Building a regulatory framework for geothermal energy development in the NWT

A report for the Government of Northwest Territories, Environment and Natural Resources Department

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The Pembina Institute is a national non-profit think tank that advances sustainable energy solutions through research, education, consulting and advocacy. It promotes environmental, social and economic sustainability in the public interest by developing practical solutions for communities, individuals, governments and businesses. The Pembina Institute provides policy research leadership and education on climate change, energy issues, green economics, energy efficiency and conservation, renewable energy, and environmental governance. For more information about the Pembina Institute, visit www.pembina.org or contact info@pembina.org. Our engaging monthly newsletter offers insights into the Pembina Institute's projects and activities, and highlights recent news and publications. Subscribe to Pembina eNews: http://www.pembina.org/enews/subscribe.

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Building a regulatory framework for geothermal energy development

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Executive Summary

There is high potential for geothermal energy use for heat and power in the Northwest Territories (NWT). Adoption of geothermal energy production to replace existing power or heat production from carbon-based fuels could help the Government of the NWT reach its commitment to reduce greenhouse gas emissions from its own operations to 10% below 2001 levels by the year 2011 and establish longer-term reductions targets.[1]

This report documents the key policy issues associated with geothermal energy development and makes recommendations for developing a regulatory framework for geothermal energy in the NWT. This report contains the results of a jurisdictional review focused on nine countries as well as interviews with geothermal energy experts around the world. This report will support discussions on the development of geothermal energy policy in the Northwest Territories.

The objectives of the study are:

- To outline the key policy issues associated with geothermal energy developments.
- To provide an overview of the regulatory framework that other leading jurisdictions in Canada and the world have established to address policy issues.
- To provide the Government of the Northwest Territories with recommendations and next steps for developing a regulatory framework to support geothermal energy development in the NWT, with a focus on tenure and royalty regimes.

Government policy in other jurisdictions in the world has reflected the type of geothermal resource, the technology employed, the size of the project, the economics of the geothermal industry, the end use of the power or heat, and the desire of governments to see it developed. Several key themes emerge from the jurisdictional review of legislation and policy for geothermal energy development: the definition of geothermal energy; legislation; resource ownership; tenure and leasing system; fees and royalties; research; and fiscal and non-fiscal incentive policies.

In developing a geothermal energy policy, the Government of the Northwest Territories should:

- Define a vision and plan for geothermal energy use in the Territory
- Design policy framework to reflect the unique nature of the resource
- Define geothermal energy legislation and create a clear legal definition of geothermal energy
- Define geothermal resource ownership
- Establish a process for geothermal tenure issuance and permitting
- Set appropriate fees and royalties
- Invest in geoscience data and programs

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[1] Northwest Territories Environment and Natural Resources, *Greenhouse Gas Strategy 2007-2011*. http://www.enr.gov.nt.ca/_live/documents/content/Greenhouse_Gas_Strategy_FINAL.pdf

- Evaluate the fiscal incentive policies needed to advance geothermal energy

Geothermal is a form of renewable energy that produces few if any greenhouse gas emissions and can provide a stable, secure supply of energy. In the NWT where the cost of energy is high, geothermal energy projects, even if they are small, may be a real solution to communities' heat and power needs in the future. Geothermal energy could contribute to energy independence of northern communities by protecting northerners from dramatic fluctuations in petroleum prices. Geothermal energy could also facilitate other spinoff economic opportunities, such as providing energy for alternative uses like food production. Effective government policy is key to harnessing the potential of geothermal energy use in the Territory.

1. Introduction

In September 2010, the Pembina Institute was commissioned by the Government of the Northwest Territories Department of Environment and Natural Resources to complete an inter-jurisdictional review of geothermal energy legislation and policy. This report contains the results of the review as well as interviews with geothermal energy experts around the world. This report will support discussions on the development of geothermal energy policy in the Northwest Territories (NWT).

1.1 Purpose of the study

The purpose of the study is to document the key policy issues associated with geothermal energy development and make recommendations for developing a regulatory framework for geothermal energy in the NWT.

The objectives of the study are:

- To outline the key policy issues associated with geothermal energy developments.
- To provide an overview of the regulatory framework that other leading jurisdictions in Canada and the world have established to address policy issues.
- To provide the Government of the Northwest Territories with recommendations and next steps for developing a regulatory framework to support geothermal energy development in the NWT, with a focus on tenure and royalty regimes.

1.2 Scope of the project

This report discusses the development of geothermal resources for electricity and direct use heat production, which tend to be found deep (more than one kilometre) in the earth and range in temperature from 50ºC to over 200ºC. Geoexchange, which is shallow surface exchange of heat using ground-source heat pumps, is not discussed here.

The inter-jurisdictional review focused on nine jurisdictions in seven countries: United States (focused on the states of Nevada and California, and federal land), Canada (focused on British Columbia), Australia, New Zealand, Italy, Iceland and Germany. These countries were selected because of their significant development of geothermal resources (United States, New Zealand, Iceland, Italy) or because of unique or recent development of government policies in support of geothermal energy development (British Columbia, Australia, Germany).

Interviews were conducted with 13 geothermal experts representing all of the jurisdictions studied. Their expertise covered geothermal regulations, geothermal exploration, geothermal resource mapping, economic incentives and more. A list of interviewees is provided in Appendix A.

1.3 Outline of the report

Following this introduction, Chapter 2 of this report describes geothermal energy development as a renewable resource worldwide, types of geothermal energy systems, potential for geothermal energy in the NWT, and an overview of the regulations that exist to manage geothermal resources in the NWT. Chapter 3, Jurisdictional Review, includes the results of a literature review and interviews with experts, with the results for each jurisdiction in table format. Chapter 4 outlines key themes that emerge from the jurisdictional review and interviews with geothermal experts. Chapter 5 suggests approaches to policy to take in the NWT to encourage geothermal energy development.

2. Background

Geothermal energy is playing an increasingly important role in the world's energy supply. There are over 10,000 MW of installed capacity electricity generation worldwide, an increase of 20% between 2005 and 2010, and this is projected to grow to 18,500 MW by 2015.[2] World-wide, at least 27,825 MW of direct heat is supplied from geothermal systems.[3] Altogether 24 countries now convert geothermal energy into electricity and 72 countries use geothermal for direct heating. Approximately half the world's existing geothermal generating capacity is in the United States and the Philippines, and Indonesia, Mexico, Italy, and Japan account for most of the remainder.[4] Figure 1 shows the distribution of installed capacity of geothermal energy in the world.

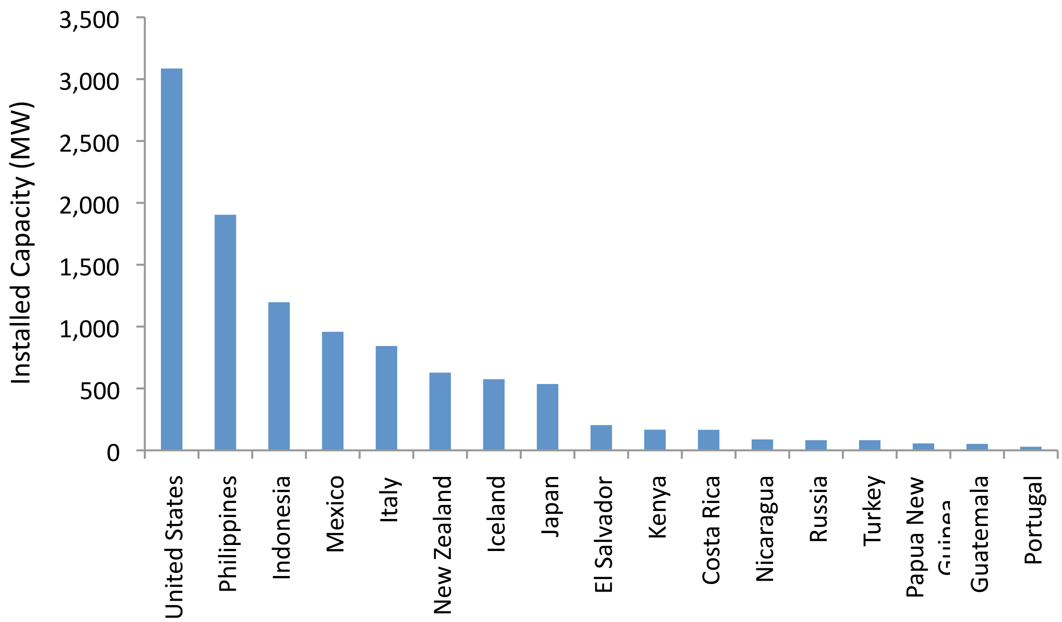

Figure 1. Installed capacity of geothermal energy in the world

Source: Data from the Canadian Geothermal Energy Association

In Canada, the geothermal energy industry is still in its infancy. Despite the high potential for geothermal development, particularly in western Canada, there is no electrical production in

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[2] Ruggero Bertani, "Geothermal Power Generation in the World: 2005–2010 Update Report," in *Proceedings of the World Geothermal Congress 2010* (Bali, Indonesia, April 25-30, 2010).

[3] John W. Lund, Derek H. Freeston, Tonya L. Boyd, "World-Wide Direct Uses of Geothermal Energy 2005," *Proceedings of the World Geothermal Congress*, 2005.

[4] Bertani, "Geothermal Power Generation in the World."

Canada as of 2010. Electricity has been produced in the past during a test at the Meager Creek facility in British Columbia. Electricity was produced in a test, but this facility is not producing as of 2010. A pilot project for production of electricity and heat from oil and gas wells in Swan Hills, Alberta is in development. Direct heat projects include a demonstration project for a greenhouse in Chilliwack, B.C. and the direct use heating of a plastics factory from an abandoned coal mine in Springhill, Nova Scotia.[5]

Geothermal energy has many advantages when compared to traditional fossil-fuel-derived energy or even some types of alternative energies.

- Geothermal provides can supply energy at a constant rate and is not dependent on weather or seasonal considerations.
- Geothermal can supplement other renewable energy sources such as hydro, wind and solar by providing baseload power.
- Geothermal development, after construction of the plant, produces low or negligible air emissions.
- Geothermal has a small surface footprint compared to some other energy applications.

Adoption of geothermal energy production to replace existing power or heat production from carbon-based fuels could help the Government of the NWT reach its commitment to reducing greenhouse gas emissions from its own operations to 10% below 2001 levels by the year 2011 and establish longer-term reductions targets.[6] The Canadian government has also made a commitment to producing 90% of Canada's electricity from non-emitting sources by 2020.[7]

2.1 Geothermal potential in NWT

There is high potential for geothermal energy production in the NWT. A favourability map generated using geophysical data found the largest known deep geothermal anomaly in Canada in the Liard River and Southern Mackenzie River Basin, based on studies completed to date.[8] This indicates a geothermal gradient of 50°C to 60°C per kilometre of depth in this region, which is the steepest gradient in NWT. Around Fort Simpson and Fort Providence there is a similarly high geothermal potential. At a depth of 2 to 3 km, the temperature would be adequate (90°C to 135°C) for a geothermal power plant.[9] The area around the communities of Deline, Tulita, Norman Wells and Fort Good Hope has a favourable (but lower) geothermal gradient that could also support energy production from geothermal.

Geothermal energy production has an advantage in cold northern climates as compared to warmer regions. The efficiency of electrical production depends on the temperature differential

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[5] Canadian Geothermal Energy Association, *Overview of Canadian Geothermal Projects* (2010) 3-7. http://www.cangea.ca/images/uploads/Index%20of%20Canadian%20Geothermal%20Projects%20and%20Hot%20Springs.pdf

[6] Northwest Territories Environment and Natural Resources, *Greenhouse Gas Strategy 2007-2011*.

[7] Governor General of Canada, "Speech from the Throne," November 19, 2008. http://www.speech.gc.ca/eng/media.asp?id=1364

[8] Northwest Territories Environment and Natural Resources, *Geothermal Favourability Map: Northwest Territories* (2010).

[9] Ibid.

between the geothermal resources and the cooling source (air or water). Thus geothermal production efficiency would be greater in winter, when power demand is highest, than in summer.[10] The best example of this is in Chena, Alaska where water at 73.3°C produces electricity, replacing a diesel generation system.[11] This is the lowest-temperature geothermal production in the world to date.[12]

2.2 Recent proposed developments in NWT

Two geothermal projects are under consideration in NWT:

- The proposed Fort Liard Geothermal Demonstration Project could provide 1 MW of electricity and 1 MWh of heat. The project is a joint venture with Acho Dene Koe First Nation and Borealis GeoPower, and has qualified for $10-20 million dollars of funding under the Federal Clean Energy Fund.[13] As of January 2011, Borealis GeoPower is moving forward with project development, and estimates that the project will be producing by the end of 2013.[14]
- The Con Mine District Heating System in Yellowknife would produce 52,000 MWh/yr to heat almost 40 commercial buildings in downtown Yellowknife. This would offset approximately 7.5 million liters of heating oil per year.[15] This project has also qualified for $14.1 million under the Clean Energy Fund.[16] As of January 2011, a concept study and feasibility study have been completed, and the city has requested private partner interest in the project. A city-wide referendum was held in March 2011 to gauge support of city residents for borrowing funds for the project.[17] The city residents voted against the request, thereby limiting the city's ability to participate in the project (although a private developer could still develop the project).

2.3 Types of geothermal systems

High-quality geothermal resources are reservoirs such as steam and super-heated hydrothermal systems with excellent water flow and over 200°C temperature water or steam. Medium-quality

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[10] Personal communication, Alison Thompson, Canadian Geothermal Energy Association. October 17, 2010.

[11] Gwen Holdmann, *The Chena Hot Springs 400kW Geothermal Power Plant: Experience Gained During the First Year of Operation* (Chena Hot Springs/Chena Power, 2007) http://www.yourownpower.com/Power/2007GRCPaper.pdf

[12] Leslie Blodgett, "Developing Geothermal Energy at Low Temps," Renewable Energy World, September 21, 2010. http://www.renewableenergyworld.com/rea/news/article/2010/09/low-temperature-geothermal-energy-expanding-market-opportunities

[13] Natural Resources Canada, "Clean Energy Fund Renewable Energy and Clean Energy Systems Demonstration Projects," backgrounder, January 2010. http://www.nrcan-rncan.gc.ca/media/newcom/2010/201001a-eng.php

[14] Canadian Geothermal Energy Association, *Overview of Canadian Geothermal Projects* (2010).

[15] Mark Henry, "City of Yellowknife District Energy Investment Decision Project: Economic Assessment Update," (presented to the Community Energy Planning Committee, September 22, 2010.)

[16] Natural Resources Canada, "Clean Energy Fund Renewable Energy and Clean Energy Systems Demonstration Projects."

[17] City of Yellowknife, "Con Mine Energy Project Progress Diary." http://www.yellowknife.ca/City_Hall/Departments/Public_Works___Engineering/YellowknifeCommunityEnergyPlan/ConMineEnergyProject/ProjectProgressDiary.html

reservoirs range from 200-120°C and low-quality reservoirs are cooler (<120°C), or may be deeper in the ground or have limited water flow.[18] High-quality resources are rare in the world; the vast majority of resources are lower-quality. Delineating these resources cannot be done from the surface; expensive well drilling is needed to determine the subsurface characteristics of the geothermal resource.

Geothermal resources can be utilized to produce two main types of energy systems: heat (for space heating, water heating, process heat) and electricity, or a combination of the two.

2.3.1 Direct use heating

Direct use systems can directly access heat from low-temperature resources (50°C to 150°C). Direct use heat systems require a source of heat (a well), a system of delivery (piping) and a method of disposal (either through re-injection of fluid into the well or storage pond). This technology can provide heat for residential and industrial facilities, and is often used for commercial applications such as greenhouses, fish farms and food processing facilities.

2.3.2 Electricity generation

Electricity generation systems use the geothermal heat resource to produce electricity. Various technologies can be employed based on the quality of the geothermal resource.

Conventional/Flash systems draw high-pressure, high temperature (for example > 180 °C) geothermal fluid to the surface into a low-pressure chamber where it 'flashes' into steam. The pressure created by this steam drives a generator. Condensed steam is either released into the atmosphere as water vapour or re-injected into the geothermal reservoir. In dual flash systems fluids are passed through a separator for a second time, allowing greater extraction of heat. These systems are most often used for electrical generation, but some plants have capability for integrated direct uses as well. The geothermal resources in the NWT are likely not adequate to support a conventional geothermal plant.[19] However, additional geoscience data might change this assumption in the future.

Binary systems (such as organic rankine cycle) involve two fluids: hot geothermal water, and a 'working fluid' (usually a hydrocarbon such as isobutene or pentane) that boils at a low temperature. Heat is exchanged between the geothermal water and the working fluid, and the working fluid boils and vapourizes, driving a turbine to produce electricity and heat. The system operates on two closed loops: cooled water is re-injected, and working fluid is condensed and cycles in the system.[20] The closed-loop system is desirable in terms of low or negligible emissions and reduced risk of contamination. Binary systems are often used for both electricity and heat generation. A binary system would be the most likely type of geothermal power

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[18] Canadian Geothermal Energy Association, "What is Geothermal?" http://www.cangea.ca/what-is-geothermal/

[19] Northwest Territories Environment and Natural Resources, *Geothermal Favourability Map: Northwest Territories*.

[20] International Energy Agency, *Renewable Energy Essentials: Geothermal* (2010). www.iea.org/papers/2010/Geothermal_Essentials.pdf

production in the NWT considering the estimated temperature range of the geothermal resources.[21]

Enhanced Geothermal Systems (EGS) involves creation or enhancement of a geothermal resource. The permeability and porosity of the reservoir can be increased through fracturing after deep drilling, and additional water may be added (from groundwater or other sources) to create a reservoir.[22] EGS can increase energy availability from drier reservoirs, or extend the life of a depleted reservoir. EGS technologies and processes are still under development, though there have been some successful applications of EGS in Europe, Australia, and the United States. A study by the Massachusetts Institute of Technology estimated that 100,000 MW of power generation from EGS could be in place in the United States by 2050 with adequate research and development support.[23]

Each geothermal energy project has an economic profile that depends on the quality of the resource, the drilling costs and associated risk, the production technology and other factors. Figure 2 describes how the classification of the resource by temperature and flow rates influences the extraction technology.

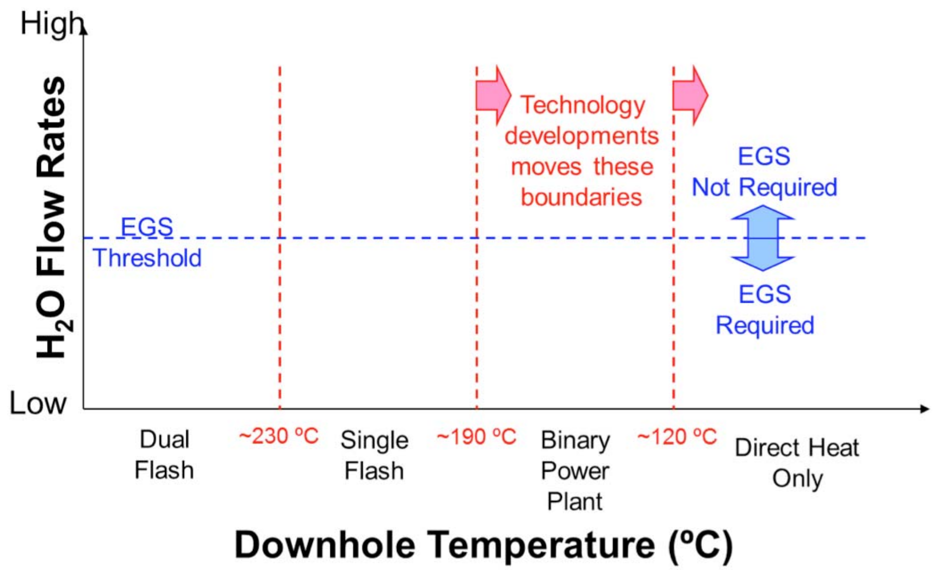

Figure 2. Simplified geothermal resource classification by extraction technology

Source: Thompson and Dunn 2010.[24]

As shown above, differences in temperature and flow rates of the geothermal energy resources affect the type of technology that can be employed. The economic profile for the development of

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[21] Northwest Territories Environment and Natural Resources, *Geothermal Favourability Map: Northwest Territories*.

[22] International Energy Agency, *Renewable Energy Essentials: Geothermal*, 1-3.

[23] Massachusetts Institute of Technology, *The Future of Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Century* (Boston, MA: Massachusetts Institute of Technology, 2007), 1-3.

[24] Tim Thompson and Craig Dunn, *Policy Recommendations for Advancing Geothermal Energy in Canada*. (Canadian Geothermal Energy Association, 2010), 128.

high-quality geothermal resources is very different from low-medium geothermal resources that use other technologies. The economics of a project are affected by the drilling depth in order access the geothermal heat. The risk of geothermal projects can be reduced over time with improvements in technology. While technology is well-established for accessing high-quality geothermal resources, recent advances in technology are creating more opportunities for heat and power production from resources with low temperatures or limited water flow.

2.4 Overview of regulatory framework in the NWT

Although the legislative framework exists for energy and natural resource management in the NWT, there is currently no geothermal-specific legislative framework. The regulatory requirements would depend on whether a geothermal energy project is located on Crown lands, municipal lands or privately owned lands (including Aboriginal land), as well as the nature of project activities.

Government policies and regulations are required for a number of stages of energy development. These stages are described in Table 1 with examples of the policies needed for each stage.

Table 1. Stages of development of energy development and associated government policies and regulations

Stage of development	Example of policy/ regulation
Regional planning	Energy strategy/policy, land use planning, strategic environmental assessment
Disposition of subsurface resources	Tenure issuance/bidding process
Permitting for exploration and drilling	Exploration/ drilling permit, water permit
Development, operations and royalties	Environmental impact assessment, development permit, royalty fees

2.4.1 Regional planning

In NWT, regional planning is completed by land use planning boards, as mandated by the Mackenzie Valley Resource Management Act. These boards develop land use plans that designate areas for protection, special management (where some development is allowed with conditions), and general zones where development is allowed. In addition, land may be nominated for protection under the Protected Area Strategy. There is an approved land use plan in the Gwich'in Settlement Area and planning processes are underway in the other regions.[25]

[25] Northwest Territories Environment and Natural Resources, "Protected Areas & Land Use Plans," *State of the Environment Report 2010* (2010).

2.4.2 Disposition of subsurface resources

In the NWT, subsurface resources are owned by either the Crown or Aboriginal governments through land claim agreements. Issuance of rights for specific subsurface resources on federal land, such as minerals or petroleum, is administered by Indian and Northern Affairs Canada.[26] On Commissioner's Lands (lands in or near communities), the administration and control of surface activities has been transferred to the territorial government but subsurface rights are retained by Indian and Northern Affairs.[27] On land where aboriginal governments own subsurface resource rights, these rights are administered by these governments.

The disposition of mineral rights to the private sector is regulated by the Territorial Lands Act[28] and the NWT and Nunavut Mining Regulations. Petroleum rights are issued under the Canada Petroleum Resources Act.[29]

2.4.3 Permitting for exploration and drilling

Drilling for geothermal wells in NWT would fall under the Canada Oil and Gas Operations Act, administered by the National Energy Board. In the Act a well is defined as an opening in the ground made "for the purpose of injecting gas, air, water or other substance into an underground formation" or, "for any purpose, if made through sedimentary rocks to a depth of at least one hundred and fifty metres."[30] Thus, any geothermal wellhole deeper than 150 metres or any hole for re-injection of geothermal fluids would fall under this Act. This Act also contains requirements for authorizations for geological/geophysical operations and drilling.

2.4.4 Development, operations and royalties

2.4.4.1 Development

Land and water use activities in the Mackenzie Valley on Crown land are regulated under the Mackenzie Valley Resource Management Act,[31] with the exception of the Inuvialuit Settlement Region and Wood Buffalo National Park. Water use for cooling for geothermal energy developments could be regulated under the NWT Waters Act,[32] the Mackenzie Valley Resource Management Act, and in the Inuvialuit Region under the Northwest Territories Waters Act. A water licence could be issued by a regional land and water board, or, within unsettled lands, by the Mackenzie Valley Land and Water Board.

The Mackenzie Valley Land and Water Board has provided for geothermal development in its licensing criteria for power production. The criteria delineates categories for production, ranging

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[26] Indian and Northern Affairs Canada, *Your Guide to Who Manages Crown Land in the Northwest Territories*. (2006). http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/clg-eng.asp

[27] Government of Canada, *Territorial Lands Act* (R.S., 1985, c. T-7)

[28] Ibid.

[29] Government of Canada, *Canada Petroleum Resources Act* (1985, c.36)

[30] Government of Canada, *Canada Oil and Gas Operations Act* (R.S.C. 1985, c. O-7 – Consolidation. 2007)

[31] Government of Canada, *Mackenzie Valley Resource Management Act* (1998, c. 25)

[32] Government of Canada, *Northwest Territories Waters Act* (1992, c. 39)

from Class (0–150 kilowatts) to Class 6 (100,000 kilowatts or more). A Class 0 power project requires a Class B Water Licence (which does not require a public hearing), and Class 1-6 power projects require a Class A water licence (which covers use of groundwater and deposit of waste, and requires a public hearing).[33,34]

Land and water boards also regulate surface land activities (such as construction of a geothermal plant) as specified in the Mackenzie Valley Resource Management Act. A Type A land use permit would be required for the construction of roads, drill pads and camps, and the clearing of land for wells, facilities and fuel storage.[35] In the Inuvialuit Settlement Region, land use permits can be obtained from Indian and Northern Affairs Canada, and on Inuvialuit owned lands, from the Inuvialuit Land Administration Office.

Land use permit and water use permit applications undergo a preliminary screening to determine if the project is expected to cause significant environmental or social impact. If the environmental or social impacts of a proposed project merit further review, the proposal would be passed on the Mackenzie Valley Environmental Impact Review Board (in the Mackenzie Valley) or the Environmental Impact Review Board (in the Inuvialuit Settlement Region) for an environmental assessment. Environmental assessment can take between one to two years to complete and the land use and water use permits would be issued at the end of the environmental assessment process if the project is approved.

Surface access permits for lands within municipal boundaries would be required from the municipality or from the Government of the NWT Department of Municipal and Community Affairs. This would be similar to the access permits that were acquired by the operators of Con and Giant mine for mining activities on land within the boundaries of the City of Yellowknife.

2.4.4.2 Operations

Anyone can produce electricity for their own needs, subject to permission of an electrical inspector as per the NWT Electrical Protection Act.[36]

To connect to the electricity grid system in any community, the producer would need to negotiate with the utility provider in that community. The Northwest Territories Power Corporation, for example, provides power for 27 communities in the territory. An independent power producer would have to set up a purchase agreement with the NWT Power Corporation (NTPC) in order to integrate power from geothermal into the existing power system. Alternatively, a geothermal energy project could be developed and operated by the NTPC or formed through a public-private partnership.

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[33] Mackenzie Valley Land and Water Board, *Activities Requiring a Water Licence* (2004). http://www.mvlwb.com/doc/WL%20Criteria%20Nov%202004.pdf

[34] Mackenzie Valley Land and Water Board, *Guide to Completing Water License Application* (2001). http://www.mvlwb.ca/mv/AppForms/Guide%20to%20Completing%20Water%20Use%20Applications.pdf

[35] Mackenzie Valley Land and Water Board, *Activities Requiring a Land Use Permit* (2004). http://www.mvlwb.com/doc/LUP%20Criteria%20Nov%202004.pdf

[36] Government of the Northwest Territories, *Electrical Protection Act* (R.S.N.W.T. 1998, c. E-3)

A geothermal plant may fall under the jurisdiction of the NWT Public Utilities Board and the Boilers and Pressure Vessels Act (administered by the GNWT Department of Public Works and Services).[37]

2.4.4.3 Royalties

No royalties are being charged for other renewable energy projects such as wind and solar in the Northwest Territories, as the energy source is never depleted.

Currently, there are no royalties specified for geothermal energy development in the Northwest Territories. Royalties are charged for petroleum and mineral development. Petroleum royalties are outlined in the Frontier Lands Petroleum Royalty Regulations, and range from 1 to 5 % of gross revenue until the costs of the project are covered, then are set at 5% of the gross revenue or 30% of the net revenue, whichever is greater.[38] Mineral royalties range from 0 to 14 % of the value of the output depending on the size of the mine.[39]

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[37] Government of the Northwest Territories, *Boilers and Pressure Vessels Act* (R.S.N.W.T. 1988, c. B-2)

[38] Northern Oil and Gas Directorate Indian and Northern Affairs Canada, "Calculating Royalties," http://www.ainc-inac.gc.ca/nth/og/flprr/calc-eng.asp.

[39] Indian and Northern Affairs Canada, *Discussion Paper: The Frontier Lands Petroleum Royalty Regulations, Proposed Amendments*, http://www.ainc-inac.gc.ca/nth/og/flprr/am/discu-eng.asp.

3. Jurisdictional review

The following chapter provides an overview of geothermal energy development and regulations in a number of countries in the world. The review is focused on seven countries, providing a summary of the resource potential, installed capacity, geothermal legislation, resource ownership regulations, leasing processes and royalty systems. The countries reviewed are: United States, (federal lands plus the states of Nevada and California), Canada (province of British Columbia), Australia, New Zealand, Iceland, Italy and Germany. These countries were selected because of their significant development of geothermal resources (United States, New Zealand, Iceland and Italy) or because of unique or recent development of government policies in support of geothermal energy development (British Columbia, Australia and Germany).

3.1 United States federal lands

Resource potential and installed capacity	In the United States there 35 generating facilities in 8 states with an installed capacity of 3086.6 MW.[40] There are a total of 789 geothermal leases covering 6,475 km^2.[41] Estimates of geothermal potential (without EGS) are 36,000 MW.[42] In total, 530 million acres of federally owned land in the western U.S. has potential for geothermal electrical generation or direct heat applications.[43]

[40] Dan Jennejohn, *U.S. Geothermal Power Production and Development Update*, (Geothermal Energy Association, 2010) http://www.geo-energy.org/pdf/reports/April_2010_US_Geothermal_Industry_Update_Final.pdf.

[41] Kermit Witherbee, "Geothermal Leasing and Operations on BLM Managed Lands," (presented during Geothermal Legal and Regulatory Challenges Webinar by EUCI, September 20, 2010).

[42] Chad Augustine, Arlene Anderson, and Katherine R. Young (National Renewable Energy Laboratory), "Updated U.S. Geothermal Supply," (presented at Stanford Geothermal Workshop, Stanford, California February 1, 2010).

[43] U.S. Bureau of Land Management, *Programmatic Environmental Impact Statement- Geothermal* http://www.blm.gov/wo/st/en/prog/energy/geothermal/geothermal_nationwide/Documents/Final_PEIS.html

Definition of geothermal resource	The Geothermal Steam Act of 1970[44] defines geothermal resources as: "(i) all products of geothermal processes, embracing indigenous steam, hot water and hot brines; (ii) steam and other gases, hot water and hot brines resulting from water, gas, or other fluids artificially introduced into geothermal formations; (iii) heat or other associated energy found in geothermal formations; and (iv) any byproduct derived from them. "(d) "byproduct" means any mineral or minerals (exclusive of oil, hydrocarbon gas, and helium) which are found in solution or in association with geothermal steam and which have a value of less than 75 per centum of the value of the geothermal steam or are not, because of quantity, quality, or technical difficulties in extraction and production, of sufficient value to warrant extraction and production by themselves."
Resource ownership, rights issuance and tenure	In an effort to identify and prioritize opportunities for geothermal development on federal land, Bureau of Land Management (BLM) and the U.S. Forest Service completed a programmatic Environmental Impact Statement (PEIS) in 2008. This top-down approach to identifying land for lease sales was completed as part of the implementation of the National Environmental Policy Act of 1969, and the National Energy Policy Act of 2005. The PEIS was a collaborative effort between public, tribal governments, universities and research institutions, stakeholder organizations, and industry.[45] The Statement covered 12 western states[46] and over 142 million acres of BLM land. The PEIS evaluated land allocation, procedures and best management practices for development. The recommendations from the PEIS were proposed as amendments to existing land use plans (also known as resource management plans). The PEIS can provide a template for project-level environmental reviews and may be adequate for project-level cumulative effects assessment.[47] However, the PEIS may be challenged in court within 6 years of adoption, and if this occurs, any project-level environmental assessment that relies on the PEIS will be undermined.[48] The PEIS did not cover induced seismicity or impact of fluids on water quality, which must be addressed at a project level. Permits and leases for geothermal energy exploration or development

[44] Government of the United States, *Geothermal Steam Act*, Public Law 91-581, 84 Stat. 1566, 30 U.S.C. 1001-1025.

[45] U.S. Bureau of Land Management, *Programmatic Environmental Impact Statement- Geothermal.*

[46] States included Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

[47] Kermit Witherbee, "Geothermal Leasing and Operations on BLM Managed Lands" (presented during Geothermal Legal and Regulatory Challenges Webinar by EUCI, September 20, 2010).

[48] Ibid.

	on BLM or Forest Service land are administrated by the BLM. Exploration permits carry with requirement for a bond of $5,000-$100,000 depending on the scale of the project.[49] Exploration activities include drilling for determination of temperature gradient, for seismic operations and construction related to drilling. BLM holds a competitive lease sale every two years, at minimum.[50] For lease issuance, a Lease Sale Notice is published 45 days prior to the lease sale, which details the time, date and place of the lease sale and any stipulations for each parcel.[51] At the lease sale, oral bids are submitted and the lease is given to the highest qualified bidder. If land is not sold during the lease sale, it is available for two years, in which time anyone can submit bids. On the first day after the competitive lease sale date, BLM will randomly select an application among the received bids to receive the lease (for either electricity or heat generation). After that first day, the first qualified applicant will received the lease.[52] Rent fees for a lease obtained under competitive bidding are $2/acre for the first year, $3/acre for Years 2 to10, and $10/acre beyond 10 years. Rent fees for a lease obtained under non-competitive bidding are $1/acre for Years 1 to 10 and $5/acre beyond 10 years. A lease is held for 10 years, with up to two five-year extensions (assuming the minimum work requirements are met).[53] For direct use projects, land can be nominated by State, Tribal or local Governments.[54] The parcel is posted for 90 days. If expressions of interest from more than one party are received, then the parcel must follow the competitive leasing process. There are nominal fees charged for direct use, outlined in a fee schedule.[55] In 2010, a Geothermal Production Expansion Act was proposed to amend the Geothermal Steam Act to allow developers to expand geothermal leases to adjacent lands on a non-competitive basis.[56]

[49] California Geothermal Energy Collaborative, *Expanding California's Confirmed Geothermal Resources Base - Geothermal Permitting Guide* (prepared for California Energy Commission, 2007).

[50] "Competitive Leasing," U.S. Code of Federal Regulations Title 43, Pt. 3203.13.

[51] "Competitive Leasing," U.S. Code of Federal Regulations Title 43, Pt. 3203.14.

[52] "Noncompetitive Leasing Other Than Direct Use Leases," U.S. Code of Federal Regulations Title 43, Pt. 3204.

[53] Ibid.

[54] "Direct Use Leasing," U.S. Code of Federal Regulations Title 43, Pt. 3205.

[55] "Product Valuation," U.S. Code of Federal Regulations Title 30, Pt. 206.356.

[56] L.X. Richter, "Geothermal Production Expansion Act Introduced in the Senate," *Sustainable Business* (December 6, 2010) http://thinkgeoenergy.com/archives/6569

[57] U.S. Department of Energy, *Geothermal Energy Production with Co-produced and Geopressured Resources*, Factsheet Geothermal Technologies Program (2010) http://www1.eere.energy.gov/geothermal/pdfs/low_temp_copro_fs.pdf

	The U.S. Department of Energy, through the Geothermal Technology Program, is supporting the development and demonstration of coproduction of geothermal fluids at oil and gas production fields. Geothermal energy, in the form of heat or pressure, which is produced as a byproduct of oil and gas development is now being considered as a resource to produce electricity.[57]
Royalties	For both competitive and non-competitive leasing, a royalty rate of 1.75% for Years 1 to 10 and 3.5% for Years 10+, charged on the gross proceeds derived from the sale of electricity.[58]

3.2 California

Resource potential and installed capacity	As of 2010, the installed capacity for geothermal power generation in California was 2565.5 MW,[59] with approximately 2000 MW additional capacity in development.[60] As of summer 2010 there were 92 leases covering 451 km^2.[61]
Definition of geothermal resource	The California Public Resource Code defines geothermal resources as "the natural heat of the earth, the energy, in whatever form, below the surface of the earth present in, resulting from, or created by, or which may be extracted from, such natural heat, and all minerals in solution or other products obtained from naturally heated fluids, brines, associated gases, and steam, in whatever form, found below the surface of the earth, but excluding oil, hydrocarbon gas or other hydrocarbon substances." [62]
Resource ownership, rights issuance and tenure	Leasing of state land and mineral rights for renewable energy is under the authorization of California Environmental Quality Act [63] by the State Land Commission. Geothermal tenure can be obtained through two methods: competitive bidding leases and prospecting/exploration permits. For competitive bidding leases, the Commission selects land to be made available, and disposes of rights with an auction similar to the federal system.[64]

[58] "Distribution and Disbursement of Royalties, Rentals, and Bonuses," U.S. Code of Federal Regulations Title 30, Pt. 219.

[59] Jennejohn, *U.S. Geothermal Power Production and Development Update.*

[60] Ibid.

[61] Witherbee, "Geothermal Leasing and Operations on BLM Managed Lands."

[62] *Geothermal Resources Act*, California Public Resources Code S. 6903.

[63] *California Environmental Quality Act*, California Public Resources Code S. 21000-21177.

[64] *Geothermal Resources Act*, California Public Resource Code S. 6901-6925.2.

	A Prospecting Permit gives the exclusive right to explore an area for two years with a possible two-year extension. Prospecting Permits can be issued to the first qualified applicant (for lands that have not been selected for competitive public bid). If the permit holder discovers geothermal resources in commercial quantities within their prospecting permit area, they are entitled to a lease for production.[65] Rental fees for a prospecting permit prior to drilling a well are $1/acre for Year 1, not more than $5/acre for Year 2, and not more than $25/acre for Years 3 and 4. Permits are available for a maximum of four years. The primary term for a lease is 10 years, with extension.
Royalties	For production from a site established under a prospecting permit, royalties of not less than 10% of the gross revenue are charged at the point of delivery to the purchaser.[66] For competitive bidding lease royalties are not more than 16 $^{2}/_{3}$ % of the gross revenue at the point of delivery to the purchaser.[67]

3.3 Nevada

Resource potential and installed capacity	Nevada has issued the most number of leases for geothermal energy development in the United States. There are 55 existing leases covering over 4909 km^2.[68] As of 2010, Nevada had 433.4 megawatts of installed capacity and approximately 3700 MW of capacity in development.[69] In 2010, there were 19 geothermal plants, at 11 different locations.[70]
Definition of geothermal resource	The Nevada Revised Statutes define geothermal resources as "the natural heat of the earth and the energy associated with that natural heat, pressure and all dissolved or entrained minerals that may be obtained from the medium used to transfer that heat, but excluding hydrocarbons and helium."[71]
Resource ownership, rights issuance	In Nevada the surface owner is the presumed owner of geothermal resources, unless it has otherwise been "reserved or conveyed to another person"[72] under the Stock-Raising Homestead Act of 1916, which granted surface lands to homesteaders, but retained the subsurface rights,

[65] Ibid., S. 6910.

[66] Ibid., S. 6913.

[67] Ibid.

[68] Witherbee, "Geothermal Leasing and Operations on BLM Managed Lands."

[69] Jennejohn, *U.S. Geothermal Power Production and Development Update.*

[70] Nevada Commission on Mineral Resources, Division of Minerals, "Nevada Geothermal Resources/Production." http://minerals.state.nv.us/ogg_nvgeorespro.htm

[71] "Geothermal Resources," Nevada Revised Statutes 534A.010.

[72] "Underground Water and Wells," Nevada Revised Statutes 534.050.

and tenure	or from subsequent sale. Geothermal development is regulated by the Nevada Commission on Mineral Resources.[73] Applicants apply for geothermal tenure from the Commission. A permit to drill or operate a geothermal well will be issued if the application is deemed consistent with policies to protect air, water and wildlife.[74] The permit is issued for two years but may be extended upon request.[75] A permit from the Commission is required to drill or operate a geothermal well. Other aspects of geothermal development are regulated by other state agencies: water appropriation permits for a geothermal flash system are required from the Division of Water Resources, sewage disposal permits are required from the Bureau of Health Protection Services, and water injection permit are required from the Division of Environmental Protection.[76] An initial fee of $200 to $500 is required for the permit to drill industrial or commercial wells. Additional fees are required annually and/or based on the depth of the well.[77] A minimum bond of $10,000 is required for each well that is drilled or operated. Some counties have regulations and fees related to well drilling. Specific requirements depend on the county.
Royalties	Geothermal operators must pay tax at a varying rate that is dependent on the ratio of the net proceeds to the gross proceeds.[78]

3.4 British Columbia

Resource potential and installed capacity	One study suggests there is a potential of 1070 MW from the top six geothermal energy sites in British Columbia, but more studies are needed to estimate the full potential of geothermal resources.[79] The Canadian Geothermal Energy Association has estimated that there is a minimum of 5000MW in western Canada, but encourages greater geoscience data collection.[80]

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[73] Nevada Commission on Mineral Resources, Division of Minerals, *Energy Resource Permitting in Nevada* (2007). http://minerals.state.nv.us/forms/ogg/_EnergyResourcePermittingInNV.pdf

[74] "Geothermal Resources," Nevada Revised Statutes 534A.070.

[75] Ibid.

[76] Nevada Commission on Mineral Resources, Division of Minerals, *Energy Resource Permitting in Nevada*.

[77] "Geothermal Resources," Nevada Revised Statutes 534A.

[78] "Taxes on Patented Mines and Proceeds of Minerals," Nevada Revised Statutes 362.140.

[79] BC Hydro, Green and Alternative Energy Division, *Green Energy Study for British Columbia* (2002) http://www.bchydro.com/planning_regulatory/energy_technologies/green_energy_research.html

[80] Personal communication, Alison Thompson, Canadian Geothermal Energy Association, January19, 2011.

	One production lease has been issued (South Meager Geothermal Project), which has the potential of 100 MW of electricity production. A flow test of the wells has been completed (where electricity was generated but not hooked to the grid), but no commercial production is occurring as of 2010.[81] After a seven-year pause in rights allocation while the government reviewed policies, four new parcels were made available for tenure in 2010.[82]
Definition of geothermal resource	The Geothermal Resources Act of 1982 defines a geothermal resource as "the earth's natural heat and all substances that get added value from it, including steam, water, water vapour and any dissolved substances."[83] Surface hot springs that have a temperature greater than 80°C at the surface are considered a geothermal resource, but waters less than 80°C are excluded. The original geothermal legislation of 1973 defined geothermal as heated water, gas and steam with a temperature higher than 121°C at the lowest locations underground. This act did not include any leasing regulations. It also included minerals that "may be obtained from the geothermal resource or be obtained by means of geothermal resource". This very open definition led to conflicts with the Mineral Act. To address this, the Geothermal Resources Act was created in 1982.[84]
Resource ownership, rights issuance and tenure	The geothermal legislation in B.C. is modeled on the petroleum and natural gas legislation when it comes to disposition of tenure. A company acquires a permit through auction, and there is no minimum bid. Land that is of interest for geothermal resources is nominated by proponents to the Ministry of Energy. Potential parcels of land undergo a referral process, where the Ministry solicits comments about the parcel from First Nations, local government and other affected agencies. This is to determine existing land uses and environmental sensitivities, and to consult land use plans. From these comments, conditions may be set on the tenure. Tenure availability is posted for six weeks prior to a sealed auction where cash bids or work bids are submitted and tenure is awarded to the highest bidder.[85]

[81] Personal communication, Garth Thoroughgood, Ministry of Energy, October 17, 2010.

[82] B.C. Ministry of Energy, "Notice of Public Tender: Competition For The Right To Explore Crown Geothermal Resources," October 26, 2010. http://www.empr.gov.bc.ca/Titles/OGTitles/geothermal/Pages/SaleNoticeOctober2010.aspx

[83] Government of British Columbia, *Geothermal Resources Act* (1996).

[84] A.M. Jessop, M. Ghomshei and M. Drury, "Geothermal Energy In Canada," *Geothermics* 20 (1991):369.

[85] Garth Thoroughgood, "Geothermal Energy in British Columbia," (presented to the B.C. Sustainable Energy Association, February 16, 2009).

	Exploration permits are for one year and can be extended for up to eight years. A permit carries an obligation to explore for geothermal resources, and gives the holder the right to apply for authorization to drill wells. After a well has been drilled and a plan for production submitted, this can be extended to a lease for 20 years with many renewals. Geoscience exploration (such as drilling a test hole) does not require subsurface rights or land tenure (but does require a geophysical licence). The average auction price for geothermal tenure is $3/ha (versus $2400/ha for oil and gas).[86] The Geothermal Resources Act does not address problems that may arise from overdevelopment (such as restrictions on the rate of production or conflicts that may arise from multiple development of a single reservoir).[87] The fee for the issuance or renewal of a permit is $500. Yearly rent for a permit is $1/ha for Years 1 to 3, $2/ha for Years 4 to 5, $4/ha for Years 6 to 7, and$5/ha for Years 8+.[88] A lease can be issued after a permit holder drills a geothermal well and submits a development plan for the location of a well. A lease is given for 20 years and can be renewed. The fee for issuance of a lease is $200. Yearly rent is $10/ha.[89] In 2008, in response to a large increase in requests for geothermal tenure, the government struck a Geothermal Task Force to examine whether change to the tenure system was required in B.C.[90] The Task Force was in discussion with industry players, who highlighted that accessibility to Crown land for exploration purposes was difficult, and made requests for fiscal and non-fiscal incentives to support a geothermal industry.[91] Despite this process, the government has made no major changes to legislation and regulation in the short term.[92] The province did make tenure available in four areas of the province where there was existing interest in geothermal resources.[93]
Royalties	There is currently no royalty system in place in B.C. While the B.C. government feels it is necessary to have public benefit

[86] Personal communication, Garth Thoroughgood, Ministry of Energy, October 17, 2010.

[87] Jessop et al, "Geothermal Energy In Canada."

[88] Government of B.C., *Geothermal Resources Administrative Regulation*, Reg. 132/83 O.C. 623/83 ().

[89] Ibid.

[90] B.C. Energy, Titles Division, "Information Letter 08-09: Geothermal." http://www.empr.gov.bc.ca/Titles/OGTitles/InfoLetters/IssueDate/Pages/TITLES-08-09.aspx

[91] B.C. Energy, Titles Division, "Information Letter 09-01: Geothermal Update." http://www.empr.gov.bc.ca/TITLES/OGTITLES/INFOLETTERS/ISSUEDATE/Pages/TITLES-09-01.aspx

[92] Thoroughgood, "Geothermal Energy in British Columbia."

[93] B.C. Energy, Titles Division, "Information Letter 09-01: Geothermal Update."

	for the use of a public resource, they feel an overly onerous royalty system could kill a new industry.[94] When production begins, the Ministry will likely set up a one-time agreement temporarily until they can evaluate the effect of the royalty. Options for designing a royalty system include net profit royalty, similar to an existing royalty program for oil and gas,[95] which charges no or minimal royalties until a proponent starts making profits on sale of a resource. Royalties would either be charged on transmission of power at the grid connection or measured as flow coming out a well.

3.5 Australia

Resource potential and installed capacity	Australia has 0.2 MW capacity installed geothermal at the time of writing this report.[96] This is not a significant part of Australia's energy mix, but this could change in the future given rising public and private interest in geothermal energy development and new government policies promoting research and development. It is estimated that geothermal could supply 2200 MW of base-load capacity by 2020 based on current government policies.[97] Since 2001, 48 companies have applied for 386 licences for various geothermal exploration and development projects covering 360,000 km^2.[98] Australia's geology is suitable for EGS, low temperature systems and direct use projects.
Definition of geothermal resource	Definitions depend on the state or territory within Australia. Some states such as New South Wales, and Tasmania define geothermal resources as a mineral. Other states have specific legislation for geothermal resources, such as Victoria and Queensland where geothermal energy is "heat energy derived from the earth's natural (subsurface heat)."[99]
Resource ownership, rights issuance	Geothermal legislation and regulation is unique to each of the states and territories in Australia. The legislation in these six states is described below.[100]

[94] Personal communication, Garth Thoroughgood, Ministry of Energy, October 17, 2010.

[95] Government of British Columbia, *Petroleum and Natural Gas Act Net Profit Royalty Regulation*, Reg. 98/2008 O.C. 281/2008.

[96] Australia Resources, Energy and Tourism, *Australian Geothermal Industry Development Framework* (2008). http://www.ret.gov.au/energy/clean_energy_technologies/energy_technology_framework_and_roadmaps/hydrogen_technology_roadmap/Documents/GEOTHERMAL%20FRAMEWORK.pdf

[97] Ibid.

[98] Australian Geothermal Association Inc., "Australian Projects Overview." http://www.agea.org.au/geothermal-energy/australian-projects-overview/

[99] Government of Queensland, *Draft Geothermal Energy Act* (2010).

[100] Andre Dauwalder, "Australia: Geothermal Energy in Queensland and Australia," Mondaq, October 5, 2009, http://www.mondaq.com/australia/article.asp?articleid=87074; South Australia Primary Industries and Resources,

and tenure	**Queensland** regulates geothermal energy under the Geothermal Exploration Act of 2004. The Act will be replaced by the Geothermal Energy Act[101] in 2011 which is intended to be more comprehensive legislation covering both exploration and production.[102] The new Act will support the goals of the Queensland Renewable Energy Plan to advance geothermal developments in the State. Currently, under the Exploration Act, a call for tenders is made and the winner is granted an exploration permit. The bids must include a proposed work program, and evidence that the applicant has the technical and financial resources to carry out the proposed work. The permit holder is required to conduct geothermal exploration and report on the resources to the State.[103] Other parcels for land can be accessed through application, provided that is it not in a restricted zone. Permits are granted for a maximum of five years and can be renewed for up to three years.[104] The initial permit fee is $1,150.[105] **New South Wales** took a different approach than Queensland by incorporating geothermal provisions into the state Mining Act of 1992, by including geothermal resources as a mineral.[106] Geothermal tenure can be issued based on a company's request on first-come, first-served basis, or as a result of tender of designated mineral allocation areas.[107] The state issues an exploration licence that gives the holder the right to explore for the minerals for up to five years (and can be renewed for up to five years). If the exploration proves positive, an assessment lease is

"Geothermal Energy: Royalties and Fees." http://www.pir.sa.gov.au/geothermal/investing_in_sa/royalties_and_fees; Australia Resources, Energy and Tourism, *Australian Geothermal Industry Development Framework*.

[101] Government of Queensland, *Draft Geothermal Energy Act* (2010).

[102] Queensland Mines and Energy, Queensland Geothermal Legislation Proposed Changes Fact Sheet. http://www.dme.qld.gov.au/Energy/geothermal_energy.cfm; Queensland Mines and Energy, "Mines Legislation and Policy," 2010. http://www.dme.qld.gov.au/mines/mines_legislation_policy.cfm

[103] Government of Queensland, *Geothermal Exploration Act* (2004).

[104] Ibid.

[105] Government of Queensland, *Licenses, Permits and Royalties*.

[106] Government of New South Wales, *Mining Act* 1992 No. 29.

[107] Personal communication, Melanie Brown, Government of New South Wales, Australia.

[108] Dauwalder, "Australia: Geothermal Energy in Queensland and Australia."

[109] Government of Victoria, *Geothermal Energy Resources Act and Regulations* (2005).

[110] Government of Victoria, *Geothermal Energy Resources Act* (2005), S. 18..

[111] Ibid., S. 20.

[112] South Australia, *Petroleum and Geothermal Energy Act* (2000).

[113] Dauwalder, "Australia: Geothermal Energy in Queensland and Australia."

[114] Western Australia, *Petroleum and Geothermal Energy Act* (1967).

[115] Dauwalder, "Australia: Geothermal Energy in Queensland and Australia."

[116] Government of Tasmania, *Mineral Resources Development Act* (1995).

[117] Dauwalder, "Australia: Geothermal Energy in Queensland and Australia."

issued to evaluate the extent of the resource. Companies must pay a security bond, reach an agreement with the landowner for surface access (including compensation for damages) and demonstrate their financial and technical ability to carry out the project.[108]

Victoria has specific legislation for high-end geothermal resources (more than 70°C at a depth of 1000 m) under the Geothermal Energy Resources Act.[109] Lower-temperature resources are regulated under existing planning and environmental laws. Applications from proponents are accepted for established parcels of land.[110] Competing applications are evaluated on the merits of the work program proposed, the benefit for society, and the social and environmental impacts of exploration.[111]

Exploration permits (to explore in an area) can last up to 15 years.

Retention leases (for discovered but not yet commercial projects) and extraction leases (to produce geothermal resources) can also both last up to 15 years.

South Australia regulates geothermal development under the Petroleum and Geothermal Act.[112] A call for tenders is put out for areas that have a potentially high-value resource. Lower-value resource areas require only an application for exploration. The following types of licences are issued: exploration licences (five years), retention licences (five-plus years), production licences, pipeline licences, preliminary and speculative survey licences (one year) and associated facilities licences. More than one exploration or production licence may be issued for petroleum and geothermal for the same parcel. An applicant must submit a work bid (commitment to spend a certain amount on exploration) and prove technical and financial resources to complete the work.[113]

Western Australia regulates geothermal resources under existing petroleum legislation.[114] The act covers the process for exploration permits (six years), specific prospecting authorities, access authorities, drilling reservations, retention leases (five years) and production licences (21 years). Like South Australia, different licences may be issued in an area for different resources (geothermal and petroleum).[115]

Tasmania regulates geothermal development (greater than 70°C and below 1000 m) under the Mineral Resources Development Act.[116] Companies must apply for areas that they want to explore and geothermal tenure is granted as a "Special Exploration Licence." The Act provides for a number of different licences, including exploration licences (issued for up to 15 years), retention licences (up to 15 years), prospecting licences and mining leases.[117]

Royalties	In South Australia, Tasmania and Western Australia, the royalty rate for geothermal energy is 2.5% of the value at the wellhead.[118] In New South Wales, the royalty rate is 4% of the value of recovered resource.[119] Victoria charges a varying rate of royalty agreed upon in the lease conditions.[120]

3.6 New Zealand

Resource potential and installed capacity	New Zealand has an abundance of premium high-temperature geothermal systems. In 2010, there were 4,000 MW of installed capacity with an additional 1,100 MW of high temperature resources available.[121] Geothermal energy is primarily for electricity generation, but is also extensively used for direct use purposes. 90% of New Zealand's primary geothermal energy development is found in one region (Waikato),[122] however there are also significant resources in other regions.
Definition of geothermal resource	The Resource Management Act (1991) defines geothermal energy as "energy derived or derivable from and produced within the earth by natural heat phenomena; and includes all geothermal water." Geothermal water is defined as "water heated within the earth by natural phenomena to a temperature of 30 degrees Celsius or more; and includes all steam, water, and water vapour, and every mixture of all or any of them that has been heated by natural phenomena."[123]
Resource ownership, rights issuance and tenure	Existing geothermal licences distributed under the former Geothermal Energy Act of 1953 were converted to water permits when the Resource Management Act came into effect in 1991. Under the new Act, resource allocation and the management of development are handled by regional governments. Each region develops a Regional Policy Statement and a Regional Plan as an integrated framework for all development, including geothermal.[124]

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[118] South Australia Primary Industries and Resources "Geothermal Energy: Royalties and Fees." http://www.pir.sa.gov.au/geothermal/investing_in_sa/royalties_and_fees; Australia Resources, Energy and Tourism, *Australian Geothermal Industry Development Framework*.

[119] Government of New South Wales, *Mining Regulations* (2003).

[120] Government of Victoria, *Geothermal Energy Resources Act* (2005), S. 103.

[121] Colin Harvey et al. "2005–2010 New Zealand Country Update," in *Proceedings of the World Geothermal Congress 2010* (Bali, Indonesia, April 25-30, 2010). http://www.nzgeothermal.org.nz/Publications/2005-2010-New-Zealand-Country-Update_0168.pdf

[122] Environment Waikato, *Operative Waikato Regional Policy Statement* (2000).

[123] Government of New Zealand, *Resource Management Act* (1991).

[124] Ibid., S. 88.

	In Waikato, the Regional Policy Statement divides geothermal resources into hydrologically distinct management units known as Geothermal Systems. Systems are classified as Large (up to 350 °C) and Small (less than 100 °C). Systems are also classified for future development potential according to vulnerability of significant features to development and the level of existing use. There are four system categories: Development, Limited Development, Protected, and Research (systems where insufficient information is available to classify).[125] Proponents interested in a new development file a Resource Consent Application which is assessed by both regional and territorial local authorities. This application must include a System Management Plan that describes how the proponent will manage the reservoir, mitigate surface effects, avoid damage to significant features, and monitor and report data.[126] When there is more than one operator in a system, protocols must be in place to divide responsibility for system management between the operators. The rights to geothermal tenure are distributed through the allocation of water withdrawals (known as Takes) and Discharges, which are regulated for each category of geothermal system.[127] Takes and discharges are issued for 10 to 35 years.[128]
Royalties	No royalty rates are charged today.[129] In contrast to other jurisdictions, New Zealand has actually used a heavy royalty regime in the past to create a disincentive to production, in response to declining reservoir pressures and depletion of geothermal resources. Operators that used re-injection or heat exchangers received a reprieve from the high royalty rates, in order to incent the switch to more sustainable production methods. This royalty regime was repealed after improvements in pressures were seen.[130]

[125] Environment Waikato, *Operative Waikato Regional Policy Statement*.

[126] Environment Waikato, “Waikato Regional Plan.” http://www.ew.govt.nz/policy-and-plans/Regional-Plan/Waikato-Regional-Plan/#geothermal

[127] Ibid.

[128] Personal communication, Jim Lawless, Sinclair Knight Merz, December 9, 2010.

[129] Personal communication, Jim Lawless, Sinclair Knight Merz, December 9, 2010 and Chris Bromley, GNS Science, December 9, 2010.

[130] Brett O'Shaughnessy, “Use of economic instruments in management of Rotorua geothermal field, New Zealand” *Geothermics* 29 (2000): 539.

3.7 Italy

Resource potential and installed capacity	Italy is the fifth-largest geothermal electricity producer in the world with an installed capacity of 843 MW.[131] Italy is the oldest producer of geothermal energy; the world's first geothermal power plant was constructed in1911 in Larderello, Tuscany. There are two major geothermal areas in Italy, producing high temperature steam. Geothermal power produces 1.8% of the country's electricity, and 25% for the Tuscany region.[132]
Definition of geothermal resource	A new law, Legislative Decree, was approved on February 15, 2010, providing rules for exploration and production of geothermal resources in Italy. The general provisions of that law are as follows. 1. Exploration and production of geothermal resources for energy purposes made in Italy, its territorial seas, and on its continental shelves, are considered in the public (*national community*) **interest** (*importance*) and public *(national community*) **utility** (*usefulness*). 2. In accordance with the effects of this law, geothermal resources are defined as being in one of three categories: a. high-enthalpy, characterized by fluid temperatures above 150°C; b. medium-enthalpy, characterized by fluid temperatures between 90°C and 150°C; c. low-enthalpy, with fluid temperatures < 90°C. 3. High-enthalpy geothermal resources, or that which are economically usable for the construction of a geothermal project ensuring certified power output of at least 20 MW, are of national interest, as well as those geothermal resources found in marine areas which are economically usable. 4. Medium- and low-enthalpy geothermal resources, or that which is economically usable for the construction of a geothermal project of power less than 20 MW geothermal fluid, are of local interest.[133]
Resource ownership, rights issuance	The authorities responsible for issuance of exploration permits and production licences relating to geothermal resources, including the functions of monitoring the application of the rules of mining

[131] Geothermal Energy Association, *Geothermal Energy: International Market Update* (2010).

[132] G. Cappetti et al., "Geothermal Power Generation in Italy 2005–2009 Update Report," in *Proceedings of the World Geothermal Congress 2010* (Bali, Indonesia, April 25-30, 2010).

[133] Personal communication, Fausto Batini, January 31, 2011.

and tenure	regulations, are the Ministry of Economic Development in cooperation with the Ministry for the Environment.[134] Administrative functions for the issuance of exploration permits and exploitation concessions have been delegated to the regional governments.[135] Exploration for, and utilization of, thermal water, meaning those waters to be used for therapeutic purposes, are excluded from regulation under this law. The injection of water and the reinjection of geothermal fluids from the same formations, or at least below aquifers usable in civil or industrial purposes, including marine area, are regionally regulated.[136] Operations and productions are regulated by the National Mining Office for Hydrocarbons and Geothermal, but also delegated to regional authoritities.
Royalties	Royalties are paid to the regional authorities. In addition to an exploitation fee a royalty is required of 0.13 euro cents per kWh of electricity produced in the geothermal field.[137]

3.8 Iceland

Resource potential and installed capacity	Iceland is at the global forefront of geothermal development. It ranks seventh in the world for overall electrical generation with 575 MW installed electrical capacity in 2010, which is an increase of 184% from 2005.[138] Iceland ranks fourth in the world for direct use, with about 6800 GW per year that provides 90% of the house heating needs in the country.[139] Most electrical development occurs on high-temperature resources, but Iceland has considerable low-temperature resources as well, and an experimental low-temperature (120°C) binary plant began production in 2008.[140]
Definition of geothermal resource	Iceland governs geothermal as a "resource" along with all other subsurface resources. A resource is defined as "any element, compound and energy that can be extracted from the Earth, whether in solid, liquid or gaseous form, regardless of the temperature at which they may be found."[141]

[134] Personal communication, Fausto Batini, January 31, 2011.

[135] International Energy Agency, *Energy Policies of IEA Countries: Italy* (2009). www.iea.org/textbase/nppdf/free/2000/italy2003.pdf

[136] US Commercial Service, *Italy: HVAC - Geothermal Heat Pump Market*

[137] Personal communication, Fausto Batini, January 31, 2011.

[138] Bertani, "Geothermal Power Generation in the World 2005–2010 Update Report."

[139] Islandsbanki Geothermal Research, *Iceland Geothermal Energy Market Report* (2010).

[140] Bertani, "Geothermal Power Generation in the World 2005–2010 Update Report."

[141] Government of Iceland, *Act on Survey and Utilization of Ground Resources* (No. 57/1998)

Resource ownership, rights issuance and tenure	In Iceland, subsurface resources are owned by the private landowner, while resources on public land are federal property. In 2008 laws were passed that disallowed public owners (the state or municipalities) to sell any land or resource that could produce more than 7 MW of power to private owners. Prior to this, private companies could buy surface land with the purpose of gaining access to high-value subsurface resources, but this is no longer the case. The resource can, however, be leased to a private development. Exploration of all subsurface resources are subject to the Act on Survey and Utilization of Ground Resources which allows the government to conduct (or issue a licence to conduct) surveying and prospecting for resources anywhere, on both public and private land. In order to gain a licence for utilization (production), a holder of a survey licence must prove there are adequate resources on the land, and must strike a deal for use with the surface owner for access. Production or use must start within three years of the issuance of the licence or it can be canceled.[142] Power plants with a capacity greater than 1 MW or that plan to distribute energy into the grid must gain a licence under the Electricity Act. Large or significant projects are subject to review under the Environmental Impact Assessment Act. Proponents of plants less than 1 MW must submit technical details of their project to the National Energy Authority in Iceland, the body which is also responsible for official monitoring of the resource. Tenure for development on public land can extend for a maximum of 65 years.[143] Iceland has developed the Master Plan for Hydro and Geothermal Energy Resources, which provides an overview on the various potential hydro and geothermal energy projects and ranks them based economic feasibility, and environmental and natural heritage impacts.[144] The plan designates resources are available for development, resources to be protected and areas for further investigation.[145] The Master Plan is a

[142] J. Ketilsson et al., “Legal Framework and National Policy for Geothermal Development in Iceland,” in *Proceedings of the World Geothermal Congress 2010* (Bali, Indonesia, April 25-30, 2010).

[143] Orkustofnun (National Energy Authority) *Geothermal Development and Research in Iceland* (2010). www.nea.is/media/utgafa/GD_loka.pdf

[144] B. Steingrímsson et al., “Master Plan For Geothermal And Hydropower Development In Iceland,” (presented at Short Course on Geothermal Development in Central America – Resource Assessment and Environmental Management, San Salvador, El Salvador, November 25–December 1, 2007). http:// www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-02-15.pdf

[145] Personal communication, Jonas Ketilsson, National Energy Authority of Iceland, January 13, 2011.

	strategic environmental assessment of geothermal energy resources and is in the process of being turned into legislation.[146]
Royalties	Iceland is currently developing a royalty system on land owned by the state and applies royalties on a case by case basis.[147]

3.9 Germany

Resource potential and installed capacity	Germany has only low-temperature resources and is thus limited to binary systems. Geothermal energy use is mainly in small plants and geothermal energy for space heating providing 144.0 MWh/yr.[148] There are three geothermal plants for power generation (two of these are combined with district heating) for a total of 6.6 MW installed in 2010.[149] Germany is actively pursuing research in EGS technologies to improve the use of their hydrological resources.
Definition of geothermal resource	Geothermal resources are considered a mineral under the federal mining laws. Geothermal heat and geothermal fluids are included under this law.
Resource ownership, rights issuance and tenure	Geothermal energy is considered a federal resource. Any drilling deeper than 100 metres is administered under the Mining Act. Exploration and production licences are required, and water protection and environmental issues are jointly dealt with by the mining authorities and environmental authorities.[150] Environmental assessments are required for all geothermal development. Rights to sub-surface area are allocated by the Minister of Energy without a depth limitation. A licence for exploration is given for a maximum of five years with the possibility of a three-year extension. If the exploration proves that a viable resource exists, a licence for production is given for up to 20 years.[151]

[146] Ibid.

[147] Ibid.

[148] R. Schellschmidt et al. “Geothermal Energy Use in Germany,” in *Proceedings of the World Geothermal Congress 2010* (Bali, Indonesia, April 25-30, 2010).

[149] Ibid.

[150] L. Rybach, “Regulatory Framework for Geothermal in Europe – with Special Reference to Germany, France, Hungary, Romania, and Switzerland,” (presented at International Geothermal Conference - Short Course, Reykjavík, Iceland, September 2003). http://www.os.is/gogn/flytja/JHS-Skjol/IGC2003ShortCourse/04Part2Rybach.pdf

[151] European Geothermal Energy Council, *Regulations for Geothermal Energy* (2003).

Royalties	Germany does not apply any royalty charges on geothermal energy, in order to support renewable energy options.[152]

[152] B. Sanner and W. Bussmann, "Current Status, Prospects and Economic Framework of Geothermal Power Production in Germany," in "Selected Papers from the European Geothermal Conference 2003," ed. F.H. Karman et. al, special issue, *Geothermics* 32 (2003). doi:10.1016/S0375-6505(03)00059-2

4. Lessons from other jurisdictions

Several key themes emerge from the jurisdictional review of legislation and policy for geothermal energy development. These themes are combined with the results of interviews with geothermal experts in the jurisdictions. For a list of interviewees, see Appendix A. These themes are categorized under the following headings: definition of geothermal energy; legislation; resource ownership; tenure and leasing system; fees and royalties; research; and fiscal and non-fiscal incentive policies.

4.1 Definition of geothermal energy

A clear definition of geothermal energy can help determine whether geothermal energy can be regulated under existing mining, petroleum or water legislation, or whether new legislation is necessary. There are multiple definitions of geothermal energy used in other jurisdictions, as shown in the jurisdiction review in Chapter 3. It has been defined as a mineral, water or as energy/heat. For example, one of the most simple and common definition is “energy stored in the form of heat beneath the surface of the Earth.”

Geothermal energy is commonly classified according to depth, temperature or end use. Other, less commonly-used parameters to define geothermal can include flow rate, pressure and installed thermal capacity.

A depth limit can be used to differentiate between shallow and deep geothermal resources. Many countries use a range of greater than 400 metres to up to 1 kilometre to define shallow geothermal.[153]

Some jurisdictions define geothermal resources by a temperature threshold. The goal of this definition may be to differentiate hot springs developments from commercial geothermal operations. However, commercial energy production from lower-temperature resources is increasingly feasible with advances in technology.[154]

For example, in B.C, the definition of geothermal resources excludes waters at the surface with a temperature of less than 80°C. In the state of Victoria in Australia, geothermal is defined as 70°C or 1 km of depth, whichever is first. A definition of geothermal resources based on surface temperature alone may exclude valuable resources that are at a higher temperatures at depth.

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[153] S. Haehnlein, P. Bayer, P. Blum, “International Legal Status of the Use of Shallow Geothermal Energy” *Renewable and Sustainable Energy Reviews* 14 (2010):2611; Personal communication, Barry Goldstein, Dept. Primary Industries, South Australia, December 15, 2010.

[154] Jessop et al, “Geothermal Energy In Canada.”

Some jurisdictions divide geothermal resources based on the technology used. This definition may create confusion or conflict as technology changes and energy production becomes even more economically viable from low-temperature resources. Although not highlighted in the jurisdictional review above, in Washington State, a geothermal resource is defined as the heat of the earth "from which it is technologically practical to produce electricity commercially."[155] This definition is flexible and does not restrict geothermal to a particular type of technology.

4.2 Geothermal legislation

The jurisdictions reviewed showed a varied approach to geothermal legislation. There are four approaches to legislation for geothermal resources as found in the jurisdictional review:

Legislation for geothermal	Jurisdiction(s)
Petroleum	South Australia, Western Australia
Mineral	Germany, Iceland, Nevada, New South Wales, Tasmania
Water	New Zealand
Geothermal-specific	B.C., U.S. federal, California, Queensland, Victoria

There are often compelling reasons for regulating geothermal under existing regulation. Because the exploration strategy for geothermal is similar to mineral exploration, it has often been classified as a mineral. Conversely, it fits well under the petroleum regime because extraction methods are similar. Because geothermal relies on water, it is often linked to the water management regulations. In addition, new legislation can be tailored to the unique impacts and benefits of geothermal energy.

Interviewees were asked if geothermal energy resources should be covered under existing legislation for other resources or if separate legislation should be developed. Several interviewees stated that is does not matter which approach is taken, as long as it is effective.[156] Effective legislation was described by interviews through its implementation; the process of issuing tenure and permits is timely, not onerous, and the responsibility of regulating agencies is clearly outlined.

Several experts interviewed in preparation of this report suggested that geothermal energy development is best managed by regulators familiar with petroleum, where the skill set and knowledge required is somewhat analogous. Oil and gas development involves drilling processes and plant operations that can be related to geothermal energy development. It is for this reason that the State of South Australia decided to link geothermal regulations with petroleum legislation and as a result did not have to expand their regulatory capacity.[157]

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[155] Government of Washington, *Geothermal Resources Act*, RCW 78.60.030 ().

[156] Personal communication, Jim Lawless, Sinclair Knight Merz, December 9, 2010; Alison Thompson, Canadian Geothermal Energy Association, January 26, 2011.

[157] Personal communication, Barry Goldstein, Government of South Australia, November 23 2010.

One interviewee suggested that geothermal energy should fit under the legislation and regulations that exist for a mature industry, whether from mining or petroleum, as the capacity, efficiency and effectiveness of the regulators' management of resources would have been tested.[158]

For shallow geothermal resources, some countries use water laws or rules for other surface activities to regulate the resources, in an effort to simplify and expedite the development of the resource. This is the case in New Zealand, where the resource is at high temperatures relatively close to the surface.

If geothermal is not regulated directly but regulated under water legislation, the difference between geothermal and water should be defined in order to avoid conflict between water legislation and geothermal legislation. For example, Nevada defines geothermal resources in terms of extractable heat resources. By separate statute, Nevada law provides that the state's water code does apply to use of fluid resources in geothermal projects, and then selectively excludes certain categories of water use (for geothermal production, followed by reinjection).

Still there are many differences between geothermal energy development and other resource developments that should be reflected in the legislation and regulations, even if geothermal energy development is linked to legislation for another resource. For example, the environmental impacts and economics are unique to geothermal energy development. Some interviewees stated that new, separate legislation for geothermal energy development should be created to reflect the unique nature of the industry.[159]

Creating a separate geothermal energy act can take a long time, and in the interim, some jurisdictions choose to incorporate geothermal energy into legislation developed for another industry. In these cases separate regulations for geothermal energy may be created at a later date once the industry begins to mature. For example, in Queensland, Australia an exploration law was first created and then replaced later by more comprehensive legislation relating to both exploration and production, once the industry became more established. The risk with this approach is that the interim regulations may not be adequate to begin with and may restrict development through inadequate and poorly defined rules for the specifics of geothermal energy development. Geothermal specific legislation and regulations developed from the beginning would help to avoid the problems created by trying to fit geothermal energy management into the regulations for other resource developments.

4.3 Geothermal resource ownership

Ownership of geothermal resources should be defined by law. The legislation should clarify who is responsible for issuing the right to explore, develop and produce geothermal energy.

Lack of clarity on ownership can lead to conflict among surface and subsurface owners, as well as delays for project companies that can affect their ability to attract and maintain investors. Interviewees cited lack of certainty of resource ownership as a barrier to geothermal energy

[158] Personal communication, Mory Ghomshei, University of British Columbia, November 10 2010.

[159] Personal communication, Tim Sadlier-Brown, Sadlier-Brown Associates, November 1, 2010, and Gary Thompson, Sierra Geothermal Power Corp, October 17, 2010.

development in B.C.[160] Where land claims had not been settled, questions about subsurface resource ownership arose. From an industry perspective, this represents a risk that at a later date the geothermal rights issued may be repealed or no longer valid as the ownership of the resource is called into question or changed.

4.4 Geothermal tenure and leasing system

An effective, efficient and fair system for licensing exploration of geothermal is a critical first step to encouraging geothermal energy development. As noted, a barrier to geothermal energy development in other jurisdictions has been uncertain or ill-defined rules and timelines for licensing and permitting. In addition, where multiple agencies are responsible for permitting, the process can be confusing and time consuming.[161]

One approach to permitting geothermal energy developments is to provide a single window for project applications so that the company does not have to apply to separate agencies for different permits. A single agency would be responsible for coordinating public consultation and government agencies' reviews. In South Australia, for example, all companies must submit a Statement of Environmental Objectives, which outlines the type of activities they will conduct, the risks associated with the activities and what mitigation they will implement. This document is submitted to all of the regulating agencies and to the general public, and all parties have an opportunity to comment on the specific proposed activities and mitigation.[162] The approach in Australia has been to place strong emphasis on policies for right issuance and resource mapping and to streamline regulations as a means of encouraging geothermal exploration.

4.4.1 Leasing system

An application process for geothermal energy leasing must be developed. Guidelines should be developed that identify the resource owner, leasing rules, and the application process including work commitments, technical inputs, and financial and reporting requirements. Similarly, a plain language version should be developed that outlines for stakeholders the regulations for geothermal energy exploration and development, and opportunities for public consultation.

Bidding and staking processes are both used in other jurisdictions to issue geothermal energy rights. When asked for their opinions on which process is most effective, interviewees gave varying responses. There are advantages to both systems, and several people stated that both systems can work, provided they are fair.[163]

- A bidding system can help guarantee that a company has the financial resources to conduct the exploration activities needed to delineate the resource. Bidding processes can, however, be time consuming and may not be appropriate to the level of demand. It

[160] Personal communication, Gary Thompson, Sierra Geothermal Power Corp, October 17, 2010, Mory Ghomshei, and Tim Thompson, Borealis GeoPower, December 1, 2010.

[161] Elizabeth Doris, Claire Kreycik and Kathleen Young, *Policy Overview and Options for Maximizing the Role of Policy in Geothermal Electricity Development,* (National Renewable Energy Laboratory, 2009). http://www1.eere.energy.gov/geothermal/pdfs/policy_overview.pdf

[162] Personal communication, Barry Goldstein, Dept. Primary Industries, South Australia, December 15, 2010.

[163] Personal communication, Mory Ghomshei, University of British Columbia, November 10, 2010.

can also increase the financial risk that a company has to bear before they have fully explored the resource potential.[164] Bidding processes exist in the U.S., B.C. and Australia. The bidding process was identified as a barrier to geothermal energy development in B.C. because it is onerous to administer.[165] A schedule of regular postings of geothermal leases was cited as an important component of a bidding process so that industry can incorporate the timing into their planning.[166]

- An application process, similar to staking for mineral rights, was suggested as more appropriate for geothermal energy development by some interviewees.[167] In advance of an application, a proponent would have to do preliminary work in geological mapping and geophysical studies. The proponent's application would be assessed based on their technical and financial ability to do the work. An application process is used for non-competitive lease sales on federal U.S. land, and state land in California. In Australia, several states compare the applicants, and competing applications are evaluated on the merits of the work program proposed and the benefit to society.

Regardless of the system used, the successful company should have requirements to conduct work, report on the resource, and prove their financial and technical capabilities. The conditions of leasing should include work commitments and a requirement to supply data to governments about the resource through exploration (after a blackout period) as is often required of subsurface exploration conducted by other industries.[168] Several interviewees suggested that where data requirements are not mandated, data acquisitions should be mandatory for all industries that conduct subsurface exploration.[169] In New Zealand, while large utility companies conducted much of the exploration of geothermal resources in the country, unfortunately geoscience data was not collected by the government for public policy purposes.[170]

4.4.2 Licensing authority

The licensing authority for geothermal energy could be the same government agency that is responsible for other subsurface resources.

The capacity and knowledge of regulators to manage geothermal energy development was raised by interviewees. In New Zealand and Italy, where the responsibility to manage resources fell to the regional governments, lack of expertise to properly manage the resource was mentioned as a

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[164] Personal communication, Tim Thompson, Borealis GeoPower, February 7, 2011.

[165] Personal communication, Tim Sadlier-Brown, Sadlier-Brown Associates, November 1, 2010; Craig Dunn, Borealis GeoPower, December 1, 2010 and Alison Thompson, Canadian Geothermal Energy Association, January 26, 2011.

[166] Personal communication, Alison Thompson, Canadian Geothermal Energy Association, January 26, 2011.

[167] Personal communication, Chris Bromley, GNS Science, November 13, 2010, Tim Sadlier-Brown, Sadlier-Brown Associates, November 1, 2010, and Tim Thompson, Borealis GeoPower, December 1, 2010.

[168] Personal communication, Jim Lawless, Sinclair Knight Merz, December 9, 2010, and Kermit Witherbee, Bureau of Land Management, December 10, 2010.

[169] Personal communication, Craig Dunn, Borealis GeoPower, December 1, 2010 and Alison Thompson, Canadian Geothermal Energy Association, January 20, 2011

[170] Personal communication, Jim Lawless, Sinclair Knight Merz, December 9, 2010.

limitation of their regulatory model.[171] Alternatively, geothermal resources managed at a more central level was recommended as the regulator would be more informed of the specific of the geothermal development process and nature of the industry. One interviewee suggested that where there is lack of knowledge or capacity of governments about geothermal resources, a panel of experts could be created to evaluate upcoming projects (including the details on exploration data) and provide advice to governments.[172]

4.4.3 Timelines for leasing and permitting

Delays in the leasing and permitting process in B.C. and the U.S. were cited as barriers to advancements in geothermal energy exploration and development.[173] The geothermal industry depends on investors, who offer conditional financing. If a permitting process takes too long, project financing can be jeopardized. To avoid this, the licensing and permitting process should have clear regulatory deadlines. This would help create certainty and clarity for developers and investors, and reduce risk of their investments. In South Australia, the one-window application process takes an average of four months.[174] In comparison the leasing and permitting process in British Columbia has taken several years.[175]

4.4.4 Existing land uses and planning

The tenure system grants licencees exclusive rights to explore for and produce geothermal resources in a given area. It is critical that this issuance should take into consideration surface uses and other subsurface mineral rights, and ensure that there are no conflicts with existing land uses.

Land claims, land use plans, and other existing land or water policy or laws can be used to guide which areas are open to geothermal energy. They can help to identify and map the areas that are off-limits for cultural, ecological or other reasons, as well as specify the type or amount of development that is acceptable in a region.

As a complement to land use planning, strategic assessments of geothermal energy development can be used to identify the areas open for geothermal development and the conditions to maximize benefits to the public and minimize environmental impacts. In Iceland, the strategic environmental assessment approach taken through the Master Plan is a way for governments to evaluate economic and environmental impacts of potential projects and regions for development

[171] Personal communication, Jim Lawless, Sinclair Knight Merz, December 9, 2010, and Ruggero Bertani, Enel Green Power, October 20, 2010.

[172] Personal communication, Chris Bromley. GNS Science, November 13, 2010.

[173] Tim Thompson and Craig Dunn, *Policy Recommendations for Advancing Geothermal Energy in Canada*; Doris, Kreycik and Young, *Policy Overview and Options for Maximizing the Role of Policy in Geothermal Electricity Development*; Personal communication, Tim Sadlier-Brown, Sadlier-Brown Associates, November 1, 2010, and Gary Thompson, Sierra Geothermal Power Corp, October 17, 2010.

[174] Personal communication, Barry Goldstein, Dept. Primary Industries, South Australia, December 15, 2010.

[175] Personal communication, Alison Thompson, Canadian Geothermal Energy Association, January 20, 2011, Craig Dunn, Borealis GeoPower, December 1, 2010, and Gary Thompson, Sierra Geothermal Power Corp, October 17, 2010.

and identify the highest priority areas for development.[176] The Programmatic Environmental Impact Assessment (PEIS) completed in the western U.S. is another example of such a process. The assessment evaluated the potential environmental impacts, evaluated reasonable alternatives, and looked at the potential cumulative impact of geothermal tenure issuance. This assessment does not preclude the requirement for an individual project assessment, but it can help to provide a template for assessing the impacts and considering cumulative impacts. The PEIS also amended regional land use plans in western states, many of which had not previously addressed the geothermal energy potential.[177] In the Western U.S., where different regulatory requirements exist for BLM, Forest Service and Tribal lands, the PEIS helped to streamline the leasing of rights of geothermal energy development and encouraged interagency coordination and public private partnerships in geothermal projects.[178]

4.4.5 Length of licence

In the jurisdictions reviewed, the granting period for geothermal exploration licences is one or two years, with renewal options. The length of time for geothermal development permits ranged from five to 20 years, with extension options. The length of an exploration licence and development permit should take into consideration the seasonal timing for activities and physical access to the land. An exploration permit does not necessarily provide surface access and time to acquire this should also be considered.[179]

4.5 Geothermal fees and royalties

The licensing fees and royalties for geothermal energy exploration and development are generally lower than for petroleum and mining. This can be justified because of the renewable nature of the resource, the lower rate of return for geothermal energy developments as compared to other natural resources, and often because governments desire to promote geothermal energy as a sustainable energy option.

Royalty fees have been applied in some jurisdictions and not in others. In some cases, the royalty rates for mineral or petroleum development are applied to geothermal, especially if geothermal fits under existing legislation. This can create a barrier to geothermal development, as has been proven in other jurisdictions.[180] Other governments have not set royalty rates, justified on the basis that the resource is renewable and development contributes to achieving national renewable energy targets set out through government policy or plans.[181] Two interviewees suggested that it is appropriate for royalty and/or fees to cover the costs for regulators to administer the

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[176] Orkustofnun, Iceland National Energy Authority, "Master Plan for Hydro and Geothermal Energy Resources in Iceland," http://www.nea.is/geothermal/master-plan/

[177]Personal communication, Kermit Witherbee, Bureau of Land Management, December 10, 2010.

[178] Doris, Kreycik and Young, *Policy Overview and Options for Maximizing the Role of Policy in Geothermal Electricity Development*

[179] Personal communication, Alison Thompson, Canadian Geothermal Energy Association, January 20, 2011.

[180] Personal communication, Tim Thompson, Borealis GeoPower, December 1, 2010.

[181] R. Goodman et al., "GTR-H: Geothermal Legislation in Europe," in *Proceedings of the World Geothermal Congress 2010* (Bali, Indonesia, April 25-30, 2010).

regulations.[182] In South Australia, companies are not required to pay royalties until projects are profitable. Royalty rates are applied to gross revenue and companies can deduct their expenses.[183]

It may be appropriate to apply different royalty rates based on the type of output (electricity or heat), the quality of the resource, or the technology employed to reflect the different economic profiles. Another approach would be to apply royalties to larger projects that are likely to be economic, for example by applying a royalty rate to projects that produce more than 10 MW of electricity.[184]

Royalties and fees could be phased in over time, or royalty holidays could be applied as a form of financial incentive to encourage exploration and development. The decision to apply royalties needs to be balanced within the wider government policy framework that includes fiscal and non-fiscal incentives (see section 4.7).

4.6 Geothermal research

Governments can contribute to geothermal energy development by establishing geoscience programs to define geothermal energy resources. Through resource mapping, governments can provide advice to the industry on where to explore to reduce the risk and ensure a higher likelihood of drilling success, which can lower project costs and therefore lower energy costs.[185] Quality resource mapping includes defining three components of the resource: the subsurface temperature, fluid and permeability.[186]

In support of public geoscience data, governments can require that data from all future wells (water, gas, oil, geothermal and other) be submitted to a central data agency so that the information can be publicly accessible.[187] This role in Canada has been filled by the Geological Survey of Canada, which conducted much geological mapping through its geothermal programs in the 1970s and 1980s; however, the program was later cut due to financial constraints within the government.

4.7 Fiscal and non-fiscal incentive policies

Governments around the world, recognizing the value and need for energy security and emissions reductions, are developing policy for fiscal and non-fiscal incentives to support the development of the geothermal industry.

[182] Personal communication, Tim Sadlier-Brown, Sadlier-Brown Associates, November 1, 2010, and Jim Lawless, Sinclair Knight Merz, December 9, 2010.

[183] Personal communication, Barry Goldstein, Dept. Primary Industries, South Australia, December 15, 2010.

[184] Personal communication, Mory Ghomshei, University of British Columbia, November 10, 2010.

[185] Personal communication, Tim Sadlier-Brown, Sadlier-Brown Associates, November 1, 2010, and Mory Ghomshei, University of British Columbia, November 10, 2010.

[186] Personal communication, Alison Thompson, Canadian Geothermal Energy Association, January 26, 2011.

[187] Personal communication, Craig Dunn, Borealis GeoPower, December 1, 2010.

Other jurisdictions demonstrate a range of approaches for approaching incentive policy development, depending on the maturity of the industry and the quality of the resource.

In jurisdictions where resources are lower quality or the industry is new, government policies can be designed to encourage development and reduce the considerable risk from exploration and drilling. Incentives can also be used to enable the fullest use of the resource.

Some examples of fiscal incentives include:

- Drilling grants – Government grants for companies to drill exploratory wells to delineate geothermal energy resources
- Research grants – Grants to delineate the resource or develop a new technology
- Renewable energy targets (also called Renewable Portfolio Standards) – Governments set a mandated proportion of electricity generated from renewable sources and encourage utilities to sign purchase power agreements for geothermal power
- Insurance policy – Tax breaks or another form of reimbursement for unsuccessful wells
- Flow-through credit scheme – Tax incentives for investors' contribution to geothermal developments
- Feed-in tariff – Guaranteed purchase price for the output energy generated by geothermal
- Production incentive – Top-up to market rates for output energy
- Low or no royalty rates
- Royalty holidays or phased royalties
- Low or no fees for land access and/or permits
- Loan guarantees – Government guarantees to investors that a loan will be repaid if the company defaults on it
- Carbon credit systems – Can induce investment in geothermal technologies as a greenhouse gas reducing technology
- Public-private partnerships – Cost sharing in public-private partnerships can defray risk

Some examples of non-fiscal incentive policies include:

- Public education (e.g., information on websites and other government-produced publications)
- Education and training (e.g., certificate or degree programs specializing in geothermal energy development)
- Infrastructure (e.g., roads, transmission lines)
- Technology research and development – Government-supported research to demonstrate new technologies and encourage technology transfer from other industries for geothermal energy development

Many governments apply a variety of fiscal and non-fiscal incentives to advance geothermal energy development. Although outside the scope of this report, further analysis of the impacts of policies and incentives that target geothermal is needed so that governments can choose appropriate mechanisms to reduce barriers and foster geothermal development.

Government policy in other jurisdictions in the world has reflected the type of geothermal resource, the technology employed, the size of the project, the economics of the geothermal industry, the end use of the power or heat, and the desire of governments to see it developed. This has been echoed by the jurisdictional review and interviews conducted for this report. In all cases, key activities to develop a policy framework include defining the resource, establishing the legislative framework, creating the rules for rights issuance, exploration and production activities, and forming a fiscal framework.

5. Recommendations

This report presents the results of an inter-jurisdictional review of geothermal policy in nine jurisdictions, and interviews with 13 geothermal experts. The results are categorized into key themes in relation to geothermal legislation, tenure issuance, royalties, research and fiscal and non-fiscal incentive policies. From these results, the following recommendations for the NWT are warranted:

Define a vision and plan for geothermal energy use in the Territory

- Geothermal energy development needs to be evaluated as a source of heat and power for communities in the NWT. The Government of the Northwest Territories could initiate a planning exercise to define a vision for geothermal energy use in the Territory. The planning exercise, conducted in partnership with relevant organizations and government agencies, would help to evaluate the areas for potential development, the economic and environmental impacts of potential projects, and the highest-priority areas for development. An outcome of the planning exercise would be greater clarity regarding the desire of governments to see the resource developed and the policy needs to see it happen. A geothermal energy strategy or a strategic environmental assessment could come out of the process and provide guidance on how geothermal energy resources should be developed, and how it fits with other heat and power options.

Design policy framework to reflect the unique nature of the resource

- The policy framework for geothermal energy in the NWT should reflect the nature of the resource and the desire of governments to see it developed. There is potential to develop geothermal energy for use within communities, for other industries or for export. Geothermal energy is a renewable, clean source of energy that would contribute to energy security and self-sufficiency in the NWT. The resource is currently thought to be of medium to low quality (based on available studies) and could be desirable to investors if there were a regulatory system and economic incentives in place to facilitate it.

Define geothermal energy legislation and create a clear legal definition of geothermal energy

- The legal framework for geothermal energy needs to be defined. There is no existing definition for geothermal energy in NWT, and lack of clarity on how companies or communities gain access to the right to explore or develop the resource.
- Existing natural resource legislation can be used or modified to regulate geothermal exploration and development. Geothermal energy regulation may fit under current mining or oil and gas legislation, provided that the resource is defined and that the regulations specific to geothermal energy are clear.
- Ideally, separate geothermal legislation and regulations are created that reflect the unique nature and economics of the resource.

Define geothermal resource ownership

- The ownership of the geothermal energy resources in the NWT needs to be clarified. For geothermal development on unsettled lands, the issue of ownership of subsurface rights should be clarified before issuing tenure.

Establish a process for geothermal tenure issuance and permitting

- A system for issuing tenure and licensing of exploration should be defined. A process for acquiring geothermal energy rights, either by application or bidding, should be developed. Guidelines should be developed that identify the resource owner, leasing rules, and the application process including work commitments, technical inputs, and financial and reporting requirements. Similarly, a plain language version should be developed for stakeholders to outline the regulations for geothermal energy exploration and development.
- The permitting process for geothermal energy should have clear deadlines for both the companies and regulators.
- Governments should look for opportunities to build the knowledge of regulators on geothermal energy through training. While some components of the geothermal energy industry are similar to mining and oil and gas, many aspects are unique.
- Geothermal energy opportunities should be considered as part of land use planning and community energy planning in the NWT. A strategic assessment of geothermal energy opportunities could be conducted to identify the areas that could be open for geothermal energy development, to supply energy for communities or for export.

Set appropriate fees and royalties

- Until geothermal projects are producing at an economic rate, low or no royalties should be charged. This can be accomplished by royalty holidays, deducting expenses, or by applying royalties based on output. Once production is profitable, royalties may be charged, although the rates should still remain lower than rates for other more profitable, and non-renewable, resource developments.

Invest in geoscience data and programs

- Governments can contribute to geothermal energy development by acquiring and managing geoscience data on the location and quality of geothermal energy resources. This will help a fledgling industry identify the best opportunities for geothermal energy development.

Evaluate the fiscal incentive policies needed to advance geothermal energy

- A wide range of fiscal incentives can be put in place to encourage geothermal energy development at the federal or territorial level. It is outside the scope of the report to assess which of these options are the most appropriate for the NWT. Further research is needed on this to identify the suite of fiscal tools that would be more appropriate and effective given the resource, population and government priorities in the NWT.

5.1 Next steps

Reviewing the experience of other jurisdictions with respect to geothermal policy is an important and useful first step in moving forward with developing a regulatory framework for geothermal resources in the NWT. To further advance the development of policy for geothermal development, a number of future research directions may be warranted, including:

- Develop a forum for a variety of agencies and organizations to discuss geothermal resource development opportunities in the NWT. This group would bring together representatives from federal, territorial and municipal governments, aboriginal governments, non-government agencies and industry.
- Develop a guideline for geothermal resource development in the NWT, with details on how to apply for geothermal rights, details on the application and permitting process, clarity on regulatory decision deadlines, and environmental assessment requirements.
- Research the opportunities for fiscal incentives for geothermal energy development at the federal and territorial levels.

Geothermal is a form of renewable energy that produces few if any greenhouse gas emissions and can provide a stable, secure supply of energy. In the NWT where the cost of energy is high, geothermal energy projects, even if they are small, may be a real solution to communities' heat and power needs in the future. Geothermal energy could contribute to energy independence of northern communities by protecting northerners from dramatic fluctuations in petroleum prices. Geothermal energy could also facilitate other spinoff economic opportunities, such as providing energy for alternative uses like food production. Effective government policy, directed by a vision for geothermal energy use in the Territory, can have a large role in the reducing the risk and barriers to geothermal energy development.

6. Appendix A: List of interviewees

Craig Dunn	COO, Borealis GeoPower
Tim Thompson	CFO, Borealis GeoPower
Jim Lawless	Geothermal Practice Leader, Sinclair Knight Merz, New Zealand
Mory Ghomshei	Professor, University of British Columbia
Alison Thompson	Chair, Canadian Geothermal Energy Association
Alan Jessop	Retired Geological Survey of Canada employee
Gary Thompson	CEO, Molten Power
Tim Sadlier-Brown	Sadlier-Brown Associates
Barry Goldstein	Department of Primary Industries and Resources Group, Government of South Australia
Kermit Witherbee	National Geothermal Program Manager, Division of Fluid Minerals, Bureau of Land Management
Chris Bromley	GNS Science, Institute of Geological and Nuclear Sciences, New Zealand
Jonas Ketilsson	Project Manager for Geothermal Development and Research National Energy Authority of Iceland
Ruggero Bertani	Geothermal Business Development, Enel Green Power, Italy
Garth Thoroughgood	Assistant Director, Policy and Planning, British Columbia Ministry of Energy