



Why Geothermal?

17 YO GUOGOOG

Emission by Energy



Primary Energy Source



Base Load



Forecast Geothermal Installed Countries by 2025



Countries



Source: Huttrer, 2020



Indonesia's History of Geothermal

Exploration geothermal of resources associated with active fumarole and solfatara fields with the objective of generating electricity was first proposed in 1918. Initial exploration drilling was undertaken by the Volcanological Section (later to become the Volcanological Survey of Indonesia,

or VSI) of the colonial Geological Survey of Indonesia (GSI), at Kawah1 Kamojang, on Java, in 1926. Several holes were drilled inside a large fumarole field. The third well (KMJ-3) was 66m deep and produced steam.



4,362 MWe

Indonesia's Geothermal Companies

Geothermal Overview



Indonesia installed geothermal power plant capacity as of October 2018

Source: https://missrifka.com/energy/top-10-geothermal-countries-and-status-of-indonesia-geothermal-power.html



| No | Geothermal Company Di Indonesia |
|----|-----------------------------------------|
| 1 | PT. Supreme Energy Rantau Dedap |
| 2 | PT. Supreme Energy Muara Laboh |
| 3 | PT. Supreme Energy Rajabasa |
| 4 | PT. Pertamina Geothermal Energy |
| 5 | PT. Star Energy Geothermal Wayang Windu |
| 6 | PT Star Energy Geothermal Salak, Ltd. |
| 7 | PT. Star Energy Geothermal Darajat |
| 8 | KS ORKA & Sorik Marapi Geothermal |
| 9 | PT. Geo Dipa Energi |
| 10 | Medco Cahaya Geothermal |
| 11 | Sarulla Operation Ltd |
| 12 | PT. PLN Gas & Geothermal |





How to Develop Geothermal?







Project Stages











Start-Up and Commissioning



8

Operation and Maintenance

PROJECT TIMELINE



Y

Year of Implementation

| | 5 | 6 | 7 | Lifetime |
|-----|------------|------------|------|----------|
| | | | | |
| | | | | |
| | | | | |
| r F | Purchase A | greement (| PPA) | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

What is Preliminary Survey?

The preliminary survey phase includes a first reconnaissance of a geothermal area based on a nationwide or regional study.

The Preliminary Survey Phase involves a work program to assess the already available evidence for geothermal potential within a specific area (perhaps a country, a territory, or an island). The initial surveying may be regional or national and essentially involves a literature review of geological, hydrological or hot spring/thermal data, drilling data, anecdotal information from local populations, and remote sensing data from satellites, if available. 6





The power market possibility



Environmental and social issues

Preliminary Survey Objectives







Source Classification



Speculative Resource

Speculative resource is resource classes that estimate potential energy based on the literature study and first preliminary survey.



Hypothesis Resource

Hypothesis resource is resource classes that energy potential based on the preliminary survey



Possible

Possible is based on geological, geochemical, and temperature gradient with the geothermal conceptual model and the estimated reservoir temperature and dimension.



Probable

Probable is estimation possibilities of energy based on exploration and identified with drilling exploration (wildcat) and continue to feasibility study.



Proven

Proven is estimation resource of energy based on details with exploration wells, delineation, and development to feasibility study.

6 7 8

Exploration Stages



SURFACE STUDY

- Assessing surface geology
- Gathering local knowledge
- Locating active geothermal surface features

GEOCHEMISTRY STUDY

- Geothermometry
- Electrical conductivity
- pH
- Flow rate of fluids from active features
- Soil sampling

GEOPHYSICAL STUDY

- Magnetotelluric
- Gravity
- Electrical resistivity
- Temperature gradient drilling
- 2D & 3D Seismics



Test Drilling

DRILLING, LOGGING AND TESTING SIGNIFICANTLY IMPROVE THE UNDERSTANDING OF THE RESOURCE, ENABLING.

Typically, at least two but more often three, deep wells are drilled to demonstrate the feasibility of commercial production and injection.





Project Review and

This phase includes the evaluation of all existing data by the developer, including new data from the exploratory phases.

Having completed the financial and technical feasibility study for the power project, the developer usually enters into a Power Purchase Agreement (PPA) with the Independent

Field Development

This requires input from the geoscience team, led by geologists and drilling engineers, who draw on information gained during previous phases of project development. In parallel with the drilling, work starts on the steam gathering system to convey the resource from the wells to the power plant



Construction & Facilities

This phase comprises installation of the steam gathering system or SAGS (i.e., a system of steam pipelines from the well heads to the power plant and back for the reinjected fluids);



Start-up and Commissioning

FINAL PHASE

Start-up and commissioning of the power plant is the final phase before the plant starts regular operation.

BELIEFS

This phase usually involves resolving many technical and contractual issues with the supplier of the plant **Providing these guarantees and bonds involves extra costs for the project developer and the EPC contractor**



6



Operation & Maintenance

OPERATION & MAINTANANCE

- Operation and maintenance can be divided into the O&M for the steam field (wells, pipelines, infrastructure, etc.)
- 2. the O&M of the power plant (turbine, generator, cooling system, substation, etc.).













Investment costs of geothermal

Investment costs of geothermal development factors:

- (i) Size of the development (MW) determined by both resource availability and demand;
- (ii) The enthalpy and depth of the resources;
- (iii) Difficulty of access to the concession area; and
- (iv) Cost and efficiency of project management.

GEOTHERMAL ECONOMICS

Investment costs of geothermal development are determined by the following



Geothermal Type of Costs

In terms of composition, geothermal costs:

- (i) Drilling costs, a function of the number wells and the cost of each well;(ii) Infrastructure costs for construction roads, well pads and other
- (ii) Infrastructure costs for constru infrastructure
- (iii) Equipment costs, including power plant and Steam field Above Ground Systems (SAGS);
- (iv) Project management costs.

GEOTHERMAL ECONOMICS

In terms of composition, geothermal development comprises four types of



Geothermal Costs Estimation

Assumed:

- Medium Enthalpy
- Easy Access Road
- Three wells will be drilled at the exploration phase.



> Medium enthalpy, temperature above 230°C but relatively low pressure; and

High enthalpy with both high temperature and high pressure.

GEOTHERMAL ECONOMICS

| | 55 MW Plant (US\$ million) | 10 MW Plant (US\$ million) |
|----------------------|-------------------------------|-------------------------------|
| Drilling | 90.5 | 18 |
| Infrastructure | 7. <mark>1</mark> | 3.3 |
| Power plant and SAGS | 101.8 | 18 |
| Project management | 10 | 2 |
| Total | 209.3 | 41.2 |

Source Data: Green Climate Fund.

Indonesia Geothermal Resources Risk Mitigation Project

Enthalpy Classification:

Low enthalpy, temperature between 180°C and 230°C;





Comparison of Clean





Thank You

EXPLORATION AND PRODUCTION OF GEOTHERMAL

Saturday, 25th 2021