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October 20, 2017

Mr. Patrick Wruck
Commission Secretary and Manager
Regulatory Support
British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, BC V6Z 2N3

Dear Mr. Wruck:

**RE: Project No. 1598922
British Columbia Utilities Commission (BCUC or Commission)
British Columbia Hydro and Power Authority (BC Hydro)
Site C Inquiry – BC Hydro Response to CanGEA
Submission of October 18, 2017**

BC Hydro writes further to the Commission's correspondence of October 19, 2017 (A-23) inviting BC Hydro to comment on CanGEA's October 18, 2017 submission (F66-4).

Attached are BC Hydro's comments on the CanGEA submission.

For further information, please contact Fred James at 604-623-4046 or by email at bchydroregulatorygroup@bchydro.com.

Yours sincerely,



Fred James
Chief Regulatory Officer

fj/af

Site C Inquiry

**BC Hydro Submission on Canadian Geothermal
Energy Association (CanGEA) Comments of
October 18, 2017**

October 20, 2017

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1 Introduction

On October 19, 2017, the Commission invited comments from BC Hydro on the submission of Canadian Geothermal Energy Association (**CanGEA**) that was filed on October 18, 2017 (F66-4), and in particular on CanGEA's conclusion that "geothermal resources must be included in the Commission's alternative portfolio".

BC Hydro reiterates that, while geothermal has potential in B.C. and could be a valuable energy and capacity resource in the future, to date, no reservoirs in B.C. have been confirmed as viable. It is highly risky and not prudent to rely on resources that merely have potential without first being confirmed through successful test drilling.

In this submission, we make the following comments on CanGEA's submission:

- GeoscienceBC's report is unbiased and well supported;
- Confirmation drilling is required in order to determine if a resource is commercially feasible. It is not appropriate to plan resources around a theoretical potential for a resource that has not been confirmed;
- CanGEA's cost estimates are not complete and the cost of geothermal resources, if proved, are likely to be substantially higher; and
- We included geothermal in our Optimistic Alternative Portfolios and the Commission Sensitivity Portfolios, and those analyses demonstrate that portfolios with Site C are still the most cost-effective.

We also note that we are not able to provide any comments on the regulatory issues CanGEA states developers have been experiencing, except to note we are not aware of any policy or permitting barriers to the three geothermal projects referred to by CanGEA, and that these projects received exploration permits in 2010, 2011 and 2014 respectively.

2 GeoscienceBC's Assessment is Unbiased and Well Supported

BC Hydro does not agree with CanGEA's criticism of the report prepared by GeoscienceBC, titled "*An Assessment of the Economic Viability of Geothermal Resources in British Columbia*" (the "Report"), and reaffirms our view that the Report is well supported and a useful analysis for understanding the potential for geothermal resources in B.C. In particular:

- GeoscienceBC's core mandate is to provide credible and unbiased geoscience information to government and the private sector to help guide new investment in mineral and energy development. Geoscience BC fulfills that mandate through rigorous procedural controls on all their technical projects, including in the development of this Report.
- GeoscienceBC held an open call for consultants to conduct the review and ultimately selected Kerr Wood Leidal, who has in-depth knowledge of B.C.'s IPP and electricity sectors, in partnership with Geothermex, a globally premiere consultancy in geothermal development and finance.
- The Report was based on publicly available and verifiable geological data, and provided a transparent analysis of the resource size, cost and risk profile, in order to build a common knowledge base of the resource and facilitate an open dialogue with stakeholders. Individual sites were reviewed and potential costs were assessed based on the combined global and B.C. experience of the consultants.
- GeoscienceBC took steps to ensure the Report was well supported and thorough, including the formation of a Technical Advisory Committee (**TAC**) of qualified geoscience professionals to sit on the Committee and provide advice to the consultants with regard to data sources and data quality, as well as review the work that ultimately went into the Report. The TAC was composed

of experts from industry and academia in geothermal resource evaluation in Canada and B.C. who specifically did not have an economic stake in the outcome.¹ The TAC conducted monthly review meetings as the work was ongoing.

CanGEA's main criticism of the Report is that developers should have been included in the review. This topic was directly addressed at one of the TAC meetings, and the Committee decided that the appropriate role for developers with a clear business interest in developing a resource in BC was as (i) suppliers of publicly available and verifiable data, and (ii) as participants in a stakeholder review after the Report was complete. This decision was made in order to produce an unbiased assessment that would be valuable to government decision-makers. The three developers with permits were to be approached by GeoscienceBC to solicit any relevant data for the Report.²

After the Report was complete, BC Hydro solicited written feedback from external stakeholders, including CanGEA by co-ordinating a presentation by the consultants who developed the Report.³ The feedback was largely positive, but also identified a few errors in the consultant's calculations. GeoscienceBC prepared a technical addendum correcting the errors and responding to the feedback. The addendum,

¹ The TAC members were: Carlos Salas, GeoscienceBC, Tim Sadlier-Brown, Sadlier-Brown Consulting, Jeff Witter, Mira Geoscience, Stephen Grasby, Natural Resources Canada, Grant Ferguson, University of Saskatchewan, Warren Walsh, Ministry of Energy and Mines, Sarah Kimball, BGC Engineering Inc., Jasmin Raymond, INRS-ETE, Nathalie Vigouroux, Douglas College/Simon Fraser University

² This is recorded in the TAC meeting minutes of February 11, 2015, which provide: "Prior to starting the formal agenda, the issue of outside parties offering to provide input to the study was discussed. It was agreed that the project must not be compromised by the perception that outside groups are manipulating the study, or that non-public information is being disclosed by the project participants, and therefore that all communication around the project should be run through GeoscienceBC. It was noted that this study must be based on unbiased information as the government will make decisions based on it. Geothermal developers may be willing to add data to the study, but will want their resource to look as good as possible. It was clarified that there are only three geothermal developers with leases or permits in the project areas (Ram, Borealis and Tectoenergy). GeoscienceBC will approach these developers to help procure data. It was agreed that final project deliverables will first be reviewed by Geoscience BC's TAC, then by BC Hydro stakeholders and external reviewers."

³ Stakeholder session reports can be found at:
<https://www.bchydro.com/about/planning-for-our-future/electricity-supply-options/updates.html>.

which is available on our website, included a sensitivity analysis around the economic parameters highlighted by stakeholders.⁴

Given this robust, unbiased and transparent process, BC Hydro retains confidence in the GeoscienceBC process and report. For more information, please refer to our response to BCUC IR 2.61.0.

3 Confirmation Drilling is Required before a Geothermal Resource can be Found to be “Commercial Feasibility”

BC Hydro recognizes the theoretical geothermal resource potential in the province. However, resources with only a theoretical potential that have not been confirmed through drilling to have sufficient heat and flow of hot fluids, rely solely on assumptions and present substantial risks, both with respect to their technical viability as well as their economic viability.

As stated in the Report, all known resource sites in B.C. are currently high risk, with the exception of Meager Creek, which is high-moderate risk. In the case of Meager Creek, BC Hydro collaborated with the federal Department of Energy, Mines and Resources in a Geothermal Energy Program focused on Meager Mountain in the late 1970s and early 1980s.

Early years of the program involved surface geological mapping, geophysical resistivity surveying, and shallow drilling – which progressively narrowed a target area for expanded research. Investigation in the early 1980s expanded to include a deep well exploration program which included drilling three deep test wells (over 3000 m depth) at Meager Creek. The wells indicated a good heat resource, but no hot fluids were produced. BC Hydro continued investigations until the cancellation of

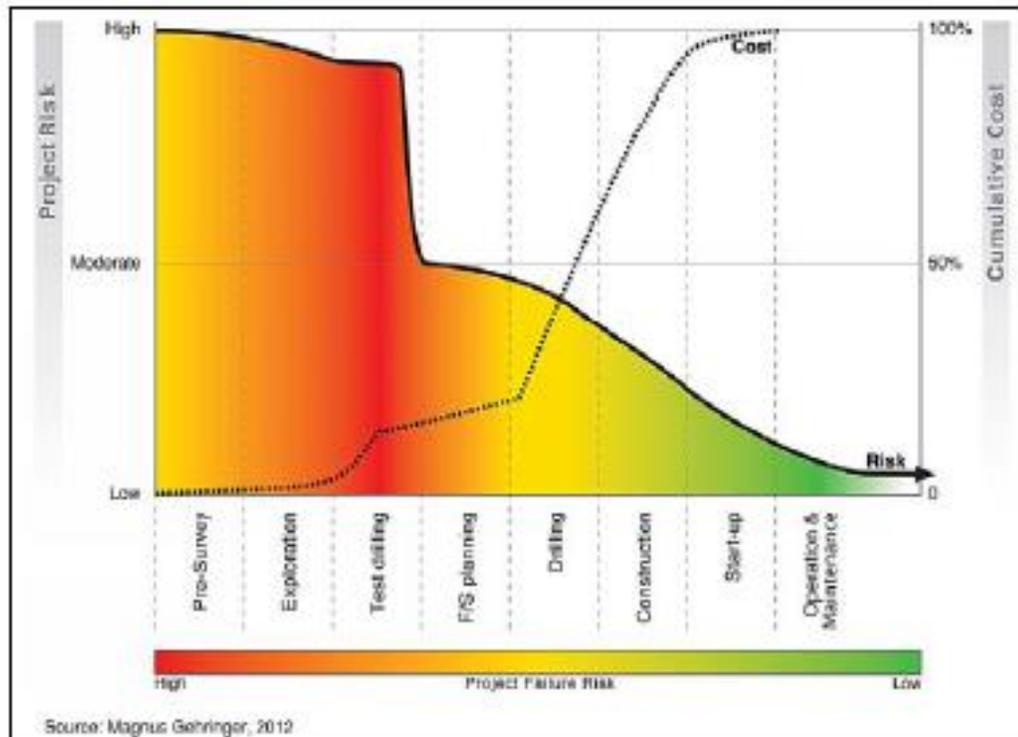
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<https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/regulatory-planning-documents/integrated-resource-plans/current-plan/rou-characterization-geothermal-technical-supplement-201610.pdf>.

the federal program. Meager Creek Development Corp conducted subsequent testing in the 2000s, including drilling four deep testing wells at a reported cost of \$30 million. That drilling yielded similarly disappointing results, and to date no viable reservoir has been identified. Nearly 40 years of intermittent effort costing tens of millions of exploration investment dollars has only marginally de-risked this site. (Refer to our response to BCUC IR 2.61.0 for more details).

All three of the sites that CanGEA states could be in-service by 2020, still have a “high risk” characterization. To date those resources have not been confirmed through drilling, which is necessary before technical and economic viability, and hence commercial feasibility, can be established. Our experience in Meager Creek is an example of a resource with high potential not being proved out at a great expense. Refer to [Figure 3-1](#) (copied below) from the GeoscienceBC report (referred to by Ms. Thomson at the hearing on October 14, 2017), which sets out the objective criteria for de-risking geothermal resources: namely, the confirmation of sufficient heat and fluid flow through test drilling.

Figure 3-1 Geothermal Project Risk Evaluation Framework



The projects cited by CanGEA are not at a stage where they can be considered commercially feasible.

CanGEA states that “Geothermal projects at Canoe Reach and Lakelse Lake and Pemberton are capable of putting 40 MW of base load electricity on to the grid each year starting in 2020, with 200 MW online by 2025.” BC Hydro agrees that the three sites mentioned are the farthest along of any geothermal development in B.C. (except for Meager Creek). Nonetheless, all are high risk and none have yet drilled a full-scale test well. It is therefore extremely optimistic and unlikely to estimate that these resources will be producing any energy and capacity by 2020, and 200 MW by 2025.

BC Hydro notes that, in response to CanGEA’s critiques regarding estimated transmission costs of those projects included in the GeoscienceBC Report, the

Report relied on a specific GIS data of distance of transmission lines to the nearest connection point as well as station, transformer and related electrical costs.

4 CanGEA does not Provide a Complete Estimate of Potential Project Costs

Geothermal resource development costs are very site specific, and costs will have large variations depending on the resource temperature, depth of the reservoir, and other factors that are unknown until exploratory drilling is conducted. The generic information relied on by CanGEA is of little assistance when resource planning.

Other issues with CanGEA's cost estimates include:

- A \$/MWh estimate for the two proposed BC-based geothermal resources, based simply on the total project capital cost divided by the estimated 30-year generation of the facility.⁵ This does not include many important cost considerations, e.g., operations, maintenance, financing, and is not a levelized cost of energy calculation.
- A \$/MW estimate from “the United States government” for a range of geothermal resource types, generation technologies, and site characteristics that may have no relevance to the B.C. sites.

Should the Commission decide to include geothermal resources in a revised alternative portfolio, the unit energy cost estimates provided in Appendix L to our August 30 Filing, and incorporated into our optimistic portfolios (in the response to BCUC IR 2.46.0) are the best estimates of the cost of geothermal resource in the event the resources can be proven.

⁵ F66-4, page 10.

5 We Tested Inclusion of Geothermal in the Optimistic and Commission Portfolios

As described in our response to BCUC IR 2.44.0, BC Hydro included geothermal resources as potential resources in both the BC Hydro Optimistic Portfolio Sensitivity and the Commission Portfolio Sensitivity:

“We modeled 1,300 GWh of energy and 200 MW of capacity as available at a unit energy cost of \$120/MWh, which is KWL’s cost estimate for the two lowest cost projects in B.C. (Meager and Pebble Creek).”

The results of those analyses are found in our response to BCUC IR 2.46.0. In general, when geothermal was selected in portfolios it was later in the analysis period or under high load conditions. This is because geothermal was not cost-effective compared to the cheaper wind and pumped storage resources.

Overall, inclusion of geothermal in the BC Hydro Optimistic and the Commission Portfolio sensitivities did not change the conclusion that completing Site C provides the greatest benefits to ratepayers.