Geothermal Market Analysis of Indonesia

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ABSTRACT

A mechanism was developed to systematically quantify the geothermal market in Indonesia and translate the traditional geothermal industry nomenclature of capacity additions over time (MW/yr) to development spend ($/yr) and quantify the geothermal market in terms of dollars and cents. This translation enabled quantification of the likely development spending in the largest potential geothermal market in the world. Information acquired through this analysis was used to engage with the local stakeholders and create a strategic business plan. This paper presents the evolution and analysis of the method used to analyze the Indonesian geothermal market, and discusses how this method can be adapted for use in other countries to further understand the global geothermal market.

Introduction

The global geothermal industry is expected to grow very rapidly in the coming years, from in 13.3 gigawatts (GW) of installed capacity as of January 2016 to an estimated 18.4 GW by 2021 (GEA, 2016). We know which countries have the largest installed capacities, but it is the countries with emerging markets and developing geothermal infrastructure that offer the most opportunity for growth. Indonesia is not only third worldwide in installed geothermal capacity, it also far exceeds all other countries in estimated geothermal potential and has a rapidly growing demand for electricity. Considering the ambitious plans by the Government of Indonesia (GoI) for geothermal development of 6,000 megawatts (MW) by 2020 (a total 9,500 by 2026), a targeted geothermal market analysis of Indonesia is a worthwhile endeavor.

As a step along the path of fulfilling an ambitious geothermal development program, GoI embarked on a country-wide assessment of geothermal potential. The government's geothermal database available in 2014 developed by the Ministry of Energy and Mineral Resources (MEMR), Indonesia, and PT PLN (Power Supply Business Plan, 2012-2021) had 276 fields and an estimated country-wide potential of 29,000 MW. But what does 29,000 MW mean in terms of money, what is the available market, and how many of these are really going to be developed? How can we communicate, in a systematic way, the size of a market that is not quantified in dollars and cents?

A mechanism was developed to systematically quantify the geothermal market in Indonesia and translate the traditional geothermal industry nomenclature of capacity additions in MW over time (MW/yr) to development spend ($/yr). This paper presents the evolution and analysis of the method used for the Indonesian geothermal market analysis in 2014. It also presents how this method was adapted for use in other countries and how it will be used in the future to further understand the global geothermal market.

Methods

Obtaining a clear picture of the geothermal market in Indonesia requires an understanding of several important factors:

- where development was and is occurring;
- where it will occur in the future; and
- who is doing it; and
- the likely development timelines.

We began our analysis with the Indonesian government's geothermal field data base compiled by MEMR. The database included a list of all the recognized geothermal areas as of 2014 along with their location, current status, developer involved (if any), and expected capacity based on preliminary surface data collected by various government agencies including MEMR, PLN, and Pertamina Geothermal Energy (PGE).

Although there are many geothermal areas in Indonesia – 276 in total according to GoI – not all are suitable for power production. Therefore, GeothermEx evaluated geothermal areas and reduced the number to 66 areas that already host or are likely to host geothermal projects. The selected projects included operating fields, fields in development, and fields with a high likelihood of development in the near future (the next 5 years). The likelihood for development was determined based on interest in the project from developers, interest from GoI, and the probable existence of a substantial and exploitable resource.

Detailed information was then gathered on the selected projects to be able to classify each one into a geothermal development stage. Based on the most up-to-date information at the time, each of the 66 projects was classified according to the five stages presented in Figure 1. Then, an estimate was made of the duration of each stage and the lag-time expected to occur between stages, which allowed the construction of a development time line, once the stage of each project was identified. Constant values were used for duration and lag time for all projects at the same stage of development. The duration of each stage is influenced by the existing geothermal legislative framework, the available infrastructure and the technical geothermal experience available in each country; that is, this is country-specific and changes with time, requiring periodic updates based on trends and current conditions in the country analyzed.

The stages of the projects were particularly important because it facilitated the development of a timeline for each project. The largest expenditure, before power plant construction, in the development of a geothermal resource is the drilling of full-diameter wells. For this reason, the market analysis was based on the potential number of wells drilled per MW developed. Surface exploration activities,

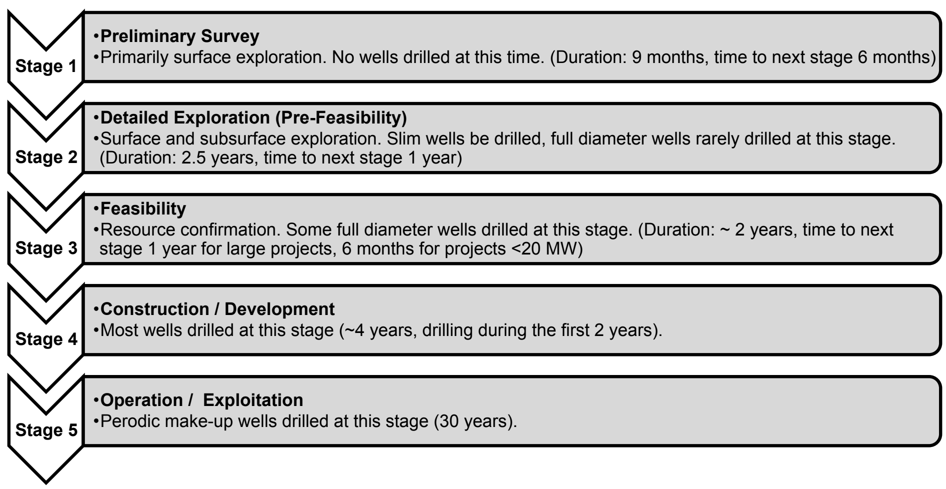

Figure 1. Stages of Geothermal Project Development for Market Analysis.

Table 1. Geothermal Market Analysis – Equation Assumptions.

Variable	Value	Comments
MW	9	High Enthalpy resource, thus a large MW/well yield
% Success Rate	68 %	Success rate remains constant; unsuccessful wells are abandoned
Standby wells	20%	20% of the wells needed to maintain production will be available in case needed.
Injection:Production Well Ratio	1/3 (0.33)	Injection wells are assumed to be drilled after all successful production wells are drilled and a 100% success rate is assumed
Fraction of wells drilled during Feasibility Stage (for projects ≤10 MW)	100%	Drilling will take the entire duration of the feasibility stage
Fraction of wells drilled during Feasibility Stage (for projects >10MW)	1/3 (0.33)	Drilling will happen during feasibility and development stages.
Make up wells	5%	Yearly replacement of 5% of the wells necessary for production. Over the entire operational life (30 years) of the plant

which comprise a small percentage of total expenditure in geothermal development, were estimated based on the expected project size (installed capacity in MW) reported by the MEMR.

Once the stage of each project was identified, monthly timeline of development activities that were likely to occur was constructed. The estimated installed capacity was known for each of the 66 projects, with this information an simple equation to systematically transform the expected MW to potential development spend ($) over time was developed.

The assumptions for this equation are detailed in Table 1. These assumptions are based on years of experience working in Indonesia and information from several relevant published papers such as Sanyal et al., 2011. All of the assumptions presented are time and country specific and should be reviewed if an update is to be done to the market analysis or if it is to be applied to a different country.

In the case of analyzing a single project, the wide ranging assumptions are not valid and determining the number of wells requires a detailed study of the project.

With the assumptions in place, the estimated spend per well over time was calculated as follows:

1) Project MW ÷ MW per well = Number of Successful Production Wells Needed (N1)
2) Number of Successful Production Wells Needed (N1) ÷ Drilling Success rate (%) = Number of Wells Needed to Achieve Production (N2)
3) Number of Successful Production Wells Needed (N1) × Injection:Production Well Ratio = Number of Injection Wells (N3)
4) Number of Successful Production Wells Needed (N1) × Standby wells (%) = Number of Standby Production Wells (N4)
5) Number of Wells Needed to Achieve Production (N2) + Number of Injection Wells (N3) + Number of Standby Production Wells (N4) = **Total Number of Wells per Project**

Once the number of wells to be drilled per project based on MW projections was known, the wells were spread out over time from 2014 through 2024, based on the timeline developed from the stages of the projects (Figure 1). Now that the kind of development occurring and when it was occurring was known , an estimate could be made of what each MW per project and the associated wells meant in terms of capital expenditure on development services.

A cost per well of $6 million USD was assumed across the board. Given the timeline extended several years (2014-2024), an inflation rate of 2.5% per year was incorporated. For surface studies and non-well related services, a fixed cost per stage, independent of project size in Stages 1 and 2 and dependent on size for Stages 3 and 4 as presented in Table 2 were assumed. For projects that were in operation but undergoing expansion, costs were treated as a project in Stage 3. Finally all 66 projects considered would be expected to continue through all stages of development and become operating plants.

Table 2. Geothermal Market Analysis – Cost Assumptions.

	USD	Comments
Stage 1	$150,000	Independent of size.
Stage 2	$750,000	Independent of size.
Stage 3	$10,000	Per megawatt developed.
Stage 4	$5,000	Per megawatt developed.
Development Full-diameter Well	$6,000,000	No distinction made between exploration and development wells.
Inflation rate/yr	2.5%	

The development spend was determined with a simple calculation. For a project in Stage 1 with an expected installed capacity of 20 MW, development spend was determined to be:

- 20 MW ÷ 9 MW/well = 2.222 (N1)
- 2.222 (N1) ÷ 68% = 3.268 (N2)
- 2.22 (N1) × 1:3 Well Ratio = 0.741 (N3)
- 2.222 (N1) × 20% = 0.444 (N4)
- 3.268 (N2) + 0.741 (N3) + 0.444 (N4) = 4.453 or a minimum of **4 wells**
  - 4 wells × 6,000,000 = 24,000,000
  - Stage 1 = 150,000
  - Stage 2 = 750,000
  - Stage 3 = 10,000 (20) = 200,000
  - Stage 4 = 5,000 (20) = 100,000

Total Spend = approximately 25,200,000 million USD

The spend was allocated per month based on the duration of each stage, for a project in Stage 1 in 2014, it would take approximately 10 years to reach operation. The 2.5% inflation rate was compounded annually after the annual spend was calculated.

This particular study was further refined; well costs were broken down into sub-sections based on working knowledge of oil and gas well drilling in Indonesia. The drilling costs were divided into rigs (37% of total well cost), casing and related equipment (14%) and others (50 %), allowing for a more complete understanding of the drilling market and its opportunities for growth.

Lastly, the developers for the projects were identified by the GoI for each project whenever a concession had already been granted. Once the timeline and spend per project were estimated, the largest geothermal players in Indonesia could easily be identified. Through this method, all the key questions that were posed in the beginning (Who?, What?, When?, Where?) were successfully answered and the information necessary to develop a successful market strategy was achieved.

Conclusion

This method not only provides the potential spend per project in a systematic way, but also gives insight into what the money will likely be spent on and when; this is essential information for understanding an emerging geothermal market and developing a successful market strategy. The database has achieved its objective of translating MW into potential development spend over time ($/yr) and has helped us better understand the geothermal market in Indonesia. It guided us in determining which geothermal clients to focus our efforts on and when theses clients would be more likely to require our services. The actions that have resulted from this market study successfully expanded our Indonesian geothermal market share. With the experience and knowledge gained in Indonesia through this market study, we can better position ourselves to take advantage of the growing geothermal industry in other emerging countries. By modifying the country and time specific variables and costs, this method can be applied in any country where a geothermal market is poised to expand.

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