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Clarke Lake Geothermal Case Study: using the Geothermal Resource Portfolio Optimization and Reporting Technique (GeoRePORT) for Community Engagement and Socio-Economic Analysis

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Summary

The Geothermal Resource Portfolio Optimization and Reporting Technique (GeoRePORT) system was developed in 2016 by the National Renewable Energy Laboratory (NREL). GeoRePORT provides the U.S. Department of Energy (DOE) Geothermal Technology Office (GTO) a methodology to track and measure the impact of its research, development and deployment funding for geothermal projects (Young et al., 2016a,b,c; Levine and Young, 2019). Perhaps more importantly, GeoRePORT provides communities, industry, small businesses, research scientists and engineers, investors, technical experts and non-expert audiences a comprehensive and quantitative means of reporting – a critical component for evaluating geothermal feasibility and project readiness (Kolker et al., 2019). The GeoRePORT uses consistent and objective assessment protocols to allow comparison of geothermal development project attributes (Young et al., 2019).

Figure 1 Introduction to the Clarke Lake Geothermal Project by Deh Tai and Fort Nelson First Nation available on YouTube: https://www.youtube.com/watch?v=BXmYjjWgaQU

Deh Tai Corporation (Deh Tai), economic development arm for Fort Nelson First Nation (FNFN), is 100% owner of the Clarke Lake Geothermal Project (CLGP). The CLGP is located in Canada's northeast British Columbia (BC), traditional territory of Treaty 8 First Nations. The people of Fort Nelson First Nation assert aboriginal

rights to ownership and jurisdiction in their traditional territory and their rights are confirmed by The Royal Proclamation of 1763, The Canadian Constitution Act (1867), Treaty No. 8 of 1899, Sections 15, 25 and 35 of the Constitution Act (1982) and Articles 33 and 35 of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP).

The CLGP (community video published by FNFN; Figure 1 above) is a 7 – 15 MW_{net} geothermal power and thermal heat (also referred to as direct-use) development project in pre-construction phase. The Project has received national media attention and significant First Nations and government support at the local, provincial and federal level in Canada (NRCan 2021). A total of $43M investment has been secured to date from a variety of funding sources as of April 2021, see statement by Canada's Minister of Natural Resources below:

> "The Clarke Lake Geothermal Project is Indigenous-owned and Indigenous-led, showcasing Indigenous communities' leadership in building a low-emissions future. Geothermal will help northern and remote communities use less diesel and more of this new clean energy technology. This is how we get to net-zero."
>
> *Seamus O'Regan Jr.*
> *Canada's Minister of Natural Resources*

The CLGP is presented as a case study and project update using the US NREL GeoRePORT methodology to outline the socio-economic, geological and technical features and overall readiness of the 100% indigenous-owned clean energy geothermal project. The GeoRePORT methodology allows for evidence based, objective descriptions of the CLGP for comparison to other geothermal resource projects going forward.

In 2016, a Geoscience BC Roadmap was published on Direct-use of Geothermal Resources in BC (TTGeo and GMC, 2016b Section B Roadmap). The CLGP ranked highest of 18 previously identified potential geothermal resource development sites when considering socio-economic factors such as transmission infrastructure, financials, regulatory framework, environmental impacts, community support, road access and constructability (Kerr Wood Leidal and GeothermEx, 2016). This ranking was completed through a Geothermal Development Decision Matrix (GDDM) methodology of the 18 resource areas in British Columbia Geoscience BC study (TTGeo and GMC, 2016a Section A Report). An important conclusion from the 2016 Roadmap for development of geothermal resources in BC was the importance of effective science communication, education and local community input, community champions and the importance of long-term investment and vision for geothermal resource development in the province (TTGeo and GMC, 2016a,b).

The CLGP is currently preparing to drill June 2021, progressing subsurface field development and flow testing to collect critical data such as reservoir temperature and pressure, geochemistry and flow rate of geothermal fluid and further understanding of the subsurface geothermal reservoir hydrodynamics (Renaud et al., 2018; internal BPG well planning report 2020). These variables will be vital for understanding the installed baseload power capacity of the geothermal power plant and producing an initial financial model and pre-feasibility design.

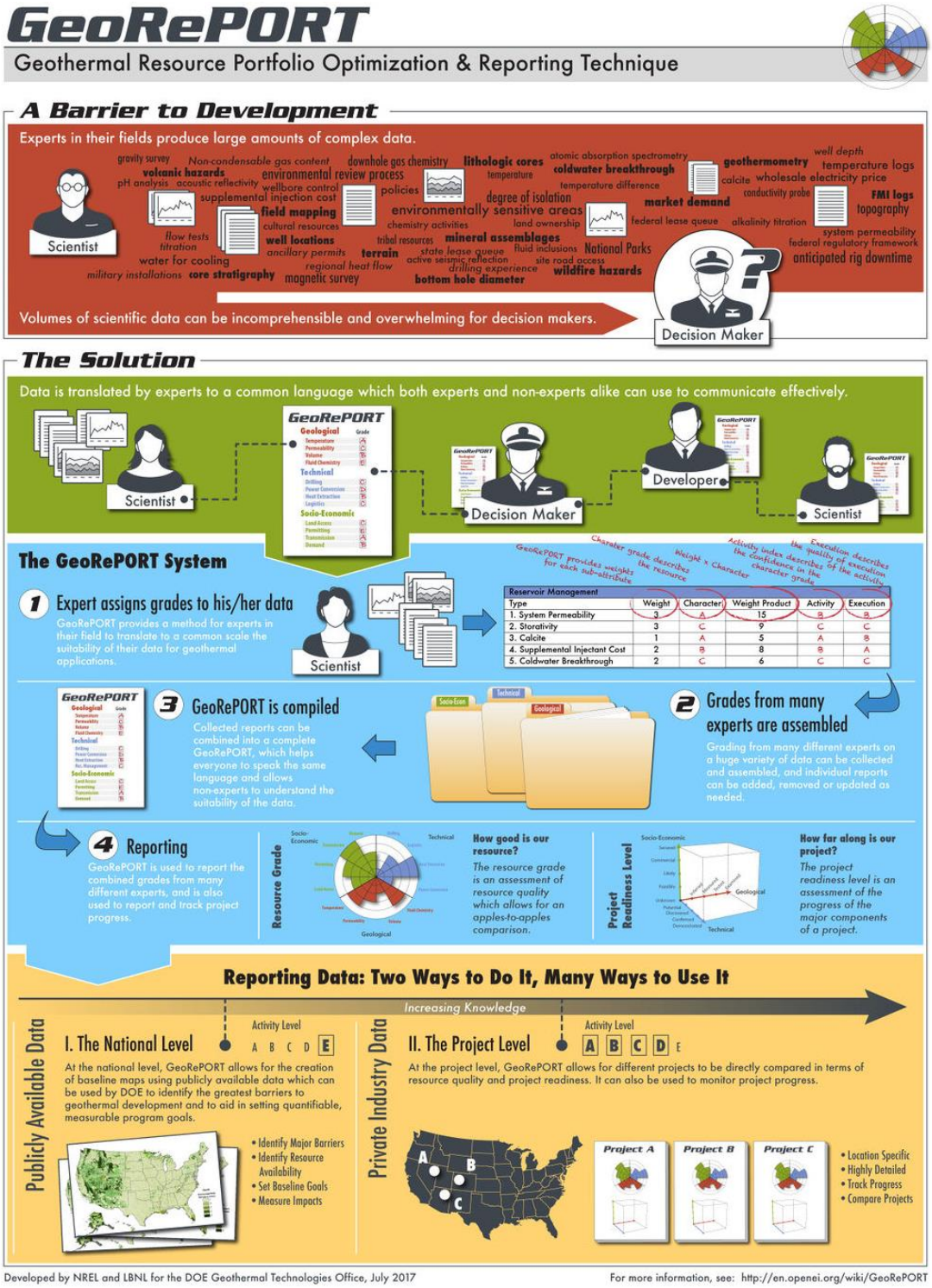

Figure 2 The GeoRePORT methodology tabulates complex geothermal project data in a reporting framework to effectively communicate the project to stakeholders, experts and non-experts.

Furthermore, a comparison to the 2016 GDDM from the Geoscience BC Roadmap will be provided to highlight important milestones and developments for the CLGP during the 5-year period between 2016 – 2021.

Theory / Method / Workflow

Please refer to Figure 2 for a brief summary of the GeoRePORT methodology, workflow and reporting technique.

The GeoRePORT methodology for the CLGP case study will require customizing the final reporting structure with Canada-specific information with respects to costs, permitting, regulations and geoscience data sources.

A community survey for CLGP is currently being developed with input from Deh Tai, providing additional socioeconomic data to inform the project decision making process going forward.

Results, Observations, Conclusions

The CLGP reservoir is currently estimated at approximately 2,000 meters depth below the surface. The electricity would be generated using an Organic Rankine Cycle (ORC) binary cycle power plant design and thermal heat utilization. In order to further prove the geothermal resource, the specific objectives of the characterization well drilling and testing that will be completed summer 2021 are (BPG, 2020):

- Acquire true and accurate temperatures of the Clarke Lake geothermal reservoir from the Slave Point Formation to the Precambrian Basement
- Test reservoir pressure, permeability, porosity and ability to sustain economic mass flow rates (minimum of 80 kg/sec to 100 kg/sec)
- Well deliverability or injectivity (Productivity Index PI), required for Well Field Modelling and Pump Design and Optimization
- Test reservoir brine and gas geochemistry for corrosion, scaling, and engineering design properties.

Additional Results, Observations and Conclusions will be summarized during the months of June, July and August 2021. Additional time will be required for completion of research and pre-approval of final Abstract, Paper and Poster submission for GeoConvention 2021.

Novel/Additive Information

Geothermal resource development is still high-risk, requiring high up front capital investment (Hira and Arianpoo, 2021). Project owners, stakeholders and Investors are expected to understand a broad array of complex, technical data that has been collected over a period of decades. In the case of Clarke Lake – the oil and gas industry data goes back to the 1960s, for a total of 144 Clarke Lake gas wells (BPG 2020; Renaud et al. 2018, Wilson-Palmer et al. 2018; Arianpoo 2009; Hira and Arianpoo 2021). The idea of re-purposing abandoned oil and gas wells has also been receiving recent research and funding attention. The CLGP poses an important demonstration testing ground for the benefits and challenges of completing a workover of an existing or abandoned oil and gas well.

It is important to note that the socio-economic and environmental benefits of geothermal resource development are not yet fully realized. This presents a need for effective science communication, marketing, regulatory and policy changes and consistent project reporting methodology to increase confidence for government, academia and industry to develop geothermal resources in British Columbia and Canada. The international community is watching with interest at how Canada is developing its geothermal resources, and the Clarke Lake Geothermal Project is certainly sharing the spotlight with other geothermal power projects such as Saskatchewan DEEP project near Estevan, SK and Terrapin Geothermics Alberta No 1 project in Municipal District of Greenview, south of Grande Prairie, AB.

The GeoRePORT methodology further allows the comparison of Canadian geothermal resource development to projects in the US and internationally. This provides increased confidence for investors, the public and interested stakeholders on an international, federal, provincial and local level.

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