

**May 10, 2011**

# **Geothermal Development in Indonesia**

## **Institutional Barriers and Opportunities for Icelandic Technology Transfer**

**M.sc. International Business and  
Politics**

**Heimir Pétursson**

**Supervisor: Mette Mønsted**

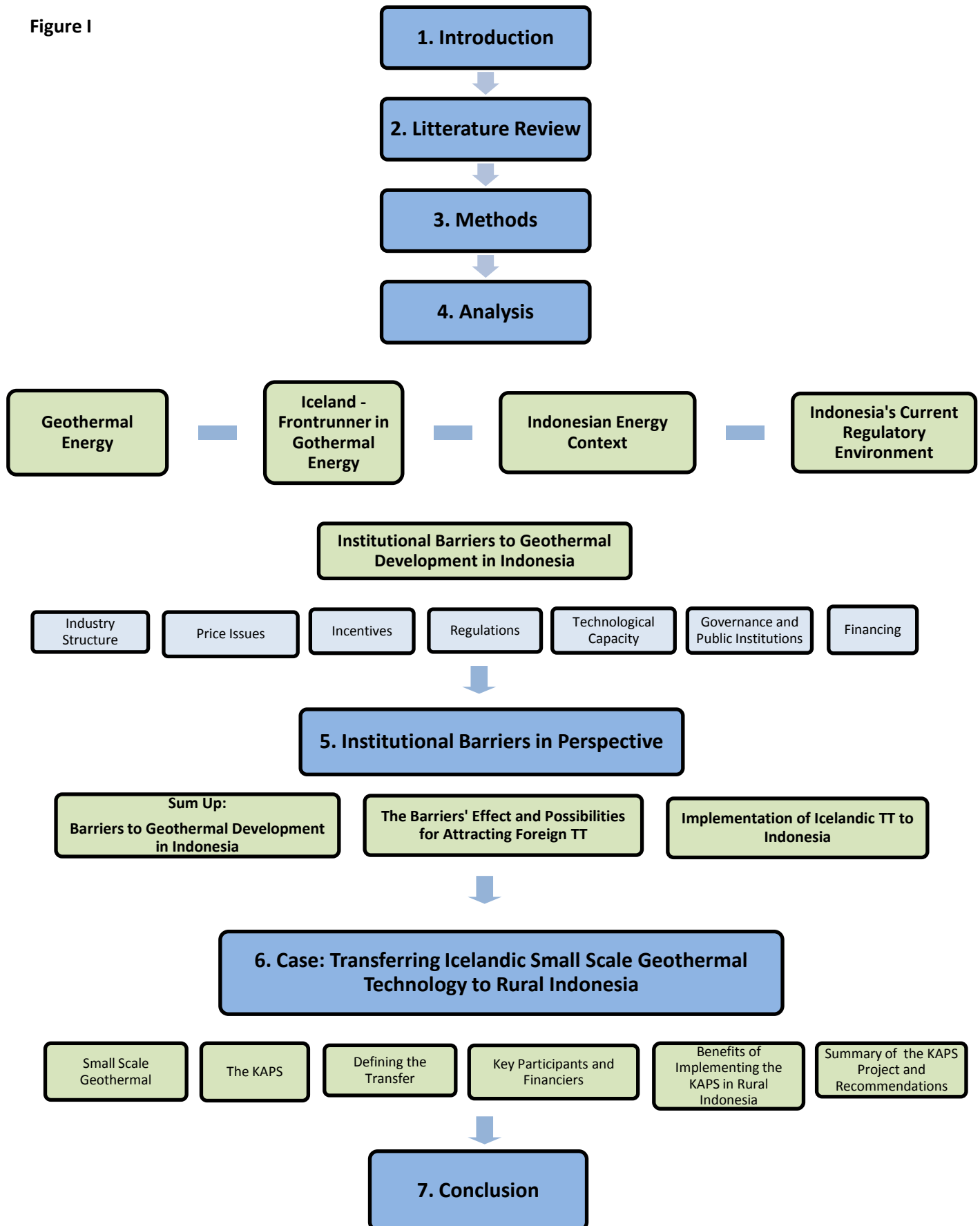
**STU count: 180.863**

## Contents

1. Introduction .....	1
1.1 Research Questions .....	3
1.2 Structure .....	3
2. Literature Review .....	5
3. Methods .....	17
3.1 Research Philosophy.....	17
3.2 Research Approach.....	17
3.3 Theoretical Framework .....	17
3.4 Methodology .....	18
3.5 Data Collection .....	18
3.5.1 Primary Data .....	18
3.5.2 Secondary Data.....	20
3.6 Scope, Strengths and Limitations .....	20
4. Analysis .....	22
4.1 Geothermal Energy.....	22
4.2 Iceland – Frontrunner in Geothermal Energy.....	23
4.3 Indonesian Energy Context.....	25
4.4 Indonesia’s Current Regulatory Environment .....	28
4.5 Institutional Barriers to Geothermal Development in Indonesia.....	29
4.5.1 Industry Structure.....	31
4.5.2 Price Issues .....	32
4.5.3 Incentives.....	36
4.5.4 Regulatory Environment.....	38
4.5.5 Governance and Public Institutions.....	41
4.5.6 Technological Capacity .....	43
4.5.7 Financing.....	43
5. Institutional Barriers in Perspective .....	45
5.1 Sum Up: Barriers to Geothermal Development in Indonesia.....	45
5.2 The Barriers’ Effect and Possibilities for Attracting Foreign TT .....	47
5.3 Implementation of Icelandic TT to Indonesia.....	50
6. Case: Transferring Icelandic Small Scale Geothermal Technology to Rural Indonesia.....	53

6.1 Small Scale Geothermal .....	54
6.2 The KAPS .....	55
6.3 Defining the Transfer .....	57
6.4 Key Participants and Financiers .....	58
6.4.1 Kaldara Green Energy .....	60
6.4.2 PLN and PLN Geothermal .....	61
6.4.3 BPPT and Local Stakeholders .....	61
6.4.4 Indonesian Authorities .....	62
6.4.5 Icelandic Authorities .....	63
6.4.6 International Finance Institutions and Development Organizations .....	64
6.5 Benefits of Implementing the KAPS in Rural Indonesia .....	66
6.5.1 Economic Arguments .....	67
6.5.2 Social Arguments .....	69
6.5.3 Environmental Arguments .....	71
6.6 Summary of the KAPS Project and Recommendations .....	72
7. Conclusion .....	76
References .....	80
Appendix I – Information on Interviewees .....	88
Appendix II – Geothermal Locations and the Selected Regions .....	90
Appendix III – Geothermal Regulations .....	91

Figure I



## **List of Abbreviates**

**TT** = Technology Transfer

**EBED** = Energy Based Economic Development

**SD** = Sustainable Development

**PLN** = Perusahaan Listrik Negara, The Indonesian State owned Utility

**MEMR** = Ministry of Energy and Mineral Resources

**GOI** = The Government of Indonesia

**KGE** = Kaldara Green Energy

**INAGA** = Indonesian Geothermal Association

**IFIs** = International Financing Institutions

**ICEIDA** = The Icelandic International Development Agency

**IPCC** = Intergovernmental Panel on Climate Change

**IPP** = Independent Power Producer

**RE** = Renewable Energy

**WKP** = Geothermal Working Area/Field

**IUP** = Geothermal mining Licence/Permit

**PPA** = Power Purchase Agreement

**KAPS** = Kaldara Power System

**SSG** = Small Scale Geothermal (= or <5 MW)

**kWh** = Kilowatt Hour

**MW** = Megawatt

# 1. Introduction

As climate change is a global problem it must be fought on a global basis. Hence, the need to switch from fossil fuel energy to clean renewable energy is important in both the developed and developing world. But the issue is of particular importance to developing countries and countries in fast transition due to their development process and the particular climate challenges that many of them face, as the driving forces for emissions are linked to the underlying development path (Metz, Berk, den Elzen, de Vries, & van Vuuren, 2002). Further, the economic burden of importing fuel is a serious problem for many of these economies, forcing them to look at alternatives (Carley, Lawrence, Brown, Nourafshan, & Benami, 2010).

Technology transfers have been identified as a tool to help fight climate change in the developing world. This idea suggests that developing countries do not have to follow the example of developed countries in terms of energy use. Rather they can leapfrog straight to the adoption of low-carbon technologies and therefore move quickly to environmentally sound and sustainable practices, institutions and technologies (Hennicke, Borbonus, & Woerlen, 2007; Miller, 2007).

However, technology transfer is far from being a simple matter. This is especially true for renewable energy technologies as a lack of experienced business models for these energy sources in national systems provide a barrier to their inclusion. In fact, these kinds of energy technologies may be considered disruptive in nature and hence, often do not fit into existing models of regulation, finance, and cost-benefit analysis (Sharma, 2007; Karakosta, Doukas, & Psarr, 2010).

Indonesia is one of the world's fastest growing economies and its energy demands are growing rapidly. Although the country has great potential in renewable energy such as hydro, solar, bio-fuel and geothermal, Indonesia, like many other developing countries, lacks behind the developed world in terms of developing these resources and is therefore largely dependent on fossil fuel energy (International Energy Agency, 2008). However, the predicted growth in energy demand along with increasing environmental awareness and depleting oil reserves are forcing the Indonesian government to focus on developing the country's renewable energy resources.

Indonesia holds the world's greatest geothermal potential, and the government has identified this energy source as a priority in its strategy to increase the proportion of renewable energy in the country's energy mix (International Energy Agency, 2008). Today, this potential is largely unexploited but the government has set forward ambitious goals to increase geothermal energy usage from its current 1.32% of the energy mix, to above 5% in 2025 (International Energy Agency, 2008). The president has further spoken of his aim to make sure that Indonesia is the world largest producer of geothermal energy by 2050 (Indonesia Today,

2010). There are doubts about how realistic these goals are as it has been suggested that Indonesia lacks knowledge, financial, and technological resources to achieve these goals (Darma, 2010 A; Ciptomulyono, 2010; Ibrahim, 2010 B). One thing is certain, Indonesia will have to mobilize a huge quantity of private investment as it has been suggested that the 2025 goal requires about USD 30 billion (Clean Technology Fund, 2010).

Iceland is blessed with geothermal energy resources because of its location in an active volcanic zone right on top of where the Eurasian and the North American tectonic plates meet. The oil crisis in the 1970s had a profound impact on the Icelandic economy and caused the country to change its energy policy, turning to the abundant domestic energy resources of hydro and geothermal. With strong governmental support, a very competitive geothermal industry has developed in the country. Today, nearly two thirds of the primary energy supply is derived from geothermal resources, saving the country more than USD 460 million annually (Íslandsbanki Geothermal Research Team, 2010).

After finding itself in acute economic crisis following the collapse of the banking system in 2008, Iceland is now considering ways to help strengthen its economy and is therefore directing its attention towards the use of its natural resources. Traditionally, Iceland has used its energy to attract companies from energy intensive industries, mainly from the aluminium sector. However, in a presentation of his work on the Icelandic geothermal cluster, professor Michael Porter of Harvard University recommended that Icelanders find ways to obtain more value for geothermal energy and sell their expertise and technology abroad, not just the energy itself (Porter, 2010; mbl.is, 2010 A).

At the geothermal congress in Bali in 2010, the delegations of Iceland and Indonesia held an informal meeting and declared their interest in cooperation within the geothermal field. The Icelandic president, Mr. Ólafur Ragnar Grímsson, suggested that Icelandic technology and knowledge, developed through the countries long history of geothermal utilization, could be of great relevance for Indonesian geothermal development (mbl.is, 2010 B).

This paper is guided by a vision to create Icelandic-Indonesian cooperation within the geothermal sector. It sets out in an explorative manner to analyse the institutional barriers to geothermal development in Indonesia. Building on that analysis and the overlapping literature of technology transfer, sustainable development, innovation diffusion, and energy based economic development; the paper suggests and develops an opportunity for collaboration between the two nations with both public and private involvement.

## 1.1 Research Questions

The following overall research question will guide this paper.

- **How can the Icelandic geothermal sector support and simultaneously benefit from the geothermal development in Indonesia?**

In order to answer this, the paper will answer the following sub-questions:

- 1. What are the institutional barriers to geothermal development in Indonesia?**
- 2. How do these barriers affect the Indonesian geothermal sector and its possibility to attract foreign technology transfers?**
- 3. How can Icelandic technology transfers to Indonesia be implemented?**

Based on the findings of the analysis the paper will identify and develop a specific case of Icelandic technology transfer to Indonesia and suggest further cooperation in the implementation and commercialization of the relevant small scale geothermal technology. This chapter will use current literature on technology transfer and related fields to define the nature of such a transfer and argue for its benefits.

## 1.2 Structure

The paper is structured in the following manner. Following the introduction a literature review provides a thorough account of the relevant theories and writings that guide this paper, namely: climate change, sustainable development (SD), technology transfer (TT), innovation diffusion, and energy based economic development (EBED). The chronicle is the recognition that low carbon technologies need to play a more long term role in the economies of developing countries. The literature review is followed by a chapter on methodology, data collection, and research philosophy which explains how the research was conducted while introducing the most important data sources used. Next, an introduction to geothermal energy and Icelandic leadership within this sector is followed by an account of the Indonesian economy and its energy infrastructure and policy. This provides the reader with significant background information to better understand the following chapters of the paper.

Guided by the literature review and an analytical framework for geothermal development, the analysis will identify the institutional barriers to geothermal development in Indonesia. This answers the first sub-question of the paper, by examining in depth the industry structure, price issues, incentives system, regulatory environment, technological capacity, public institutions, and financing. The following chapter



will provide a summary of these barriers and put them into perspective. This information, along with relevant background information and the conceptual framework developed through the literature review, is then used to answer the second and third sub-questions of this paper and draw up a picture of the Indonesian geothermal context.

The final chapter will elaborate on the last sub-question by suggesting and developing a case of Icelandic small scale geothermal TT to Indonesia. The chapter will identify the nature of the transfer, define key participants and possible financiers, and describe the potential benefits of the technology for Indonesia by making use of economic, social, and environmental arguments. The conclusion merges the findings of the thesis and discusses further collaboration between Iceland and Indonesia.<sup>1</sup>

---

<sup>1</sup> For a visualization of the structure see figure I above.

## 2. Literature Review

During the last couple of decades, climate change has become an increasingly important issue for politicians, companies, scholars, scientists, and the public at large. Ever since the 1992 “Earth Summit” in Rio de Janeiro which established the UNFCCC and laid the foundations for the Kyoto Protocol, the amount of time and resources donated to this subject has increased enormously.

The issue has been the subject of heated debates, but today it is becoming widely acknowledged that the problems and threats of climate change are real. The fourth assessment report (2007) from the Intergovernmental Panel on Climate Change (IPCC) documented the continued strengthening of scientific evidence for climate change and its predominant human causes. On a similar line, Dressler and Parson (2010) argue that contrary to the impressions one might get from following the debate in the media, current scientific understanding of the climate, and influences on it, is actually quite advanced and accepted. Furthermore, these sources provide decisive evidence that climate change is occurring at an unprecedented speed and that it is largely caused by human activities.

What to do about it remains the key question. There is a wealth of literature on specific aspects of the climate change policy regime. These can be divided into two groups according to the responses provided to the problem at hand. The first group focuses on adaptive measures to the negative economical, social, and environmental impacts of climate change while the latter group targets the reduction in harmful Greenhouse gas (GHG) as a way of combating climate change. Although adaptation is an important and unavoidable issue, most of the existing research activities and policy measures follow the methodology of the second group, based on the argument that it is economically more sensible to attack the root of the problem rather than simply adapting to its consequences (Michaelowa, Tangen, & Hasselknippe, 2005). Hence, it is becoming a more generally accepted conclusion that the cost of not doing anything about climate change is simply too high (Dressler & Parson, 2010).

Achieving solutions for our environmental problems requires long-term actions for sustainable development (SD). SD has been adopted as an overarching goal of economic, social, and environmental development (World Commission on Environment and Development, 1987), and there is growing emphasis on the mutually reinforcing relationship between SD and climate change mitigation in the literature (Metz, Berk, den Elzen, de Vries, & van Vuuren, 2002; Beg, et al., 2002).

The energy system is the largest source of human driven climate disruption and therefore represents the most obvious area of action (Dressler & Parson, 2010). Furthermore, studies have predicted an enormous growth in future energy demand, especially within developing countries in fast transition because of e.g.

their growing populations and economic development (International Energy Agency, 2010; International Energy Agency, 2010). Due to the strong link between economic output and energy service inputs, this underlines the need for a radical change in energy technologies, as formidable environmental and energy security problems would result if growth in energy demand were solved by using conventional fossil fuels (UNDP et.al., 2000). Continued oil supply disruptions resulting from political instabilities and projections of declining global oil productions further add to this argument (Williams, 2001), and recent events in Japan have underlined the risks that are inherent to nuclear energy.

The current energy system landscape is changing as these concerns have stimulated government, entrepreneurs, and civil society to search for alternative energy supplies. As the landscape changes, new opportunities emerge for novel technologies that have varying potential for contributing to an energy system transformation (Verbong & Geels, 2007). In this regard, renewable energy (RE) resources such as hydro, sun, wind, biomass, and geothermal energy, can provide efficient and effective solutions. RE technologies have the benefits of being environmentally benign, diverse, secure, locally based, and abundant and will thus constitute a key component of SD (Omer, 2008; Dincer & Rosen, 2005).

As climate change is a global problem it must be fought on a global basis. Hence, the need to switch from fossil fuelled energy to clean renewable energy is important in both the developed and developing world. But as indicated above, the relationship between SD and climate change is of particular importance to developing countries. This is due to their energy intensive development process and the particular climate challenges that many of them face, as the driving forces for emissions are linked to the underlying development path (Metz, Berk, den Elzen, de Vries, & van Vuuren, 2002). It is therefore important that developing countries do not follow the historic evolution of the developed world in terms of energy use and thus avoid a carbon-intensive development path (Hennicke, Borbonus, & Woerlen, 2007). This urgency is reflected in the prominence of TT within contemporary international climate negotiations (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008).

The adoption of low-carbon sustainable technologies offers many opportunities to avoid past unsustainable actions, and move quickly to environmentally sound and sustainable practices (Miller, 2007; Intergovernmental Panel on Climate Change, 2007). Hence, the diffusion of these technologies is the key for developing countries to efficiently reduce their emissions (Pan, 2005). Furthermore, the acquisition and diffusion of knowledge or technology are of great importance for economic development, as the adoption of new techniques, machines, and production processes is a key determinant of productivity growth (Hoekman & Javorcik, 2006). This represents a dilemma as many of these countries do not possess the low carbon technologies and knowhow required. Hence, the literature suggests that developing countries

require assistance with building human capacity, appropriate institutions, and with acquiring and adapting specific technologies (Karakosta, Doukas, & Psarr, 2010). Understanding and implementing these TTs is therefore an urgent priority (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008).

The process of TT is informed by a range of literature on innovation, development, behavioural change, and economic development (Karakosta, Doukas, & Psarr, 2010). Schnepf et al. (1990, p. 3) define TT as *“a process by which expertise or knowledge related to some aspect of technology is passed from one user to another for the purpose of economic gain.”* In the case of low carbon TT, the economic benefits highlighted by Schnepf et al. include the mitigation of the future costs associated with climate change as well as any financial benefits to the companies involved in the transfer process.

The IPCC report on methodological and technological issues in TT (2000) provides another definition. They define TT in a climate change context as a set of processes *“covering the flows of knowhow, experience, and equipment, for mitigating and adapting to climate change amongst different stakeholders”* (Foreword). This definition broadens the scope of TT. The broad and inclusive term “transfer” encompasses diffusion of technologies and technology cooperation across and within countries. It covers TT processes between developed countries, developing countries, and countries with economies in transition. The IPCC definition also introduces multiple stakeholders to the process e.g. project developers, technology owners, recipients, and users, financiers and donors, government authorities, international organisations, and NGOs. This definition is a good fit for low carbon TTs as it does not limit their purpose to economic gain and thereby opens up for social and environmental purposes of the transfers.

The origin of transferring sustainable energy technologies in the context of international climate co-operation, and in particular from industrialised countries to developing countries, lies in Article 4.5 of the United Nations Framework Convention on Climate Change (UNFCCC). The Article states that developed country Parties and other developed Parties included in Annex II are to take *“all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and knowhow to other Parties, particularly developing country Parties”*, and to *“support the development and ‘enhancement of endogenous capacities and technologies of developing country Parties”*, and calls on other Parties and organisations to assist in facilitating the transfer of such technologies (United Nations Division for Sustainable Development, 1992, chapter 34). This article is formulated on the basis of the recognition that in order to achieve the ultimate objective of the UNFCCC, as formulated in Article 2.2, technological innovations and the rapid and widespread transfer and implementation of technologies (including knowhow) will be required (Karakosta, Doukas, & Psarr, 2010).

Within the context of the UNFCCC and international development co-operation, programs have been established to support TTs to developing countries. For instance, the global environment facility (GEF) has been established under the UNFCCC to support climate policy-based technology and knowledge transfers from industrialized to developing countries. In addition, the Kyoto Protocol contains market mechanisms like the clean development mechanism (CDM) which enable industrialized countries to invest in GHG emission reduction projects on the territory of other countries, either industrialized or developing (UNFCCC, A).

The IPCC (2000) identifies basic stages within the processes of TT. These are identification of needs, choice of technology, assessment of conditions of transfer, agreement and implementation, evaluation and adjustment to local conditions, and replication. It also stipulates that TT can take place in a number of ways e.g. through government assistance programs, direct purchases, licensing, foreign direct investment (FDI), joint ventures, strategic alliances, cooperative research arrangements, co-production agreements, education and training, and government direct investment. It classifies pathways into three primary types:

- Government-driven pathways: TTs initiated by government to fulfil specific policy objectives.
- Community-driven pathways: TTs involving community organisations and collective decision-making.
- Private-sector-driven pathways: TTs between commercially oriented private-sector entities.

The demise of socialism and the effects of widespread market deregulation and privatization have provided an increase in the relative amounts of technology under the control of private rather than public actors (Davis, 2005). Hence, Brewer (2009) emphasizes the importance of trade and FDI as the principal mechanisms by which technology is transferred internationally, making the private sector the greatest enabler of low carbon TT. He proposes two different paradigms of climate change TTs:

1. North- South Technology and Financial Flows: this paradigm is currently dominant as is reflected in the numerous documents produced on the implementation and negotiating processes of the UNFCCC. It is predominantly focused on North-South TTs and financial flows through bilateral and multilateral official development assistance (ODA).
2. Global Technology, Trade, and Investment Flows: this paradigm reflects the fact that TTs occur in substantial part as a result of trade and FDI, and also acknowledges that technologies can reside in the developing world, opening up the possibility of South-South and South-North TTs.

Hence, to a great extent international TTs takes place within multinational firms' internationalized R&D and manufacturing processes, sometimes with collaborators from host countries. But large multinationals are not the only important sources of technology innovation or international diffusion. Indeed, small and

medium-sized firms (SMEs) are often the originators of new technologies and even the principal internationalizers of them. For instance, SMEs have been instrumental in the development of biodiesel technology in many countries (Brewer, 2009).

Hence, today foreign entrants are often welcomed as a source of new technologies, better management and marketing techniques, and skilled jobs. However, not all types of foreign investment are perceived as equally beneficial to host countries. Rather, host country governments tend to favour those modes that enable active participation of local firms on the grounds that this will facilitate the greatest local absorption of new technologies and knowhow (Javorcik, 2006). In this respect, intermediary entry modes like joint ventures and strategic alliances are primary vehicles for the transfer of knowledge and skills, while they may also include export-import activities (Hollensen, 2007).

Through such projects, developing countries hope not only to import more efficient foreign technologies but also to improve the productivity of local firms through spillover effects. At the micro level, the literature (Saggi, 2006) suggests three potential channels of spillovers;

1. **Demonstration Effects:** as the payoff from the adoption of a foreign technology or knowhow can be highly uncertain, the successful application of such a technology in the local environment can help reduce uncertainty, thereby generating informational spillovers for local firms.
2. **Labour Turnover:** foreign entrants can bring with them skilled labour from abroad who can provide at least a temporary upheaval in the labour force. The argument is that this skilled labour, and the knowledge embodied in it, might later diffuse into local companies.
3. **Linkages and Vertical TT:** the argument is that technological diffusion will occur through linkages generated between the foreign entrants and local firms, and that this may eventually lead to productivity improvements. In this respect, Ockwell et.al. (2008) have pointed out that less integrated TT arrangements e.g. acquisitions of different plant items from a range of host country manufacturers are more likely to involve knowledge exchange and diffusion through recipient country economies and thus build up technological capacity.

Furthermore, the entry of foreign players may benefit host countries even if it fails to result in spillovers for local firms. For example, local workers and suppliers may enjoy positive externalities through generation of work while local firms improve their productivity as a result of e.g. better infrastructure provided by the foreign entity (Saggi, 2006)

TT may appear a relatively simple process if assuming the classical economic view of technology as objects that can be moved around. Thus, a transfer can be as simple as the sale or purchase of industrial equipment. However, inherent to this view of TT as a simple relocation of a fully blown technology from

one economic and cultural context to another is that it creates and maintains dependency on the part of the recipient (Karakosta, Doukas, & Psarr, 2010). A key insight to emerge from the literature is that TT is not just a process of capital equipment supply from one firm to another. It also includes the transfer of skills and knowhow for operating and maintaining technology hardware while facilitating deeper technological understanding so that further independent innovation and progress is possible by recipient firms (Bell, 1990). Worrell et al. (2001) call this knowledge accumulation 'technological capacity' and conclude that it is the most important ingredient to ensure the long-term uptake of low carbon technologies in recipient countries and further advances in their development. Hence, while classical commentators assumed that the learning that underpins capacity building within developing countries automatically followed capital investments, and therefore could be encouraged by a more competitive economic policy environment, more recent theories of TT take a more evolutionary view of the process and stress that learning is a key factor in making capital investments successful (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008).

An important distinction in the literature on TT is between vertical TT, the transfer of technologies from the R&D stage through to commercialization; and horizontal TT, the transfer from one geographical location to another. The case of low carbon TT between developed and developing countries is likely to include elements of both horizontal and vertical transfers as many low carbon technologies are currently pre-commercial or supported technologies and therefore undergo development towards commercialization within the new country context (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008).

However, conventional wisdom provides cautions against developing countries taking the lead in commercializing technologies not widely in use elsewhere on the basis of the argument that by facing so many pressing needs, developing countries cannot afford to take the many risks associated with technological innovation. According to Williams (Williams, 2001), this perspective has been a hallmark of the energy development assistance community but he provides several reasons to question this. First, developing countries, especially the rapidly industrializing ones, are becoming favourable theatres for innovation as they often have large, rapidly growing, un-served internal markets, nascent infrastructures for industry, commerce, transport, and housing, and plentiful natural resources including renewable energy. Furthermore, many developing countries are undergoing market reforms that will produce better investment climates for innovation, and have substantial numbers of capable scientists and engineers within their elite populations.

Second, developing countries have needs for new technologies that are often different from those of already industrialized countries. Third, their lower wage rates at all levels of scientific, engineering, and managerial skills make developing countries attractive to technology owners for launching new

technologies in the market. Fourth, the risk involved in technological innovation can be shared in various ways e.g. through joint ventures or strategic alliances between industrialized and developing country partners with mutual interest in developing the technologies and with assistance from multilateral and bilateral development organizations. These factors could enable developing countries to become leaders in the development and deployment of selected new sustainable energy technologies with eventual export capability (Williams, 2001).

This underlines that TT is more than just imports of readymade goods and opens up the possibility for multilateral and bilateral international cooperation. Such collaboration can work to increase the widespread benefits of R&D by providing better returns on R&D investment through the sharing among participants of financial outlay, workload, and results. International collaboration can reduce the need to expend public sector funds on R&D that is underway in other countries. They allow the use of specialized expertise that resides in one country to benefit all countries involved. Further, they can strengthen technology market uptake by combining national comparative advantages such as the science and technology strengths of an industrialized country and the lower labour costs for manufacturing in a developing country (International Energy Agency, 2008; Hollensen, 2007). Thus, one of the emerging features of the twenty-first-century innovation landscape is that it is increasingly a multiplayer game in which organizations of different shapes and sizes work together in networks (Tidd, Bessant, & Pavitt, 2005).

Innovation according to Schumpeter (1939) involved the demonstration of a technology, and then the diffusion of that technology across space and over time. Thus, the process included both adoption by the market and dissemination through it. However, the process of adoption is complex and involves behavioural changes of the receiver, as people must make an effort to actively seek out and adopt the technology and adapt to its requirements. The efficiency of this process will depend on peoples' experience, values, and perceptions as well as on the economic, social and political environment. The TT process for sustainable energy technology involves a process of innovation into an existing energy system. Hence, the innovation chain involves both the processes of research and development and the commercialisation of the technology, including its social acceptance and adoption (Karakosta, Doukas, & Psarr, 2010). In this respect, Tidd et.al. (2005) point out that innovation is often confused with invention, but the latter is merely the first step in a longer process of bringing a good idea to widespread and effective use. Examining the social and political context within which an organization operates is thus important to be able to effectively manage the innovation process.

The importance of social capital for successful innovation has also been pointed out by the National Systems of Innovation (NSIs) approach (Lundvall, Johnson, Andersen, & Dalum, 2002) which integrates the



elements of capacity building, access to information, and an enabling environment into comprehensive approaches to TT and the creation of an innovation culture. They point out that innovation system ideas are rooted in development theories that highlight the role of institutions when analyzing economic change. Hence NSI puts emphasis on the social processes involved in innovation diffusion and the nature of social institutions in determining responses to innovation. Institutions play a key role in the process of relationship and trust building, and the regulatory and legal environment such as property rights, contract laws, and labour market institutions will have an effect on this. Hence, if TT is to be effective in reducing carbon emissions in developing countries in the long term, it needs to form part of a broader process of technological change with an overall aim of increasing low carbon technological capacity (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008).

As implied by the above, when analysing the prospects for alternative low carbon energy socio-technical system approaches that place technical and economic considerations within wider social and political processes are needed to more fully assess energy portfolio options (Stephens & Jiusto, 2010). A growing body of research on socio-technical systems provides a framework for understanding the role these factors play in shaping the course of technological evolution. Central to this framework is the notion that large technical systems co-evolve with associated social, cultural, and political institutions. Market dominating technologies engender social formations with strong incentives to protect and promote the entrenched regime. Thus, socio-technical transition occurs when a niche technology gains enough traction to compete with, and sometimes replace, the entrenched socio-technical regime. Often this occurs as developments in the broader landscape undermine the entrenched regime, thereby creating opportunities for destabilizing the mainstream (Smith, Stirling, & Berkhout, 2005; Loorbach, 2007). Studies (Unruh, 2000; 2002) have shown that energy systems are subject to this kind of inertia and lock-in effects as they tend to re-invest in established competences. Hence, disruptive technologies (e.g. some RE technologies) may have difficulties in entering as key stakeholders may consider unfamiliar technologies as low priority (Winskel, McLeod, Wallace, & Williams, 2006). This may have implications for how TT processes should proceed.

The above discussion implies a possibility of numerous barriers in the TT process. Such barriers exist on both national and international levels and have been identified by many researchers (Ellis & Kamel, 2007; Worrell, van Berkel, Fengqi, Menke, Schaeffer, & Williams, 2001). Looking at the transfer processes as a system particular to the type of technology and country context means that barriers are related to blockages in the flows through the system or a lack of supporting and enabling institutions (Intergovernmental Panel on Climate Change, 2000). Commonly encountered barriers identified by the IPCC (2000) include lack of information, insufficient human capabilities, political and economic barriers, trade

and policy barriers, high transaction costs, lack of full cost pricing, lack of understanding of local needs, business limitations, and inadequate environmental codes and standards.

As Schneider et al. (2008) describe, barriers are closely linked to the institutional framework that a country provides. For instance, trade restrictions through tariffs and non-tariff barriers can limit a technology's commercial viability; access to capital is more restricted if investors are worried about political risks and weak enforcement of regulations; and high level of corruption complicates the process of obtaining the right information and thus raises transaction costs. Hence, stability of the political system, sound economic policy and regulatory frameworks, legal security, trade openness, and a low level of corruption are important elements of an enabling environment suitable for attracting foreign technology (Intergovernmental Panel on Climate Change, 2000).

The issue of international property rights (IPRs) is another subject that has become very prominent within TT literature. However, access to IPRs is not likely to be sufficient itself to facilitate TTs (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008). Furthermore, the work of Barton (2007) on IPRs and renewable energy technologies concludes that although IPR issues are sometimes important, they are not likely to present insurmountable barriers in larger developing countries.

Barriers to TT suggest a central role for both national and international policy interventions in achieving low carbon TT. At the national level, domestic policies that provide incentives for the use of low carbon technologies as opposed to conventional ones can play a strong role in overcoming barriers and creating markets for new low carbon technologies. These include, for example, emissions trading schemes as well as emissions limits. However, tax credits and grants usually constitute the core of the public policies to support the dissemination of sustainable energy technologies, alongside qualification of materials guaranteeing performance. These can take the forms of feed-in tariffs or obligations for installations to increase the share of renewable energy sources in the energy mixes through e.g. green certificates (Karakosta, Doukas, & Psarr, 2010; Ockwell, Watson, Mackerron, Pal, & Yamin, 2008). Domestic policies are also needed to develop NSI by actively engaging with international collaborative R&D initiatives and ensuring appropriate infrastructure to foster low carbon innovation (Intergovernmental Panel on Climate Change, 2000).

At the international level, there is a clear role for fostering activities that aim to develop low carbon technological capacity within developing countries. Collaborative R&D and information sharing initiatives are examples of such activities and their success will rely on engaging with private companies (Evans, 1999). Donor banks and development organizations like the World Bank can also play an important role in

fostering TT and scaling up public and private investment in low carbon technology by addressing the barriers hindering such development (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008).

Such policy incentives should address barriers related to both horizontal and vertical transfers as many low carbon technologies are at early, pre-commercial stages of development. The stage of technology development impacts the nature of the barriers to TT. For example, risks related to capital costs and reliability are more acute for technologies that are still at an early stage of development. Pre- and supported-commercial technologies are also likely to require more effort to encourage market development than technologies that are already in widespread commercial use. In this respect, incentives can be targeted towards reducing risks associated with e.g. high capital costs and limited operational experience. One possible approach is for government to share the funding of demonstration activities with industry. Alternative approaches might be to offer support for technologies on a performance basis or by allowing low carbon technologies to sell their electricity at higher prices (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008). But the high demonstration costs and early deployment activities coupled with the general scarcity of public sector resources dictate that public investments in these activities should prioritize technologies that offer major 'external' social benefits (Williams, 2001).

In this light it is relevant to note that in the literature, the fields of economic development and energy policy and planning have converged in recent years. This is in line with arguments of the reinforcing relationship between SD and climate change mitigation (Metz, Berk, den Elzen, de Vries, & van Vuuren, 2002). Both theory and practice in economic development have come to emphasize local asset-based competitiveness, technology innovation, local or regional scale developments, and a growing role for public policy and public-private partnerships in shaping the development of economies. Similarly, the field of energy policy and planning has evolved to emphasize local resources, technology innovation, policy interventions mostly implemented at the sub-national level, and functional public-private partnerships (Carley, Lawrence, Brown, Nourafshan, & Benami, 2010).

Energy security, economic growth, and environmental protection are the national energy policy drivers of any country in the world (Omer, 2008). It is now becoming common to find economic development initiatives that involve energy strategies or energy policy and planning initiatives that involve economic development aspects, as each discipline's goals frequently complement those of the other. In short, the goals are increased energy efficiency, diversification of energy resources, job creation and retention, and regional wealth creation (Carley, Lawrence, Brown, Nourafshan, & Benami, 2010).

Numerous studies have illustrated the importance of infrastructure in poverty reduction, income growth, and access to economic activities (Gibson, 2009; Gibson & Olivia, 2008; Yamauchi, Muto, Chowdhury, &

Dewina, 2009; The World Bank, 2006). As an example, Sharma (2007) concludes that decentralized power generation through renewable sources of energy is not just an option for affordable and sustainable power supplies to rural populations, but also a means for achieving development in under developed areas. In these places, improved electric infrastructure can trigger economic activity, income generation for individuals, and prosperity for the entire community.

Carley et al. (2010) have termed this emerging discipline “energy-based economic development” (EBED) and offer the following definition: *“Energy-based economic development is a process by which economic developers; energy policymakers and planners; government officials; industry, utility, and business leaders; and other stakeholders in a given region strive to increase energy efficiency or diversify energy resources in ways that contribute to job creation, job retention, and regional wealth creation”* (2010, p. 6). This definition is broad but it holistically describes the convergence of energy policy and economic development, allowing for a wide set of policies and practices directed at the goals of EBED.

To sum up the above, radical changes in the energy system are essential in the decades immediately ahead in order to address effectively the multiple economic, social, environmental, and insecurity challenges posed by conventional energy. This calls for a rigorous international effort to speed up the rate of worldwide technological innovation and diffusion that addresses sustainable development objectives. Particular attention should be given to developing countries which account for much of the world’s growth in energy demand and where problems posed by conventional energy are most severe. The transfer of low carbon technologies to developing countries has a key role to play in reducing carbon emissions associated with future economic development. However, in order for the transfer of low carbon technologies to have a sustained impact on the carbon intensity of economic activity in developing countries, it needs to be a part of a broader process of technological change and capacity building. Since most technology and knowhow is owned by the private industry, these efforts should be aimed at channelling some of the enormous private-sector financial and technological resources to the development and widespread deployment of such new energy technologies where they are most needed. This calls for greater international collaboration within the private sector so that global opportunities and knowhow can be utilized to their full potential, and to secure that the benefits of technological innovation are felt throughout the world. In this respect, governments and authorities can play an important role in facilitating this development by effectively promoting policies that support innovation and diffusion of technology for sustainable development and remove barriers to TT. Developing countries should furthermore strive to make their countries favourable theatres for TT and energy technological innovation well-suited for their development needs. If successful, this can facilitate capture of technological capacity which may provide

these countries with an opportunity to become market leaders for selected sustainable energy technologies with eventual export capability.

Much of the work on TT to date, such as the IPCC (2000) report on technology transfer, has focused upon the theoretical level. However, a lack of empirical evidence and research on how low carbon TT might be effectively implemented is a key contributor to disagreements within international climate negotiations. Coupled with the prominence of the issue, this suggests an urgent need for research efforts into TT implementation and how international collaborative mechanisms are most likely to effectively facilitate this (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008). Although this paper does not aim to produce grand theories or frameworks for TT implementation, it contributes to such work by suggesting a specific case of low carbon TT from an industrialized country to a developing country. It proposes how this should be implemented and who should implement it, under the goal of creating Icelandic-Indonesian cooperation within the geothermal sector. This work will be built on the above theoretical discussions recognizing the need for international, public and private cooperation to combat the threats of climate change.

## **3. Methods**

### **3.1 Research Philosophy**

This paper is written from a social constructionism viewpoint in the broad sense as it does not consider reality to be something objective and exterior, but rather socially constructed and given meaning by people as they try to make sense of the world. Social constructionism forms part of a group of approaches that Habermas referred to as interpretive methods (Easterby-Smith, Thorpe, & Jackson, 2008). However, the paper leans on economic theory to make sense of this and could therefore qualify as a post-positivist approach (Ryan, 2006). The author of this paper tries to interpret the reality of geothermal development in Indonesia by interviewing key stakeholders within this field and analyzing secondary data while leaning on economic theory for guidance.

The paper is furthermore guided by a normative vision; to create cooperation between Iceland and Indonesia within the geothermal sector and provide recommendations for transferring geothermal technology and knowhow from Iceland to Indonesia that offers benefits to all parties involved.

### **3.2 Research Approach**

As the study is built on an inductive approach the aim is not to verify or falsify any specific set of hypotheses but rather to produce knowledge regarding institutional barriers to geothermal development in Indonesia. Thereafter the paper uses that knowledge to suggest and develop a case of Icelandic TT to Indonesia and provide recommendations for further cooperation between the parties in the implementation and commercialization of the relevant technology.

### **3.3 Theoretical Framework**

The study builds on the overlapping literatures of TT, innovation, economic development, and EBED as presented in the literature review. The chronicle recognises the need for low carbon technology to play a long term role in the economies of developing countries. This guides the analysis in identifying the institutional barriers to geothermal development in Indonesia, while respecting the specificity that the local context necessitates.

### **3.4 Methodology**

As the research on TT and commercialization of renewable energy is an ongoing process, this paper will be using both descriptive and exploratory research strategies. The study is designed using an explorative approach to gather qualitative and quantitative data on geothermal development in Indonesia through semi-constructed in-depth interviews with key stakeholders involved in Indonesian geothermal development, and secondary analysis of research reports, position papers, and other archival data. By analyzing this data the paper induces knowledge on institutional barriers to geothermal development in Indonesia and applies this knowledge to suggest a case for Icelandic technology transfer to Indonesia. The paper includes normative suggestions on the future development of geothermal energy in Indonesia as it points to a specific area that should be prioritised by relevant authorities while suggesting how these could be implemented.

### **3.5 Data Collection**

The study gathers qualitative and quantitative data on geothermal development in Indonesia, and the Indonesian and Icelandic contexts. This data originates from both primary and secondary sources.

#### **3.5.1 Primary Data**

Semi constructed in-depth interviews with key stakeholders involved in Indonesian geothermal development. The author used a snowballing method to identify and gain access to these stakeholders. Snowball sampling starts with someone who meets the criteria for inclusion in a study who is then asked to name others who could be eligible (Easterby-Smith, Thorpe, & Jackson, 2008). Hence, the author started by trying to identify, through online research and conversations with Danish embassy personnel, someone who fitted the criteria needed to be an interesting interviewee: either an expert on geothermal development in Indonesia or having access to such experts.

After sending a few e-mails around, a couple of interviews/meetings were set up: one at Pelangi, an Indonesian NGO, and the other at the Danish embassy in Jakarta. In both cases, the interviewees identified and helped provide access to other individuals who met the criteria for inclusion in the study. When interviewed, some of these individuals then provided access to others who fitted the criteria and thus the data sampling could be compared to a rolling snowball. In this way, the interview at Pelangi led to two of the referenced interviews below (Riki F. Ibrahim, Udibowo Ciptomulyono), while the interview at the Danish embassy lead to the rest.

It should be noted that in this process, a few interviews were conducted which have not been used or referenced in this paper. The importance of these interviews was thus not so much in the information gathered, but rather in the links that were provided to other interviewees. Some of the interviews led to continued information exchanges and conversations through e-mail. Furthermore, on top of supplying direct information, the interviewees also pointed out and provided access to secondary data that otherwise would have been difficult to allocate. The interviews were conducted in the period between October 2010 and January 2011. The stakeholders interviewed and referenced in this paper are:

- Taufan Surana – Program Director for Geothermal Energy Technology at BPPT, an organization under the ministry of Energy and Mineral resources.
- Udibowo Ciptomulyono – President Commissioner of PLN Geothermal, a geothermal subsidiary of the state owned utility company PT PLN.
- Dicky Edwin Hindarto – Coordinator chief of the carbon trade mechanism division under the National council on Climate change.
- Djoko Winarno – Vice Chairman of METI/IRES (Indonesia Renewable Energy Society), and owner of various small and medium scale RE energy projects in Indonesia.
- Riki Firmandah Ibrahim – Senior Geothermal Business Analyst and a member of the board of experts at INAGA (Indonesia Geothermal Association).
- Ratih Widayanti – Chief Researcher at Pelangi, respected Indonesian NGO that works with climate change, energy, and environmental issues.<sup>2</sup>

The data gathered in the interviews was used to create a picture of the Indonesian geothermal market, its status, needs, and the barriers hindering its development. Hence, the interviewees are quoted throughout the paper to underline the arguments put forward. Furthermore, the data (most notably from Taufan Surana) was used to develop a specific case of Icelandic TT to Indonesia. In developing this case, the author also consulted with experts at Kaldara Green Energy. Their role was restricted to an informative one, as they did not have any direct saying on the contents of this paper. They did however provide valuable information which would otherwise have been difficult to gather. The specialists consulted where

- Hákon Skúlason, CEO
- Skúli Jóhannesson, Manager

---

<sup>2</sup> Further information on the interviewees is provided in appendix I.



### 3.5.2 Secondary Data

Qualitative and quantitative data e.g. research reports, position papers, newspaper articles and other archival data and literature that carry relevant information on the subject. The sources include scholars, research units, news agencies, NGOs, international organizations, development banks, sector organizations, and private companies. A few data sources have been drawn upon extensively in the paper. These are:

- *Indonesia Critical Development Constraints (2010)*: a diagnostic study produced by respected sources: the Asian Development Bank, the International Labour Organization, and the Islamic Development Bank.
- *Energy Policy Review of Indonesia (2008)*: a review of the Indonesian energy market and energy policy by the respected International Energy Agency, an autonomous body within the OECD framework.
- *Phase 1 Report: Review & Analysis of Prevailing Geothermal Policies, Regulations and Costs (2010)*: a study conducted by the respected consultancy, Castlerock Consulting, for the Indonesian Ministry of Energy and Mineral Resources, financed by the World Bank.

## 3.6 Scope, Strengths and Limitations

The study is bound geographically to Indonesia and the author lived in the country's capital during parts of the research time. Indonesia is an increasingly attractive market for geothermal development due to the country's huge geothermal potential, its large geographic distances, and poor electricity infrastructure.

Due to the nature and purpose of this paper, the study does not go deep into technological issues of geothermal development, although naturally this has to be looked at to some extent. Rather, the paper will focus on the business part of this development which is influenced by political, economic, social, and environmental aspects.

This paper suggests a specific case of low carbon TT from a developed to a developing country, including its implementation and further cooperation with the commercialization of this technology. By doing this, the paper contributes to the urgent need for research into implementation of low carbon TTs, and how international collaborative R&D mechanisms can facilitate this (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008).

The author chooses to develop a specific case, but it is important to note that this does not represent the only option for TT or cooperation between the countries. But through the author's knowledge on the

Icelandic geothermal industry, and the information gathered in the analysis of this paper, the specific case suggested and developed in this paper was identified as a great and realistic opportunity for both countries. Further argumentation for this choice is provided in the paper itself.

In developing the case of Icelandic TT to Indonesia, the paper does not discuss the issue of international property rights. This is because the author does not believe it will have an impact on the subject, as the basic approaches to solving the specific technological problems within geothermal energy have long been off-patent. What are usually patented are specific improvements or features. Thus, there is competition between a number of patented products within this sector while further competition is provided by other sectors and alternate sources of fuel or electricity. These are the factors that allow Barton (2007) to conclude that although IPR issues are sometimes important, they are not likely to present insurmountable barriers to entries of RE technologies into developing countries.

It should be noted that the author of this project was in contact with Kaldara Green Energy during the development of the case suggested in this paper. However, the company did not have any direct saying or influence over any aspects of the study. Rather, it functioned as an inspiration and a valuable information provider on data otherwise difficult to find. The author takes critical subjectivity (Easterby-Smith, Thorpe, & Jackson, 2008) by acknowledging his view of the potential for small scale geothermal development in Indonesia without allowing this view to control his analysis.

In the light of the much emphasized importance of country contexts when it comes to analyzing aspects for TT and sustainable energy development (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008), the findings of this paper cannot be generalized to other countries. However, the information provided in the paper may also be useful to researchers studying other types of renewable energy in Indonesian while the normative suggestions made could work as inspiration for geothermal development in other countries.

## 4. Analysis

### 4.1 Geothermal Energy

There are two main ways to use geothermal energy: directly for heating or cooling purposes or to produce electricity. The focus of this thesis is on the latter. Geothermal activities consist of preliminary survey, exploration, feasibility study, exploitation and utilization. When talking about geothermal business, a distinction is often made between upstream activities (exploration and production) and downstream activities (power generation and sales). There are two major ways to produce electricity from conventional geothermal energy: flash and binary methods. The type of system used in a particular application depends on the resource temperature which also gives a rough idea of the resource value through a positive correlation. Generally, Binary method is used for resources with temperatures below 180°C while Flash is used for those with temperatures above 180°C. A third way termed 'Enhanced Geothermal Systems' also exists but this method is still in an experimental phase and is not widely deployed (Dickson & Fanelli, 2004).

A well designed geothermal system is perhaps the most environmental friendly source of energy available. When compared to conventional power sources, geothermal energy has enormous environmental advantages. These include far fewer and more easily controlled atmospheric emissions, readily maintainable groundwater quality, minimal amounts of troublesome waste, and more modest land requirements for power production facilities (The Energy and Geoscience Institute of the University of Utah). Furthermore, geothermal energy is completely domestic in supply, reliable, renewable and sustainable. Geothermal power plants are very self-sufficient compared to other energy options. Once a plant is up and running, it can produce at full capacity for more than 8000 hours per year (90-98% capacity factor), and carefully managed production with modern techniques can allow geothermal systems to be commercially sustained for centuries. This is appealing when compared to the occasional delivery of e.g. wind and solar power that require reserves from non-renewable backup power (Axelsson, 2010; Orkustofnun, 2010; Dickson & Fanelli, 2004).

All geothermal power plants have high start up expenditures, a factor that has long hindered investment in the resource. Capital costs for geothermal power projects are as much as two or three times the cost per MW of fossil fuel generation. The higher costs are mainly due to exploration and drilling expenses which also contain the highest risks as the true potential of the resource is not yet known at this stage. But there are no raw fuel costs and operational and maintenance cost are very low. This makes geothermal energy cost competitive with conventional forms of energy on a life-cycle basis. However, investors tend to favour technologies with lower capital costs as a fraction of total cost because of the lower initial financial risk.

Hence, modern economies are prone to take the short term view in which even essentially guaranteed long term profitability does not offset the reasonable risk associated with the start up. On top of this, public policy support for renewable energy sources has traditionally been biased in favour of wind and solar rather than geothermal in many countries, despite their inferior economics (Ketels, 2010; Orkustofnun, 2010; The Energy and Geoscience Institute of the University of Utah).

Geothermal energy can have a huge impact in the global fight against climate change as it can reduce our reliance on fossil fuels and thus help reduce carbon emissions (Dickson & Fanelli, 2004). If exploited correctly, geothermal energy could assume an important role in the energy mix of numerous countries. The U.S. Geothermal Energy Association states that 39 nations have the possibility to cover 100% of their electricity needs through geothermal, and another 18 could cover 10% or more. This excludes usages for heating etc. (Glitnir Geothermal Energy Research, 2008). Furthermore, about 70% of geothermal world potential is located in developing countries. As geothermal is a very consistent provider of base load energy it can be a reliable energy supplier for industry of all kinds. This is why Chandrasekharam and Bundschuh (2002) conclude that geothermal energy will become the most suitable, cost effective, and sustainable energy source for the developing world in the present decade.

## **4.2 Iceland – Frontrunner in Geothermal Energy**

Iceland is blessed with geothermal energy resources because of its location in an active volcanic zone, right on top of where the Eurasian and the North American tectonic plates meet. Iceland has for many years been at the forefront of geothermal development and today it is number seven in terms of overall installed capacity for electricity generation and number four in terms of direct utilization (Íslandsbanki Geothermal Research Team, 2010).

The political drive towards utilisation of the country's own natural resources after the oil crisis in the 1970s saw increased efforts put into geothermal research and development. At the time of the crisis, 50% of the population was dependent on oil for heating purposes. This had profound impacts on the Icelandic economy and caused the country to change its energy policy, turning to domestic energy resources like hydro and geothermal (Íslandsbanki Geothermal Research Team, 2010).

Due to the strong governmental support, a very competitive geothermal industry has developed. The Icelandic National Energy Authority (NEA), a government agency that provides advisory capacity, promotes energy research, and administrates the utilization of energy resources has established itself as one of the leading geothermal energy research institutions in the world. The NEA has together with other Icelandic

industry players participated in international research and cooperation while providing geothermal education through, amongst others, the United Nations Geothermal Training Programme. Furthermore, Iceland has introduced its geothermal expertise in its official development aid programs in cooperation with the Icelandic International Development Agency, thereby supporting geothermal development in various third world countries.

As a result of the government's strong involvement in the energy sector, most Icelandic utilities are publicly owned. Working together, the government, municipalities, and public enterprises have done the research that has laid the groundwork for the sector and later attracted private industry. Thus, numerous private firms have developed and operate within e.g. exploration, drilling, operations, engineering, consultancy, and equipment supply. Many have strong International experience and reputation (Íslandsbanki Geothermal Research Team, 2010).

It is important to note that the Icelandic geothermal sector was established on a community-based approach as the development of knowhow and technology needed to be adapted to the requirements of small towns, villages, and local communities (Forseti.is, 2010). As an example of this, many communities around the country have developed and built their own heating distribution systems and the first geothermal power plant in Iceland, Bjarnarflag (3 MW), was built to provide electricity to an ill accessible and remote area of the country (Orkustofnun, 2010). Today geothermal plays a significant role in the overall energy mix of Iceland and has been important in reducing dependency on foreign supplies for heating and electricity purposes. Nearly two thirds of the primary energy supply is derived from geothermal resources, saving the country more than USD 460 million annually (Íslandsbanki Geothermal Research Team, 2010).

After finding itself in acute economic crisis following the collapse of the banking system in 2008, Iceland is now considering ways to help strengthen its economy and is therefore directing its attention towards the use of its natural resources. Traditionally, Iceland has used its abundant energy resources to attract companies from energy intensive industries, but due to the recent crisis there have been severe delays and cancelation of energy projects in Iceland, as the sector faces difficult obstacles like the weak Icelandic Krona, foreign currency denominated debt positions and limited financial resources of companies - both public and private. This has already resulted in layoffs within the sector (mbl.is, 2010 C).

In a presentation on his work on the Icelandic geothermal cluster (Porter, 2010; mbl.is, 2010 A), Professor Michael Porter of Harvard University discussed his views and some initial findings of his research. In his speech he said that if Icelanders could not use the opportunities presented by geothermal energy they should be ashamed. He argued that Iceland has the possibility to be a large player in this market and that in

the future, Icelanders would have the possibility to own and operate geothermal companies around the world. He further stressed that Iceland needs to find ways to better utilize the opportunities presented by geothermal energy and sell their technology and knowhow internationally.

Any economic growth needs to be export lead and involvement in geothermal activities in emerging market economies can be rewarding for both the Icelandic economy and the host country. But there are also risks, especially since investments in the energy sector tend to be large, capital intensive and long-term while political and economic uncertainty is often high in emerging markets. The already troubled Icelandic economy does not need additional financial problems, and investments in emerging markets thus need careful balancing between risks and rewards (Hilmarsson, 2010). This is especially true as the Icelandic geothermal sector mostly consists of SMEs.

Working in partnerships with international companies/consortiums, international financing institutions (IFIs), bilateral development agencies etc. is one way of reducing risks. In his article on opportunities for Icelandic energy companies in emerging market economies, Hilmarsson (2010) emphasizes that Icelandic companies should avoid high up-front development costs in the preparation of such projects without a fair sharing of those costs and a firm commitment from the host government and other partners involved, including IFIs. The credit risk associated with the offtake purchaser should, for example, be of particular concern to the project company and the lenders. This is where guarantees from the host governments and IFIs, including the World Bank, become important. He adds that the Icelandic government has devoted limited funding and few human resources towards its relationship with IFIs and that the country is not a member of key IFIs like the regional development banks, AsDB, AfDB, and IDB. This can be a barrier to the progress of Icelandic projects within foreign markets.

### **4.3 Indonesian Energy Context**

Indonesia is the fourth most populous nation in the world (240 million) and a developing economy with annual economic growth on a stable path of 5-6% (Economist Intelligence Unit, 2011). The Indonesian government (GOI) is committed to achieve continued growth that reduces poverty, is socially inclusive, and environmentally sustainable (Asian Development Bank et.al., 2010). However, organizations such as the World Bank (2008 A) and the Asian Development Bank (2010) have identified inadequate and poor quality of infrastructure, including electricity supply, as one of the most critical constraints to these goals.

Indonesia is a major player in the world energy economy. It is the world's leading steam coal exporter, a substantial LNG exporter, and until recently also a net oil exporter. However, Indonesia's declining oil and

gas production along with the fast increasing domestic requirements for oil, gas and electricity have underlined the need to develop the country's RE sources (International Energy Agency, 2008). This need becomes even more obvious when considering the geographically dispersed archipelago of the country. Indonesia consists of more than 17000 islands (6000 inhabited) that are not properly connected or interconnected in terms of electricity. These conditions make it difficult to develop cost effective grid connection which is why there is a huge need for small and scattered electricity generation. As the country's abundant renewable resources are widely spread geographically, their development represents an opportunity to help improve electricity services to rural areas while simultaneously decreasing the countries dependence on fossil fuel energy (International Energy Agency, 2008).

At the end of 2007, Indonesia had an installed electricity generation capacity of about 44.5 GW, of which about 57% was owned by the state-owned utility company Perusahaan Listrik Negara (PLN). The largest part of the privately held capacity (14.8 GW) was owned by about 10,000 industrial and manufacturing units that had to generate their own power due to lack of supplies and reliability from PLN (Asian Development Bank et.al., 2010). Based on forecasts by the Indonesian ministry of energy and mineral resources (MEMR), Indonesia's electricity demand is set to triple over the next two decades which is equivalent to an average annual increase of 7%. A slightly higher share of these increases is forecasted outside the Java-Madura-Bali region (International Energy Agency, 2008).

The Indonesian electricity sector is characterized by a low electrification rate, low consumption, and high inefficiency in transmission and distribution. The electrification is around 60%, the per capita electricity consumption around 566 kilowatt hours (kWh), and system transmission and distribution losses are more than 11%. These numbers confirm that the country lags behind most other major Southeast Asian economies in terms of energy infrastructure. The conditions vary greatly across geographic regions, e.g. the electrification rate varies from 21% in East Nusa Tenggara to 88% in the Jakarta province. Generally, the conditions are worst in the outer islands where power shortfalls and blackouts have become an everyday occurrence. These rural areas have received far less public and private investment in the past compared to the Java-Bali region (Asian Development Bank et.al., 2010).

Economic growth and poverty reduction have often been carried out in environmentally unsustainable ways in Indonesia. This has resulted in degradation of the environment and natural capital as the impacts of climate change have become increasingly obvious and severe (Asian Development Bank et.al., 2010). The World Bank (2008 B) states that the country has an appalling pollution problem and has warned that its population faces grave health risks unless the government changes its attitude to the environment. Air pollution is severe in the country and Indonesia's significant GHG emissions are projected to increase in the

future. The National Council on Climate Change of the Republic of Indonesia (2009) in collaboration with the UNFCCC estimates Indonesia's annual GHG emissions to be around 1.72 Gt CO<sub>2</sub>e in 2000 and 2.12 Gt CO<sub>2</sub>e in 2005. This underlines that environmental consideration needs to be integrated into the development planning processes at both national and regional levels. Without due consideration of environmental concerns, any effort for economic development and poverty reduction will jeopardize its long-term sustainability.

Recognizing these conditions, the Indonesian government has issued ambitious energy policy goals (The National Council on Climate Change of the Republic of Indonesia, 2009; Clean Technology Fund, 2010; International Energy Agency, 2008). These goals include:

- Reduce significantly the use of oil to below 20% of overall energy use by 2025
- Increase the use of coal and natural gas up to 33% and 30% respectively by 2025
- Increase the use of renewable energy up to 25% (more than 5% from geothermal) of the energy mix by 2025.
- Reducing the national energy intensity by 1% annually
- Reduce GHG emissions by 26% by 2020 (41% with International support)
- Improve energy infrastructure.
- Increase electrification rates up to 100%
- Promote private investments for energy development by applying both fiscal and non-fiscal economic incentives

GOI has identified geothermal energy development as the key to achieve these goals. This was evident in president Yudoyono's statement at the 2010 world geothermal congress in Bali:

*"Nations are striving to liberate themselves from overdependence on fossil fuels. And to many countries, including Indonesia, a large part of the solution to that problem is the successful tapping of vast resources of geothermal energy"* (Indonesia Geothermal Association (API), 2010, p. 5).

Hence, the national energy blueprint 2006-2025 targets geothermal energy to reach 5% (9500 MW) of the total energy mix by 2025 (Clean Technology Fund, 2010). The president has since increased this target to 12400 MW in his "25/25 vision" and his second 10.000 MW crash program aims at developing 3,967 MW before 2014 (Ministry of Energy and Mineral Resources, 2011).

Located between the Eurasian and Indo-Australian tectonic plates, Indonesia is a country that has abundant geothermal resources, around 40% of world potential (International Energy Agency, 2008). But even though the country is the third largest producer of geothermal electricity, utilization of geothermal



potential has proceeded very slowly as the sector has faced difficult challenges and uncertainty (KPMG, 2010).

By June 2010, there were 265 geothermal locations (mainly high temperature) identified in Indonesia with the total energy potential of about 28.950 MW<sup>3</sup>. Counting also medium- and low heat-temperature sources the geothermal potential could even exceed 100,000MWe. However, only 1189 MW, around 4% of the potential resources, has been utilized (about 52 % of proven reserve). Furthermore, only 26 WKPs (Working areas/fields) had been issued by the government. This is because a large part of geothermal areas (54.34%) are still in the stage of preliminary survey. Hence, there is an urgent need to improve the knowledge of these areas by raising the level of surveys performed at these locations. This is particularly true for the rural outer regions and remote parts of the country (CCOP Indonesian Delgation, 2010).

Although geothermal energy involves high upfront capital cost and risk, it could be of great value to Indonesia when viewed from a long term perspective. The long lived nature of the abundant geothermal resources and their non-exportable character means that it is in the best interest of the country to utilize them to the maximum. This will help to diversify the energy mix, increase energy security, and optimize export value of transferable energy commodities such as coal, oil and gas. Furthermore, geothermal is renewable, highly reliable, predictable in terms of price, and environmentally friendly, making it an excellent energy resource to meet the growing energy demands of Indonesia (Darma, 2010 B).

#### **4.4 Indonesia's Current Regulatory Environment**

To understand the geothermal regulatory environment it is important to introduce the mechanism of Indonesian law. In Indonesia law is declared by parliament. However, under Indonesia's legislative system, law is usually very thin lacking both in definitions and implementation. Rather they work as normative declarations of will or brief guidelines. Hence, implementing regulations are needed in the form of government, presidential, ministerial, and regional regulations or decrees. These regulations provide further details and definitions, and stipulate how exactly the laws will be implemented.

Article 33 of the Indonesian Constitution states that land and water, and whatever contained therein, is government property and shall be utilized to the maximum welfare of the people. Geothermal resources fall within this definition. The geothermal development itself is governed by two separate regulatory frameworks. Law 27/2003 governs all WKP (geothermal working areas/fields) awarded after its enactment.

---

<sup>3</sup> For more information on geothermal locations in Indonesia see appendix II

WKPs issued before this are governed by Presidential Decree 45/1991. These are termed legacy WKPs and those who remain unexploited all belong to Pertamina (the state owned oil enterprise) and PLN. This study will focus on progress under the 2003 law as it governs the development of all new WKPs.

Law 27/2003 opened geothermal development up to private participation through competitive tendering conducted by the competent government authority responsible for the WKP. It splits geothermal business in to 6 phases; 1) preliminary study; 2) tendering of WKPs and issuance of a geothermal mining license (IUP) to the winner; 3) exploration; 4) feasibility study; 5) exploitation; 6) and utilization (producing electricity or direct usage).

It is important to note that the right to conduct geothermal business in a WKP area under an IUP does not include title to land rights. The IUP holder by itself is responsible for acquiring land for its geothermal business. An IUP can be held by an Indonesian entity with foreign or Indonesian ownership. With foreign ownership, the ownership is subject to limits prescribed on foreign investment under the Negative List Regulation No. 77/2007. There is no specifically prescribed limit for geothermal business activities, but the limit on electricity business activities, including power generation, is 95% foreign ownership.<sup>4</sup>

The above summary is based on the following sources (Indonesia Geothermal Association, 2010; Indonesian Electric Power Society (MKI), 2010; Castlerock Consulting, 2010; Ibrahim, 2010 A; Digges, 2010).

## **4.5 Institutional Barriers to Geothermal Development in Indonesia**

If Indonesia is to achieve its ambitious goals of geothermal development, it has to overcome the current lack of knowhow, finance, and technological resources (Darma, 2010 A; Ciptomulyono, 2010; Ibrahim, 2010 B). The literature suggests that developing countries require assistance with this (Karakosta, Doukas, & Psarr, 2010). Hence, it is not surprising that in its technology needs assessment on climate change mitigation to the UNFCCC, Indonesia concluded that high priority should be given to attracting geothermal TTs (Indonesian Ministry of Environment et.al., 2010).

The conceptual framework drawn up in the literature review underlined that numerous barriers can hinder TT. Looking at the transfer processes as a system means that barriers are related to blockages in the flows through the system or a lack of supporting and enabling institutions (both formal and informal) (Intergovernmental Panel on Climate Change, 2000). Thus, the TT process for sustainable energy technology involves a process of innovation into an existing energy system and includes both R&D

---

<sup>4</sup> For more information on the 2003 geothermal law and implementing and associated regulations see appendix III

processes and the commercialisation of the technology, including its social acceptance and adoption (Karakosta, Doukas, & Psarr, 2010). Socio-technical system theories underline that large technical systems co-evolve with associated social, cultural, and political institutions. (Smith, Stirling, & Berkhout, 2005; Loorbach, 2007) Factors such as the stability of the political system, economic policy, regulatory frameworks, technology infrastructure etc. are thus important elements to create an enabling environment capable of attracting TT (Karakosta, Doukas, & Psarr, 2010; Schneider, Holzer, & Hoffman, 2008; Lundvall, Johnson, Andersen, & Dalum, 2002).

Regional and national systems of innovation represent the context within which organizations operate and such environments vary widely. Thus, barriers should be evaluated particular to the type of technology and country context. Examining this social and political context is important to be able to effectively manage the innovation process (Tidd, Bessant, & Pavitt, 2005). Hence, in order to answer how the Icelandic geothermal sector can support and benefit from the geothermal development in Indonesia, we first have to analyse the institutional barriers to geothermal development in the country.

In the book, "Geothermal Energy Resources for Developing Countries", Coviello (2002) states that geothermal development comes up against a variety of different barriers all over the world that basically can be categorized as economic barriers (e.g. higher capital costs for geothermal than fossil), regulatory barriers (e.g. absence of a clear regulatory framework), financial risks (e.g. project risks like credit, contractual and fuel supply risks), and market related risks (e.g. political risk and macroeconomic risk). Furthermore, he states that political will on the part of national decision makers is the most important requirement to stimulate a country's geothermal development. A typical example of political will is the application of incentives and measures to promote the sector. These measures refer to institution building – e.g. the creation of competent authorities necessary for structuring regulatory frameworks and the promulgation of regulation – and establishing fiscal measures for the sector. In this respect he mentions an independent national authority, a well defined regulatory framework, and sectoral incentives or rewards for causing less pollution, as indispensable for successful geothermal development.

Guided by this analytical framework the rest of this chapter will analyze the context of the Indonesian energy market and introduce the main institutional barriers (formal and informal) that stand in the way of geothermal development. Although these have been categorized into different subchapters, they are very much interrelated and overlapping. The analysis is built on the interviews that were introduced in the methodology section along with secondary data sources.

### 4.5.1 Industry Structure

The monopoly of PLN as the single authorized buyer of electricity in Indonesia (with the exception of direct industry production, and small scale production where PLN has no grid), is seen as a major obstacle to renewable energy development in Indonesia. PLN, with its close government relationships, is in control of the generation, dispatch, transmission, distribution, and customer service of electricity. Independent power producers (IPP) are the only exception to this vertically integrated monopoly although they still have to negotiate their price directly with PLN and thus are completely reliant upon them (International Energy Agency, 2008). It is hard to see the *“convergence between PLN’s business goals as the monopoly buyer, GOI as the regulator and the renewable energy producers. With this set-up there can be no real breakthrough for renewable energy in Indonesia”* says Ibrahim (2010 B, p. 28), an expert at the Indonesian Geothermal Association (INAGA). PLN does not have good enough knowledge of geothermal business and their philosophy is not holistic. They do not look at the big picture and do not dare to go against what the government says (Ibrahim, 2010 A).

Surya Darma (2010 A), chairman of INAGA, says that the commitment of PLN to use geothermal energy is very low. *“All developers have to struggle against PLN which prefers to take the energy from other resources because geothermal is more like a commodity, rather than a business.”* Many have called for market reforms to restructure this vertically integrated sector and introduce mechanisms of competition that would allow the country to better harness the power of market forces and private capital within the energy sector (International Energy Agency, 2008). But the needed reforms are easier said than done.

#### 4.5.1.1 Attempted Reforms

After much struggle, GOI accepted in 2002 a new electricity law that was supposed to restructure the industry, introduce competition, redefine the role of government, improve private participation, introduce a tariff regime based on full cost recovery, and strengthen the legal and regulatory framework with the establishment of an independent regulatory body. In December 2004, the Constitutional Court scrutinized the law and annulled it completely on the grounds that electricity belongs to a sector of production that is crucially important for the country and has a widespread effect on the life of the people. Therefore the sector must be controlled by the state, it must not be subject to competition, and its business should be conducted by a state-owned enterprise (International Energy Agency, 2008).

New laws from 2007 and 2009 on energy and electricity respectively have tried to introduce some of these reforms although with a milder approach. For example the 2007 law states that electricity price should be based on economic (instead of social) grounds. But to this date, these regulations lack the necessary supporting implementations to enforce them and thus remain largely ineffective (Ibrahim, 2010 B). Hence,

this market remains very much monopolized and difficult for IPPs to operate within. This is the way that PLN wants to keep it as they have opposed regulatory reforms aimed at decentralizing the market (Widayanti, 2010; Ciptomulyono, 2010).

This draws up a picture of the socio-technical system, in which the geothermal energy sector operates, where PLN and the GOI are dominant players. This can hinder the uptake of RE like geothermal, as the market dominating institutions have strong incentives to protect and promote the entrenched regime and tend to re-invest in established competences (Winskel, McLeod, Wallace, & Williams, 2006; Unruh, 2002).

## **4.5.2 Price Issues**

### ***4.5.2.1 Exclusion of Externalities in Energy Prices***

There are no taxation schemes on emission or disincentives to emit in Indonesia. Hence, the price of emitting heavy fossil fuels does not include the externalities that they cause, thereby making it more difficult for alternatives to be cost competitive (International Energy Agency, 2008). This can be seen in a study (Castlerock Consulting, 2010) that assessed geothermal resources in Indonesia and compared them to coal-fired generation. They found that geothermal was generally competitive with coal-fired generation when environmental externalities were taken into account. If not, it was expected to be more costly. This is referred to as the “incremental cost gap” and when applied to the government planned expansion of geothermal, the expected gap reaches approximately USD 95 million by 2014, 187 million by 2016, and 376 million by 2020 (in constant 2010 USD).

### ***4.5.2.2 Energy Tariffs and Subsidies***

Energy price caps and fuel subsidies have substantially altered the least-cost fuel mix of PLN. *“In my 15 years within the energy sector this has always been the biggest barrier to renewable energy and energy conservation”* says Dicky Edwin Hindarto (2011), coordinating chief of the Carbon Trade Mechanism Division. Electricity tariffs for individual consumers are politically determined by the government who pursues a social tariff-setting scheme. These tariffs have only partially been adjusted to reflect the change in the cost base of generation and thus keep electricity prices below market levels. This makes the country highly vulnerable to global energy price movements, because while energy prices have stayed the same, input costs have risen dramatically with increasing oil prices. The average revenue currently received by PLN is around USD 6 cents per kWh while average costs for generation are about USD 12 cents per kWh (International Energy Agency, 2008). In many of the outer islands, generation is almost entirely powered by diesel and costs are as high as USD 25 cents per kWh (Surana, 2010; Ibrahim, 2010 A; Ciptomulyono, 2010).

PLN receives direct subsidies to cover the gap between its production cost and the cost recovery from electricity sales, and indirect subsidies through purchases of subsidized oil. These are huge sums as can be seen on their average deficit and because 27% of PLN's power production is currently oil-based, mainly concentrated in the outer regions. Subsidies consume a large share of government expenditures and electricity subsidies have been pushed up as a result of the fixed electricity tariffs and higher production costs due to higher fuel prices. Direct and indirect government subsidies to PLN's operations was around IDR 38 trillion (USD 4.3 billion) in 2005 or around 1.4% of the GDP (The World Bank, 2008 A).

The OECD and numerous other organizations have recommended that the GOI make more room in the national budget by raising tariffs and cutting energy subsidies which account for more than 10% total state spending. The total energy subsidy in 2011 is set at IDR 136.6 trillion (USD 15.3 billion) (Bisara, 2010). Political will has prevented substantial action and the limited adjustments that have been made in the past have been strongly opposed at the community level, triggering violent public demonstrations around the country (International Energy Agency, 2008).

The rationale for maintaining the subsidized tariffs is to ensure that essential services remain affordable to poorer communities. However, while the direct subsidies are no longer available for larger industrial consumers, they are equally accessible to Indonesia's poor and wealthy. The consumption subsidy is regressive in its impact. Although tariffs are lowest for low voltage connections, typically used by the poorest consumers, the poorest consumers also purchase small quantities of electricity. The combined effect is that the richest consumers receive relatively more of the total subsidy than the poorer consumers because their consumption is greater. The regressive impact of the consumption subsidy is even worse when it is considered that 40% of the population does not even have electricity access and so receives no benefit at all from the electricity subsidies (The World Bank, 2008 A). In May 2008, the Coordinating Ministry of Economic Affairs of Indonesia advised that the top 40% of high income families benefit from 70% of the subsidies, while the bottom 40% of low income families benefit from only 15% of the subsidies (International Energy Agency, 2008). So in essence, the subsidies are missing their target. Research has shown that the negative impacts of upwards tariff adjustments are more than offset by improvements in service quality, increased access for the poor, and the structure of public finances that most benefit them (Asian Development Bank et.al., 2010; The World Bank, 2008 A).

The subsidies and price caps are blunt instruments that impose immense distortions on all of Indonesia's energy sectors; it inhibits and misallocates public and private sector investment, undermines diversification of energy sources and technologies, undermines energy efficiency, reduces enterprises' capacity for environmental compliance, provides greater support to the rich than the poor, undermines the financial

ability of the government and PLN to extend its service to the poorer communities, removes incentives for PLN to connect customers in high-cost regions, and locks Indonesia into a non-sustainable path (International Energy Agency, 2008; The World Bank, 2008 A). *“We (PLN) are suffering. The subsidy is not for us, it is for the buyer, for the people, for the consumer. We don’t even get full subsidy. This system makes it difficult for us to obtain financing and stops us from investing in renewable energy and energy infrastructure”* (Ciptomulyono, 2010).

Hence, price issues have considerably undermined investment in geothermal energy since the high upfront risk in developing the resource calls for higher prices per kWh. But PLN is not willing to offer competitive prices to attract investors as its cost recovery is bound by politically mandated tariffs. Furthermore, pressed by the government to minimize its losses, PLN prefers to avoid the high upfront capital costs of geothermal development and stick to simple fossil fuels like coal or subsidized oil.

#### **4.5.2.3 The Price for Geothermal Energy**

In an approach to try and spur investment in geothermal energy, the MEMR issued regulation No. 32/2009 on geothermal contracting with PLN. This regulation issued a price ceiling for geothermal electricity in Indonesia, allowing PLN to pay up to USD 9.7 cents per kWh of geothermal energy. However, there are many problems with this regulation. Geothermal resources are diverse in size, temperature, and fluid characteristics and thus entail differences in the exploration, production, and the associated uncertainty. Hence, a “one size fits all” pricing scheme is not appropriate to facilitate development. Analysis of geothermal costs in Indonesia suggests that field costs may be segmented by size and exploration status while competing technologies face huge differences in cost according to locations (Castlerock Consulting, 2010). *“The prize needs to be flexible; small geothermal should not be compared to large geothermal”* (Ibrahim, 2010 A; Ciptomulyono, 2010). More flexible pricing mechanisms have been developed for e.g. hydro where differentiation is made between micro, medium, and large projects (Kadiman, 2010).

In this light, Abadi Purnomo, CEO of P.T. Pertamina Geothermal Energy, argues that while the USD 9.7 cents price may be fair for large projects and large players like themselves and Chevron, SME developers working on smaller projects with capacity below 55 MW will often need higher prices (Respati, 2010). Taufan Surana (2010), Program Director for Geothermal Energy Technology at BPPT agrees: *“According to our calculations 9.7 is not economical for many small scale geothermal. The price needs to be higher than that. I don’t understand why PLN are reluctant to invest in geothermal energy while their operating costs are so high for diesel generation.”* Another of the interviewees says he knows why this is, but does not want to be quoted. *“It is the PLN system. Diesel and coal is easy and they don’t want to bother with geothermal even though it will be better in the long run. They don’t want to press the government. If they do bother, they want to*

*control it all themselves. Now they have a subsidiary that is to develop geothermal.*” Udibowo (from PLN) (2010) says that the 9.7 ceiling is a very good price, and that PLN is *“allowed to negotiate for higher price in special circumstances.”* But it has to be kept in mind that whatever price the business may want for geothermal, it will always be too high for PLN as long as they cannot charge higher prices for electricity (Hindarto, 2011).

#### **4.5.2.4 Negotiation of the Geothermal Price**

PLN insist on determining prices on a business to business basis. Hence, even though the price is the biggest factor when selecting winners of a tender, PLN only considers this price to be a starting point for negotiations. *“After tendering, the winning price has no meaning. PLN will always negotiate a new price with the winner”* (Surana, 2010). This process is not open and is ill-defined (Castlerock Consulting, 2010). It puts considerable constraints on company resources as these negotiations can be time consuming and involve a re-evaluation of the commercial feasibility of the project. This also risks that developers will bid low, simply to win and then re-negotiate with PLN.

But it is important to raise PLN's viewpoint. They are precluded from participation on the tender committees, leaving their fate in the hands of often incompetent regional authorities (see below). Furthermore, at the stage of tendering, information on the resource at hand is often limited and at best only provides a best guess of the resource characteristics. This involves a risk for both PLN and developers. The developers do not want to base their project investment cost on assumptions and thus seek very high prices. But likewise, PLN does not want to offer high prices before they know the characteristics of the resource (Ibrahim, 2010 B). *“We are PLN and we are the only buyer, so we want some negotiation of course because the price is not necessarily aligned with what we think it should be”* (Ciptomulyono, 2010).

At the end of this study, the MEMR enacted regulation No. 02/2011 which is intended to tackle some of these problems. It obligates PLN to buy electricity of all geothermal power plants without negotiation as long as the price resulting from the tender is within the ceiling price of USD 9.7 cent per kWh. Should the developer want a higher price, the regulation leaves room for negotiation with PLN subject to approval by the MEMR. The law further states that the government shall guarantee the commercial feasibility of PLN for purchasing this power (Ibrahim, 2010 A). Whether this will encourage investment and speed up geothermal development remains to be seen.

The off-take requirement and government guarantee are certainly positive developments, but with a closer look it is not certain what this entails. While PLN is ordered to buy all geothermal energy on the price resulting from tendering, the law does stipulate the involvement of several government agencies (including PLN) to review, audit, and approve the price of the winning bid. It thus appears to subject it to the same



negotiations as before. Furthermore, even though the law says that the government will guarantee the commercial feasibility of these purchases for PLN, it is not clear how this will be done as no extra subsidies have been included in the pre-determined amount for 2011 (Castlerock Consulting, 2010). Djoko Winarno (2011), vice chairman of Indonesian Renewable Energy Society, says that there is not enough coordination between the ministries on energy law and therefore these laws are hard to implement. *“We are all waiting for a presidential regulation that will enforce the mandatory off-take and provide the subsidies needed to make it viable for PLN”* (Surana, 2010).

Furthermore, the same fundamental problem exists. The price might be too low for SME developers while PLN will continue to sit in the dilemma of being pressed to keep down losses while geothermal prices are fundamentally higher than their electricity tariffs. Ibrahim (2010 A) concludes, that this is the key problem: *“the mandatory off-take is a good idea but we need it to be implemented by making sure that the difference between PLN’s buying and selling price is covered by subsidy through a presidential decree.”* This will create a level of certainty for both investors and PLN.

In sum, externalities are not included in energy prices while energy price caps and fuel subsidies have substantially altered the least-cost fuel mix of PLN. Coupled with the difficult geothermal pricing scheme, price issues present considerable barriers to geothermal development in Indonesia.

### **4.5.3 Incentives**

The conceptual framework drawn up in the literature review suggests a central role for national policy incentives to overcome barriers to renewable energy development and thus low carbon TT. Policies that provide incentives for the use of low carbon as opposed to conventional technologies can play a strong role in overcoming barriers and creating markets for new low carbon technologies. These include, for example, emissions trading schemes as well as emissions limits. However, tax credits and grants usually constitute the core of the public policies to support the dissemination of sustainable energy technologies, alongside qualification of materials guaranteeing performance (Karakosta, Doukas, & Psarr, 2010; Ockwell, Watson, Mackerron, Pal, & Yamin, 2008).

Indonesian authorities have implemented some fiscal incentives for renewable energy through VAT, import duty, and income tax facilities. These include: a net income reduction of 30% for capital investment over a six year period where the reduction is 5% annually, expedited depreciation and amortization for certain classes of tangible fixed assets, and VAT and import duty exceptions for up- and downstream equipment

that cannot be obtained locally (Ali, 2010). However, these incentives have not been implemented to the extent that they should have (Ibrahim, 2010 B).

These attempts should be applauded but it has not been enough to seriously attract private investors. Externalities remain excluded from Indonesian energy prices and no emission limits or national trading scheme exists (Castlerock Consulting, 2010). Furthermore, the social tariff system and subsidies remain in place. This hinders RE development and thus, it is not surprising that many have called for further economic incentives e.g. through lucrative feed-in-tariffs or further tax deductions (Darma, 2010 B; Ibrahim, 2010 B).

#### ***4.5.3.1 Risk Sharing***

Another way that governments can assist renewable energy development is through risk sharing mechanisms with industry (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008). This is especially important for geothermal projects due to the high risks and uncertainty associated with the exploration. Hence, in order to overcome existing financial barriers and promote geothermal development, the focus must be on seeking a balance in distributing these risks between the government and public investors (Coviello, 2002).

Coviello (2002) puts policy mechanisms for risk distribution in to 3 broad categories:

1. The first category entails that investors take all the risk in exploring and developing the field. Thus, this approach will force investors to demand a higher price per kWh.
2. The second category entails that governments finance identification and exploration of fields until the commercial feasibility of the projects is established and then invite tenders to bid for the development, construction and operation of the field. Here, government assumes the biggest risk, which will help them to obtain better prices for electricity production while simultaneously attracting investors.
3. The third category is to distinguish between field operation and the generation of electricity, allowing the government to control the former, and thereby assuming the biggest risk. But this option is difficult if the government lacks the financial and technical resources to meet the need for geothermal development.

Coviello then argues that finding the right balance in risk distribution will clearly depend on the availability of financial resources for undertaking investments and the levels of electricity rates that are desirable for the development of the sector. But for the sake of geothermal development, the second category presented above would be the most suitable (Coviello, 2002). This type of mechanism has been used successfully to promote geothermal development in e.g. the Philippines, Iceland and Japan.

The Indonesian policy falls within the first category as there is no risk sharing mechanism or insurance scheme to help developers. A preliminary study is performed by central or regional authorities, but can also be sourced to private entities. This study is used to determine a new WKP and only offers hypothetical estimations of the reservoir. The WKPs are then tendered and the remaining risk of development, including exploration, lies with the developer. GOI has promised support for exploration for the last 10 years, but they have limited resources and their priorities are elsewhere so this never really becomes reality (Ibrahim, 2010 A).

During the end of this study, GOI announced that it was going to spend USD 128 million for geothermal exploration risk mitigation as part of the 2011 state budget. However, the details of this program have yet to be decided and no information on its distribution has been issued (Darma, 2010 A). So whether this will become reality or just another empty promise remains to be seen.

#### **4.5.4 Regulatory Environment**

*“The main barrier holding up Indonesia’s geothermal development for power generation is the lack of legal and contract certainty. Business confidence is based on this”* (Ibrahim, 2010 B, p. 26). *“Investors are afraid of Indonesia. They don’t trust the country, the laws, or PLN”* (Ibrahim, 2010 A).

The energy sector has identified the lack of clarity and transparency due to inconsistency and insufficient details of legislation and poor co-ordination across government as a key issue hindering investment in Indonesia. Investors have expressed concerns over lack of legal certainty, the difficulties of negotiating and enforcing contracts, arbitration and award judgments, and the perceived unequal treatment of domestic versus foreign companies. There are concerns about the clarity of the tendering and approval process for energy sector contracts, along with the plans, programs, and budgets developed based on approved contracts (International Energy Agency, 2008).

Some of the concerns can be traced back to the Asian financial crisis in 1997-98. Before the crisis, investment in the power sector kept pace with the growth in demand. The recession triggered a collapse of the Indonesian Rupiah which meant that average costs for PLN escalated dramatically as their contract with IPPs were denominated in US dollars (including geothermal contracts). PLN found itself unable to meet its payments to IPPs and the relationship between the parties broke down with most investors seeking recourse through arbitration or the courts in an attempt to cut their losses. These processes were lengthy and acrimonious and had devastating effects on investor confidence in Indonesia’s energy sector (International Energy Agency, 2008).

#### **4.5.4.1 Regulatory Reforms**

The electricity law of 2002 which was annulled by the Constitutional Court was amongst others meant to improve investor confidence. Law on investment No. 25/2007 was also intended to address some of the concerns expressed by investors on the lack of legal certainty, difficulties of negotiating and enforcing contracts, arbitration and award judgments, and the perceived unequal treatment of domestic versus foreign companies. The Law establishes basic investment protections but while it appears to address some of the concerns, many of the government institutions have yet to fully implement it (International Energy Agency, 2008).

Importantly, discussions with industry suggested that it is not the policy that is the sticking point, but rather its slow implementation (Asian Development Bank et.al., 2010). This is a huge problem in Indonesia where laws often completely lack in definitions and implementation. This is suggested to be the case for the law on Geothermal (No. 27/2003). The law was meant to establish a clear authority on geothermal development and address concerns of regulatory clarity in geothermal development. However, many of the government institutions have not finalized internally the micro aspects of the law and it has thus not achieved the results it set out to accomplish. Those implementing regulations that have been put into force have failed to tackle the problem e.g. the pricing and tendering regulations issued to date (Darma, 2010 B; Ciptomulyono, 2010). Hence *“since the 2003 geothermal law, not much has really happened. Field development is almost entirely limited to the geothermal working areas (WKPs) of Pertamina and PLN, awarded before 2003”* (Johnson, 2010, p. 19).

#### **4.5.4.2 Clear Authority**

The lack of a clear authority and regulation on geothermal development has left many projects in bureaucratic lock jams. *“Different authorities produce conflicting law and developers end up struggling to proceed because of contradicting regulations on e.g. regional autonomy, geothermal development, and deforestation”* (Ibrahim, 2010 A). An example is given by Mr. Soko Sandi, president director of PT. Jasa Sarana Rekind Geothermal (a majority state-owned joint venture). His company won a bid put out by a local authority to develop a geothermal field in the region. However, Sandi explains that his company faces major difficulties in attracting investors for the project as two different departments at the ministry of forestry argue about whether parts of the WKP belong to the management of a national park (Respects, 2010 A). This is further acknowledged in a survey from 2009, where key stakeholders from the infrastructure sector in the Java district identified difficulties in land acquisition as one of the most critical constraints to infrastructure investment (Asian Development Bank et.al., 2010).

Nearly all geothermal projects need to consider forestry land issues since most WKPs are located in mountains which are usually under the status of conservation forest. The geothermal regulatory framework under law 27/2003 does not comply with the requirements of law and implementing regulations on forestry and land use which has stalled the progress of many projects (Castlerock Consulting, 2010). In order to speed up this process the government issued law No. 24/2010 granting the utilization of geothermal in forest areas. *“The problem is that there is no clarity in this law, it is only a general law and the supporting definition and implementations are missing, so it is not working as of yet”* (Widayanti, 2010). The sector is now waiting for a presidential regulation that will put this into effect (Indonesia Geothermal Association, 2010).

Coviello (2002) argues that a transparent and independent regulator which is able to operate separately from the government and consistently in the balanced interest of consumers and the supply industry is essential to this market. International experience has shown that the existence of a national geothermal authority is indispensable for regulating the exploration and use of the resource. It is not by chance that geothermal energy has been satisfyingly developed in those countries where such clarity in the structure of authority and regulation does exist (Coviello, 2002). Investors consider this a priority. Jim Blackwell, president of Asia-Pacific exploration and production at Chevron, argues that it is critical to designate a single body that could bring together various ministries and regional authorities to regulate the geothermal sector (Johnson, 2010). Djoko Winarno (2011), a seasoned veteran in the energy sector says that he does not want to enter the geothermal business because it is so much politics and complications, *“it is much easier to do biomass, hydro, coal and solar.”*

#### **4.5.4.3 Tendering Process**

The tendering process for new WKPs has also been heavily criticized for being complicated, un-transparent and lacking in standardization. The current system for preliminary assignments is not attracting the level of competition necessary to achieve efficient, least-cost development. This is because preliminary assignments are often sourced to companies that later participate in the tendering process and thus face a conflict of interest in that they prepare the technical assessment upon which the tender will be based. International procurement practice generally prohibits such arrangements (Castlerock Consulting, 2010).

Regarding the tendering process itself, the relevant authorities (MEMR if at a national level, the Governor if at a provincial level, or the mayor/regent if at a city or regency level) determine if and when a WKP is ready to tender. However, no standards exist to determine this. This has resulted in unsuccessful tendering and severe project delays as the tendering contracts have been based upon extremely limited or incorrect information about the resource and the availability of needed permits, particularly forestry and land

permits (Castlerock Consulting, 2010). Therefore, PLN will continue to insist on negotiating the power purchase agreement (PPA) after tendering (Ciptomulyono, 2010).

Furthermore, the tender documents do not include any model PPA. Rather, the price setting must be verified through a complicated process involving many institutions like e.g. the Financial and Development Supervision Agency, PLN, the Ministry of Finance, the Ministry of State-owned Enterprises, the Directorate General of Electricity, and the government authority that conducted the tender. This process appears to be very impractical and counterproductive to the goal of accelerating geothermal development as it is time consuming and involves peripheral agencies (e.g. Ministry of State-owned Enterprises) with questionable technical competencies (Castlerock Consulting, 2010). Lastly, criterion for selecting winners focuses only on price and thus does not disqualify companies with e.g. no geothermal experience. There are many other things that are important to evaluate including intended exploration and exploitation programs as well as proposed community impacts and CSR strategies of the bidders (Ibrahim, 2010 B).

As a result of these issues, many have called for the introduction of internationally accepted procedures for the tendering process, clarification of evaluation guidelines, and the development of a model or standard PPA that would be included in the tender document package and contain a formula for tariff escalation according to resource productivity (Ibrahim, 2010 B; Johnson, 2010; Castlerock Consulting, 2010).

#### **4.5.5 Governance and Public Institutions**

The Asian Development Bank (2010) has identified weak governance and institutions as a critical constraint that hampers development in Indonesia. This is manifested in e.g. the prevalence of corruption, poor government effectiveness, and occasional occurrence of terrorism and violence incidences. This reduces the development impact of public sector investment and adds to investors' cost of doing business.

##### ***4.5.5.1 Corruption and Safety of Investment***

Investment climate surveys indicate that businesses identify corruption as a major constraint to investment in Indonesia (International Energy Agency, 2008). These conditions are apparent in international measurements of the Indonesian business environment. Transparency International (2010) ranked Indonesia at 110th out of 176 countries in its 2010 Corruption Perception Index. Other indexes have also ranked Indonesia very low on "safety of investment" and "ease of doing business" (Asian Development Bank et.al., 2010; International Energy Agency, 2008). This is very effective in scaring away investors, especially when considering the issues of legal uncertainty and the lack of clarity on contract law and

tendering processes. *“The procedures in geothermal development involve central and local government, PLN and investors and these are not transparent. We are afraid that there is corruption”* (Widayanti, 2010).

#### **4.5.5.2 Regional Disparity**

Corruption has especially been a problem at the regional level. This is particularly important in light of the recent decentralization reforms that have taken place in the country where local authorities have become responsible for e.g. formulating their own energy policies, thus controlling geothermal development in their respective regions (International Energy Agency, 2008). The World Bank Governance Indicators suggest that the country's government effectiveness plummeted during this decentralization, and although this has been improving, Indonesia still compares unfavourably with most of the major economies in the region. This hinders spending in key sectors like energy, especially at the sub-national level where the largest spending item is on core government administration which account for 32% of all expenditures (The World Bank, 2008 A). There is high risk of multiple fees, taxes and regulatory regimes on the upstream geothermal WKPs issued by local authorities which has contradicting results on tendering processes (Johnson, 2010).

One of the most prominent issues in this regard has been the apparent lack of relevant training and diversity of regional tender committees. The local authorities do not have the capacity needed to run the tenders (Darma, 2010 B). They only think about getting as much money as possible (Ciptomulyono, 2010). Currently there are no standards for the technical qualifications of the tender committee members; an argument used by PLN to justify the lengthy negotiations that have followed after the identification of tendering winners. This has resulted in calls for capacity building at the regional level to ensure the capability of the tendering committees (Castlerock Consulting, 2010; Widayanti, 2010).

#### **4.5.5.3 Public Participation**

Pelangi, one of Indonesia's biggest NGO's working with energy topics, has underlined the importance of public participation in energy issues and identified poor transparency and lack of public information as the main obstacles to this. They argue that even though a new regulation will allow geothermal projects in protected forest areas, this is only half of the battle won as local people still have to be convinced of these projects. The very limited knowledge on geothermal development in many of these areas coupled with the lack of information available to the public on these projects create incorrect images of the resource as e.g. farmers think it will contaminate their lands. Hence, Pelangi fights not only for greater transparency and availability of information in the electricity sector, but also for a nationwide campaign to promote awareness on the utilization of geothermal and other forms of renewable energy (Pelangi et.al., 2009).

#### 4.5.6 Technological Capacity

Technological capacity (skills and knowhow to understand, maintain, and operate technology) is the most important ingredient to ensure the long-term uptake of low carbon technologies in developing countries and further advances in their development (Worrell, van Berkel, Fengqi, Menke, Schaeffer, & Williams, 2001). In Indonesia there is limited availability of qualified personnel and organizations necessary to carry out expanded exploration and exploitation activities. This is especially true in the outer regions as inequitable distribution of well-qualified personnel and a lack of effective coordination amongst levels of governments have hampered delivery of high quality services and infrastructure (Asian Development Bank et.al., 2010).

As an example, Abadi Purnomo, CEO of PT Pertamina Geothermal Energy, says that the country does not have enough trained geothermal specialists (Respati, 2010). *“Unless we can find enough geothermal engineers in Indonesia or abroad, we will not be able to sustain the planned speed of the expansion”* (Respects, 2010 C, p. 10). Thus, the Asian Development Bank (2010) has identified weak human capacity as a critical constraint to investment in Indonesian energy infrastructure.

Furthermore, there is a lack of technological resources within Indonesia, both for actual geothermal production, but also for exploration activities, e.g. drill rigs. Hence, most of the geothermal technology to date is imported (Ibrahim, 2010 A; Ciptomulyono, 2010; Surana, 2010). Indonesia’s limited RE technology manufacturing and servicing capability and the lack of skilled technicians for the installation and maintenance of RE technologies hamper the entry and sustainability of RE technologies in Indonesia’s energy mix (International Energy Agency, 2008).

The limited support to private R&D helps to maintain this status quo in the geothermal industry (Darma, 2010 B). This is a general problem in Indonesia as private sector R&D (including state-owned enterprises) is very limited. It reduces opportunities for innovation and market uptake and places the responsibility for energy R&D almost exclusively on the public sector (International Energy Agency, 2008). This underlines the need for Indonesia to create a NSI which is capable of fostering low carbon innovation and attracting FDI and TTs, as they can bring with them an infusion of knowledge and skills into the economy (Karakosta, Doukas, & Psarr, 2010).

#### 4.5.7 Financing

The International Energy Agency (2008) lists three broad options for obtaining the required investment funds to address the situation of the Indonesian energy sector: 1) from domestic utilities supported by



semi-official borrowings and underpinned by reliable income flows from consumer revenues, 2) from direct private-sector financing (possibly with the support of aid agencies) who will seek an economic return on those investments, and 3) from budget financing supplied either directly or through subsidies provided by the government. The overwhelming obstacle to the first two options is the tariff pricing policy currently deployed by Indonesian authorities (International Energy Agency, 2008).

Until the resource has been proven, traditional long term project financing is usually not available for geothermal, but as the project develops, so the project risk decreases and it becomes easier to attract capital (Íslandsbanki Geothermal Research Team, 2010). The risk profile of early stage geothermal exploration and development is always an obstacle in attracting private investors to this industry. Hence, as mentioned above, exploration and pre-feasibility studies are often carried out by public funds. But since this is not the case in Indonesia, the importance of a generally attractive investment climate becomes even more vital.

When it comes to financing the geothermal projects, there are a lot of factors that influence investor interest. Factors that are of essence are the political situation, political risk, investment climate, investment opportunities, and rate of return (Íslandsbanki Geothermal Research Team, 2010). These factors combine to provide investors a sense of long-term certainty; a key factor in attracting investment, more important than economic incentives (International Energy Agency, 2008). The many barriers introduced above hamper the creation of such long-term certainty, thus damaging Indonesian investment climate while decreasing the legitimacy of government policy.

Other factors such as high interest rates and the lack of government guarantees make it even harder to finance geothermal projects in Indonesia (Ciptomulyono, 2010; Ibrahim, 2010 A). Compliance with Indonesian Public Private Partnership (PPP) regulations is required if projects are to benefit from government guarantees. Such guarantees could be important to facilitate lending from offshore banks, exempt these projects from the legal project lending limit (regulation No. 7/3/PBI/2005), and mitigate risk from developers. However, Indonesian PPP law requires projects to be tendered on the basis of at least a pre-feasibility study which at a minimum requires definitive geochemical and geophysical data and may even require exploratory drilling. Such information does not exist when tendering new geothermal WKPs in Indonesia (Castlerock Consulting, 2010).

## **5. Institutional Barriers in Perspective**

### **5.1 Sum Up: Barriers to Geothermal Development in Indonesia**

It is apparent from the above analysis that numerous institutional barriers to geothermal development exist in Indonesia. Coviello (2002) argues that political will from national decision makers, in the form of relevant institution building, is the most important requirement for a country's geothermal development. In this respect he mentions an independent and national authority, a well defined regulatory framework, and sectoral incentives as indispensable factors.

The Indonesian geothermal regulatory framework is neither well defined nor successfully implemented. A lack of coordination between different authorities results in contradicting regulations and interpretations which leads to difficulties in their implementation. This has negative consequences for geothermal development as the majority of projects face delays due to policy and regulatory issues e.g. forestry and land issues and faulty tendering processes (Castlerock Consulting, 2010). It underlines the need for a central organization which could bring together the various ministries and regional authorities and ensure more coordination and cooperation on geothermal regulations. Such an organization could act in an advisory manner and should be transparent, operating in the balanced interest of the GOI, consumers, and the industry. Investors consider such authority a priority (Johnson, 2010).

Although the Indonesian government should be applauded for introducing incentives like tax deduction and import duty exemptions, these have not been enough to make up for existing barriers and attract investment. Externalities remain excluded from Indonesian energy prices and no emission limits or national trading scheme exist. Furthermore, the social tariff system and subsidies remain in place and coupled with the inappropriate "one size fits all" price cap on geothermal energy this creates an unfavourable investment climate for geothermal development.

Hence, the Indonesian geothermal sector is full of paradoxes. On the surface, political will for geothermal development appears to be abundant, manifested in ambitious goals and numerous regulations. But when looking deeper, Indonesian authorities do not seem ready for the task. Regulations struggle to achieve their intended benefits as different authorities fail to communicate and cooperate on the interpreting and implementing aspects. Furthermore, it is hard to see the convergence between GOI policy, PLN's business goals, and the role of IPPs. The relationship is unclear. GOI introduces ambitious goals for geothermal development while failing to implement the most critical changes (e.g. tariffs) that will allow PLN to realize these. PLN, faced with severe difficulties in financing geothermal expansion, continues to act in a monopolistic way and does not accept the outcomes of tenders, i.e. the price, rather persisting to pursue

costly and time consuming business-to business-negotiations with IPP's. The president of the Indonesian Geothermal Association argues: *"the regulation has been changed several times, and it is not easy to revise it. What we must have is willingness from the president, and an understanding on how to implement this willingness by his inner circle, staff, ministers, and PLN"* (Darma, 2010 A).

Attempted market reforms (e.g. 2002 Law on electricity) aimed at unbundling the vertically integrated energy sector and introducing market forces to promote RE, have not been successful. But such reforms are also easier said than done. Research on socio-technical systems show that large technical systems co-evolve with associated social, cultural, and political institutions where the dominant players have strong incentives to protect and promote the entrenched regime (Smith, Stirling, & Berkhout, 2005; Loorbach, 2007). Energy systems are subject to this kind of inertia and lock-in effects as they tend to re-invest in established competences (Unruh, 2002; Unruh, 2000). Thus, RE like geothermal has difficulties in entering the system, as PLN is more used to working with other energy forms.

Changes take time, especially in a young democracy like Indonesia that is going through a process of regionalization and market reforms. Socio-technical transition occurs when a niche technology gains enough footing to compete with, and sometimes replace, the entrenched socio-technical regime. Often this occurs as developments in the broader landscape undermine the entrenched regime, creating opportunities for destabilizing the mainstream (Smith, Stirling, & Berkhout, 2005; Loorbach, 2007). Although progress is slow, Indonesian authorities are increasingly realizing the potential of their geothermal resources. Thus, it is important for future progress to create success stories that have spiralling effects and further embed geothermal energy into the national mindset.

Those interviewed for this paper did not believe that the goals of GOI for geothermal development would be achieved without some major regulatory changes. While the government has targeted 3967 MW of new geothermal energy to be online before 2014, a more realistic target would be 600 MW, taking current development status into consideration (Castlerock Consulting, 2010). The latest long range projections from the MEMR show a growing dependence on coal for electricity production, rising from the current 36.5% to 52% in 2025, and 86% by 2050. Thus, it has become clear that Indonesia's geothermal regulatory framework must be critically reviewed and revitalized if the government is going to realize the potential of geothermal power (Castlerock Consulting, 2010).

However, it is not the aim of this paper to produce specific policy recommendation for the progress of geothermal development in Indonesia. For more information on that see e.g. (Asian Development Bank et.al., 2010; Castlerock Consulting, 2010; International Energy Agency, 2008). Rather, the aim is to examine

how the Icelandic geothermal sector can assist and simultaneously benefit from geothermal development in Indonesia and thus develop an opportunity for cooperation.

To sum up, the analysis has identified the many institutional barriers to geothermal development in Indonesia e.g. the pricing scheme and the tendering process and thereby answered the paper's first sub question. The next section will, based on the above analysis, examine how these barriers affect the Indonesian geothermal sector and the possibilities for attracting foreign TT.

## **5.2 The Barriers' Effect and Possibilities for Attracting Foreign TT**

Coviello (2002) argues that the two most important risks associated with attracting private investment to geothermal development are political risk and the risk related to exploration and field development. He defines political risk as containing specific regulatory aspects of the sector, the general legal framework, and economic regulations. Considering the current lack of a risk sharing mechanism for geothermal exploration in Indonesia and the numerous political risks identified above e.g. contradicting regulation, un-transparent PPA negotiation, and a difficult tender process, it is not surprising that investments in geothermal development have been limited.

These factors combine to damage Indonesian investment climate and hinder the sense of long-term certainty which is essential for attracting investment (International Energy Agency, 2008). Unpredictability in the political and economic environment of the host market increases the perceived risk and uncertainty experienced by firms (Hollensen, 2007). Hence, a member of the board of experts at the Indonesia Geothermal Association concludes: *"investors are afraid of Indonesia. They don't trust the country, the laws or PLN"* (Ibrahim, 2010 A). The result is that Indonesia has not attracted nearly enough investment in geothermal development nor other energy forms, as both public and private investment has declined relative to the overall size of the economy (The World Bank, 2008 A). This is reflected in the appalling condition of the electricity infrastructure as investment has not kept up with electricity demand.

The lack of investments affects the country's ability to attract TTs and develop its geothermal resources. The literature review emphasized the private sector as the greatest enabler of low carbon TT as technologies are increasingly owned by private rather than public actors (Davis, 2005). Hence, the principal mechanisms for international TTs are international trade and FDI, and multinational firms' internationalized R&D and manufacturing processes (Brewer, 2009). Thus, the lack of long term certainty has severely damaged Indonesia's ability to attract international TTs for the geothermal sector as investors are reluctant to commit resources to the market.

Furthermore, the high risk nature of the Indonesian geothermal market means that SMEs will have difficulties in investing in geothermal development due to their limited resources. This is especially true for foreign SME's where the literature suggests that when country risk is high, a firm would do well to limit its exposure to such risk by restricting its resource commitments in that particular national domain (Hollensen, 2007). The result is that the geothermal business in Indonesia has been predominantly the domain of large corporations who can afford to take higher risks (Kadiman, 2010). But large multinationals are not the only important sources of technology innovation or international diffusion. Indeed, small and medium- sized firms are often the originators of new technologies and even the principal internationalizers of them (Brewer, 2009).

This inflates the importance of assistance from governments, IFIs, and development or donor organizations in fostering TT to Indonesia. As private firms tend to invest in technological demonstration and R&D at less than the socially optimal amount, the literature on TT argues for public support to implement such projects. This is especially true for radical new energy technologies (e.g. geothermal technologies) because energy is a commodity and most of the benefits offered by new technologies are public rather than private, e.g. reduced air pollution, reduced risk of climate change, or reduced energy insecurity (Williams, 2001).

Geothermal projects usually have high capital costs and the low operating costs. Thus, the costs of servicing interest and principal repayments for the debt required to fund capital costs becomes a major expense. Obtaining intelligent financing from IFIs or development and donor organizations could substantially lower these expenses (Digges, 2010) and spur geothermal development in Indonesia. As an example, development banks are a vital source of financial and technical assistance to the world's developing countries. They provide loans, low-interest loans, interest-free credits, insurance and risk sharing mechanism, and grants to developing countries for a wide array of purposes. Financing mechanisms specifically aimed at promoting sustainable development and climate change mitigation within developing countries are becoming more common within these organizations. Such assistance creates a more enabling environment for private TT and international cooperation (Karakosta, Doukas, & Psarr, 2010).

In fact, the World Bank, the Asian Development Bank, and the IFC in 2010 put forward financing for public sector large scale geothermal development in Indonesia under the Clean Technology Fund (2010). However, such assistance should recognize the private sector as the most promising agent for bringing about international TT (Brewer, 2009; Davis, 2005). Furthermore, as the exploration and drilling phases involve the highest risk in geothermal development (Dickson & Fanelli, 2004) such assistance should focused on these activities.

Although hierarchical entry modes involving high resource commitments might not be attractive for foreign entrants, export or intermediary modes (e.g. licensing, strategic alliances or joint ventures) would be a possibility as these entail lower levels of financial and management resource commitments and thus limit risk exposure (Hollensen, 2007). Importantly, simple export-import models are not favourable vehicles for genuine TT as they do not foster transfers of knowledge and skill (Worrell, van Berkel, Fengqi, Menke, Schaeffer, & Williams, 2001) and thus create and maintain dependency on part of the recipient (Karakosta, Doukas, & Psarr, 2010). This leaves intermediary modes as a viable option for implementing TTs to Indonesia.

Intermediary entry modes are distinguished from export modes because they are primarily vehicles for the transfer of knowledge and skills, although they may also create export opportunities. They are distinguished from hierarchical entry modes in the way that there is no full ownership (by the parent firm) involved. Rather, ownership and control is shared between partners (Hollensen, 2007). Such modes can allow active participation of local firms which is a key factor to facilitate local absorption of new technologies and knowhow as such diffusion is most likely to happen through integrated linkages between foreign entrants and local firms (Javorcik, 2006). Thus, they can foster technological capacity on part of the receiver, the most important ingredient to ensure long-term uptake of low carbon technologies and further independent progress (Worrell, van Berkel, Fengqi, Menke, Schaeffer, & Williams, 2001). Furthermore, such modes also provide opportunities for risk sharing between partners.

In order to mitigate risks, investors (both private and public) have preferred to focus on large projects where the investment is spread over a larger amount of resulting kWh. The predominant focus on large projects is evident in Indonesian investment plans put forward by the Clean Technology Fund (2010) where the financial resources are restricted to large scale-geothermal.

The absence of smaller projects is negative for geothermal development in Indonesia. While big projects are important, smaller ones also have great potential. They could e.g. provide vital energy to the outer regions where electricity infrastructure is worst but demand growth is highest. However, these regions are left out as they usually have smaller energy demand and cannot absorb large projects. Therefore geothermal development is mostly concentrated in the Java-Bali region. By end 2008, 95% of installed geothermal capacity was based there while the remaining 5% was located on Sumatera and Sulawesi (World Energy Council, 2010). Hence, it is vital to pull SME's and smaller projects into the geothermal development (Darma, 2010 B; Ibrahim, 2010 A; Kadiman, 2010). At the moment, they are marginalized and almost out of the picture (Respects, 2010 B).

So, “despite all the enthusiasm at the Bali World Geothermal Congress, in practice, a few larger companies like Chevron, GE-Star and Pertamina Geothermal Energy are taking comparatively lower risks on larger projects” (Darma, 2010 B, p. 25). The result is that only a few large multinational energy companies have accomplished TTs to Indonesia (International Energy Agency, 2008). This contributes to the continuing lack of technological resources and knowhow. The limited amount of private sector R&D (International Energy Agency, 2008) helps to keep this status quo. Thus, Indonesia has not been successful in creating a NSI which is capable of fostering low carbon innovation and attracting FDI and TTs.

In sum, the institutional barriers to geothermal development in Indonesia hinder the entrance of FDI and TT. Risks are too high for greenfield investments, especially for SMEs with limited financial resources. This is paradoxical for a country in great need of TT and knowhow to further develop its geothermal industry. Shared liability initiatives might be the most viable solutions for attracting TT to Indonesia as multinational companies and SMEs will be less exposed to the risk inherent to the institutional environment of Indonesia. Furthermore, these conditions increase the importance of assistance from governments or development organization in implementing TT to Indonesia.

The paper will now proceed to examine how Icelandic geothermal TT to Indonesia can be implemented.

### **5.3 Implementation of Icelandic TT to Indonesia**

Porter (mbl.is, 2010 A) suggested that in the future, Iceland has the opportunity to own and operate geothermal projects around the world. Although this may be true, this paper argues that currently this would not be an attractive option in Indonesia. The Icelandic geothermal sector mostly consists of SMEs who currently face difficult economic circumstances like the weak Icelandic Krona and limited financial resources (mbl.is, 2010 C). Indeed, size is an indication of firm resources. Although SMEs may desire a high level of control over international operations and wish to make heavy resource commitments to foreign markets, generally they do not have the resources necessary for such activities (Hollensen, 2007). Hence, the risky nature of the Indonesian geothermal market, coupled with the lack of risk mitigation for exploration means that it will be very difficult for Icelandic companies to invest in this market. This is especially true since investments in the geothermal sector tend to be large, capital intensive and long-term (Hilmarrsson, 2010).

The size and limited financial resources of Icelandic geothermal firms means that they have to avoid high up-front development costs unless favourable risk and cost sharing mechanism with e.g. host government is in place (Hilmarrsson, 2010). But the Indonesian government does not provide guarantees on geothermal

projects making it too risky for Icelandic companies to operate a geothermal power plant in the country. Thus, the literature suggests that they should rather invest in more familiar and less risky markets (Hollensen, 2007).

However, this does not mean that Iceland cannot assist Indonesian geothermal development. The amount of risk a firm faces is a function not only of the market itself, but also of its method of involvement there (Hollensen, 2007). Hence, although entry modes involving high resource commitments are not attractive, intermediary and export modes would be a possibility. This thesis is guided by a vision to create Icelandic-Indonesian cooperation and asked 'how the Icelandic geothermal sector could support and simultaneously benefit from geothermal development in Indonesia.' As export modes limit the benefits experienced by the receiver (as argued above), these would not be appropriate for the purpose of this paper although they might be an important source of income for Icelandic technology owners. This leaves intermediary modes as the most viable option for implementing Icelandic TT to Indonesia.

Intermediary entry modes could facilitate Icelandic export of technology and knowhow while simultaneously transferring knowledge and skills to Indonesia. They would also allow Icelandic companies to share ownership and control with partners. Intermediary entry modes include a variety of arrangements such as licensing, management contracts, turnkey contracts, joint ventures, strategic alliances, and knowhow or coproduction arrangements (Hollensen, 2007). These arrangements entail different levels of resource commitments; while a joint venture will often involve commitment of capital or investment from partners into the joint venture, strategic alliances are typically non-equity cooperation's. Choosing between the different arrangements is a matter of how to formalize the cooperation (Hollensen, 2007). By choosing less resource committed entry modes such as strategic alliances, Icelandic companies could severely reduce the risk of entering the Indonesian market.

Thus, transferring technical assistance, technology, and knowhow to Indonesia through intermediary entry modes is the most viable way for the Icelandic geothermal sector to support and simultaneously benefit from the geothermal development in Indonesia. Such modes could foster beneficial cooperation between the countries. Cooperation could provide better returns on R&D investment for all involved through the sharing among participants of financial outlay, workload, and results. From an Indonesian perspective, collaboration with industrialized country partners with more geothermal experience could e.g. speed up geothermal development, build local technological capacity, and reduce the pressure on public sector R&D for geothermal development. The last point is important in light of the limited role currently played by the private sector, including state owned enterprises, in Indonesian energy R&D (International Energy Agency, 2008). From an Icelandic perspective, such projects would provide valuable opportunities to export



technology and knowhow while providing Icelandic companies with access to Indonesian national advantages such as lower labour costs and the large un-served market. Thus, collaboration could allow the sharing of capabilities between the countries to further the competitiveness of both.

Furthermore, such collaboration could merit the support of multilateral and bilateral development organizations on the grounds that they could lead to valuable GHG reduction and TTs to a developing country. Working in partnerships with international companies/consortiums, IFIs, bilateral development agencies etc. could greatly reduce the risk involved in geothermal development (Hilmarsson, 2010). Hence, the Icelandic government would do well in devoting resources to enhance its relationship with such organizations, e.g. the major development banks, in order to provide a better environment for Icelandic projects abroad.

This paper has suggested that intermediary entry modes are the best way of implementing Icelandic geothermal TT to Indonesia. Thus, the Icelandic geothermal sector can support and benefit from the Indonesian geothermal development through transfers of technical assistance, technology, and knowhow. The rest of this paper will further consider how such TT could be implemented. This will be done by proposing and developing a specific case of Icelandic TT to Indonesia and further cooperation in the implementation and commercialization of the relevant technology. This chapter will use current literature on TT and related fields to define the nature of such a transfer and argue for its benefits.

## **6. Case: Transferring Icelandic Small Scale Geothermal Technology to Rural Indonesia**

As stated here above, Indonesian Geothermal Development has mostly been the domain of large companies, focused on large projects, and concentrated in the Java-Bali regions. This development has thus excluded rural areas in the outer islands of the country where arguably the energy is more badly needed as these regions have the worst electricity infrastructure and highest demand growth (International Energy Agency, 2008). However, their low demand means that these regions will not be able to absorb large projects. But if geothermal projects could be adapted to the needs of these communities, they could have big impact on economic, social and environmental development.

Icelandic geothermal development took place on a community-based approach as the development of knowhow and technology needed to be adapted to the needs of small communities (Forseti.is, 2010). Hence, many Icelandic companies have experience with small scale geothermal (SSG) development which makes them equipped to consult on similar projects in Indonesia. As an example, Iceland has been part of a cooperative project called Energy Development in Island Nations (EDIN), which supports small island states in all aspects of developing clean energy, amongst others geothermal. Kaldara Green Energy (KGE), an Icelandic SME, has furthermore developed an innovative approach to harness geothermal energy in small scales. Their technology, called the KAPS (Kaldara Power System), could be very relevant for Indonesia's outer regions and the Indonesian economy as a whole.

Hence, the rest of this paper suggests and develops a case of Icelandic TT, specifically the KAPS, to rural Indonesia and cooperation between the involved parties in the implementation and commercialization of this SSG technology. This could play a part in promoting the viability of smaller projects and SMEs in Indonesian geothermal development by embedding these in the Indonesian context via success stories that will have spiralling effects and make future development easier. Importantly, this paper does not mean to imply that this represent the only option for TTs or cooperation between the countries. However, the author has identified this specific cooperation as an interesting and realistic opportunity for both Icelandic and Indonesian. As argued below, it could develop a business case for SSG in rural application and promote social inclusiveness in Indonesia by supporting economic, social and environmental development in the rural communities of the outer islands. Thus it provides a good case for speculating on how to implement Icelandic TT to Indonesia. This project will be referred to as the 'KAPS project' below.

Drawing on the theories presented in the literature review, the following chapters will define the nature of such a transfer and use that knowledge, along with empirical evidence, to suggest how to implement the

transfer and who should do it. However, before doing so, the paper will provide a short account of SSG utilization and introduce the KAPS. After discussing the nature of the transfer and its implementation, the paper will proceed to identify specific regions where the KAPS project should be implemented. This will be followed by an evaluation of the benefits that the project could have on the selected regions. The argumentation will be based on the grounds of sustainable development goals, namely economic, social, and environmental development (World Commission on Environment and Development, 1987).

## **6.1 Small Scale Geothermal**

SSG is defined here as projects of 5 MW or below. SSG units have traditionally been used within larger geothermal developments, e.g. they have been installed early in the process to provide energy for an ongoing construction of a bigger plant or to harness energy from a well that lies outside the economical zone of a steam transporting pipeline. Hence, they are usually part of a larger project (Vimmerstedt, 2002).

SSG projects for rural application face more financing challenges than larger projects because of fixed costs that are independent of project size, exploration costs, and capacity factor issues. Furthermore, project financing is difficult to obtain for small projects, but several methods exist to reduce the exploration cost: costs can be held down by systematically using and adding to pre existing knowledge of geothermal areas (e.g. existing exploratory wells and geological knowledge) and by carefully selecting project locations; by using less detailed testing and drilling and using exploratory wells for production; and by using small diameter (slim) holes for exploration and production (cheaper than conventional drilling). Mass producing and standardizing SSG plants would also greatly reduce the cost of each plant (Vimmerstedt, 2002).

The cost implication of the load profiles in the targeted service areas is another critical part of this market. Geothermal plants are most economic as base load energy providers and thus require a high capacity factor, but remote loads are notorious for their low base load requirements. In contrast, the cost penalty for a diesel system operating at lower capacity factor is relatively small if its primary expense is fuel (Vimmerstedt, 2002). But in almost the whole of Indonesia, demand exceeds production capacity substantially and thus there is a huge need for base load additions (MKI, 2010). Thus, the energy produced by SSG projects would most often be instantly absorbed by the market.

Advances in rural implementation in recent years, e.g. in USA and Mexico, have shown that SSG projects can be an attractive option in rural areas (Lacey, 2010). Furthermore, technological advancements made by the Icelandic/Norwegian firm Kaldara Green Energy (KGE) have made SSG more economical and easier to

implement. Thus, small plants can help to meet the energy requirements of isolated areas or communities which could be of great relevance for Indonesia.

SSG is not entirely new to Indonesia. In the 1990's, the partly World Bank funded EIREC project provided support for PLN's rural electrification program. Although the project was mostly aimed at promoting micro-hydro, it also included a 3 MW geothermal plant in Flores, East Nusa Tenggara. However, this project was cancelled after the Asian financial crisis in 1997-98 and to date the Flores project remains in a development status (Draeck, 2008; Ciptomulyono, 2010). Furthermore, PLN has done some SSG development in cooperation with the MEMR with one 2.5 MW plant already operating. However, further progress has been very slow due to financial constraints and different priorities. Furthermore, the technology used (from China) has not worked efficiently, and PLN have voiced their unhappiness about this (Ciptomulyono, 2010).

BPPT, a public agency under the MEMR responsible for R&D and technology assessment and application for the Indonesian market, has identified SSG as an attractive option to replace diesel power plants in rural Indonesia. BPPT has put forward recommendations to the government that they look more into this option and has conducted research on the applicability of SSG technology for rural Indonesia. The organization has already developed a 2 kW binary geothermal plant in cooperation with the German technological institution GFZ, but wants to build a 5 MW plant to demonstrate the viability of SSG for rural Indonesia (Surana, 2010). Whether these plans will be realized remains to be seen, as BPPT has often been severely underfunded (Ciptomulyono, 2010).

## **6.2 The KAPS**

Kaldara Green Energy (KGE) is an Icelandic/Norwegian SME and the innovator behind the KAPS. The company is a true born global, a firm that from its inception pursues a vision of becoming global and globalizes rapidly without any preceding long term domestic or internationalization period (Hollensen, 2007). The headquarters are in Reykjavík, Iceland where the core technical and R&D team is based. It is owned by a Norwegian holding company, Green Energy Group (GEG) while the manufacturing takes place at its partner (majority stake owned by GEG), Hindustan Turbomachinery, in Bangalore India (Kaldara Green Energy, 2008). When using the abbreviate 'KGE' below, the paper is referring to the whole of this company. The company's sole focus is on producing and selling the KAPS. As the Icelandic market is not big enough to satisfy economical production of the KAPS, the market for the product was from the beginning global.

The KAPS is a small, modular, transportable, and easily maintained geothermal electrical power generating unit. KAPS can be used for all types of Wet/Dry and Binary/Flash Geothermal Systems and come with 2.5 or

5 MW capacity. The KAPS concept is to place a miniature power house in standard sized shipping containers next to the production boreholes. KAPS units can operate stand-alone, but can also be built up, step by step, simply by adding another unit. Hence, KAPS units can operate together in interconnected power farms that can reach the same capacity as large geothermal power plants (Kaldara Green Energy, 2008; Green Energy Group, 2011).

The KAPS solution was developed based on the fact that traditional deployment of geothermal power plants take many years from project start until the power is online and require very high investments to complete. Furthermore, in the traditional large scale centralized approach, generation is concentrated on a single spot (powerhouse) with steel pipes carrying the steam from the production holes (which lie in the vicinity) to the powerhouse (Kaldara Green Energy, 2008). In recent years, it has become evident that this could lead to overloading of the geothermal reservoir if they cannot recharge fast enough. This leads to lower pressures in geothermal reservoirs, resulting in reduced power production capacity (Orkustofnun, 2010; Johannsson, 2010).

With the KAPS approach, boreholes can be harnessed at an earlier stage or within weeks after drilling is completed (see table I), as the units can be installed at the production site in a few weeks rather than years. This is very valuable as it will allow production, electricity sales, and revenue generation, to start earlier. Immediately after developers have steam data from their wells, calculations can show exactly how much MW a KAPS unit can produce with specific optimization for every well to maximize power output. Furthermore, the KAPS approach is decentralized as it is based on small plants that are placed next to the boreholes over a more extended area, thus avoiding overloading of a small area. This provides better resource management, giving longer lifetime to the whole project, while large powerhouse structures and on-surface steam pipes are avoided (Kaldara Green Energy, 2008; Johannsson, 2010).

KAPS units have been made economical through mass production and standardization in highly qualified manufacturing process. They can compete in price with larger size geothermal turbines/power plants but arguably with better risk management. This is due to the modular and small-step approach which allows boreholes to be harnessed at an earlier stage and thus generate faster revenues. This helps developers to increase their IRR significantly, while further financing (in case of expansion) becomes easier due to faster cash flow and less risk, as the resource has been proven. Furthermore, as the KAPS is container based, the entire solution is transferrable which allows for easy reallocation if some sort of well failure occurs. Lastly, the technology lowers barriers of entry into the realm of geothermal power production, until now restricted by the number of production boreholes necessary (around 10) to make sufficient energy for an

economical version of conventional geothermal power plants (>30 MW) (Kaldara Green Energy, 2008). The first KAPS unit started production in early 2011 as part of a larger project at the Olkaria field in Kenya

**Table I**

<b>Typical Total Geothermal Power Start up Procedure</b>										
Phase	1. Year	2. Year	3. Year	4. Year	5. Year	6. Year	7. Year	8. Year	9. Year	10+ Year
Geological Research										
Drilling										
Evaluation										
Construction										
Operation										
<b>KAPS Unit 5 MW</b>										
Phase	1. Year	2. Year	3. Year	4. Year	5. Year	6. Year	7. Year	8. Year	9. Year	10+ Year
Geological Research										
Drilling										
Construction										
Operation										

Source: (Johannsson, 2010)

To sum up, by providing cheaper standardized generation units, reducing risk, and allowing production to commence sooner, this innovative product has made SSG utilization more economical while arguably being more environmentally friendly and sustainable than traditional large scale geothermal utilization. Hence, this product could be relevant for Indonesia's outer regions. By adding KAPS units in a stepwise development, the generation capacity in these regions could be increased in line with future economic development and resulting demand growth.

## 6.3 Defining the Transfer

The technological feasibility of SSG technologies like the KAPS is proven, but their operational and economic feasibility for remote applications is less sure (Vimmerstedt, 2002). This is also true for the KAPS as it has not yet been implemented in a rural context. Hence, with regards to rural applications, innovation theories would suggest that a crucial part of the innovation process, the implementation, was still uncompleted (Schumpeter, 1939; Tidd, Bessant, & Pavitt, 2005).

This means that the transfer of the KAPS to rural Indonesia would involve both horizontal and vertical elements of TT. The technology would be transferred from one geographical location to another (horizontal), but the transfer would also involve a progression from the R&D stage to commercialization

and implementation as their economical and operational feasibility for remote application would be tested (vertical). Hence, the KAPS would undergo development towards rural commercialization within the new country context.

Thus, the transfer demands more than just simple export-import of a readymade technology. Rather, it calls for cooperation between Icelandic and Indonesian stakeholders to ensure a successful implementation in Indonesia and thereby demonstrate the commercial ability of the KAPS to compete in rural circumstances. Such cooperation could ensure active involvement of local stakeholders and thus contribute to technological capacity development on part of the receiver (Javorcik, 2006; Ockwell, Watson, Mackerron, Pal, & Yamin, 2008).

By allowing Indonesia to use the specialized expertise that resides in Iceland, the collaboration could reduce the need to expend Indonesian public sector funds on SSG development and thus help relieve some of the R&D expectations of the government. According to Williams (2001), developing countries are becoming attractive to technology owners for launching new technologies into the market. This is due to factors such as their large un-served internal markets, nascent infrastructure, abundant natural resources and lower wage rates. Hence, from an Icelandic perspective, not only could this project export Icelandic technology and knowhow by providing access to the huge market of Indonesia. This collaboration could also provide favourable conditions to prove the commercial ability of the KAPS in rural circumstances by combining national comparative advantages, e.g. the knowhow that resides in Iceland with the lower labour costs and market conditions in Indonesia.

## **6.4 Key Participants and Financiers**

As pointed out by Karakosta et.al. (2010), the TT process for sustainable energy technology involves a process of innovation into an existing energy system. Hence, the commercialisation of the technology involves its social acceptance and adoption. Thus, for a technology to be successfully implemented in a given market, that technology will need to gather support from its social and political environment. This is termed social capital by NSI theory (Lundvall, Johnson, Andersen, & Dalum, 2002), which highlights the role of institutions in determining responses to innovation and emphasizes the social processes involved in innovation diffusion.

So, in order to transfer the KAPS to Indonesia, the process needs support from key players and institutions within the Indonesian market. Hence, the project must be placed within a wider social and political environment to determine how it should be implemented. Socio-technical systems theories underline that

large technical systems co-evolve with associated social, cultural, and political institutions (Smith, Stirling, & Berkhout, 2005; Stephens & Jiusto, 2010). Despite political declarations of will, actions have not been enough to reform and replace the existing socio-technical regime which favours conventional energy sources. Hence, PLN continues to solve rural energy demands with inefficient small scale diesel supplemented by emission heavy coal generation. RE continues to be marginal, mostly confined to hydro and micro hydro projects (MKI, 2010).

As argued above, in the current environment, this problem will not be solved by IPP as they are more interested in developing larger scale projects, especially within the geothermal context as was explained above. This underlines that in order to successfully transfer the KAPS to rural Indonesia, getting key stakeholders on board, like PLN and national and regional authorities, will be vital.

However, to enjoy the benefits of the KAPS project, considerable up-front investment is required. This is always the case for geothermal projects and has long been a barrier to geothermal development (Dickson & Fanelli, 2004). As was argued above, due to the resource constraints of Icelandic companies and the risky nature of the Indonesian geothermal market, it is difficult for Icelandic firms to invest in geothermal operations in Indonesia. Coupled with the financial constraints of PLN as introduced in the analysis, this means that the KAPS project is likely to require assistance from government or development organizations/funds in order to be realized.

As the KAPS is a radical new energy technology and much of its benefits are public rather than private and thus not reflected in energy prices, the literature would argue for public support as private firms tend to invest in technological demonstration and R&D at less than the socially optimal amount (Williams, 2001; Ockwell, Watson, Mackerron, Pal, & Yamin, 2008). However, as will be argued here below, investing in the KAPS could also make economic sense for Indonesia. Furthermore, to get developing countries more engaged in such energy technological innovation, the literature suggests multilateral and bilateral assistance as these countries need risk-sharing partners in order to become effectively engaged in such long-term problem solving, due to their many pressing development needs (Williams, 2001). This is why EBED theories underline the importance of aligning economic development with energy policy (Carley, Lawrence, Brown, Nourafshan, & Benami, 2010).

Assistance from government and development organizations should be focused on exploration activities and could e.g. assist with a small number of demonstration projects in the hope that successful implementation might attract private investors. Thus in the future such assistance might not be needed.

Based on the above discussion, for the purpose of transferring the KAPS to rural Indonesia, this paper proposes a strategic alliance between KGE and relevant and Indonesian stakeholders, backed up by



assistance from governments and development organizations/funds. A strategic alliance can be defined as the sharing of capabilities between two or more firms with the view of enhancing their competitive advantages and/or creating new business without losing their respective strategic autonomy. What makes an alliance strategic is that the sharing of capabilities affects the long term competitiveness of the firms involved (Lasserre, 2007).

A similar micro hydro cooperation has already been jointly implemented with considerable success, by the German GTZ (technical cooperation institution), Indonesian national and local governments, NGOs and local entrepreneurs. These micro hydro projects are usually very small (<1 MW) and serve rural villages which did not have access to electricity before (International Energy Agency, 2008). The KAPS project could add to this by implementing renewable base load energy from local geothermal sources in rural Indonesia.

Below are the key players that should be involved in transferring the KAPS to rural Indonesia.

#### **6.4.1 Kaldara Green Energy**

Tidd et.al. (2005) argue that within the innovation process, companies need to develop a clear and strategic plan on how to execute the implementation of the invention into the market. From a KGE perspective, the suggested cooperation could serve this purpose. Selling KAPS units to Indonesia is obviously interesting for them but furthermore, getting the chance to prove the commercial ability of the KAPS for rural application could be beneficial for the company, as it could create a new business case for the KAPS, in addition to the traditional one, 'as a part of a larger project.'

Doing this through cooperation would allow KGE to share the risk involved with other participants. In fact, born globals often govern their sales and marketing activities through networks in which they seek partners that can complement their own competences, a necessity caused by their limited resources as most born globals are SMEs. They are also vulnerable as they depend on a single product (niche market) that they have to commercialize in lead markets no matter where such markets are situated geographically. Hence, their pathways are based on different types of cooperation and partnerships to facilitate rapid growth and internationalization (Hollensen, 2007). The company could assist with debt financing but it does not aim to get involved in the operation of geothermal projects. However, it provides training to its customers in all the operational and maintenance elements of the technology. It assists with designs for civil works, project management, and consults with clients throughout the process (Kaldara Green Energy, 2008). They could therefore promote technological capacity in Indonesia through the project.

### **6.4.2 PLN and PLN Geothermal**

PLN is the operator of diesel power plants in the selected regions (introduced below). By investing in the KAPS, PLN could switch out many of its diesel generators on the outer islands with geothermal energy. This could further help them improve their services to these rural areas by increasing electrification rates and improving reliability of electricity infrastructure, both are high on the mandate for the company (Asian Development Bank et.al., 2010). PLN has experience with the Indonesian geothermal context and has already showed interest in SSG, but has not been successful in developing it on a larger scale due its constrained financial conditions and prioritisation of large energy projects (Ciptomulyono, 2010). As the KAPS has made SSG utilization more economical and less risky, a strategic alliance with KGE in implementing the KAPS project could be of interest to them, especially if the project was to obtain financial assistance from e.g. government or development banks to help demonstrate its viability. This was confirmed in an interview the author took with Udibowo Ciptomulyono (2010), the President Commissioner of PLN Geothermal.

As any geothermal development would always have to negotiate with PLN as the sole buyer of electricity, having them on board from the start would make this otherwise difficult process faster and easier (Ciptomulyono, 2010; Ibrahim, 2010 A; Winarno, 2011). Furthermore, PLN has recently formed a subsidiary called PT PLN Geothermal which is meant to deal with the geothermal activities on behalf of the mother firm. PLN Geothermal already holds several WKPs, some within the selected areas (introduced below), and the company's strong government ties put them in a good position to access other WKPs. They also own slim hole drilling technology which can be used to reduce exploration cost for SSG (Ciptomulyono, 2010).

### **6.4.3 BPPT and Local Stakeholders**

BPPT is a public agency (under the MEMR) responsible for R&D and technology assessment and application for the Indonesian market. This organization has already conducted some research on SSG and identified it as an attractive option to replace the many diesel power plants in rural Indonesia (BPPT, 2009). Recognizing the lack of development in this area, BPPT in cooperation with local manufacturers has ambitions to build a 5MW flash plant to demonstrate the viability of SSG projects in rural Indonesia (Surana, 2010). However, BPPT does not have SSG experience (Surana, 2010) and is often severely underfunded (Ciptomulyono, 2010). Thus, it could be interesting for BPPT to cooperate with KGE which has more experience and a proven SSG technology. In an interview with Taufan Surana (2010), Program Director for Geothermal Energy Technology at BPPT, he indicated keen interest for such cooperation and recognized the need to implement SSG at numerous locations throughout Indonesia.

In such collaboration, BPPT could provide valuable information on the local context and use their connection to local industry to ensure their participation in the implementation of the KAPS project e.g. through civil works and certain implementation and spare parts. This could promote technological capacity for Indonesian participants and thus play an important role in ensuring the long-term operational viability of the KAPS in Indonesia. If this was successfully implemented it could lead to increased manufacturing in Indonesia e.g. through a licensing agreement.

#### **6.4.4 Indonesian Authorities**

TT literature suggests that national authorities should strive to develop NSIs, which create an enabling environment for sustainable TTs and promote engagement with international collaborative R&D initiatives. This is especially true for developing countries like Indonesia where a lack of technological capacity hinders progress (Karakosta, Doukas, & Psarr, 2010). Supporting collaborative projects like the KAPS project is one way of doing this.

The general scarcity of public sector resources dictates that public sector investments in innovative activities be prioritized, giving priority to technologies that offer major external social benefits, e.g. environmental, social, or energy security benefits that are not adequately valued in energy prices (Williams, 2001). The KAPS project could fit into this prioritization as argued below.

Since the government has been reluctant to allow PLN to offer higher prices for geothermal energy (Castlerock Consulting, 2010), Ockwell et.al. (2008) would suggest to share the funding of demonstration projects as another approach to support the industry. Thus, if plans of the GOI to create a fund that supports geothermal exploration are realized, the KAPS project could be a possible beneficiary as it involves elements of a technological demonstration, the operational viability of SSG in rural circumstances, and such pre commercial technologies are likely to require more effort to encourage market development than technologies that are already in widespread commercial use (Ockwell, Watson, Mackerron, Pal, & Yamin, 2008). Furthermore, SSG projects would arguably benefit the most from such assistance as they face more financial difficulties than larger projects (Vimmerstedt, 2002). Another possibility for GOI assistance lies in a new policy from the MEMR which argues that the government should pay for one exploration well at every WKP that is being worked on by the formal authorities (Surana, 2010). If this would materialize, these wells could possibly be used for SSG production, or at least reduce the exploration cost of such projects (Vimmerstedt, 2002). This could obviously aid the KAPS project.

With the decentralization process, local authorities have gained more influence on energy development in Indonesia (International Energy Agency, 2008). Those authorities could aid the implementation of the KAPS by e.g. allowing the use of public infrastructure. Indeed, experience shows that local governments are keen to attract energy investments of all kinds (Winarno, 2011).

#### **6.4.5 Icelandic Authorities**

The Icelandic government and its organizations should actively assist the geothermal industry in selling technologies and knowhow abroad (Hilmarrsson, 2010). Obviously, Icelandic authorities are mostly concerned with Icelandic energy security and development. Hence, any direct financial assistance to geothermal development in Indonesia would not represent good usage of taxpayer money unless it secured export earnings and business opportunities for Icelandic companies.

Porter (2010) argues that Iceland needs to find new ways to sell their technology and knowhow abroad. Supporting a project like the one suggested here through development assistance could be one option to achieve this. Official development assistance is an important mechanism for TT and it can clearly play a role in facilitating geothermal development in the developing world. It can also work to promote export of technology and knowhow, either directly through tied aid, or indirectly through networking and relationship building (Vimmerstedt, 2002).

Sustainable development is one of the pillars of Iceland's development cooperation which emphasizes the sustainable use of natural resources, particularly with regards to energy. The Icelandic International Development Agency (ICEIDA) is increasing its focus on geothermal energy by assisting countries that have untapped geothermal resources to develop their resources. ICEIDA, in cooperation with Icelandic geothermal organizations, has assisted with preparation of geothermal projects through explorative activities, technical assistance, capacity building, and regulatory revising in developing countries (Orkustofnun, 2010).

As indicated above, a large part of geothermal areas in Indonesia are still in the stage of preliminary survey. This is especially true for the outer islands (CCOP Indonesian Delgation, 2010). Hence, there is an urgent need to improve the knowledge on these resources by raising the level of surveys performed at these locations. ICEIDA and its partners could aid the KAPS project by systematically using and adding to pre existing knowledge of carefully selected geothermal fields. This can reduce exploration costs for SSG projects (Vimmerstedt, 2002). Furthermore, ICEIDA could simultaneously provide training and capacity

building for local stakeholders to ensure the long term operational effectiveness of the project through local capture of technological capacity.

Due to KGE's Norwegian arm, the company could possibly also draw upon Norwegian sources to assist in financing the project e.g. the *Norwegian Guarantee Institute for Export Credits*.

#### **6.4.6 International Finance Institutions and Development Organizations**

Obtaining intelligent financing, soft loans, risk sharing mechanisms or grants, would obviously be positive for the KAPS project in demonstrating its viability. This section will name a few such opportunities, but will not provide an exhaustive account due to limited space.

The World Bank, the Asian Development Bank, and the IFC have already put forward financing for public sector large scale geothermal development in Indonesia under the Clean Technology Fund (2010). In the argumentation for this financing, the participants hope this can have a demonstration effect by promoting some successful large scale geothermal projects in Indonesia and thus attract more private sector participation to the sector. Assistance to the KAPS project could be awarded on the same grounds; 'for the promotion of SSG'.

Mechanisms under the UNFCCC, the Global Environment Facility (GEF) and the Clean Development Mechanism (CDM) could also aid the KAPS transfer. The GEF is the financial mechanism of the UNFCCC and is a key multilateral institution for sustainable energy TT. The GEF provides grants to developing countries and countries with economies in transition for projects that benefit the global environment, linking local, national, and global environmental challenges and promoting sustainable livelihoods (Global Environment Facility). It could thus assist the Indonesian government and PLN in financing the KAPS project. The CDM mechanism under the Kyoto Protocol is also considered an important mechanism for technology transfer to developing countries. The CDM allows emission-reduction projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO<sub>2</sub>. These CERs can be traded and sold and used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol (UNFCCC, B). It has been suggested that carbon credits can provide a significant contribution to geothermal funding in Indonesia (Castlerock Consulting, 2010). To date, two Indonesian geothermal projects have used the CDM mechanism to help finance development and the contribution is around USD 1 cent per kWh (Surana, 2010; Hindarto, 2011). The CDM might help finance the KAPS project but its contribution is uncertain, due to uncertainty of carbon prices and considering the small size of the KAPS plants (Hindarto, 2011; Surana, 2010). Importantly, there is a possibility that the KAPS projects would not

have to undergo additionality tests, as specified in EB meeting no. 54 regarding RE energy that is = or < 5 MW (Hindarto, 2011).

Several Development funds exist that could be of interest for the proposed project. To name an example, The Nordic Development Fund's (NDF) objective is to facilitate climate change investments in low-income countries. NDF grants provide co-financing of projects and are made in cooperation with relevant governments, bilateral and multilateral development institutions, and Nordic firms, organizations and networks (Nordic Development Fund). The KAPS project might qualify for the fund's support. Indeed, NDF has shown interest in the Icelandic geothermal sector and recently sent a delegation to Iceland to get acquainted with Iceland's geothermal experience and learn about ICEIDA's activity within this sector (ÍSOR Iceland GeoSurvey, 2010).

The Indonesian Climate Change Trust Fund could also be interesting for the KAPS project. The ICCTF is part of the government's commitment to enhance national ownership and improve aid coordination in response to climate change. The primary objective is to support investment into energy and forestry with the aim of overcoming barriers to early deployment and market penetration (Indonesia Climate Change Trust Fund). As the KAPS project represents a vertical transfer, a demonstration of the viability of SSG in rural conditions, this might qualify it for support. Other funds that could be of interest for the KAPS project include e.g. the Global Energy Efficiency and Renewable Energy Fund (GEEREF) which focuses on investments in smaller energy projects and aims to accelerate the transfer, development, and use of environmentally sound technologies for the world's poorer regions, and the Indonesian Green Investment Fund which aims to support development that speeds up economic growth while helping to cut emissions.

To sum up, a strategic alliance has been suggested where KGE would provide the technology and related knowhow, PLN would be the buyer and the operator as they have the need and the market, while BPPT would provide valuable knowledge on the geothermal context in the outer regions while assuring that local technological capacity would be strengthened. The thesis has further more suggested assistance from the GOI, ICEIDA, and international donor organizations to implement demonstration projects. Such assistance would address the considerable upfront investment and risk that is needed in order to enjoy the benefits of the KAPS project. The paper will proceed to speculate on these benefits below:

## 6.5 Benefits of Implementing the KAPS in Rural Indonesia

Having proposed how this transfer could be implemented, and who should participate, the next step is to answer why it should be implemented. This will be done by selecting specific regions for the implementation and evaluate the impact that the KAPS could have in these places. This work is partially based on unpublished research by BPPT which the author, with assistance from Taufan Surana (2010), has further developed and applied to the purpose of this paper.

Currently, many of Indonesia's outer islands run on extremely inefficient and unreliable diesel generators which are a great burden to their operator (PLN), the Indonesian economy, and for economic development in these islands. Thus, the government has put a priority on replacing diesel fuel generation (Clean Technology Fund, 2010). As many of these areas have geothermal resources, their development represents an opportunity to help improve electricity infrastructure while simultaneously decreasing the dependency on fossil fuels and thus reducing emissions. However, due to low energy demand, large scale geothermal projects will not be appropriate in most of these places. But KAPS would provide an efficient solution, as the isolation and remoteness coupled with the mountainous geography suggest that this market will be best served with decentralized small scale generation (International Energy Agency, 2008).

Electrification approaches divide rural electricity into three distinct markets: individual home systems, national grids, and mini grids. Although technically feasible, the extremely small demand of the first market means it is not economically viable for SSG. However, in the other two markets, SSG can be an interesting option. Within national grids, SSG projects in remote locations could have value associated with generation that is distributed throughout the grid closer to loads. This value arises because distributed generation may improve reliability and power quality where national grids have capacity, reliability, and line loss problems (Vimmerstedt, 2002). This is exactly the case in most of Indonesia (Asian Development Bank et.al., 2010). Hence, in remote regions of the national grid, the KAPS could make sense.

However, establishing, extending, or improving micro or mini grid is argued to be the most likely market niche for SSG projects in rural circumstances (Vimmerstedt, 2002; Dickson & Fanelli, 2004). Here SSG plants would compete with diesel, micro hydro, wind, and biomass. This could represent a great opportunity for transferring KAPS to Indonesia as it could supplement or displace the inefficient and unreliable diesel generation in the many mini grids of the outer islands.

BPPT, in cooperation with the Ministry of Research, has looked closer into the suitability of SSG for the islands in eastern Indonesia with the aim of substituting diesel plants. This research focused on four regions: West Nusa Tenggara, East Nusa Tenggara, Maluku, and North Maluku. The geothermal potential in

these regions is huge, but currently almost all electricity is based on small scale diesel generators (<5MW) which have low capacity factors as many of them are old and have not received adequate maintenance (BPPT, 2009; Surana, 2010). There is no RE generation in these regions other than a very limited micro hydro production. However, energy demand is considerably higher than generation capacity and so there is a great need for additional base load energy (MKI, 2010). Although KAPS could be relevant at many other locations in the country, this paper will use these four regions as a basis to argue for the benefits of transferring and implementing the KAPS to rural Indonesia. These areas will be referred to below as the “selected regions”<sup>5</sup> and the benefits are presented below:

### **6.5.1 Economic Arguments**

To determine the potential of switching out diesel generation with SSG plants, data is required on the relative cost of diesel and geothermal generation for specific locations. When talking about price of geothermal, it must be noted that the real cost can only be determined after sufficient information exists on the nature of the resource and exploitation wells (Dickson & Fanelli, 2004). Although some preliminary surveys have been conducted in the selected regions, these are not thorough enough to determine the exact price of production and thus the prevailing discussion is based on assumptions and best guesses. However, these are developed by experienced geothermal experts and thus provide a good basis for comparison to the known cost of diesel generation.

The average operating cost of diesel generators in the selected regions is above USD 25 cents per kWh. This extremely high cost is due to the small size of these generators, bad maintenance, high oil prices, and difficulty in transporting the fuel to these places (Surana, 2010; Ibrahim, 2010 A; Ciptomulyono, 2010). A detailed study on 50 WKPs by Castlerock Consulting (2010), estimated the cost of electricity production at each WKP on a probabilistic basis. The study underlined that location and size are big factors for price estimations in Indonesia. The bigger projects (in MW) are cheaper than the smaller per kWh while development in the outer islands is generally more expensive than in the Java-Bali region. The study was very thorough and took consideration to information on each field’s location, field characteristics, power production potential, the transmission system, the distance between existing transmission systems and the geothermal field, and relevant market demand (calculations assume that generation capacity is constrained by the demand for base load power). The research did however show some positive results for SSG in

---

<sup>5</sup> For more information on these regions see appendix II



remote locations. Provided cost estimates for SSG projects on WKPs that lie within the selected regions of this study ranged from USD 10-15 cents/kWh.

The study also compared geothermal costs to coal-fired generation, a cheap energy form with much lower uncertainty. The findings showed that the assessed geothermal prospects were generally competitive with coal-fired generation when environmental externalities were taken into account. Excluding externalities geothermal power is, however, expected to be more costly (Castlerock Consulting, 2010). However, for the most part, Indonesia's coal resources are located in Sumatra and Kalimantan (International Energy Agency, 2008). The problem of transport thus inflates the price of coal generation in the selected regions. The study provides cost estimates from USD 11-14 cents/kWh (excluding externalities), and USD 14-17 cents/kWh (including externalities), suggesting that the incremental cost of geothermal caused by remoteness may often be smaller than the incremental cost of transporting fuel to these locations. Thus, the study concludes that the prevailing price cap of USD 9.7 cents/kWh precludes some economically justified geothermal development when compared to conventional generation alternatives. Some WKPs within the selected regions are named as an example of this (Castlerock Consulting, 2010).

Research by BPPT indicates that numerous SSG projects could be economically implemented in rural Indonesia with price estimates ranging from USD 12-17 cents/kWh. The study concluded that if there was a diesel plant within a 20 km radius of the geothermal field, it could be economical to replace it with a SSG plant. On these grounds, the study identified more than 200 diesel generators that could be replaced by adding SSG to existing grids (Surana, 2010). As can be seen in table II this amounts to nearly 200 MW of diesel generated energy that could be economically switched out by approximately 21-38 SSG units of 10 and 5 MW respectively in the selected regions.

Thus, if implemented, not only would this save PLN huge amounts of money in terms of lower operating costs, it would also save nearly 160 thousand kiloliters of diesel annually which is the equivalent of almost USD 109 million. This would be beneficial for the Indonesian economy because of the growing burden of electricity and fuel subsidies on government funds, and in light of the fact that Indonesia became a net oil importer early in the 21<sup>st</sup> century (World Energy Council, 2010). Furthermore, based on Icelandic experience (average exploration costs, drilling costs, interest rates, electricity prices etc) KGE evaluates a payback period of 6 years for a 5 MW KAPS project with an IRR of 20% (Kaldara Green Energy, 2008). As every geothermal project is unique, this cannot be generalized to other projects. Unfortunately, average costs for Indonesia are hard to find, symbolic for the general lack of clarity in the geothermal sector. However, the Icelandic example provides a picture of how SSG can be implemented.

Table II

Replacing Diesel Generators with SSG in the Selected Regions							
No.	Province	Capacity of diesel that can be substituted by SSG (MW)	Diesel fuel consumption (KL/year)	Savings (IDR Billion)	Savings (USD Million )	No. Of SSG (unit)	CO <sub>2</sub> savings from substituted diesel (Tons/year)
1	West Nusa Tenggara	36	39926	259,52	27,32	7 x 5 MW, or 4 x 10 MW	106,51
2	East Nusa Tenggara	38	27702	180,07	18,95	7 x 5 MW, or 4 x 10 MW	73,90
3	Maluku	75	57634	374,62	39,43	15 x 5 MW, or 8 x 10 MW	153,75
4	North Maluku	45	33958	220,73	23,23	9 x 5 MW, or 5 x 10 MW	90,59
<b>Total</b>		194	159220	1034,94	108,93	38 X 5 MW, or 21 x 10 MW	424,75

Source: The table is produced by the author, based on data from BPPT and with assistance from Taufan Surana (2010)

Switching out diesel with SSG would increase energy price stability as geothermal prices are not subject to volatile world market prices like oil. By developing its geothermal resources, Indonesia would diversify its base load generation and reduce dependence on fossil fuels and the specific risks associated with the use of coal, such as energy price spikes and supply chain disruptions. Hence, geothermal utilization would strengthen energy security (Castlerock Consulting, 2010).

Utilizing techniques to reduce the exploration cost (as argued above) could help make the KAPS project more economical. This could be done by e.g. utilizing the knowhow of ICEIDA to systematically use and add to pre existing knowledge of carefully selected geothermal fields, by using existing exploratory wells drilled by the formal authorities, and by using PLN's slim hole technology for exploration and production.

### 6.5.2 Social Arguments

As introduced above, the Indonesian electricity sector is characterized by a low electrification rate (60%), low consumption, and high inefficiency in transmission and distribution. This means that there are more than 90 million people without access to electricity in the country. Furthermore, numerous others live with

extremely unreliable generation where system overloads and lack of maintenance means that blackouts are an everyday occurrence. 'Bottom of the Pyramid' theories would underline the huge un-served and untapped market that this represents (Prahalad, 2005).

A report by the Asian Development Bank (2010) identified inadequate and poor quality of electricity infrastructure as one of the main hurdles to economic development in Indonesia. Infrastructure plays a key role in promoting economic and social inclusiveness as numerous studies have illustrated the importance of infrastructure for poverty reduction, income growth, and access to economic activities (Gibson, 2009; Gibson & Olivia, 2008; Yamauchi, Muto, Chowdhury, & Dewina, 2009; The World Bank, 2006).

The conditions are worst in the outer islands where electrification is as low as 21% in East Nusa Tenggara (one of the selected regions) and the existing diesel generation is very unreliable. The low reliability of the electricity infrastructure has forced industries to pursue self generation (Asian Development Bank et.al., 2010). But self-generation of electricity is not easy, especially for SMEs. Hence, these conditions undermine industry and thus economic development. An example can be found at Sirnasari, a village which lies close to a huge untapped geothermal field. The bread and butter of this community is garment production and other cottage industries. But frequent blackouts due to infrastructure problems result in production delays that affect the profit margins of these small entrepreneurs (Veda, 2010).

Ironically, these are arguably the areas where improvements are most needed, but where the least progress has been made as GOI has failed to mobilize the investment required. But there exists will to change this. Both the government and PLN have set out ambitious electrification targets of 93% and 100% respectively by 2020 while aiming to improve electricity reliability and efficiency (International Energy Agency, 2008). Furthermore, the government is committed to achieving higher economic growth that reduces poverty, is socially inclusive, and is environmentally sustainable. Energy Based Economic Development theories (EBED) suggest that this represents two sides of the same coin (Carley, Lawrence, Brown, Nourafshan, & Benami, Energy-based economic development, 2010). The KAPS project could be an example of this.

Geothermal energy is highly reliable base load energy (Dickson & Fanelli, 2004). Supplying this energy to rural areas through the KAPS could therefore provide a better environment for industrial growth and economic development. Importantly, these processes would be mutually reinforcing. Geothermal energy would not only provide a better environment for industry, but any growth in industry would also provide a better environment for geothermal energy. This is because geothermal plants are most economic as base load energy providers and thus require a high capacity factor (Vimmerstedt, 2002). Industry growth would increase base load energy demand and thus improve conditions for geothermal utilization.

Furthermore, the implementation process could create valuable jobs in these regions as construction and civil work could be done by local companies, while manufacturing of some spare parts and implementing parts could also be outsourced to local firms. Eventually, if the KAPS implementation would be successful, this might lead to further manufacturing taking place in Indonesia, possibly through licensing agreements.

The KAPS project would also necessarily have to include local training and capacity building in the operation and maintenance of the technology as the plants would be run by PLN and regional authorities. This paper has suggested supplementing this with more thorough capacity building on geothermal development conducted by ICEIDA. This would promote technological capacity within the local workforce which is important as the Asian Development Bank (2010) has identified weak human capacity as a critical constraint to investment in Indonesian infrastructure, especially in the outer regions. The temporary entry of Icelandic experts through KGE and ICEIDA would also be important as there is a limited availability of qualified personnel and organizations necessary to carry out exploration, feasibility studies, and exploitation activities (Respati, 2010).

To sum up, transferring and implementing the KAPS to the outer islands of Indonesia would not only supply affordable, sustainable, and environmentally friendly energy to these rural communities. It would also provide a basis to achieve economic development in underdeveloped areas, as improved electricity infrastructure can trigger economic activity, income generation for individuals, and prosperity for the entire community (Sharma, 2007). Supplementing this with capacity development, the KAPS could raise the standard of living in the selected regions.

### **6.5.3 Environmental Arguments**

In the past, economic growth and poverty reduction have often been carried out in environmentally unsustainable ways in Indonesia. This has resulted in degradation of the environment and natural capital as the impacts of climate change have become increasingly obvious and severe (Asian Development Bank et.al., 2010). Social and environmental issues are not yet specifically addressed as an integral part of electricity reform and regulatory processes in Indonesia, so national planning in the electricity sector does not include detailed environmental considerations (Pelangi et.al., 2009). This is evident as PLN continues to meet electricity demands with constructions of small scale diesel plants in rural Indonesia. If this is to be changed, current and future energy demand of the outer islands cannot continue to be met with diesel energy nor replaced with other emission heavy fuels like coal. Rather, environmental considerations need to be incorporated into the development processes in order not to jeopardize its long-term sustainability. The diffusion of low carbon technologies is a key factor to achieve this (Pan, 2005).

By substituting diesel with environmentally friendly geothermal energy, considerable emission reductions could be achieved. Considering the selected regions, if the suggested switch out of diesel was implemented, nearly 160 thousand kiloliters of diesel would be saved annually. This would save around 424.75 tons of CO<sub>2</sub> per year (calculated with guidelines from the IPCC). Although these numbers may not be high compared to the potential of large scale RE projects, any GHG reduction is good. Furthermore, with future economic development, the growth potential of the KAPS and the enormous geothermal potential within these regions would allow for continued environmentally friendly generation to satisfy growing energy demand. Implementing the KAPS in rural Indonesia could therefore help Indonesia meet its ambitious GHG reduction goals (26%-41% by 2020). Furthermore, as the diesel generators are often situated within small towns and communities, switching them out for geothermal might improve local air quality.

Because of its small size, the KAPS can also be more easily adopted to the environment than large power plant structures, as the containers could be hidden into hillside areas or placed underground to avoid offensive structures in the environment. Also, as the KAPS is placed next to the boreholes, large powerhouse structures and on-surface steam pipes are avoided (Kaldara Green Energy, 2008; Johannsson, 2010). This makes the KAPS solution an ideal entry to harness delicate areas for geothermal electrical power production. This is important for Indonesia as nearly all geothermal projects need to consider forestry and land issues (Castlerock Consulting, 2010).

## **6.6 Summary of the KAPS Project and Recommendations**

In geographically challenged countries such as Indonesia, infrastructure plays a key role in promoting inclusiveness. While the infrastructure at the regional level may not be attractive to private sector investment, there is good potential for the private sector to lead development in national level infrastructure. To unleash this potential, the government will need to adopt a proactive approach towards expanding the use of public-private partnerships. (Asian Development Bank et.al., 2010). The KAPS project could be an example for this.

By providing cheaper standardized generation units, reducing risk, and allowing production to commence sooner, the KAPS has made SSG utilization more economical while arguably being more environmentally friendly and sustainable than traditional large scale geothermal utilization. This product could therefore be very relevant for rural Indonesia where its implementation could lead to considerable economic, social, and environmental benefits which would also be felt on a national scale. Thus, this paper proposes a case of

Icelandic TT of the KAPS to rural Indonesia through a strategic alliance, where the participants would share their different capabilities with the view of enhancing their respective competitiveness.

When forming an alliance, participants must be sure that the goal of the alliance is compatible with their existing business, so their expertise is transferable to the alliance (Hollensen, 2007). The goal of the KAPS project would be to implement SSG in rural Indonesia because of the economical, social, and environmental benefits that it could provide, while simultaneously prove the operational and economical viability of the KAPS for rural circumstances. KGE is the owner of the technology and naturally wishes to prove its viability and sell it throughout the world. But they are not interested in getting involved in operating such plants, especially in a high risk market like Indonesia. PLN could benefit enormously by acquiring a technology like the KAPS and use it to help switch out its diesel generators in rural Indonesia. BPPT wishes to demonstrate the viability of SSG for rural Indonesia. They have performed valuable research on its applicability for the outer islands and have connections to local manufacturers who could aid and benefit from the project. But due to their limited financial resources and SSG experience, they are interested in cooperating with partners who could supplement them. Neither PLN nor BPPT are interested in getting involved in manufacturing of SSG units (Ciptomulyono, 2010; Surana, 2010).

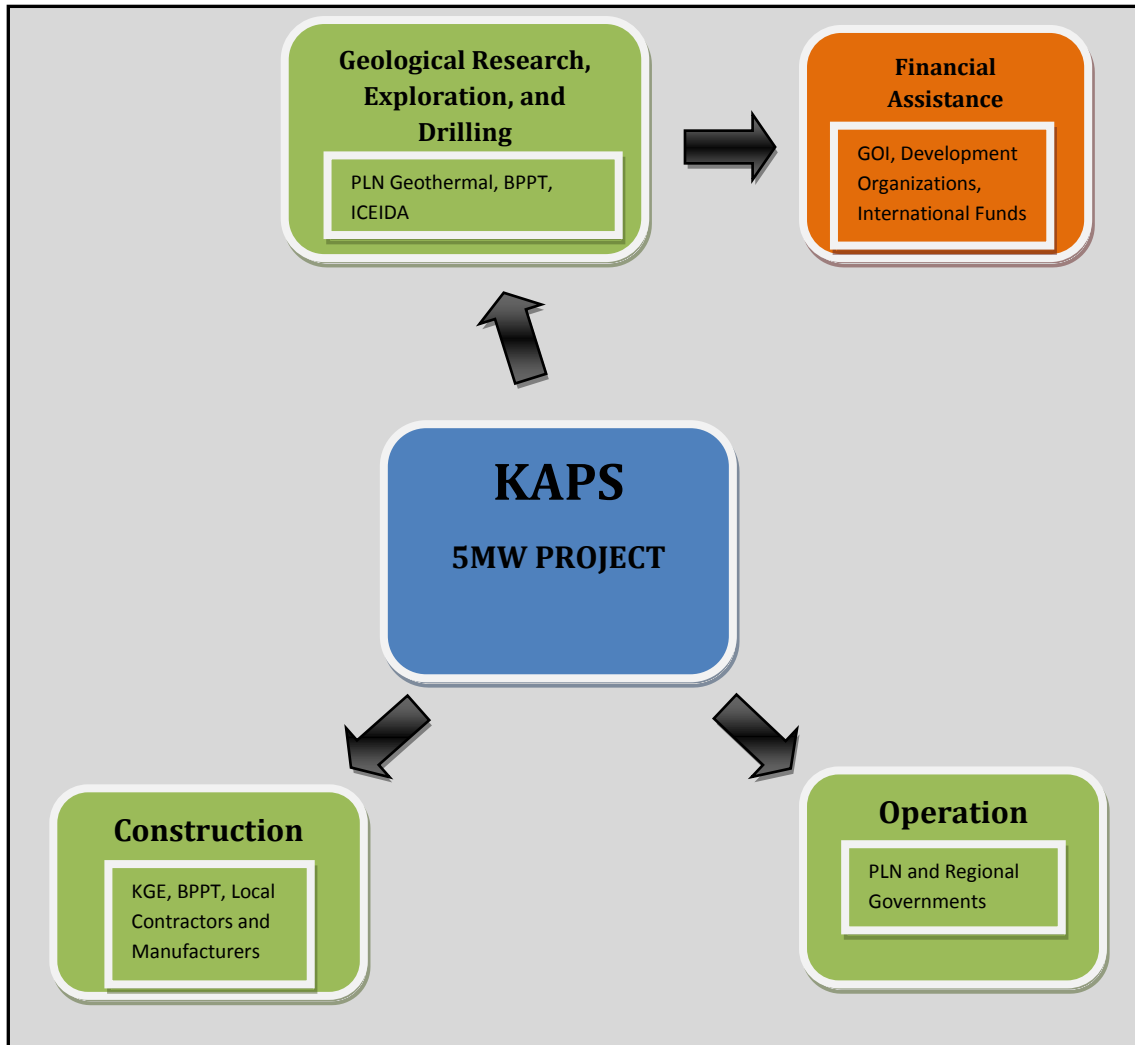
Hence, these partners have a mutual interest in the KAPS project, but this interest is based on different aspects and they would play different roles in the collaboration. This is what the literature calls X coalition, where partners have different but complementary competences within the value chain (e.g. where one is strong the other is weak) and thus divide value chain activities between themselves (Hollensen, 2007). KGE has the technology and wants to sell it (technology provider), PLN has the need for it and controls the market (operator), while BPPT wants to promote SSG for rural Indonesia and knows the local context (technical assistance). In this way, the KAPS project would combine national comparative advantages.

Developing an exact business plan or negotiating the agreement and management of the alliance is beyond the scope of this paper. Rather, the aim was to demonstrate and argue for the benefits of this cooperation. It would provide better returns on R&D investment for all involved through the sharing among participants of financial outlay, workload, risks and results. It would allow KGE to earn export revenues while simultaneously creating a business case for the KAPS in rural circumstances. It would save Indonesian public sector funds on SSG R&D and energy subsidies.

Through TTs, developing countries hope not only to import more efficient foreign technologies but also to improve the productivity of local firms through e.g. information sharing, access to skilled labour, job creation, improved infrastructure, and vertical linkages between foreign and local firms (Saggi, 2006). As has been argued, the KAPS project would not only provide cheaper, more environmentally friendly, and

more reliable energy to rural Indonesia, it would also provide a better environment for industry, create local jobs, and improve local technological capacity etc. Thus, the KAPS project adheres to the agenda of EBED (Carley, Lawrence, Brown, Nourafshan, & Benami, 2010) as it integrates energy policy and economic development by contributing to energy security and diversification in ways that contribute to job creation and regional wealth creation.

**Figure II**



Thus, although conventional wisdom provides cautions against technologies undergoing commercialization within developing countries as they cannot afford to take the many risks associated with technological innovation (Williams, 2001), this paper argues that the economic, social, and environmental benefits, coupled with the lowered risk obtained through Icelandic cooperation, should encourage the GOI to assist the KAPS project. Icelandic development assistance (ICEIDA) could also be used to help implement the project as it would earn export revenues, generate jobs, and create business relationships between Iceland and Indonesia. Finally, to help finance demonstration projects of the KAPS (and thus SSG) in rural Indonesia,

this paper argues for support from international development organizations and funds. The project merits such support due to its nature as a vertical transfer of an important low carbon technology to a developing country and the extensive economic, social, and environmental benefits that could result from its implementation. Such assistance should address the considerable upfront investment and risk (exploration and drilling) that is needed in order to enjoy the benefits of the KAPS project. Figure II provides a graphic explanation of the cooperation and its participants.

If successfully implemented, the KAPS project could create a business case for SSG in rural Indonesia and thus help to attract more private sector participation in SSG development. These are priority concerns according to many experts (Darma, 2010 B; Kadiman, 2010).



## 7. Conclusion

Indonesia is one of the world's fastest growing economies and its energy demands are growing rapidly. Although the country has great potential in renewable energy, most notably geothermal, these resources remain largely unexploited and the country remains largely dependent on fossil fuel energy. However, the predicted growth in energy demand along with increasing environmental awareness and depleting oil reserves are forcing the Indonesian government to focus on developing the country's enormous geothermal potential (International Energy Agency, 2008). This would help to diversify the energy mix, increase energy security and optimize export value of transferable energy commodities such as coal, oil and gas.

But in order to develop this potential, Indonesia has to overcome the current lack of knowhow, finance, and technological resources. Thus the GOI has concluded that high priority should be given to attracting geothermal TTs (Indonesian Ministry of Environment et.al., 2010).

Iceland has for many years been at the forefront of geothermal development and the Icelandic geothermal sector is considered a world leader. After finding itself in acute economic crisis, Iceland is directing its attention towards the use of its natural resources to help strengthen its economy. In this respect, Professor Michael Porter recommended that Icelanders find ways to obtain more value for geothermal energy and sell their expertise and technology abroad, instead of just selling the energy itself by attracting energy intensive industries to Iceland (mbl.is, 2010 A).

Thus, the Icelandic and Indonesian contexts imply a possibility for cooperation between the nations to the benefit of both. While Iceland needs to find ways to sell its technology and knowhow abroad, Indonesia needs to attract such capacities in order to develop its geothermal potential. In fact, delegations from the nations declared their interest in cooperation after meetings at the 2010 geothermal congress in Bali (mbl.is, 2010 B). Hence this paper asked: 'how can the Icelandic geothermal sector assist and simultaneously benefit from the geothermal development in Indonesia'.

In order to answer this, the paper has identified numerous institutional barriers to geothermal development in Indonesia. The Indonesian geothermal regulatory framework is not well defined as a lack of coordination between different authorities' results in contradicting regulations and interpretations which leads to difficulties in their implementation. The difficulties of the tendering process have been raised as an example of this as its lack of clarity hampers progress. Furthermore, externalities remain excluded from Indonesian energy prices while social tariff setting and energy subsidies, coupled with the inappropriate

“one size fits all” price cap on geothermal, create an unfavourable investment climate for geothermal development. The lack of Incentives and a risk sharing mechanism makes these barriers hard to overcome.

Hence, the Indonesian geothermal sector is full of paradoxes. On the surface, political will for geothermal development appears to be abundant, manifested in ambitious goals and numerous regulations. But when looking deeper, it becomes apparent that Indonesian authorities have failed to implement the most critical changes (e.g. tariffs) that will allow the country to achieve its goals. The Indonesian energy sector suffers from inertia and lock-in effects as it re-invest in established competences, making it difficult for RE like geothermal to enter the system. Thus, PLN continues to solve rural electricity needs with costly and unreliable small scale diesel (MKI, 2010), while long range projections from the MEMR predict rapidly growing dependence on coal for electricity production (Castlerock Consulting, 2010).

The various barriers combine to damage Indonesian investment climate and hinder the sense of long-term certainty which is essential for attracting investment. The result is that Indonesia has not attracted nearly enough investment in geothermal development nor other renewable energy forms as firms are reluctant to commit resources to this risky market. This is reflected in the appalling condition of the electricity infrastructure. As the private sector is the greatest enabler of low carbon TT (Brewer, 2009; Davis, 2005), the lack of long term certainty has also severely damaged Indonesia’s ability to attract international TTs for the geothermal sector. This inflates the importance of assistance from governments, International Financing Institutions (IFIs) and development or donor organizations in fostering TT to Indonesia.

The reality is that the Indonesian geothermal sector has predominantly been the domain of a few large corporations who can afford to take higher risks (Kadiman, 2010; Darma, 2010 B). The result is that only a few large multinational energy companies have accomplished some geothermal technology and knowhow transfers to Indonesia which contributes to the continuing lack of technological resources and knowhow. But large multinationals are not the only important sources of technology innovation or international diffusion. Indeed, small and medium- sized firms are often the originators of new technologies and the principal internationalizers of them (Brewer, 2009). As an example, the numerous competent geothermal firms in Iceland are mainly SMEs.

SMEs generally do not have the resources necessary for heavy resource commitments in foreign markets (Hollensen, 2007). Thus, the size and limited financial resources of Icelandic geothermal companies means that it is too risky for them to invest in geothermal operations in Indonesia. This is especially true since investments in the geothermal sector tend to be large, capital intensive, and long-term (Hilmarsson, 2010).

But this does not mean that Iceland cannot be of assistance to Indonesian geothermal development. Although entry modes involving high resource commitments are not attractive, export and intermediary

entry modes would be a possibility. But simple export-import models are not favourable vehicles for genuine TT as they do not foster transfers of knowledge and skills (Worrell, van Berkel, Fengqi, Menke, Schaeffer, & Williams, 2001) and thus create and maintain dependency on part of the recipient (Karakosta, Doukas, & Psarr, 2010). As this paper asked 'how the Icelandic geothermal sector could support and simultaneously benefit from geothermal development in Indonesia' it leaves Intermediary modes as the most viable option to accomplish this.

Intermediary entry modes are primarily vehicles for the transfer of knowledge and skills, although they may also create export opportunities. They do not involve full ownership, rather ownership, control and thus risk is shared between partners (Hollensen, 2007). Such modes can allow active participation of local firms and thus foster technological capacity on part of the receiver, the most important ingredient to ensure long-term uptake of low carbon technologies and further independent progress (Worrell, van Berkel, Fengqi, Menke, Schaeffer, & Williams, 2001).

Hence, intermediary entry modes could facilitate Icelandic export of technology and knowhow while simultaneously transferring knowledge and skills to Indonesia. Such modes could foster beneficial cooperation and sharing of capabilities between the two countries. It would allow Indonesia to collaborate with industrialized country partners with more geothermal experience which could e.g. speed up geothermal development, build local technological capacity, and reduce the pressure on public sector R&D. It would further provide valuable opportunities to export Icelandic technology and knowhow, while providing Icelandic companies with access to Indonesian national advantages such as lower labour costs and the large un-served market.

With this information in mind, the paper suggested and developed a specific case of Icelandic SSG TT to Indonesia and further cooperation in the implementation and commercialization of this technology. Indonesian geothermal development has focused on large projects. While big projects are important, smaller ones also have great potential. They could e.g. provide vital energy in the outer regions and help displace the expensive and unreliable diesel generation that is dominant there. However, these regions are currently left out of geothermal development as they usually have smaller energy demands and thus cannot absorb large projects.

Icelandic companies have experience with SSG development and Kaldara Green Energy, an Icelandic SME, has developed an innovative approach to harnessing geothermal energy in small scales. Their technology, called the KAPS, provides a more economical and less risky way of utilizing SSG. Due to the huge economic, social, and environmental benefits that this technology could provide if successfully implemented in rural Indonesia, this paper suggests transferring it to the country through a strategic alliance. This project would

combine national comparative advantages as the participants would share their different capabilities with the view of enhancing their respective competitiveness. Thus, it was argued that the project would merit assistance from both Indonesian and Icelandic authorities.

Furthermore, to support the implementation of this project, the paper argued that it merits assistance from IFIs and development organizations and funds due to its nature and the possible benefits that could result of its implementation. Such assistance could be used to help finance demonstration projects which could confirm the operational potential of the KAPS, and thus SSG, in rural circumstances. This could create a success story which might have spiralling effects and make future progress easier. Such success stories are important to further embed geothermal energy into the national mindset and help Indonesia develop its huge potential.

Hence the KAPS project could represent an opportunity for successful cooperation between Iceland and Indonesia. But numerous other opportunities could also be developed. There is a great need for both direct and indirect utilization of the geothermal potential in Indonesia and the Icelandic geothermal sector has numerous competent firms which operate within e.g. exploration, drilling, operations, engineering, consultancy, and equipment supply. Many of these have strong International experience and reputation (Íslandsbanki Geothermal Research Team, 2010). As an example, Icelandic technology for deep drilling and usage of geothermal for air conditioning might be of interest to Indonesia.

Identifying and implementing cooperation between the Icelandic and Indonesian geothermal sectors could be hugely beneficial for both as success of international commerce is increasingly facilitated by partnerships with foreign businesses through e.g. joint research and development platforms (Hollensen, 2007).

## References

- Ali, M. (2010). Indonesia's Geothermal Business: Legal Framework, Tax and Fiscal Incentives. *Respects: Clean and Renewable Energy Review* , 1 (4), 54-55.
- Asian Development Bank et.al. (2010). *Indonesia: Critical Development Constraints*. Mandaluyong City: Asian Development Bank.
- Axelsson, G. (2010). Sustainable geothermal utilization—Case histories; definitions; research issues and modelling. *Geothermics* , 39 (4), 283-291.
- Barton, J. H. (2007). *Intellectual Property and Access to Clean Energy Technologies in Developing Countries*. Geneva: ICTSD Trade and Sustainable Energy Series.
- Beg, N., Morlot, J. C., Davidson, O., Afrane-Okesse, Y., Tyani, L., Denton, F., et al. (2002). Linkages between climate change and sustainable development. *Climate Policy* , 2 (2-3), 129-144.
- Begg, K., Flamos, A., & van der Gaast, W. (2009). the UNFCCC Subsidiary Body for Scientific and Technological Advice. *Applied Energy* , 86, 230–236.
- Bell, M. (1990). *Continuing Industrialisation, Climate Change and International Technology Transfer*. Sussex: SPRU.
- Bisara, D. (2. November 2010). Reform Drive Seen As Key To Growth. *Jakarta Globe* , B1.
- BPPT. (2009). *BPPT Annual Report 2009*. Jakarta: BPPT.
- Brewer, T. (2009). Technology Transfer and Climate Change: International Flows, Barriers and Frameworks. I L. Brainard, & I. Sorkin (Edit.), *Climate Change, Trade and Competitiveness* (p. 93-113). Washington, DC: The Brookings Institution.
- Carley, S., Lawrence, S., Brown, A., Nourafshan, A., & Benami, E. (2010). Energy-based economic development. *Renewable and Sustainable Energy Reviews* , 15 (1), 282-295.
- Castlerock Consulting. (2010). *Phase 1 Report: Review & Analysis of Phase 1 Report: Review & Analysis of Regulations and Costs*. Jakarta: Ministry of Energy and Mineral Resources.
- CCOP Indonesian Delegation. (2010). *Annual Member Country Report*. Bangkok: Coordinating Committee for Geoscience Programmes in East and Southeast Asia.
- Chandrasekharam, D., & Bundschuh, J. (2002). *Geothermal Energy Resources for Developing Countries*. (D. Chandrasekharam, & J. Bundschuh, Edit.) Lisse: A.A. Balkema Publishers.
- Ciptomulyono, U. (9. December 2010). Institutional Barriers to geothermal Development in Indonesia. (H. Petursson, Interviewer)
- Clean Technology Fund. (2010). *Clean Technology Fund: Investment Plan for Indonesia*. Washington: Climate Investment Funds.

- Coviello, M. F. (2002). Barriers, Risks and New Regulatory Schemes for the Development of Geothermal Resources. In D. Chandrasekharam, & J. Bundschuh (Edit.), *Geothermal Energy Resources for Developing Countries* (p. 63-75). Lisse: A.A. Balkema Publishers.
- Darma, S. (2010 A). Geothermal Power Generation: What are the Hurdles in Realizing it? *Geothermal Power Generation: What are the Hurdles in Realizing it?* (p. 1-3). Jakarta: The Executive Network.
- Darma, S. (2010 B). The Bali Commitment and Indonesia Geothermal. *Respects: Clean and Renewable Energy Review* , 1 (2), 24-25.
- Davis, K. E. (2005). Regulation of Technology Transfer to Developing Countries: the Relevance of Institutional Capacity. *Law & Policy* , 27 (1), 6-32.
- Dickson, M. H., & Fanelli, M. (February 2004). *What is Geothermal Energy - International Geothermal Association*. Retrieved on November 20<sup>th</sup> 2010 from [www.geothermal-energy.org](http://www.geothermal-energy.org): [http://www.geothermal-energy.org/314,what\\_is\\_geothermal\\_energy.html](http://www.geothermal-energy.org/314,what_is_geothermal_energy.html)
- Digges, A. (12. May 2010). Indonesian Geothermal IPPs: Full Steam Ahead? *Infrastructure Journal* .
- Dincer, I., & Rosen, M. A. (2005). Thermodynamic aspects of renewables and sustainable development. *Renewable and Sustainable Energy Reviews* , 9 (2), 169-189.
- Draeck, M. (2008). *Reinforcing Provision of Sustainable Energy Services in Bangladesh and Indonesia for Poverty Alleviation and Sustainable Development*. Brussels: Intelligent Energy Europe.
- Dressler, A., & Parson, A. E. (2010). *The Science and Politics of Global Climate Change: a Guide to the Debate* (2nd ed.). Cambridge: Cambridge University Press.
- Easterby-Smith, M., Thorpe, R., & Jackson, P. R. (2008). *Management Research* (3rd ed.). London: Sage Publications.
- Economist Intelligence Unit. (18. January 2011). *Indonesia Country Profile*. Retrieved on January 18<sup>th</sup> 2011 from Economist Intelligence Unit: <http://country.eiu.com.esc-web.lib.cbs.dk/article.aspx?articleid=1187955503&Country=Indonesia&topic=Summary&subtopic=Basic+data&subsubtopic=Basic+data>
- Ellis, J., & Kamel, S. (2007). *Overcoming Barriers to Clean Development Mechanism Projects*. Paris: OECD/IEA.
- Evans, P. C. (1999). Japan's Green Aid Plan: the Limits of state-Led Technology Transfer. *Asian Survey* , 39 (6), 825-844.
- Forseti.is. (26. April 2010). *Heimsþing um jarðhita*. Retrieved on Agust 10<sup>th</sup> 2010 from Forseti.is: <http://www.forseti.is/Frettir/Ollfrettin/3694>
- Gibson, J. (2009). The Constraints Associated with Infrastructure Faced by Non-Farm Enterprises at the Kabupaten Level. In N. McCulloch (Edit.), *Rural Investment Climate in Indonesia*. Singapore: Institute of Southeast Asian Studies.

- Gibson, J., & Olivia, S. (2008). *The Effect of Infrastructure Access and Quality on Non-Farm Enterprises in Rural Indonesia*. Hamilton: University of Waikato.
- Glitnir Geothermal Energy Research. (2008). *Geothermal: The Story of Iceland and its Implications for Other Nations*. Reykjavík: Glitnir.
- Global Environment Facility. (u.d.). *about us: Global Environmental Facility*. Retrieved on February 26<sup>th</sup> 2011 from Global Environmental Facility: <http://www.thegef.org/gef/whatisgef>
- Green Energy Group. (2011). *Our Solution: Green Energy Group*. Retrieved on Mars 12<sup>th</sup> 2011 from Green Energy Group: <http://www.greenenergyas.com/our-solutions>
- Hennicke, P., Borbonus, S., & Woerlen, C. (2007). The GEF's interventions in the climate change focal area: the contribution to strategies for climate change mitigation and sustainable development. *Energy for Sustainable Development*, 11 (1), 13-25.
- Hilmarsson, H. P. (2010). Public-private Partnerships and Energy Sector Investments in Emerging Market Economies: Can the Risk Mitigation Instruments Offered by International Financial Institutions Help Private Investors from Small States? *Tiltai*, 2 (51), 25-39.
- Hindarto, D. E. (20. January 2011). Institutional Barrier to Geothermal Development in Indonesia. (H. Petursson, Interviewer)
- Hoekman, B., & Javorcik, B. S. (2006). Lessons from Empirical Research on International Technology Discussion through Trade and Foreign Direct Investment. In B. Hoekman, & B. S. Javorcik (Edit.), *Global Integration and Technology Transfer* (p. 1-26). Washington, DC: Palgrave Macmillan and the World Bank.
- Hollensen, S. (2007). *Global Marketing* (4<sup>th</sup> ed.). Essex: Pearson Education Limited.
- Ibrahim, R. F. (12. November 2010 A). Institutional Barriers to Geothermal Development in Indonesia. (H. Petursson, Interviewer)
- Ibrahim, R. F. (2010 B). Speeding up Indonesias Geothermal Development. *Respects; Clean and Renewable Energy Review*, 1 (2), 26-28.
- Indonesia Climate Change Trust Fund. (u.d.). *About: Indonesia Climate Change Trust Fund*. Retrieved on Mars 26<sup>th</sup> 2011 from Indonesia Climate Change Trust Fund: <http://www.icctf.org/site/node/1>
- Indonesia Geothermal Association. (2010). *Understanding Indonesia Geothermal Business*. Jakarta: Indonesia Geothermal Association.
- Indonesia Today. (2010). *Indonesia Set to Become no. 1 User of Geothermal*. Retrieved on November 21<sup>st</sup> 2011 from Indonesia Today: <http://indonesiathisday.blogspot.com/2010/04/indonesia-set-to-become-no-1-user-of.html>
- Indonesian Electric Power Society (MKI). (2010). *The Indonesian Electrical Power Business Book 2010-2011*. Jakarta: Indonesian Electical Power Society.

- Indonesian Ministry of Environment et.al. (November 2010). *Country Reports: Indonesia's Technological Needs Assessment on Climate Change Mitigation*. Retrieved on December 12<sup>th</sup> 2010 from UNFCCC website: <http://unfccc.int/ttclear/jsp/CountryReports.jsp>
- Intergovernmental Panel on Climate Change. (2007). *Climate change 2007*. Cambridge: Cambridge University Press.
- Intergovernmental Panel on Climate Change. (2000). *IPCC Special Report on; Methodological and Technological Issues in Technology Transfer*. Cambridge: Cambridge University Press.
- International Energy Agency. (2008). *Energy Policy Review of Indonesia*. Paris: International Energy Agency.
- International Energy Agency. (2010). *World Energy Outlook 2010*. Paris: International Energy Agency.
- Íslandsbanki Geothermal Research Team. (2010). *Iceland Geothermal Energy: Market Report*. Reykjavík: Íslandsbanki.
- ÍSOR Iceland GeoSurvey. (2010). *News: The Nordic Development Fund looks into Icelandic cooperation*. Retrieved on December 15<sup>th</sup> 2010 from ÍSOR Iceland GeoSurvey website: <http://geothermal.is/news/nordic-development-fund-looks-icelandic-cooperation-geothermal-development>
- Javorcik, B. S. (2006). Technological Leadership and the Choice of Entry Mode by Foreign Investors. In B. Hoekman, & B. S. Javorcik (Edit.), *Global Integration & Technology Transfer* (p. 179-205). Washington, DC: Palgrave Macmillan and the World Bank.
- Johannsson, S. (12. May 2010). *About Us, Articles: Kaldara Green Energy*. Retrieved on December 15<sup>th</sup> 2010 from Kaldara Website: <http://www.kaldara.com/aboutus/Articles/>
- Johnson, D. L. (2010). Matching Regulatory with Commercial Interest: Some Lessons Learned from the Development of Geothermal Project in Indonesia. *Respects: Clean and Renewable Energy Review*, 1 (3), 19-20.
- Kadiman, K. (2010). The Big are Few, The Small are Many. *Respects: Clean and Renewable Energy Review*, 1 (4), 5-6.
- Kaldara Green Energy. (2008). *KAPS: Kaldara web page*. Retrieved on November 20<sup>th</sup> 2010 from Kaldara website: <http://www.kaldara.com/KAPS/>
- Karakosta, C., Doukas, H., & Psarr, J. (2010). Technology transfer through climate change: Setting a sustainable energy pattern. *Renewable and Sustainable Energy Reviews*, 14, 1546–1557.
- Ketels, C. (2010). Profile of the Icelandic Geothermal Cluster. *Iceland Geothermal 2010* (p. 1-23). Reykjavik: Harward Business Shcool.
- KPMG. (2010). *World Geothermal Market & Outlook*. Reykjavík: KPMG.
- Lacey, T. (2010). Small Geothermal Works. *Respects: Clean and Renewable Energy Review*, 1 (4), 28-29.



- Lasserre, P. (2007). *Global Strategic Management* (2<sup>nd</sup> ed.). New York: PALGRAVE MACMILLAN.
- Loorbach, D. (2007). *Transition Management: New Mode of Governance for Sustainable Development*. Utrecht: International Books.
- Lundvall, B.-Å., Johnson, B., Andersen, E. S., & Dalum, B. (2002). National systems of production, innovation and competence building. *Research Policy*, 31 (2), 213-231.
- mbl.is. (26. Agust 2010 C). *20 sagt upp hjá Jarðborunum*. Retrieved on Agust 26<sup>th</sup> 2010 from [www.mbl.is: http://mbl.is/frettir/innlent/2010/08/26/20\\_sagt\\_upp\\_hja\\_jardborunum/](http://mbl.is/frettir/innlent/2010/08/26/20_sagt_upp_hja_jardborunum/)
- mbl.is. (1. November 2010 A). *Tækifæri sem ekki má vanrækja*. Retrieved on November 1<sup>st</sup> 2010 from [www.mbl.is: http://feeds.mbl.is/frettir/innlent/2010/11/01/taekifaeri\\_sem\\_ekki\\_ma\\_vanraekja/#](http://feeds.mbl.is/frettir/innlent/2010/11/01/taekifaeri_sem_ekki_ma_vanraekja/#)
- mbl.is. (26. April 2010 B). *Vilja samvinna við Ísland*. Retrieved on Agust 13<sup>th</sup> 2010 from [www.mbl.is: http://mbl.is/mm/frettir/innlent/2010/04/26/vilja\\_samvinna\\_vid\\_island/](http://mbl.is/mm/frettir/innlent/2010/04/26/vilja_samvinna_vid_island/)
- Metz, B., Berk, M., den Elzen, M., de Vries, B., & van Vuuren, v. V. (2002). Towards an equitable global climate change regime: compatibility with Article 2 of the Climate Change Convention and the link with sustainable development. *Climate Policy*, 2 (2-3), 211-230.
- Michaelowa, A., Tangen, K., & Hasselknippe, H. (2005). Issues and Options for the Post-2012 Climate Architecture - An Overview. *International Environmental Agreements*, 5 (1), 5-24.
- Miller, A. S. (2007). The Global Environment Facility program to commercialize new energy technologies. *Energy for Sustainable Development*, 11 (1), 5-12.
- Ministry of Energy and Mineral Resources. (11. February 2011). *It's Time to Optimize Non-Fossil Energy Utilization*. Retrieved on February 20<sup>th</sup> 2011 from the Ministry of Energy and Mineral Resources: <http://www.esdm.go.id/index-en/83-energy/4150-its-time-to-optimize-non-fossil-energy-utilization.html>
- MKI. (2010). *The Indonesian Electrical Power Business Book 2010-2011*. Jakarta: MKI (Indonesian Electrical Power Society).
- Nordic Development Fund. (u.d.). *About Us: Nordic Development Fund*. Retrieved on February 26<sup>th</sup> 2011 from Nordic Development Fund Website: <http://www.ndf.fi/index.php?id=34>
- Ockwell, D. G., Watson, J., Mackerron, G., Pal, P., & Yamin, F. (2008). Key policy considerations for facilitating low carbon technology transfer to developing countries. *Energy Policy*, 36, 4104– 4115.
- Omer, A. M. (2008). Energy, environment and sustainable development. *Renewable and Sustainable Energy Reviews*, 12, 2265–2300.
- Orkustofnun. (2010). *Geothermal Development and Research in Iceland*. Reykjavík: Orkustofnun.
- Pan, J. (2005). Meeting Human Development Goals with Low Emissions : An Alternative to Emissions Caps for post-Kyoto from a Developing Country Perspective. *International Environmental Agreements: Politics, Law and Economics*, 5 (1), 89-104.

- Pelangi et.al. (2009). *Publication, Indonesia: Electricity Governance Initiative*. Retrieved on November 14<sup>th</sup> 2010 from Electricity Governance Initiative: <http://electricitygovernance.wri.org/publications/electricity-governance-initiative>
- Porter, M. E. (2010). The Icelandic Geothermal Cluster: Enhancing Competitiveness and Creating a new Engine of Icelandic Growth. *Iceland Geothermal 2010* (p. 1-50). Reykjavík: Harvard Business School.
- Prahalad, C. K. (2005). *The Fortune at the Bottom of the Pyramid*. New Jersey: Wharton School Publishing.
- Respati, J. (2010). PGE: Leadership by Design. *Respects: Clean and Renewable Energy Review* , 1 (4), 34-36.
- Respects. (2010 A). Geothermal Project Lost in Forest. *Respects: Clean and Renewable Energy Review* , 1 (4), 13-15.
- Respects. (2010 B). New Big Players are Exploring Indonesian Geothermal Prospects. *Respects: Clean and Renewable Energy Review* , 1 (4), 16-17.
- Respects. (2010 C). Where Does the Expertise Come From? *Respects: Clean and Renewable Energy Review* , 1 (4), 8-10.
- Ryan, A. B. (2006). Post-positivist Approaches to Research. In M. Antonesa, H. Fallon, A. B. Ryan, A. Ryan, T. Walsh, & L. Bory, *Researching and Writing your Thesis: a guide for postgraduate students* (s. 12-28). Maynooth: MACE.
- Saggi, K. (2006). Foreign Direct Investment, Linkages, and Technology Spillovers. In B. Hoekman, & B. S. Javorcik (Edit.), *Global Integration & Technology Transfer* (s. 51-65). Washington, DC: Palgrave Macmillan and the World Bank.
- Schneider, M., Holzer, A., & Hoffman, V. H. (2008). Understanding the CDM's Contribution to Technology Transfer. *Energy Policy* , 36 (8), 2930-2938.
- Schnepp, O., Von Glinow, M. A., & Bhambri, A. (1990). *United States-China technology transfer*. Englewood Cliffs, N.J.: Prentice Hall.
- Schumpeter, A. J. (1939). *Business Cycles: a Theoretical, Historical and Statistical Analysis of the Capitalist Process*. New Your/Toronto/London: McGraw-Hill Book Company.
- Sharma, D. C. (2007). Transforming rural lives through decentralized green power. *Futures* , 39, 583–596.
- Smith, A., Stirling, A., & Berkhout, F. (2005). The Governance of Sustainable Socio-Technical Transitions. *Research Policy* , 34 (10), 1491-1510.
- Stephens, J. C., & Jiusto, S. (2010). Assessing innovation in emerging energy technologies: Socio-technical dynamics of carbon capture and storage (CCS) and enhanced geothermal systems (EGS) in the USA. *Energy Policy* , 38, 2020–2031.
- Surana, T. (16. November 2010). Small Scale Geothermal in Indonesia. (H. Petursson, Interviewer)

- The Energy and Geoscience Institute of the University of Utah. (u.d.). *What is Geothermal? The Geothermal Resource Council*. Retrieved on November 20<sup>th</sup> 2010 from [www.geothermal.org/GeoEnergy.pdf](http://www.geothermal.org/GeoEnergy.pdf)
- The National Council on Climate Change of the Republic of Indonesia. (2009). *National Economic, Environment and Development Study for Climate Change: Indonesia Country Study*. Jakarta: The National Council on Climate Change of the Republic of Indonesia.
- The World Bank. (2008 B). *Investing in Indonesia's Health: Challenges and Opportunities for Future Public Spending*. Washington, D.C.: The World Bank.
- The World Bank. (2006). *Making the New Indonesia Work for the Poor*. Washington, D.C.: The World Bank.
- The World Bank. (2008 A). *Spending for Development: Making the Most of Indonesia's New Opportunities*. Washington: The World Bank.
- Tidd, J., Bessant, J., & Pavitt, K. (2005). *Managing Innovation: Technological, Market and Organizational Change*. Chichester: John Wiley & Sons.
- UNDP et.al. (2000). *Energy and the Challenge of Sustainability, World Energy Assessment*. New York: UNDP, UNDESA, WEC.
- UNFCCC A. (u.d.). *About CDM*. Retrieved on February 26<sup>th</sup> 2011 from UNFCCC website: <http://cdm.unfccc.int/about/index.html>
- UNFCCC B. (u.d.). *Cooperation & Support: UNFCCC*. Retrieved on November 15<sup>th</sup> 2010 from UNFCCC web site: [http://unfccc.int/cooperation\\_and\\_support/items/2664.php](http://unfccc.int/cooperation_and_support/items/2664.php)
- United Nations Division for Sustainable Development. (1992). *Agenda 21: The Report of the United Nations Conference on Environment and Development, Chapter 34: Transfer of Environmentally Sound Technology, Cooperation & Capacity-building*. Rio de Janeiro: United Nations.
- Unruh, G. C. (2002). Escaping Carbon Lock-in. *Energy Policy* , 30 (4), 317-325.
- Unruh, G. C. (2000). Understanding carbon lock-in. *Energy Policy* , 28 (12), 817-830.
- Veda, T. (22. April 2010). Indonesia's Geothermal Potential Remains Untapped. *Jakarta Globe* .
- Verbong, G., & Geels, F. (2007). The ongoing energy transition: Lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960–2004). *Energy Policy* , 35 (2), 1025-1037.
- Vimmerstedt, L. (2002). Small Geothermal Projects for Rural Electrification. In D. Chandrasekharam, & J. Bundschuh (Edit.), *Geothermal Energy Resources for Developing Countries* (p. 103-127). Lisse: A.A. Balkema.
- Widayanti, R. (14. October 2010). Institutional Barriers to Geothermal Development in Indonesia. (H. Petursson, Interviewer)
- Williams, R. H. (2001). Addressing challenges to sustainable development with innovative energy development. *Energy for Sustainable Development* , 2, 48-73.

Winarno, D. (25. January 2011). Small Scale Geothermal for Indonesia. (H. Petursson, Interviewer)

Winkel, M., McLeod, A., Wallace, R., & Williams, R. (2006). Energy Policy and the Institutional Context: Marine Energy Innovation Systems. *Science and Public Policy*, 33 (5), 365-376.

World Commission on Environment and Development. (1987). *Report of the World Commission on Environment and Development: Our Common Future*. Oxford: Oxford University Press.

World Energy Council. (2010). *2010 Survey of Energy Resources*. London: World Energy Council.

Worrell, E., van Berkel, R., Fengqi, Z., Menke, C., Schaeffer, R., & Williams, R. O. (2001). Technology transfer of energy efficient technologies in industry: a review of trends and policy issues. 29 (1), 29-43.

Yamauchi, F., Muto, M., Chowdhury, S., & Dewina, R. (2009). *Spatial Networks Labor Supply and Income Dynamics: Evidence from Indonesian Villages*. Washington, D.C.: International Food Policy Research Institute.

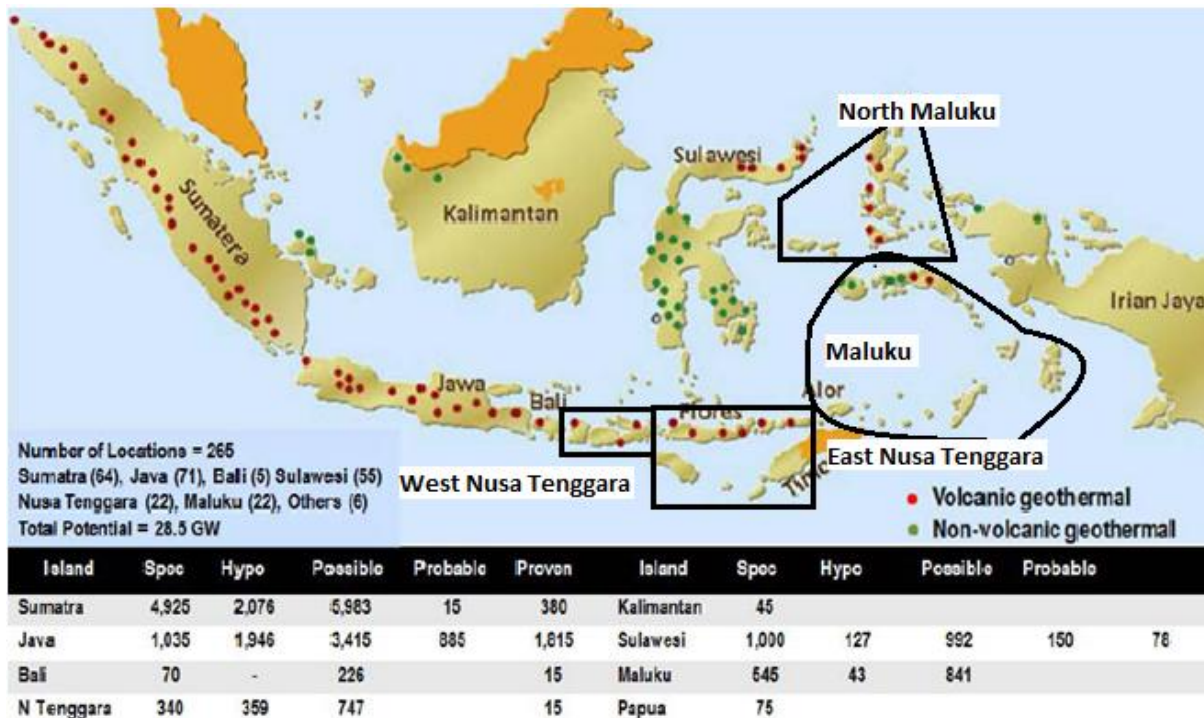
## Appendix I – Information on Interviewees

As introduced in the methodology, this study gathered data through semi constructed in-depth interviews with key stakeholders involved in Indonesian geothermal development. Below is a more thorough account of the interviewees and their organizations:

1. **Taufan Surana** is the Program Director for Geothermal Energy Technology at BPPT (<http://www.bppt.go.id/>). BPPT is a non-departmental government agency under the coordination of the Ministry of Research and Technology which has the tasks of carrying out government duties in the field of assessment and application of technology. Mr. Surana has a long experience with the Indonesian geothermal context and has extensive knowledge on small scale geothermal utilization.
2. **Udibowo Ciptomulyono** is the President Commissioner of PLN Geothermal (<http://www.plngeo.com/>). PLN Geothermal is a subsidiary of the state owned utility company PT PLN. PLN Geothermal handles geothermal expansion on behalf of its mother firm. Mr. Ciptomulyono is an expert on both upstream and downstream geothermal business and has been within the PLN for more than 20 years.
3. **Dicky Edwin Hindarto** is the Coordinator chief of the Carbon Trade Mechanism Division under the National Council on Climate Change (DNPI) (<http://adaptasi.dnpi.go.id/index.php/main/home>). The goal of the DNPI is to formulate national policies, strategies, programs, and activities on climate change control, to coordinate the implementation of climate change mitigation activities, to formulate a mechanism for carbon trading, to carry out monitoring and evaluation of policy implementation on climate change control, and to strengthen Indonesia's position in respect to climate change. Mr. Hindarto is an expert on the CDM mechanism and before joining the DNPI he worked for numerous public and private energy companies, including geothermal.
4. **Djoko Winarno** is the Vice Chairman of METI (Indonesia Renewable Energy Society) (<http://www.meti.or.id/>). METI is a non-profit organization with the goal of promoting renewable energy development in Indonesia. Its members consist of individuals, associations, companies, cooperatives, and academics, nationals as well as internationals, which are involved in renewable energy in Indonesia. The organization produces recommendations for the development of renewable energy and provides a forum for communication and consultation for the renewable energy industry. Mr. Winarno has extensive experience of the Indonesian energy sector. He has worked for numerous private and public companies and owns and operates several energy projects throughout Indonesia, including various small and medium scale RE energy projects.

5. **Riki Firmandah Ibrahim** is a Senior Geothermal Business Analyst and a member of the board of experts at INAGA (Indonesia Geothermal Association) (<http://www.api-inaga.org/>). INAGA is a non-profit organization established in 1991 with the goal of boosting the development of geothermal energy in Indonesia. The organization provides a forum for communication, coordination, and consultation for the geothermal industry and formulates opinions and advice for the expansion of geothermal energy in Indonesia. Its members comprise of individuals, associations, companies, cooperatives, and academics, nationals as well as internationals, which are involved in the Indonesian geothermal industry. Ibrahim has also worked as a consultant for numerous private geothermal companies and is the former Secretary-General of INAGA and IRES (Indonesia Renewable Energy Society).
6. **Ratih Widayanti** is a Chief Researcher at Pelangi Indonesia (<http://www.pelangi.or.id>). Pelangi Indonesia is a global environmental think tank that seeks to form a society that self-governs and secures the quality of its natural resources and environment while pursuing equitable and democratic socio-economic well-being. It has a long-standing program on climate change and energy and has undertaken work on power sector policy, energy efficiency, public benefits in electricity sector restructuring, and renewable energy. Pelangi is a part of the Global Village Energy Partnership. Before joining Pelangi, Widayanti had been involved in renewable energy projects throughout Indonesia.

## Appendix II – Geothermal Locations and the Selected Regions



Source: (CCOP Indonesian Delgation, 2010)

This paper selected four regions as a basis to argue for the benefits of transferring and implementing the KAPS to rural Indonesia. These four regions are: West Nusa Tenggara, East Nusa Tenggara, Maluku, and North Maluku and they are all in the eastern part of Indonesia, as shown on the map above. The geothermal potential in these regions is huge, but currently almost all electricity is based on diesel generators (<5MW) which have low capacity factors as many of them are old and have not received adequate maintenance (BPPT, 2009; Surana, 2010). There is no RE generation in these regions other than a very limited micro hydro production. Below is information on the installed capacity in each region:

1. West Nusa Tenggara: Total installed capacity is 178.49 MW with effective capacity only 122.93 MW. Peak load in 2010 reach 180 MW and is predicted to reach 448 MW in 2019.
2. East Nusa Tenggara: Total installed capacity is 144 MW with effective capacity only 90 MW. Peak load in 2010 reached 92.5 MW and is predicted to reach 251 MW in 2019.
3. Maluku: Total Installed capacity is 62.6 with effective capacity only 40 MW. Peak load in 2010 reached 71.2 and is predicted to reach 159 MW in 2019.
4. North Maluku: Total installed capacity is 20.5 MW with effective capacity only 14 MW. Peak load in 2010 reached 41 MW and is predicted to reach 92 MW in 2019.

Apparent from this is that energy demand is considerably higher than generation capacity. Thus, there is great need for additional energy (MKI, 2010).

## Appendix III – Geothermal Regulations

Geothermal development is governed by two separate regulatory frameworks. Law 27/2003 governs all WKPs awarded after its enactment. WKPs issued before this are governed by Presidential Decree 45/1991. These are termed legacy WKPs and those who remain unexploited all belong to Pertamina and PLN (state enterprises), but will be returned to the government if they do not progress in the near future. Hence, the 2003 law is more important to current development.

Law 27/2003 is influenced by three new policy trends that emerged in Indonesia following the Asian financial crisis: regionalization, de-monopolization, and requests for transparent competition. It opened geothermal development up to private participation through competitive tendering conducted by the competent government authority responsible for the WKP. It splits geothermal business into 6 phases; 1) **preliminary study** undertaken by the Ministry of Energy and Mineral Resources (MEMR), regional authorities, or private business; 2) determination and **tendering of WKPs** and issuance of a geothermal mining license (IUP) to the winner, is processed by regional authorities or the MEMR; 3) **exploration** is conducted by the holder of the WKP/IUP; 4) **feasibility study** is conducted after submission of a detailed exploration report; 5) the holder of the WKP/IUP can start **exploitation** by producing steam; 6) and **utilizing** it for either indirect purposes (electricity), or direct purposes like heating. Some key points of Law 27/2003 include:

- Considers geothermal power as a single undertaking, combining upstream exploration and production with downstream power generation and sales.
- Companies must have a license (IUP) to conduct geothermal activities.
- The national government is responsible for regulations, policy, licensing and supervising in areas that cross provincial borders.
- The Government also defines the WKP area to be tendered by any level of government
- Regional governments are responsible for regional regulations, licensing and supervising in their respective areas of authority.
- Head of the respective level of government will publicly tender new WKPs. However, the basis for the award (e.g. lowest price) is not specified.
- Companies conduct Exploration, Feasibility Study, and Exploitation together, unless the Government conducts Exploration, in which case they may be conducted separately.
- Companies have to return WKP to the Government over time (35-55 years subject to negotiation).
- Contracts issued prior to this law are unaffected, hence the continued operation and development of legacy WKP held by PGE and PLN under Keppres 45/1991.



- Geothermal electricity production will be governed by electricity regulations.

The MEMR is primary responsible for energy and electricity sector policy and regulation. IUPs are given for 35 years but can be extended by 20 years subject to negotiation. Below is a list of the most important implementing and associated regulation of the 2003 geothermal law:

- Government Law No. 30/2007 on Energy
- Presidential regulation No. 5/2006 on National Energy Policy (2006-2025)
- Government Regulation No. 59/2007 on the closing date for exploitation of legacy WKP (Keppres 45/1991)
- Government Regulation No. 24/2010 on the utilization of forest area for geothermal purposes
- Government regulation No. 30/2009 on electricity. This regulation stopped the monopoly of PLN on supplying and distributing electricity to end costumers, allowing IPPs to enter this business although subject to a right of first priority provided to PLN
- Ministry of energy regulation No 32/2009 on geothermal contracting with PLN and Government approval of price. This regulation puts a ceiling on the purchase price for geothermal power at 9.7 US cents/kWh
- Ministry of energy regulation No 02 Year 2011 states that PLN must purchase the electricity produced by geothermal field, but the ceiling price is still the same, US 9.7 cent per kWh
- Ministry of energy regulation No. 2/2009 on the process for preliminary survey
- Ministry of energy regulation No. 11/2008 on the designation of WKP
- Ministry of energy regulation No. 11/2009 on tendering, exploration, feasibility studies, and exploitation
- Ministry of energy regulation No. 10/2005 and 26/2008 on licensing and commissioning for electricity supply
- Ministry of energy regulation 15/2010 which lists geothermal projects targeted by the Government as part of its accelerated power development program
- Ministry of finance regulation No 114/2009, 177/207, 21/2010, 24/2010 and 35/2010 on tax rates, VAT, and custom duty mechanisms for geothermal projects (import and operation).

This summary is based on the following sources: (Indonesia Geothermal Association, 2010; Indonesian Electric Power Society (MKI), 2010; Castlerock Consulting, 2010; Ibrahim, Institutional Barriers to Geothermal Development in Indonesia, 2010 A).