Assessing geoexchange potential in Whitehorse

by Dr. Scott Schillereff, (P.Geo) EBA Engineering Consultants Ltd..

Imagine harnessing renewable earth heat in a thriving Canadian capital north of 60°. The City of Whitehorse has that vision, and is looking at geoexchange energy technology as part of its Integrated Community Sustainability Plan. The resulting project won a 2008 Consulting Engineers of BC Award of Merit at a recent association gala.

Charrette helps to build a solid ICSP

The City of Whitehorse hosted a very successful charrette last year, the outcomes of which contributed to the development of its Integrated Community Sustainability Plan. Lesley Cabott (standing), manager of integrated community sustainability, led the discussion at one table.

"The City of Whitehorse is excited about developing alternative energy technologies," says Lesley Cabott, manager of integrated community sustainability planning. "And what we've learned, during the development of our Integrated Community Sustainability Plan, is that geoexchange is an efficient, renewable and attractive energy technology which, contrary to first impression, can be applied in northern settings." In fact, information gleaned from the process was used to support an application for Green Municipal Funds to examine the feasibility of a geoexchange district heating system for Whistle Bend, a new sustainable neighbourhood expected to house 10,000 Whitehorse residents over the next 20 years.

PROCESS UNDERSTANDING

In the spring of 2007, the City of Whitehorse hired EBA Egineering Consultants Ltd. to help them determine if and how geoexchange technology could be used to produce an efficient, affordable, and environmentally friendly alternative to its existing power sources.

As "energy architects," the consultants assisted with long-term municipal planning in three ways. Firstly, they assessed the areal distribution and quality of geoexchange potential. Secondly, they assessed the location and type of demand for geoexchange, including district energy systems. And thirdly, they presented their findings and municipal energy options — on user-friendly maps — at a four-day, city-hosted sustainability planning charrette in October that involved more than 80 participants from government, the private sector, and the public (including First Nation groups).

"As far as we know," says Cabott, "these maps at city scale are the first of their kind for any municipality in Canada. They are helping to drive the creation of 50-year guidelines for development."

GEOEXCHANGE TECHNOLOGY

Geoexchange is the process of coupling low-grade heat from earth sources and transforming it using heat-pump technology to higher-grade heat for building conditioning, domestic hot water, or process purposes. Ground sources can be soil, rock, groundwater, surface water, ocean, or waste heat.

Geoexchange technology incorporates heat pumps to move heat energy from a source to a load. Heat pumps extract energy from low-grade heat sources and 'concentrate' the heat to higher temperatures for delivery to a building space. Heat pumps can be reversed to provide cooling. By moving heat instead of burning fossil fuels to generate heat, geoexchange systems can provide heating or cooling more efficiently than with conventional systems. Typically, two-thirds or more of the total heat energy delivered from a geoexchange system is extracted from the earth.

The earth side of a geoexchange system is developed around a ground heat exchange, which can be grouped in two broad categories:

- Closed-loop — involving conductive heat transfer between the earth and a network of buried piping through which a thermal exchange fluid is circulated in a closed circuit.

- Open-loop — involving heat exchange with water (e.g., groundwater or surface water) pumped from one source and disposed of at a different

Waste heat can also be recovered from municipal sewer systems.

AN INNOVATIVE APPROACH

Consultants mapped the likely suitability of closed-loop borehole, groundwater open-loop, and sewer waste-heat recovery systems throughout the city. A weighted scoring system was developed to semi-quantitatively evaluate geoexchange potential by combining subsurface, physical, and land-use information, with the study area restricted to currently developed and developable areas. The assessment was founded on a database of 121 control points around the study area, each with the following information:

- database parameter
- location (UTM coordinates)
- lot size
- depth to bedrock
- dominant overburden type
- bedrock type
- depth to groundwater
- thermal conductivity
- transmissivity
- ease of drilling and installation.

Data sources included existing well and borehole logs, the city's OCP, technical reports, surficial and bedrock geology maps, contractor information, and reference documents. A score was developed for each parameter and combined to produce a total score of geoexchange potential for each type of earth heat coupling for each point in the database. The total scores were contoured, and a rule set developed to define "good", "fair," and "poor" conditions. Stop-light colours were used — green for "good", yellow for "fair" and red for "poor" — making the results intuitively clear to a wide audience.

"The innovation was in compiling existing and well-documented physical site and land use information, and processing it to produce contoured weighted scores and pragmatic, intuitive maps," explains Cabott. "These maps are readily useable for municipal planning and management, engineering support for developers, and raising awareness of renewable energy technology with the public.

"In fact, the maps and the charrette kick-started a tremendous wave of interest for geoexchange renewable energy in Whitehorse," she adds. "From the charrette, there was a radio interview, two newspaper articles, a TV panel, a TV interview, and a headline piece on CBC's national website, all relating to geoexchange. We also presented on this project at the Building Sustainable Communities conference organized by the Fresh Outlook Foundation in Kelowna, BC."

TRIPLE BOTTOM LINE INTEREST

The maps show that large areas of the city are amenable to geoexchange applications or sewer-heat recovery. Geoexchange technology has economic value because operational costs are 40 percent lower than for conventional forms of heating. After capital costs are recovered, owners realize long-term savings that are insulated from escalating fossil fuel costs.

In Yukon, where base electricity is generated hydroelectrically, emission of greenhouse gases from geoexchange systems can be substantially lower than from conventional systems burning fossil fuels. This provides aesthetic and marketing value for environmentally conscious building owners. In addition, Canada is establishing mechanisms for municipalities to trade carbon credits. Carbon credits from avoided greenhouse gas emissions could become a revenue stream for municipalities promoting geoexchange energy utilities.

For more information contact: Dr. Scott Shillereff, P.Geo, a principal with EBA Engineering Consultants Ltd. and team leader of its geoexchange engineering practice. He can be reached at 250-862-4832 or sschilleregg@eba.ca. Lesley Cabott is manager of integrated community sustainability for the City of Whitehorse; contact her at 867-668-8600 or lesley.cabott@whitehorse.ca.