GEOTHERMAL PLANT IN ICELAND

GEOTHERMAL ENERGY

Gaining Steam: A Regulatory and Policy Framework for Geothermal Energy Development in Alberta

Module 4: The Regulation of Geothermal Energy in Other Jurisdictions

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The Environmental Law Centre (ELC) has been seeking strong and effective environmental laws since it was founded in 1982. The ELC is dedicated to providing credible, comprehensive, and objective legal information regarding natural resources, energy and environmental law, policy, and regulation in the Province of Alberta. The ELC's mission is to educate and champion for strong laws and rights so all Albertans can enjoy clean water, clean air, and a healthy environment. Our vision is a society where laws secure an environment that sustains current and future generations.

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MODULE 4: THE REGULATION OF GEOTHERMAL ENERGY IN OTHER JURISDICTIONS

What can we learn from other jurisdictions' regulations of their geothermal industries? This module looks at several jurisdictions: British Columbia, Saskatchewan, California, Europe (Germany and Italy), Iceland, Chile, Japan, New Zealand, and the Philippines. For each jurisdiction, there is an overview of the legislative framework, the definition of geothermal resources, the ownership regime, the licensing regime, and the policy mechanisms adopted. It should be noted that in some instances, due to language barriers, direct reference to legislative and policy materials was not possible. In these cases, we relied on relevant literature.

1. British Columbia

British Columbia has specific legislation dealing with geothermal activities. The *Geothermal Resources Act*, R.S.B.C. 1996, c. 171 provides key definitions (such as geothermal resource and geothermal well), clarifies ownership of geothermal resources, and establishes the licensing regime for exploration and development. As of March 31, 2018, implementation of the Act is governed by the Oil and Gas Commission.

1.1 Definition of Geothermal Resources

The *Geothermal Resources Act*, R.S.B.C. 1996, c. 171 defines **geothermal resource**, **geothermal exploration**, **geothermal well** and **well** (s.1(1)).

Geothermal resource means the natural heat of the earth and all substances that derive an added value from it, including steam, water and water vapour heated by the natural heat of the earth and all substances dissolved in the steam, water or water vapour obtained from a well, but does not include

> (a) water that has a temperature less than 80 °C at the point where it reaches the surface, or
>
> (b) hydrocarbons.

Geothermal exploration means investigation of the subsurface of land for the presence of a geothermal resource by means of

> (a) seismic, gravimetric, magnetic, radiometric, electric, geological or geochemical operations,
>
> (b) well drilling, or
>
> (c) any other method approved by the commission.

Geothermal well means a well in which casing is run and that the minister considers is producing or capable of producing a geothermal resource from a geothermal resource bearing zone.

Well means a hole in the ground

> (a) made or being made by drilling, boring or any other method for the purpose of producing a geothermal resource or through which a geothermal resource is or can be produced,
>
> (b) used, drilled or being drilled for the purpose of injecting any substance into subsurface strata to assist the production of a geothermal resource, or to dispose of water produced in connection with the production of a geothermal resource, or
>
> (c) used, drilled or being drilled for the purpose of obtaining information about a geothermal resource.

1.2 Ownership of Geothermal Resources

Ownership is vested in the provincial Crown (*Geothermal Resources Act*, R.S.B.C. 1996, c. 171, s. 2).

1.3 Licensing Regime

Dispositions are made pursuant to the *Geothermal Resources Act*, R.S.B.C. 1996, c. 171. A person may hold a geothermal permit (which confers exploration rights for a limited period of time), or a geothermal lease (which enables development and production of a geothermal resource). Only a person who holds a permit prior is entitled to apply for a lease (and it must be on the same land).

Permits are issued via public tender for a one-year term renewable up to 7 times (beyond 7 times, need written authorization of the Minister). A permit grants the exclusive right to drill wells within the boundaries of the permittee's location. Once a permit has been obtained, the holder may apply for a well authorization to allow the drilling of geothermal wells. Under the *Geothermal Operations Regulation* (s.44), a well authorization expires in 2 years if the holder

has not begun an operation by that date. Operation includes drilling, completing, recompleting, intervening, re-entering, carrying out a work over, suspending or abandoning a well (s.1).

Once a geothermal well has been drilled, the permittee may submit a development plan and seek a lease. A lease will only be issued to the person who holds a permit for the applicable location, and only if a well has been drilled and a development plan is submitted. A lease is granted for a 20-year period which may be renewed for an additional 5 years or, if a production plan is approved, an additional 20 years.

According to CanGEA, the existing leasing process has proven problematic/ deficient and so there is currently a *de facto* moratorium on land sales.[1] CanGEA notes that this moratorium has recently been eased to some degree and some permits have been issued (although the tenure approach remains insufficient). The leasing process has also been criticized for the duration of its leases and permits.[2] Specifically, the exploration permit is one year with no **right** to renew which may be insufficient for exploration purposes and the renewal of 20 years is not tied to actual or deemed production.[3] While these critiques of the permit and lease durations were made in 1985, the language pertaining to renewal in the *Geothermal Resources Act* has not changed significantly.[4] Neither the *Geothermal Resources Act* nor *Geothermal Resources General Regulation* provides a right to renew a permit, or ties lease renewal to actual or deemed production (although a lessee must demonstrate that they are not in

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[1] CanGEA website at https://www.cangea.ca/policy.html.

[2] Sheilah L. Martin, "The Geothermal Resources Act: A Case Study in Resource Management" (1985) 19 U. Brit. Colum. L. Rev. This author also criticized the competitive bidding process and suggested that the Minister ought to be able grant rights on other terms and conditions (not just through competitive bidding).

[3] *Ibid*.

[4] *Geothermal Resources Act*, 1982, ch. 14.

default of any obligations under the lease which could conceivably set production requirements).

Despite these critiques, in mid-2018, the first geothermal permit was issued pursuant to the *Geothermal Resources Act*.[5] The permit authorizes drilling on four prospective geothermal wells to collect geotechnical information. Eventually, it is hoped that there will be future development of a small pilot geothermal project near Valemount in east-central B.C. (hotsprings and a small power plant).

The *Geothermal Resources General Regulation*, B.C. Reg. 39/2017 deals with general administrative issues associated with geothermal regulation. For instance, the Regulation prescribes the value of geothermal exploration that must be done to maintain a permit (ranges from $5 to $25 per hectare) and the annual rent for a lease ($10 per hectare). The Regulation also addresses the confidential status of geothermal reports.

In addition, the *Geothermal Resources General Regulation* provides that the *Environmental Protection and Management Regulation*, B.C. Reg. 200/2010 (under the *Oil and Gas Activities Act*) applies to geothermal activities (with the exception of section 8.1 which provides that Part 3 of the Regulation applies to a master license to cut timber). The *Environmental Protection and Management Regulation* sets some basic requirements to lessen impacts on water, wetlands, forest health and soil. For instance, section 18 requires that seismic lines be no more than 3 metres wide, avoid large standing trees, and leave soil and ground cover generally undisturbed. Section 19 requires a person who carried out geothermal activities (including geophysical exploration) to restore the operating area by de-compacting soils that were compacted by the operations, redistributing surface soils to restore soil structure to the extent

[5] B.C. Oil and Gas Commission News Release (May 30, 2018) at https://www.bcogc.ca/node/14894/download.

practicable, restore the natural drainage pattern to the extent practicable, re-vegetating exposed soils, removing structures that were constructed to cross water bodies, stabilizing any cut slopes and re-contouring bladed areas or excavations.

Issues associated with geothermal exploratory wells are addressed by the *Geothermal Geophysical Exploration Regulation*, B.C. Reg. 358/98 which provides that, for the purposes of the *Geothermal Resources Act*, the *Geophysical Exploration Regulation* (under the *Oil and Gas Activities Act*) applies with the exception of s.12 (which sets obligations on cancellation or cessation of operations). Pursuant to the *Geophysical Exploration Regulation*, B.C. Reg. 280/2010, a geophysical permit only allows geophysical exploration; it does not allow extraction of the resource or injection of water. Further, if drilling of exploratory holes causes the release of gas or water to the surface, the drilling must be stopped, and the holes plugged (s.8). The regulation sets requirements for clean-up after geophysical exploration (refuse (s.9) and campsites (s.10)). It also provides that, if a geophysical permit holder's project causes damage to any land or property, holder must take immediate steps to prevent further damage and repair the damage (s.11). The *Geophysical Exploration Regulation* also sets reporting requirements for geophysical exploration activities.

Detailed operational requirements for geothermal wells are found in the *Geothermal Operations Regulation,* B.C. Reg. 79/2017. This regulation sets minimum setbacks from things such as roads, easements, buildings, subsurface mines, and underground storage facilities (s. 5). It also sets requirements for surface-control measures to contain escaping fluids (s. 5) and other well control equipment (s. 9), for earthen pits designed to store liquid wastes (s. 21), for other structures to store water-based fluids (s. 21) and for well casing (s. 31). As well, this regulation addresses matters such as well spacing (s.27), acceptable fracking depths (s. 28), and hydraulic isolation (s.30). A variety of notification, record-keeping, and reporting requirements are set out in the Regulation. Finally, the regulation sets out a security requirement ($225,000 for a well and $7,500 for each thermal gradient well in the same formation to a maximum of

$50,000) (s.47). The security is returned with the issuance of a certificate of restoration or if the security is no longer required to secure obligations under the Act.

Geothermal projects are subject to other provincial licensing and permitting requirements dealing with matters such as land leases, drilling permits, wildlife protection, public health and safety, environmental monitoring and protection, road construction and water use.[6]

1.4 Policy

British Columbia does not have a comprehensive policy scheme in place to encourage development of geothermal resources. However, some project support has been provided via the Small Business Venture Capital Project and government grants.

The Small Business Venture Capital Project is not specifically designed to support geothermal projects but rather for support of small businesses in British Columbia. This program gives British Columbia investors a 30% tax credit on their investment in a venture capital corporation or an eligible business corporation. Kitselas Geothermal Inc. which is developing a geothermal district heating and cooling project has qualified under this program.[7] Another geothermal district heating and cooling project in Valemont, known as Sustainaville (which is being

[6] See www.cleanenergybc.org.

[7] See http://www.borealisgeopower.com/kitselas.html. See also Andrea Miller et al., *Community Energy in Western Canada: Insights from case studies on small-scale renewable energy development* (Edmonton: 2019, Future Energy Systems, University of Alberta).

developed by Borealis GeoPower Inc.), is supported by a $1.54 million federal grant.[8]

2. Saskatchewan

The Government of Saskatchewan, along with the federal government, is funding a geothermal power demonstration plant in South Saskatchewan. A flow testing program run in the spring and summer of 2020 demonstrated "temperature and flow rates... sufficient to support multiple geothermal power facilities".[9]

While Saskatchewan does not have legislation dealing specifically with geothermal projects, it has included geothermal projects in its Integrated Resource Information System (IRIS) which is the Government's online business system that supports the development and regulation of the provincial energy and resources industry.[10] Effectively, geothermal power is being squeezed into different aspects of the existing oil and gas and mineral resource regulatory schemes.

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[8] See https://www.nrcan.gc.ca/science-and-data/funding-partnerships/funding-opportunities/current-investments/canadas-geothermal-village-sustainaville-geopark/20923.

[9] "Canada's first geothermal production and injection well test exceeds expectations: First 20-megawatt facility in design phase" (September 10, 2020) Pipeline News available at https://www.estevanmercury.ca/canada-s-first-geothermal-production-and-injection-well-test-exceeds-expectations-1.24200570.

[10] This inclusion was effective March 28, 2018.

Under the IRIS, geothermal projects are classified as a type of storage project. In the Government's guidance for storage project applications, geothermal projects are defined as:[11]

> A geothermal project means a development where geothermal energy is recovered through deep well(s). There are two main types of geothermal project; open-loop and closed- loop. An open-loop system includes: (1) withdrawing formation water for the purpose of extracting geothermal energy as part of an industrial process, and (2) disposing the cooling fluids into subsurface following the extraction of its heat content. In a closed-loop system, the source fluids are circulated in a sealed wellbore – heat exchange loop and there are no formation fluids to be withdrawn or fluids to be disposed. The geothermal project application is only applied to the subsurface activities.

In the guidance for disposal wells (which may form part of a geothermal project), geothermal projects are defined as:[12]

> a development that geothermal fluids are produced from a water source well, the geothermal energy is recovered at surface as part of an industrial process for any purpose, and the cooling fluids are disposed into subsurface through a waste disposal well.

Any necessary disposal well applications can be authorized as part of a geothermal project application (a separate application in not needed).

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11 Government of Saskatchewan website, https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/oil-and-gas/oil-and-gas-licensing-operations-and-requirements/oil-and-gas-drilling-and-operations/gas-storage-and-cavern-storage-disposal.

12 Government of Saskatchewan website, https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/oil-and-gas/oil-and-gas-licensing-operations-and-requirements/oil-and-gas-drilling-and-operations/disposal-injection-wells.

2.1 Definition of Geothermal Resources

There is no statutory definition of geothermal resources in Saskatchewan. The only legislative mention of **geothermal** is found in the *Oil and Gas Conservation Regulations, 2012*[13] which states that:

> s. 4(1) For the purpose of clause 2(1)(j.1) of the Act, substances from the following industries are non-oil-and-gas substances…. (n) the geothermal industry.

There is no definition provided for **geothermal industry**. The effect of this provision is to bring geothermal activities under the purview of the *Oil and Gas Conservation Act*, RSS 1978, Chapter O-2 for the purposes of regulating injection of associated wastes into subsurface formations. It does not provide a regulatory or licensing regime for geothermal activities.

2.2 Ownership of Geothermal Resources

While there are legislative provisions addressing the ownership of water[14] and minerals,[15] there appears to be no explicit legislative statement as to ownership of geothermal resources.

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[13] Chapter O-2 reg. 6. Promulgated pursuant to the *Oil and Gas Conservation Act*, RSS 1978, Chapter O-2.

[14] *The Water Rights Act*, R.S.S. 1940, ch. 41, s. 6 which provides all water in the province is owned by the Crown.

[15] *The Provincial Lands Act*, S.S. 2016, ch. P-31.1 and *The Crown Minerals Act,* S.S. 1984-85-86, ch. C-50.2 which address tenure of minerals owned by the Crown. It should be noted, that as in Alberta, there are some freehold mineral titles.

2.3 Licensing Regime

Saskatchewan does not have a comprehensive regulatory regime for geothermal activities. Rather, the demonstration geothermal power plant in Saskatchewan is being regulated via existing subsurface and mineral regulations. Specifically, the province has used rental of space agreements to facilitate geothermal operations.[16]

For instance, the developer of the geothermal well in Saskatchewan announced that they have secured mineral rights for brines needed for the project.[17] The *Subsurface Mineral Tenure Regulations*, ch. C-50.2, Reg. 30 governs dispositions of subsurface minerals. Section 2 of the regulations define subsurface minerals as:

> all natural mineral salts of boron, calcium, lithium, magnesium, potassium, sodium, bromine, chlorine, fluorine, iodine, nitrogen, phosphorus, and sulfur, and their compounds, occurring more than 60 metres below the surface of the land.

In addition, lease of space agreements have been obtained by the developer of the demonstration geothermal power plant.[18] Given that all **spaces** (defined as the "spaces occupied or formerly occupied by a Crown mineral")[19] are

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[16] A. Thompson, F. Bakhtheyar and G. Van Hal, "A Qualitative Assessment of Major Barriers Facing the Geothermal Industry In Canada" (2014) 38 GRC Transactions 71.

[17] See https://deepcorp.ca/deep-successfully-secures-mineral-rights-for-brines-is-commencing-with-spring-summer-testing-and-drilling-program/.

[18] See the DEEP website at https://deepcorp.ca/deep-drills-4-new-geothermal-wells-and-increases-subsurface-rights-by-700/.

[19] *Crown Minerals Act*, s. 27.2.

owned by the Crown, a lease of space agreement allows access.[20] The area for a lease of space agreement is determined by the Minister.[21]

Aspects of geothermal activities that involve injection into sub-surface formations are regulated via the *Oil and Gas Conservation Act*, R.S.S. 1978, ch.O-2. Under the Act, non-oil-and-gas substances can be prescribed via regulation as being subject to the Act[22] and the *Oil and Gas Conservation Regulations, 2012* have done so for the geothermal industry. The purposes of the Act include regulation of the injection of non-oil-and- gas substances into subsurface formations (s. 3(1)(h)). As well, under the Act, the Minister may make orders respecting containment, storage, handling, transportation, treatment, processing, recovery, reuse, recycling, destruction, and disposal of non-oil-and-gas substances at a licence facility or associated site (s. 17(1)(k)). Ministerial orders respecting the processing and storing of non-oil-and-gas substances at a licensed facility or well or associated site may also be made (s. 17(1)(n)). Finally, the Minister may make orders approving plans for injecting, storing or disposing of … non-oil-and-gas substances in subsurface formations (s.17.1(1).

Cabinet has authority, under the Act, to make regulations for a variety of operational matters (s. 18):

- regulations (A) authorizing or requiring the drilling, casing, cementing, operating and plugging of wells in accordance with good practice and in any manner to prevent the (B) harmful intrusion of water, oil and gas wastes, non-oil-and-gas substances into an oil or gas stratum or the environment, or (C) the pollution of fresh water supplies by oil, gas, salt water, oil and gas wastes, or non-oil-and-gas substances;

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[20] *Ibid*.

[21] *The Oil and Gas Tenure Registry Regulations*, S.S. 2016, ch. C-50.2 Reg 31, s. 9-3(5).

[22] *Oil and Gas Conservation Act,* R.S.S. 1978, ch. O-2, s. 2(1)(j.1).

- regulations respecting containment, storage, handling, transportation, treatment, processing, recovery, reuse, recycling, destruction and disposal of … non-oil-and-gas substances at a well, pipeline, facility or site of a well or facility AND the injection, disposal and storage of … non-oil-and-gas substances in subsurface formations; and

- regulations respecting the processing and storing of non-oil-and-gas substances at a licensed well or facility.

If a geothermal project involves a reinjection well, detailed requirements are outlined in *Directive PNG008: Disposal and Injection Well Requirements Directive*. Any public notices requirements are set out in *Directive PNG009: Public Notice Requirements*.

2.4 Policy

Much like British Columbia, Saskatchewan lacks a comprehensive policy approach to encouraging geothermal resource development. To date, there has been an *ad hoc* approach consisting of government grants. As mentioned previously, the demonstration geothermal power plant is being supported with provincial and federal government grants.[23]

[23] See https://www.pipelinenews.ca/news/local-news/federal-funding-totalling-25-6-million-announced-for-deep-earth-energy-production-1.23599258.

3. California

California is the largest generator of electricity from geothermal resources in the USA, providing almost 6% of the state's electrical energy.[24] In 2018, this amounted to 11,528 GWh of electricity produced by 43 operating geothermal power plants (with installed capacity of 2,730 MW).[25] Production and injection wells used for the discovery and extraction of geothermal resources in public and private lands is regulated by the California Geologic Energy Management Division (CalGEM)which oversees drilling, operations, maintenance and abandonment of geothermal wells.

Legislation regulating geothermal resources is found in the most recent compilation, the *California Geologic Energy Management Division, Statutes & Regulations (January 2020)*.[26] Essentially, modifications have been made to fit geothermal resources into the existing regulatory regime for oil and gas development. There are 2 types of geothermal projects: exploratory and field development which are deemed to be separate and distinct from each other.[27] Each type of project requires permits and are subject to a variety of requirements such as set-backs from roads, land boundaries and other wells/projects, casing, blow-out prevention and other equipment requirements, and record-keeping (logs, core record, and drilling history).[28]

The regulations require that wells be drilled to protect or minimize damage to environment, useable ground waters, geothermal resources, life, health and

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[24] California Geologic Energy Management Division, website.

[25] California Energy Commission website, at https://ww2.energy.ca.gov/almanac/renewables_data/geothermal/index_cms.php.

[26] See https://www.conservation.ca.gov/index/Documents/CALGEM-SR-1%20Web%20Copy.pdf.

[27] *Public Resources Code* (P.C.R.), § 21090.1.

[28] *California Department of Conservation, Statutes & Regulations* (January 2020).

property.[29] As well, drilling in unstable areas (such as fumaroles, geysers, hot springs, mud pot, etc.) is not permitted unless a geological investigation demonstrates drilling is feasible. Annual well fees are imposed on producing, service, and idle wells (but not temperature-gradient or observation wells).[30] As well, indemnity bonds are required as security ($25,000 for each well, for low-temperature wells from $2,000 to $25,000 based on well depth, or $100,000 to cover multiple wells).[31] These indemnity bonds are collected to ensure compliance with Division 3 of the *Public Resources Code* and orders of the State Oil and Gas Supervisor.

It should be noted that a Pre-Rulemaking Discussion Draft was issued February 16, 2018 which may result in amendment of state-wide geothermal regulations.[32] This discussion draft contains:

- additional requirements around classifying wells as observation wells and for submitting data gathered by such wells;
- changes to subsidence provisions - in particular, require each operator to have a subsidence monitoring and mitigation plan for all wells - sets out requirements for such plans;
- additional requirements for plugging and abandonment of geothermal wells; and

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[29] 4 *California Code of Regulations* (C.C.R.) Subchapter 4. State-wide Geothermal Regulations.

[30] P.C.R., §3724.5. A temperature gradient well is an exploratory tool used (a shallow hole examined with a temperature probe), see https://openei.org/wiki/Thermal_Gradient_Holes. An observation well is used to monitor important hydrologic parameters of a geothermal system, see https://openei.org/wiki/Observation_Wells.

[31] P.C.R., §§ 3725, 3725.5 and 3726.

[32] 4 C.C.R. subchapter 4 (State-wide Geothermal Regulations) is undergoing amendment. See *Pre-Rulemaking Discussion Draft (February 16, 2018)*.

- new provisions for "junk-in-hole" and lost radioactive tools.

As of July 2020, the CalGEM is reviewing public comments on the discussion draft and, as such, the above provisions are still proposals not regulation.

3.1 Definition of Geothermal Resources

Geothermal resources are defined as:[33]

> For the purposes of this chapter [methane gas hazards reduction], "geothermal resources" shall mean 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 mineral 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.

Other relevant definitions include geothermal exploratory project and geothermal field development project.

A **geothermal exploratory project** is defined as "composed of not more than 6 wells and associated drilling and testing equipment whose chief purpose is to evaluate the presence and characteristics of geothermal resources prior to commencement of a geothermal filed development project".[34]

Geothermal field development project means a "development project as defined in Section 65928 which is composed of geothermal wells, resource

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[33] P.C.R., § 6903.

[34] P.C.R., § 21065.5.

transportation lines, production equipment, roads, and other facilities which are necessary to supply geothermal energy to any particular heat utilization equipment for its productive life, all within an area delineated by the applicant."[35]

3.2 Ownership of Geothermal Resources

Section 6407 of the *California Public Resources Code* expressly includes geothermal resources as one of many types of mineral resources that are reserved to the State when found in lands that are or could be owned by the State. This provision operates in conjunction with section 6401 which reserves, among other things, minerals on public lands to the State and clarifies that a purchaser of state land does not acquire these reserved minerals. This means that the State owns the geothermal resources under its public lands and continues to own geothermal resources even when land is deeded to a private owner. It should be noted that the inclusion of geothermal resources occurred in 1975. As such, there is some argument that earlier deeds did not contain this reservation leading to the possibility of some private ownership of geothermal resources.[36] However, section 6407 could also be interpreted as a declaration that geothermal resources are and always have been reserved to the State meaning there is no private ownership.

3.3 Licensing Regime

The CalGEM regulates production and injection wells used for the discovery and extraction of geothermal resources on state and private land. Geothermal resources are regulated via specific modifications of the existing regulatory

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[35] Cal. Government Code, § 65928.5.

[36] See Sho Sato, Thomas D. Crocker and L.J.P. Muffler, "Property Rights to Geothermal Resources" (1977) 6(2) Ecological. L. Q. 247 for more discussion of this Issue.

regime for oil and gas development. There are 2 types of geothermal projects: (1) exploratory and (2) field development which are deemed to be separate and distinct from each other. Permits are required for both types of projects.

The State Oil and Gas Supervisor is responsible for the supervision of the drilling, operation, maintenance and abandonment of geothermal resources wells "as to encourage the greatest ultimate economic recovery of geothermal resources, to prevent damage to life, health, property, and natural resources, and to prevent damage to, and waste from, the underground geothermal deposits, and to prevent damage to undergraduate and surface waters suitable for irrigation or domestic purposes by reason of the drilling, operation, maintenance, and abandonment of geothermal resource wells".[37]

Public and agency review and approval/disapproval of geothermal exploratory projects under the *California Environmental Quality Act* is required.[38] Such review must be completed within 135 days of the receipt of the project application.[39]

In addition, each district deputy must collect information about geothermal wells within their district as necessary for the proper supervision of the wells.[40] In addition, "maps and other accessories necessary for determining the underground conditions in a geothermal area, the location and extent of strata bearing water suitable for irrigation or domestic purposes, or surface suitable for those purposes" must be prepared by the district deputy.[41] This work is done in order to advise operators of the best means to protect the geothermal resources, the water bearing strata and surface water, as well as assisting in

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[37] 4 C.C.R., § 3714.

[38] 4 C.C.R., § 3715.5.

[39] *Ibid*.

[40] 4 C.C.R., § 3716.

[41] *Ibid*.

ordering tests or repair work at wells.[42] The data collected is available to the Director of Water Resources, the State Geologist and the appropriate regional water quality control board. [43]

3.4 Policy

Since 1980, the State of California has provided co-funding to over 184 geothermal projects in the amount of $74 million.[44] This is accomplished via the Geothermal Resources Development Account (GRDA) Program which is established by legislation and enables cost-shared drilling.[45] Section 3800 of the *Public Resources Code* provides that geothermal revenues are to be disposed of to achieve certain general objectives including:

- Reduction of dependence on fossil fuels and stimulation of the state's economy through geothermal development; and

- Mitigation of the adverse social, economic, and environmental impacts caused by geothermal development.

The GRDA is funded by geothermal lease revenue,[46] and the GRDA funds are used to support the general objectives stated in the *Public Resources Code*. The legislation requires that 40% of the revenues derived from leases must be

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[42] *Ibid*.

[43] *Ibid.*

[44] See Cheryl Closson, "California Energy Commission, Geothermal Grant and Loan Program: Past, Present & Future" (April 17, 2017) Renewable Energy Lead Commissioner Workshop at https://efiling.energy.ca.gov/GetDocument.aspx?tn=217199&DocumentContentId=28093.

[45] P.R.C., §§ 3800 to 2827 and 20 C.C.R., §§ 1660 to 1665.

[46] P.R.C., § 3820.

disbursed to the county of origin for the purposes specified in the legislation.[47] The legislation also provides that 30% of the GRDA's revenues shall be available as grants or loans to local jurisdictions or private entities subject to certain conditions (including a requirement for investments by the recipient).[48] The GRDA funds disbursed to counties of origin or as grants/loans may only be used for purposes provided in the legislation including, among other things: [49]

- research and development projects relating to geothermal resource assessment and exploration, and direct use and electric generation technology; and

- undertaking projects demonstrating the technical and economic feasibility of geothermal direct heat and electrical generation applications.

Additional details for the GRDA program, such as application and award procedures, are found in Title 20 of the California Code of Regulations.[50]

Aside from this state program, the geothermal industry in California also benefitted from numerous federal programs (which supported geothermal development throughout the US not just in California). These programs included:

[47] P.R.C., § 3821.

[48] P.R.C., § 3822.

[49] P.R.C., § 3823.

[50] 20 C.C.R., §§ 1660 to 1665.

- A production tax credit which has been applied to geothermal production since 2004.[51]

- A cost-shared drilling program known as the Geothermal Resource Development and Definition (GRED) program[52] which ran from 2000 to 2007.

- An industry-coupled case studies program established in 1978 (but now discontinued) led to the development of 7 geothermal planets with a combined capacity of 137 MW.[53]

- A user-coupled confirmation drilling program which provided cost-sharing with industry partners in the exploration phase of confirming hydrothermal reservoirs.[54] This program covered 90% of costs in the case of unsuccessful drilling and 20% in the case of successful drilling.[55] In addition to cost-sharing, this program generated significant engineering and geoscientific expertise to be used for future exploration, reservoir confirmation and development.[56]

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[51] Marietta Sander, "Lessons Learnt from Geothermal-Friendly Regulatory Frameworks in Iceland, Kenya, New Zealand, Philippines and the United States of America" (2012) 36 GRC Transactions 1239 [Sander].

[52] U.S. Department of Energy, *Exploration 1976-2006: A History of Geothermal Energy Research and Development in the United States* (2010).

[53] Bethany Speer, Ryan Economy, Travis Lower, Paul Schwann and Scott Regenthal, *Geothermal Exploration Policy Mechanisms: Lessons from International Application*, *Technical Report NREL/TP-6A20-61477* (Golden, CO: 2014, National Renewable Energy Laboratory) [Speer et al.].

[54] Sander, *supra.* note 51.

[55] Speer et al., *supra.* note 53.

[56] *Ibid*.

- Numerous federal loan programs have existed through the years.[57] In 1974, there was a program to underwrite loans for exploration, research, and development of geothermal resources. In 1980, a direct loan for geothermal reservoir confirmation program was established (although it was never actually funded and implemented).[58] In 2009, loan guarantees which enabled participation in the Department of Energy's Financial Institutional Partnership Program for conventional geothermal projects (the Section1705 Loan Program).[59]

Other federal programs, focused on research and development, have provided grants to the geothermal industry. For instance, in 1976 the Program Research Development Announcement was initiated.[60] This program provided grants for feasibility studies, supported technologies for industrial processes and moderate low temperature heat applications.[61] The Technical Assistance Grant Program, operated by the U.S. Department of Energy, enabled new geothermal developers to access technical advice from a consultant or research institute including for resource assessment and feasibility studies.[62] The federal *American Recovery and Reinvestment Act of 2009* allocated almost $400 million to the Department of Energy's Geothermal Technologies Program which emphasizes innovative exploration and drilling projects, EGS demonstration projects, acquiring data, and ground source heat pumps.[63]

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[57] *Ibid*.

[58] *Ibid*.

[59] *Ibid*.

[60] Sander, *supra*. note 51.

[61] *Ibid*.

[62] *Ibid*.

[63] *Ibid*.

Aside from these programs, geothermal development in California (and elsewhere in the US) was encouraged with the federal *Public Utility Regulatory Policies Act of 1978* (PURPA)[64] which was passed in 1978. The PURPA required utilities to purchase energy from qualifying facilities (including geothermal).[65] By guaranteeing a market for geothermal electricity, the PURPA was a "major motivator for geothermal development through the early 1990s".[66] Tax credits in place since the 1990s have "made taking early stage geothermal risk worthwhile for some [independent power producers]".[67]

4. Europe: Italy and Germany

In Europe, the three most active geothermal resource industries are found in Italy, Germany and Iceland (as at 2013).[68] The European directive on the promotion of the use of energy from renewable sources[69] sets legally binding 2030 targets for renewable energy use by member states and sets rules for renewable energy support programs (it should be noted that while heavily integrated into the European Union, Iceland is not a member state).

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[64] *Public Utility Regulatory Policies Act of 1978*, 16 U.S.C. §§ 2601 – 2645 (PURPA).

[65] Office of Energy Efficiency & Renewable Energy, *A History of Geothermal Energy In America* at https://www.energy.gov/eere/geothermal/history-geothermal-energy-america (Federal Government, US).

[66] Subir K. Sanyal et al., Comparative Analysis of Approaches to Geothermal Resource Risk Mitigation: A Global Survey, Energy Sector Management Assistance Program, Knowledge Series 024/16 (Washington, D.C.: 2016, The World Bank Group) [Sanyal et al.].

[67] *Ibid*.

[68] Philippe Dumas et al., R*eport on Geothermal Regulations: Report presenting proposals for improving the regulatory framework for geothermal electricity* (Luxembourg: 2013, GEOELEC, European Union) [Dumas et al.].

[69] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (PE/48/2018/REV/1).

As part of this directive, the European Parliament and Council has developed a common definition of **geothermal energy** as "energy stored in the form of heat beneath the surface of solid earth".[70] This means that the legislation of any member state, including Italy and Germany, must adopt this definition.[71]

Despite a common definition of geothermal, the approaches to ownership and licensing regimes vary throughout Europe. Within Europe, there are generally two approaches to ownership:[72]

- addressed by adoption of mining law or mineral resources law (e.g. Germany); or

- owner of the surface owns the underground resources (e.g. Iceland).

4.1 Italy

Italy has a long history of geothermal resource development starting with a geothermal power plant in operation since 1904.[73] There are currently 34 geothermal power plants in operation with an installed capacity of 915.5 MW_e.[74] In addition, direct use applications are "widespread over the whole Italian

[70] *Ibid.* at art. 2.

[71] Philippe Dumas and Luca Angelina, "The EU Legal Framework for Geothermal Energy" (Proceedings World Geothermal Congress 2015, Melbourne, Australia 19-25 April 2015).

[72] Information on legal regimes based on Dumas et al. *supra*. note 68.

[73] Davide Serra, Maurizio Cei and Micro Lupi, "Geothermal Energy Use: Country Update for Italy (2015-2019)" (Proceedings World Geothermal Congress 2020, Reykjavik, Iceland, April 26-May 2, 2020).

[74] *Ibid*.

territory"[75] and include district heating systems and shallow geothermal heat pumps.

4.1.1 Ownership of Geothermal Resources76

In Italy geothermal resources are owned by the state. The central government owns the deep enthalpy valleys which consist of vapours or liquids over 150 Celsius and areas that can provide geothermal capacity of about 20 MW and their reinjection liquid has an average of 15 celsius. Otherwise, geothermal resources belong to the local, regional governments.

4.1.2 Licensing Regime[77]

Italy does have a specific geothermal regulatory regime; although rules tend to be plant or sector-based rather than resource-based.[78] Permits for exploration and exploitation are issued by the Italian regions. There are annual fees for permits (based on size of the license area). Exploitation activities must be compatible with the environment and may necessitate an environmental assessment.

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[75] *Ibid.* at 1.

[76] Information on legal regimes based on Dumas et al. *supra*. note 68.

[77] *Ibid*.

[78] For more information on status of geothermal development in Italy see, Adele Mandela et al., "Geothermal Energy Use, Country Update for Italy" (European Geothermal Congress 2019, Den Hagg, The Netherlands, 11-14 June 2019).

4.1.3 Policy

Use a feed-in premium but many of the bonuses granted are used to encourage upgrading of older geothermal technology.[79] Nearly all exploration and development was government-led (via publicly owned utility).[80] The Italian electricity market only recently opened to privatization which included the introduction of a feed-in premium.[81]

4.2 Germany

Germany's geothermal resources are used in both direct heat and electrical generation applications.[82] At the end of 2018, there were approximately 190 direct use geothermal operations (including district heating, thermal spas and a greenhouse) amounting to about 406.3 MW_{th}.[83] As of July 2019, there were 10 geothermal power plants with an installed capacity of 43.05 MW_{el} being fed into the grid.[84] In addition, there are numerous decentralized heat pumps using shallow geothermal for heating and cooling of homes and other buildings.[85]

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[79] *International Geothermal Support Mechanisms Best Practices: Identifying the Canadian Gap* (Calgary: 2015, Canadian Geothermal Energy Association) at 85 [CanGEA Gap Report].

[80] *Ibid.* at 85.

[81] *Ibid*. at 85.

[82] Josef Weber et al., "Geothermal Energy Use in Germany, Country Update 2015-2019" (Proceedings World Geothermal Congress 2020, Reykjavik, Iceland, April 26-May 2, 2020).

[83] *Ibid*.

[84] *Ibid*.

[85] *Ibid*.

4.2.1 Ownership of Geothermal Resources[86]

In Germany, geothermal resources are deemed to be **freely mineable resources.**[87] This means that geothermal resources are not attached to surface ownership and may only be exploited via licences issued pursuant to the *German Federal Mining Act*.[88]

4.2.2 Licensing Regime[89]

In Germany, the main piece of legislation is the *German Federal Mining Act*[90] which requires both exploration and extraction licences for geothermal resources. An exploration licence allows both seismic exploration and drilling. An extraction licence, along with a mining proprietorship, allows the production and appropriation of geothermal energy, along with construction and operation of related facilities. Operation of a geothermal power plant will also require a water act licence and building permit.

4.2.3 Policy

Germany introduced the first national feed-in tariff (FIT) legislation in Europe in 1990.[91] This legislation required utilities to "buy electricity from non-utility

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[86] Information on legal regimes based on Dumas et al. *supra*. note 68.

[87] *Federal Mining Act* of 13 August 1980 (Federal Law Gazette I p. 1310), last amended by Article 2 (4) of the Act of 20 July 2017 (Federal Law Gazette I, p. 2808), s. 3.

[88] *Ibid*.

[89] Information on legal regimes based on Dumas et al. *supra*. note 68.

[90] *Supra*, note 87.

[91] Toby D. Couture et al., *A Policymaker's Guide to Feed-In Tariff Policy Design, Technical Report NREL/TP-6A2-44849 (*Washington, D.C.: 2010, National Renewable Energy Laboratory) [Couture et al.].

[renewable energy] generators at a fixed percentage of the retail electricity price".[92] The percentage ranged from 65-90% depending on the technology type and the project size.[93] A project size cap of 5MW was imposed on hydropower, landfill gas, sewage gas and biomass facilities.[94] In addition, some municipal utilities in Germany began offering FIT prices based on the actual costs of renewable energy generation (primarily to encourage solar energy).[95]

Later, in 2000, the *Renewable Energy Sources Act* was enacted and made significant changes to the German FIT program, including:[96]

- FIT prices were decoupled from electricity prices at a national level.
- Utilities were allowed to participate in generation (in contrast to the previous approach which fostered non-utility generation).
- Renewable energy sources granted priority access to the grid.
- FIT prices are based on the costs of generation for all technology types.

In order to ensure that FIT prices are based on the costs of generation, several elements are found in the German FIT program:

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[92] *Ibid*. at 9.

[93] *Ibid*.

[94] *Ibid*.

[95] *Ibid*.

[96] *Ibid*.

- There are size differentiated tariffs: higher amounts for smaller installations to match the tariff amount to the actual generation cost.[97] The goal is to approximate the same rate of return no matter the size of the project (that is, to accommodate for economies of scale). The programs differentiate according to a linear function in relation to capacity thresholds (other countries use a step down approach) which approximates the gains from economies of scale.[98]

- Degression rates are used so that tariffs decrease on a pre-determined annual basis (to reflect fact that total costs of a technology tend to decrease with experience); more rapidly evolving technologies have greater degression rates.[99]

- Rather than adjusting for inflation annually, a 2% annual inflation rate is assumed in its FIT calculation methodology and establishes FIT payments using this assumption.[100]

- Technology-specific bonus payments are made for the use of high efficiency systems (in the geothermal sector, there is a bonus for using cogeneration).[101]

Other notable elements of the German FIT program includes the use of 20 year contracts[102] and planned program revisions every 4 years (where tariffs,

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[97] *Ibid*.

[98] *Ibid*.

[99] *Ibid*.

[100] *Ibid*.

[101] *Ibid*.

[102] *Ibid*.

eligibility, caps/targets and so forth are reviewed).[103] Currently, there are no caps on the total amount of renewable energy developed, no caps on project size (except for landfill and sewage gas projects), and no caps on total costs of policy.[104] As well, Germany has a mechanism to share costs among all ratepayers to equalize investment costs across the country whether nearby a renewable energy development or not.[105]

The success of FITs in Germany is commonly credited to the overall stability and continuity of the policy framework, despite periodic modifications, the FIT program is framed as "a central part of a long-term strategy to meet its overall objectives".[106] As part of that strategy, the use of FITs is augmented with the *Renewable Energies Heat Act* (2009) which requires the installation of renewable heat sources in new buildings.[107]

Aside from its use of FITs, Germany also has a loan guarantee and a lending support mechanism for geothermal activities known as the Risk of Non-Discovery of Deep Geothermal Energy program.[108] This program applies to deep geothermal heat or power projects.[109] The program offers loan forgiveness of up to 100% of the borrowed money in the case of failed exploratory drilling.[110] In addition, the program offers loans up to 16 million euros or 80% of eligible drilling

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[103] *Ibid*.

[104] *Ibid*.

[105] *Ibid*.

[106] *Ibid.*at 10.

[107] See more detail, CanGEA Gap Report *supra.* note 79.

[108] Speer et al., *supra.* note 53.

[109] Christian Boissavy, Report reviewing existing Insurance schemes for geothermal (deliverable number D3.1), EU GEORISK project, available at https://www.georisk-project.eu/wp-content/uploads/2020/02/D3.1_Report-reviewing-geothermal-risk-mitigation-schemes-v2.pdf.

[110] Speer et al., *supra.* note 53.

costs to undertake exploration drilling.[111] Given that the lender is the National Development Bank of Germany, this is effectively a government-provided loan program.[112]

Additionally, Germany has contributed a significant amount of money (174.2 million euros between 2004 and 2013) to government led research and development.[113]

5. Iceland

Iceland has a well-developed geothermal resource industry. Approximately 25% of its total electricity production is from geothermal resources.[114] In addition, geothermal resources are used for space heating.[115]

All licensing for research and use of geothermal resources is subject to *The Act on Survey and Utilisation of Ground Resources, No. 57/1998* and the *Electricity Act, No. 65/2003* (regardless of private or public ownership of the resource). As well, geothermal resource activities are subject to the *Nature Conservation Act*, *Planning and Building Act* and other acts that relate to the survey and use of land.[116] Generation, transmission, distribution and trade of electricity is governed by the *Electricity Act, 2003 No. 65* regardless of the energy source.

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[111] *Ibid*.

[112] *Ibid*.

[113] CanGEA Gap Report, *supra*. note 79.

[114] Orkustofnun (National Energy Authority of Iceland) website.

[115] *Ibid*.

[116] See Kristin Haraldsdottir, "Introduction to the Legal Environment in Iceland for Utilisation of Geothermal" (2010) 28 J. Energy & Nat. Resources L.1. A variety of land use planning and

The approach to development of geothermal resources has been project-based as opposed to ecosystem-based.[117] There is no predetermined and objective criteria in the legislation dealing with the allocation of research and use licenses where there are competing applications.[118]

5.1 Definition of Geothermal Resources

Geothermal energy means "on the one hand, reserves of energy in the bedrock, and, on the other hand, a constant flow of heat from the bowels of the earth which does not constitute groundwater".[119]

Groundwater is defined as "water that below the ground in a contiguous mass, immobile or free flowing and generally fill all openings in the stratum in question and which is extracted for purposes other than to transmit heat to the surface of the earth or to utilize its potential energy".[120]

The primary piece of legislation (*The Act on Survey and Utilisation of Ground Resources, No. 57*/1998) covers resources in the ground, at the bottom of rivers and lakes, and at the bottom of the sea within netting limits.[121] A **resource** is

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environmental protection legislation may also be relevant – *Public Lands Act* No. 58/1998, *Planning and Building Act* No. 73/1997, the *Nature Conservation Act* No. 44/1999, the *Strategic Environmental Impact Assessment Act* No. 105/2006, the *Hygiene and Pollution Act* No. 7/1998, the *National Heritage Act* No. 107/2001 and specific parks acts (*Vatnajokull National Park Act* No. 47/2004 and *Pingvallavatn National Park Act* No. 85/2005).

[117] Kristin Haraldsdottir, "Introduction to the Legal Environment in Iceland for Utilisation of Geothermal" (2010) 28 J. Energy & Nat. Resources L. 1.

[118] *Ibid*.

[119] *Act on the survey and utilisation of ground resources*, 1998 No. 57 10 June (Amended by Act No. 5/2006, art. 2.

[120] *Ibid*. art. 3.

[121] *Ibid*. art. 1.

defined to be "any element, compound and energy that can be extracted from the earth whether in solid, liquid or gaseous forms regardless of the temperature at which they may be found".

5.2 Ownership of Geothermal Resources

Resource ownership attaches to the owner of private land.[122] In the case of public land, the state owns the geothermal resource (unless a person can demonstrate ownership).[123] By virtue of an amending law passed in 2008,[124] the State or municipalities cannot sell geothermal resources although use rights may be leased for up to 65 years (this period may be extended).

5.3 Licensing Regime

The Orkustofnun is responsible for regulation of the geothermal resource industry. The licensing regime consists of prospecting licences and resource use licences.

With respect to prospecting licences, the Orkustofnun issues these licences for both private and public lands. While a private landowner does not require a prospecting licence for prospecting on their own land, they do not have priority for use unless they have been issued a prospecting licence.

Any use of the geothermal resource requires a license regardless of whether on private or public lands. The exception is that a landowner may use, without permission, geothermal energy on their own land for household and agricultural

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[122] *Ibid.* art. 3.

[123] *Ibid.* art. 2.

[124] Act No. 58/2008 amending various acts of law relating to natural resources and energy.

uses up to 3.5 MW based on the heat extracted from the ground (however notice must be provided to the Orkustofnun of any proposed drilling).[125]

Landowners are required to provide access to prospecting and use licence-holders. Compensation is determined by private agreement between the landowner and licence-holder, or a licence-holder may seek to obtain expropriation and assessment.[126]

The construction and operation of an electric power plant using geothermal energy (or any energy source for that matter) is subject to the *Electricity Act*, 2003, No. 65 although no license is needed if the power plant is rated under 1 MW.[127]

Any prospecting or utilisation work must take care to not cause danger or damage to persons, moveable property, or livestock. As well, these activities must be conducted so as to not cause pollution or damage to the biosphere. There is a special licensing requirement for investigation and use of micro-organisms that may be processed in geothermal areas.[128]

Geothermal resource extraction must be conducted so as to maximize long-term efficiency. This includes not extracting more geothermal energy than necessary and drilling in a manner that causes the minimum possible inhibition of future use. Both prospecting or resource use licence holders must report annually to the Orkustofnun. In addition, a drilling journal must be kept by licence holders.

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[125] *Act on the survey and utilisation of ground resources*, 1998 No. 57 10 June (Amended by Act No. 5/2006, Article 10.

[126] *Ibid.* art. 12 and ch. X.

[127] *Ibid.* art. 10.

[128] *Ibid*.

Aside from regulatory requirements directly relevant to exploration and development of geothermal resources (as administered by the Orkustofnun), there are requirements for environmental assessment. Iceland has both strategic environmental assessment and environmental impact assessment legislation. The *Strategic Environmental Assessment Act*, No. 105/2006 adopts EU's *Directive 2001/42/EC* which requires adoption of environmental assessment at the planning and programme level. The *Environmental Assessment Act*, No. 106/2000 requires environmental assessment of geothermal power plants larger than 50MW. Other geothermal activities - for example, geothermal drilling in low temperature areas – may be required to undergo environmental assessment at the discretion of the Skipalagsstofnun (the National Planning Agency). As a result of environmental assessment, conditions may be placed on the relevant licences.

Extensive monitoring of the use of geothermal resources pursuant to the *Act on Official Monitoring No. 27/1999*. This includes monitoring of geothermal areas being researched or used. Developers are required to provide information to enable monitoring by the Orkustofnun.[129]

5.4 Policy

Since 1969 (i.e. the time of Iceland's first geothermal plant), "resource exploration, exploration drilling, development, and electricity production have remained mostly the responsibility of municipal, regional, or national government entities, under the regulation of the National Energy Authority".[130] A significant amount of Iceland's resources (3.1% of GDP) are devoted to energy

[129] Joana Ketilsson et al., Legal Framework and National Policy for Geothermal Development In Iceland, Proceedings World Geothermal Congress 2015, Melbourne, Australia, 19-25 April 2015.

[130] Speer et al., *supra* note 53 at 29.

sector research and development (this includes, but is not exclusively, geothermal research).[131]

In 1953, legislation passed "permitting the issuance of loan guarantees for up to 80% of total construction and drilling cost for geothermal district heating projects".[132] In 1961, an Electricity Fund was established to support geothermal exploration by the State Electricity Authority[133] and offered loans to communities and farmers for up to 60% of exploratory drilling costs (which converted to grant if drilling was not successful).[134] As well, in 1961 a Geothermal Fund was established to provide national government support to the projects undertaken by government or municipally owned companies.[135] These funds were merged in 1967 into the National Energy Fund which offers loans for geothermal exploration and drilling. Where the expected results are not obtained, the loans convert to grants.[136]

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[131] CanGEA Gap Report, *supra*. note 79 at 85.

[132] *Ibid.* at 85.

[133] Joana Ketilsson et al., Legal Framework and National Policy for Geothermal Development In Iceland, Proceedings World Geothermal Congress 2015, Melbourne, Australia, 19-25 April 2015.

[134] CanGEA Gap Report, *supra*. note 79 at 85.

[135] Speer et al., *supra*. note 53.

[136] Sveinbjorn Bjornsson, Geothermal Development and Research In Iceland (2006) National Energy Authority and Ministries of Industry and Commerce.

6. Chile

Chile has one the largest unexploited geothermal potentials in the world.[137] There is state ownership of the geothermal resource.[138] Access to the geothermal resource must be negotiated with the landowner.[139] As well, indigenous community engagement must occur.[140]

Central to Chile's geothermal regulatory regime is *Law No. 19,567 on Geothermal Energy Concessions* (2000). Under this law, any person may seek a concession to carry out exploration or development activities. Both exploration and development concessions are granted for 2-year periods which can be extended by an additional 2 years by showing sufficient progress on an implementation or action plan. In addition, to the limited term of concessions, all concessions must be in parallelogram shape.[141] Concessions are obtained via a public tender process. [142]

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[137] Bart van Campen et al., Geothermal Costs and Policy Impacts in Chile and Latin America (Conference Paper - October 2016) www.researchgate.net/publication/309319500.

[138] *Ibid*.

[139] *Ibid*.

[140] Law No. 19,253 Law of Indigenous People.

[141] Natural Resources Defense Council Issue Brief, Geothermal Energy: Unleashing the Earth's Power to Fuel Chile's Future (November 2013).

[142] Bart van Campen, "Comparison of Geothermal Regulation between Chile, Phillipines and New Zealand" (Proceedings World Geothermal Congress, Melbourne, Australia, 19-25 April 2015) available at www.researchgate.net/publication/280621073 [van Campen].

Geothermal resource activities are subject to environmental laws[143] which include environmental assessment and matters such as wildlife, emissions, forest, and hazardous waste.[144]

Chile's insufficient regulatory framework also hinders development of its geothermal resources. [145] Legal barriers within the regulatory regime include the terms of concessions, the inefficient process for concessions, the legal vacuum in environmental matters, and the absence of regulation for overlapping easements and other types of rights (such as mining or water rights).[146]

Aside from legal barriers, there is a barrier created by Chile's lack of clear medium-to-long term energy policies and lack of general direction regarding development of geothermal resources.[147] In particular, policies could be put into place to attract investment.[148]

6.1 Policy

Despite government and private investment since the late 1960s, Chile's geothermal resources remain untapped.[149] Assistance in developing its

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[143] Law No. 19,300/94 *Environmental Act*.

[144] van Campen, *supra*. note 142.

[145] Natural Resources Defense Council Issue Brief, Geothermal Energy: Unleashing the Earth's Power to Fuel Chile's Future (November 2013) [NRDC]. See also Geothermal Center for Excellence for the Andes in Santiago/Chile, Comparative analysis of Geothermal Energy Legislation, 2018 (English Executive Summary available at http://www.thinkgeoenergy.com/cega-report-and-recommendations-on-geothermal-energy-legislation-in-chile/) [GCEA].

[146] GCEA, *supra*. note 145.

[147] van Campen, *supra*. note 142.

[148] NRDC, *supra*. note 145.

[149] Sanyal et al., *supra*. note 66.

geothermal resources is being provided via the Clean Technology Fund through the World Bank Group and the Inter-American Development Bank.[150]

While a 400 million USD fund has been established by the state development agency and the national energy commission with the aim of reducing and sharing costs of exploration and transmission lines, there remains a significant level of risk associated with geothermal development in Chile.[151]

7. Japan

As one of the world's most tectonically active countries, Japan has tremendous geothermal resources. However, until very recently, the total installed geothermal power capacity was only 0.2% of total power generation facilities (about 535 MW).[152] There is a stated intention to increased installed capacity to more than 1,500 MW by 2030 (approximately three times the 2016 level).[153]

Japanese development of its geothermal resources began in the early 20th century (with a power plant established in 1924) with more active development encouraged in the 1970s with cost-shared drilling programs.[154] However, when

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[150] *Ibid*.

[151] S. Fraser et al., European Geothermal Risk Insurance Fund EGRIF, Deliverable no. 3.2 (2013) GeoElec funded by EU at 64 [Fraser et al].

[152] Seiki Kawazoe and Noriyuki Shirakura, "Geothermal Power Generation and Direct Use In Japan" (Proceedings World Geothermal Congress, Antalya, Turkey 24-29 April 2005). See also Seiki Kawazoe and Jim Combs, "Geothermal Japan: History and Status of Geothermal Power Development and Production" (2004) GRC Bulletin 58.

[153] T. Tosha, N. Nishikawa, T. Shimada, and T. Oishi, "Country Update of Geothermal Energy Development in Japan and the Activity of JOGMEC" (2016) 40 GRC Transactions 29.

[154] Sanyal et al., *supra.* note 66 at 2.

government policy changed and the cost-shared drilling programs were ended, geothermal development stalled.

After the Fukushima nuclear accident in 2011, renewed efforts have been made to encourage development of geothermal power projects.[155] These efforts include relaxing restrictions against development in national parks (where about 80% of the geothermal resources are located),[156] and the introduction of policy tools such as FITs and subsidies. In May 2019, a large-scale geothermal project was completed for the first time in 23 years.[157]

The construction and operation of a geothermal power plant project is subject to a variety of laws: the Electric Utility Law, the Electric Power Development Promotion Law, the *Air Pollution Control Act*, the *Water Pollution Prevention Act*, the *Effluvium Prevention Act*, the *Noise Control Act*, and the *Vibration Control Act*.[158] Environmental assessment is required for construction of a geothermal power plant 7,500 KW and above.[159] However, there is no national legislation enacted for the development of geothermal energy or generation.[160]

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[155] Hidefuni Nakashima, Sukenori Hospya, Toshiyuki Tosha and Tadaaki Shimada, "On the Japan's Geothermal Energy Development and the Role of JOGMEC" (Proceedings World Geothermal Congress, Melbourne, Australia, 19-25 April 2015).

[156] JOMEC, Current Situation of Geothermal Power Generation in Japan (n/d) slide deck [JOMEC].

[157] Joshua S. Hill, "Japan switches on first new geothermal power plant in 23 years" (May 23, 2019) www.reneweconomy.com.au.

[158] Fumio Yamaguchi and Seiki Kawazoe, "Process of Geothermal Energy Development in Japan", Japan Geothermal Energy Association (n/d) [Yamaguchi and Kawazoe].

[159] Takahiro Kobayashi and Shigeto Okatani, "Electricity regulation in Japan: overview" (2019) www.practicallaw.com/energy-guide [Kobayashi and Okatani].

[160] Yamaguchi and Kawazoe, *supra.* note 158.

Given that the vast majority of geothermal resources are located in national parks and the desire to increase geothermal energy production, there have been recent legislative changes which lessen the restrictions of developing geothermal resources within national parks.[161] In addition, the cultural and tourism value of onsens (natural hot spring pools) has created a damper on development of geothermal energy.[162] Permission to drill geothermal wells is required under the *Hot Spring Law* which is administered by the Environment Agency.[163] The Governor of the local government can grant permission to drill a geothermal well after accepting the opinion of the Natural Environment Conservation Council in the local government and considering the influence of the well on other hot springs. [164]

7.1 Policy

In 1974, the Japanese Agency of Industrial Science and Technology (and transferred to the New Energy Development Organization in 1980) operated a large geothermal research program "for the purpose of reducing exploration risk".[165] In conjunction with the research program, there was a cost-sharing program for costs of exploration drilling (cover 50% of drilling costs which must be repaid if the wells are successful) and costs of development and injection wells (20% of costs) .[166]

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[161] JOMEC, *supra*. note 156.

[162] "Unlocking Japan's geothermal energy potential" (n/d) The Japan Times.

[163] Yamaguchi and Kawazoe, *supra*. note 158.

[164] Yamaguchi and Kawazoe, *supra*. note 158.

[165] Speer et al., *supra*. note 53 at 31.

[166] *Ibid*.

Government policy changed in the late 1990s and cost-shared drilling was eliminated with the result that there was no new geothermal developments for almost 20 years.[167] However, in the last decade, there has been renewed interest in developing Japan's geothermal resources and a variety of policies and programs are now in place to support such development.

The Ministry of Economy, Trade and Industry (METI) oversees Japanese energy policy and implemented a Renewable Portfolio Standards (RPS) program which was later replaced with a FIT program to increase renewable energy sources.[168]

The *Act of Special Measures Concerning Procurement of Renewable Energy Sourced Electricity by Electric Utilities* establishes the FIT program which requires an electric utility, at the request of a renewable energy producer, to sign a contract to purchase electricity at a fixed price for a long-term period guaranteed by the government.[169] In order to be certified for the FIT program, the renewable energy producer must be (1) capable of stable and efficient generation of electricity during the guaranteed period (2) capable of transparently and fairly measuring the amount of electricity produced from renewable energy that is supplied to the electric utility (3) the facility used for power provision must be specified in detail.[170] Unlike other renewable energy sources, there are no additional specific geothermal requirements (such as certification of conformity to specified standards). It should be noted that the FIT program is currently under review and may be revised by 2121.[171]

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[167] Sanyal et al., *supra.* note 66.

[168] See International Energy Agency website, *Japan: Green Power: Renewable Portfolio Standards* at https://www.iea.org/policiesandmeasures/pams/japan/name-23884-en.php.

[169] METI, Feed-In Tariff Scheme in Japan (n/d) slide deck.

[170] *Ibid*.

[171] Kobayashi and Okatani, *supra.* note 159.

Since 2012, the Japan Oil, Gas and Metals National Corporation (JOMEC) has been responsible for providing technical and financial support for geothermal development.[172] JOMEC supports geothermal development with subsidies ranging from 50-100% of necessary funds, equity capital investment (up to 50%, so long as not largest shareholder), and liability guarantees (up to 80% of loan provided by financial institutions).[173] According to S. Fraser et al., "[t]his great expenditure of public funds for geothermal exploration and drilling greatly reduced resource and financial risk for the private entities involved in Japan's geothermal industry."[174]

8. New Zealand

New Zealand uses its geothermal resources both for direct use applications (in pulp and paper, dairy, agriculture, fisheries, residential and commercial buildings, hot pools and tourist attractions) and for producing electricity.[175] The total production of geothermal electricity stands at over 900 MW with a potential for another 1,000 MW.[176] There is also potential to expand the amount of direct use of geothermal resources.[177]

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[172] JOMEC, *supra*. note 156.

[173] *Ibid*.

[174] Fraser et al., *supra*. note 151.

[175] Colin C. Harvey and Brian R. White, A Country Update of New Zealand Geothermal: Leading the World in Generation Growth Since 2005 (Proceedings of the 4th African Rift Geothermal Conference 2012, Nairobi, Kenya, 21-23 November 2012).

[176] Government of New Zealand website, Energy Efficiency and Conservation Authority, Geothermal.

[177] *Ibid*.

While geothermal resources were initially regulated by the *Geothermal Act 1953* and the associated *Geothermal Regulations 1961*, much of that legislation has been replaced by the *Resource Management Act 1991* (RMA) which is the primary planning and environmental legislation in New Zealand. Under the RMA, sustainable management of geothermal resources is vested in regional authorities. Each regional authority must develop a Regional Policy Statement which outlines the main resource management issues, policies, and methods to achieve integrated management resources of the region. As well, a regional authority may develop a Regional Plan to provide rules about the use of natural and physical resources. The Regional Policy Statement and Regional Plans are guided by National Policy Statements developed pursuant to the RMA.

Portions of the *Geothermal Regulations 1961* remain in place (under the *Health and Safety in Employment Act 1992*, s. 24). These remaining regulations address safety matters such as requirements for pipes, valves and pressure vessels; the use, handling and storage of substances used in drilling; and the use, handling and storage of toxic, corrosive and eco-toxic substances.[178] There are also codes of practice and guidelines addressing operations of geothermal wells and geothermal heating equipment.[179]

While New Zealand has common law relating to groundwater and aboriginal title, these are a little practical relevance to the regulation of geothermal resources due to the statutory framework.[180]

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[178] Donna Ellis, Wayne Vernon and Sam Lord, "Challenges of New Zealand Geothermal Legislation" (Proceedings World Geothermal Congress, Melbourne, Australia, 19-25 April 2015).

[179] *NZS 2403:1991 Code of Practice for Deep Geothermal Wells; NZS 2402P:1987 Code of Practice for Geothermal Heating Equipment; Health and Safety Guidelines for Shallow Geothermal Wells 1996; and Health and Safety Guidelines for Self-Management of Shallow Geothermal Bore Systems 2005*.

[180] R.P. Boast, "Geothermal Resources in New Zealand: A Legal History" (1995) 6 Canterbury L. Rev. 1.

8.1 Definition of Geothermal Resources

Geothermal energy means "energy derived or derivable from and produced within the earth by natural heat phenomena; and includes all geothermal water".[181]

Geothermal water means "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".[182]

8.2 Ownership of Geothermal Resources

New Zealand's legislation vests the right to manage the resource (as opposed to ownership of the resource) with the Crown[183] which is an approach more similar to New Zealand's legal treatment of its water than its mineral resources. The question of ownership of geothermal resources is not entirely clear.[184] The common law of New Zealand suggests that there is no absolute ownership and the Maori tribes claim geothermal resources as "taonga" (i.e. prized possession of the people).[185] At least one scholar has concluded that, in New Zealand, no one owns the geothermal resources rather entitlement is granted only for

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[181] *Resource Management Act* 1991, s. 2.

[182] *Ibid.* at s. 2.

[183] Brian White, Grant Morris and Tom Lumb, New Zealand Geothermal Resource Ownership – Cultural and Historical Perspective (1995) available at https://www.geothermal-energy.org/pdf/IGAstandard/WGC/1995/1-white.pdf [White et al.]

[184] van Campen, *supra.* note 142.

[185] White et al., *supra.* note 183. See also Tom Bennion (Tribunal Staff), *New Zealand Law and the Geothermal Resource* (July 22, 1991) prepared as background to the Waitangi Tribunal's inquiry into geothermal claims.

sustainable use of the resources.[186] While ownership is not clear, the local Maori tribes have significant control over the geothermal resources, along with district and regional governments.[187]

8.3 Licensing Regime

Generally, geothermal energy is considered an attribute of water.[188]

There is no specific consent or permit required for exploratory activities (aside from potential environmental impacts).[189]

Development may require a resource consent which is issued by the relevant regional authority. Different regional authorities may take different approaches to geothermal resource development.[190] Particular types of developments or developments in certain areas may be classified as:[191]

- Permitted Activity

  Allowed by a regional plan without need for a resource consent so long as certain conditions met.

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[186] Simon Schofield, "Geothermal and Wind Energy in New Zealand" (2013) 17 N.Z. J. Envtl. L. 155.

[187] White et al., *supra*. note 183.

[188] Donna Ellis, Wayne Vernon and Sam Lord, Challenges of New Zealand Geothermal Legislation (April 2015) Proceedings World Geothermal Congress (Melbourne, Australia, 19-25 April 2015).

[189] van Campen, *supra.* note 142.

[190] Katherine M. Luketina, "New Zealand Geothermal Resource Management - A Regulatory Perspective" (Proceedings World Geothermal Congress, Melbourne, Australia, 19-25 April 2015) [Luketina].

[191] *Ibid*.

- Controlled Activity

A resource consent is required but is granted so long certain conditions are met. Typically, public submissions on the application are not taken for these activities.

- Discretionary Activity

These are large-scale activities requiring a resource consent. Likely to involve public notification and, perhaps, a public hearing.

- Non-complying Activity

These activities contravene a rule in a regional plan and, therefore, require a resource consent. Likely will trigger a public notification requirement.

- Prohibited Activity

Activities that are expressly prohibited in a regional plan and for which no resource consent will be issued.

Depending on the type of activity, the resource consent process can include an environmental assessment, and public notification and consultation.[192] A hearing may be required if there are submissions filed in opposition to issuance of a resource consent. A resource consent may have conditions attached and, in some cases, a bore bond may be required.

[192] Luketina, *supra.* note 190.

Although the RMA enables regional authorities to collect payments for use of geothermal energy, it appears this clause has never been used.[193] However, administrative payments are often required by regional authorities for monitoring, peer review programs and applications.

A project developer needs to obtain consent from the surface landowner who controls physical access to the geothermal resource. This usually takes the form of a lease agreement, some form of payment, or partial ownership/co-investment.[194]

8.4 Policy

According to Speer et al., "[m]ost of New Zealand's geothermal power development was due to government-led exploration".[195] Most development occurred at a time when the government bore exploration risk (via government-owned utilities). Although the Crown reserves a right to charge a royalty of geothermal energy, as a matter policy it does not actually do so (due to social benefits of clean energy).[196]

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[193] van Campen, *supra.* note 142.

[194] *Ibid*.

[195] Speer et al., *supra.* note 53 at 31.

[196] CanGEA Gap Report, *supra.* 79 note at 85.

9. Philippines

In 2013, The Philippines ranked third in the world in geothermal development (after the US and Indonesia).[197] In recent years, the Philippine government has attempted to promote and encourage development of geothermal resources with minimum regulation.[198] The development and use of geothermal resources is regulated by the *Renewable Energy Act of 2008*.[199] The Act sets out several purposes which characterize the Philippines long-term energy plan: [200]

- accelerate exploration and development of renewable energy sources (including geothermal) to reduce dependence on fossil fuels and to reduce emissions;

- increase use of renewable energy by institutionalizing growth and development of national and local capabilities; and

- promote efficient and cost-effective commercial application of renewable energy by providing fiscal and non-fiscal incentives.

The Act sets out a variety of policy mechanisms designed to encourage development of renewable energy resources.[201] This includes a RPS program which requires power producers to maintain a minimum renewable energy

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[197] See Philippines Department of Energy website, at https://www.doe.gov.ph/energist/philippines's-ranking-geothermal-energy-generation-slides-third-after-indonesia.

[198] Darwin P. Angeles, "The State of Philippine Law on Geothermal Power: Policies, Projects, Implications" (2013) 87 Phil. L.J. 415 [Angeles].

[199] *Renewable Energy Act of 2008* (RA No. 9513).

[200] *Renewable Energy Act of 2008*, s. 2. See also Angeles, *supra.* note 198.

[201] Angeles, *supra.* note 198.

generation, along with tradable certificate which can be bought and sold to meet the RPS requirements. There are also policy mechanisms aimed at consumers such as green energy options (allowing consumer choice of renewable energy) and net-metering for renewable energy. In order to encourage transmission and distribution system development, the Act mandates that National Transmission Corporation include required connection facilities for renewable energy based power plants in their transmission and distribution development plans. Finally, there is policy encouraged off-grid development of renewable energy resources.

A variety of incentives for potential renewable energy developers and investors are created under *The Renewable Energy Act of 2008*.[202] These include numerous tax incentives, feed-in-tariffs, and preferential financial assistance from government financial institutions, among others.

9.1 Definition of Geothermal Resources

The *Renewable Energy Act of 2008* defines **geothermal energy** as a renewable, mineral resource "produced through: (1) natural recharge, where the water is replenished by rainfall and the heat is continuously produced inside the earth; and/or (2) enhanced recharge, where hot water used in the geothermal process is re-injected into the ground to produce more steam as well as to provide additional recharge to the convection system".[203]

9.2 Ownership of Geothermal Resources

Under Article XII, Section 2 of the 1987 Constitution, all "minerals, coal, petroleum, and other mineral oils and all forces of potential energy… are

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[202] *Ibid*.

[203] *Renewable Energy Act of 2008* (RA No. 9513), s. 4(q).

owned by the State". Geothermal resources are considered a force of potential energy and therefore owned by the government.[204]

9.3 Regulatory Regime

The *Renewable Energy Act of 2008* provides a streamlined process for exploration and development of renewable energy resources. Exploration is permitted pursuant to a renewable energy contract which, upon discovery of a feasible and productive renewable energy resource, allows development to be undertaken without the need to obtain a separate development contract.[205] The rules for entering contracts are set out in the Department of Energy's Department Circular DC2009-07-0011.

9.4 Policy

Initial development of the Philippines' geothermal resources, starting in the 1960s, was led by a dedicated geothermal subsidiary of the state-owned Philippine National Oil Company.[206] At the same time, the state invited an international oil company to conduct geothermal exploration and development.[207] The "balance between private and public partnerships…helped rapidly scale-up geothermal development".[208] The state is no longer actively involved in the development of geothermal resources.

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[204] Angeles, *supra*. note 198.

[205] *Ibid*.

[206] Sanyal et al., *supra*. note 66.

[207] *Ibid*.

[208] *Ibid*. at 23.

According to Bethany Speer et al., the "state-owned national oil company *developed* nearly all of its existing geothermal capacity".[209] In light of more recent privatization, there was a FIT program attempted. The FIT program required interconnection to the grid before project could be considered eligible (thus considerable risk remained on the project developer).[210] That, in combination with an aggressive tariff, resulted in an oversubscribed program which left many projects stranded.[211] In light of these shortcomings, a decision was made to move to a RPS approach.[212]

Currently, there is only a draft RPS program design.[213] The RPS sets a 35% by 2030 target and requires distribution utilities, electric cooperatives, and retail electricity suppliers to source a portion of their energy supply from eligible renewable energy facilities (including geothermal facilities).[214] There is a 1% annual increment to targets.[215]

Aside from experimenting with a FIT program and a possible RPS program, financial benefits are offered through the *Renewable Energy Act* (2008) and the *Philippine Geothermal Service Contract Law (Presidential Decree 1442)*. As summarized by S. Fraser et al.:[216]

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[209] Speer et al., *supra*. note 53 at 7.

[210] Jenny Hester, Bethany Speer and Mark B. Flick, International Best Practices for Implementing and Designing Renewable Portfolio Standard (RPS) Policies, Technical Report NREL/TP-6A20-72798 (Golden, CO: 2019, National Renewable Energy Laboratory).

[211] *Ibid*.

[212] *Ibid*.

[213] *Ibid*.

[214] *Ibid*.

[215] *Ibid*.

[216] Fraser et al., *supra*. note 151 at 65.

> The Renewable Energy Act passed in December 2008 provides specific and attractive benefits to companies involved in geothermal exploration and development. Terms include a 7-year tax holiday on capital goods, reduction in corporate income tax from 30% to 10%, exemption from VAT and reduction in royalty to be paid to the government on sale of electricity from 6% to 1%. Although not specifically designed to reduce exploration risk, these incentives are encouraging private entities to perform surface exploration and drill exploratory wells at their own risks."

Significant incentives provided via the *Philippine Geothermal Service Contract Law (Presidential Decree 1442)* include "exemption from payment of tariff duties and compensating tax on the importation of machinery and equipment, spare parts and all materials required for geothermal operations", "entry of foreign technical and specialized personnel who may exercise their profession solely for the operations of the contractor", and "repatriation of capital investment and remittance of earnings derived from its service contract operations".[217]

In addition, there are also numerous financial support schemes such as the renewable energy trust fund (for financing research, development and demonstration of productive renewable energy use), project preparation fund, loan guarantee fund, and new and renewable energy financing program.[218] Other fiscal incentives include income tax holiday, duty free importation of renewable energy machinery, equipment and materials, special tax rates on equipment and machinery, net operating loss carry-over, accelerated depreciation, tax exemption on carbon credits, tax credit on domestic capital equipment and services, and special corporate tax rate.[219] In addition, there is a

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[217] Sander, *supra*. note 51.at 1243.

[218] *Ibid*. at 1243.

[219] *Ibid*. at 1243.

requirement on grid system operators to "purchase, connect to the grid and transmit geothermal energy as a priority".[220]

10. Lessons Learned

Review of several jurisdictions illustrates the importance of government support in development of geothermal resource development. Those jurisdictions with high levels of geothermal resource development have benefited from government-led research and development, policies designed to encourage development (such as grants, FITs), or both. In contrast, those jurisdictions that lack comprehensive approaches to regulation and policy support also lack geothermal resource development.

[220] *Ibid*. at 1243.

Jurisdictions at a Glance

Jurisdiction	Definition	Ownership	Policy Tools	Geothermal Development
British Columbia	Natural heat of the earth and all substances that derive an added value from it, including steam, water and water vapour heated by the natural heat of the earth and all substances dissolved in the steam, water or water vapour obtained from a well, but does not include (a) water that has a temperature less than 80°C at the point where it reaches the surface, or (b) hydrocarbons	Crown	No comprehensive approach Small Business Capital Project program and government grants	Minimal
Saskatchewan	No statutory definition	No express legislative statement	No comprehensive approach Government grants	Minimal
California	For the purposes of this chapter [methane gas hazards reduction], "geothermal resources" shall mean 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 mineral in solution or other products obtained from	State	Numerous policy mechanisms at both the state and federal level including grants, cost-shared drilling programs, industry-coupled case studies program, user-coupled	Moderate

Jurisdiction	Definition	Ownership	Policy Tools	Geothermal Development
	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.		confirmation drilling program, production tax credits, PURPA legislation (requiring utilities to purchase from geothermal producers)	
Europe: Germany	Energy stored in the form of heat beneath the surface of solid earth	Freely mineable resources	Feed-in-Tariffs Loan guarantee and lending support programs Government led research and development	Moderate
Europe: Italy	Energy stored in the form of heat beneath the surface of solid earth	Italy	Most development has been government-led Feed-in-Tariffs	Moderate
Iceland	On one hand, reserves of energy in the bedrock, and, on the other hand, a constant flow of heat from the bowels of the earth which does not constitute groundwater	Private land: surface owner Public land: state (and as of 2008, cannot sell those	Most development has been government-led Loan guarantees Loans (which convert to grants	Moderate

Jurisdiction	Definition	Ownership	Policy Tools	Geothermal Development
		geothermal resources)	in the event of failure) Significant investment in renewables research and development	
Chile		State	General lack of direction and policy Government investment Assistance via the World Bank Group's Clean Technology Fund	Minimal
Japan			Cost-shared drilling programs (in the 1970s) Renewable Portfolio Standards later replaced with Feed-in-Tariffs Technical and financial support via subsidies and loan guarantees	Rapid expansion in recent years

Jurisdiction	Definition	Ownership	Policy Tools	Geothermal Development
New Zealand	Energy derived or derivable from and produced within the earth by natural heat phenomena; and includes all geothermal water Geothermal water means water heated within the earth by natural phenomena to a temperature of 30°C	Ownership not entirely clear Management right vested in the Crown	Government-led exploration and development	Moderate
Philippines	Renewable, mineral resource produced through (1) natural recharge, where the water is replenished by rainfall and the heat is continuously produced inside the earth; and/or (2) enhanced recharge, where hot water used in the geothermal process is re-injected into the ground to produce more steam as well as to provide additional recharge to the convection system	State	Initial development government-led Feed-in-Tariff which has been discontinued and is planned to be replaced by a Renewable Portfolio Standard	Moderate