Presented at "Short Course on Geothermal Development and Geothermal Wells",
organized by UNU-GTP and LaGeo, in Santa Tecla, El Salvador, March 11-17, 2012.

UNITED NATIONS UNIVERSITY
GEOTHERMAL TRAINING PROGRAMME

LaGeo S.A. de C.V.

LEGAL AND REGULATORY FRAMEWORK – BARRIER OR MOTIVATION FOR GEOTHERMAL DEVELOPMENT?

Ingimar G. Haraldsson
United Nations University Geothermal Training Programme
Orkustofnun, Grensasvegi 9, 108 Reykjavik
ICELAND
ingimar.haraldsson@os.is

ABSTRACT

Legal and regulatory frameworks addressing geothermal development comprise a complicated set of rules that developers must follow through the development cycle, from the very first exploration surveys to the construction and operation of a power plant. Being aware of and heeding them all may seem like a heavy task and in some cases these laws and regulations may present themselves as barriers to development. As a consequence, the following question arises: Do legal and regulatory frameworks present barriers to geothermal development or are they a motivating influence? In order to formulate an answer, the literature has been consulted on topics such as the definition of geothermal resources, ownership, permitting processes, and economic support for geothermal development, as expressed by laws and regulations in various countries around the world.

1. INTRODUCTION

Unlike the geosciences and geothermal engineering, which are identical or similar between countries, the legal and regulatory framework directing geothermal exploration and development can vary in many respects between countries, and even within them. The aim of this paper is to compare some key topics of such frameworks and address the question of whether they present barriers to geothermal development or if they should be viewed as a motivating factor. To this end, a review of recent international literature was conducted.

2. DEFINITIONS OF GEOTHERMAL RESOURCES

The definitions of geothermal energy and geothermal resources must be at the core of any legal framework addressing geothermal development and resource management. These definitions vary between countries and states and can broadly be classified into three categories (Table 1) in which geothermal resources are considered:

- A part of the mineral estate and are handled by mineral legislation;
- As water resources and are thus handled by water legislation; and
- As resources unique in themselves (sui generis).

Although legislation most often refers to *geothermal resources*, the term *geothermal energy* is preferred in some countries/states. In others the terms are defined separately.

In the following subsections, some examples of definitions are given.

2.1 Australia

Collyer et al. (2010) report that the geothermal energy sector has much in common with the mining of petroleum and is regulated as such in South Australia and Western Australia. In those territories, petroleum legislation has been amended so that it now regulates both petroleum and geothermal energy. In New South Wales and Tasmania, a geothermal resource is defined as a mineral and is regulated under mining legislation. In Queensland, Victoria and the Northern Territory, geothermal energy is regulated by a dedicated act.

2.1.1 Queensland

In Queensland, *geothermal energy* is defined as the heat energy derived from the earth's natural (subsurface) heat. *Geothermal resources* are defined as the geological strata and associated material in which elevated levels of geothermal energy exist (Parliament of Queensland, 2010).

2.2 European Union (EU)

Legislation concerning the development and management of geothermal resources within the EU is different between member States. From 2006 to 2009, the GTR-H project was run to review the regulatory framework for geothermal resources in selected member States. The study found that geothermal regulation within the EU, as well as internationally, is predominantly influenced by preceding natural resources legislation (Goodman et al., 2010).

The RES Directive 2009/28/EC defines *geothermal energy* as the energy stored in the form of heat beneath the surface of the solid Earth.

One of the conclusions of the project was that the clear definition of geothermal energy was of primary importance in the legislative framework (Goodman et al., 2010). The authors also recommended the harmonization of basic terminology between different member States, using only the term *geothermal energy*, which would serve to increase clarity and consistency.

It is likely that differences between legislative and regulatory frameworks for geothermal development between EU countries can serve as barriers for developers to step from one country to another, thus inhibiting the free flow of investment and services in the geothermal sector within the union.

2.3 Germany

Different laws/regulations apply to the harnessing of geothermal resources in Germany depending on whether they are found in deep or shallow systems. Deep geothermal energy refers to energy extracted from deep hot-water aquifers with temperatures up to around 160°C. The harnessing of such resources is first and foremost dictated by mining regulations and the same legal provisions apply as for the extraction of crude oil. The utilization of shallow geothermal energy (e.g. by heat pumps), is mainly subject to water laws and those can be different between the German federal states (Gassner, 2010).

2.4 Iceland

The Icelandic Act on the Survey and Utilization of Ground Resources defines *geothermal energy* as reserves of energy in the bedrock on one hand, and on the other, a constant flow of heat from the depths of the earth which does not constitute groundwater (Parliament of Iceland, 1998). While this definition treats geothermal energy as unique in itself, it is categorized by the act as a ground resource along with minerals and groundwater. A large part of the act addresses the category as a whole, but specific parts treat the constituents (minerals, geothermal energy and groundwater) separately, as unique in themselves. Iceland is therefore placed in all categories in Table 1.

2.5 Philippines

Peñarroyo (2010) notes that under the Philippine Renewable Energy Act of 2008, *geothermal resources* are referred to as mineral resources, classified as renewable energy resources, in the form of: (i) all products of geothermal processes, embracing indigenous steam, hot water, and hot brines; (ii) steam and other gases, hot water, and hot brines resulting from water, gas, or other fluids artificially introduced into geothermal formations; (iii) heat or associated energy found in geothermal formations; and (iv) any by-product derived from them.

This definition is much broader than some definitions of *geothermal energy*, especially when considering item (iv) above.

2.6 United States (US)

Miethling (2011) points out that while the State government has in most cases been the initiator of geothermal development in a country, this was not the case in the US, where single entrepreneurs gathered funding for geothermal projects in the Geysers field in Northern California in the 1950s. As a result, legislation lagged behind development and a lack of resource definition posed some serious hurdles. Early attempts to introduce specific geothermal legislation were the California Geothermal Resources Act of 1967 and the federal Geothermal Steam Act of 1970, but they did not provide guidance on whether to handle geothermal as water, mineral, or as a resource unique in itself (sui generis).

Bloomquist (1986) reports that the federal Geothermal Steam Act of 1970 defined *geothermal resources* as follows: 'Geothermal steam and associated resources' means (i) all products of geothermal processes, embracing indigenous steam, hot water, and hot brines; (ii) steam and other gases, hot water, and hot brines resulting from water, gas, or other fluids artificially introduced into geothermal formations; (iii) heat or other associated energy found in geothermal formations; and (iv) any by-products derived from them.

It is interesting to note that the Philippine definition is identical.

As the act did not state how geothermal resources should be characterized, the courts were asked to settle the matter. They declared that geothermal was to be looked upon as a mineral resource for purposes of ownership and leasing (Reed and Bloomquist, 1995).

The states also have their own definitions of geothermal resources and those differ from state to state as the following subsections reveal.

2.6.1 Alaska

Alaska tried to separate the regulation of high-temperature *geothermal resources* capable of electrical generation (greater than 120°C), from low-temperature resources that could be used directly and which were to remain under provision of water law (Reed and Bloomquist, 1995). This is similar to the approach taken by Germany.

2.6.2 California

Bloomquist (1986) reports that the California Resources Act of 1967 defines *geothermal resources* as the natural heat of the earth, the energy, in whatever form, below the surface of the earth present in resulting from or created by, or which may be extracted from, such natural heat, and all minerals in solution or other products obtained from naturally heated fluids, brines, and associated gas, and steam, in whatever form, found below the surface of the earth, but excluding oil, hydrocarbon gas, or other hydrocarbon substances.

Although somewhat different from the federal definition, it is similar in scope and broader than most definitions of *geothermal energy*.

2.6.4 Hawaii

The state of Hawaii characterizes geothermal resources as mineral (Reed and Bloomquist, 1995).

2.6.3 Idaho

Idaho's definition includes an explicit reference to water, defining *geothermal resource* as the natural heat energy of the earth, the energy, in whatever form, which may be found in any position and at any depth below the surface of the earth present in, resulting from, or created by, or which may be extracted from such natural heat, and all minerals in solution or other products obtained from the material medium of any geothermal resource. Ground water having a temperature of two hundred twelve (212) degrees Fahrenheit or more in the bottom of a well shall be classified as a geothermal resource (Callison, 2010).

2.6.4 Nevada

Nevada defines a *geothermal resource* as the natural heat of the earth and the energy associated with that natural heat, pressure and all dissolved or entrained minerals that may be obtained from the medium used to transfer that heat, but excluding hydrocarbons and helium (Callison, 2010).

2.6.5 Utah and Wyoming

In Utah and Wyoming, the states have characterized geothermal resources as water (Reed and Bloomquist, 1995).

2.6.6 Washington

A different approach is taken in Washington, where a *geothermal resource* is taken as the natural heat energy of the earth from which it is technologically practical to produce electricity commercially (Reed and Bloomquist, 1995). A geothermal resource is therefore considered to be unique in itself (sui generis).

2.7 Synopsis

The preceding examples show the diversity of definitions of *geothermal resources* and *geothermal energy* between different countries, as well as within countries. As these definitions are the underpinnings of legislative and regulatory frameworks for geothermal development and often form the basis for determining ownership of the resources, it is of primary importance that they be clear cut. The diversity may be seen as a barrier for national or international geothermal developers who need to get acquainted with the different legislative frameworks. This is especially true for developers that operate within a single country, such as Australia, Germany, or the United States, but have to adapt to new legislation/regulations as they pass between territories/states. This is also valid for developers within the European Union that have to adapt to different rules in different member States and for international developers that operate globally. Consistency between legislative frameworks is therefore important.

TABLE 1: The classification of *geothermal resources* or *geothermal energy* into categories in different countries and states.

Mineral	Sui generis	Water
Australia: New South Wales South Australia Tasmania Western Australia Germany (deep) Iceland Philippines United States: Federal Hawaii	Australia: Northern Territory Queensland Victoria European Union Iceland United States: Washington	Germany (shallow) Iceland United States: Utah Wyoming

3. OWNERSHIP

3.1 Germany

Gassner (2010) notes that the right to exploit geothermal energy using deep geothermal energy plants is not part of real estate property, but has to be granted by state authorities for certain areas.

3.2 European Union

Ownership of geothermal resources in the EU follows different rules in different member States.

3.3 Iceland

The ownership of resources in the ground is attached to private land in Iceland, while on public land resources in the ground are the property of the State of Iceland, unless others can prove the ownership (Parliament of Iceland, 1998).

3.4 Philippines

Peñarroyo (2010) notes that all natural resources in Philippine territory belong to the State, as declared in the country's constitution. The handling of those resources is also an affair of the State as the exploration, development, and utilization of natural resources shall be under the full control of the State. The State may however enter into partnerships with Philippine citizens or corporations that are at least 60% owned by citizens. In addition, the president may enter into agreements with foreign-owned corporations based on contributions to the economic growth and general welfare of the State.

3.5 United States

Reed and Bloomquist (1995) note that separation of mineral rights from surface rights in the US in the 19th century, and the associated separation of ownership rights, has led to much confusion. In some cases ownership of surface rights and subsurface mineral rights goes hand in hand, but in other cases the ownership is separate. In the former case, a developer negotiates an agreement with a single owner, while in the latter case a permit must be sought from two separate owners, which adds to the complexity of the permitting/leasing process and can thus be viewed as a barrier to development.

In the Western United States, large areas of land are owned by the federal government or state governments (Reed and Bloomquist, 1995). Some land is privately owned and Indians and Inuits are in charge of their reservations. The federal government has the ownership rights to geothermal resources where it holds the mineral rights, but different approaches are taken by the states in accordance with their categorization of geothermal resources. California's claim to ownership of geothermal resources is in line with the approach taken by the federal government, as both categorize these resources as belonging to the mineral estate. In Washington state, where geothermal resources are categorized as sui generis, geothermal resources belong to the surface owner. In Wyoming, which categorizes geothermal resources as water, they are considered as belonging to the public (Reed and Bloomquist, 1995).

Again this poses hurdles for developers and makes the permitting/leasing process more difficult to navigate.

3.6 Synopsis

Bloomquist (1986) points out that problems associated with the establishment of ownership are greatly reduced when geothermal resources are categorized as either mineral or water, whereas the sui generis categorization clouds the ownership question as in some cases it leaves little guidance for the resolution of disputes between surface and subsurface owners. Settling such disputes in court can be time consuming and cause serious delays in projects. Here, clarity is of utmost importance.

More than one owner may have the rights to a single geothermal field/resource. This is a potential barrier to development, as it may complicate utilization rights and the issuance of permits. An extreme example is when a geothermal field extends across a national border, as is the case with the Tufiño-Chiles prospect that lies across the Colombia-Ecuador border. In this case, the governments of Colombia and Ecuador have signed a bilateral agreement on the development of the resource (Haraldsson, 2012).

Differences in determining ownership between states/countries can again cause hurdles for developers that operate in more than one state/country and consistency between legislative frameworks is therefore of great value.

4. PERMITTING AND ADMINISTRATIVE PROCESSES

4.1 Australia

Collyer et al. (2010) report that geothermal permitting and administrative processes differ between the Australian territories. In South Australia, a Statement of Environmental Objectives must be approved by the relevant minister before activity commences. If such a statement already exists for petroleum activities, it can also be used for geothermal activities as both are governed by the same act. In addition, native title negotiations must be approached in accordance with the legislation that applies to geothermal resources/energy in each territory. In Victoria, native title holders must be compensated for any loss or damage resulting from geothermal activities on their land. In the Northern Territory, the relevant minister must acknowledge that the native title holder's consent has been obtained in accordance with federal Native Title Act procedures. They also note that geothermal tenements may overlap with other tenements, such as those granted for the exploitation of petroleum or gas. If petroleum production is already in place, geothermal exploration or production cannot be undertaken if it adversely affects the rights of the first tenement holder.

4.1.1 Queensland

Zillmann and Makras (2010) inform that applications for a geothermal exploration permit in Queensland can be made through two processes, as dictated by the Geothermal Energy Act of 2010. In one process an area is released for competitive bidding. In the other, eligible persons can apply for land of choice at any time. The exploration tenure lasts for 15 years. For large scale geothermal production, a lease must be obtained. An applicant must submit a plan of development and intended energy production to the relevant authority. Production must start within 2 years of the lease grant. The lease has an initial maximum term of 30 years, but can be renewed for 20 year periods. A royalty is payable on the lease, although a royalty holiday is granted until 2020 to encourage development. After that, a royalty-free threshold applies to the early years of production. Various legislation has to be obeyed in the permitting process, including environmental protection, water, and health and safety acts. In the case of overlapping tenements, the relevant minister decides on priority. Tenure holders also have responsibilities in relation to land access to private land and must compensate the land owner appropriately.

4.2 Germany

Gassner (2010) notes that in Germany, mining regulation is most important when it comes to the exploitation of deep geothermal resources. Surface permits have to be granted by state authorities for certain areas and laws relating to water, construction, planning and nature conservation must also be observed. A number of special, separate approvals are therefore necessary for any given project.

4.3 Iceland

According to the Act on the Survey and Utilization of Ground Resources, the State, local governments, and companies that are fully owned by those bodies are not allowed to transfer ownership of geothermal resources or groundwater resources permanently, whether directly or indirectly, to other entities, beyond that which may be deemed necessary for domestic use. However, they may transfer rights between themselves or to new companies owned by those bodies. The said bodies are permitted to lease the right to utilization for up to 65 years and the leaseholder has the right to initiate discussions on the extension of the lease when half of the leasing period has expired. The relevant minister shall negotiate royalties and take care that the lease decision leads to economic utilization of resources and investment in structures (Parliament of Iceland, 1998).

The minister can initiate surveying and prospecting for ground resources or issue a license for such an undertaking to others. Private landowners are however allowed to initiate surveying on their own accord without a license, if a license has not previously been issued to others. When a surveying license is issued for private land, the landowner is obliged to allow the surveyors unobstructed access to the land, and to endure any inconvenience that may ensue from the surveying.

The relevant minister can issue utilization licenses for ground resources on both public and private land. A land owner does not have priority for the utilization of a resource under his land, unless a surveying license has previously been issued to the owner. Various conditions can be set in the license terms, including maximum production. Before the license holder, if different from the land owner, starts utilizing the resource, the holder needs to reach an agreement with the land owner on compensation for the resource or obtain permission for expropriation.

The National Energy Authority of Iceland (NEA; Orkustofnun) administers both surveying and utilization licenses on behalf of the minister (Ketilsson et al., 2010).

In accordance with the Environmental Impact Assessment Act, geothermal power stations with a heat output of 50 MW or more and other power installations with an electricity output of 10 MW or more are always subject to an environmental impact assessment (Parliament of Iceland, 2000).

According to the Electricity Act, the developer must obtain a license from NEA to construct and operate a power plant for electrical generation, unless the rated capacity is below 1 MW (Parliament of Iceland, 2003).

As noted by Gunnlaugsson (2007), a development consent and building permit are needed from the local authority. An operation license is also required from the environmental division of the local community. In addition, other special permits may be needed, such as a permit from the Archaeological Heritage Agency to certify that the development does not disturb archaeological relics.

4.4 New Zealand

Luketina (2000) reports that according to the Resource Management Act of 1991 (RMA), a resource consent application must be accompanied by an environmental assessment. All interested parties, including adjacent landowners, occupiers of land, native tribes, the Department of Conservation, the relevant district council, environmental groups, and special interest groups must be consulted. The application must be advertised publicly and if formal opposition is filed, the matter goes before a Hearings Committee. The decision of the Committee may be appealed to the local Regional Council, Environment Court or High Court, as applicable. Application costs are determined by how detailed an environmental assessment is needed, processing time, and whether the application is faced by opposition resulting in a hearing process. Notified applications may take from a couple of months to a few years if a hearing process is needed. A consent may be issued with conditions. Most power plants need about 15 consents, each of which has to be paid for.

4.5 Philippines

Peñarroyo (2010) informs that a new contractual system for the award of geothermal exploration and production has been put in place in the Philippines by the ratification of the Renewable Energy Act of 2008. A developer can thus obtain an exclusive right over a certain period to the exploration and development of a particular renewable energy area through an agreement with the government through the Department of Energy. Prior consultation, consent and certification are needed from local government units or the National Commission of Indigenous Peoples, as applicable. Even though indigenous cultural communities do not own the natural resources on or under their lands, they have the right to benefit from the utilization of those resources and to be compensated for any social and environmental costs of such activities. Development must comply with the Environmental Impact Assessment System, which often requires the issuance of an Environmental Compliance Certificate (ECC) from a regional office of the Department of Environment and Natural Resources. The ECC lists specific measures and conditions that must be undertaken before and during the unraveling of a project in order to mitigate environmental impacts. Utilization of protected areas can only be permitted through Congress. Although the Renewable Energy Act facilitates the development of the country’s geothermal resources, it fails to address access into private lands and concession areas. According to Peñarroyo, the approval and permitting process is still complicated and needs review.

4.6 United States

4.6.1 Federal land

Reed and Bloomquist (1995) report that development on federal land requires a lease. The lease can be obtained on a non-competitive basis, in which case the developer pays a filing fee, a set rental amount per annum, and a royalty on production, or on a competitive basis. The lease extends for a duration of 35 years after the start of successful development. According to a 1988 court decision, the leasing requires the completion of an Environmental Impact Statement (EIS). Resource production requires an environmental review and approval by the Bureau of Land Management (BLM), which also coordinates the processing of all applications to construct geothermal power plants. Other entities, such as state agencies, may also have authority in the permitting process.

4.6.2 State land

According to Reed and Bloomquist (1995), the majority of states have developed an access system similar to that of the federal government. In all cases, proper permits are required before exploration and development commences, and thorough environmental reviews are required before the granting of most permits.

4.6.3 Private land

When geothermal resources are found on or under private land, the interested developer must reach an agreement on access with the land owner(s). A single geothermal field can stretch over land owned by more than one owner. Reed and Bloomquist (1995) report that:

> Geothermal development on state or privately owned land usually requires a series of permits from state or local agencies for road and pipeline construction, water and sewage disposal, air emissions, and solid waste disposal. Unlike geothermal development of federal land, there is no one plan of operations to document all stages of development. Usually, the environmental review process for initiating the geothermal operations will address all aspects of development and the needed permits and licenses.

They also note that a state issued well drilling permit is normally required for exploratory drilling on private land.

4.6.4 Indian land

In their coverage of geothermal development on American Indian lands in the US, Reed and Bloomquist (1995) note that the Indian tribes manage all resources within their lands, including geothermal resources, and take responsibility for environmental protection. Permitting, lease approval and administration is handled by the Bureau of Indian Affairs (BIA). Surface disturbing activities, such as prospecting and development must get approval by the BIA and the BLM.

4.7 Synopsis

Many issues and potential barriers present themselves in the coverage of permitting processes in the previous subsections. Some examples of hurdles encountered in the permitting process for geothermal development in Iceland, which are probably representative for other countries as well are reported on by Andrésdóttir et al. (2003):

- The time taken by the relevant authorities for the processing of permits for different power plant projects is variable between projects;
- The overall permitting process is complicated and extends over a long time span;
- Repeated environmental impact assessments have been needed at different stages in the overall process (i.e. for the exploratory and exploitation stages), leading to extra expenses and delays.

While such barriers are observed by geothermal developers, it should probably be expected that any given permitting process can be complex in the modern world where varied issues need to be considered before development can proceed. A multitude of permits is therefore called for in order to ensure that all these issues are given due consideration. In New Zealand for example, most geothermal power stations need about 15 permits (Luketina, 2000). Commonly the needed permits are administered by several different authorities. This is necessary to some extent, as environmental permits and utilization permits for example should not be issued by the same entity due to a potential conflict of interest. It is, however, important to streamline the overall permitting process as much as possible in order to decrease complexity, save time and money, and encourage development. One way to achieve this is to have one authority coordinate all/most permitting, as is the case for geothermal development on US federal land, which is coordinated by the Bureau of Land Management. Although the BLM is responsible for the granting of most of the permits, it is also possible to envisage an entity established for the sole purpose of coordinating and preparing guidelines on various permitting processes, without the authority to grant permits.

In some countries, there is more than one process of obtaining leases from a single owner, e.g. competitive or non-competitive bidding on federal and/or territory/state land as is the case in Australia and the US. This contributes to the complexity of the permitting environment, in addition to the complexity that arises from different permitting processes between different owners such as State governments, states/territories, private or native owners.

In addition to applying for permits to various authorities, the geothermal developer may need to consult a multitude of concerned groups and obtain their consent before applying for a resource consent as is the case in New Zealand, where adjacent landowners and occupiers of land, local native tribes, the Department of Conservation, the relevant district council, environmental groups, and special interest groups such as fishing and hunting clubs may need to be consulted (Luketina, 2000).

In Australia, the issue of overlapping tenements is a concern and Bloomquist (1986) has noted that problems may arise when more than a single owner has the right to a geothermal resource. Both of these issues indicate the possibility of conflicts arising between a particular geothermal rights holder and other rights holders: on the one hand holders of rights to a different resource (e.g. petroleum or gas) and on the other hand holders of rights to the same geothermal resource. To avoid such conflicts from arising, legislation/regulations should be clear on the ownership issue, the prioritization of rights in the case of overlaps of different resources, the division of rights in the case of many claims to a single resource, and be able to answer questions that come up in such cases without a need to resort to hearings, committees or courts that may drag out over long time periods with associated inconvenience and economic loss.

In many countries, natives have special rights to resources attached to land that they inhabit. Examples are found in Australia, New Zealand, the Philippines, and the US. While this may be a just arrangement, it adds to the complexity of permitting for geothermal developers.

Geothermal areas are often areas of uniqueness and profound beauty and are therefore conserved. Examples of this may be found in Costa Rica, Iceland, Japan, Nicaragua, the Philippines, the United States and probably most other countries with significant geothermal potential. In some countries, utilization within conserved areas is strictly forbidden, whereas in others developers may be able to obtain conditional exploration and exploitation licenses through special processes. Costa Rica is an example of a country where geothermal development is not allowed within protected areas, whereas Nicaragua has allowed such development based on conditions set forth in a reform to law No. 443 on the exploration and exploitation of geothermal resources (Moya and Rodríguez, 2007). Article 7 states:

> The proclamation of National Interest authorizes geothermal resource exploration and exploitation. In cases where an area under investigation for exploration or exploitation is located totally or partially in protected areas, the concession holder(s) must obtain the respective approval of the Environmental Impact Study and the Environmental Permit from the Ministry of Environment and Natural Resources, before initiating exploration or exploitation of the resource. Three percent of the estimated value of the Environmental Impact Study and the Environmental Permit shall be paid to the Ministry of Environment and Natural Resources by the concession holder as funds to be utilized exclusively for the process of monitoring and overseeing of the execution of these studies.

In the Philippines, the National Integrated Protected Areas System Act of 1992 allows the survey of energy resources in protected areas solely for data gathering, but exploitation is only allowed through passage of law by Congress (Peñarroyo, 2010). Geothermal development in protected areas can therefore be quite complicated if allowed at all, but with good reason.

Based on the previous discussion it is clear that geothermal developers may face several barriers in the permitting process. In fact, it is probable that the main legal barriers may be found in this process. In their assessment of geothermal legislation in the EU, Goodman et al. (2010) advise that a licensing system for exploration and exploitation of geothermal energy resources should be in place as a *primary* requirement to develop and regulate the national geothermal sector. They go on to lay out the following recommendations, which if enacted might eliminate or lower many of the barriers to geothermal development within the EU and elsewhere:

- Existing national legislation can be used, with modifications if necessary to regulate the shallow and deep geothermal sectors, while taking care to minimize the regulatory burden for shallow systems in order to encourage the use of heat pump systems;
- The geothermal licensing system should grant a licensee the exclusive rights to exploration and exploitation/development of geothermal resources over a defined area and for a specified period of time;
- The geothermal licensee must be protected from other external parties depleting or damaging the geothermal resource available within their license area and conflicting rights relating to overlap of geothermal licenses with other resources or licenses must be avoided;
- The geothermal resource must be clearly defined and ownership and right of access must be clear;
- Guidelines should be developed on the application procedure for deep geothermal exploration and exploitation licenses;
- A time limit should be imposed on the administrative process for granting deep geothermal exploration and development licenses;
- A time limit should be imposed on the duration of exploration licenses;
- Deep geothermal energy development licenses should have a duration appropriate to the normal minimal lifetime of the exploitation/development wells and a renewal option for a defined period should be made available to the license holder;
- Administrative procedures for geothermal licensing should be streamlined, and the burden on the applicant should reflect the complexity, cost and potential impacts of the proposed geothermal energy development;
- The administrative structures and organization, the respective responsibilities of national, regional and local administrative bodies for geothermal procedures must be *coordinated and clearly defined*.

Many of these recommendations touch upon issues that have previously been discussed and are in line with what other authors have proposed, while others have not been covered. One of these is the proposition that the appropriate duration of development licenses should be in line with the normal *minimal* lifetime of geothermal wells. According to Thorhallsson (2012), experience has shown that geothermal wells have a productive lifetime of 30-40 years.

In Queensland, a geothermal production lease has an initial maximum term of 30 years, but can be renewed for 20 year periods (Zillmann and Makras (2010). A geothermal development lease on federal land in the US extends for a duration of 35 years after the start of successful development (Reed and Bloomquist, 1995). In Iceland, a lease for geothermal utilization can be obtained for up to 65 years.

5. LEGAL AND REGULATORY FRAMEWORKS AS AN INFLUENCE ON ECONOMICS

In spite of some barriers existing within the legal framework for geothermal development, they are minor compared to the most significant barriers of all: the risk inherent in drilling deep into the ground for resources that can only be inferred with indirect measurements and circumstantial evidence prior to drilling and the high costs associated with those drilling activities. While drilling based on the advice of competent geoscientists will without a doubt lead to profitable resources on average, there will be misses due to the uncertainty about the exact conditions deep down in the ground. A dedicated long-term investor with pockets deep enough to absorb temporary losses from such misses and with an access to geothermal professionals, should be able to make a decent return on her investment in a few decades if she invests in projects involving a large number of wells in a fair number of geothermal fields. In reality, however, investors in geothermal projects do often not have the financial resources needed to absorb the misses and wait for the return. As a result, the early stages of development are perceived as carrying a high risk that many investors are unwilling to take. A shortage of investment is thus the great barrier to geothermal development and in this respect legal and regulatory frameworks have generally acted as a motivating influence. These are directly related to States' willingness to support geothermal development.

Miethling (2011) looked into the role of the State in geothermal energy development by examining the history in Germany, Iceland and the US. He concluded that the State appears to be the prime initiator of geothermal development, although the US appears to be an exception. It is informative to expand this investigation in a coarse manner to look at the role of government in the initiation and support of geothermal development in some of the countries with highest current electricity output from geothermal.

5.1 The role of government in initiating and supporting geothermal development in selected countries

The following subsections list countries in order of geothermal electricity generation in 2009 (parenthesis) as reported by Bertani (2010).

5.1.1 United States (15.0 TWh/yr)

As pointed out by Miethling (2011), a noteworthy geothermal development started in the US in the 1950s with single entrepreneurs who gathered funds to drill wells in the Geysers area in Northern California. Subsequent alliances were formed with big oil and gas companies and electricity companies. The involvement of the federal and state governments were minimal and primarily reactive, as regulatory frameworks were constructed in reaction to private sector interest in utilization. A lack of resource definition and administrative processes therefore posed some serious obstacles to early geothermal development. Since then, the federal and state governments have created various incentive mechanisms to support geothermal development.

5.1.2 Philippines (10.3 TWh/yr)

Catigtig noted in 2008 that the status of the Philippines as the second largest user of geothermal energy was the result of the deliberate effort of the government to develop an indigenous resource that nature provided and its desire to loosen the grip of imported fuels on the energy sector. The catalyst was the oil crisis that hit the country in the early 1970s and as a result, the government enacted laws that served as the foundation for the rapid development of geothermal resources. The first two geothermal steam fields were developed by a private company at the initiative of the National Power Corporation (NPC), a governmentally owned electricity generation company. Recognizing the massive task ahead, the government established the Philippine National Oil Company – Energy Development Corporation (PNOC-EDC) in 1973 to develop additional fields that would be operated by NPC. Laws passed in 1987 and 1990 removed the power generation monopoly of NPC and paved the way for PNOC-EDC to enter the power generation business through Build-Operate-Transfer (BOT) contracts with private contractors that would hand the plants over to PNOC-EDC within a defined cooperation period. Due to concerns that arose upon handover of BOT plants, regarding whether PNOC-EDC was legally allowed to own and operate power plants as a government owned and controlled corporation, the company was privatized in 2006 and 2007, in spite of some objections due to the company's generation of income for the State (Catigtig, 2008).

The company is presently listed on the Philippine Stock Exchange and is owned by both Philippine nationals and foreigners (EDC, 2012).

5.1.3 Indonesia (9.6 TWh/yr)

Fauzi et al. (2005) inform that the Indonesian government conducted a country-wide inventory of thermal features in 1972 in cooperation with several countries whose development was well under way. The results were used to issue new policies to accelerate geothermal development and encourage energy diversity in the country. To implement these policies, a decree was issued by the government in 1974 appointing the state owned company Pertamina to explore and develop geothermal energy in conjunction with domestic and international partners. Pertamina started exploration at the Kamojang field in the same year and installed the first small turbine in 1978. Two years later, the government issued a presidential decree allowing Pertamina to enter joint ventures with local and international partners. Since then, other decrees have been issued to support geothermal development. Of 7 geothermal power plants in operation in 2005, 3 were operated by Pertamina and 4 by others (Fauzi et al., 2005).

5.1.4 Mexico (7.0 TWh/yr)

Ocampo and Vivar (2004) report that geothermal exploration in the Cerro Prieto geothermal field started in the late 1950s and lead to drilling of the first deep exploration wells in 1960-1961. The State owned Comisión Federal de Electricidad (CFE), which operates and manages Mexico's geothermal projects, began commercial power production in 1973. Three other fields are in operation in Mexico and several others have been explored (Gutiérrez-Negrín et al., 2010). All are managed and operated by CFE.

5.1.5 Iceland (4.6 TWh/yr)

The State and local governments have been instrumental in the development of geothermal resources in Iceland, both for heating and electricity generation. The first large scale district heating (DH) system in the country was established in Reykjavik, the capital of Iceland, in 1930 by the municipal government. The subsequent enlargement of the Reykjavik DH system and construction of DH systems around the country has in almost all cases been undertaken by municipal governments. The State supported this development by guaranteeing foreign loans with favorable interest rates to municipalities (Björnsson, 1995). The State government supported this development by establishing an energy fund through legislation that has granted numerous loans for geothermal exploration and drilling over the decades. The loans were converted to grants if drilling failed to yield the expected results (Björnsson et al., 2010). The State has also supported the mapping of geothermal resources in the country through the National Energy Authority and later through the state owned institution ÍSOR – Iceland GeoSurvey. The construction of the country's first geothermal power plant at Krafla was initiated by the State. Out of three major geothermal companies, one is owned by the State, another by municipalities, and a majority stake in the third has recently passed from municipal ownership to a foreign publicly listed company. The legal and regulatory framework in Iceland is supportive of geothermal exploration and development, but does not allow for subsidies for geothermal projects.

5.1.6 New Zealand (4.1 TWh/yr)

Thain (1998) notes that severe electricity shortages in 1947 following a drought period that affected hydro power generation, and the desire by the government for New Zealand to be independent of imported fuels, prompted the development of the Wairakei field in the North Island by government engineers, where production started in 1958. In 1995, White et al. reported that almost all of the major investigation and development of New Zealand's geothermal resources had been carried out by the government or government agencies. At present, New Zealand's geothermal projects are managed and operated by government owned companies, privately held companies and companies listed on the country's stock exchange.

5.1.7 Kenya (1.4 TWh/yr)

The exploration and development of geothermal resources in Kenya have mostly been driven by State owned companies. Ng'ang'a (1982) reports that the East Africa Power and Lighting Corporation (a quasi-government company responsible for power generation and distribution in Kenya) undertook exploration for geothermal energy at the Eburru, Olkaria, and Lake Bogoria fields with assistance from the United Nations Development Programme (UNDP). Subsequently, the Kenya Power Company (KPC), a government body, became responsible for development at Olkaria and the first unit came online in 1981. In 1998, KPC became Kenya Electricity Generating Company (KenGen), which was fully owned by the government, but in 2006 the government sold 30% of its shares to the public (KenGen, 2012). KenGen currently operates 2 single flash power plants at Olkaria I and II that generate a total of 150 MWe. Private companies operate 2 power plants at Olkaria III and the Oserian flower farm, totaling 52 MWe (Mutia, 2010). The Geothermal Development Company (GDC) was founded by the government as a follow-up to Sessional paper No. 4 of 2004 in order to promote rapid development of geothermal resources in the country through surface exploration and drilling (GDC, 2012). The government has passed two laws that regulate geothermal development: the Geothermal Resources Act of 1982 and its supplementary legislation of 1990, and the Environmental Management and Coordination Act of 1999 (Mwangi-Gachau, 2009).

5.1.8 El Salvador (1.4 TWh/yr)

According to the Salvadoran Constitution, the subsurface is the property of the State, which can award concessions to private entities for its exploitation (Rodríguez and Arévalo, 2007). Rodríguez and Velis (2007) inform that early development in El Salvador was carried out by the State run electric utility company Comisión Ejecutiva Hidroeléctrica del Río Lempa (CEL). The first exploration efforts were carried out in the late 1950s, and in the early 1960s the UNDP supported CEL with 3 deep exploratory wells in the Ahuachapán geothermal field, where the first generating unit came online in 1975 (Rodríguez and Monterrosa, 2007). The field and power plant at Ahuachapán, and later Berlín, were operated by CEL until 1999 when LaGeo S.A. de C.V. was formed. During this period, electricity prices were set by political considerations and by CEL's need for income. LaGeo was formed in response to a call for decentralization of CEL's production activities set forth in legislation that reformed the electricity sector. Although ownership of shares and appointment of the Board of Directors was still retained by CEL, LaGeo was to compete in the open electricity market under private sector legislation (Rodríguez and Velis, 2007).

ENEL Green Power acquired an 8.5% share in LaGeo in 2002 after the government of El Salvador launched an international public tender in 2001 to select a strategic partner for the development of geothermal energy in the country. By capitalizing investments in LaGeo, ENEL increased its share to 36.2% and maintained its right to reach majority ownership through reserved capital injections in exchange for investments in accordance with shareholder agreements. However, CEL objected to this interpretation of the agreement, and as a result ENEL took the issue to the International Court of Arbitration of the International Chamber of Commerce. In 2011, the arbitration tribunal declared its recognition of ENEL's claim of rights to subscribe to new shares in the company and to reach majority ownership. This ruling has been contested by CEL / the government of El Salvador and the issue is still being disputed (ENEL Green Power, 2011).

5.1.9 Other countries

In order to complete a list of the top 10 geothermal electricity producers, Italy and Japan would have to be added. As information on the role of government in their geothermal development is not as accessible as for the other countries, they are omitted. However, it can be noted that electricity generation from geothermal resources in Italy, and in the World, was initiated by an individual, Prince Piero Ginori Conti who used a piston engine connected to a dynamo to generate 10 kW of electricity from geothermal heat at Larderello in 1904 (Lund, 2004). In addition, Germany can be mentioned as a minor player in geothermal electricity generation where the government has introduced a legally stipulated feed-in tariff structure to promote electricity generation from deep geothermal resources (Gassner, 2010). In China, which tops the list for direct use, the government has also been instrumental in geothermal development.

5.1.10 Synopsis

Miethling's assertion that the State appears to be a prime initiator of geothermal development appears to hold up when considering the countries that produce the greatest amounts of electrical energy from geothermal resources. In the US and Italy, development was initiated by private entrepreneurs, whereas the State was a prime mover in the Philippines, Indonesia, Mexico, Iceland, New Zealand, Kenya, and El Salvador. The degree to which the State has controlled and managed the development has however varied between countries. Indonesia for example, appears to have opened up to cooperation with private entities fairly soon in its development, whereas in El Salvador the State held tight control for an extended period through CEL.

Miethling (2011) suggests that once public funds have been used to develop necessary institutions and demonstrate successful utilization, the development enters an expansion phase where private investors play a large role. Such an expansion phase may be supported by incentive mechanisms in legislation, such as the US federal Public Utility Regulatory Policies Act (PURPA) that obliged utilities to collect power produced by independent power producers and pay a tariff equaling the avoided costs of the utilities' own generation. Even though private investors are instrumental in carrying out the expansion in this case, the State sets the stage by introducing motivating legislation, without which the expansion might not take place. There are also examples of the State being a direct mover of expansion. This is the case in Kenya, where the government has laid out plans to expand the energy sector through clean renewable energy options such as geothermal energy in its Kenya Vision 2030 policy (Mutia, 2010). The government has already embarked on this journey as large exploration and drilling efforts are being carried out and three new power plants are expected to come on line in the period 2012 – 2014, totaling 420 MWe. In the next 20 years, 30 new geothermal power plants are expected to be constructed as part of the expansion program. Yet, even though the government is the prime force behind this drive, it recognizes that such a massive capital undertaking can only be realized through a joint effort by both the public and private sectors (Mutia, 2010).

It is interesting to note that even though the State is the prime initiator of geothermal development, there appears to be a certain drift towards increased participation of the private sector with time. This can be seen in the Philippines, where PNOC-EDC was privatized in 2006/2007 and the Philippine Renewable Energy Act of 2008 allowed for joint ventures between the State and Philippine citizens as well as participation of foreign owned companies through Presidential agreements. In Iceland, a majority stake in one of the major geothermal companies of the country has recently gone from public to private foreign ownership. In New Zealand, private companies have had an increasing role in the country's geothermal development. Kenya's government sold 30% of it share in KenGen in a public offering in 2006 and ENEL Green Power acquired shares in LaGeo in 2002. In spite of this seeming trend towards increased participation of private entities, the State holds ownership of the resources in many cases.

The role of the State is probably not any less prominent in countries that have lower quality geothermal resources, as decent return on investment may be harder to obtain without support from the State, as is the case in Germany.

From the previous review and discussion, it appears clear that the State has a major role in initiating and supporting geothermal development. This may be attained through direct control of the whole energy sector, as was the case in El Salvador when the government set electricity prices by political considerations and by CEL's need for income. Where the State is in total control, there may be no need to issue specific legislation to support geothermal development. However, in countries where private entities play an active part in electricity production and prices are set by the markets, the main tool of the State to assert its influence/policies may be legislation. Indeed, many countries have introduced various economic incentives to support private sector participation in geothermal development.

5.2 Legal and regulatory frameworks as a source of economic support to geothermal developers

There are various ways in which governments ensure economic support to geothermal developers through policies, programs and legislation. Many of these are touched upon in the following subsections.

5.2.1 Tariffs

Where feed-in tariffs are in place for electricity generated from geothermal resources, producers are guaranteed a price for the electricity that they provide into utility grids. Rybach (2010) informs that such tariffs are in place in many countries in Europe, including Austria, Belgium, the Czech Republic, Estonia, France, Greece, Slovakia, Slovenia and Spain, and that the system has led to large scale geothermal development in Germany. Gassner (2010) reports that the German Renewable Energy Sources Act of 2009 obliges operators of electricity supply grids to accept and give priority to electricity provided by renewable energy sources and to pay minimum prices stipulated by law for a 20 year period. The additional costs are passed on to consumers. In this way, Gassner notes, the State itself is not involved in financing, but instead merely controls the framework conditions, which allow project developers, investors and operators to reliably calculate yields for the first 20 years of operation.

According to Reed and Bloomquist (1995), the Public Utility Regulatory Policies Act of 1978 has proven the single greatest incentive to geothermal development in the US, by guaranteeing a market for electricity generated from geothermal resources. PURPA led to a dramatic growth in the number of geothermal projects in California and Nevada, where state public utilities aggressively implemented the act in the 1980s. About a third of the 2000 MWe installed during the decade came from plants in the two states taking advantage of PURPA.

5.2.2 Portfolio standards

Portfolio standards require that a certain percentage of utilities' electricity come from specific sources, such as renewables. The International Energy Agency's technology roadmap for geothermal heat and power states that renewable portfolio standards can be effective if they are sufficiently ambitious and binding for utilities – that is, if the financial penalties are set at appropriate levels in case of little or no compliance with the targets (OECD/IEA, 2011).

Miethling (2011) reports that Texas and Arizona employed renewable portfolio standards (RPSs) in 2001 and California followed suit a year later. California's RPS was accelerated in 2006 under a

Senate Bill by requiring that 20% of electricity retail sales be served by renewable energy resources by 2010 (California Energy Commission, 2011). In 2008, the goal was set higher as the state governor signed an executive order requiring that the proportion of electricity sales from renewable resources be increased to 33% by 2020. Chile has also enacted an RPS through the Non-Conventional Renewable Energy Law, which requires providers in systems of an installed capacity of 200 MW or greater to demonstrate that at least 10% of the energy provided comes from non-conventional renewable energy resources by 2024 (Haraldsson, 2012). The Renewable Energy Heat Act in Germany obliges building developers to source a minimum percentage of the energy requirement for heating and hot water from renewable energy sources (Gassner, 2010).

Some countries have set non-binding targets for the share of electricity generated from renewables before a specific year, and many of these are related to the countries' commitments to reducing carbon dioxide emissions as a response to the threat of global warming. It is worth noting that where RPSs are in place, geothermal has in most, if not all, cases to compete with other renewables.

5.2.3 Tax credits

Various forms of tax credits exist to support geothermal development. Reed and Bloomquist (1995) inform that the 1978 Energy Tax Act established a 10% energy tax credit for investment by a business taxpayer in property used to produce, distribute or use energy from a geothermal deposit. This tax credit expired in 1990, but was later reauthorized. The American Recovery and Reinvestment Act of 2009 grants a federal renewable electricity production tax credit to eligible tax payers to generate electricity from geothermal resources through 2013 (IRS, 2009). Miethling (2011) notes, however, that small companies may have difficulties in making use of tax credits when facing a negative net income in the beginning of operations and have therefore been forced into agreements with lending institutions to benefit from the credits.

Peñarroyo (2010) reports that the Philippine Renewable Energy Act of 2008 provides various fiscal and non-fiscal incentives for renewable energy developers. These include an income tax holiday for the first 7 years of commercial operations of renewable energy facilities, special realty tax rates on equipment and machinery, net operating loss carry-over, accelerated depreciation, 0% VAT rate for the sale of renewable power, tax exemption of carbon credit sales, and tax credit on domestic capital equipment and services.

5.2.4 Loans

Governments may back or provide loans to the geothermal sector directly. The Icelandic government backed foreign loans with favorable interest rates to municipalities in the decades of geothermal development after World War II, which the municipalities might otherwise not have been able to secure (Björnsson, 1995). The Icelandic Energy Fund was established in the 1960s to provide low-interest loans to municipalities, firms or individuals for geothermal drilling and to share the risk of drilling with developers (Björnsson, 1995; Björnsson et al., 2010). The loans normally covered 60% of drilling costs and could be converted into grants if the development of a new geothermal field proved unsuccessful. A number of loan programs have also been authorized by the US federal government through the years. According to Reed and Bloomquist (1995), the best known of these was the Geothermal Loan Guarantee Program, which was authorized under the Geothermal Research, Development, and Demonstration Act of 1974. Loans for up to 75 percent of project costs could be granted under the act, with the federal government guaranteeing the full amount. Goodman et al. (2010) suggest that geothermal energy should receive low interest rate loans in the EU, in line with those available for the development of some other renewable energy sources.

5.2.5 Insurance

Due to the inherent risk in drilling for geothermal resources, insurance may be coveted by investors that do not have pockets deep enough to absorb the economic setbacks associated with drilling failures. The idea behind the Icelandic Energy Fund, besides granting loans for exploration and drilling, has been to provide such insurance. This has been achieved by turning loans into grants in case of failed attempts to develop new fields. Miethling (2010) reports that Germany has installed a similar drilling insurance where a premium is paid on a loan, which is converted into a grant in the case of drilling failure.

Rybach (2010) informs that a governmental risk coverage system has been in place in France since 1981. A short-term risk guarantee covers all or part of an investment in a well in case of drilling failure and a long-term risk guarantee covers the risk of resource decline for up to 25 years. A risk guarantee system was also established by the Parliament of Switzerland in 1986 and implemented by the federal government in 1987 (Rybach, 2010). The guarantee extended to 50% of drilling and testing costs and in specific cases up to 80%. A new governmental risk coverage system was introduced in 2008, in which the maximum guarantee is 50% of the subsurface costs. Goodman et al. (2010) suggest that geothermal risk insurance should extend to the whole EU0.

Beside State insurance schemes, some multi-national institutions and a large reinsurance company are considering to offer, or are offering, geothermal drilling risk insurance.

5.2.6 Easement of import duties

Peñarroyo (2010) has informed that one of the ways in which the Philippine Renewable Energy Act supports renewable energy development is to relieve developers from tariff duties on imported machinery and equipment. El Salvador has also lowered tariff duties on imported equipment for geothermal power plants.

5.2.7 Direct support

Yet another way for the State to support geothermal development is through direct financial support in the form of grants and cost sharing. The US Department of Energy (DoE) has awarded grants for research and development, technical assistance, feasibility studies and demonstration projects, and provided cost sharing with industry on exploration, reservoir assessment, and reservoir engineering, in addition to releasing exploration data to the public (Reed and Bloomquist, 1995). Recently, DoE's Geothermal Technologies Program has granted millions of dollars to geothermal research and development projects in the US.

Wahjosoedibjo and Hasan (2012) inform that in its 2011 State Budget, the government of Indonesia committed to allocate the equivalent of USD 145 million to a fund dedicated to geothermal development. The purpose is to attract investment by sharing costs for initial exploration and to provide potential developers and investor with sufficient and credible information on green field geothermal sites that will be offered during the tendering process of new areas. Besides reimbursing interested parties with exploration costs, the provision of high quality information on pre-selected green field geothermal sites should help to reduce unknowns and alleviate risk aversion.

The Indonesian plan is in line with Rybach's (2010) recommendation that governments would finance the exploratory, and preferably also the pre-feasibility, phases of geothermal development, letting investors take over when it is known where to go. This methodology is also in line with the methodology of the Icelandic government, which has funded geothermal exploration activities for decades for the benefit of the public.

Rybach (2010) also reports on the substantial financial assistance of the Australian government to new geothermal projects in the country in order to foster progress towards the commercialization of geothermal energy resources.

5.2.8 License fees and royalties

Goodman et al. (2010) advice to keep license fees and royalties for the use of geothermal energy to a minimum within the EU and to keep them in perspective with fees and royalties for higher value resources such as hydrocarbons. According to them, the fees should take into account the return on investment. As geothermal resources within most countries of the EU are of rather low quality compared to the high-temperature resources found in many of the leading geothermal countries, it follows that they are also of lower economic value.

5.3 Synopsis

From the preceding overview it is evident that the State plays a large role in the initiation and continued support of geothermal development. In countries where the State is in total control, there may not be much need for economic support through legislation, but in countries where private entities play a large role, the State can stimulate development through legal and regulatory frameworks. In those cases, legislation seeks to overcome barriers and acts as a motivating influence on development.

It is worth noting, however, that incentives for other renewables that are in direct competition with geothermal can become a barrier to geothermal development if those incentives lead to more economically attractive projects than those that can be carried out in the geothermal sector.

6. LACK OF LEGISLATION/REGULATION AS A BARRIER TO GEOTHERMAL DEVELOPMENT

Clarity and consistency are important to geothermal developers, as uncertainties and ambiguities are perceived as risk factors that may delay or hinder development. Legal and regulatory frameworks thus need to address all aspects of development in a clear and consistent way, as gaps can lead to confusion and difficulties. A simple example is the uncertainty surrounding the nature of geothermal resources as defined in the US federal Geothermal Steam Act of 1970, which afflicted the sector until the issue was settled by the courts in 1977 after 6 years of litigation.

The investigators in the GTR-H study aimed at identifying and reviewing the regulatory barriers and deficiencies for geothermal heating in unregulated EU countries, found that the lack of regulation for geothermal energy exploitation over most of the EU is inhibiting the effective exploitation of the resource (Goodman et al., 2010). Haehnlein et al. (2010) point to a lack of clarity in energy, water and environmental legislation and specific regulation for geothermal energy as the most primary regulatory barriers to geothermal development in Hungary, Ireland, Poland and the United Kingdom.

Andrésdóttir et al. (2003) note that a lack of official policy and plans on where to permit geothermal utilization in Iceland has made it difficult for developers to plan future development. This indicates again that lack of clarity serves to inhibit development. A Master Plan for hydro and geothermal energy resources currently in the making by the Icelandic government is slated to clarify which areas will be available for future exploitation (Björnsson et al., 2012; Steering committee on the Icelandic Master Plan, 2010).

7. STABILITY AND PREDICTABILITY OF LEGAL AND REGULATORY FRAMEWORKS ADDRESSING GEOTHERMAL DEVELOPMENT

In addition to clarity and consistency of legal and regulatory frameworks across the spectrum of issues pertaining to geothermal development, stability and predictability are of significant importance to developers. This is recognized in the German Renewable Energy Sources Act (EEG), which stipulates feed-in tariffs over a 20 year period. As pointed out by Gassner (2010), this means that developers and investors can reliably calculate yields for the first 20 years of operation. In contrast, renewable electricity tax credits were presented to US federal tax payers through the American Recovery and Reinvestment Act of 2009, but are only available through 2013. While the credits have been extended various times over history, the developer cannot take for granted that such will be the case in the future. Miethling (2010) notes that experts have debated the importance of incentives with such short duration.

8. CONCLUSION

The coarse literature survey conducted for this study was undertaken in order to attempt to answer the question: Do legal and regulatory frameworks present barriers to geothermal development or are they a motivating influence? The idea was to collect information from various countries around the world that utilize geothermal resources. The countries covered were to a large extent selected on the basis of availability of literature on the topic.

Examples of definitions of geothermal resources/energy were given, followed by coverage of ownership issues and the permitting process in various countries and their states/territories. It appears that some barriers exist in these aspects of the legal and regulatory frameworks governing geothermal development. Definitions may be unclear, ownership uncertain, and the permitting process can be unnecessarily complex. Clarity, consistency and completeness therefore seem to be the keywords when it comes to these concepts and processes, as they must be for other aspects of the law.

Legal and regulatory frameworks in many cases also address the economic environment of geothermal development projects – especially in States where private entities play a significant role. The very purpose of these aspects of the law is generally to support development and they can therefore be considered as a motivating influence.

Thus, the simple answer to the question posed is: A little of both.

This answer should hardly come as a surprise, as the law and its branching regulations are a complicated edifice with much greater variation between countries than other disciplines that need to be consulted in geothermal development. In contrast, the geosciences and geothermal engineering are the same or similar in all corners of the world.

Whatever the underlying policies, legislators and regulators should strive for clarity, consistency, completeness and predictability of legal and regulatory frameworks addressing geothermal development, emphasizing streamlining of processes without over-simplification, or as Dr. Einstein put it: Make everything as simple as possible, but not simpler.

ACKNOWLEDGEMENTS

Many thanks to Dr. Ingvar B. Fridleifsson, Director of the United Nations University Geothermal Training Programme, for his critical reading of the paper and guidance on Icelandic geothermal history.

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