Indonesia Geothermal Backcasting Analysis:

A Methodological Proposal for Policy Planning

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Abstract

Indonesia has approximately 40% of world geothermal energy reserves, with 27,000 MW potential. Currently, it is ranked as the third in the world for geothermal energy consumption, following the US and the Philippines. It is also the third biggest emitter of greenhouse gases and aims to reduce GHG emissions by 16% by 2025. The Indonesian government recently established a goal to increase geothermal resources by 9,500 MW by 2025, becoming the world's largest producer of geothermal energy (Darma, et al., 2010). It is, however, not certain how the Indonesian government is going to reach the target. The Indonesian geothermal roadmap, for example, does not specify what policies are required by when, and who would implement it. In order to make the geothermal target feasible, there is a need to clearly demonstrate the way to reach the target through various policy options, spanning political, economic and social issues. This article proposes a conceptual and methodological framework for the policy roadmap in which the Indonesian government to reach the target. It also addresses the need for the policy administrative schedule, that identifies and allocate responsibilities and time schedule for policy implementation. By addressing policy roadmap where policy administration schedule is laid down, the reaching the target is expected to be more feasible.

1. Introduction

In the recent years, there is a growing interest into geothermal energy for electricity generation, as geothermal does not have emissions and other byproducts as fossil fuels and nuclear do when used in electricity generation. Geothermal electricity is usually harnessed on the edge of tectoic places where high temperature geothermal resources is available near the Earth's surface.

Currently, there are several countries actively promoting geothermal electricity, including Iceland, Indonesia, Japan, Philippines and USA, with five countries in the world (El Salvador, Kenya, the Philippines, Iceland, and Costa Rica) that generate more than 15% of their electricity from geothermal resources. As the number of countries developing geothermal power grows, the total volume of geothermal power capacity of the world has increased from 9,000 MW of installed capacity in 2005, generating 56,000 GWh per year, to 10,700 MW generating 67,200 GWh in 2010, meaning a 20% increase over the period (Bertani, 2010).

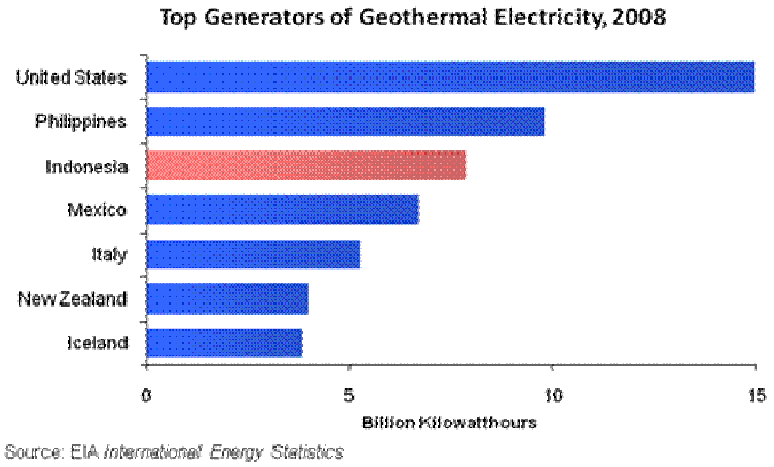

Figure 1. Top generators of geothermal electricity (US EIA)

Indonesia is one of these countries where high temperature geothermal resources are available. In the year between 2005 and 2010, Indonesia saw the installed capcity increase of 400MW, correspinding to about 50% (Bertani, 2010). However, its growth is relatively modest when its physical potential for electricity generation is taken into account. Indonesia has approximately 40% of world geothermal energy reserves, with 27,000 MW potential. Currently, it is ranked as the third in the world for geothermal energy consumption, following the US and the Philippines. The Indonesian government recently established a goal to increase geothermal resources by 9,500 MW by 2025, becoming the world's largest producer of geothermal energy (Darma, et al., 2010).

It is, however, not certain how the Indonesian government is going to reach the target. The Indonesian geothermal roadmap, for example, does not specify what policies are required by when, and who would implement of the policy options. In order to make the geothermal target feasible, there is a need to clearly demonstrate the way to reach the target through various policy options, spanning political, economic and social issues.

This paper raises an issue on identifying the policy options available to the Indonesian government to reach the target. It addresses the need for "policy roadmap" for Indonesian geothermal devlopment that demonstrates the policy program administrative schedule, that identifies and allocate responsibilities and time schedule for policy implementation.

2. Indonesian Geothermal Outline:

2.1 History of Development

Most of the Indonesian arcs are located upon the edge of tectonic places, with surface manifestation of high temperature fluid. Indonesia is suitable for geothermal power generation using this sufficiently high temperature fluid. Under the dutch colonial government, from the early 19th to the middle of the 20th century, Indonesian geothermal resources were mainly documented by the Dutch colonial geological survey. Upon independence, the Volcanological Survey of Indonesia (VSI) was established as an official Indonesian government institute, responsible for investigating, recording of volcanoes in the Indonesia (Hockstein, 2008) .

Modern geothermal energy development in Indonesia was started with in the Kamojang Geothermal Field in 1983, followed by the operation of Unit-1 Geothermal Power Plant (30MW) in 1983, and 2 units were in operation with a capacity of 55 MW in 1985. On Sumatra Island, Monoblock (2MW) in Sibayak-Brastagi was in operation for the first time as the first Power Plant and the first Geothermal Power Plant with a capacity of 20 MW was in operation in Lahendong region in August 2001 (Pertamina Geothermal, 2011). For geothermal, the President Decree No.16/1974, President Decree No.22/1981, President Decree No.23/1981, President Decree No. 45 in 1991 and President Decree No.49/1991 appointed the Pertamina, a state own oil company to conduct exploration, exploitation and utilised the steam into energy (Darma, et al., 2010).

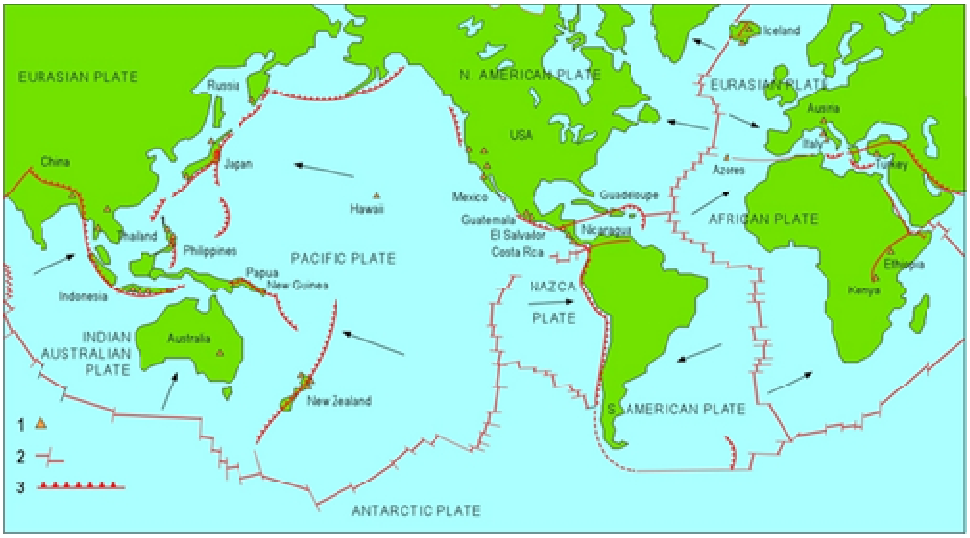

Figure 2. World pattern of plates, oceanic ridges, oceanic trenches, subduction zones, and geothermal fields (Dickson and Fanelli, 2010)

2.2 The Geothermal Law

Indonesia is also known for its oil and gas reseves, but these have decreased over the decades, because of over-exploration and reduced production from main oil fields (US EIA, 2011). Based on the Indonesian government's recognition of the significance of geothermal as an alternative energy source to oil and gas, the Parliament formed a team to draft a bill for geothermal development.

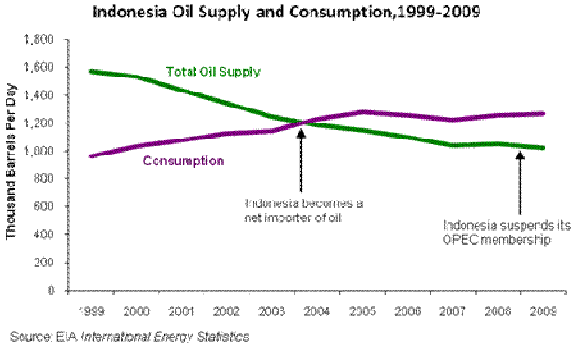

Figure 3. Indonesia oil supply and consumption, 1999-2009 (IS EIA)

In 2003, the Geothermal Law (Law No. 27/2003 regarding Geothermal Energy) was approved by the Parliament and took effect, wherein Pertamina, the state owned oil and gas company, no longer has monopolistic rights to geothermal energy business. The Law restricted Pertamina's power for geothermal development and provides guidelines and rules for geothermal investment and administration. Pertamina established PT Pertamina Geothermal Energy (PT PGE) as a subsidiary to manage business activity in the field of geothermal energy in 2006.

The geothermal Law is intended to regulate geothermal production, being the legal basis for geothermal development and utilization. It also defines local government roles in geothermal development and sets equal competition between domestic and foreign investment by issuing operational permits for both. It specifically requires implementing the following issues;

Article 9(3) - provisions regarding guidelines, boundaries, coordinates, area extent, procedures and requirements pertaining to offers, procurements and preparation of tender documents and implementation of tenders
Article 10(6) - Provisions on Direct Use in connection with the utilization of geothermal energy
Article 13(3) – Provisions regarding the extent of a work area that may be retained for the exploration stage and changes to the extent of an IUP area in each stage of geothermal energy mining business
Article 30(4) – Provisions regarding the types and rates of non-tax state revenues
Article 33 – Provisions regarding guidance and supervision of work and of the execution of business activities with respect to compliance of applicable laws and regulations

This Law is followed by the Government Regulation No.59 year 2007 which functions as a guide for the corporate bodies and the Government to activate the geothermal business in Indonesia. Also, the Government blue print for geothermal development was issued as the Government Regulation No.3/2006, where Geothermal is expected to contribute at least 5% of the national energy consumptions. To support the policy, government has further issued to Minister of Energy Decree regarding to a pricing policy to attract the economic of return of geothermal project (Darma, et al., 2010).

In addition, the geothermal roadmap has been drawn to specify short, medium to long-term capacity increase targets (Figure 5). Altough the roadmap is a clear statement of the Indonesian government's intention for further capacity increases, there are, however, few supporting policies and mechanisms to ensure its feasibility. The lack of the sufficient support has been evidenced by the marginal geothermal electricity capacity increase in recent years.

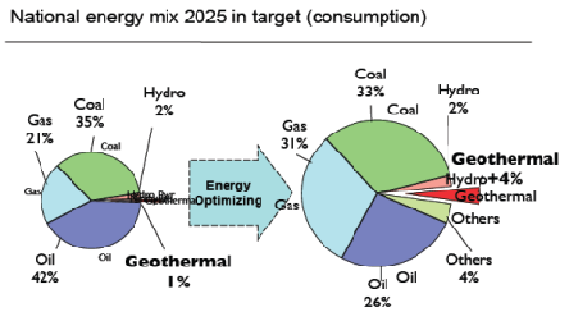

Figure 4. National energy mix 2025 target (E.Terras)

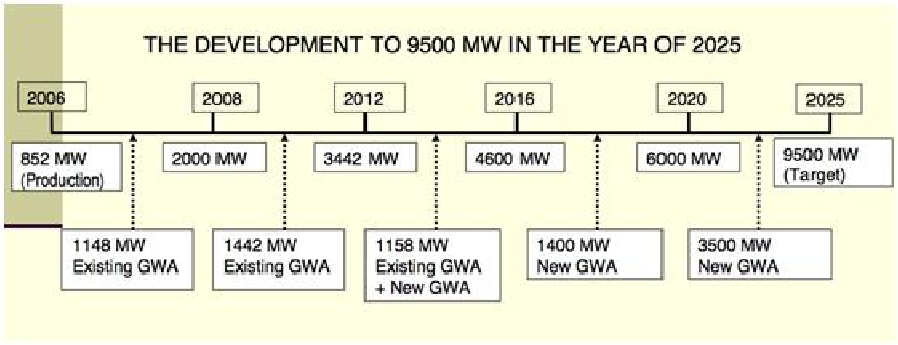

Figure 5. Geothermal roadmap by 2025 (PLN Geothermal)

3. Challenges for the Roadmap Implementation

Insufficiency of geothermal capacity increases is mainly due to lack of investment in the relevant projects. Behind this, there are some structural problems related to the energy industry framework and central/local government political imbalances. Therefore, this section is to describe the electricity market condition in Indonesia to highlight the background to the barriers for Indonesian geothermal electricity development.

The Indonesian electricity sector is currently dominated by PT PLN (Perusahaan Listrik Negara), the state-owned utility. PLN is responsible for the majority of Indonesia's generation, and is the monopoly provider of transmission, distribution and supply of electricity. Indonesia has an installed capacity estimated at 27.8 GW in 2008, with 86% coming from thermal sources, 8% from hydro sources, and 6% from geothermal and other renewable sources (US EIA, 2011).

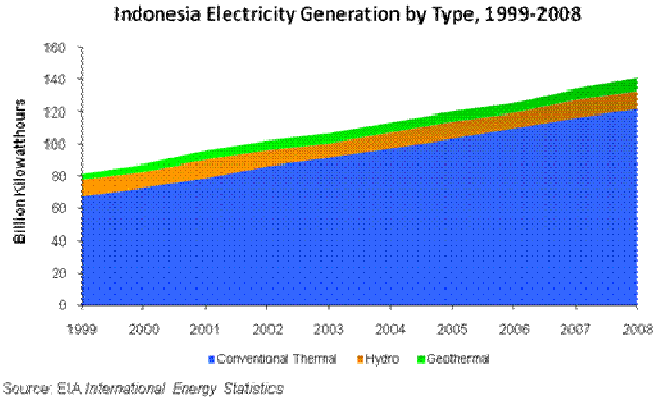

Figure 6. Indonesia electricity generation by type, 1999-2000 (US EIA)

The Indonesian government has passed legislation aiming to liberalize the power sector. The 2002 Electricity Law opened up certain power generation markets for competition from 2007 (Silviati, 2005). Power producers were allowed to have direct sales to their customers rather

than through PLN. The background to the Indonesian power market reform is the PLN's financial deficit. It has been the norm that the government sets the retail electricity prices. Since the Asian Financial Crisis, because PLN was dependent mainly oil for electricity production, the generation cost sharply increased such that PLN was forced to sell electricity at the price less than the cost of power generation. As a result, PLN lost its financial allowance for investing in new power production capacity.

Shortages of power supply in an expanding economic recovery created a situation where frequent blackouts and interruptions in industrial and other processes led the Indonesian government to urge PLN to implement a broad crash program for power project development. These programs are to increase power generation capacity by 10,000MW consisting of 60% with geothermal electricity (Darma, et al., 2010). Since the Electricity Law legislation, however, not much progress has been made for increasing foreign investment into the power sector, mainly because there is little guarantee that the foreign players may receive legitimate return on their investment (US EIA, 2011).

Also, as the geothermal energy business requires capital investment on feasibility research and mining activities, as well as electricity production. It means, compared to the oil and coal powered electricity production; geothermal projects demand large investment into fuel search and development, that usually falls onto individual business responsibility.

In order to overcome the structure problem on energy industry, and to invite more players to join the Indonesian geothermal businesses, experts suggest there is a need to formulate strategies taking the following issue into account:

- Competitiveness of Geothermal Energy Price;
- Continuing Subsidy of Fossil Fuel Price;
- Lack of Political Will to Intensify Geothermal Energy Utilization;
- Shortage of Competence Human Resources;
- Absence of Technology and Research & Development Supports;
- Lack of renewable incentives;
- Lack of Risk Appreciation and Mitigation Efforts;
- Absence of Integrated Energy Planning;
- Lack of Information and Publicity on Indonesia'
- Geothermal Potency and Benefits; and Low Environmental Awareness.

(Darma, et al., 2010)

It is, however, still not clear how these backgrounds can be translated into more specific policy options. One way to identify the policy options is to focus on the current policy barriers, because once they are identified, they can be easily converted as the policy targets to be overcome. Threrefore, the next section is going to introduce some of the issues being identified as main barriers for the energy industry framework.

4. Methodological Proposal

Determining how to achieve the Indonesian geothermal target requires considerable thought. There is a need to clearly demonstrate a feasible path to deliver the goal. With this in mind, the research proposes a method to connect a normative target and the current situation. Since the Indonesian geothermal taget is ambitious, a backcasting structure is relevant as a conceptual framework.

The Backcasting framwework involves working from a normative future, to identify how the future could be achieved, through a range of policy measures. The major difference between the forecasting and backcasting methods is that the latter concerns the “implications of different policy goals”, while the former indicates "what the future will likely be” (Robinson, 1982). The fundamental philosophy behind the backcasting is a will for a discovery and understanding on human choices to retain freedom of action, rather than an assumed causality over the things that happen (Dreborg, 1996).

The elements of discovery and learning, however, are difficult to be formalised as a systematic policy methodology. It is here propose the Indonesian geothermal development requires systematic policy process which connect the prescribed target and the currently available insitutions and legal tools with imaginable policy options that overcome the gaps between them.

There are, however, a wide range of policy measures potentially available to achieve prescribed target. The policy options can create policy roadmap that connect the desired future and the status quo. This is particularly important to notice the current Indonesian geothermal roadmap is not linked to policy consideration to deliver the prescribed target.

4.1 Policy Roadmap for Indonesia Geothermal Development

The “Policy Roadmap” is a methodological device that demonstrates what policies are needed to trigger changes, in advance to future events unfold, identifying within the framework of the backcasting approach (Suwa, 2005). The combination of backcasting and the “Policy Roadmap” approaches would produce powerful inputs to decision making, as they enable proactive policy planning that ensures freedom of action, through clear guidance on the scope and timing of necessary policy interventions.

Roadmaps is generally to provide “common language and structure for both the development and the deployment of strategy” (Phaal and Muller, 2009). Roadmapping has been mostly driven by practitioners, such as companies, governmental agencies and consulting firms. Roadmaps are also identified as “a tool for collaborative strategic planning, that enable us to make strategies and take actions towards the desired future, with special emphasis on anticipating changes in Technologies and new business opportunities” (Kamtsiou, et al., 2006). There are generally main two elements in roadmap: timeframe, typically the vertical axis, and task layers, horizontal axis. Some structural examples are demonstrated by Phaal and Muller, which shows a visual time based, multi-layered chart providing a structural framework (Phaal et al., 2001).

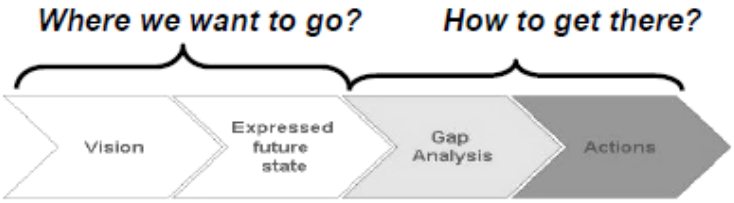

Figure 7. Roadmapping stages (Kamsiou, 2006)

Roadmapping can be categorised as one branch of gap analysis, where the gaps between expected and desired future situations lays proposal for actions and recommendations aiming to bridge them. A roadmap includes a foresight dimension, but it is not a tool for predicting the future. Roadmapping is essentially an instrument of modeling and disseminating visions,

facilitating communication, knowledge sharing and collaborative strategic decision-making within an organization, across organizations or at national or transnational level (Ioannou, et al., 2009).

Most literature is currently focusing on its applications to enterprising planning and diffusion of technology strategies, whereas its applications to policy process is limited (Ioannou, et al., 2009). Application of roadmapping to policy dimension shall be particularly important, especially in Indonesia where the geothermal road map is not connected to the policy discussion, and there is much uncertainty as to how and who would formulate and implement these strategies to link them into effective geothermal administration. Policy roamap should be organised to systematically make steps to the defined target.The timing of introduction of the policy options and the strength of their implementation also have to be identified, so that synergies among the policy options can be maximised.

Also roadmapping, the process of making a roadmap, is significant itself as the process would assist in building consensus and incorporate an important knowledge creation and learning dimension. Ownership of this roadmap is critical, it could firstly conceived by a single designated person or group of people (committee or steering group), but can be shared ultimately on a wider basis among the stakeholders as a communication tool (Phaal et al., 2001).

A particular emphasis should be given to policy implementation aspects, as it has been generally experienced that the most challenging task after policy roadmapping is the deliveration of policy objectives. It is particularly the case in developing countries, including Indonesia, where relatively weak central/local government capacity of policy implementation has often resulted in delay in achieving desired policy targets.

4.2 Stakeholder Involvement to Roadmapping Procedure

A variety of energy experts shold be invited to the policy roadmap construction processes. The backcasting methodology generally requires qualitative judgement on the prescribed target and the way to get there, involvement of multiple experts should be designed to give an assessment on the consistency between the future targets and the paths leading to them.

The important aspect of the roadmapping process is that the process itself is already a part of the dissemination strategy of the project results. It serves as a means to interact with the key figures in the energy policy field, who could have influences on the real policy formulation process. Particular attention was therefore paid to contacting those who are active and open to strategic policy making. Also, a great care has been taken to have a wide spectrum of backgrounds, so that their inputs can be instrumental in clarifying alternatives and priorities.

So far, the main options to be considered can be summarised as 1) addressing geothermal exploration risk, 2) establishing a segmented pricing framework, and 3) funding the incremental cost gap, as identified. Exisitng literature suggests that, by coordinating these options, future Indonesian geothermal development framework should be look like. The Indonesian Minstry of Energy and Mineral Resources, for example, identified the future geothermal development procedure shall be drawn as demonstrated in Figure 8.

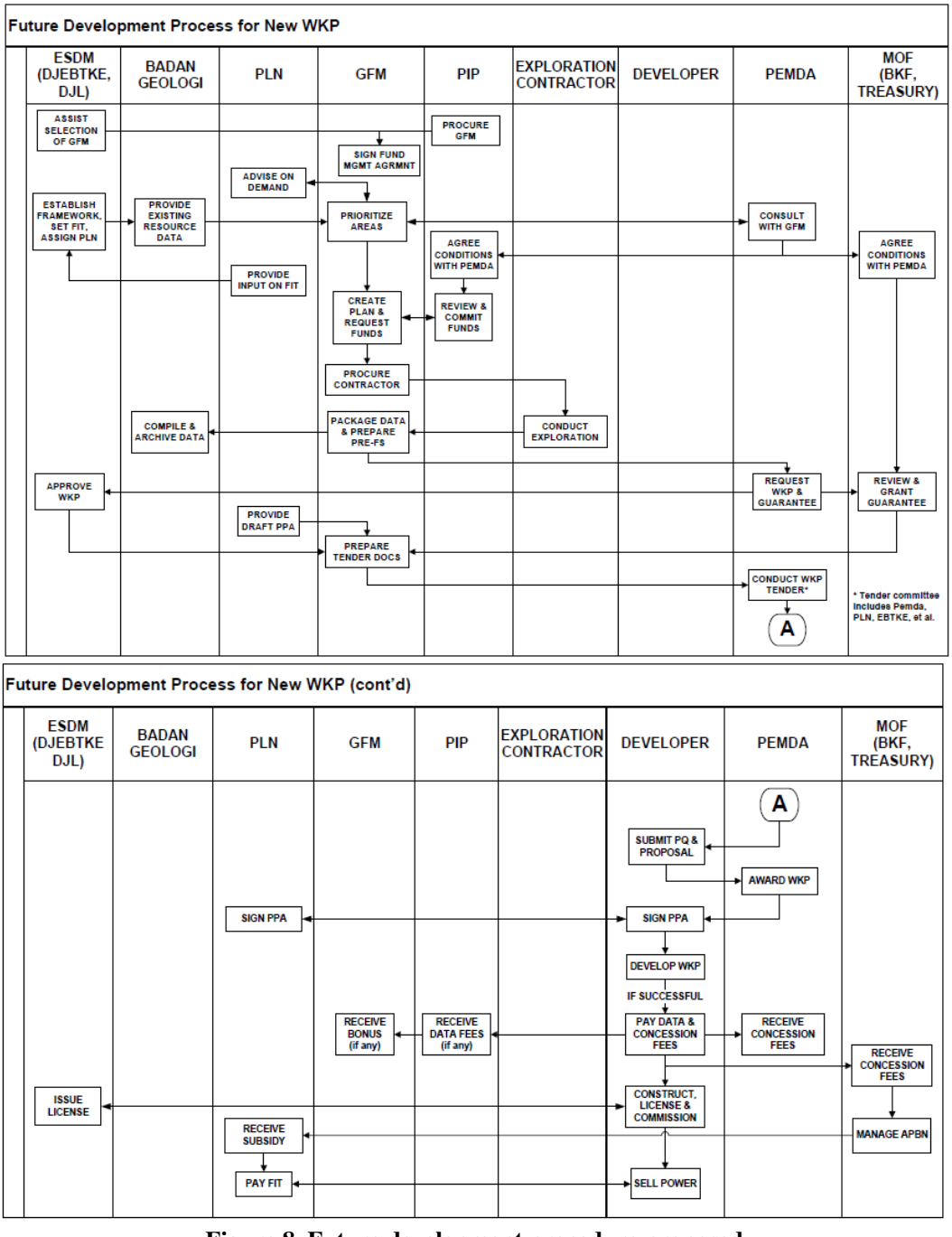

Figure 8. Future development procedure proposed
(Ministry of Energy and Mineral Resource, 2011)

It is, however, still not clear how to deliver the future development procedure, unless there is a clear guidance as to how allocation of responsibility and task coordination is framed to make the framework feasible. Thus policy options (measures) should be organised to create policy roadmaps which are systematically ordered to make steps to the defined target and structure. In Indonesian case, the policy roadmap should clearly address a clear guidance on the fall of

responsibility, schedule of implementation, policy option programs, and cost allocation to the individual policy option programs.

Conclusion

Indonesia is one of these countries where high temperature geothermal resources are available. In the year between 2005 and 2010, Indonesia saw the significant level of installed capcity increase, but its growth is relatively modest when its physical potential for electricity generation is taken into account. The Indonesian government recently established a goal to increase geothermal resources by 9,500 MW by 2025, becoming the world's largest producer of geothermal energy.

It is, however, not certain how the Indonesian government is going to reach the target. The Indonesian geothermal roadmap, for example, is not linked to the policy dimension who, what, when and how the prescribed capacity increase shall be implemented. The responsibility and policy schedules have to be clearly demonstrated, especially in the Indonesian energy market shere a great deal of structural problem being the barriers for geothermal and other renewable capacity increases.

Roadmapping is one of the techniques that could provide useful framework to identify the links between prescribed futures with the tasks necessary to deliver the future. It is currently a normative approach generally found in the industry and science/technology, but its application to policy aspets will address "what should be done" to reach a national energy policy target.

This paper raises an issue on identifying the policy options available to the Indonesian government to reach the target. So far, the main options to be considered can be summarised as 1) addressing geothermal exploration risk, 2) establishing a segmented pricing framework, and 3) funding the incremental cost gap, as identified. There shall be a need for "policy roadmap" for Indonesian geothermal devlopment that demonstrates the policy program administrative schedule, that identifies and allocate responsibilities and time schedule for policy implementation.

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References

Bertani, R., (2010), Geothermal Power Generation in the World - 2005–2010 Update Report, World Geothermal Congress 2010, Bali, Indonesia, April 25-30, 2010, available at: http://www.geothermal-energy.org/pdf/IGAstandard/WGC/2010/0008.pdf

Darma, S., Harsoprayitno, S., Setiawan, B., Hadyanto, Sukhyar, R., Soedibjo, A.W., Ganefianto, N., and Stimac, J., (2010), Geothermal Energy Update:Geothermal Energy Development and Utilization in Indonesia, Proceedings World Geothermal Congress, Bali, Indonesia, April 25-30, 2010, Available at: http://www.geothermal-energy.org/pdf/IGAstandard/WGC/2010/0128.pdf

Dickson, M.H., Fanelli, M., (2004), What is Geothermal Energy?, http://www.geo-energy.org/pdf/reports/GEA_International_Market_Report_Final_May_2010.pdf, retrieved 2011-12-12

Dreborg, K., (1996), Essence of backcasting, Futures, Volume 28, Issue 9, Pages 813-828

E.Terras AG, (2007), Geothermal in Indonesia, http://www.dena.de/fileadmin/user_upload/Download/Veranstaltungen/2007/07/4.4._Geothermie_in_Indonesien.pdf

Hochstein, M.P., Sudarman S., (2008), History of geothermal exploration in Indonesia from 1970 to 2000, Geothermics, Volume 37, Issue 3, Pages 220-266

International Energy Cooperation Website, (2011), Indonesian IPP Report, available at: http://apecenergy.tier.org.tw/database/db/ewg20/gndppr/10.3-4.pdf

International Geothermal Association (IGA), (2010), Installed Generating Capacity http://www.geothermal-energy.org/246.direct_uses.html

Ioannou, C.A., Panagiotopoulos, P., Stergioulas, L., (2009), Roadmapping as a Collaborative Strategic Decision-Making Process: Shaping Social Dialogue Options for the European Banking Sector, World Academy of Science, Engineering Technology, vol. 54.

Jakarta Updates.com, (2010), Indonesian Electricity Price for Renewable Energy, available at http://www.jakartaupdates.com/344-09/indonesian-electricity-price-for-renewable-energy

Jupesta, J., Wicaksono, A., Suwa, A., (2011), Modelling Geothermal as Low Carban Sources in Indonesia, 30th USAEE/IAEE North American Conference, 9-12 October, Washington DC, USA.

Kamtsiou, V., Naeve, A., Stergioulas, L.K. and Koskinen, T., (2006), Roadmapping as a knowledge creation process: The PROLEARN roadmap, Journal of Universal Knowledge Management, Vol.1, No.3, pp163-173

Ministry of Energy and Mineral Resource, (2011), Geothermal Pricing & Incentive Policy Study: Policy Recommendations Workshop, 30 November 2011, available at: www.castlerockasia.com/

Pertamina Geothermal, Brief History of Pertamina Geothermal, available at: http://pge.pertamina.com/index.php?lang=en&option=com_content&view=article&id=66&Itemid=39

PLN Geothermal, availabla at http://plngeo.com/geothermal-energy/geothermal-in-indonesia

Phaal, R., Farrukh, C. and Probert, D., (2001), Technology Roadmapping: linking technology resources to business objectives. Centre for Technology Management, University of Cambridge.

Phaal, R. & Muller, G., (2009), An architectural framework for roadmapping: Towards visual strategy, Technological Forecasting and Social Change, vol. 76, no. 1, pp. 39-49.

Robinson, J., (1982), Energy backcasting: a proposed method of policy analysis. Energy Policy 10 4, pp. 337–344.

Suwa, A., (2009), Soft energy paths in Japan: a backcasting approach to energy planning, Climate Policy, Volume 9, Number 2, pp. 185-206 (22)

Trading Economics, (2011), Electricity production from coal sources in Indonesia, available at: http://www.tradingeconomics.com/indonesia/electricity-production-from-coal-sources-percent-of-total-wb-data.html

US Energy Information Administration, Country Analysis Indonesia, http://www.eia.gov/countries/cab.cfm?fips=ID

Silviati, A., (2005), Electricity Power Sector In Indonesia, U.S. Commercial Service, Jakarta, available at: 11/8/2005http://www.nema.org/gov/trade/briefs/indo_elecsurvey.pdf