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The Case for Geothermal Energy in Western Canada

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Western Canada has a scatter of hot springs, yet a conspicuous lack of further development of geothermal for heat or power uses. This raises a question "what economic scenario makes a business case for geothermal energy?" While this question seeks to understand the economic viability of geothermal energy resource development in Western Canada, it will contribute to the gathering momentum in promoting multi-disciplinary synergy that could lead to breakthrough in geothermal energy exploitation in Canada. We expect the research to produce data on social and environmental dimensions of geothermal energy development.

Previous studies demonstrated positive potential for geothermal energy resources in Western Canada, which have formed the basis for the current development of the Canadian Geothermal Energy Industry. Relatively steep thermal gradient in the Western Canadian Sedimentary Basin and throughout the mountain belt, coupled with technologies, such as the Enhanced Geothermal (Hofmann et al., 2014) present new opportunities. Similarly, Rahmanifard (2018) demonstrated with techno-economic modeling that geothermal compressed air energy systems (CAES) technology can offer a very low cost of energy (LCOE) with significant CO_2 reduction potential. The potential for geothermal electricity generation in the Western Canadian Volcanic belts is being raised with reports of reconnaissance surveys in the region (Natural Resources Canada, 2019; Lyle, 2019).

Hypothesis

This study aims at reviewing the potential of Western Canada for geothermal resource development to meet the 25-year term electricity demand and economic growth. It has been established that the most active geothermal resources are found along major plate boundaries where earthquakes and volcanoes are concentrated (Holroyd, 2011; Towler, 2014). A majority of British Columbia and western Alberta lie either along the plate boundary or the mountain belt (Fig. 1a), which will be the focus of this study. The western coast of Canada, much of eastern British Columbia lies along a portion of the Pacific "Ring of Fire" (Fig. 1b), which could be analogous in geological settings to some of the most notable geothermal power plants, such as the Geysers power plant in California and Maibarara Geothermal Power Plant in the Philippines. We argue that the active volcanic region of Western Canada can potentially generate and deliver geothermal energy to power energy intensive industrial sites, such as the proposed LNG projects, delivering power at between US$0.07 and 0.15/kWh (International Renewable Energy Agency, 2018) with positive NPV for a 25 years life cycle based on proposed export licenses. If proven possible, geothermal energy could become competitive when compared to electricity power generated from natural gas turbine. Also, ancillary gains that are potentially derivable from avoided carbon emission could be additional consideration for cost benefit analysis.

Method

We test this hypothesis with a combination of qualitative and quantitative research methods. Our qualitative method involves analysis of key geological parameters of the target area (the relevant Western Canada volcanic complex) and comparison of these parameters with the analogues to establish basis for geothermal potential. The quantitative method involves numerical analysis of available geothermal energy implementation techniques and technological options as well as alternative analysis for ranking the options. We also carry out economic and risk analysis in our research. We use conventional mapping and data analysis techniques for interpretation and result presentation.

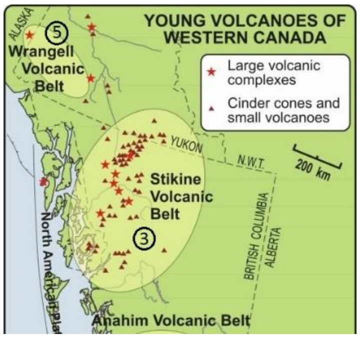

Fig. 1a. Target geothermal setting, Western Canada Volcanoes (NRCan, 2019)

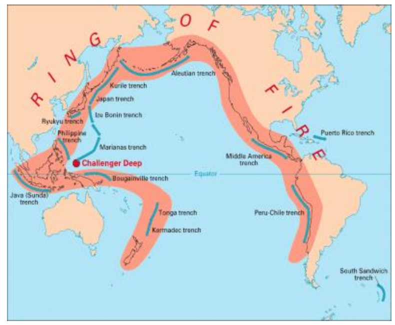

Fig 1b: Map of the pacific ring of fire (USGS - pubs.usgs.gov)

Analysis of Results

This study provides a scientific basis for geothermal energy opportunity in Western Canada. We present geothermal sites on maps and other data presentation formats with embedded order of ranking based on potential electricity power output and estimated power generation life cycle. We also present other renewable energy options in similar style by illustrating other related data such as associated risks and possibility of success in prospecting the geothermal opportunities as well as proximity to the proposed LNG plants and other key power destinations on the composite map. The major outcome of the study is a validation of the hypothesis and supporting cost benefit analysis based on current economic indices and consideration of the realistic technologic trends and market projection. The study will identify and consider the enterprise environmental factors such as policies, legislation and the interactive forces of other local renewable energy options.

Summary

We evaluate the unexplored geothermal energy opportunity in the subsurface of the Western Canadian volcanic complexes by de-risking the uncertainty associated with supply of electricity power for the LNG projects proposed for West coast of Canada. A combination of qualitative and quantitative methods provides ranking data in form of influence diagrams, tables and maps that can be deployed for decision making in the choice of energy for social and economic development in the regions. This work will contribute to Canada's commitment under the Paris Agreement by reducing its GHG emissions by 30% below 2005 levels by 2030.

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