An Overview of Borealis GeoPower Projects and Community Engagement

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ABSTRACT

Borealis Geopower Inc. is currently the lead proponent of three geothermal projects in Western Canada: the Canoe Reach Geothermal Project, located 15km south of the Village of Valemount, British Columbia; the Lakelse Lake Geothermal Project, in cooperation with Kitselas Geothermal Inc., located on Kitselas First Nation traditional land 10km south of Terrace, British Columbia; and the Fort Liard Geothermal Project, in cooperation with the Acho Dene Koe First Nation, located in southwestern Northwest Territories. The projects will represent three of the several geothermal reservoir systems found in Canada: a fractured rock system, volcanic system, and hot sedimentary aquifer system. This paper will provide an overview of each project with recent updates and discuss the involvement of and the anticipated benefits to First Nations communities.

1. Introduction

Borealis GeoPower Inc. (Borealis GeoPower) is a private Canadian corporation focused on developing high temperature geothermal projects throughout Western and Northern Canada. The diverse projects involve working closely with the host communities and First Nations partners to build enabling geothermal energy projects that support local job creation, a diversified economy, local food, zero emission power, and heat production, while also earning an economic return.

The Canoe Reach Geothermal Project (Canoe Reach) and Lakelse Lake Geothermal Project (Lakelse), both in British Columbia, will tap into a fractured rock system and volcanic system, respectively, while the Fort Liard Geothermal Project (Fort Liard Geothermal) will tap into a hot

sedimentary basin in the Northwest Territories (NWT). The project locations and underlying geothermal systems are shown in the map in Figure 1.

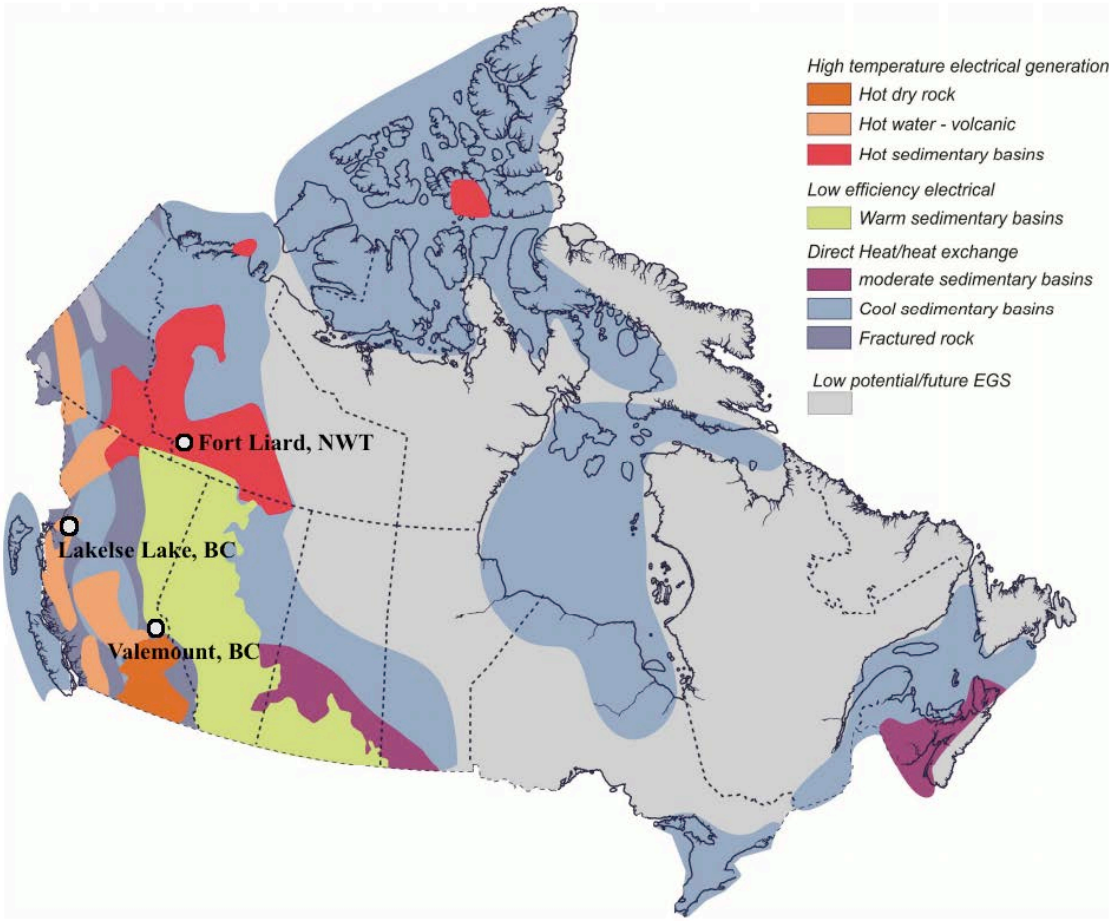

Figure 1: Borealis GeoPower's three current projects are located in various geothermal plays in Western and Northern Canada (adapted from Grasby et al., 2013).

We are in varying phases of exploration and development for each project; both Canoe Reach and the Lakelse have completed a pre-feasibility study, while Fort Liard Geothermal has completed a Front End Engineering Design (FEED). All three projects include a phase development approach involving micro or commercial power and a geoheat park called Sustainaville. The Sustainaville projects are geothermal powered and heated industrial parks with the purpose of not only offering new renewable energy options to community commercial development, but also demonstrating the viability of geothermal resources in Canada. Furthermore, all projects are being developed in collaboration with First Nations groups who traditionally inhabited the region.

2. Canoe Reach Geothermal Project

The geological environment in the Canoe Reach area, located 15km south of the Village of Valemount, BC, shows high potential for developing a geothermal project. The area hosts one of the hottest surface hot springs in Canada at the historic Canoe Reach Hot Springs (Gomshei, 2010). Borealis GeoPower has completed extensive exploration work since 2010 to identify key areas for project development.

We are taking a 3-phase approach to develop 450kW of micropower, a geoheat park, and a 15MW power plant, which will benefit not only the Village of Valemount, but also the Robson Valley Region as a whole (Figure 2).

Figure 2: Although the Village of Valemount is the target area for micropower generation and a geoheat park, the entire Robson Valley is expected to see benefits from Borealis' geothermal project. (Robson Valley Region)

2.1 Benefits to the Area:

Local commercial operations, including a brewery, fish farms, biomass operations, and greenhouses, have shown keen interest in being involved in the geoheat park. Our project intends to further grow current operations such as the local brewery by helping them operate with geothermal heat and power, and also to help kickstart new businesses that may have been too costly without a geothermal source. Furthermore, an electricity source close to Valemount may aid in the Village's issue with power failures. BC Hydro statistics indicate that Valemount has the most power failures in B.C., with an average of 36.3 hours without power per year (Figure 3) (The Vancouver Sun, 2017). The Village relies on a single power line that extends hundreds of kilometers and is commonly damaged by falling trees and adverse weather, so power failures are

more common and more difficult to resurrect (BC Hydro, 2017). The local geothermal power source will allow for short power lines directly to the community and the surrounding area.

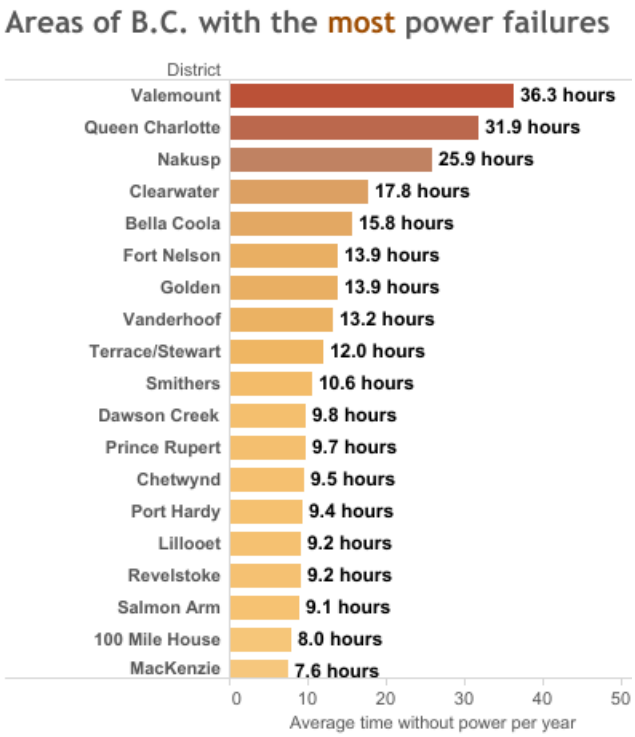

Figure 3: Valemount has the most hours without power per year in B.C. due to the reliance on a single, long power line.

2.2 Involvement and Anticipated Benefits to First Nations Communities:

The Canoe Reach project area is located on Simpcw First Nation, Lheidli First Nation, and Shuswap First Nation traditional territories. Earlier this year, Crown land near Valemount and within the Canoe Reach project area was transferred to the Simpcw First Nation. This will allow Borealis GeoPower to collaborate with the Simpcw First Nation in commercial heating and electricity opportunities and to develop commercial industries in the area while creating jobs.

2.3 Recent Updates

In October 2017, Borealis GeoPower completed a pre-feasibility study for Canoe Reach. This included magnetotelluric, gravity, and passive seismic surveys which we used in combination with other ongoing exploratory and reservoir modeling activities to target initial exploration drilling sites. Subsurface temperatures based on available geothermometry in the region are estimated to exceed 200°C at a depth of approximately 1,000m. The reservoir area is estimated to be approximately 30km^2 with an overall thickness of 500m.

These results indicate that, relative to an ambient temperature of 15ºC, 11,200 petajoules (PJ) of thermal energy in place may exist, which is estimated to be capable of yielding 58 MWe of continuous electrical power over a 30-year span.

In December 2017, the BC Ministry of Energy and Mines and Petroleum Resources, Electricity & Alternative Energy Division granted Borealis GeoPower an additional geothermal permit in the Valemount area. This area, referred to as "permit extension", is indicated in Figure 4. This extension has allowed Borealis GeoPower to consider development in further areas of high geothermal potential.

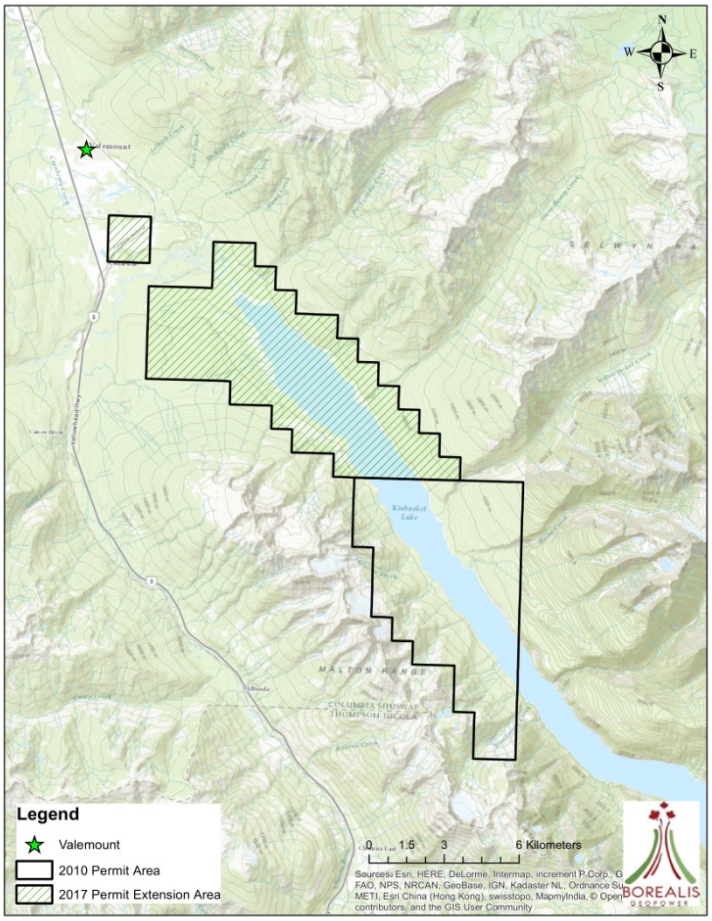

Figure 4: Areas of granted permit for Canoe Reach cover the northern area of Kinbasket Lake and a small area between the lake and the Village of Valemount.

Our most recent success made international news on May 29, 2018 when the BC Oil and Gas Commission (Commission) issued geothermal resource well authorizations to Borealis GeoPower for four thermal gradient wells for Canoe Reach. This marks the first time the Commission has issued a well authorization under the Geothermal Resource Act and is a significant milestone for both British Columbia's and Canada's geothermal industry. The well

authorizations allowed us to begin drilling for collection of geotechnical and temperature gradient information. In June 2018, we spudded our first temperature gradient well.

2.4 Next Steps

Subsurface confirmation drilling is continuing to provide a more accurate understanding of the resource. The confirmation drilling plan consists of drilling up to five temperature gradient holes to depths of 200 – 1,000 m. Converted wells are then intended to energize the Canoe Reach Sustainaville demonstration project.

3. Lakelse Lake Geothermal Project

Borealis GeoPower is working as a partner in Kitselas Geothermal Inc. (KGI) to develop a 2-phase geothermal project that includes a community heat project and a commercial power project by tapping into a volcanic rock system. The project area is located on Kitselas First Nations traditional land in west-central British Columbia, approximately 10km south of the town of Terrace. Specifically, it lies within the wide north-south running Kitsumkalum-Kitimat Valley, between the steep and rugged Hazelton and the Coast Mountains.

Borealis GeoPower has been collecting historical data and performing fieldwork towards constraining the resource potential of the Lakelse Lake area since 2012. This includes biogeochemistry surveys, soil sampling, natural and water well temperature and chemistry sampling, and both 30cm depth CO_2 flux and temperature readings over the permit area. Borealis GeoPower contracted out additional surveys, including an Interferometric Synthetic Aperture Radar (InSAR) survey that mapped areas of historical ground movement and a Spectral-Spatial Analysis (SPAN) study involving historic satellite/aero-based gravity and magnetic data.

We mapped the resulting datasets from this extensive field campaign to analyze their individual spatial distribution. We also correlated the datasets with one another and with other various datasets such as geological features, local infrastructure, local First Nations territories, and environmentally sensitive/protected areas. The results determined the locations of highest development potential within the area.

In 2015, we performed further analysis on all datasets, including normalization of biogeochemistry results between species type, re-interpolation using gloval krigging and B-spline algorithms, applying a correlation matrix between all elements in the biogeochemistry to determine correlated element groupings, spatial correlation between mapped variables, and a stochastic favourability treatment of all data sets using the Analytical Heirarchy Process.

Since then, we have continually updated the schema for collecting field data and implemented amendments and updates to both the in-house database as well as an online collector component.

3.1 Involvement and Anticipated Benefits to First Nations Communities:

Much of the technical exploration work completed in 2017 on Lakelse involved resource mapping for surface project development in conjunction with current Kitselas First Nation ongoing activities. Activities associated with KGI have focused on the dialogue and necessary

due diligence associated with BC Hydro's Standard Offer Program. The goal is a future Electrical Purchase Agreement and design, as well as site selection for future drilling of geothermal gradient exploration wells.

3.2 Recent Updates

In 2017, Borealis GeoPower announced the completion of a pre-feasibility study for Lakelse. Subsurface temperatures, based on available geothermometry, have been estimated to exceed 150°C at a depth of approximately 2,000m. The reservoir area has been estimated to be approximately 15km^2 with an average thickness of 500m. These results indicate that, relative to 15°C, 5,300 PJ of thermal energy in place may exist, which is estimated to be capable of yielding 23 MWe of continuous electrical power over a 30-year span. A continued surface exploration program and confirmation-drilling plan that consists of drilling to a depth of no more than 2km are anticipated.

4. Fort Liard Geothermal Project

Fort Liard is a hamlet of approximately 600 Acho Dene Koe First Nation (ADKFN) people located in the southwestern part of NWT (Government of British Columbia). Borealis Geopower has partnered with the ADKFN to develop a combined geothermal heat and power project in Fort Liard. Specifically, the project will adopt a 2-phase approach by developing 600 kW of micropower and a geoheat park. This project aims to offer cost-effective electricity generation and direct heat opportunities to the community, which is currently producing its power from diesel generation. Reducing or eliminating the community's reliance on diesel could significantly decrease their heating and electricity costs, while the geoheat park has potential to create several economic opportunities for the ADKFN.

Previous geothermal studies have identified the Fort Liard area to be overlying a hot sedimentary aquifer system. The potential exists to develop a viable power generation project in the area using Organic Rankine Cycle (ORC) heat engines. The ADKFN, in partnership with Borealis GeoPower, proposed the "ADK Borealis Geothermal Demonstration Project" which includes geothermal wells and a surface power plant for the community of Fort Liard.

A feasibility study identified and confirmed the existence of geothermal energy resource underlying Fort Liard with sufficient energy to power the community. The study further verified the design of a combined surface and sub-surface technical solution for fluid heat extraction and electrical power conversion. This solution was third party reviewed and met all the necessary codes and regulations for operating a power generation plant in NWT.

Earlier this decade, Borealis GeoPower obtained the first geothermal land use permit and Type A Water Licence issued by the Mackenzie Valley Land and Water Board, and in so doing established a regulatory pathway for permitting future geothermal projects in Canada's North (Natural Resources Canada, 2016).

4.1 Involvement and Anticipated Benefits to the First Nations

Over the past few decades, the hamlet has been host to considerable oil and gas exploration (Karanasios & Parker, 2016). Although there are currently no significant industrial users of power, a small but viable market exists for renewable base load energy to this community, where a diesel power plant supplies electricity at a cost of 29.2 of 68.37 cents/ kWh for up to and beyond 600 kWh, respectively (Northwest Territories Power Corporation, 2018). Currently, three diesel generators with a total capacity of 1.32 MW power Fort Liard (Northwest Territories Power Corporation, 2018). Should this project move ahead to the development of the geothermal system, it could demonstrate significant cost savings to the community. Furthermore, the community may benefit from heat project opportunities through district heating of community facilities, residential heating, greenhouses, industrial applications, and a tourism/spa destination.

5. Conclusion

Borealis GeoPower's three current geothermal projects are all in progress to produce electricity and direct heat while working closely with the communities and First Nations groups of the region. The development of each project is the accumulation of several years of research in collaboration with various government departments and locals with the aim of providing renewable heat and energy options to the area through our Sustainaville development projects and proposed power plants. Although all three projects aim to provide similar outcomes, Canoe Reach, Lakelse, and Fort Liard Geothermal will utilize a fractured rock system, volcanic system, and hot sedimentary aquifer system, respectively, and therefore involve different methods of exploration and development.

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