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Geothermal Energy Development in Canada—Country Update

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ABSTRACT

Canada has maintained a position of significance as a fallow frontier for the development of geothermal energy, particularly in the field of high-temperature hydrothermal resources. Although the high temperature resource is geographically restricted to the Province of British Columbia (BC), Alberta, and the Yukon and Northwest Territories, as much as 5,000 MWe of economically feasible geothermal potential is believed to exist in this region. However, policy obstacles still exist which prevent extensive development of Western Canada's high-temperature geothermal resources for electrical power generation.

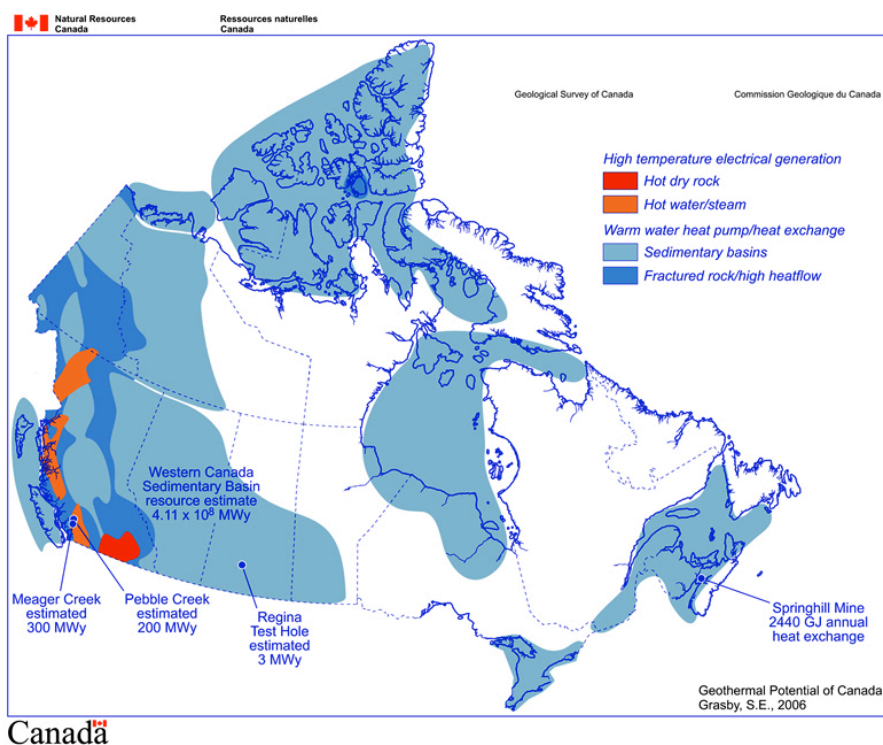
The cumulative Canadian geothermal resource remains poorly quantified due to a 25 year hiatus in Federal government funding of geothermal science. Through commercial avenues, approximately 100MW of geothermal power potential has been identified as of 2009, although there is still no geothermal power in Canada's electrical grid. As an under-explored geothermal resource, Canadian geothermal projects will represent a pertinent frontier for commercial development in the near future. The corporate and public awareness of geothermal technologies has grown recently through an increased media focus, and a strengthening support for carbon-friendly lifestyle choices.

Currently, the Canadian Geothermal Energy Association is leading 33 government policy projects at the Federal and Provincial levels to establish a foundation for the imminent development of geothermal electrical projects. In the Western Canadian geothermal corridor, most of the local power is generated hydroelectrically, although neighbouring export markets still generate a significant amount of power from fossil fuels. As the effect of recent carbon taxes permeate electricity markets, new geothermal projects will be well positioned to fill the vacuum with clean and reliable power.

Canada's Geothermal Energy Potential

Estimates of Canada's geothermal energy potential have routinely been stated at more than 5,000 MWe of traditional geothermal potential. Enhanced geothermal systems (EGS) multiply this estimate by several times and place geothermal energy in close proximity of nearly all Canadians. The Canadian Geothermal Energy Association (CanGEA) and its members believe that as much as 5,000 MWe of traditional geothermal power could be brought online as soon as 2015.

For the most part Canada's easily accessible geothermal resources are located in the western third of the country. Here there are mountain ranges which grant access to the hot geothermal resources which lie below. This region is akin to the tranche of



geothermal resources located in the western United States, Alaska, and Mexico. The interior of Canada is comprised of deep crust referred to as the Canadian Shield making geothermal resources harder to access. Similarly, eastern Canada also has less predominant geothermal resources.

The map on the previous page, compiled by the Geological Survey of Canada, illustrates the potential for geothermal energy development across the country. The most favourable regions for development include Alberta, British Columbia, and the Yukon and Northwest Territories – all located in the western third of Canada. In these regions the resource is both significant and relatively easily accessible. There exist hot springs and pools in all of these locations, not to mention extensive geological knowledge gained from mineral and oil & gas exploration activities. These data provide a foundation for geothermal exploration even in the absence of government support for geosciences and mapping.

Geothermal Policy Development in Canada

Currently only one jurisdiction (British Columbia) has legislation governing the exploration and development of geothermal resources. Other provinces and territories are currently considering the adoption of such legislation and the Canadian Geothermal Energy Association is active in the consultation process to expedite the prudent development of these resources. On the federal front geothermal energy development remains a lower priority in the context of other energy resources such as oil & gas, hydroelectric, wind, and solar power. Through active policy work and advocacy the Canadian Geothermal Energy Association is making headway in attracting interest and progressive policy to advance the industry.

British Columbia

The Province of British Columbia is perhaps the most progressive jurisdiction in terms of policy and administration for geothermal energy development. The Province recently held its first tenure permit auction since 2004 and has scheduled two more auctions to take place later in 2010. This effectively ends a period of government inactivity in the geothermal sector and reflects a renewed interest in the industry and its ability to meet the clean energy demands of the Province.

In addition to geothermal tenure permit auctions the Province recently announced the new Clean Energy Act and is undertaking industry consultation to modernize its legislation and regulations for the geothermal industry. The new Act will provide greater Ministerial authority in advancing clean energy projects while streamlining certain processes to expedite project development. The industry is hopeful that the new Act will usher in a flurry of geothermal resource exploration and development for the Province and provide the needed government support to attract further investment in the industry.

Alberta, Yukon and Northwest Territories

The remaining western Canadian jurisdictions with strong geothermal resources are also keenly looking at ways to advance the development of their geothermal resources. In Alberta, where electricity generation is largely dependant on fossil fuel generation facilities, policy reform remains a goal of the industry even

though current projects are being governed by other legislation such as oil & gas and mineral exploration and extraction. Though there is a lack of tailored policy there is great interest in geothermal energy and a provincial agency has put forth funding for a co-produced fluids geothermal project. In the northern territories there is similar interest in developing geothermal resources for electricity production and also for residential and commercial heating. Typically these northern and remote communities have relied upon fossil fuel and food imports which are both costly and environmentally damaging. Geothermal energy represents a comprehensive solution to these issues and is an ideal alternative worth consideration. The federal government has sponsored one geothermal power pilot project and one geothermal heating project in the Northwest Territories. These projects, combined with the Alberta project, may soon be Canada's first geothermal power plants and generate the country's first megawatts of electric power from the earth's energy.

Other Canadian Provinces and Territories

Many other jurisdictions in Canada are pursuing aggressive plans to initiate and develop alternative and renewable means of energy production. Quebec and Ontario, similar to British Columbia, have each adopted progressive energy policies that promote renewable electricity and heat production through incentives and attractive government policies. Geothermal energy has largely been left out of these programs as the resource is either less tangible or insufficient without EGS technology in these regions. Nonetheless there is interest in examining future opportunities for geothermal development and the Canadian Geothermal Energy Association is active in promoting this valuable resource throughout Canada.

CanGEA Members and Projects

The Canadian Geothermal Energy Association has grown significantly in recent years and now includes 37 members ranging from geothermal developers, equipment manufacturers, and utilities, to firms specializing in the consulting, engineering, construction, financial, and legal aspects of geothermal energy. Together, CanGEA's pure play geothermal producers represent over \$1 Billion in market capitalization on the Toronto and Venture Stock Exchange and more than 1,959 MW of installed geothermal energy globally, though there is currently no domestic geothermal power production in Canada.

Nevertheless, the Canadian geothermal industry has been proactive in instituting the Geothermal Code for Public Reporting (the Code) to increase investor confidence and provide an accurate means for comparison within the industry. The Code provides a minimum set of requirements for the public reporting of Exploration Results, Geothermal Resources and Geothermal Reserves. Furthermore, the Code will provide a basis for transparency, consistency and confidence in the public reporting of geothermal information.

The Geothermal Code for Public Reporting recognizes **three levels of Geothermal Resource (Inferred, Indicated, and Measured)** based on increasing levels of geological confidence and knowledge, which directly affect the assessment of probability of occurrence. **Two categories of Geothermal Reserves** are recog-

nized by the Code (**Probable and Proved**) based upon increasing levels of geological confidence and the application of “Modifying Factors”. Modifying Factors directly affect the likelihood of commercial delivery and include, but are not limited to, production, marketing, legal factors, land access, social issues, environmental factors and regulatory factors. General relationships and pathways between various Geothermal Resource and Reserve categories that are permitted under the Code are shown below in Figure 1.

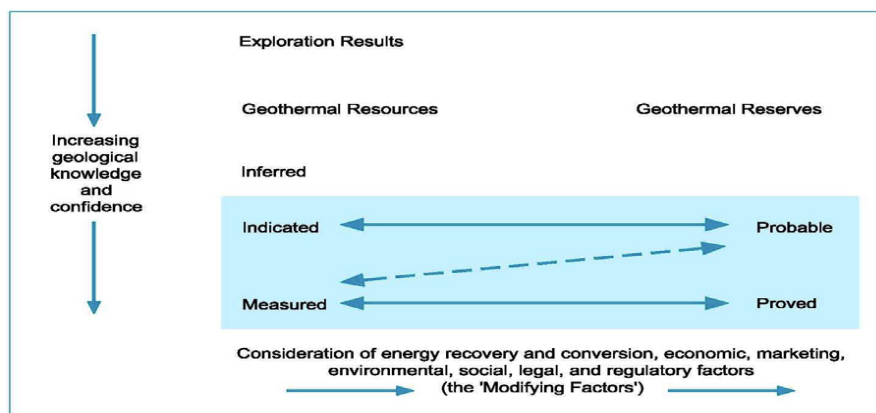


Figure 1. Relationships between Exploration Results, Geothermal Resources and Geothermal Reserves. Source: Australian Geothermal Energy Association. The Geothermal Reporting Code. 2008 Edition.

Exploration Results

Exploration Results include data and information generated by exploration programs. The Exploration Results may or may not be part of a formal declaration of Geothermal Resources and/or Reserves.

The reporting of Exploration Results is common in the early stages of the exploration when the quantity of data available is generally not sufficient to allow any reasonable estimates of Geothermal Resources. Public reports of Exploration Results must not be presented to unreasonably imply that potentially economically extractable energy has been discovered.

Geothermal Resources Defined

A Geothermal Resource is a geothermal play, which exists in a form, quality and quantity that there are reasonable prospects of eventual economic extraction. The location, quantity, temperature, geological characteristics and extent of the Geothermal Resource are known, estimated or interpreted from specific geological knowledge and evidence. Geothermal Resources are subdivided, in order of increasing confidence, into:

- Inferred Resources;
- Indicated Resources;
- Measured Resources

The term Geothermal Resource covers those geothermal plays, which have been identified and estimated through exploration and sampling and within which Geothermal Reserves may eventually be estimated by reduction of the risk after the consideration and application of the Modifying Factors. The term ‘reasonable prospects for eventual economic extraction’ implies a judgment with

respect to the technical and economic factors likely to influence the prospect of economic extraction.

Geothermal Reserves Defined

A Geothermal Reserve is that portion of an Indicated or Measured Geothermal Resource which is deemed to be economically recoverable after the consideration of both the Geothermal Resource parameters and the Modifying Factors. These assessments demonstrate, at the time of reporting, that energy extraction could reasonably be economically and technically justified. Geothermal Reserves are subdivided, in order of increasing confidence, into:

- Probable Reserves
- Proved Reserves

The term ‘economically recoverable’ implies that heat extraction of the Geothermal Reserve has been demonstrated to be viable under reasonable financial assumptions. What constitutes ‘reasonably economically and technically justified’ will vary with the type of geothermal play, the level of study that has been carried out and the financial criteria of the individual company.

With increasing geological knowledge and confidence the Geothermal Resource progresses from **Inferred**, to **Indicated**, to **Measured**. Similarly, with consideration of energy recovery and conversion, economic, marketing, environmental, social, legal, and regulatory factors (all Modifying Factors) the resource may be labelled a **Probable** or **Proved** Geothermal Reserve.

The important distinction is that geological results alone do not indicate whether a geothermal resource can be stated as a Probable or Proved Geothermal Reserve. The Modifying Factors must be taken into consideration to determine whether the geothermal resource can be classified as a Geothermal Reserve.

CanGEA members have an active roster of 76 projects worldwide with 1,470 MWe under development and 2,000 MWe of operating power plants. With such a large breadth of experience Canadian geothermal developers are well suited to tap Canada’s vast geothermal resources to provide clean, reliable, base-load power for Canadian and export markets. Furthermore, with such ambitious support from Canadian investors it is clear that the geothermal energy in Canada is sure to play an important role in Canada’s energy future.










The table on the previous page summarizes the various projects and installations of CanGEA member geothermal developers. It is important to note that absent from this list are the service providers who also have active rosters of projects under development both within Canada and abroad.

Conclusion

Canada occupies an interesting position as a nation with vast geothermal potential, extensive knowledge and expertise in geothermal development, and strong interest from financial markets yet has currently no geothermal power production. However this

peculiarity is imminently changing as the first few projects aim to come online within the coming months. Going forward Canada's role within the geothermal community is sure to evolve as the nation transitions to advance the development of its rich geothermal resources.

However, this development will be tempered by government policy and incentives. Progressive policy matched with fiscal incentives to support Canada's fledgling geothermal industry is needed to bring Canada's domestic geothermal potential to life. At the same time, there is much work to be done to provide education and awareness to Canadians in regards to the benefits and merits of geothermal power. These challenges have fallen on the Canadian Geothermal Energy Association and its members who together are active in promoting geothermal energy at all levels in order to advance the development of this renewable, base-load energy source. As this work progresses so to will the development of Canada's geothermal resources and its standing in the global geothermal community.

Company	Exploration Results	Inferred Resources	Indicated Resources	Measured Resources	Probable Reserves	Proved Reserves	Total
	22 Projects	6 Projects 1,120 MW	1 Project 41 MW			193 MW	29 Projects 1,354 MW
	14 Projects	4 Projects 120 MW					18 Projects 120 MW
	2 Projects	1 Project 15 MW				53 MW	3 Projects 68 MW
	8 Projects	2 Projects 64.5 MW				471 MW	10 Projects 535.5 MW
	5 Projects			1 Project 25 MW	62 MW	10 MW	6 Projects 97 MW
						1,273 MW	1,273 MW
		1 Project 1 MW		1 Project 2 MW			2 Projects 3 MW
	6 Projects	1 Project 19.5 MW					7 Projects 19.5 MW
	1 Project						1 Project
Total	58 Projects	15 Projects 1,340 MW	1 Project 41 MW	2 Projects 27 MW	62 MW	2,000 MW	76 Projects 3,470 MW