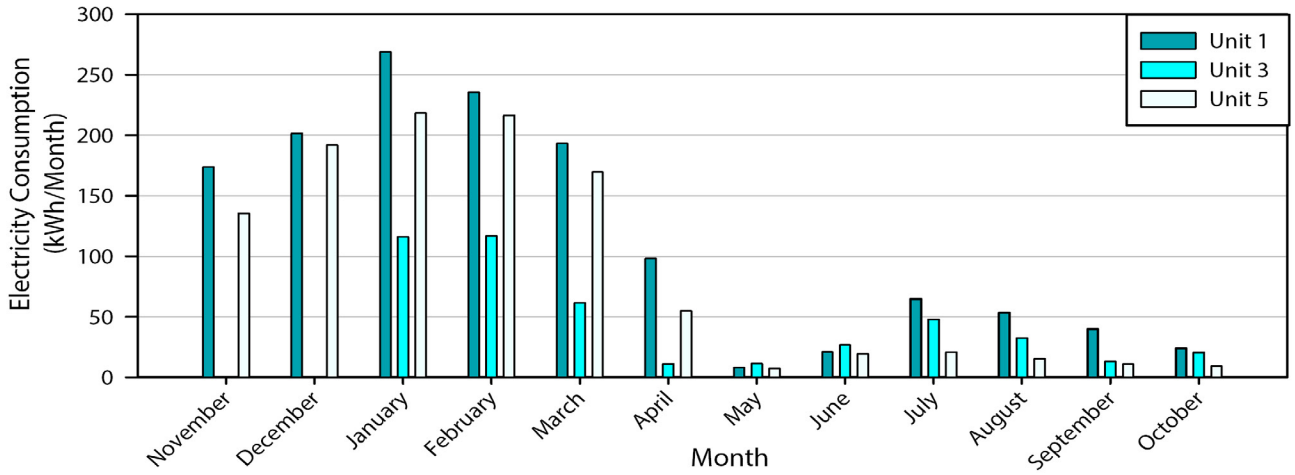

Figure 3. Monthly energy consumption of the air-to-water heat pump units installed in the GreenLife Condominium. Consumption includes both the compressor and the air handling unit.

Monthly electricity consumption of the three heat pumps over the one year monitoring period is presented in Figure 3. The annual electricity consumption to heat and cool units 1 (1 bedroom), 3 (1 bedroom), and 5 (2 bedrooms) were 1070 kWh, 458 kWh and 1382 kWh respectively. The energy expenditure of the system normalized for square footage is rather small compared to detached buildings examined in Janssen et al., (2014), which speaks to the energy efficiency of the condominium.

COSTS

Del Ridge paid for the up-front costs of the geoexchange system and all other building construction costs. System maintenance and usage of the shared ground-loop is covered by condominium fees. Residents are billed individually for the electricity consumption for the heating and cooling of their units. Although the capital costs for the geoexchange system was reported by management to have approximately a 20% premium over a conventional HVAC system, the life cycle cost of the geoexchange system (accounts for system longevity, energy savings, and maintenance) may be considerably lower.

SUCCESSES

Management has received positive feedback from residents in GreenLife facilities, which provide a more sustainable alternative to traditional condominium living. Common feedback from tenants is that during the heating season, they are able to go months without turning on their heat. As a result, management claims that energy consumption is 75% lower than comparable conventional buildings, reducing electricity bills and condominium fees substantially.

LESSONS LEARNED

Management reported that there was a learning curve associated with early geoexchange projects. The first installed system was in retrospect found to be grossly oversized, partially due to inexperience. The size of new systems however, have been reduced by nearly 50% without consequence.

REFERENCES

Janssen, Erik, Dahai Zhang, and Tim Van Seters. Performance assessment of urban geoexchange projects in the Greater Toronto Area. Toronto and Region Conservation Authority, 2014.

For more information on STEP's other initiatives visit us online at www.sustainabletechnologies.ca

This communication has been prepared by the Toronto and Region Conservation Authority's Sustainable Technologies Evaluation Program. Funding support for geoexchange case studies is provided by Toronto Atmospheric Fund, York Region, and Region of Peel. For more information about this project, please contact STEP@trca.on.ca