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Comparison of Geothermal Regulation between Chile, Philippines and New Zealand

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ABSTRACT

Geothermal projects combine aspects of high-risk exploration activities (as in petroleum sectors) and complex, localized electricity markets. Aligning support policies to the 3 basic dimensions of resource access, electricity market regulation and environmental consenting is vital. This paper studies 3 jurisdictions (Chile-newly developing, Philippines – recently restarting under private sector regulation, New Zealand) with similar public resource ownership – private energy market policies, that have found different regulatory solutions. What lessons can be learnt from these 3 jurisdictions?

1. INTRODUCTION

Geothermal energy is seen as a renewable and reliable source of power generation with substantial unlocked potential in many countries around the world. Important barriers to geothermal development around the world are often related to the high upfront costs and risks involved in geothermal resource exploration and production (especially drilling). In that respect, geothermal energy shares many characteristics of 'traditional' resource industries like oil and gas. However, geothermal power produced is not sold into global oil markets (with open access to a global free market with transparent prices), but into local electricity markets, with often very specific regulation, pricing and contracting issues.

Geothermal regulation therefore is complex, and needs to cover a wide range of aspects. Different examples from around the world can be used as a guide for discussing and designing such regulations. Three countries in the main geothermal development regions around the world, with different resource ownership and public-private sector development mix have been chosen:

- Chile: state resource ownership; private developers; inexperienced with 2 geothermal projects approved but none operational;
- New Zealand: public resource ownership; private and state-owned developers; experienced with ca. 900 MWe installed;
- Philippines: state resource ownership; former state-owned developers, but newly developing under privatized geothermal development regulation; experienced with approximately 1900 MWe installed;

In each country case, the following aspects are briefly described:

- History and background of geothermal energy;
- Resource ownership and access;
- Electricity market and renewables support policies;
- Regulation of environmental impacts;
- Other issues specific to geothermal development in that country.

2. CHILE

Chile is home to around 3,000 or 10% of the world's volcanoes (Reed, 2013). It has one of the highest per capita incomes in Latin America and high economic growth rates over the last decades. With the consistently high energy prices over the last decade, it should be an excellent location for geothermal power plant development. Chile has no operational geothermal power plant in production to date, but four geothermal power projects have passed the first exploration and drilling stages and have received exploitation and environmental consents. Early exploration phases in Chile have in the past, however, stopped short of building actual power plants. The exploration of geothermal resources in Chile could be described in three main periodic stages (Reed, 2013):

- **1908-1923:** the Italian colony of Antofagasta city (northern Chile) brought researchers from Larderello, Italy to carry out the first geothermal exploration program in the country;
- **1968-1978:** the Chilean State promoted research in the northern-most part of the country (17° to 24°S) focused at energy supply for the growing mining industry. This period of exploration was possible through a collaborative project between the Chilean Development Corporation (CORFO) and the United Nations Development Program (UNDP);
- **2000-date:** private investors looking in both the North and South of Chile, with the Chilean Government acting as a regulator and providing some support policies. Current estimates of geothermal potential for Chile range from 3,000 MWe to 16,000 MWe (Lahsen, 2005). In 2000, the Chilean government enacted a Geothermal Law establishing a framework that promotes private companies (both international and domestic) to develop geothermal exploration and exploitation projects in Chile.

2.1 Resource ownership and access

According to the Constitution of Chile, the state has the absolute, exclusive and inalienable ownership of all minerals including mineral deposits, geothermal resources, and oil and gas reserves. In relation to mineral deposits and geothermal resources, any

[1] Note this is a condensed version of a Discussion Paper written for the International Renewable Energy Agency (IRENA).

person is allowed to request a concession in order to carry out exploration or exploitation activities. Law N° 19,657 specifically regulates the geothermal concessions (2000, updated in 2013) and is the current framework for undertaking high temperature, geothermal electricity generation projects in Chile.

The law establishes two kinds of concessions: exploration and exploitation. An exploration concession is granted for two years and can be extended for two years, by showing a progress of at least 25% of the implementation or action plan that is part of the concession tendering process. The concession includes all the activities needed to ascertain the geothermal energy system and its energy potential, including geoscientific exploration, exploration drilling and any analysis required. An exploitation concession is a permit to carry out all the activities to produce energy, including drilling, construction and transformation of geothermal fluids into thermal or electric energy. The holder of a geothermal energy exploitation concession has the right to develop, consume and exercise on an on-going basis, the underground waters outcropping in the concession area. The concession is granted indefinitely, and the right of utilization of geothermal fluids is inherent to the geothermal energy concession (Fuentes, 2013).

Every natural person, born in Chile or any corporate body organized under Chilean law is able to apply for geothermal energy concessions. The normal mechanism is a public bidding/tendering process. The applicant must submit technical and economic information of the geothermal energy exploration or exploitation program and the expected investment for its implementation. The law establishes some additional requirements related to financial reliability, capital assets and license fees. The law also establishes the possibility that more than one operator utilizes a geothermal field (multi-tapping). In case of disagreement between the operators, an arbitrator shall settle the matter ensuring an optimal exploitation of the field.

Even though the government of Chile has the absolute right of all subsurface resources, there is a great sensitivity to indigenous communities and environmental organizations, which has led to several consented, but controversial energy projects being blocked because of environmental, cultural and economic reasons. According to Ministry of Energy of Chile, one of the most critical challenges to the electricity industry is to promote environmental sustainability and recover the public trust (Min Energia, 2011).

Physical access to the resource (for purposes of drilling, power plant construction, roads, etc.) has to be negotiated with the land-owner. However, in many cases the geothermal resources are in remote locations, where the state is the formal land-owner. On the other hand, in many remote regions with potential geothermal resources, there can be significant contesting of access and resource rights by local, indigenous communities. Chile, being signatory of the International Convention of Indigenous People and having its own Law 19,253 (Law of Indigenous People) has faced opposition and legal challenges to mining, transmission and geothermal projects. Indigenous community engagement is therefore seen as an important factor by both government and private developers.

2.2 General electricity market and renewable support policies

Chile was one of the 'trail-blazers' for deregulating and privatizing the electricity sector in the 1980s. Through the years, numerous droughts and a significant gas crisis from 2004 onwards, the private electricity market has been changed in parts, but maintained its main design features (well described in Fuentes (2013), Pusschel (2012) and Palma (2012). Some of its main features include: independent, private electricity generators; centralized dispatch by CDEC (including optimal long-term hydro-modelling), a generator-only wholesale market to 'trade' short-term differences and long-term contracts with large users (especially mining companies) and regulated distributors (who on-sell to smaller end-users).

Chile has 2 major electricity systems in the north (SING) and the central region of the country (SIC). Historically hydro-electricity has made up a large percentage of generation in the central region (SIC), which – together with the import of cheap gas from Argentina - provided for low electricity market prices and hence unattractiveness of geothermal generation. However, since the 2004 gas crisis involving heavy restrictions on imported gas from neighbouring Argentina, the price of electricity in Chile has become one of the highest in Latin America and higher than the average price in most other OECD countries. The marginal cost of electricity in the SIC increased from less than 50 US$/MWh before 2004, to more than 100 US$/MWh in 2007 (Min Energia, 2012), reaching a maximum of 325 US$/MWh in February 2008 in SIC; and 291 US$/MWh in August 2008 in SING (Systep, 2013), before settling down to more modest levels around 190 US$/MWh (SIC) and 90 US$/MWh (SING) in 2012.

Long-term contract prices (between generators, large users and (regulated) distribution companies) are lower, but tend to follow spot electricity prices with some delay. Average 2010-2104 contract prices in SIC were US$ 82.6/MWh with future contract prices varying from US$ 93 to 125 (Systep, 2014).

Chile has introduced a type of Renewable Portfolio Standard and Trading Scheme that excludes large hydro-electric projects (> 50 MWe), called Non-Conventional Renewable Energy (NCRE), with the aim to promote the use of indigenous, renewable electricity resources and reduce import dependence on gas. Variations of such schemes can be found in most hydro-electricity dominated Latin-American countries. In Chile, the government set a mandatory NCRE-percentage to generators as part of their annual generation portfolio (% of GWh contracted). The companies are free to reach that percentage by building NCRE-power plants themselves or trading with other generators in a government-backed NCRE-certificate market. A fine is set in the case of non-compliance, which effectively works as a 'market cap' (presently approximately US$25/MWh). Initially the target was set at 5% (new contracts only) with a slow growth scenario to 10% by 2020. As this percentage is easily reached with the existing NCRE-capacity, NCRE-credit trade has been limited and prices have been relatively low (average US$10/MWh in 2011, Min Energia). After extensive discussions, in November 2013, a new law (called the 20/25 Law) has been passed, increasing the NCRE-goal gradually to 20% by 2025. This increasing NCRE-target is expected to start impacting significantly by 2017-2018, when NCRE-credit trade and prices are expected to rise. In case the 'market' won't result in significantly more NCRE-plants being built, the Ministry of Energy has created itself the option of directly tendering for NCRE- contracts with generators. Details are not clear yet, but if similar mechanisms are used as in auctions in other Latin-American countries (e.g. Peru & Argentina), this would mean direct, long-term contract with fixed NCRE-prices for different NCRE-technology generation providers, which could provide much-needed long-term price certainty for geothermal projects with large upfront, fixed capital costs and low running costs.

Clean Development Mechanism (CDM) credits were available and provided financial support for some early wind projects and would be available in theory for future renewable (geothermal) projects, but the world-wide state of climate change negotiations and CDM-credits has left these with relatively little value at present and high uncertainty about future prices.

2.3 Regulation of environmental impacts

The Constitution of Chile, in Article 19, guarantees "the right to live in an environment free from contamination" (Fuentes, 2013). It is the duty of the State to watch over the protection of this right and the preservation of nature. Chile has many environmental regulations; the most important being: Law N°19,300/94 (Environmental Act) which was modified in 2000. This law provides the framework to the Environmental Impact Assessment System (SEIA), compulsory to any activity or project developed in Chile during either construction or operation stage. In addition to the Environmental Act, there are various specific decrees that can impact geothermal power projects, such as:

- Decree N°29/2012, which defines the norms on Wildlife Species according to their conservation status
- Decree N° 93/1995 that established the regulation related to Emission Norms and Environmental Quality Standard,
- Decree N°95/2001 that established the SEIA regulation,
- Law 20,283/08 Law of Recuperation of Native Forest and Forestry Promotion,
- Decree N° 148/04 Health Regulation on Hazardous Waste Management
- Law 19,253 Law of Indigenous People

Since 2010/11 the Chilean environmental institutions have undergone a major governance change, including the split of policy-making, consenting and monitoring functions between MMA, SEA and SMA (see Table below). In addition, in June 2012 the Law No. 20,600 created the Environmental Court as a specialized body.

Institution	Duties
Ministry of Environment (Ministerio de Medio Ambiente – MMA)	▪ Design and the application of the environmental laws ▪ Define plans and policies related to environmental matters, including protection and preservation of the biodiversity, natural resources and water ▪ Promote sustainable development ▪ Ensure the integrity of the environmental policy and the regulations
Environmental Assessment Agency (Servicio de Evaluacion Ambiental - SEA)	▪ Responsible for the assessment and consenting of all the projects that, according to the Environmental Act, must be assessed with an SEIA (Estudio de Evaluacion del Impacto Ambiental)
Ministerial Sustainability Council (CMS)	▪ Propose and advise policies to promote the sustainable development
Superintendency for the Environment (Superintendencia del Medio Ambiente – SMA)	▪ In charge of monitoring and oversight of environmental qualification resolutions (RCA), prevention and decontamination plans, environmental quality standards and emission norms, management plans and others mechanisms established by law
Environmental Court	▪ Solve environmental disputes arising in the country. It is competent in the following matters: ▪ Compensation for environmental damage ▪ Complaints challenging decrees providing for environmental quality standards and emissions rules ▪ Claims filed by individuals or legal entities against the SMA; CMS or the Executive Director of SEA ▪ Complains filed by individuals or legal entities against rulings by the Sustainability Ministries Council or the Executive Director SEA, if those rulings were not based on an environmental impact assessment (EIA) ▪ Complaints against administrative decisions rendered by a Ministry or a public service entity for the execution or implementation of emissions and/or quality standards ▪ Complaints against administrative decisions that rescind an environmental law

Table 1: Overview of main Chilean environmental institutions and their roles (Eyzaguirre, 2013)

In general, projects are assessed on a regional/provincial basis involving regional branches of the mentioned ministries and agencies. For very specialized matters and projects involving more than one region (e.g. Tolhuaca geothermal project developed by MRP-Chile), the central services get involved.

The main process for geothermal projects is to apply for an Environmental license via a staged assessment process. The environmental assessment procedure uses a concept called the "single window", integrating and coordinating all the environmental requirements of the public services and their respective permits. SEA provides the coordination role. The process has five steps:

- Scoping and choice of an Environmental Impact Assessment (SEIA) or a simpler Environmental Impact Declaration (DIA);
- Preparation of the document (SEIA or DIA);
- Technical evaluation. The agencies can request additional information. Normally there are two or more rounds of requests and clarifications, which are answered by the holder using a document called 'adenda'. All information is summarized in the Assessment Consolidate Report (Informe Consolidado de Evaluación - ICE) ;
- Based on the ICE the SEA comes to a final decision: Environmental Qualification Resolution (RCA)
- Potential appeals.

SEA can take (maximum) 120 business days to issue a decision regarding an SEIA. This may be extended up to 180 business days under qualified circumstances. For a DIA the period is 60 business days, which can be extended up to 90 business days under qualified circumstances. However, these terms may be longer due to the possibility of the applicant to suspend the environmental assessment (Eyzaguirre, 2013). In practise, the process to obtain the Environmental Qualification Resolution (RCA), takes on

average 14 months, more than double the maximum period established by Law. The geothermal project “Cerro Pabellón” (ENEL) and “Geotérmica Curacautín” (Tolhuaca, MRP-Chile) have recently been approved (Fuentes, 2013).

2.4 Other issues

As discussed in the previous chapters social, environmental and indigenous resistance to large scale energy and mining projects have become an issue in Chile. Community and indigenous participation in Chile is part of the SEA-process. Furthermore, in many indigenous regions with potential geothermal resources, there can be significant contesting of access and resource rights by local, indigenous communities. Chile, being a signatory of the International Convention of Indigenous People and having its own Law 19,253 (Law of Indigenous People), has been faced with opposition and legal challenges to many large power projects in general, and also to some geothermal and related transmission projects: the El Tatio geothermal project is the most well-known example.

In general, Chile favours liberal economic policies, and the present geothermal regulation is therefore geared towards private investment with the government providing limited support. The new government, however, is evaluating transmission corridors, drilling insurance and a new geothermal law (esp. low enthalpy resources) to support speed up geothermal development. International organizations like IADB and KfW are also reportedly contemplating supporting geothermal investment, based on successful experiences in Kenya. An area that Chile is investing in significantly is geothermal capacity building, esp. through the Centro de Excelencia en Geotermía de los Andes (CEGA, the only such centre in the Andes/Latin America) supported with government funds, scholarships and exchanges.

3. NEW ZEALAND

The majority of New Zealand’s geothermal resources are located strategically in the Central North Island and geothermal power has been a significant part of its generation matrix since the 1950s, providing ca. 13.5% of annual generation by 2013 (MBIE, 2013). They also provide significant direct heat for pulp&paper, dairy, agriculture and fishery industries, and for use in residential and commercial buildings, as well as hot pools and tourist attractions. It has been analysed as one of the most economic new sources of electricity generation for New Zealand, as gas prices have risen and most hydro power sites have been tapped (MED, 2011).

3.1 Resource ownership and access

In New Zealand, legal ownership of minerals, water and geothermal resources are treated as separate from land ownership, i.e. the landowner is not the automatic owner of the resources on or under the land. However, whereas most minerals (notably petroleum, gold, silver, coal and iron sands) are property of the Crown (Crown Minerals Act, 1991), water and geothermal resources are treated differently and their ownership is an issue of some historical contention.

Geothermal resources were first regulated through the Geothermal Energy Act 1953 and the Geothermal Energy Regulations 1961, which stated that “the sole right to tap, take, use and apply geothermal energy on or under the land shall vest in the Crown, whether the land has been alienated from the Crown or not” (Section 3 (1) cited in Malafeh, 2013). Maori traditional water rights were recognized to some extent. However, the Act and Regulations were recognized as providing little legal control over the sustainable use of geothermal water or protection of surrounding ecosystems. In 1967 the Water and Soil Conservation Act (WSCA) introduced a system of water rights (including geothermal water).

The Resource Management Act 1991 (RMA) is a significant, and at times, controversial Act of Parliament passed in 1991. The RMA is a wide-ranging act that regulates access to natural and physical resources such as land, air and water, with sustainable use of these resources being the overriding goal. The RMA is now the principal legislation controlling the use of geothermal resources in New Zealand, replacing most previous acts. It introduced a similar structure of resource consents to the WSCA-1967, but covering a wider area of ‘impacts’ including resource off-take and disposal/re-injection, emissions to air and water, and ecosystem and community impacts. By maintaining the main structure of the WSCA, geothermal energy in New Zealand is effectively regulated as a water resource, with the main consenting criteria defined in tonnes of water/liquid volume per day/year (rather than GJ or MWe). Geothermal regulation in New Zealand is therefore more water- than energy based.

The ‘nationalisation’ under the 1953 Geothermal Energy Act and subsequent legislation, was contentious and indigenous Maori people/tribes in some cases claim the ownership of these resources in terms of Kaitiakitanga or guardianship, which implies to manage the resource for the benefit of future generations. They believe that geothermal resources are a gift from their ancestors. Much of the controversy goes back to The Treaty of Waitangi (1840) that established the relationship between Maori People and the British Crown. The second article guarantees the possession of "Land and Estates Forest, Fisheries and other properties" to Maori people. However, there are on-going discussions about how this article should be interpreted (White, 1995). Some of the above-mentioned cases are part of historical claims against the Crown in front of the Waitangi Tribunals. Some of these have been settled, some are still under negotiation.

In practice, the RMA (1991) vests the sustainable management of the geothermal resources – regardless of ownership – in regional authorities, under a requirement for resource consent to use (exploit) a natural resource with numerous clauses and conditions to assure sustainable use of the resource. No specific consent or permit is needed in New Zealand to explore for a resource, apart from the potential *impact* of exploratory drilling and permission from the land-owner.

In the case of geothermal, the resources and therefore their management are mainly concentrated in the regions of Waikato (WRC) and Bay of Plenty (EBOP). Whereas integrated resource management is largely vested in regional authorities, the central government does have the ability to steer some aspects through the National Policy Statements (NPS) or National Environmental Statements (NES), especially to harmonize activities or practices between different regional authorities. Two recent NPS have relevance for geothermal projects: on Electricity Transmission (2008) and Renewable Energy Generation (2011). These statements emphasize the aim to the central government to increase the renewable contribution in the electricity supply and require transmission and environmental decision-makers (including regional councils) to take these preferences into consideration.

Under New Zealand law, no royalty payments are required for the use of geothermal resources, although the RMA (1991) does contain a provision in Sections 112 and 360, for regional authorities to collect payments (royalties) for the use of geothermal energy. This clause has, however, never been used and implementation would be expected to be contentious. There are limited 'administrative' payments by developers to regional councils for monitoring, peer review programmes and consent applications.

Waikato and Bay of Plenty have historically aimed to maintain a 'single-tapper' policy, insisting that there is one developer per geothermal system, irrespective of multiple land-ownership. This was mainly to avoid the 'tragedy of the commons', where multiple users of the same geothermal system are incentivized to tap the resource at a higher (unsustainable) rate, out of fear other users might deplete the resource before them. In the 1990s this was successfully challenged in the High Court by an independent geothermal developer, who eventually won the case but went bankrupt. This ruling-in-principle led to multi-tapping as an option. The regional councils have adapted their policies since then, by allowing multi-tapping, but insisting on a 'joint management plan'.

A geothermal project developer will need to negotiate and gain permission from the landowner above the resource, who controls the physical access to the geothermal resources. Negotiations generally result in a lease agreement or some other payment, or a partial ownership/co-investment in the project. Many geothermal projects are sited on land owned by Maori groups, reinforcing their role in NZ geothermal development.

3.2 General electricity market and renewable support policies

In the 1980s, successive labour and national governments embarked on a radical restructuring and liberalization of the economy including the electricity industry. Between 1986 (State-Owned Enterprises Act) and 2001, the sector was gradually separated in regulated, monopoly transmission and distribution lines companies, while generation and retail (including to small end-users) are markets open to full competition. In 1996 the New Zealand Electricity Market (NZEM) was created and started to trade all wholesale electricity (gross pool) between generators and retailers over a full set of pricing nodes (255 at present). In practise, over the years, generators and retailers integrated to manage risks, resulting in 5 integrated 'gentailers' covering ca. 95% of the market.

New Zealand consists of two major islands - North and South Island - and a large number of smaller ones. The electricity grids between both islands are interconnected. In 2012, the total installed capacity was 9,603 MWe and the total energy generation was 42,900 GWh pa (MBIE, 2013). Electricity demand has grown quite steadily over the years with 1.5 – 2% over the previous decades, with expectations of 1-1.5% growth continuing until 2025. However, since the global financial crisis in 2008, demand growth has actually been virtually flat, which has created an oversupply of generation. Many planned generation investments (including geothermal) have been put on hold until demand picks up.

New Zealand generates a high proportion of electricity from renewable resources. In 2012, renewable energy accounted for 73% of generation (down from 77% in 2011) of which more than 50% was generated from hydro-electric sources, and 13% from geothermal sources, which has been replacing the relative importance of coal and gas-fired generation. Wind generation has also slowly been increasing to 5% of annual generation. The bulk of hydro-electric generation is heavily dependent on variable hydro inflows: the hydro generation percentage fell from 58% in 2011 to 53% in 2012. Reliable baseload and back-up generation (like coal, gas and geothermal) are therefore important to the stability of the system.

New Zealand in effect has very limited support policies for renewable energy. In 2008 an Emissions Trading Scheme (ETS) was introduced, but successive governments have weakened the scheme and recent developments in international climate change negotiations have resulted in extremely low prices providing little support for renewables. General wholesale electricity prices are also relatively low (but volatile), averaging around NZ$ 80-90/kWh (MBIE, 2013), but due to the excellent geothermal resources, located in the Central North Island close to demand and transmission, geothermal projects are among the most competitive, new generation projects (at 80-100 NZ$/MWh). At the same time, older existing fossil fuel generation projects are under pressure to close or reduce operation: two 250 MWe coal-fired units have already been mothballed, and several gas-fired baseload CCGT-units have been starting to run in mid-merit, instead of baseload operation.

3.3 Regulation of environmental impacts

As described in 3.1 the RMA is the main Act defining the management of both the resource use and environmental impacts in New Zealand. The RMA is considered a "meta policy" instructing regional authorities to take control of their own objectives, policies, rules and any other method to manage their resources (Dickie, 2005).

The RMA requires that each regional council must have a Regional Policy Statement (RPS), which should establish an outline of the main resource management issues, policies and methods to achieve the integrated management resources of the region. They may also develop a Regional Plan, which provides the rules about the use of natural and physical resources (WRC/Luketina, 2010). District councils have to develop district plans to regulate land use activities. These policies are guided by National Policy Statements (NPS) and the cumulative case law confirmed by the hierarchical Environment Court and High Court decisions.

The main environmental authorities involved in the geothermal decision making and monitoring processes are:

Institution	Duties
Ministry of Environment	▪ Maintains an active overview of the implementation of the RMA ▪ Makes suggestions on matter of National Policy Statements, National Environmental Standards and water conservation ▪ Can "call-in" proposals of nationwide importance
Regional Councils	New Zealand has 12 regional Councils, which must control: ▪ The taking, use and damming of groundwater, surface and geothermal water ▪ Discharge of pollutants to air, water or land ▪ Maintains indigenous biodiversity ▪ Land use, controlling natural hazards and dangerous substances ▪ The planned integration of infrastructures with land use ▪ Other matters related with coastal and marine area ▪ Prepare the regional policy statement and regional plans ▪ Monitor state of the environment and the effects of their actions and decisions ▪ Resolve on application for resource consents, under their jurisdiction
District and City Councils	There are 73 Districts and City Councils, which are territorial authorities under the RMA. Their responsibilities include controlling of: ▪ Noise activities ▪ Effects of activities on rivers and lakes ▪ Effects of land use ▪ Effects on indigenous biodiversity ▪ Resolving on application for resource consents, under their jurisdiction
Unitary Authorities	The RMA includes 5 unitary authorities that combine the functions of Regional, District and City Councils in smaller regions
Environmental Court	The Environment Court is the specialist court established by RMA, which resolves any disputes related to environmental and resource management matters, some of the most important responsibilities and attributes are: ▪ Hears appeals on decisions made by councils ▪ Hears prosecutions under the RMA ▪ Can change policy statements and plans ▪ Can change legal decisions on application for resource consents

Table 2: Overview of main New Zealand environmental institutions and their roles

The Waikato Regional Council (WRC) which covers ca.70% of New Zealand's geothermal resources, has defined a rather unique approach in its RPS to deal with one of the main regulation issues in geothermal management: sustainable management of the resource. In principle the sustainability of resource used is enshrined in the RMA, which means according to the RMA, the management of resources such as water and geothermal, should be available to future generations. In practice, however, it is recognized that large-scale geothermal development cannot be easily combined with full-scale sustainability for every system (Dickie, 2005). WRC has therefore developed a set of tools to manage the 'portfolio of Waikato geothermal resources', effectively mapping and classifying each geothermal system into five categories, based on their vulnerability of features, size and existing use. The two main categories are:

- Development Systems: are where large-scale development is allowed; Waikarei-Tauhara, Mokai, Ohaaki and Rotokawa;
- Protected Systems: are those that contain exposed geothermal features valued for their cultural and scientific characteristics, which need to be protected; Horomatangi, Orakeikorako, Te Kopia, Tongariro, and Waikite-Waiotapu-Waimangu.

The above classification provides a pragmatic solution to the needs for large-scale geothermal development and the need to protect major features. The other three categories are assigned to small or research systems. Future development might be possible in these categories, but would be considerably more difficult to get consented. Developers therefore concentrate on the assigned Development Systems category for the foreseeable future

3.4 Other issues

Due to historic circumstances, indigenous Maori participation in New Zealand geothermal developments has been significant and is on the increase. Some of the basis for this lies in the RMA – especially sections 6-8 - which recognise Maori values (Brockelsby, 2013). The RMA also provides for significant consultation with affected parties and traditional users of geothermal features and resources. Finally, many of the high temperature geothermal resources in the Central North Island are on land owned by Maori groups or Land Trusts. These processes have resulted in the need and evident success of good, long-term relationship between geothermal developers and Maori iwi in New Zealand. In several cases co-investments/joint-ventures have been created, e.g.:

- Tuaropaki Trust has been involved in the development of Mokai, where the Tuaropaki Trust owns 25% of the Tuaropaki Power Company; and
- Tauhara North N° 2 Trust has successfully developed the Rotokawa field and in a joint venture with Mighty River Power installed the Nga Awa Purua power station (Mizuno, 2013).

4. PHILIPPINES

The Philippines is a low-medium income development economy that has been growing 'sluggishly' over the past decades in comparison with other Southeast Asian countries. Hence, since the Aquino Administration (1986-1992), the government's overriding economic priority has been a program of economic liberalization, focusing on: the elimination of monopolies; opening the economy to foreign investment and reduction of trade barriers; widespread privatization of government services (including the energy sector); and simplification of the tax code (Woodhouse, 2005).

The Philippines imports most of its fossil fuels, and accordingly energy and electricity prices are among the highest in South East Asia. However, the country is very rich in geothermal resources, being situated on the western flank of the Pacific 'Ring of Fire', and numerous active and dormant volcanoes can be found on all the main islands. Under these volcanic centres, lie vast geothermal resources. According to the Department of Energy the Philippines had 1,903 MWe geothermal capacity under generation in 2011 - the 2nd largest installed geothermal capacity in the world and giving geothermal a 15% share of the generation mix (Layug, 2012). According to a study conducted by the Philippines Department of Energy, there is a geothermal potential of at least 3,337 MWe (Fronda, 2010). The government has an ambitious vision to see at least another 1,200 MWe geothermal generation commissioned by 2030 (see figure 10 and 11, and annex 6). The potential, new geothermal projects, however, are expected to be smaller and more difficult to develop: either in remote regions with difficult access or small expansions of existing projects. Such greenfield geothermal developments are therefore expected to be slower and more expensive than before.

Development of the presently installed geothermal power plants in the Philippines occurred in two main 'waves', starting after the energy crisis in the 1970s with very active government support and involvement. Unocal (then owning Philippine Geothermal Incorporated (PGI) now sold to Chevron) developed the first geothermal fields at Tiwi and Makban, but subsequently the Government decided to further develop geothermal resources on its own, through the creation in 1976 of the national geothermal power company PNOC-EDC: a cooperation between the Philippines National Oil Corporation (PNOC) and Energy Development Corporation (Layug, 2012). PNOC-EDC developed the Tongonan and Palinpinon geothermal power stations and in these efforts requested and received considerable international technical, training and financial assistance from donors like New Zealand and World Bank. This first wave between 1973 and 1984 resulted in 980 MWe of installed geothermal generation (making the Philippines the world's 2nd largest geothermal producer). The second wave of geothermal development was led by the nationally owned PNOC-EDC in the 1990s after the passing of the Build-Operate-Transfer-law (1990) that allowed EDC to have international companies design and install geothermal power plants, which were subsequently transferred to EDC for operation. This wave resulted in another 920 MWe of installed geothermal capacity, until the 1997 Asian financial crisis slowed the country's economy down significantly, reducing electricity demand and investment appetite.

Since the 1990s wave of installations, very little geothermal investments occurred until the passing of the new geothermal law and regulations in 2008 and 2012 (RA 9513 - further discussed in detail below). In the intermediate period, the Philippines privatized the main parts of the electricity sector under the Electric Power Industry Reform Act (RA9136 of 2001), including EDC and most of PNOC. New geothermal projects are expected to be developed by private sector developers, with a range of investment and electricity price support instruments. Many (small) projects are now in pre-development stage with hope of an additional 1,200 MWe or more geothermal capacity to be installed by 2030.

4.1 Resource ownership and access

In the Philippines, geothermal resources belong principally to the state, going back to Article XII, Sec. 2 of the 1987 Constitution, which provides that: 'All lands of the public domain, waters, minerals, coal, petroleum, and other mineral oils, all forces of potential energy, fisheries, forest or timber, wildlife, flora and fauna, and other natural resources are owned by the State.' (referenced in Peñarroyo, 2010).

The Philippines model of resource development was clearly national and state-centred, but the Constitution - and successive geothermal and other resource laws - allow private sector participation (both national and foreign). The preference for public/state or private sector development of the geothermal resources and the modes for this (co-investment, production-sharing, Financial and Technical Assistance Agreements (FTAAs) and Geothermal Service Contracts (GSCs)) have varied over the years and under different legislations. Many of the large, existing geothermal projects still operate under contracts or conditions relating to earlier laws or decrees.

In 2008, nearly twenty years after it was first filed, Republic Act ("RA") No. 9513, also known as the "Renewable Energy Act of 2008" was signed, paving the way for a speedier and more aggressive development of the country's renewable energy resources including geothermal (Peñarroyo, 2010). RA-9513 defines exploration contracts and exploitation contracts (called Geothermal Service Contracts) with similar ownership-resource use arrangements and time frames (25 years) as under PD1442, but royalties for the use of geothermal energy are brought back to 1.5% of gross energy earnings, with a ratio of 60:40 split between national and local government (unless otherwise specified).

4.2 General electricity market and renewable support policies

Private companies managed most of the Philippines power sector in the early days, but in 1936 the National Power Corporation (NPC) was established to 'construct, operate and maintain facilities for the production of electricity.' Until the major power industry reforms in 2001, the NPC dominated the power industry, both in power generation and in transmission (KMPG, 2013). This was reinforced under the Marcos regime in 1972 with the issuance of Presidential Decree No. 40 (PD 40), under which NPC controlled and monopolized both the transmission and generation sectors, which were effectively nationalized. By the late 1980s, NPC had accumulated billions in debt and therefore lacked the financial capability to efficiently operate its existing generation portfolio or to build new generation capacity. Hence in 1987, the new Aquino administration - as part of a wider privatization process - passed Executive Order No. 215 (EO 215) to permit and encourage private sector participation in power generation.

In 2001, the Congress enacted Republic Act No. 9136 (the Electric Power Industry Reform Act 2001 - EPIRA), to achieve a complete overhaul of the power sector and divert control of the generation and transmission sectors from NPC to the private sector, including:

- Privatization of NPC assets;
- Creation of a wholesale electricity spot market (WESM);
- Introduction of retail competition and open access for large, contestable customers;
- Regulation of transmission, distribution and small (captive) electricity consumers segments (KPMG, 2013).

Though implementation of the EPIRA has been severely delayed, by end-2012, the Power Sector Assets and Liabilities Management Corporation (PSALM) had privatized more than 70% of the total generating capacity of NPC in Luzon and Visayas Islands, as well as more than 70% of the total energy output of power plants under contract with NPC to various independent power companies (KMPG, 2013). All geothermal generating assets are now privately owned.

Due to the import dependence on fossil fuels, the Philippines' power prices are said to be among the highest in Asia (second only to Japan) at an average of at US$ 202.66 per MWh in Manila (Luzon Island). The biggest component of this tariff¬ is the wholesale electricity generation component which averaged US$ 132.80 per MWh paid to generators on the main island of Luzon (IEC, 2012). Despite these already high electricity prices, more policy support was deemed necessary to promote the development of the Philippines' indigenous, renewable electricity generation sources (including geothermal). In 2008, the Renewable Energy Act was passed, followed in 2011 by the National Renewable Energy Program (NREP). Under the Act and Regulations, the government has formulated ambitious goals to triple the renewable energy contribution by 2030, including a 75% growth in geothermal capacity (NREP, 2011) and a range of instruments and incentives. As the Philippines' power sector has been largely privatized, these instruments are largely chosen to provide price support for renewables and geothermal, including:

- A Renewable Portfolio Standard (RPS) requiring electricity suppliers to source a certain amount of their energy supply from RE resources;
- A Green Energy Option program, established by the Department of Energy which provides end-users the option to choose renewables as their sources of energy;
- The National Transmission Corporation ("TRANSCO") and all distribution utilities ("DUs"), shall include the required connection facilities for RE-based power facilities in the Transmission and Distribution Development;
- Tax incentives, feed-in-tariffs and other fiscal and non-fiscal incentives, like Tax Holidays, Duty-Free Import of certain goods, accelerated depreciation and preferential financing packages from national banks (see 5.6);

Since the passing of the new RE-law (2008) and the related NREP (2011) a total of 32 geothermal/RE service operating contracts were awarded by the Department of Energy (Layug, 2012).

4.3 Regulation of environmental impacts

The 1987 Philippine Constitution defines the protection of the right of the people to a balanced and healthful ecology as one of its major policy statements. The main national environmental framework is incorporated in the Philippine Environmental Policy (Presidential Decree 1151 or PD 1151) and in the Philippine Environmental Code (Presidential Decree 1152 or PD 1152) both of which were enacted in 1977. PD 1151 defines the continuing policy of the state to develop and maintain a better quality of life for present and future generations by recognizing the right of every Filipino to a healthy environment. Being the first environmental law it also introduced the concept of Environmental Impact Statements. PD 1152 defines the management policy objectives and strategies for water, air, natural resources, land and waste management by prescribing the enforcement of environmental quality standards (Pascual, 2005).

The implementation of Philippines environmental management is governed by many institutions and has been shaped by many local laws and international treaties and conventions and is deemed to be complex and a barrier by many of the geothermal developers (Benito, 2005; Pascual, 2005; EDC, 2012). In 1996, the Congress tried to initiate a revision of the Philippine Environmental Code (PD 1152) with the intent of creating one holistic national program on environmental management, integrating all the regulatory requirements of the EIA System, Air Quality Management, Water Quality Management, Waste Management, Environmental Adjudication Commission, etc. However, due to the sheer magnitude and scope of the proposed Code and the lack of government funds to implement such a scale, the government instead opted to break down the various components into several Acts (Pascual, 2005). To date, among those are the National Integrated Protected Areas System (RA 7586, 1992), Mining Act (RA 7942, 1995), Indigenous Peoples Reform Act (RA 8371, 1997), Clean Air Act (RA 8749, 1999), Ecological Solid Waste Management Act (RA 9003, 2000) and the Clean Water Act (RA 9275, 2004).

Many geothermal resources are located in protected areas, adding another layer of complexity. The National Integrated Protected Areas System Act of 1992 (Republic Act No. 7586) allows the survey of energy resources in protected areas solely for data gathering. Any exploitation and utilization of energy resources found within NIPAS areas is only allowed through passage of law by Congress (Haraldsson, 2012).

As many geothermal projects in the Philippines have been supported with donor funds, those project developers have to be compliant with their environmental and social safeguards as well. For example, the now private company EDC has 'inherited' some of the World Bank/IFC-loans for the geothermal projects developed in the 1990s by (then state-owned) PNOC/EDC and therefore needs to comply with IFC/World Bank and Equator Principles, covering standards for areas like social and environmental assessment, biodiversity, pollution prevention, indigenous peoples and cultural heritage (EDC, 2012).

Environmental protection in the Philippines is not delegated to a single government agency but instead environment-related concerns are part of the directives of several agencies dealing with agriculture, natural resources, health, housing and public works, making environmental compliance in the Philippines one of the 'challenges' for investors (Benito, 2005, Pascual, 2005, EDC, 2012).

The National Environmental Protection Council (NEPC) was created in 1977 as the main policy-making body on matters related to environment. Later the Environmental Management Bureau (EMB) was created in 1987 under the Department of Environment and Natural Resources (DENR) where it assumed the duties of NEPC and now is the lead agency that implements the Environmental Impact Statement ("EIS") System and handles the review and evaluation of the environmental impact of development projects (Pascual, 2005).

The Philippine EIS System was introduced as the National Environmental Policy instrument in 1977 but was officially established in 1978 with the passage of PD 1586. Under the EIS System, the proponent of a project that is either an Environmentally Critical Project (ECP) or situated within Environmentally Critical Areas (ECA) must obtain an Environmental Compliance Certificate (ECC) from the appropriate regional office of the DENR prior to the commencement of the project. The areas and types of projects subject to the EIS System are contained in Presidential Proclamation 2146 (1981) (Baba, 2003; Pascual, 2005). Resource extractive industries (like geothermal) are considered such Environmentally Critical Projects. An ECC certifies that an approved project will not cause significant negative environmental impact and that the proponent has complied with all the requirements of the EIS System and has committed to implement its approved Environmental Management Plan. The ECC contains specific measures and conditions that the project proponent has to undertake before and during the operation of a project, and in some cases, during the project's abandonment phase to mitigate identified environmental impacts. The EIA results are documented and submitted to EMB for review and evaluation where Environmental Compliance Certificated is then issued. The EIS system is implemented by EMB and is responsible for evaluating system documents. The required EIS studies in are conducted by the proponent or the expert group commissioned by the proponent. Therefore the developer bears all the costs associated with the exercise. Benito (1998) mentions also that it took PNOC-EDC almost 3 years to obtain its ECC for the Mt Apo project. Since then several amendments on the structure, assessment parameters and scope of operations have been made to strengthen the EIS System. Notable among these improvements was the incorporation of enhanced public participation as a major process in validating the social acceptability of the project. The EIS processing and approval procedure have also been streamlined to prevent undue delay in ECC applications (Pascual, 2005).

4.4 Other issues

The Philippines is made up of many islands with a diverse, indigenous population and an evolving framework of sharing governance responsibilities between central and regional levels, particularly in areas with high indigenous populations. In the context of geothermal resources, this is reinforced by RA 8371 (the Indigenous Peoples Rights of Act of 1997) which confers certain preferential rights to indigenous peoples over their ancestral domains and all resources found therein. The RA 8371 requires that no agreement for the exploitation of natural resources shall be approved unless there is a prior certification from the National Commission on Indigenous Peoples ("NCIP") that the area does not overlap any ancestral domain or that the free and prior informed consent ("FPIC") of the concerned indigenous cultural communities or indigenous peoples ("ICCs/IPs") has been obtained (Peñarroyo, 2010). Some of the royalties required under the new RA 9513 Renewable Energy Act (2008) are shared with regional and indigenous institutions. Also the Philippine EIS system requires public participation to make projects more socially acceptable and also prioritizes the host communities surrounding the project as primary beneficiaries with respect to allocation of socioeconomic benefits (Pascual, 2005). Benefits may include priority employment of qualified residents, provision of social development projects and basic extension/livelihood services, taxes, subsidies, and royalties.

On top of the above 'legal requirements', companies developed their own methods and experiences. In the early days, the then state-owned PNOC-EDC was largely developing projects internally and setting its own standards and procedures, guided by requirements set in some of the international development loans (notably World Bank). Therefore, PNOC pioneered public consultation as a test case in Mount Apo (Mindanao) geothermal project as a critical strategy to alleviate severe public opposition. In 1994-1996, PNOC initiated subsequent enhancements of this mechanism in its Mt. Labo and Northern Negros geothermal projects. In fact, these two projects were among the first in the country to model the complete participative process. The various tools used by the Company during public consultations include conduct of scoping meetings, information drives, key informants interview, focused group discussions, perception surveys, and public dialogues (Pascual, 2005; EDC 2012). EDC (2009) describes in detail the case study of Mount Apo (Mindanao) geothermal project and the involvement of the people of Mount Apo.

5. TENTATIVE CONCLUSIONS

Geothermal regulation is complex and encompasses at least 3 distinct areas. It is important to note that these regulation areas are generally covered by different institutions, not all of which necessarily have a major focus on or expertise with geothermal projects. Streamlining of different geothermal regulations and institutions can take time and should be seen in this bigger context.

The table at the end of this article summarizes the findings for the 4 countries over the subject areas studied. Tentative conclusions and lessons learnt are:

1) Ownership and access to the underground geothermal resource are the basis for (sustainable) resource management and potential royalties. Resource management starts with resource ownership and the ways to transfer property or user rights to those that would develop the resources. Physical access to the resource (for drilling wells, building plants and creating transport infrastructure) is also a vital aspect of resource management. In geothermal development - as with similar high investment, high-risk exploration and production developments in other natural resource sectors like mining and petroleum - clear procedures need to exist before (private) companies are willing to invest the large amounts of capital in the subsequent phases of geothermal development. From the country cases described, this is either done through direct contracts or auctions with the national government (Philippines, Chile) or access contracts with landowners, combined with a 'sustainable use permit' from regional authorities (New Zealand). In all cases a clear framework/'contract' exists giving the developer certainty and confidence to use a certain amount of heat or fluid resource over a minimum period to provide a (potential) geothermal generation facility. Care has to be taken, that procedures and conditions are fit for specific, sustainable geothermal resource use, and strike the appropriate balance between investor certainty and flexibility on the one hand vs. public control and monitoring of resource use on the other hand. Agreement on resource payments (royalties) for the use of a public resource are generally encompassed in these regulations and contracts, although they are generally very low (or '0') compared to petroleum royalties.

2) Electricity market regulations: ultimately the price that geothermal power receives will determine the return on investment and hence the competitiveness and feasibility of geothermal generation. Understanding the access to existing power market and any geothermal/renewable support are therefore essential to understanding the effective price for produced geothermal power, as well as

the degree of contract certainty that the developers have that agreed prices and off-take volumes will last for the life of the project. In the case of the three countries studied:

- In all 3 countries studied (private) geothermal generators have relatively open access to the electricity market and transmission system;
- Power prices are set either through contracting with a regulated monopoly distributor or free-market negotiations of Power Purchase Agreements (PPAs) as in Philippine and Chile, or by 'internal contracting' in vertically integrated generators-retailers in New Zealand.
- Power prices in Philippines and Chile are significantly higher than in New Zealand, but the quality of the latter's resources and central location have meant that at present geothermal is competitive in New Zealand with very little government/state support;
- In the Philippines geothermal seems to have become competitive again due to high power prices and considerable additional support (feed-in-tariffs, tax breaks, lowered import tariffs.
- In Chile power prices are high and NCRE-credits seem significant, but Chile's geothermal resources are generally in remote regions, up in the Andes and expensive to develop. NCRE-prices seem to be rising, but are a 'tradable commodity' and don't provide the long-term income certainty developer would prefer.

3) Environmental regulations: despite having generally less and more benign environmental impacts than most competing (especially fossil fuel based) generation technologies, impacts of fluid chemicals, reservoir subsidence, noise/visual impacts, impact on surface features and habitat disturbance due to the geothermal production and associated infrastructure impacts, can be significant and need to be properly regulated and monitored. This is generally covered under a plethora of regulations, emissions standards, etc. All 3 countries studied have created agencies to coordinate the application of these via a process of Environmental Impact Assessment, in which the developer is supposed to map out the major impacts of the geothermal project, measured to mitigate impact and compliance with regulations and standards. That way Chile and New Zealand have successfully created a one-stop-window covering all (or most) environmental regulations in one step, facilitating the process for developers. An important public awareness raising task might lie with government authorities to explain that a well-managed geothermal project is much different and has lower impacts in general than an extractive mining or petroleum project (more common to the regions). The Philippine government has shown its willingness to promote geothermal energy in that way.

4) Other issues: In Philippines, Chile & New Zealand, many geothermal systems lie in areas inhabited in large part by indigenous peoples, that have a special cultural or spiritual connection with the geothermal (and other natural) resources. Chile and New Zealand show that there are various ways of involving and rewarding (indigenous) communities in the process of developing geothermal power plants. Depending on historic, social and legal circumstances, this can be through a combination of national legislation and sharing of royalties (Philippines) or land-ownership, access and regional environmental requirements (New Zealand). Chile hasn't built any geothermal power plants yet, but community consultation is part of the EIA-process and Chile is signatory to ILO Convention No 169 of Indigenous People (Chile). Developers are therefore engaging early with communities, base-monitoring important surface features, etc. in order to prepare/facilitate future agreements when plants will be built.

It is also important to note that, whereas in all three countries studied (new) geothermal developments are to be developed in large part by private investors, in New Zealand and Philippines most (all) previous projects and a large, critical base of geothermal experience and expertise have been built under (previous) government sponsored programmes, absorbing much of the initial geothermal development risk. In 2008 the Philippines government introduced a new geothermal (renewable) energy support package, including feed-in-tariffs, reduced taxes and other incentives. Chile, as the most advanced Andean geothermal country, has had much success in attracting private developers to invest in the (pre)-exploration stages, but no projects have been taken to the (most expensive) production drilling and construction phase. Barriers mentioned (Reed, 2012) are among others high cost and risk involved, absence of support policies and problems reaching appropriate electricity off-take contracts (PPAs). Realizing this, the new government since March 2014, has announced investigation of several support options for exploration (drilling) risk and transmission policies. The Chilean government has also invested significantly through government-sponsored centres of research and education (CEGA); state-funded scholarships for specialised study abroad; and exchanges of geothermal experts. This is helping to create a general base of geothermal expertise in universities, government agencies, as well as companies. In contrast, it is interesting to note that in the Philippines the large existing base of geothermal expertise has largely been built within companies (many now privatized like Energy Development Company - EDC), but very little base has been created within the national universities, government and research institutes, which might hamper future geothermal development under now privatised geothermal regulations.

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	New Zealand	Chile	Philippines
History & background	Since 1950s; 900 MWe installed; original state intiated development, now private developers; 3-5 GWe potential	Recent exploration wave, 2-4 projects 'approved'; none installed yet; complete private development; 3-16 GWe potential	Since 1970s; 1900 MWe installed; previous state development; newly development under privatized framework (2008-); 3-4GWe potential
Ownership & access	No ownership', but Regional Authorities 'managers' of resource' via RMA-consents to use resource under sustainability conditions (30-35 years); access through private (indigenous) land-owners. No royalties.	State resource ownership; exploration and exploitation licensing rounds & contracts under Ministerio de Energia (perpetual licenses). Much private & indigenous land (state can force access).	State resource ownership, but need for regional/ indigenous approval. New Renewable Energy Act (2008) defines exploration & geothermal service (=exploitation) contracts (25 yrs +15) under Department of Energy. Contracts also specify royalties.
Electricity market & RE-policies	Open competetion between private & (part) state-owned generation companies. Very limited support from NZ Emissions Trading Scheme. Geothermal competitive 'on its own'	Open competition between privately owned generators. High power prices on imported fossil fuels & support from NCRE-policies, but geothermal higher cost in Andes & 'marginally competitive'	Newly privatized electricity market. High power prices on imported fossil fuels.Various types of RE-support for geothermal (in RE-Act-2008). Same Act defines feed-in-tariffs. Seems competitive: new geothermal plants in pipeline.
Regulation of environmental impacts	Resource Management Act (1990) authorizes regional authorities through resource consents, incl effects on land use, water and air, indigenous biodiversity, etc. 1-stop-window. Regions guided by National Policy Statements	Environmental Assessment Agency responisible to coordinate impact assessment & approval of each project. Since 2012 separate SMA for monitoring (&fining) there-after. 1-stop-window. Generally provincial level.	Department of Environment & Natural Resources coordinates but environmental laws spread over many agencies and Presidential Decrees
Community/indigenous participation	High involvement of indigenous (Maori) people due to RMA-requirements, historic-cultural ties and land-ownership & co-investment	Several local and international indigenous laws. No geothermal projects yet, but 'talking to communities'. Much environmental and indigenous protest against energy projects of late, hence great sensitivity.	Many geothermal fields in remote, indigenous regions. Much experience with developing geothermal projects in participation with indigenous communities. Geothermal royalties are shared with regions & indigenous groups
Geothermal investment & risk policies	Previously heavy state involvement in exploration, resource de-risking and project development. Now all private, but most large geothermal fields have geophysics, well and other data available (brownfield)	In principle complete private development, but slow. State considering/investigating support in transmission and drilling risk. Government already investing significantly in research, education & capacity building	Previously mainly state and donor development, recently completely privatized. Government support includes exploration studies, tax holidays, reduced import tariffs, etc

Table 3: Summary of main findings for three countries studied