Unlocking Saskatchewan's Low Enthalpy Geothermal Resources

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Introduction

In Canada, space and domestic water heating accounts for over 60% of energy requirements of commercial buildings, and about 80% in residential applications [1]. In Saskatchewan and Alberta, much of this energy is provided by the combustion of natural gas. Where subsurface conditions are suitable, a sizable portion of this energy can be provided by low-grade geothermal energy, extracted from deep sedimentary aquifers.

Resource

Much of southern Saskatchewan and most of Alberta are underlain by sedimentary rocks, being part of the Western Canada Sedimentary Basin (WCSB). In locations where the temperature of suitable aquifers is greater than 50 °C, open-loop geothermal systems can deliver a reliable and sustainable heat-energy source for generations without the direct emission of CO_2. Assuming a geothermal gradient of 30 °C, suitable aquifers greater than 1.7 km in depth could contain warm water suitable for direct-heating applications. Figure 1 shows the thickness of the sedimentary section within the WCSB and vast area with geothermal heating potential. Other investigations have recorded gradients greater that 30 °C/km, supporting the development of innumerable projects.

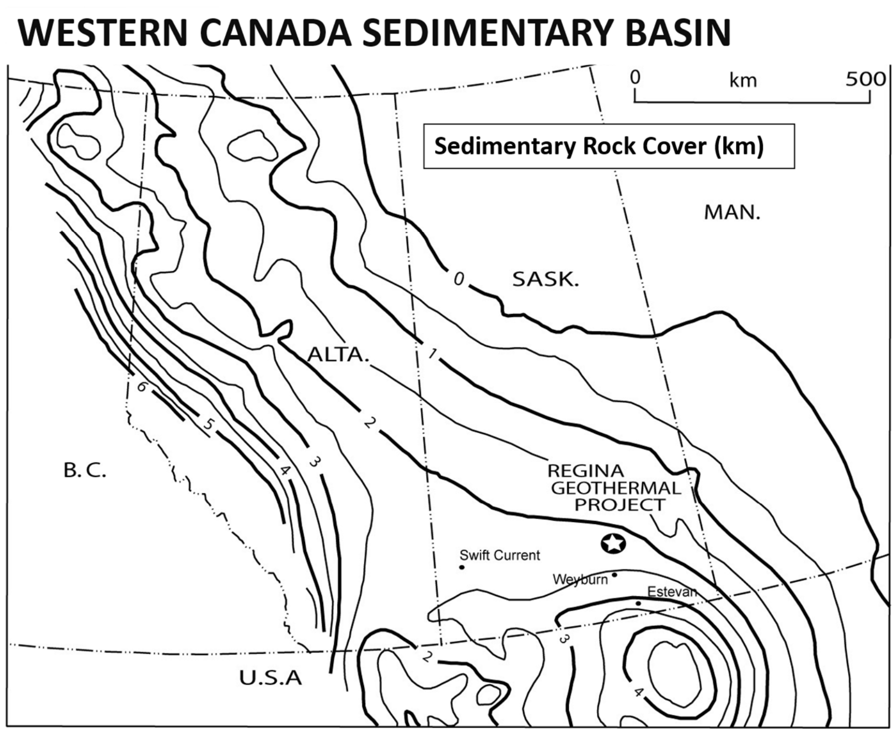

Figure 1: Thickness of sedimentary rock cover of the WCSB.

In Saskatchewan, the Basal Clastic Unit is comprised of the Cambrian Deadwood and Ordovician Winnipeg Formations which covers the Precambrian surface. These are the deepest, and therefore the warmest aquifers present over a substantial portion of southeastern Saskatchewan. In the Regina area, this interbedded siliciclastic aquifer section is approximately 120 m thick with an average porosity of 13.8% and average permeability of 155 mD. It is used extensively for potash mining brine disposal.

In 1979, visionary researchers at the University of Regina committed to proving this resource by drilling a 2200 m deep geothermal test well next to the campus. Completing the well included coring, drill stem and production testing the Basal Clastic Unit. Although the second well necessary to complete the geothermal loop was not completed, and the project was eventually abandoned, the technical feasibility of the geothermal resource in the greater Regina area was confirmed.

Technology Application

The City of Regina has developed and adapted an Energy & Sustainability framework to support the goal of making Regina a net-zero City by 2050. When planning began to construct a new Indoor Aquatic Facility, a pre-feasibility study on utilizing geothermal energy was conducted by the City, PTRC, a Regina-based energy research group and a team of specialized consultants. This investigation confirmed with a high level of confidence the capacity, sustainability and longevity of operating a geothermal system to provide reliable baseload heating to the new aquatics facility over it’s expected lifetime.

Consideration was given to the anticipated energy requirements of the facility to match the productive capacity of the aquifer with well infrastructure to deliver sufficient volumes of 58 °C water to satisfy the anticipated heating load. The volumetric flow rate to satisfy this load is estimated at 3600 m^3/day or 660 usgpm. The well separation in the aquifer was designed to achieve thermal breakthrough beyond the 70-year lifecycle of the building.

The environmental value of using a geothermal system is the *avoided emission of* CO_2 from the combustion of natural gas, which for this project is estimated to be 8700 t/yr. Over the anticipated 70-year lifecycle of this single facility the total emissions avoided would be approximately 609,000 tonnes.

The economic value of this project is equal to the *avoided purchase of natural gas* to supply equivalent heating *plus* the *avoided payment of the carbon levy*, less operating expenses. Life-cycle analysis compared the business-as-usual case of installing natural gas boilers compared to the installation of a geothermal system. Back up gas boilers will also be installed and used when the geothermal system is inoperable or peak demand exceed the capacity of the system. Results from this assessment supports the business case for developing the geothermal system.

Where technically and economically appropriate, utilizing a low-temperature geothermal energy source in a direct heating application for individual and district heating systems rather than relying on natural gas for heating helps to keep municipalities, property developers and industry from potentially locking-in a commitment to using fossil fuels over the lifetime of the structure, or eventually operating more expensive electrically fired boilers.

Showcasing how a low enthalpy geothermal resource at Regina can be used in a commercial application will provide confidence to architects and developers throughout the WCSB and other parts of Canada where this natural endowment of nearly inexhaustible geothermal energy can be harnessed.

References

1. 2015 NRCan Energy Factbook.