

Pertamina Geothermal Energy Drilling Campaign

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ABSTRACT

Pertamina Geothermal Energy (PGE) started a drilling campaign in 2007. Using the semi-integrated project management (semi-IPM) concept, PGE had finished a total 86 drilling wells and seven work-over wells in all its working areas. PGE developed two criteria to measure the drilling performance: ROWC (rate of well completion) and GDUC (geothermal drilling unit cost). Using these two criteria, PGE evaluated the nonperforming contractors, materials, and some drilling practices for performance improvements. Achievements and challenges during drilling campaign were also briefly outlined and reviewed.

1. INTRODUCTION

As a state-owned enterprise, PGE had the privilege to explore and develop 15 geothermal working areas all over Indonesia. Three areas are already on developing stage. These are Kamojang (West Java), Lehendong (North Sulawesi), and Sibayak (North Sumatera). From these areas, the total PGE installed capacity is only 0.3 GW. To achieve 2.3 GW, as mandated by the state, PGE planned to explore (and develop) eight areas, namely, Ulubelu (Lampung), Lumutbalai (South Sumatera), Kamojang (West Java), Karahabodas (West Java), Hululais (Bengkulu), Sungaipenuh (Jambi), Tompaso (North Sumatera) and Kotamobagu (North Sumatera).

These wide-ranging exploration areas are difficult and challenging as a marginal business. Thus, it is necessary to keep the costs as low as possible. The easiest scheme to handle this kind of operation is using integrated project management (IPM). The company delivers all responsibility of well planning and design, drilling services, materials purchasing, and drilling operation decisions to one contractor. The contractor itself may deliver the responsibility to another company (subcontractor). The contractor calculates all the risks and these are reflected on the price, which is likely to be much higher. On the other hand, the company risk regarding reservoir management due to operations mishandling during drilling is at stake. This is why PGE developed a semi-integrated project management (semi-IPM) concept, which modifies the full integrated project management (IPM) concept (Figure 1). In the full IPM concept, the responsibilities on the material supply, uncommon services (infrequently used or limited services such coring, logging, and air drilling), and operational decisions are separated. The semi-IPM concept is designed so that PGE still has control in work quality.

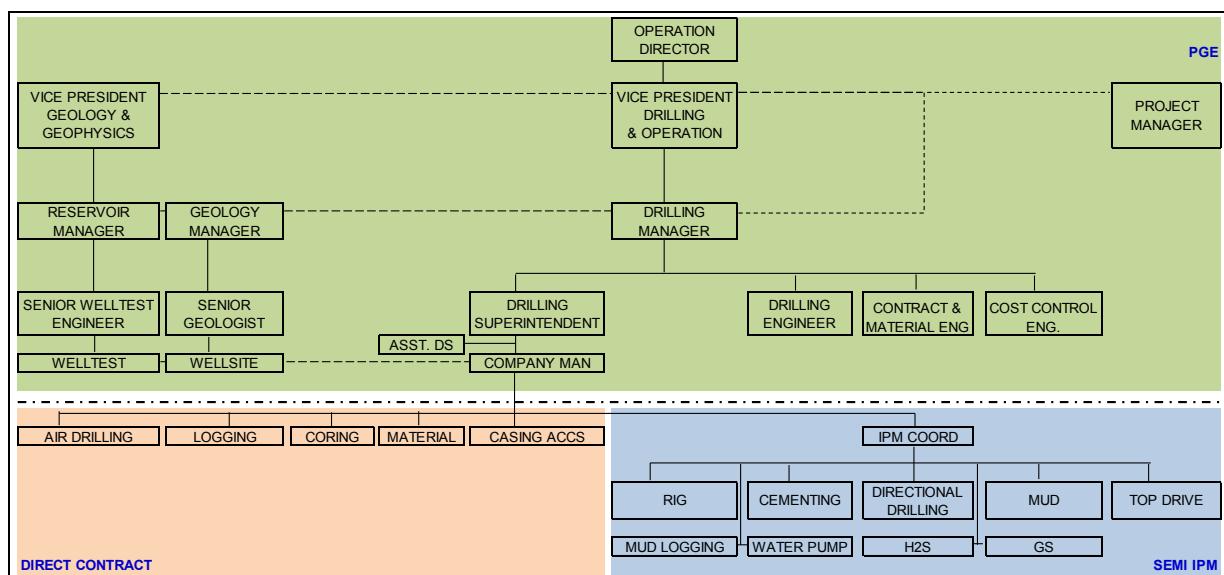
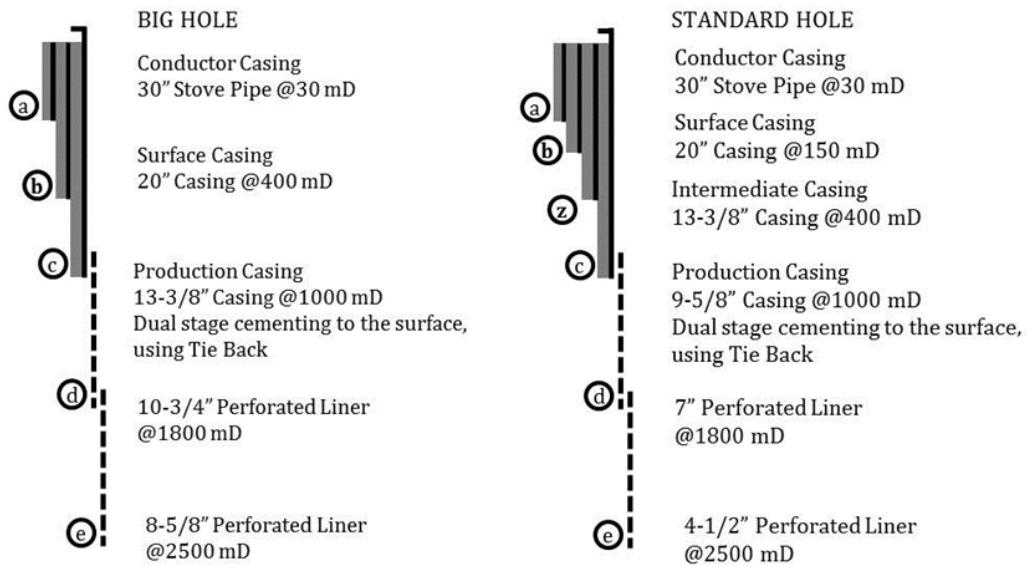


Figure 1: PGE Semi-IPM Concept

The semi-IPM concept allows PGE to simplify the procurement process. In addition, contracts can be extended or even terminated in one go because most of the services are under one contract. Thus, less effort and personnel are needed to adopt changes in the contract.

In term of technical considerations, the wide-range of the exploration area locations results to unique characteristics for each. For example, the same downhole problem cannot always be solved with the same previous solution because of the difference in

formation characteristics. Nevertheless, a typical well design is shown in Figure 2. Big holes are preferred due its flexibility, where another casing size (7" and 4-1/2") can be added if needed. Moreover, big holes likewise allow the production of steam with higher water fraction. Thus, big holes are more desirable even though it costs PGE 20% more compared to standard holes.



**Picture not to scale*

Figure 2: Casing Configuration

2. THE CAMPAIGN

The campaign to achieve 2.3 GW electricity from steam wells began in 2007 (Figure 3). First, one standard hole wells was drilled in Ulubelu. This was continued until a total of 10 and 21 wells in Kamojang, Lahendong and Lumutbalai were reached on 2008 and 2009, respectively. In addition, 18 wells were drilled in the next two years. On the other hand, only 16 well were drilled in 2012. 2013 was the hardest phase of the campaign. There were difficulties encountered in finding drilling rigs and the existing rig also performed poorly. Thus, only seven wells were completed that year.

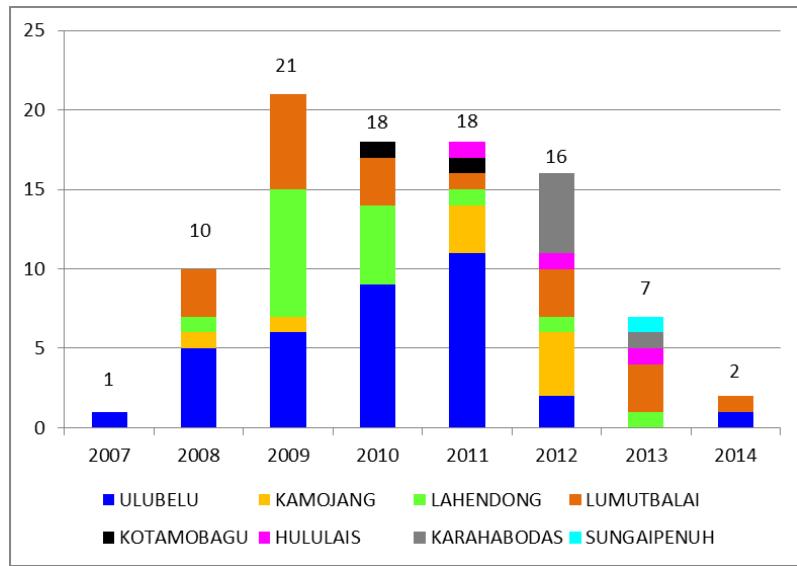


Figure 3: Completed Well Distribution on PGE Drilling Campaign 2007-2014

In order to measure the drilling performance quantitatively, PGE closely monitored the total drilling days and final well depth completed (Figure 4). PGE likewise developed two criteria: rate of well completion (ROWC; meter/day) and geothermal drilling unit cost (GDUC; USD/meter) (Figure 5). ROWC was the final well depth divided by the total drilling days while GDUC was the total direct cost from spud to completion divided by the final well depth.

From 2007 to 2011, it can be observed that there was a positive slope in the learning curve (Figure 4). The average total drilling days decreased while the final depth increased. Both GDUC and ROWC also increased, which meant that the campaign was on the

right track at that time. However, poor performance occurred from 2012 to 2013 which was triggered by the urge to drill in new exploration areas with a drilling contractor unfamiliar with the area. The challenge itself was quite difficult because it required that a high angle well (50° inclination) be drilled up to 3,000 mD, which was the desired final depth. As expected from an exploration well, the drilling hazards were hard to identify.

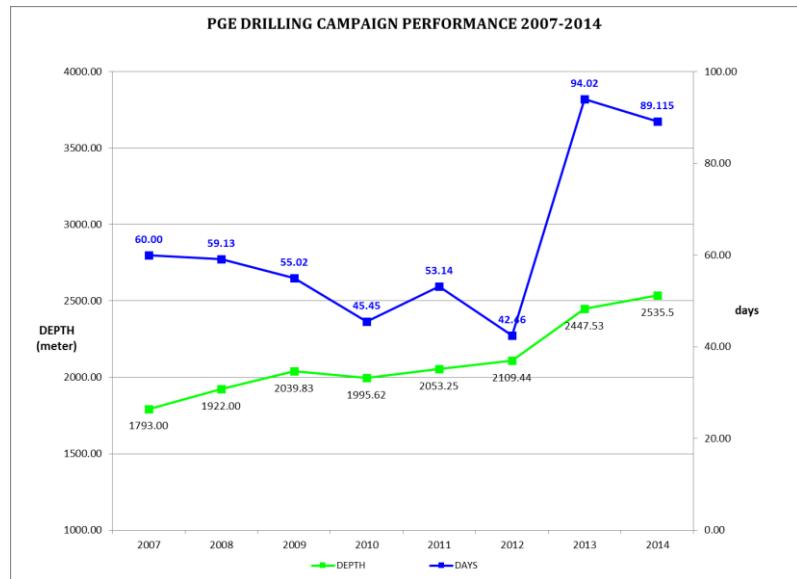


Figure 4: Average Depth & Days on PGE Drilling Campaign 2007-2014

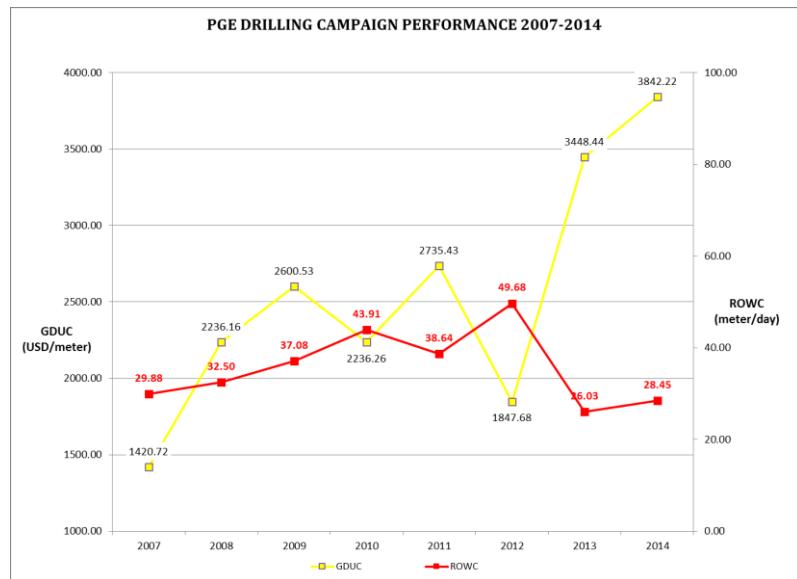


Figure 5: Average GDUC & ROWC on PGE Drilling Campaign 2007-2014

3. LESSONS LEARNED

During the campaign, PGE had to perform workovers in seven wells. Three of them (all in Lahendong areas) were related to production-casing collapse issues when the wells were producing steam. Furthermore, three workovers were done to reopen the abandoned and plugged wells and one workover was used for sidetracking. Further evaluation showed that the dual-stage cementing collar (DSCC), cement slurry design, and quality control on casing material were the three main factors which caused the collapse. This issue encouraged PGE to use a Tie-Back System as the alternative on production casing cementing since 2010. No additional collapsed casing issues have been recorded since.

Two wells in the Hululais area and one well in the Karahabodas region were affected by poor rig performance. Despite positive production results (HLS-C1 is one of the biggest producer wells in PGE at 15 MW), it was difficult to drill because many of the rig spare parts were difficult to find since the rig manufacturer closed already. The demand for 1500 HP rigs left PGE with very limited options from the market. PGE had to wait for three months (totally halted operations) to wait for the rig spare parts e.g. mud pumps, generators, and tubular goods. All of those rigs were fully equipped and met the contract specifications at the beginning, but PGE could not perform a more thorough check on the quality of the equipment. Hence, to prevent this from happening in the future, PGE

will conduct third party rig inspections after the contracts is signed and prior to spud in on the first well. The inspection will also include the functional test and load test.

PGE likewise prepared 10-3/4" modify-tieback cementing accessories to address what was happening in wells KRC-B1 and LMB-2/1. At that time, the problematic zone occurred on the 17-1/2" hole section. After many days spent on attempts to go deeper, it became apparent that this seemed impossible (with high torque and loss condition). Thus, it forced PGE to define a casing point that was shallower than its initial program. However, since the reservoir target was at a high depth, PGE still needed to cover the interval with cemented casing (or liner). After this, the 10-3/4" cementing was conducted with the 10-3/4" float collar only. This resulted in poor cementing and it also cost delay on the drilling days. Though the use of a cemented 10-3/4" casing is not a basic plan on any drilling program, it is now a doable contingency plan, if needed, especially on exploration well drilling.

4. REFERENCES

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