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The Development of Ulubelu Geothermal Power Plant Unit 3 & 4, 2 X 55 MW – Lampung Indonesia

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ABSTRACT

PT. Pertamina Geothermal Energy (PGE) has been succeeded to commercially operates a new geothermal power plant in Ulubelu, consist of Ulubelu Unit 3&4 with the total capacity of 2x55 MW. The Commercial Operation Date (COD) of Ulubelu Unit 3 is July 26th, 2016 and Unit 4 is March 25th, 2017. Ulubelu Geothermal Area is located in Tanggamus Regency – Lampung province in South Sumatera. The steam field is two-phase flow, water dominated system, with a central separator system. These two units GPP are supplied by piping system to convey separated steam from separators to the power station and a steam scrubbing system to provide steam at power station interface to the specified quality. Furthermore, a piping system to convey geothermal brine separated from the separators, and condensate, to the far away reinjection well cluster and reinjecting the fluid into designated reinjection wells. Many challenges occurred during this project, such as project construction parallel with land acquisition, drilling the wells, unpredicted swampy area in reinjection pipelines area, etc. Despite these limitations, with strong teamwork and strategy, good project management and the implementation of effective engineering practices, all the problems can be solved, and the project successfully completed ahead of schedule. Many learned lessons can be useful for similar projects in the future.

1. INTRODUCTION

Ulubelu Geothermal Power Plant (GPP) Project Units 3 & 4 2 X 55 MW is located in the Geothermal Ulubelu-Waypanas Concession Area (WKP) managed by PGE. Administratively, the Ulubelu Unit 3 & 4 Project is located in Tanggamus Regency, Lampung, Indonesia.

Figure 1: Location of Ulubelu Geothermal Power Plant Unit 3&4 (Courtesy of Google Maps)

This project was intended to add a new unit/installed capacity of 2 x 55 MW with a total project scheme (construction of production facilities and power plants). It is in an effort to optimise steam reserves in the Ulubelu Area and take advantage of business opportunities related to the lack of electricity supply in the Lampung and South Sumatera regions. Power Purchase Agreement (PPA) between PGE and PT. PLN (state-owned electricity company in Indonesia) for the development of the Ulubelu GPP Unit 3&4 has been signed on March 11, 2011, with an operating period of 30 years. The project began in 2009 and targeted to be Commercial Operation Date (COD) in August 2016 for Unit 3 and June 2017 for Unit 4.

The scope of the Ulubelu GPP Project Unit 3 & 4 includes surveys, permits, infrastructures, drillings, productions testing, Front End Engineering Design (FEED), EPCC for SAGS (Steam Above Ground System) and Geothermal Power Plant (GPP) facilities. This project was financed through loans from the World Bank for the EPCC phase, including FEED, and the rest was financed by equities.

Drilling the wells were began in 2010 then continued with well production tests, preparation of FEED documents, auctions and EPCC project. COD Unit 3 was on July 26, 2016, while COD Unit 4 was on March 25, 2017, and both units can be finished faster than the targeted date.

2. DEVELOPMENT OF ULUBELU GPP UNIT 3 & 4

The Ulubelu geothermal field is one of many potential high-temperature geothermal prospects in Indonesia, especially in Sumatera, and it is one of the PGE geothermal fields. It is located in Ulubelu, District of Tanggamus, Lampung Province, about 100 km west of Bandar Lampung, the capital city of Lampung Province (Figure 1). Ulubelu is classified as a liquid-dominated reservoir system.

Previously Ulubelu has two units of GPP Unit 1 & 2 with an installed capacity of 2 x 55 MW that already operated since 2012. SAGS of Unit 1&2 was built and operated by PGE while GPP of Unit 1&2 was built and operated by PLN. Ulubelu GPP Project Unit 3&4 was built adjacent to the existing Unit 1&2 around 800m to the north and intended as the empowerment of geothermal energy potential as an environmentally friendly alternative energy development in line with the national energy diversification policy and anticipating the elimination of fuel subsidies and reducing fossil-based energy use. The advantages of the development are:

- Optimising geothermal reserves in Ulubelu (and Lampung) area as an alternative energy
- Take advantage of market opportunities related to "electricity shortage" in the South Sumatera area
- Increasing of Indonesia's geothermal energy market share (installed geothermal capacity)
- Profit contribution to the company

Ulubelu GPP Unit 3&4 was financing by the equity in the upstream (infrastructure, drilling) and by a loan from the World Bank in the downstream (FEED, EPCC). The bidding processes and procedures for the EPCC phase are followed to the World Bank's procedures. The consortium of PT. Rekayasa Industri and Sumitomo Corporation were appointed as EPCC contractor based on the result of bidding processes.

2.1 Design of Ulubelu GPP Unit 3&4

Ulubelu is classified as a liquid-dominated reservoir system; therefore, the design of the separator system should be determined first according to the availability of the area, pipeline design, process system related to pressure drop and construction cost. Power Plant was designed similar to existing area Unit 1 & 2 to accommodate operational flexibilities.

2.1.1 SAGS design

The two units GPP are supplied by piping system to convey separated steam from separators to the power station and a steam scrubbing system to provide steam at power station interface to the specified quality. Based on the process simulation and cost-effectiveness, the separator system was designed as a central separator system which is three separators with capacity around 40MW respectively installed in one designated area. Furthermore, a piping system to convey geothermal brine separated from the separators, and condensate from Power Plant, to the far away reinjection well cluster and reinjecting the fluid into designated reinjection wells.

2.1.2 GPP design

Generally, GPP Unit 3&4 was designed similar to existing Unit 1&2 in order to accommodate SAGS operational flexibility between them. The steam turbines were condensing type machines directly coupled to the generator without the use of a gear reducer. The condenser was direct contact type located below the turbine centre line. Gas Removal System, hotwell pumps, cooling tower and other types of equipment in the Balance of Plant was provided to support power generation 2 x 55 MW.

2.2 Problems During Project Execution

During project execution, especially the EPCC phase, many challenges raised up, and the solution should be found as soon as practicable considering project schedule and cost. The main consequence of this condition is surely the potential delay and additional cost of this project. These could be useful lesson learns for the next similar project.

2.2.1 Land acquisition

Ulubelu land area is dominated by communities' land, and most of them are farmers and coffee planter. During FEED, pipeline route has been determined based on process requirement, the system needed and considering availability and possibility of its land (since some land are not acquired yet); also preliminary topographic has been developed to support calculation and process simulation. Since the pipeline route has been determined, therefore, can be followed by the land acquisition process. Land acquisition is one of the various problems that might appear in many projects and area, including Ulubelu. The complexity of land acquisition process needs extra effort and also time-consuming; otherwise, the project should be started in order to achieve the targeted date. This caused a condition that the project had begun when there was required land along the pipeline route that had not been acquired. Impacts of this condition are:

a. During the engineering phase, process calculation and simulation can not be started before the final pipeline route has been decided.
b. Some case occurred that pipeline route should be shifted since the required land can not be acquired due to some reason. This condition consequently needs process recalculation, additional material, equipment and human resources to compensate project schedule.
c. Since land acquisition is not finished yet, consequently, soil data and topographic map can not be developed. It caused during FEED many assumptions were used to calculate design requirements. Land acquisition was conducted parallel with EPCC phase based on FEED data and followed by soil investigation by EPCC contractor. Unfortunately that the reinjection pipeline is located along the swampy area and the contour of the pipeline route is highly varied while its design is continuous slope from separator area to reinjection wells. This problem has become the main problem during EPCC phase, there is a significant change to the design of pipe support foundation due to the swampy area need deeper bore pile, and the contour of the land put the pipeline in high elevation in some area at a continuous slope. Deeper bore pile and high elevation pipeline are impacted to construction method that needs more material, equipment, human resources and additional time indeed.

2.2.2 EPCC while drilling

Ulubelu GPP Unit 3&4 was targeted to be commercially operated on 2017. Refer to the project schedule to achieve this milestone; then FEED should be started with the condition that steam availability is less than 220 MW at that time. Drilling activities to increase steam availability are still ongoing. According to this condition, then the process calculation and simulation used assumptions data for some wells refer to the adjacent wells. The implication is that pipeline design should be reviewed during EPCC refer to actual wells production test and for some cases pipeline is constructed as per assumptions data since the pipeline construction could not be held waiting for drilling or well production test finished.

2.2.3 Soil investigation and topographic data

As a previous explanation in 2.2.1.c above, the acquisition of some area were not finished during FEED. Assumptions were used to calculate design requirements. It becomes problems during EPCC since the actual condition was different from the initial assumption, and some area has been rerouted due to obstacles during land acquisition. These conditions cause potential delay to the project schedule and change the order by the contractor if immediate mitigation action was not implemented.

2.3 Efforts to Mitigate Problems

Problems faced during project execution should be mitigated to avoid delay in the project schedule. Some actions performed by Ulubelu project team (both PGE and contractor) are:

2.3.1 Optimization of working hours, human resources and types of equipment

a. Additional working hours by two (2) shift scheme for working activities that possible to be overtime, such as indoor area activities, pipe welding activities, bore pile activities.
b. Additions to the amount of human resources to increase productivity in achieving physical work such as the additional number of civil works labour and welder.
c. Additions to the number of types of equipment to increase the productivity of pipe support installation such as the number of bore pile machines and welding machines.

2.3.2 Design modification

As a previous explanation that main problem during the construction of SAGS Unit 3&4 was reinjection pipeline is located along the swampy area and the contour of the pipeline route is highly varied. Based on the study to the construction method and possibility of completion schedule, additional works and material and the availability of types of equipment, design of the reinjection pipeline should be redesigned. Pipe elevation follows the contour along with the reinjection land from Separator Station to reinjection wells. As a consequence of the reduction in pipe elevation, several drain pot was installed at the pocket points. Impact of this design modification is the method of construction of pipe installation is easier, and the execution of work can be faster to compensate project schedule.

2.3.3 Intensive Monitoring and Coordination between PGE team and contractor

a. Daily monitoring meetings were held every afternoon at 4 pm to check daily achievement results then compared to the daily target and evaluated for the next planning.
b. Weekly meetings were conducted to discuss strategic issues and evaluate weekly achievements.
c. Monthly meetings were conducted, which included the top project management team to discuss strategic issues in a broader perspective and evaluate monthly progress achievements.

3. CONCLUSIONS

Ulubelu GPP Project Unit 3 & 4 was successful in adding installed capacity for geothermal electricity in Indonesia. The project can be finished ahead of the schedule, although many problems occur during project execution. Many lessons learned can be useful for the next similar project. Recommendations for a similar project are:

a. Land acquisition has been completed before FEED to minimise rework during EPCC.
b. Comprehensive risk mitigation related to social aspects, especially related to land acquisition if FEED before land acquisition finished.
c. Soil investigation and topographic data need to be more comprehensive during FEED
d. Steam availability include complete and accurate data of wells production test should be available during FEED

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