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Schematic Approach to Boost Geothermal Direct Use Development in Indonesia

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ABSTRACT

Despite the rapid growth of direct use development world-wide, predominant focus on geothermal power generation development in Indonesia, has kept direct-use development in Indonesia remained ever marginal. Nevertheless, the potential opportunities and strategic values offered in direct-use development should have entailed direct-use a more considerable role to support geothermal power development and the general energy provision in Indonesia. Therefore, a schematic approach consisting systematic efforts is required to overcome the challenges and to shift the current development paradigms in order to revitalize direct-use development in Indonesia. Also provided in this paper, are the key considerations and direct-use development concepts which can be potentially applied in various geothermal area development circumstances.

1. INTRODUCTION

Geothermal power development bottlenecks in Indonesia have remained largely unresolved despite the sole focus and efforts poured towards the aggressive geothermal power generation campaign. Meanwhile, direct-use applications, as well as the other forms of low-temperature geothermal resource utilization i.e. small-scale power generation and non-conventional geothermal systems, has hardly taken any significant attention and yet to be considered as an unlikely measure to bring geothermal development in Indonesia back on course. Nevertheless, although the fact that there are still plenty high-enthalpy under-tapped hydrothermal resources to be exploited in Indonesia, direct-use of geothermal energy offer solutions we simply cannot ignore. Statistics has shown that countries world-wide develop and took direct-use incredibly serious as if they were fiercely competing with each other.

Table 1: Global geothermal power generation and direct-use production capacity (Bertani, 2010; Lund et al., 2010)

Geothermal Electricity Production		Geothermal Direct Use	
Country	GWh/yr	Country	GWh/yr
United States	16,603	China	20,932
Philippines	10,311	United States	15,710
Indonesia	*9,600*	Sweden	12,585
Mexico	7,074	Turkey	10,247
Italy	5,520	Japan	7,139
Iceland	4,597	….	
New Zealand	4,055	*Indonesia*	*11.8*

Meanwhile, although Indonesia is amongst the leading world producers of geothermal for power generation, astonishingly Indonesia has an extremely low recorded volume of direct-use annual capacity (11.8 GWh/yr based on Lund et al., 2010). In contrast, countries gifted with hydrothermal resources similar to Indonesia e.g. United States, Japan, Iceland, Italy and New Zealand, have relatively equal or proportionate volume of direct-use compared to its geothermal electricity production. The climatic conditions of non-tropical countries that perfectly suits and allow a greater use of ground-source heat pump (GSHP) systems along with development of district heating systems, may have a significant contribution to the large numbers of direct-use utilization in most of the countries. These applications in tropical countries is yet to be economical and instead often seen irrelevant. However, even if we take ground-source heat pump (GSHP) and district heating applications from those numbers, the volume of direct-use activity in Indonesia is still worryingly low.

With vast ranges of agriculture, aquaculture and fishery commodities produced adjacent to geothermal areas, as well as the large interest of people for bathing, swimming and therapeutic use using hot geothermal water, theoretically, geothermal use in Indonesia for industrial processes, recreation and tourism should have been way more considerable than what is shown in the worrying statistics. Accordingly, provided in the following sections, are the present challenges, strategic values, potential opportunities and schematic solutions to revitalize direct-use development in Indonesia.

2. DIRECT-USE DEVELOPMENT CHALLENGES AND PARADIGMS

2.1 Current Direct-use Development Challenges in Indonesia:

These are some of the key challenges identified in current direct-use development in Indonesia, in which each of the challenges strongly correlates with one another:

- Direct-use applications are not presently viewed as an attractive proposition for development
- Implementing regulations and policy framework that sets out detailed rules and systems are still not available
- There are no schematic and strategic plans for long-term direct-use development

Apart from the recreational/tourism applications of geothermal, the unattractive proposition of the current direct-use projects in Indonesia are mainly related to the lack of investment security that corresponds to the project sustainability of a long-term direct-use business project. This continuation requires clear short and long term policies that at least guarantee the supply of geothermal energy to ensure the supply-chain of a particular business cycle. Indonesia also faces insufficient number of direct-use experts with adequate technical and commercial direct-use capacities, which may have been resulted from the lack of interest towards the "less interesting" direct-use development and has resulted to suboptimal bridge to resolve the gap between user requirements and utilization requirements.

Moreover, plenty of studies and assessments related to direct-use applications have been carried out and applied throughout the country, with most ending up at a demonstration project or prototype phase. Accordingly, current existing or developed direct-use projects mostly fail to maintain an economical commercial performance or to grow much further on. This un-preferred direct-use development condition may probably be caused by several paradigms that people still consider and often wrongly take regarding to direct-use development in Indonesia.

2.1 Direct-Use Development Paradigm in Indonesia

2.1.1 Direct-Use Project Initiation and Scale of Development

The scale of development (business scale) of a direct-use project in a particular geothermal field in Indonesia will always be limited to a level where the volume of used energy (geothermal mass intake) will not have an adverse impact to the production activity and capacity. Therefore, direct-use projects are limited to micro-small medium scale enterprises, which requires less use of geothermal energy, or only to be part of a field developer's Corporate Social Responsibility (CSR) program. The use of brine from a power generation activity or heat directly harnessed from an available surface manifestation will be sufficient for this scale of development. For these reasons, the presence of direct use projects, in most of these cases, highly depends on the field developer's initiatives, in which they have more critical focus on their power generation activities rather

A significantly larger scale of development will require a greater volume of energy from geothermal resource, often more than the brine from power plants could provide, therefore, drilling activities will be necessary. For instance, a large pulp industry or district heating/cooling system using geothermal could require several production and injection wells to provide the required energy. Therefore, major industrial use or district energy systems that take substantial consumption of geothermal resources in geothermal power development areas are presently irrelevant due to the concerns of potential adverse impact towards the main power generation activity.

2.1.2 Strategic Value of Electricity

Electricity's strategic value will always be, rightly, superior to any possible commodity that uses direct-heat use of geothermal energy. Direct-use of geothermal energy has limited distance of benefit due to the temperature and pressure drop when moved from one location to another. On the other hand, electricity could be transported to anywhere, for any end-use activity, and for any destined user. The urgency and growing concerns towards present power deficiency in Indonesia have also raised the strategic value of electricity provision from power generation developments. The governing concept that requires a single buyer (The National Utility Company) obliged to purchase electricity from geothermal power generation, in a way, also reflects the urgency of power provision. In the other hand, post direct-use commodities require additional and self-efforts in searching potential demand and market.

This perspective of the incomparable value between electricity and direct-use commodities are often wrongly taken, causing people to consider the whole geothermal industry development as an order or ranks of priority stacked with geothermal power development as the top priority and places direct-use development as the least priority to be addressed. Contrarily, direct-use development should have been taken as one of the measures and supplement to support geothermal power development in Indonesia, as how geothermal capacity building through education has been considered as a supporting aspect to accelerate geothermal power development in Indonesia.

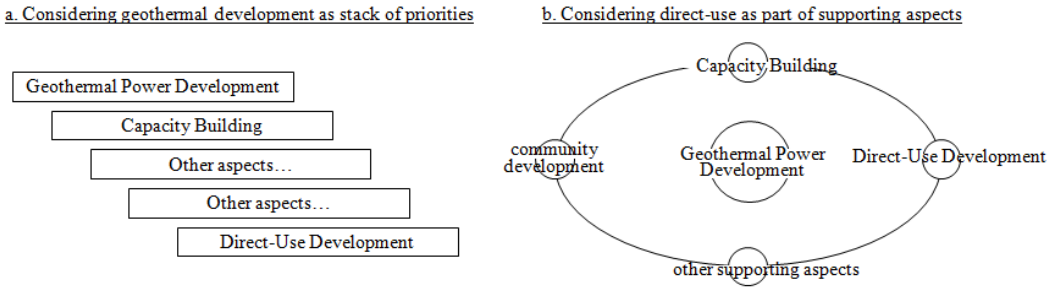

Figure 1: Different approach and perspective towards direct-use role

2.1.3 Direct-Use Applications in Non-Geothermal Areas

Despite the controversies whether ground-source heat pumps (GSHP) has been properly categorized as part of geothermal energy, the huge success and wide application of ground-source heat pumps (GSHP) in the global industries, in a way, has inevitably

managed to promote the overall geothermal predicate/name in the energy industry and public. However, it is widely believed that ground-source heat pump (GSHP) is completely irrelevant to be applied in tropical countries, including Indonesia. Nevertheless, despite having lower efficiencies, ground-source heat pump systems (GSHPs) may still provide considerable energy savings once applied in the tropical climate of Indonesia when several adjustments are applied (Taqwim, 2014). Placing more considerable efforts in developing "tropical-adjusted" ground-source heat pump (GSHP) will result better efficiencies of the systems and further improved energy savings, in which will certainly give extra advantage in promoting geothermal in the future.

It is quite encouraging that Indonesia has begun to investigate and measure the opportunities to explore non-hydrothermal or non-conventional geothermal resources, such as hot-sedimentary aquifers and geo-pressured geothermal systems. The ability to harness these resources in the future will open significantly more attractive applications, for instance: district cooling, coal drying and broader seawater desalination application. In another words the presence of these resources will manage to place geothermal much closer to the larger demands. Regardless of the premature stages, studies regarding these direct-use applications should start from now.

3. KEY DIRECT-USE DEVELOPMENT ISSUES IN GEOTHERMAL AREAS

In order to simplify the identification of key issues in geothermal areas, the scope of area is divided into 3 general categories:

1. *Existing Geothermal Power Development Areas*: Areas where a geothermal power development or operation has existed before any considerable direct-use activity took place e.g. Darajat, Kamojang, Wayang Windu and all geothermal development areas across Indonesia
2. *Existing Geothermal Direct Use Development Areas*: Areas where considerable direct-use activities have existed before any geothermal power development took place e.g. Ciater geothermal area (hot-water springs, tourism)
3. *Greenfield Prospect Areas*

3.1 Existing Geothermal Power Development Areas:

Since geothermal power development or operation has existed before any considerable direct-use activity took place, the main issue (as explained in section 2.1.1) is the field power developers concern of direct-use activity impact towards the power production. Limited and controlled brine use from power generation activity and direct geothermal fluid usage from manifestation will have insignificant impact towards the geothermal reservoir and the power production activity. However, it is the larger scale of direct-use activity, which usually requires drilling activities to produce a large amount of geothermal water that will end up resulting significant impact towards the power generation activity and geothermal reservoir. Despite the large scale of direct-use activity or major industrial geothermal use in Indonesia is still uncommon, it is necessary to anticipate the possibility in finding this situation in the future.

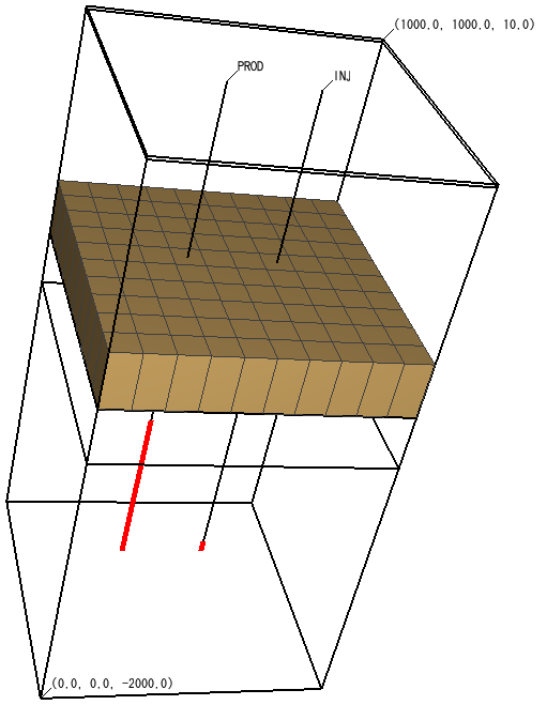

Figure 2: Synthetic model of direct-use activity constructed using Petrasim Software for a simplified reservoir simulation

Accordingly, these impacts should be interpreted and further converted as a particular compensation that must be paid by the user of geothermal for direct-use activity towards the geothermal power field developer. If the compensation is further defined as a certain cost or royalty to the field developer, then ideally the cost should be a function of mass flow-rate, intake temperature, reinjection temperature and production issue constant (scaling, corrosion, etc.) or it could be also a function of kWh, energy used for the direct-use activity. This is due to the different productivity we will find when drilling in one location to another and the various changes of reservoir dynamics in response to different reinjection temperature values. The formulation of this compensation

cost or energy price ideally requires a particular assessment towards the dynamics of the geothermal reservoir considering the impact of direct-use activity, with various of scenarios, in which may be comprehensively provided by conducting a typical reservoir simulation (Figure 2). Therefore, the formulation of the compensation cost or energy price will vary from one location to another. An alternative formulation of the energy price is to just to simply correlate the existing power purchase price with the deviation/margin of the production decline due to the direct-use activity.

Furthermore, in determining a reasonable range of compensation cost, the compensation should take into account the economic competitiveness aspect for using geothermal energy instead of other energy resource or fuels, which may be considered as upper merit of the cost value. Meanwhile the lower limit is the estimated loss regarding to the impact of direct-use activity. However, in particular for the case of existing geothermal development areas, since the reserves of the geothermal area is relatively more accurate (proven) and the electricity purchase price has been determined, the compensation may be derived or proportionate from the electricity purchase price.

3.2 Greenfield Prospect Areas

For large potential direct-use activities in Greenfield areas cases, it is expected that there is a possibility that direct-use activity could be carried out earlier than the field power generation development (section 4.2) and thus the electricity purchase is not available at present, the determination of compensation cost or royalty by reservoir simulation seems to be mandatorily required with concept as explained in section 3.1.

3.3 Existing Geothermal Direct-Use Development Areas:

Another possibility of direct-use development in Indonesia is that the direct-use activity could have been established or existed far earlier or even before a power development campaign took place. Opposite to existing geothermal power development areas, the main issue is the concern of direct-use developers of the impact of direct-use activity towards the existing direct-use productivity or feature extensiveness (especially in geothermal tourism sites and hot water pools). In some cases, these concerns are followed by systematic propaganda and rejection towards any geothermal power development campaign in the area. Therefore, a similiar compensation cost approach with a particular assessment towards the dynamics of the reservoir or even the geothermal system as explained in section 3.1 may be required.

4. POTENTIAL MEASURES TO REVITALIZE DIRECT-USE DEVELOPMENT

4.1 Provide Key Supporting Instruments for Direct-Use Development

To be able to progress much further in the long-term direct-use development, it is crucial to have these key instruments i.e.:

1. Regulatory and policy framework
2. Database and information system: inventory of direct-use volume of activities and prospects
3. Direct-use development roadmap
4. Institution with direct-use technical, commercial and legal assistance capacity

In the leading direct-use countries, these key instruments has been provided years ago (>30 years ago) by other leading direct-use countries and has been improved from time to time. Conversely, these instruments have not been provided comprehensively in Indonesia due to the challenges and development paradigm explained in section 2. For instance, although the governing geothermal regulation exists, the detail and implementing regulations has not been developed until present. Although it seems rather uncomplicated, establishing these key components comprehensively requires further systematic and specific efforts

4.1.1 Regulatory, Policy Framework and the Role of Local Governments

Based on the governing geothermal regulation in Indonesia, direct use development is largely part of The Local Governments (province, city or district) authority. Therefore, local governments will have a key role in taking the main initiative to encourage direct-use development in Indonesia. This initiative should begin with the establishment of supporting policies and regulatory framework that specifies the detail provisions for direct-use development in Indonesia and also to encourage direct-use technology development. For instance, West Java Provincial Government, through the energy and mineral resource agency, is currently preparing the early materials required to set up supporting policies and regulatory framework necessary for direct-use development in their province. Related assessments and studies are conducted, e.g. direct-use energy price, compensation, supply chain management, institutional framework, financial support and incentives scheme etc., in which the results will be used to construct academic documents/scripts prior legislation. Furthermore, these policies will not only secure investment for a direct-use project but also to secure and protect the geothermal power developers and other stakeholders interests.

4.1.2 Database and Information System: Inventory of Direct-Use Volume of Activities and Prospects

A direct-use database and information system is not comprehensive unless it consists accurate and detail information regarding to direct-use volume of activities and prospects. This information is a benchmark for any further direct-use development and should be able to be easily accessed by potential geothermal users. Currently, data regarding the volume of activities (GWh/yr) and prospects is mostly inaccurate (underestimated) and incomplete.

4.1.3 Direct-Use Development Roadmap

In order to have a schematic approach in developing direct-use in their region, West Java Provincial Government has defined a regional direct-use development scheme that describes their efforts for short-, medium- and long-term (Table 2). These are the minimum efforts and key steps that the local government must go through regarding to direct-use development. Accordingly, direct-use development responsibility and authorization has been given solely to the provincial government based on the new principal geothermal governing regulation, Geothermal Regulation No.21/2014. Therefore, the provincial governments will have a great role in the development of direct-use activities in Indonesia.

Regarding to direct-use technology development, The West Java Province is completing the prototype of air-conditioning systems using available domestic ground-water wells for ground-water heat pumps, in which in the future, such systems are expected to be developed across the region. Despite having lower efficiencies, ground-source heat pump systems (GSHP) may still provide considerable energy savings once applied in the tropical climate of Indonesia with several adjustments are applied (Taqwim, 2014). Moreover, The West Java Province is also investigating other (new) opportunities of direct-use applications and activities, which in the future can be applied in West Java e.g.:

- Measuring opportunities for Sea-water Desalination (Potential geothermal areas for application: Cisolok-Cisukarame and Gunung Kromong)
- Tropical-adjusted ground-source heat-pump system applications in households, commercial buildings and industrial purposes.
- Revitalization of the hot geothermal water bathing, swimming and Spas across West Java
- Initiating world tropical-geothermal-use conference

Table 2: West Java Province regional direct-use development scheme

Development Aspects	Short-Term (in the next 0-3 years)	Medium-Term (3-5 years)	Long-Term (>5 years)
	Main objective: Revitalization	**Main objective:** Commercialization	**Main objective:** Acceleration
Policy and Regulatory Framework	Preparing supporting materials for policy and regulatory set-up e.g. direct-use energy price, compensation, supply chain management, institutional framework, financial support and incentives scheme etc	Set-up and establish policy, legal and regulatory framework for direct-use development (Legislation)	Harmonization of direct-use policies and regulations with non-conventional geothermal development (EGS, HSA, etc) policies and regulations
Technology, Innovation, Research & Development	Inventory of direct-use volume of activity in West Java and Direct-Use Potential Development Map	Code and Standards, Best Practices, Guidebooks, Institution for legal and technical assistance	Direct-use application available in all geothermal areas (mandatory part of geothermal power development activity).
	Resource characterization and market identification for direct-use applications in West Java		Utilization of non-hydrothermal and EGS resources for Direct-use applications
	Revitalization and optimization of existing direct use projects		
	Direct-use feasibility studies, prototypes and project demonstrations		
Collaboration	Establish a new dedicated institution or nominate from existing institution for direct-use technical, commercial and legal assistance		
Others	Promoting, awareness, Public acceptance	Market penetration to major industries	

4.1.4 Institution with Direct-Use Technical, Commercial and Legal Assistance Capacity

In the later stages of direct-use development in Indonesia, it is necessary to have an institution that has sufficient capacity and resources to provide technical, commercial and legal assistance for any interested party who intends to develop a direct-use project or to utilize geothermal energy for their business. This institution could be a new established entity that is dedicated for direct-use development or part of a large institution/entity which has enough resources to provide such assistance and capacity. The West Java Provincial Government along with other geothermal stakeholders in The West Java Province has initiated the establishment of "West Java Geothermal Center of Excellence", which one of its tasks is to provide such capacities.

4.2 Extreme Scenarios: Direct-Use Placed as Mandatory Activity to Begin a Particular Geothermal Power Development

Geothermal power development in several areas in Indonesia has been inundated by resistance from the local people, which led to development hold ups and slow downs. Most of these acceptance issues rise from local people's lack of awareness and understanding towards the actual activities and benefits of geothermal development in their areas. Moreover, the "surprise/shock effect" experienced by local people in the early stages of development, since the presence of heavy machines and sudden disturbance to their area, may also trigger their resistance later on.

Direct-use developments have a significantly smaller scale of activity and hype compared to geothermal power development by having lesser machines and disturbance introduced in the local area. Accordingly, direct-use activity could therefore be used as a

starting interface to begin a power development campaign by lowering the “surprise/shock effect”, while also be potentially used as a media to insert early awareness and to give early understanding tucked in slowly to the locals during the direct-use project development.

In accordance, by placing the direct-use activity in the early stages of power development, it is therefore possible to have earlier involvements of the local people rather than later involvement promised after a minimum of 5 years of power development, such as job employment for local people during operation stages, which often may be too late and the resistance has gone far. This approach could potentially be joined and combined by micro-small scale power development, in which aims to electrify the entire local environment prior to the large scale geothermal power development. Moreover, other similar advantageous features between small scale-development and direct-use development is that both could potentially improve local and domestic economy through the major use of local content/components, early local people involvements and productivity improvement of the domestic commodities (direct use) or significantly improved electrification ratio of the area (small-scale power generation).

5. CONCLUDING REMARKS

Due to the specific geothermal development background and paradigms, direct-use in Indonesia requires a schematic approach that requires rectification right up to the fundamental direct-use development concepts in order to revitalize direct-use development in the country. A particular approach would be required by considering the specific conditions. This study require much further works to detail the provided concepts.

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