

3.2 Geothermal Energy

Geothermal energy is heat that is stored in the rock and fluid contained in the Earth's crust (Geothermal Resources Council, 2011). The heat is generated by the natural decay over millions of years of radiogenic elements, including uranium, thorium and potassium (Geoscience Australia and Australian Bureau of Agricultural and Resource Economics, 2010). This heat is constantly moving from the Earth's core to the surface and can therefore provide a sustainable energy source.

Low temperature geothermal resources (with temperatures typically between 38°C and 150°C (Geothermal Resources Council, 2011) can be used directly (without conversion to electrical energy) for the purpose of heating or cooling. Heating applications can include: agricultural purposes (for example, greenhouse heating), industrial purposes (for example, evaporation drying, sterilization and chemical extraction), space heating, bathing, aquaculture, and water desalination (KPMG, 2010).

Another application of geothermal resources is to produce electricity – the geothermal policies of Australia and Indonesia have focused on the use of geothermal resources for the production of electricity so this use is the focus of this paper.

Electricity production usually requires a geothermal resource with a temperature of more than 100°C (International Energy Agency, 2011). The geothermal heat required to produce electricity typically comes from hydrothermal or “conventional systems.” These systems use naturally occurring hot water or steam circulating through permeable rock. They are commonly associated with active volcanoes. To use these resources it is necessary to drill a production well to extract the hot water or steam. The used water is typically returned to the geothermal reservoir via an injection well. Conventional systems use a mature technology. They are typically shallow (<3km), have a relatively low well cost and temperatures between 200°C to 350°C.

Until recently, geothermal exploitation was limited to conventional systems – in areas with high temperatures and where the fluid will transfer to the surface without additional lift (International Energy Agency, 2011). New technologies now permit the exploitation of deeper and cooler resources as found in hot sedimentary aquifers and enhanced geothermal systems (KPMG, 2010). These technologies have significantly expanded the global geothermal resource potential.

- To extract energy from Enhanced Geothermal Systems it is necessary to pump high pressure water through an injection well into a deep body of hot compact rocks causing it to fracture, artificially creating a reservoir. The water is heated by the rocks and returned to the surface via a production well. This technology is relatively new and not yet commercially proven (Electric Power Research Institute, 2010).
- Hot sedimentary aquifer systems are similar to conventional systems. They contain naturally occurring reservoirs of hot water or steam. To use these reservoirs it is necessary to drill both a production and injection well. The key difference between hot sedimentary aquifers and conventional systems is that hot sedimentary aquifers involve drilling into hot sedimentary basins with temperatures typically lower than conventional systems. Furthermore, they occur at greater depths than conventional systems. While hot sedimentary aquifer systems are

considered to be less risky than enhanced geothermal systems they nonetheless remain to be proven commercially.

The use of geothermal resources to produce electricity provides a number of benefits. It can reduce a economy's reliance on imported fuels and thus promote energy security; it is environmentally friendly – geothermal power stations emit effectively no greenhouse gases (Geoscience Australia and Australian Bureau of Agricultural and Resource Economics, 2010) and when compared to coal based power generation virtually eliminate local air pollutants such as sulphur dioxides, nitrogen oxides and particulates (Asian Development Bank, 2010); and unlike many other forms of renewable energy geothermal power is not subject to short term or seasonal weather variations and can therefore provide reliable base-load capacity.

3.2.1 Geothermal Energy in Australia

Key findings

- Australia's geothermal resource is projected to be very large. However, its potential to support commercially viable power plants has not yet been proven and early projects have produced sub-optimal results.
- The key barriers to development of Australia's geothermal industry are resource uncertainty, cost, and financing difficulties. To overcome these barriers Australian governments have supported basic research and development (R&D) programs and grants for research, development and deployment. Geothermal power is also eligible for the renewable energy target (RET).
- Australia's geothermal sector has leveraged a significant amount of private sector capital to date. This capital has flowed in the early development and exploration phase of the technology. However, additional capital is still required to take these investments through to the demonstration stage.

Costs, benefits and promotion

- Australian government grants to companies for research, development and deployment have looked to mitigate early mover risk. However, governments have faced significant challenges in trying to co-manage the development of new technologies. This has led to significant implementation delays and makes grants hard to justify on a benefit/cost basis.

Scientific integrity

- Australian estimates of the resource indicate a substantial technical potential. It is now estimated that if just 1% of Australia's geothermal resource to a maximum depth of 5km and a minimum temperature of 150°C could be accessed, it could provide roughly 25,000 times Australia's primary energy use.

Flexibility

- The flexibility of Australian government geothermal programs differs. At the national level support for the industry is flexible because governments have not committed to any specific development targets.
- In terms of grant-based programs, governments have typically provided one-off funding rounds which are regularly changed. However, once announced, grant programs lack flexibility.

Transparency

- Australian governments have developed a number of mechanisms to facilitate the stakeholder input to the policy development process. This includes the Australian Government's

Commonwealth Grant Guidelines introduced in 2009 to promote better practice approaches to grants including stakeholder consultation, and the Australian Government's Best Practice Regulation Handbook, most recently updated in 2010.

Alignment

- Some alignment problems have been highlighted by stakeholders, but Australian governments have taken a number of steps to achieve policy alignment. Policies between the Australian and State and Territory governments are coordinated through the Council of Australian Governments (COAG), while a system of Ministerial Councils under COAG facilitates consultation and cooperation between jurisdictions in specific policy areas.

A. Size and Significance

The Australian Government has identified geothermal as a strategically important technology class due to its potentially significant role in Australia's future energy mix as well as generating additional spill over benefits in the form of intellectual property or export earnings (Australian Government, 2011a). Australian Government modeling indicates that geothermal could account for between 13% and 23% of total Australian electricity generation in 2050 (Australian Treasury, 2011). It is estimated that this would require the generation of between 5000 MW and 9500 MW of power from geothermal in 2050 (The Age 2011). The Australian Government does not have a specific geothermal target. As such, the role it will play in the future will be determined by factors such as overcoming resource barriers at a competitive cost.

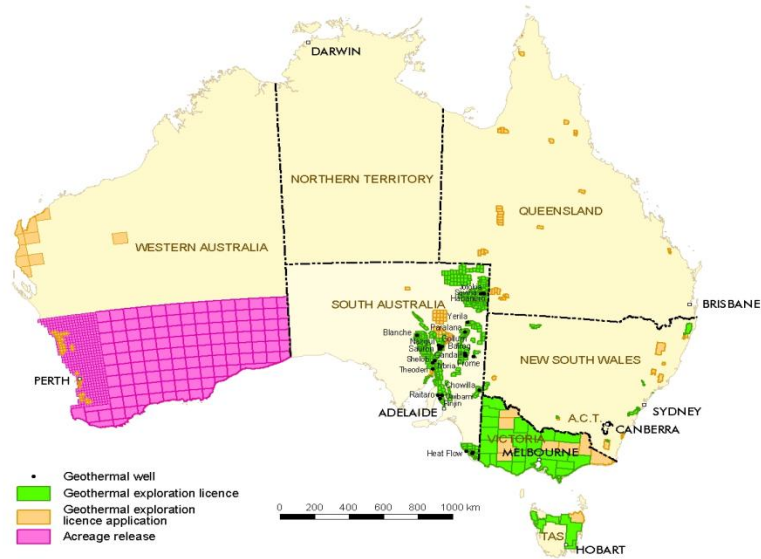
The exploration of geothermal resources in Australia is governed by State and Territory governments. Between 2001 and 2009 all Australian jurisdictions except the Australian Capital Territory (ACT) developed new legislation or amended existing legislation (developed for minerals or oil) to allow the exploration and exploitation of geothermal resources. South Australia has been described as "Australia's hot rock haven" and this renewable energy form could provide an estimated 6.8% of Australia's base load power needs by 2030. Investors have continued to support capital requirements for geothermal projects, and funding continued to increase.

In 2006, Geodynamics, Petrathern, Green Rock Energy, Eden Energy, and Geothermal Resources raised AU\$20.78 million (US\$ 19.7 million) from public share subscriptions during the year. As of 31 December 2006, the market capitalization of these five companies amounted to about AU\$ 172 million (US\$ 163.4 million).¹⁶⁶ In the first two months of 2007, Geodynamics, Petrathern and Torrens Energy all announced significant additional injections of capital. There are indications that investors remain willing to back geothermal energy projects. By 2010, 57 companies held exploration licenses over an area of more than 457,900 square km (Bendall et al., 2011). However, current installed capacity is still limited to an 80 kW power plant that has been operating at Birdsville, Queensland since 1992. Most of the companies that hold licenses are speculative and are not involved in exploration activity (Allen Consulting Group, 2011).

¹⁶⁶ Please refer to the assessment by Department of Manufacturing, Innovation, Trade, Resources, and Energy accessed at http://www.pir.sa.gov.au/geothermal/ageg/geothermal_basics/potential_use.

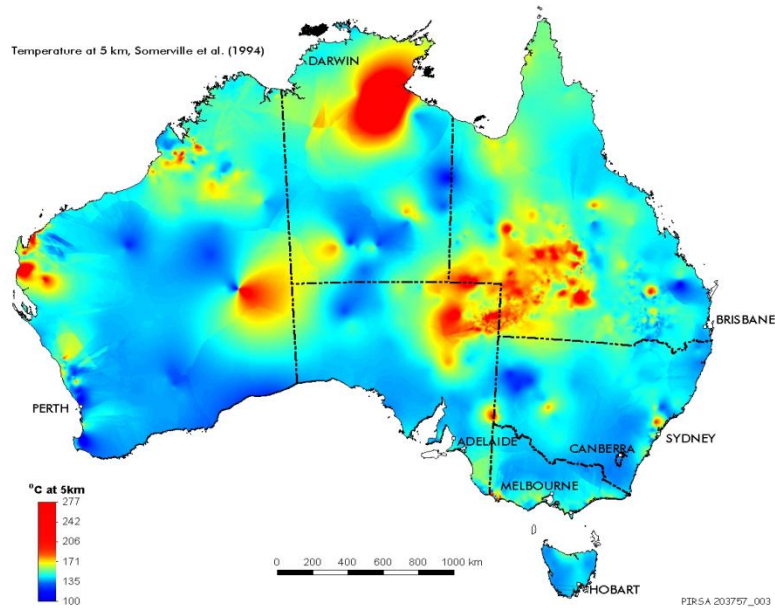
Figure 3.2.1 below shows the geothermal licenses, applications and gazettal areas as of February 2009. The map indicates that most exploration licenses have been awarded in South Australia whereas acreage releases are the most in Western Australia. And Figure 3.2.2 shows extrapolated temperature at 5km intervals across Australia. It indicates that the region in and around the border of South Australia and Queensland shows technical promise for geothermal energy in addition to some parts of the Northern Territory.

Figure 3.2.1 Geothermal licenses, applications, and gazettal areas



Source: Department of Manufacturing, Innovation, Trade, Resources, and Energy (2012) accessed at http://www.pir.sa.gov.au/geothermal/ageg/status_of_geothermal_licence_activity

Figure 3.2.2 Temperature map of Australia



Source: Somerville et al. (1994)

B. Policy Formulation

(i) History and Background

Due to the fact that there are no conventional geothermal resources available in Australia, the prospect of using geothermal energy has only recently emerged with the development of enhanced geothermal systems and hot sedimentary aquifer systems. Nonetheless Australian governments¹⁶⁷ have been active in updating their regulatory systems to accommodate the needs of the geothermal industry for over a decade.

In recognition of the early stages of geothermal technology development applicable to Australian circumstances (no conventional resources available) the Australian and State Governments provided grants for early stage industry research and development and provided to individual companies and research organizations. In total, such measures to support the development of the geothermal industry amounted to AU\$ 297 million (US\$ 282.2 million) to 2010 through government budgets (Bendall et al., 2011).

(ii) Policy Description

MANDATES

Regulations governing geothermal exploration and exploitation

Each State and Territory government (with the exception of the Australian Capital Territory) has introduced legislation setting out the rules for geothermal exploration and exploitation. They have so far encouraged the registration of 380 geothermal exploration licenses.

The regulatory regime adopted by each jurisdiction is different but includes some significant similarities. For example all regimes include the right to collect a royalty based on exploitation of the geothermal resource (although some States choose not to enforce this right) and include provision for the following types of licenses:

- *An exploration license*

A firm that wishes to explore geothermal resources must obtain an exploration license. Exploration licenses may be issued via tender (for working areas identified by the government) or after application from a geothermal firm.

- *A retention lease*

Firms that find a geothermal resource that is not yet commercially viable but is expected to become viable may apply for a retention lease.

¹⁶⁷ Australia is governed by a federal system consisting of a national government, six state, and two territory governments. To help promote the development of Australia's geothermal industry, Australian governments (the national and state and territory governments) have introduced a range of policies.

- *An exploitation lease*

Firms that wish to exploit a geothermal resource (but not the right to build a power plant or build facilities for the direct use of geothermal resources, as these are governed by separate regulations) must apply for an exploitation lease.

Renewable Energy Target

The Australian Government introduced the renewable energy target (RET) in 2001 to promote the development of a range of renewable energy sources including geothermal. The RET is designed to achieve approximately 20% of Australia's electricity production by 2020 from broad range of renewable energy sources including hydro, wind, solar, biomass, wave, tidal, and geothermal. The scheme requires liable entities to obtain and surrender renewable energy certificates up to the target for that year. The scheme includes two components: the Large-scale Renewable Energy Target Scheme (LRET) and the Small-scale Renewable Energy Scheme (SRES) which includes the Solar Credits rebate scheme.

The RET provides generators of renewable energy sources with a premium over the price of other electricity sources such as coal. In this way the RET is similar to a feed-in tariff (FiT)¹⁶⁸ scheme. However, it is not technology specific (one premium price is offered to all renewable energy technology types) and the price is not determined in advance but responds to changes in the cost of achieving the set target. For example, if the price of renewable energy falls then the cost of meeting a set target and the price of the premium paid to renewable energy sources will also fall.

FINANCIAL INCENTIVES

Research and development (R&D) grants

Australian governments have provided support to basic geothermal research and development (R&D) through public organizations such as the Commonwealth Scientific and Industrial Research Organization (CSIRO), geothermal centers of excellence, universities, and Geoscience Australia. This funding aims to support technological innovations and develop an improved understanding of Australia's geothermal resources.

Beyond basic research, Australian governments have provided significant support to private sector research, development, and demonstration of geothermal projects in the field. For example, the Australian Government allocated AU\$ 50 million (US\$ 47.5 million) to seven projects under the Geothermal Drilling Program and AU\$ 152.8 million (US\$ 145.2 million) to two projects under the Renewable Energy Demonstration Program. This is in addition to support provided through the RET (see above).

FUTURE PROGRAMS

In July 2011, the Australian Government introduced a range of new climate change policies to begin in July 2012. This included a national carbon pricing scheme that will initially impose a fixed price of

¹⁶⁸ Feed-in tariffs refer to a guaranteed purchase agreement for electricity generated from renewable energy sources. These agreements are generally framed within long-term (15–25 year) contracts.

AU\$23 (US\$ 21.9) (rising at 2.5% in real terms) per ton of CO₂e emissions on around 500 of Australia's largest polluters (liable entities) including stationary energy and then transition to an emissions trading scheme on 1 July 2015 (Australian Government, 2011c). It also included the AU\$ 3.2 billion (US\$ 3.1 billion) Australian Renewable Energy Agency (ARENA) to promote the research and development, demonstration, commercialization and deployment of renewable energy projects to improve the sector's competitiveness; and the AU\$ 10 billion (US\$ 9.5) Clean Energy Finance Corporation (CEFC) to provide commercial or concessional loans or equity investments to clean energy companies.

C. Regulatory Review

ECONOMIC EFFICIENCY AND EFFECTIVENESS

The main focus of State and Territory Government interventions has been the creation of a regulatory environment conducive to geothermal exploration and exploitation. In addition, Australian governments (including at the national level) have provided R&D funding to accelerate the maturation process of technologies that may lead to the commercial exploitation of the non-conventional geothermal resources available in Australia.

Assessing the economic efficiency and effectiveness of Australia's geothermal policy against these goals is not straightforward given that they are relatively intangible and/or will involve long payback periods. Some of the key barriers governments are trying to help address for the fledgling geothermal industry are discussed in the following paragraphs.

One of the barriers to the development of Australia's geothermal industry is that the technologies for exploiting *enhanced geothermal systems* and *hot sedimentary aquifer* resources are still at the development stage. While both are believed to be technically feasible (Electric Power Research Institute, 2010) – and Australian stakeholders have expressed confidence that they can be successfully applied under Australian conditions (Allen Consulting Group, 2011) – more development is required before commercial viability is achieved.

Another barrier is resource risk. Even if non-conventional technologies can be used in Australia it will still be necessary to develop geothermal resources for which a number of factors remain uncertain until substantial investments are undertaken. These include temperature, flow rates, acidity, depth and other factors that affect costs and therefore commercial viability.

Financing is another challenge. The cost of drilling geothermal exploratory wells is large (around AU\$ 15 million to AU\$ 20 million (US\$ 14.3 million to US\$ 26.6 million) (Australian Government, 2011b), may significantly exceed initial expectations¹⁶⁹ and is an expense that must borne prior to confirmation of the geothermal resource. This makes it risky and difficult to finance. The challenge of financing exploratory drilling is particularly acute in Australia because there is only one domestically based drilling rig and the cost of sourcing a rig from overseas is high due to the large distances involved, the small size of the industry and inexperience in drilling (Australian Government, 2011b). This will limit

¹⁶⁹ For example, the cost to Petrathern (a geothermal company) of drilling was approximately AU\$ 15 million (US\$ 14.3 million) higher than expected and the cost to another geothermal company, Geodynamics, as AU\$ 30 million (US\$ 28.5 million) instead of an expected AU\$17 million (US\$16.2 million) (Allen Consulting Group, 2011).

the number of geothermal companies that can finance geothermal exploration and slow the pace of industry development.

All of these barriers contribute to the cost of geothermal power. To be competitive on a large scale, geothermal will have to supply power into a competitive wholesale electricity market (there may be a few opportunities to supply electricity directly to users in some regions). The largest market is known as the National Electricity Market (NEM) and covers every Australian jurisdiction with the exception of Western Australia and the Northern Territory. In 2010, the average wholesale price in the NEM was AU\$ 45/MWh (US\$ 42.8/MWh). At this price and including a modeled AU\$ 65/MWh (US\$ 61.8/MWh) premium under the Australian Government's Renewable Energy Target scheme it is estimated that there is currently a shortfall of AU\$ 10 – \$40/MWh (US\$ 9.5 – US\$ 38/MWh) before the cost of electricity from geothermal resources could be commercially competitive (Allen Consulting Group, 2011). In other words, the enhanced geothermal systems and hot sedimentary aquifer technologies required to access Australia's non-conventional geothermal resources are not yet competitive with other renewable technologies.

Some studies suggest that this may change in the future and non-conventional geothermal technologies may become competitive with other renewables and some fossil fuel sources (Electric Power Research Institute, 2010). However, some caution may be necessary as these declining price projections are not based on any operating Australian examples and will be heavily influenced by site-specific factors such as temperature, acidity and flow rates. In addition, they do not account for the cost of connecting to the grid (which could be very large).¹⁷⁰

To help overcome these barriers Australian government have introduced geothermal regulations and a range of support mechanisms. The costs and benefits of each of these policies, including impact on promotion is described below.

(i) Costs, Benefits and Promotion

Regulations and administrative procedures

Formal cost benefit analysis is difficult in this area given that regulations are meant to be enabling the exploration and exploitation of the still immature technologies that apply to the Australian context (no conventional geothermal resources are available). It therefore remains unclear whether State and Territory geothermal regulations have helped maximize the benefits while minimizing the costs of the geothermal industry on society.

That said there is evidence that Australian State and Territory government have considered the cost impact of their geothermal regulations. For example, South Australia has a single window for project applications so that companies do not have to apply to separate agencies for different permits. Under this approach an application takes an average of four months (Holroyd and Dagg, 2011). There are no suggested improvements in the geothermal regulatory regime although problems could become more evident as the industry develops.

¹⁷⁰ It is estimated that the cost of connecting one of the more promising sites in the Cooper Basin in South Australia to the national could be around AU\$ 1 billion (US\$ 0.95 billion). (Allen Consulting Group, 2011)

Research and development (R&D) grants

A feature of Australian government grants available to the geothermal industry is that much of the funding remains unspent. This problem is not unique to the geothermal sector. Daley et al (2011) estimate that over the last decade Federal and State governments have announced more than AU\$ 7.1 billion (US\$ 6.8 billion) in competitive grants aimed at reducing greenhouse gas emissions. Yet on average only 3% of funding is spent within 5 years and 18% within 10 years. The likely reason for these delays is it is difficult for governments to select the best projects when the projects involve cutting-edge technologies and are highly complex (Daley et al, 2011). This underscores the informational problems associated with governments choosing technological winners.

The delay in implementing grant programs means that Australian government funding has often not been spent. It will, however, still impose a cost on Australia in terms of under-utilized funding which could have been allocated to more productive areas of the economy. This suggests that many Australian government grant programs to the geothermal industry are unlikely to have minimized costs, making grants difficult to justify on a cost-benefit perspective. Governments should consider if grant programs are the most appropriate form of assistance to support research, development, and deployment.

Renewable Energy Target

The RET provides generators of renewable energy sources with a premium over the price of other electricity sources such as coal. Important design features of the RET to improve the efficiency of the scheme include that it does not favor one renewable technology over others (one premium price is offered to all renewable energy technology types), and the price is not determined in advance but responds to changes in the cost of achieving the set target. For example, if the price of renewable energy falls then the cost of meeting a set target and the price of the premium paid to renewable energy sources will also fall.

Government support for the RET could in the past be justified on the basis that it helped internalize the cost of greenhouse gas emissions. This rationale will be weakened when the national carbon pricing scheme is introduced in July 2012. The government has decided to continue to support the RET on a transitional basis up to 2020 in order to bring forward the development of renewable energy sources. This provides an opportunity to reduce the long term cost of emission reductions but will increase the short term cost of the emissions trading scheme because it will crowd out some potentially lower cost emission reduction options, for example, in the forestry or energy efficiency sectors.

The costs and benefits of the RET have been assessed through a number of studies. For example, in 2009 it was projected that the cost of achieving Australia's target of 20% renewable energy by 2020 would be AU\$ 4/MWh (US\$ 3.8/MWh) or a 3% increase in electricity prices (McLennan Magasanik Associates, 2009). There is also evidence on the actual performance of the RET. In 2010, it was estimated to have achieved abatement of 8.8 Mt CO₂e more than any other on-going Australia climate change program¹⁷¹ and has done so at a cost of between AU\$ 30 – \$70/tCO₂e (US\$ 28.5 – US\$ 66.5/tCO₂e) (Daley et al, 2011) and impact of around 1 to 2% on electricity prices (Productivity Commission 2011).

¹⁷¹ The largest contribution to emission reductions activities is land clearing reforms introduced by the States of Queensland and NSW. However, this only provides a one-off reduction in emissions.

The abatement costs of the RET compares well relative to some other policies. For example, abatement under solar subsidies has cost up to AU\$ 1000/tCO₂e (US\$ 950/tCO₂e). However, it is more expensive than energy efficiency standards (which are estimated to provide net benefits) and some grant programs (although the abatement achieved through grant programs is low) (Daley et al, 2011). The RET by itself is unlikely to provide an incentive for the geothermal industry because emission reductions can be achieved more cheaply from other technologies such as wind.

(ii) Scientific Integrity

Australia has historically been considered “cold” with limited geothermal potential but more recent research has provided a different outlook (Ghori, 2008). It is now estimated that if just 1% of Australia’s geothermal resource to a maximum depth of 5km and a minimum temperature of 150°C could be accessed, it could provide roughly 25,000 times Australia’s primary energy use (Geoscience Australia and Australian Bureau of Agricultural and Resource Economics, 2010).¹⁷² This resource is estimated to be spread across Australia and includes enhanced geothermal systems and hot sedimentary aquifer systems resources but not conventional high temperature systems because there are no volcanoes on the Australian continent.

The benefit to society of government support to develop Australia’s geothermal resource is that it provides the potential for base load power at a competitive price and with a near zero environmental footprint (Allen Consulting Group, 2011). However, it is not without risks. This is because evidence of Australia’s potential resource is still limited and unevenly distributed, and where no data is available the existing data has been interpolated over large areas to generate national scale maps (Allen Consulting Group, 2011). Australia is also yet to confirm the existence of a commercially viable geothermal plant.

(iii) Flexibility

The flexibility of Australian government geothermal programs differs. At the national level support for the industry is flexible because governments have not committed to any specific development targets. (It does have a 20% renewable energy target but this can be met using a number of different technologies including potentially electricity from geothermal resources).

In terms of grant-based programs, governments have typically provided one-off funding rounds which are regularly changed. However, once announced, grant programs lack flexibility. For example, grants are likely to be provided according to a set of criteria designed to ensure that government funds are not misused. These criteria may limit the firm’s ability to respond to changed circumstances (which are quite likely during the early stages of technology development). This occurred in the Geothermal Drilling Program (GDP). The GDP was initially expected to cover around half of recipients drilling costs; however, by 2010 the funding was expected to cover less than a third of the costs. This made it harder to

¹⁷² The estimate of Australia’s geothermal resource is based on a set of more than 5700 temperature data points taken from deep drill holes used for the petroleum and mineral industry and more than 150 heat flow data points. This information has been improved over time including through the recent Australian Government’s Geothermal Energy project.

finance the additional costs and more than half of the recipients agreed to hand back their grant funding in August 2011.

Market mechanisms offer a more flexible policy approach. They have been applied to large range of emission reduction activities and therefore provide businesses with greater freedom to choose how they will contribute to the environmental target (e.g. a business may choose to contribute to the RET through the development of solar, wind, geothermal, or any other eligible technology). This flexibility allows business to respond to market conditions, for example, to reduce the use of a particular technology in response to price rises or vice versa. This helps to minimize costs for business while still ensuring the environmental objectives are achieved.

ADMINISTRATIVE AND POLITICAL VIABILITY

(iv) Transparency

Australian governments have developed a number of mechanisms to facilitate the stakeholder input to the policy development process. This includes:

- The Australian Government's *Commonwealth Grant Guidelines: Policies and Principles for Grants Administration* introduced in 2009 to promote better practice approaches to grants including stakeholder consultation.
- The Australian Government's Best Practice Regulation Handbook, most recently updated in 2010 (see Box 3.2.1 for an overview of the Australian Government's approach to best practice regulation).

Box 3.2.1 Australian Government approach to best practice regulation

The Australian Government's approach to regulatory impact assessment (RIA) is described in the Best Practice Regulation Handbook (Australian Government, 2010) (Handbook). In most cases a regulatory proposal cannot go to Cabinet or other decision maker unless it has complied with the RIA requirements.

The Handbook provides detailed guidance to policy makers on how to conduct an RIA with particular attention given to preparation of analysis of the costs and benefits of regulation through a regulatory impact statement (RIS). A RIS is mandatory for all decisions made by the Australian Government and its agencies that are likely to have regulatory impact on business or the not-for-profit sector, unless that impact is of a minor or machinery nature and does not substantially alter existing arrangements. This includes amendments to existing regulation and the rolling over of sun-setting regulation. A RIS includes detail on:

- the nature and scale of the problem that will be addressed by the regulation;
- the objectives of government action;
- an impact analysis (an assessment of the environmental, economic and social costs and benefits of the proposal to society);
- stakeholder consultation (which should comply with a set of government consultation principles);
- a recommendation; and
- a strategy for implementation and review.

The Australian Government has established the Office of Best Practice Regulation (OBPR) to assist agencies in meeting RIA requirements. The OBPR also monitors and reports on compliance by government departments and agencies with these requirements.

There is evidence that stakeholders have had an opportunity to contribute to the range of government policies and that a copy of these policies is readily available.

Regulations

The development of State government geothermal regulations began more than 10 years ago (with the South Australian Petroleum and Geothermal Energy Act). The South Australian Government indicates that this piece of legislation was developed over a four year period and involved extensive stakeholder consultation (Government of South Australia, 2012). The development of more recent regulatory regimes has also involved stakeholder input. For example, in 2009, the Queensland Government released the Geothermal Energy Bill 2009 Consultation Paper. This paper provided an overview of the Geothermal Energy Bill 2009 and explanatory material and questions to guide public submissions prior to the finalization of the Geothermal Energy Act 2010. The Northern Territory Government also released a discussion paper on its Geothermal Energy Bill in 2006 to assist in developing legislation that was finalized in 2009.

All State and Territory governments have made a copy of the geothermal legislation available on-line.¹⁷³ To further promote transparency some state and territory governments have provided additional explanatory material. For example, the Northern Territory Government has prepared an Explanatory Statement to the Geothermal Energy Bill 2009 and Victoria has prepared the *Geothermal Energy in Victoria: Landholder Information* to advise landholders with land that is subject to geothermal exploration or extraction of their rights.

Research and development grants

The Australian Government has taken steps to understand the barriers facing the geothermal industry and promote stakeholder involvement in the development of grant programs, for example:

- In 2008, the Australian Government Department of Resources, Energy and Tourism released the *Australian Geothermal Industry Development Framework* and the *Australian Geothermal Industry Technology Roadmap*. The documents were developed in consultation with National, State, and Territory government agencies; private interest groups; and research organizations and outlined key barriers to industry development and strategies for addressing the challenges.
- In 2008, the Australian Government announced the two largest geothermal grants so far: the Geothermal Drilling Program (GDP) and the Renewable Energy Demonstration Program (REDP). The GDP was developed in consultation with industry (Minister for Resources and Energy, 2008a) and draft guidelines for the REDP were released for public comment prior to finalization (Minister for Resources and Energy, 2008b).
- In 2009, the Australian Government released the *Commonwealth Grant Guidelines: Policies and Principles for Grant Administration* (2009). The Guidelines note the importance of involving stakeholders in the development and modification of grant programs. They also suggest that grants programs should be advertised to stakeholders through modern technology or traditional media and advertised on government web portals such as Grantslink.¹⁷⁴
- In 2010, the Australian Centre for Renewable Energy (ACRE) established by the Australian Government commissioned the Allen Consulting Group to consult with industry participants and report on the challenges facing the industry and recommend a pathway to overcome these challenges. The findings were discussed by geothermal experts from government, industry and research organizations, State and Territory governments, and the ACRE Board, to develop a strategy to support the further development of the geothermal industry.

However, there is also evidence that stakeholders have not always been adequately consulted on grant programs. For example, the Australian National Audit Office (ANAO) (2010) conducted a review of 5 large climate change grant programs that commenced between 1999 and 2005. This review suggests that

¹⁷³ For example, the Queensland Geothermal Energy Act is available at www.legislation.qld.gov.au and the Victorian Geothermal Energy Resources Act 2005 is available at www.legislation.vic.gov.au.

¹⁷⁴ Please refer to www.grantslink.gov.au

some early grant programs (including some that were open to the geothermal industry) were designed with significant stakeholder input but others were not.

Market Mechanisms

Stakeholders (from business, different levels of government and the non-for-profit) sector have had an opportunity to provide input to the development of the RET and the national carbon pricing scheme. For example, a 2003 independent review of the mandatory renewable energy target (MRET) received 264 substantive submissions, met with 115 different stakeholders and travelled to 16 different communities (Mandatory Renewable Energy Target Review Panel, 2003). More recently stakeholders have been asked to provide feedback on the 2009 and 2010 RET legislative amendments including feedback on scheme design options, exposure drafts of legislation and regulation, and input to parliamentary inquiries.

To help develop the national carbon pricing scheme the government organized a series of roundtables with business groups, environmental/non-government organizations, community sector groups, and primary industry representatives over a 6 month period (Australian Government, 2011d). The government also received over 1300 submissions from individuals, business groups, non-government organizations, community groups, state and local government bodies, and industry associations.

The legislation and regulation underpinning both schemes is available at the Australian Government's ComLaw website¹⁷⁵ and through the website of the Department of Climate Change and Energy Efficiency. The interpretation of regulations and legislation is assisted by explanatory memoranda and overview documents developed by Australian Government agencies. For example, the Office of the Renewable Energy Regulator has developed a range of guidance material on the operation of the RET.

(v) Alignment

Australian governments have taken a number of steps to achieve policy alignment. At a broad level policies between the Australian and State and Territory governments are coordinated through the Council of Australian Governments (COAG). The COAG includes the Australian Prime Minister as its Chair, State Premiers, Territory Chief Ministers, and the President of the Australian Local Government Association. It has been operating since 1992.

Australia has also established a system of Australian and State and Territory government Ministerial Councils under COAG to facilitate consultation and cooperation between jurisdictions in specific policy areas. An Organization for Economic Co-operation and Development (OECD) review found that Australia stands out among OECD member economies for establishing mechanisms for systematic coordination and cooperation across levels of government (OECD 2010a).

Australian Governments have taken specific action to achieve alignment on climate change policies. For example, in 2007, the Australian Government commissioned the *Strategic Review of Australian Government Climate Change Programs* (Wilkins, 2008) to review all existing climate change programs to ensure complementarity with its proposed national emissions trading scheme (the Carbon Pollution

¹⁷⁵ www.comlaw.gov.au

Reduction Scheme or CPRS¹⁷⁶) and rationalize duplicative and overlapping programs. Wilkins (2007) found that there were too many climate change programs, many were ad hoc or not properly targeted, there was no clear framework or logic to organize the policies and there was significant overlap between Australian and State and Territory government programs.

To help address this issue, in 2008 COAG agreed to a set of principles to ensure complementarity between mitigation measures and the CPRS and that each jurisdiction would review existing policies. The review identified 488 State and Territory government climate change programs (Australian National Audit Office, 2010). As a result of the review State and Territory governments agreed to redesign or terminate some of their programs. For example, NSW reported on 26 programs and agreed to terminate three and redesign or partially terminate another 16 programs.

Australian governments have also worked collaboratively through COAG on the design of the expanded RET, this included the replacement of existing national and state based schemes with a single national approach. Outside of the COAG process, alignment of policies at the Australian and State and Territory government level is encouraged through best practice regulatory and grants processes, for example, the Australian Government's Best Practice Regulation Handbook (see Box 3.2.1, above). More informal alignment is achieved through cooperative industry-government-research organizations such as the Geothermal Research Institute and the Australian Geothermal Energy Group (AGEG).

The lack of alignment and coordination of policies has been raised by stakeholders as an issue to be addressed. For example, the Allen Consulting Group (2011) finds that geothermal research and development activity should be better coordinated. The lack of alignment of State government regulations was also identified in the Australian Geothermal Industry Development Framework (2008) as a possible barrier to industry development (Department of Resources, Energy and Tourism, 2008). Concerns were raised that inconsistencies between regulations could increase costs for geothermal firms and encourage exploration in regions with the best regulatory regime rather than the best geothermal resource. This issue does not seem to have been addressed; however, it has not been raised as a key barrier to development in subsequent industry reviews.

¹⁷⁶ The Carbon Pollution Reduction Scheme was rejected by the Australian Parliament and has been superseded by the national carbon pricing scheme.

3.2.2 Geothermal Energy in Indonesia

Key findings

- Indonesia has an existing commercially competitive installed geothermal capacity of around 1200MW but its potential (at cost competitive rates) is estimated to be much larger.
- The key barrier to the cost effective development of Indonesia's geothermal industry has been the institutional pricing arrangements that have limited the incentive of the sole buyer of electricity, state-owned company Perusahaan Listrik Negara (PLN), to provide acceptable conditions, including acceptable tariffs, to geothermal producers.
- Indonesia has been unsuccessful in promoting development of its geothermal industry. This suggests that existing policies, such as electricity planning and pricing arrangements, are likely to be discouraging geothermal development. Other disincentives include regulatory uncertainty and permitting arrangements.

Costs, benefits and promotion

- The price paid for electricity (from fossil fuel and renewable energy sources) for a given region is bureaucratically determined. This price distortion does not allow the government to choose the least cost supply option and requires the enactment of potentially costly geothermal development targets.

Scientific integrity

- There are indications that government policies to support the development of Indonesia's geothermal resources are founded on evidence of a large, relatively low risk and cost competitive geothermal resource of between 27,500 MW and 30,000 MW, which equates to around 40% of the global total.

Flexibility

- Indonesian geothermal policies are based on targets and fixed prices. Targets are not flexible enough to respond to changing market conditions and could potentially be costly for Indonesia if enforced.

Transparency

- Indonesia has established a formal law/regulation making framework through the National Legislation Program (known as Prolegnas) which requires stakeholders to play an active role in the regulatory formulation process. Nevertheless, many business associations do not have the capacity to effectively critique government proposals which may limit their influence over government policy.

Alignment

- There is a general sense that further work is required to coordinate policy development among central government agencies and local governments. Overlapping responsibilities for climate change policy, industry development and electricity market arrangements are leading to policy coordination difficulties within the central government as well as with local governments.

A. Size and Significance

Geothermal currently provides about 0.3 percent of global electricity and 0.2 percent of global heat supply. Analysis by the International Energy Agency (IEA) reveals that under conditions of favorable government support, geothermal's share of global electricity and heat could reach 3.5 per cent and 3.9 per cent respectively (IEA, 2011). To date, Indonesia has tapped approximately 4 percent of its geothermal potential, which is estimated to be approximately 28,100 MW of geothermal capacity.¹⁷⁷ This potential of 28,000 MW is approximately 40% of the world's geothermal reserves (Brenhouse, 2010). At present, Indonesia is the third largest producer of geothermal energy in the world after the US and the Philippines (Allard, 2010). This was used mostly in the electricity generation. In 2007, 3.7% of Indonesia's electricity was supplied by geothermal energy (IEA, 2008). The current administration, led by President Yudhoyono, has announced aggressive plans to develop Indonesia's untapped geothermal resource. The aim is to build 44 new geothermal plants by 2014. This would raise Indonesia's geothermal electricity generation capacity to 4,000 MW – a nearly threefold increase. The longer-term goal is to become the world's leading geothermal producer with installed capacity of 9,000 MW (Allard, 2010).

B. Policy Formulation

(i) History and Background

Indonesia's geothermal power industry has a long history and regulatory policies date back nearly four decades. The first regulation (Presidential Decree 16/1974) was developed in 1974, and assigned Pertamina, the state-owned oil company, to explore and develop geothermal resources on behalf of the Indonesian government.¹⁷⁸ The first commercial plant (30 MW) was opened in 1983.

Indonesia has gradually opened up its geothermal industry (exploration, exploitation and power production) to private enterprises. It has provided a range of incentives to encourage development of the industry and produced several industry development targets, including:

- A National Energy Policy that aimed to increase the role of geothermal in total national energy consumption to 5% by 2020;
- A Roadmap of Geothermal Development which proposed that geothermal capacity would reach 3,442 MW in 2012, 6,000 MW in 2020 and 9,500 MW in 2025 (International Energy Agency, 2008a); and
- An Electricity Fast Track Program¹⁷⁹ that aimed to develop 10,000 MW of new generation capacity by 2014, including an additional 3,967 MW of geothermal power – with 3,097 MW

¹⁷⁷ This is roughly equivalent of about 12 billion barrels of oil.

¹⁷⁸ Article 33 of the Constitution (1945) states that the land, water and whatever is contained therein, is government property and shall be utilized to the maximum welfare of the people. Geothermal resources fall within this definition and hence have been managed as government property (Castlerock Consulting 2010).

¹⁷⁹ The first electricity Fast Track Program was announced in 2006 and planned to develop 10,000MW of new coal based generation.

to be developed by Independent Power Producers (IPPs)¹⁸⁰ (PricewaterhouseCoopers, 2011a). This would take total geothermal capacity in Indonesia (including existing projects and other project under development) to 5,710 MW by 2014 (Castlerock, 2010).

The international community has also agreed to provide funding. For example, the Asian Development Bank negotiating the provision of a US\$ 500 million loan to support the development of three geothermal power projects with a capacity of 165 MW (Jakarta Post, 2011a). Despite the incentives and government development targets, and a high annual growth rate in the demand for electricity, Indonesia's installed geothermal generation capacity is only around 1200 MW (PricewaterhouseCoopers, 2011b) – less than half the 2012 capacity forecast by the Government's Roadmap of Geothermal Development.

(ii) Policy Description

In addition to the targets mentioned above, the Indonesian Government has introduced the following key policies to help promote the development of Indonesia's geothermal industry:

The legacy and new geothermal regulatory frameworks

The *legacy framework* applies to all geothermal work areas known as WKP (wilayah kuasa perusahaan) issued by the Ministry of Energy and Mineral Resources (MEMR) prior to 2003. These WKPs are largely governed under Presidential Decree 45/1991. This Decree allowed the development of small scale geothermal plants (of 10MW capacity or less) by entities other than Pertamina. It also allowed Joint Operating Contracts or JOCs (contracts between Independent Power Producers (IPPs) and the State Owned Oil Company, Pertamina) to build and operate power plants and sell the electricity to Perusahaan Listrik Negara (PLN).¹⁸¹ With the exception of two WKP held by PLN, all legacy WKPs are now held by Pertamina Geothermal Energy (PGE) and many have already been developed and are now operated through JOCs (Castlerock, 2010).

In 2003, Indonesia introduced a new geothermal law (Geothermal Law 27/2003) and has subsequently issued a number of supporting regulations including Government Regulation 59/2007 on Geothermal Business Activity. The *new regulatory framework* removed the need for IPPs to operate geothermal power stations in partnership with Pertamina through JOCs, mandated the use of competitive tendering for allocating WKP and provided an active role for regional governments (Castlerock, 2010). The new framework applies to all WKP issued since 2003 and is most relevant to the future development of the industry. (Box 3.2.2 provides an overview of the key steps for exploiting geothermal resources under this framework.)

¹⁸⁰ An independent power producer is considered to be an entity that owns facilities to generate electric power for sale to utilities and end users.

¹⁸¹ Perusahaan Listrik Negara (PLN) is the state-owned, electricity distribution company.

Box 3.2.2 Key steps in developing geothermal power plants under the new regulatory framework

Preliminary survey. A preliminary survey and community consultation must be undertaken before a WKP is defined by MEMR. The relevant government authority (the Minister for MEMR, governor or regent/mayor¹⁸²) may undertake the survey or MEMR may assign another party to do it. The party undertaking the survey may subsequently bid for the WKP but is not automatically entitled to it. The activities involved in a preliminary survey include desktop data research and analysis, regional reconnaissance, preliminary geology and geochemistry resource studies aimed at identifying the prospects of a site (Castlerock, 2010).

Tender process. A WKP must be offered through competitive tender by a tender committee headed by the relevant government authority. The lowest cost bidder carries a preference to win the bid although the entity that undertook the preliminary survey has a right to match the lowest price bid. The WKP does not grant rights to access land which must be negotiated separately. Winning bidders are offered a geothermal development license known as an IUP (Izin Usaha Pertambangan).

Exploration. Exploration includes surveys, test drilling and drilling exploration wells for the purpose of discovering or accessing geothermal resources. Exploration must be started within 6 months of being awarded an IUP and must be completed within 3 years (but it may be extended twice for a period of one year provided technical and financial requirements are met). Exploration may be undertaken by a company (together with a feasibility study and exploitation) or undertaken by the Central government in which case it may be undertaken separately.

Feasibility studies. To commence the feasibility phase a firm must apply for a feasibility study license by outlining a work program. A feasibility study license is valid for 2 years and is not extendable. This phase of development includes securing a PPA.

Exploitation. The IUP holder must submit an exploitation plan to the relevant government authority, including information on proposed wells, financing, geothermal utilization plans and an analysis of environmental impacts. This stage is valid for 30 years and is extendable for a further 20 years. Exploitation involves obtaining drilling permits, development of production and re-injection wells and construction of field facilities and power plants.

Utilization. Utilization of the geothermal resource (often referred to as downstream activities) may be direct or indirect (the conversion of geothermal energy into electrical energy). This stage involves the operation and monitoring of production and reinjection wells and geothermal facilities. It may also involve drilling new make-up wells if required.

Electricity supply. To sell and supply electricity geothermal firms must also obtain an Electricity Supply Business Permit (IUPTL – Izin Usaha Penyediaan Tenaga Listrik) under Electricity Law 30/2009.

Electricity pricing

The price paid for electricity by PLN is determined through one-on-one negotiations with the independent power producer (IPP) or as stipulated in regulation. The most recent regulation on geothermal pricing is MEMR Regulation 2/2011. This regulation applies to all WKP identified as part of

¹⁸² The relevant government authority is MEMR if the WKP lies across regional boundaries otherwise it is the governor or regent/mayor.

the 2nd Electricity Fast Track program. It provides that PLN must accept the geothermal tender price up to a maximum of US\$ 0.097 per kWh or may enter into one-on-one price negotiations with the winning bidder if the price exceeds US\$ 0.097 per kWh.

Fiscal and non-fiscal incentives

Independent power producers (IPPs) may be eligible for a range of incentives including tax and VAT exemptions and investment credits. IPPs may also benefit from the Ministry of Finance (MOF) Regulation 77/2011 that provides assurance on the financial viability of Perusahaan Listrik Negara (PLN).

C. Regulatory Review

ECONOMIC EFFICIENCY AND EFFECTIVENESS

(i) Costs, Benefits and Promotion

It is estimated that Indonesia has a large a geothermal resource that would likely be cost competitive without policies such as subsidies that are required to promote the development of many other renewable resources. A World Bank analysis indicates that geothermal power would be competitive with coal power up to almost 4GW (up from around 1.2GW today) without any additional payments and up to more than 10GW if carbon and local environmental benefits are considered (World Bank, 2010). However, Indonesia has been largely unsuccessful in promoting development of its geothermal industry. This suggests that existing policies, such as electricity planning and pricing arrangements, are likely to be discouraging geothermal development. Other disincentives include regulatory uncertainty and permitting arrangements. It should be noted that a formal cost-benefit analysis does not form a part of the regulatory process.¹⁸³ Akin to the evidence from other sectors and economies, the policy formulation process focuses on the benefits that accrue from promoting a particular technology. The costs of such interventions are often accorded low weightage.

Key disincentives to geothermal development

Electricity planning and pricing arrangements

The Indonesian electricity market is dominated by the state-owned electricity company; Perusahaan Listrik Negara (PLN). PLN is the sole buyer, seller and distributor of electricity in Indonesia.¹⁸⁴ It controls around 86% of generation capacity and purchases the rest from Independent Power Producers (IPPs) with the price and other conditions set out in a long term power purchase agreement (PPA). PLN plays a key role in electricity planning through preparation of a 10 year electrification development plan (RUPTL)

¹⁸³ Based on interviews held with the following Ministries in Indonesia on the 15 – 16 March, 2012: Ministry of Energy and Mineral Resources, Ministry of Environment, BAPPENAS (the national development planning agency), and the Ministry of Finance.

¹⁸⁴ The new Electricity Law (30/2009) provides that other parties may also distribute and sell electricity but PLN retains a priority right to do so. Despite these recent legal changes the role of private enterprise in Indonesia's electricity sector is still limited to generation (PWC 2011a).

which contains amongst other things, future expansion plans, fuel requirements (e.g. coal, gas, geothermal etc) and identifies the role of PLN and IPP investors (PricewaterhouseCoopers, 2011a).¹⁸⁵

PLN also plays a role in determining the price that will be paid for electricity. In the 1990s the price paid for geothermal was between US\$ 0.06 and US\$ 0.09 per kWh (Schlumberger Business Consulting, 2008). However, in 1997, Indonesia was hit by the Asian Financial Crisis. The crisis caused the Indonesian Rupiah to depreciate by 83% against the US dollar between June 1997 and July 1998 (Purra, 2010) and created significant losses for PLN which had agreed to pay contracts for electricity in US dollars but received revenues in Rupiah. As a result, PLN sought to renegotiate contracts with many IPPs and indefinitely suspended seven geothermal projects in late 1997 (Geothermex, 2010). Following the crisis the price paid for electricity from geothermal power plants fell (it was estimated in 2008 that the average price paid for geothermal power was US\$ 0.0452 per kWh – less than other technology types including coal¹⁸⁶) and industry development stalled.

To help address the pricing issue, Indonesia has introduced a range of fiscal incentives, including, for example, exemptions on import duties and value-added tax and investment credits. More recently Indonesia introduced MOF Regulation 77/2011 to provide assurance to geothermal firms that PLN would be able to meet its financial obligations. These arrangements are likely to be welcome to geothermal IPPs. However, they are typically also provided to other technology types and are therefore unlikely to provide a competitive advantage to the geothermal sector over other technology types.

Indonesia also introduced MEMR Regulation 32/2009 which allowed PLN to pay a maximum price of US\$ 0.097 per kWh of electricity from geothermal power plants (which was above the price typically offered for coal power and above the average selling price of electricity). This approach relied on PLN paying the price offered by an IPP for a WKP through competitive tender as required by Geothermal Law 27/2003. However, the relationship between the tender price and the actual price paid by PLN was unclear (Castlerock, 2010); and PLN, which relies on government subsidies for its financial survival (see Box 3.2.3), did not have an incentive to pay IPPs any more than the average selling price of electricity. The price was therefore likely to have been agreed through lengthy negotiations between PLN and IPPs.

Box 3.2.3 Indonesia's electricity subsidy arrangements

The price at which PLN can sell electricity to consumers is determined by the government and since 1998 has, on average, been less than the cost of buying electricity (Morgan Stanley, 2011). The difference is made up by government subsidy which is approved by the Indonesian Parliament on an annual basis. The subsidy is typically very large – it peaked at Rupiah 78.58 trillion (US\$ 8.5 billion) in 2008 (PLN 2009) when the price of oil peaked and was forecast to reach Rupiah 65.6 trillion (US\$ 7 billion) in 2011 (Ministry of Finance 2011). The subsidy approved by the Indonesian Parliament has often not been sufficient to cover PLN's costs. This provided an incentive for PLN to agree to pay a price for electricity that is no greater than the average selling price of electricity.

¹⁸⁵ PLN shares electricity planning decisions with MEMR who prepare an electricity master plan (RUKN) and must approve the 10 year electrification development plan (RUPTL). Regional governments also play a role through the development of a regional development plan (RUKD) which must be consistent with the RUPTL.

¹⁸⁶ In 2008, it was estimated that the electricity from coal fired power stations was sold at an average price of 5.5 cents per kWh; electricity from gas at an average price of 7.1 cents per kWh; and from diesel oil at an average of 17.1 cents per kWh (Schlumberger Business Consulting 2008).

To address this issue Indonesia replaced MEMR Regulation 32/2009 with MEMR 2/2011. This new regulation (which applies to all projects listed under the 2nd electricity crash program) requires PLN to accept the bid price offered by IPPs through the WKP tender process without further negotiation up to a maximum price of US\$ 0.097 per kWh. For bid prices over US\$ 0.097 per kWh it still allows PLN to negotiate a final price with the IPP. The benefit of this new regulation is that it may speed up the development of some geothermal projects. However, it is unlikely to maximize benefits for Indonesia because it does not address the following issues.

Geological uncertainty

The price paid by PLN for geothermal power must be agreed prior to development of the geothermal resource to provide price certainty and allow the IPP to raise finance. This price must be bid (or negotiated with PLN) on the basis of the results of a preliminary geological survey. The survey may be undertaken by the Government or a private firm who may subsequently bid for the WKP. Castlerock (2010) have identified three problems with this approach: the information in the survey may not be sufficient to facilitate tendering, the survey may not be undertaken by a qualified firm, or the firm may have an interest in withholding information because they wish to subsequently bid for the WKP.

The provision of poor information at the time of tender will negatively impact the development of geothermal resources. It will likely increase resource risk (and hence development costs); reduce competition between IPPs for WKP; and encourage IPPs to undertake their own additional and possibly duplicative research. It also creates uncertainty for PLN about the likely cost of producing geothermal power. In cases where PLN is not required to automatically accept the bid price this uncertainty is likely to lead to lengthy price negotiations. This is because IPPs will not be willing to accept a low price as there is a risk that as the geothermal resource will turn out to be less productive than first thought; and PLN may be unwilling to pay a higher price in case the resource turns out to be more productive than first thought.

Fossil fuel subsidies

The price paid for electricity by PLN excludes a range of subsidies provided to fossil fuel-based electricity generators, including:

- *The cost of future rises in the price of fossil fuels (known as the fuel price pass through)* If the price of fossil fuel rises over time the Indonesian Government and not the IPP will pay the additional cost. This provides fossil fuel generators with a free fuel price hedge.
- *The opportunity cost of foregone revenues from fossil fuel exports* Indonesia requires domestic coal producers to provide coal to meet domestic needs at a discount to export prices. This reduces production costs for domestic coal-based generators and deprives Indonesia of additional export revenues.
- *The cost of carbon emitted by fossil fuel based generators* Indonesia has voluntarily committed to reduce greenhouse gas emissions by 26% by 2020 compared to business as usual levels or 41% with international assistance. At the moment there is no clear mechanism

for encouraging the power sector to contribute to these targets either through incentives or access to international carbon markets.

- The free use of infrastructure such as roads, ports and storage facilities needed to transport fossil fuels to power stations.

The failure to account for these subsidies reduces the headline cost of fossil fuel based electricity and is likely to encourage decision makers including PLN and the Indonesian Parliament to favor fossil fuel based generation over other potentially cost effective renewable energy sources such as geothermal.

Fixed national price

A further reason why current arrangements are unlikely to maximize the benefits of Indonesia's geothermal resource is the use of a bureaucratically-determined national pricing formula of US\$ 0.097 per kWh for geothermal electricity. The problem with this approach is that in some low cost regions such as the main Java-Bali grid, a price of US\$ 0.097 per kWh is higher than the average cost of electricity. In this case, PLN may be required to pay more for geothermal power than for alternatives such as coal. In other regions, PLN may choose to renegotiate the bid price leading to lengthy development delays even if the bid price was less than the average price for electricity in that region.

Potential solutions

To promote the cost effective development of Indonesia's geothermal industry the government could consider the following strategies:

- *Leveling the playing field* The Indonesian Government should ensure that the price paid by PLN for electricity includes the full costs and benefits of electricity production. This means that the price should exclude subsidies so that fossil fuel-based generators are not favored over renewable sources such as geothermal. The Indonesian Government should also establish a mechanism to allow geothermal IPPs to benefit from international carbon markets.
- *Offer a market-based price for geothermal* The Indonesian Government should offer geothermal IPPs a tariff that reflects the market price of achieving a given amount of generation capacity in a given region (rather than the national approach that is currently being used). In other electricity markets such as Australia, the market price for electricity is determined through competition between generators in a wholesale market. Investors must make their own assessment of likely future wholesale prices before deciding to invest. Indonesia lacks a wholesale market but the market price could still be approximated based on the assessment of demand and relative technology costs in a given region over time. This price would reflect the cost of electricity in that region and should be offered to IPPs by PLN without further negotiation.
- *Addressing resource uncertainty* The Indonesian Government should take steps to ensure that PLN is willing to sign geothermal PPAs without delay. This involves addressing the uncertainty around the cost of geothermal power generation. This could be achieved through two policy measures. Firstly, the Indonesian Government should introduce their proposed

geothermal risk mitigation scheme¹⁸⁷ to improve the quality of data available to PLN and IPPs at the time that WKPs are offered through competitive tender. The second would be to introduce a profit sharing mechanism that allows the Government to also benefit if the geothermal site turns out to be more productive than first anticipated. There are precedents for such an approach in Indonesia's oil and gas sector.

Other barriers to geothermal development

Regulatory policy

The slow rate of development of Indonesia's geothermal industry may also be explained by the way in which laws and regulations are prepared. Typically, Indonesian law leaves specific details to implementing regulations (Organization for Economic Co-operation and Development, 2010b). In many cases these regulations take a long time to develop, creating uncertainty for investors. This has occurred in the geothermal sector. The Geothermal Law (23/2003) was introduced in 2003 but many supporting regulations were not issued until many years later (for example, MEMR Regulation 11/2008 on procedures for determining geothermal work areas and MEMR 11/2009 on guidelines for implementation of geothermal business activities). This issue may be addressed by the MOF-OECD regulatory review task force.

Transaction costs

Another potential explanation for the delay in developing Indonesia's geothermal sector is the cost of doing business in Indonesia. The World Bank prepares an annual Ease of Doing Business assessment which examines issues such as starting a business, enforcing contracts and dealing with construction permits. In 2012 the World Bank ranked Indonesia 129 and of 183 assessed economies. The relatively poor assessment of Indonesia in this area is supported by others. For example, Otsuka et al (2011) found that new or revised regulations on taxes and levies on business activities have proliferated at the local level and added to the burden for investors; Goodpaster (2011) reported that applicants seeking requisite permits or permit renewals face many difficulties; and Caroko et al. (2011) found that among the key reasons for the slow investment rates in the post-decentralization period has been the conflicting and overlapping nature of licenses issued by local and central government authorities. There is also some evidence that permitting issues have specifically impacted the geothermal sector. For example, Castlerock (2010) report that of the 56 geothermal work areas under development in Indonesia in 2010, 12 of these (21%) face delays due to permitting issues (largely related to forestry approvals).

To address this burden the Indonesian Government has introduced one-stop integrated services (PTSP) for investors at both the central and local levels. The PTSP seeks to cut processing time and improve the predictability and transparency of investment registration. However, there remain an excessively large number of licenses which should be further streamlined and local level implementation of PTSP has been uneven (Otsuka et al, 2011).

¹⁸⁷ The Indonesian Government committed US \$128 million in the 2011 state budget to establish a geothermal risk mitigation fund to undertake exploratory drilling prior to tender (Castlerock 2010) with a view to improving pre-tender information. However, no final details on the operation of the fund have yet been announced.

(ii) Scientific Integrity

There are indications that government policies to support the development of Indonesia's geothermal resources are founded on evidence of a large, relatively low risk and cost competitive geothermal resource.

Indonesia is located in the "ring of fire" volcano belt and has more than 200 volcanoes spread across the islands of Sumatra, Java, Bali and the islands of Eastern Indonesia (Darma et al, 2010). It has a total estimated geothermal resource of between 27,500 MW and 30,000 MW (Geothermex, 2010), which equates to around 40% of the global total. This includes around 11,400 MW of probable reserves, just over 1000 MW of possible reserves and around 2,300MW of proven reserves. The rest is still a speculative or hypothetical resource (PricewaterhouseCoopers, 2011b).

In addition to a large potential resource, the quality of the resource is very high in Indonesia, leading to typically higher well capacity and lower drilling costs than in most in other economies (Geothermex, 2010), and much of Indonesia's estimated geothermal resource is close to load centers. It is projected that these characteristics could support the development of a relatively large amount of low cost geothermal power.

(iii) Flexibility

Indonesia has adopted relatively rigid policies to support the development of its geothermal industry. A key policy is the 2nd electricity crash program which aims to develop an additional 3,967 MW of geothermal capacity by 2014. This target-based approach may help focus resources but is an inflexible and potentially costly way to achieve geothermal development outcomes because it does not automatically respond to changing market conditions. For example, the target will not increase if the cost of competing technologies such as coal increase and will not decrease if Indonesia's geothermal resource turns out to be less productive than initially forecast.

The following section consists of an assessment of Indonesia's geothermal regulations on the basis of political feasibility and distributional equity which include transparency and alignment.

ADMINISTRATIVE AND POLITICAL VIABILITY

(iv) Transparency

Indonesia has established a formal law/regulation making framework through the National Legislation Program (known as Prolegnas) (see Indonesian Biofuel Case Study)¹⁸⁸ which requires stakeholders to play an active role in the regulatory process. For example, relevant stakeholders such as political and civil society groups, academics, experts, and practitioners are invited to help prepare the text to support draft laws and regulations. Public comment is then sought on the draft proposal.

Otsuka et al (2011) notes that the government has introduced more institutionalized public consultation processes for new policies and strengthened the appeal processes, yet many business

¹⁸⁸ The description of the steps involved in policy development is based on OECD (2010).

associations do not have the capacity to effectively critique government proposals which may limit their influence over government policy (Organization for Economic Co-operation and Development, 2010b). The Geothermal Law 27/2003, the Electricity Law 30/2009, the Government Regulation 59/2007 and MEMR Regulations 11/2008, 2/2009, 11/2009 and 2/2011 are all available in Bahasa Indonesian from the Ministry of Energy and Mineral Resources website (www.esdm.go.id).

(v) Alignment

One of the reasons for the struggles in policy coordination is that Indonesia “does not have a systematic mechanism to develop, monitor and evaluate laws/regulations or a centralized regulatory oversight body with ‘whole of government’ responsibility for regulatory policy” (Organization for Economic Co-operation and Development, 2010b).

Another reason is that, after the Suharto government in 1998, Indonesia has pursued a program of decentralization that has led to the sharing of powers between the central and more than 500 local governments (The Asia Foundation, 2010). This approach has provided greater autonomy to the regions but led to some confusion about the division of responsibility between the levels of government and resulted in the responsibility for some policies resting with local government that did not always have the capacity to establish a regulatory environment conducive to business (Organization for Economic Co-operation and Development, 2010b).

Coordination has also proved difficult in development of geothermal policies. There are a several agencies with an interest in the geothermal industry, including MEMR, the Ministry of Finance (MOF), PLN, PGE, Ministry of Forestry and Bappenas (the national development planning agency). Many of these ministries also have their own international advisors on geothermal policies. For example, MEMR has engaged the consulting firm Castlerock to advice on geothermal electricity tariffs and the MOF had previously engaged EcoPerspectives to advice on a range of industry issues including an appropriate tariff.

The findings from these consultants are shared across government agencies but there is no formal policy coordination process. This may help explain why PLN continues to provide a cost pass through for fossil fuel used by fossil fuel-based generators even though this conflicts with the MOF’s objective of reducing subsidies for the electricity sector. This reduces the chance of Indonesia meeting its climate change objectives.

Stakeholders interviewed for this study were of the view that additional institutional structures would not provide the answer to the coordination problems afflicting geothermal policy development. Instead, they pointed to the need for institutions with existing coordination roles to renew their engagement and redouble efforts.¹⁸⁹

¹⁸⁹ Interviews were held with the following Ministries in Indonesia on the 15 – 16 March, 2012: Ministry of Energy and Mineral Resources, Ministry of Environment, BAPPENAS (the national development planning agency), and the Ministry of Finance

3.2.3 Concluding Remarks

The geothermal industry in Australia and Indonesia are at different stages of maturity. Indonesia is amongst the top three economies as far as installed geothermal capacity is concerned, whereas Australia has only recently begun exploring its geothermal potential. The technical nature of their reserves differs as well. Hence, the dynamics of regulations in these two economies make for an interesting comparison.

Consider the basic issue of the structure of the electricity industry in the two economies. Australia's evolution to a competitive electricity market allows for a price signal that is the best reflection of the cost of supplying electricity. However, in Indonesia, the price paid for electricity for a given region is still determined by the bureaucracy. In following market-based pricing, the Indonesian government will be in the position to choose the least cost electricity supply option without having to frame potentially costly geothermal development targets.

Both economies could use a regulatory approach that is more flexible. The fixed targets and prices that underlie the Indonesian geothermal policies are unable to respond to changing market conditions and could prove to be very expensive. The pan-Australian strategy of non-commitment to specific development targets for geothermal energy is a preferred approach given its flexibility. However, the opportunity cost that arises from the inflexibility of Australia's grant programs is something that the Indonesians can learn from.

Facilitation of stakeholder involvement is at the core of Australian regulatory policy. Australia has instituted several mechanisms to facilitate the stakeholder input. Indonesia too has formalized the process of stakeholder involvement in the regulatory formulation process. Australia has instituted formal mechanisms to ensure policy cohesion. This is an area where Indonesia has been facing difficulty given the ill-defined roles of the myriad government institutions at the national and local level with overlapping jurisdictions. Indonesia might consider setting up a formal coordinating agency as in Australia to drive policy coordination.

Australia's geothermal sector has leveraged a significant amount of private sector capital to date despite its resource being viewed as unconventional. Capital has flowed in the early development and exploration phase of the technology. However, additional capital is still required to take these investments through to the demonstration stage. Conversely, Indonesia has been largely unsuccessful in promoting development of its geothermal industry. This suggests that existing policies, such as electricity planning and pricing arrangements, are likely to be discouraging geothermal development. Other disincentives include regulatory uncertainty and permitting arrangements.

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