Canadian Geothermal Energy Association (CanGEA)
Phase 2 Consultation Submission to the B.C. Climate Leadership Team

Contact:
Alex Kent | Policy Intern | info@cangea.ca

CanGEA P.O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

The Canadian Geothermal Association (CanGEA) is the collective voice of Canada's geothermal energy industry with a focus on power generation and industry-scale direct use of heat from geothermal resources. Our association represents 100+ members with the goal of unlocking Canada's tremendous geothermal energy potential. **We champion the development of geothermal energy because our data supported position is that geothermal is a key ingredient to achieving a prosperous, and sustainable future for Canada - especially in northern and remote Indigenous communities.** CanGEA has 6 corporate members based in B.C. and 54% of our total corporate membership wants to develop geothermal energy in B.C.

The Climate Leadership Team's recommendations to Government report stated that "a piecemeal approach will not prove effective economically or environmentally"[1]. This is why CanGEA is offering a unified energy solution that will power, heat, and economically diversify British Columbia. **CanGEA contends that geothermal energy development in B.C. will help satisfy recommendations 1, 2, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 19, 26, and 27.**

Topic 1: Clean Tech & Clean Energy	**What is Geothermal**
What We Value, The Way We Live, The Way We Work **Satisfies Recommendations: 1, 2, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 19**	

Geothermal energy is a clean and renewable source of power and heat derived from deep, (1 - 5 km) underground reservoirs of brine solution. There are 3 main classifications of geothermal resources in British Columbia that each use different technology to develop: Volcanic/Magmatic, Hot Sedimentary Aquifer, and Enhanced Geothermal Systems in hard rock. Ground Source Heat Pumps/Geoexchange are commonly referred to as shallow "geothermal" and are represented by the Geoexchange Coalition and will therefore not form part of CanGEA's submission.

B.C. has the potential to host all of the forms of geothermal energy development (figure 1.) Hot Sedimentary Aquifers (HSA) dominate the north-eastern quadrant of the province. The HSA have been extensively explored by oil and gas development in the region that also allows for the co-production of geothermal heated fluids as well as natural gas. The temperatures of these wells are among the hottest in Canada and are suitable for power generation.

Low temperature co-produced fluids also occur in conjunction with mining activities and thus B.C.'s interior, and it's many communities, also have the ability to develop this underutilized heat resource as Springhill, NS does.

Direct use of heat geothermal applications have the widest possible distribution, as they could be developed throughout almost all of B.C. and provide heat energy to almost every community.

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

Conventional hydrothermal resources, traditionally called Volcanic/Magmatic geothermal, are found along the coast, as well as throughout the valleys and mountain ranges that dominate much of B.C.'s interior and form the south-eastern border with Alberta.

Offshore geothermal, a Volcanic/Magmatic resource, is widely distributed along the coastline and could provide power and heat to many remote coastal communities.

Finally, Enhanced Geothermal Systems (EGS) are a future technology that BC could consider. However, given the ubiquitous conventional geothermal resources available in the province listed above, CanGEA does not currently support EGS applications.

Because there are different types of geothermal, much like there are different types of fossil fuels, the public and policy makers at all levels of government in Canada have, at times, misunderstood this renewable energy. The misunderstanding has led to barriers to development and a widespread sentiment that geothermal doesn't work in Canada – or else somebody would have developed it already. Our submission aims to clarify the benefits geothermal energy would deliver to all of B.C. with the greatest benefits felt by remote & northern communities.

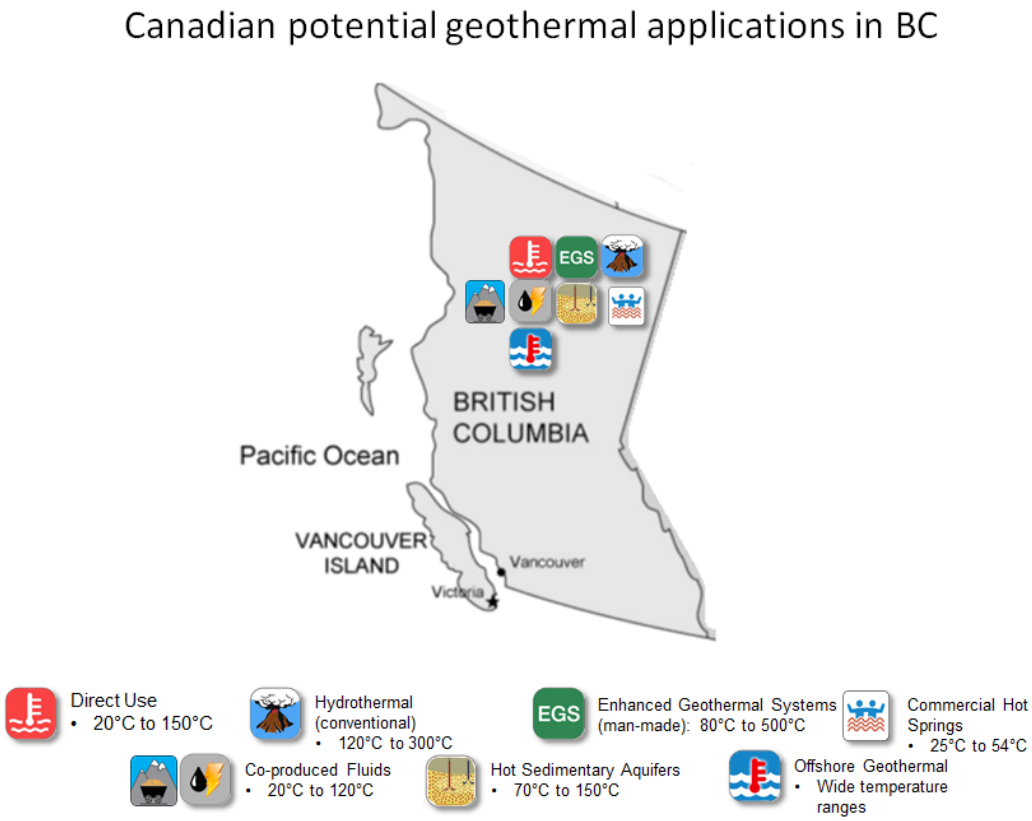

Figure 1. Geothermal resource diversity in B.C.

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

Despite having no geothermal power facilities in Canada, North America is the largest continental producer of geothermal electricity thanks to the US and Mexico. The geothermal energy resources in all three countries are similar in distribution and quality but development of geothermal to the south has occurred because of government, industry and public understanding of the benefits that geothermal energy provides.

The Climate Leadership Team should know that geothermal energy:

- Is the most affordable renewable energy with a per-kWh cost ½ of hydroelectric or wind[2].
- Is a base load generator of electricity and heat with an average capacity factor of 92% compared to 25% for solar[2].
- Creates 11X more jobs than hydroelectricity and 17X more jobs than natural gas plants[3].
- Supplies heat to whole communities via district energy thereby offsetting thousands of tonnes of Greenhouse Gas emissions from furnaces[4].
- Increases food security for remote/northern communities by enabling otherwise impossible greenhouse agriculture in cold weather conditions as Iceland has demonstrated[5,6].
- Allows for commercial aquaponic fish farms that do not harm native fresh or saltwater fish species[6].
- Is ideal for B.C., especially northern and remote communities, because of the Province's world-class geothermal resources[7].
- Synergizes with B.C.'s established mining and oil/gas resource development talent and infrastructure that would allow out of work drillers and underemployed miners to return to work developing natural resources[8].
- Minimizes the area required for energy generation because geothermal has the smallest project footprint for equivalent generation requiring 1.1% of the area needed for solar photovoltaic and 3.4% of the area used by a wind farm[9].
- Can deploy gigawatts of energy in less than 4 years[10].
    - Table 1. Growth in Geothermal between 2010 and 2014 in Select Countries

Country	MWe	GWh
Turkey	306	2637
Germany	20	136
Kenya	392	1418
Nicaragua	72	182
New Zealand	243	2945

- Creates significant employment in the tourism industry[11]. Banff National Park was built around a geothermal resource and Moose Jaw was revitalized because of a geothermal tourism project. Indeed, several BC towns thrive due to the presence of a nearby hot spring.

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

Topic 2: Efficiency Improvements	**B.C. is Green but Not Yet Sustainable**
What We Value, The Way We Live, The Way We Travel, The Way We Work Satisfies Recommendations: 12, 13, 14, 15, 19	

Currently, B.C. has the largest amount of renewable electricity in Canada with renewable electricity generation around 93%[1]. However, that only accounts for approximately 18% of the province's energy use when heating and transportation are considered, as they should be[12,13]. The B.C. Climate Leadership Team's recommendations to government reported that communities were responsible for 40% of B.C.'s carbon emissions and transportation for 37%[1]. If B.C. is to significantly decrease its greenhouse gas emissions the carbon emitted by heating and transportation will have to be reduced. Geothermal energy can significantly assist B.C. in achieving this goal.

CanGEA would like the Leadership Team to consider that multiple projects throughout Germany, a country with generally inferior geothermal resources to B.C., have built very efficient and successful district energy projects to heat communities[4]. The net result of the district energy projects is reductions in both the carbon footprint and the cost to residents taking advantage of the systems. Another benefit of using geothermal district energy is that not only is natural gas, propane, or diesel, not burned for heat, which produces CO_2, but methane (a much more serious greenhouse gas) leaks through the petroleum supply chain are avoided altogether.

To assist the province supply electricity for the transportation sector, geothermal energy electrical generation plants, due to resource ubiquity throughout B.C.[7], should be given serious consideration. To power an all-electrical vehicle fleet, B.C will have to more than double its current electrical generation. A reference has calculated that to displace the fossil fuel energy used in transportation and the built environment would require over 30 large hydro electrical projects[13]. **Geothermal energy, because it offers heat and electricity and a more ubiquitous resource distribution, that reduces required transmission infrastructure, means that only a fraction of B.C. would have to be converted to energy production to achieve a carbon neutral economy.**

Also, your own panel has identified a major short fall of the current electrical systems in that "approximately 60 remote communities — including many First Nations — in B.C…. are not connected to the integrated electricity grid. Most of these communities rely on diesel generation for power supply"[1](Figure 2)[14]. High quality geothermal energy resources, power and heat, are found throughout B.C.[7] making them deployable to almost every community. As most geothermal energy plants could be situated adjacent to the communities that would use the energy, the transmission cost would be minimized. **It is CanGEA's position that geothermal energy provides a solution to the province's heating, electrical needs and remote community electrification challenges.**

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

Figure 2. Diesel generators are mostly found in the remote north of the province and generally do not occur near major transmission infrastructure[14].

Topic 3: Competitive Industries	**Redeploy Under-Employed Oil, Gas and Mining Expertise and Repurpose Infrastructure Via the Development of the Geothermal Energy Industry**
What We Value, The Way We Live, The Way We Work **Satisfies Recommendations: 6, 7, 11, 14**	

Geothermal development in B.C. is aided by two major factors - resource availability and resource accessibility, both of which derive from B.C.'s geology and synergy with the mining and upstream petroleum sectors. Because the exploration and development of geothermal reservoirs use techniques and technologies nearly identical to the petroleum and mining industries, geothermal energy is the best way to redeploy existing B.C. subsurface geoscience expertise and associated services toward the renewable energy future. In particular, the development of geothermal

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

energy provides oil, gas, and mining workers with a social license to use their skills and services toward a renewable economy. Also, **the B.C. natural gas industry could see significant synergies and greenhouse gas reductions if geothermal energy co-generation is mandated for hot sedimentary aquifers**.

Under the current regime the co-produced fluids from wells in B.C.'s north-eastern hot sedimentary aquifer are not being used when they could instead provide micro generation and heat to a quadrant of the province. More than electricity and heat are available, though, if B.C. supports capturing geothermal energy from co-produced fluids. Geothermal energy from co-produced fluids would support continuous jobs in associated communities. Construction jobs stemming from transmission lines off of large, but distant hydroelectric projects are temporary, while production jobs, such as employment at a greenhouse, built around geothermal energy, would provide continuous employment. Continuous jobs are more valuable than intermittent employment, just as base load electricity is more valuable than intermittent power, because it would provide the B.C. government more consistent revenue and expenditures related to citizens in the N.E. quadrant of the province.

Topic 4: Healthy & Resilient Communities	**Geothermal Energy Adds New Jobs to Communities**
What We Value, The Way We Live, The Way We Work **Satisfies Recommendations: 8, 11, 12, 13**	

Geothermal energy is a unique energy source because it is a job creator par excellence. A United States Department of Energy study found that a geothermal energy project would create approximately 11-17 times as many full time jobs as a comparable Hydroelectric or Natural Gas facilty[3]. Geothermal energy does this because all the way down the heat supply chain new industries are enabled, each of which creates new jobs and opportunities for people (Figure 3)[15]. Geothermal energy is thus an excellent candidate to satisfy the Leadership Team's industry policy which is "intended to stimulate innovation and jobs within B.C.'s existing industries"[1].

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

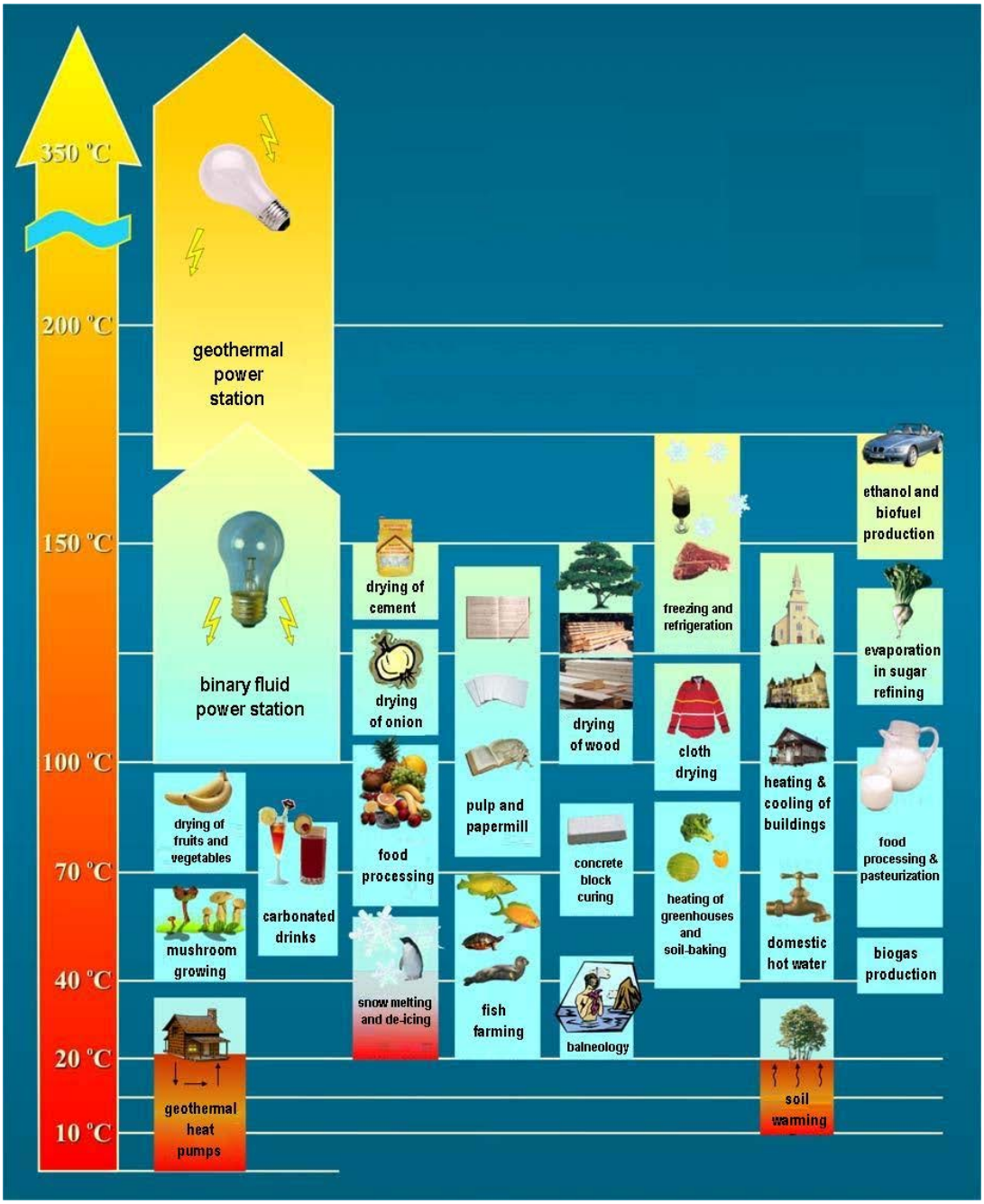

Figure 3. Geothermal Energy Uses[15].

CanGEA members have multiple drill ready projects in B.C. each of which will provide energy and economic diversification to their respective communities. These projects include the eastern British Columbia town of Valemount that has set aside lands for an integrated GeoPark that is to include greenhouses, fish farms, lumber drying and a microbrewery. Another project is a geothermal system in the coastal town of Terrace B.C. where the project plans to produce power to the grid and

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

provide heat for a local agriculture operation. CanGEA believes both of these projects are of special interest to you because the western British Columbia project is owned 50% by a First Nations partner and the eastern British Columbia project has the full public support of the local First Nations. There is also significant interest from bands within Treaty 8 to develop co-produced fluids in north-eastern B.C.

Topic 5: Strong Ecosystems	**Geothermal Energy has the Smallest Footprint and Transmission Need**
What We Value, The Way We Live **Satisfies Recommendations: 12, 13, 14**	

The best way to strengthen ecosystems is to reduce the impact that human industry has on the landscape through low or no impact operations. Geothermal energy has the smallest project footprint of a renewable energy source[9]. The small project footprint combined with electrical and thermal energy generation means that geothermal energy is the most area efficient renewable energy source B.C. could build. Strategic placement of geothermal heat and power plants will also eliminate the need for B.C. Hydro to build, or upgrade, transmission lines throughout the province; which further reduces the geothermal energy project footprint.

Topic 6: Leadership & Collaboration	**Geothermal is Carbon Neutral, has a Small Footprint and has First Nations Support.**
What We Value, The Way We Live, The Way We Work **Satisfies Recommendations: 1, 2, 4, 5, 7, 26, 27**	

CanGEA recognizes that to meet its economic growth goals, especially concerning the liquefied natural gas industry, B.C. will have to invest in new electricity generation. Currently, the province has focused its attention on further hydroelectric development, namely the proposed Site C dam. Hydropower from large dams is debateable as a clean energy choice and also has considerable environmental and social costs related to the flooding of arable land and the displacement of people. Both of which have repeatedly occurred in B.C. such as with the Tsay Keh Dene in the creation of the W.A.C Bennett Dam[16], and the Cheslatta T'En First Nation[17] for the Kenney Dam.

CanGEA with its report "Geothermal Energy: The Renewable and Cost Effective Alternative to Site C"[18] demonstrated that geothermal energy is cost competitive to the Site C project, and offers various advantages that will be forfeited should the Site C hydroelectric project proceed. Or put another way, B.C. does not have to lose farmland and displace people to get its power. This puts CanGEA in agreement with Green Jobs BC who in their submission to your Team's phase 1 consultation stated that:

> "The economic risk of developing smaller, more numerous projects is lower than it is with megaprojects such as Site C. This will also decrease variations in production and reduce the cost of buying replacement energy in low

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

> production periods. While major energy developments can deliver significant economic benefit to single communities, a diversified energy generation portfolio can spread out job creation and economic benefits across the province, into communities small and large. It will also build on the already substantial and growing clean energy economy in BC."[19]

CanGEA considers our report's finding especially important given that your team has found that "[o]ver 90 per cent of survey respondents feel that climate change is a serious issue" which is meaningful because B.C. is already the best jurisdiction in Canada for GHG reduction and renewable electricity. B.C. citizens are currently world leaders in climate change mitigation but they understand that they still need to do more so they expect their elected leaders and business community to do the same.

CanGEA recognizes that geothermal energy wasn't properly evaluated against Site C because their government mandate and the Clean Energy Act[20] limited B.C. Hydro. Green Jobs BC found that:

> "BC Hydro is currently limited by the Clean Energy Act and cannot pursue research, piloting, or full-scale development of other energy projects. Further, the province has no specific plans for energy production after Site C."[19]

CanGEA contends that geothermal energy should be considered as an energy solution for B.C.'s further economic development and environmental protection. Geothermal energy is the holistic solution to B.C.'s energy challenge. Being sustainable is not just about reducing greenhouse gas emissions, it is about supporting people to lead productive lives in the location of their choosing and geothermal energy will allow the province to support people to do just that.

Recommendations:	**How the B.C. Climate Leadership Panel can Capture the Benefits of Geothermal Energy for B.C.**
What We Value, The Way We Live, The Way We Travel, The Way We Work Satisfies Recommendations: 1, 2, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 19, 26, 27	

Based on the information CanGEA has supplied and the recommendations your team put forward to the B.C. government we have develop five recommendations for this consultation phase. Each recommendation is designed to be realistic, obtainable in a short to medium timeframe, ensure wide public support, and require industry to innovative and collaborative in their work with the province. Achieving a sustainable future is the responsibility of citizens, industry, as well as government and CanGEA believes geothermal energy will enable all three groups to grow and prosper.

1) CanGEA recommends that the province meet with geothermal energy industry experts and other interested parties in order to identify and correct policy impediments to the successful establishment of a geothermal energy industry in British Columbia. A useful starting point would be to reform the Geothermal Resources Act (GRA). Under the current act, even if developers

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

come to the table with First Nations support, wait times of years have ensued to obtain permits. Moreover, even if a permit is granted, it is often smaller than the original request. Worse, is the fact that areas of the province used by oil and gas activity have been taken out of consideration for geothermal project development. This is especially worrisome given the enormous opportunities that hot sedimentary aquifer geothermal energy plants represent to electrify and heat northern and remote B.C. communities. Geothermal energy is also advantageous for taxpayers because on site micro generation at natural gas wells frees the province from the cost of developing transmission infrastructure to those wells.

Such obstructions do not exist, to this degree, with shale gas wells, wind, solar and run of river permits. Correcting such shortcomings should go a long way to ensuring that B.C.'s significant geothermal potential does not remain unutilized.

2) Amend the provisions of B.C. Hydro Standing Offer Program to allow any sized generation facility (currently capped at 15 MW) if the generation source is deemed high dispatch and grid stabilizing, for example exceeding a 75% dispatch rate. CanGEA believes this will benefit the province by encouraging renewable energy generation while improving grid stability. Geothermal energy is favoured under this recommendation but solar, wind etc. would also be able to take advantage given additional energy storage technology.

3) Put out an immediate call for competitions to replace the diesel generation in the province but ensure that **total community energy use (heat and power), total community carbon pollution, total community long-term employment and First Nations approval** are all necessary factors in any final decision. Additionally, if increased food security is part of community redevelopment plan B.C. could roll energy redevelopment into addressing an important challenge remote communities are exposed to.

   Geothermal energy will win many of these competitions by virtue of being able to displace heating costs, supply low cost electricity, provide numerous jobs to the surrounding community and increase food security through greenhouse agriculture. Sustainability is about more than electricity and geothermal can deliver sustainability to whole communities.

4) CanGEA urges the B.C. government to aid in the completion of demonstration projects in the province. We believe this is a fair request given that B.C. Hydro built demonstration wind turbines for the Province. CanGEA members have two drill ready developments in B.C. that could both act as effective demonstration projects. The completion of these projects will serve to provide a B.C. specific model of the true costs and benefits of geothermal power and heat in the province. The province can leverage its own spending by utilizing matching federal funding programs, through organizations such

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

Western Economic Diversification and Sustainable Development Technology Canada, to promote geothermal energy development.

5) A public education program on geothermal energy production should be established. This should include geothermal energy in all discussions, and news releases related to B.C. renewable energy as well as support for demonstration projects to showcase the various merits of geothermal energy.

Conclusion

Thank you for considering our submission for this phase 2 consultation. Following this submission, at a time of your choosing, CanGEA would like to provide to you our geothermal presentation as well as make our world leading geothermal talent available for further questions. We believe that our submission has outlined how geothermal energy will support the Climate Leadership Team's recommendations and significantly reinforce B.C. as a world climate leader. Geothermal energy will allow B.C. to protect the environment we all value, ensure that energy for our way of life is readily available and responsibly sourced, as well as improve the way we work by creating new jobs and new competitive industries throughout the province.

Sincerely,

Alex Kent
Policy Intern, CanGEA

Canadian Geothermal Energy Association
P. O. Box 1462 St. M, Calgary, Alberta, T2P 2L6, Canada
Phone: (403) 801 6805, info@cangea.ca - www.cangea.ca

Citations

1. Climate Leadership Team. (2015). Recommendations to Government. Retrieved from https://engage.gov.B.C..ca/climateleadership/files/2015/11/CLT-recommendations-to-government_Final.pdf on March 4, 2016.
2. United States Department of Energy (2015) Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2015. p.6.
3. United State Department of Energy (2006) Buried Treasure The Environmental, Economic, and Employment Benefits of Geothermal. p.12.
4. EnergyGlobal District Energy Awards (2015)Deep Geothermal Energy | Kirchweidach, Germany. Retrieved from http://www.districtenergyaward.org/deep-geothermal-energy-kirchweidach/ on January 28,2016.
5. National Energy Association of Iceland (N.D.) Greenhouses. Retrieved from http://www.nea.is/geothermal/direct-utilization/greenhouses/ on January 28,2016.
6. Ragnarsson,Á. (2005)Geothermal Development in Iceland 2010-2014.Fish farming,4,9.
7. CanGEA (2014)CANADIAN NATIONAL GEOTHERMAL DATABASE AND PROVINCIAL RESOURCE ESTIMATE MAPS. Retrieved from http://www.cangea.ca/B.C.-geothermal-resource-estimate-maps.html on January 28,2016.
8. Harvey,C.(2011)Oil and gas wells find new life with geothermal. Retrieved from https://www.newscientist.com/article/mg21228394-100-oil-and-gas-wells-find-new-life-with-geothermal/ on January 28,2016.
9. Islandsbanki Geothermal Energy Team(2011)United States Geothermal Energy Market Report.p.9
10. Bertani,R.(2015)Geothermal Power Generation in the World 2010-2014 Update Report. p12.
11. CanGEA(2014)Temple Gardens Case Study.
12. Wiebe, J. (2007). The Endless Energy Project: A Blueprint for Complete Energy Self Sufficiency For British Columbia. The Globe Foundation. Retrieved from http://globe.ca/wp-content/uploads/2012/10/globe_endlessenreport.pdf on March 8, 2016.
13. King, B. (2015) Dispelling Some Myths About British Columbia's Energy Picture. Retrieved from http://www.huffingtonpost.ca/blair-king/B.C.-energy-site-c-dam-hydro_b_7969110.html on March 8, 2016.
14. Stephen, R. (2013). Managing Aging Hydro Assets. Hatch Energy Innovations. sRetrieved from https://www.hatch.ca/News_Publications/Energy_Innovations/June2013/guest.html on March 14, 2016.
15. Geotermia. (N.D.) Lindal Diagram. Retrieved from http://geotermia.lapunk.hu/tarhely/geotermia/dokumentumok/lindal_angol_ok.jpg on March 14, 2016.
16. Loo, T. (2007). Disturbing the peace: environmental change and the scales of justice on a northern river. Environmental history, 12(4), 895-919.
17. Report on the Royal commission on Aboriginal Peoples. (2007) The Cheslatta T'en and the Kemano Hydro Project. Retirieved from http://www.collectionscanada.gc.ca/webarchives/20071211055222/http://www.ainc-inac.gc.ca/ch/rcap/sg/sg40_e.html#118 on March 8, 2016.
18. CanGEA (2014) Geothermal Energy: The Renewable and Cost Effective Alternative to Site C.
19. Green Jobs BC. (2015). Submission to the Province of British Columbia's Climate Leadership Plan Discussion Paper. p 6 . Retrieved from https://engage.gov.bc.ca/climateleadership/files/2015/12/159_-Green-Jobs-BC.pdf on March 15, 2016.
20. Hunter, J. (2016). Site C not the best choice for B.C.'s energy needs, report author says. The Globe and Mail. Retrieved from http://www.theglobeandmail.com/news/british-columbia/site-c-not-the-best-choice-for-bcs-energy-needs-report-author-says/article29024804/ on March 14, 2016.