Lahendong II Geothermal Power Plant Project in Indonesia

Takako Hattori

Fuji Electric Systems Co., Ltd.

Keywords

Indonesia, north Sulawesi, 20 months project period, 20 MW, series plant

ABSTRACT

The Lahendong II Geothermal Power Plant (LH2), owned by PT. PLN Persero, started commercial operation in June 2007. LH2 is an extension of the Lahendong I Geothermal Power Plant (LH1), and provides 20 MWe additional generating capacity for the public grid.

Fuji Electric Systems Co., Ltd. (FES) constructed LH2 as an entirely turnkey project, acting as a subcontractor to Sumitomo Corporation. The turbine-generator units for the plant were manufactured and supplied by FES and the balance of the plant facilities were procured by an internal consortium consisting of FES and PT. Rekayasa Industri. In this paper we describe the principal characteristics of the new LH2 plant.

Introduction

In recent years Indonesia has suffered from power shortages. Blackouts occur regularly in some region of the country. After recovery from the economic crisis in 1997 continuous economic growth began in Indonesia, but available power supplies have been unable to keep pace with the increasing demand. Analyses carried out by the Electrical Power Utilization Directorate (EPUD) of the Energy and Mineral Resources Department of Indonesia showed that consumption of primary energy sources in 2004 was Oil; 52%, Gas; 21%, Coal; 20%, Hydro; 4% and Geothermal; 2%. The country relies heavily on oil, and the oil price hikes of recent years have directly impacted Indonesia, causing one of the primary obstacles to economic recovery. Records indicate that in the past, whenever the cost of the electricity production went up due to soaring primary energy prices, the utilities companies usually passed the increases on to the consumers. But the Indonesian government now maintains end-user price controls except for commercial-scale utility consumers. As a result, the financial impact has now shifted to the power companies. Considering all these facts, the government decided to reduce the country's dependence on oil as a primary energy source and to focus on alternative sources. Utilization of renewable energy appears to be one of the possible solutions for those issues.

Recently, Indonesia has received international attention as the country with the highest geothermal resource potential. The gross power generation potential from Indonesian geothermal energy has been estimated to be approximately 27 GWe, even though prior to 1970 no geothermal electricity was generated in Indonesia at all, and the present total geothermal generating capacity is only 0.807 GWe, according to EPUD. This suggests that there is a great deal of underutilized geothermal resource remaining in the country. The Lahendong II project is the first geothermal power plant project to be undertaken in Indonesia since the economic crisis of 1997.

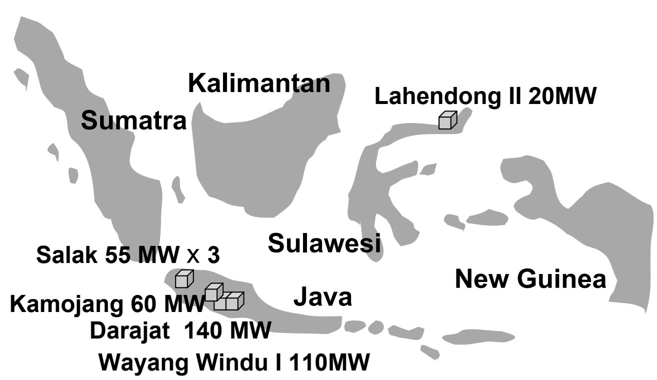

Figure 1. Geothermal power plants in Indonesia supplied by Fuji Electric Systems Co. (FES) – 3 55MW turbine-generator units in Salak, 110 MW total plant system in Wayang Windu unit 1, 55 MW and 85 MW generators in Darajat and one 60MW turbine-generator unit in Kamojang.

The Lahendong II Power Plant Project

The Lahendong II Geothermal Power Plant (LH2) is located at the Lahendong Geothermal field, Northern Sulawesi, in the Republic of Indonesia. The project site is 30 km south of Manado, the capital city of the region, at an altitude of 860 m above sea level. The contract was signed with PT. PLN (Persero) in October 2005 as an extension of the Lahendong I Geothermal Power Plant (LH1). The LH2 contract specified an entirely turnkey project, including engineering, procurement of equipment and material, manufacturing, construction and commissioning of a 20 MW power generator plant unit with 150 kV switchyard equipment. The prime contractor for this project was Sumitomo Corporation, and FES was assigned as the technical leader of the project and the principal equipment supplier. Civil and architectural work, the 150 kV switchyard, and some other local procurements were handled by internal consortium partner PT. Rekayasa Industri (EPCC company in Indonesia). The steam supplier (including the separator) is PT. Pertamina, an Indonesian oil company.

Although the 20 month contract project schedule was very tight, construction of the plant was successfully completed in early June 2007 and the plant has proved capable of generating the rated output of 20 MW.

Project Schedule

The overall project schedule was for 20 months, from the contract commencement date to takeover by the client. This tight schedule was a critical issue for this project from the outset. However we finished engineering and procurement in the early stages and succeed in delivering all major equipment from all over the world to the LH2 site within 12 months after the contract commencement date. After the major equipment arrived on-site, installation was finished within 3 months and pre-commissioning was completed after another six weeks. Power receive from the grid for plant commissioning began five months after the equipment arrived. During plant commissioning, progressing from initial load to full load took only 5 days. In summary, we kept to the contract schedule and demonstrated the quality of FES engineering as the technical leader of this project.

Plant Description

Figure 2 shows an overall diagram of the power plant, a single-flash condensing turbine-generator system. Separated steam drives the turbine blades, and the condenser is cooled by circulating condensed water through a wet cooling tower. In the following, the various components of the system are discussed.

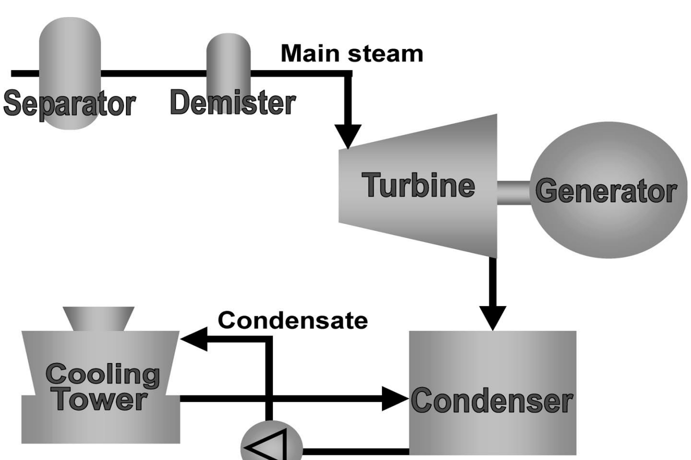

Figure 2. Principal features of the power plant.

Steam Turbine Generator System

The steam turbine has two sets of steam inlet stop valves and governor valves. It is a single flow top exhaust reaction type skid mounted design. It is also equipped with a blade washing system, allowing injection of condensate water into the wheel chamber to wash scale from the blade surfaces during operation under load. An electrical-hydraulic governor is used to control the turbine. The generator is air-cooled and a brushless exciter is used. Table 1 shows the major design parameters of the steam turbine and generator. Figure 3 shows a front view of the turbine unit.

Table 1. Design parameters of the steam turbine and generator.

Steam Turbine

Type	Single cylinder, Single flow, Reaction, Condensing
Rated output	20 MW
Inlet steam pressure	8.35 bar abs
Inlet steam temperature	172.2 deg C (saturated)
Exhausted pressure	0.115 bar abs
Steam flow	39.8 kg/s
NCG in steam	1.0 wt%
Rotation speed	3,000 rpm

Generator

Type	Totally Enclosed Water-to-Air Cooled (TEWAC)
Capacity	25 MVA
Voltage	11 kV
Rotation speed	3,000 rpm

Figure 3. Photo of Turbine unit.

Condenser and NCG Extraction System and Main Cooling Water System

The pressure in the low-level direct-contact condenser is maintained at 0.115 bara. The condenser has an NCG removal system and consists of two stages and two sets of 100% capacity ejectors. The extracted gas from the main condenser is discharged from the condenser. The circulating water system consists of two sets of 50% capacity hotwell pumps which discharge condensate from the condenser hotwell to the cooling towers. The cooling tower is a concrete structure with three cells and is of the counter flow type with splash fill design. The cooling system was designed to be compact; the main condenser, NCG extraction system, main cooling water line and cooling tower occupy only 250 m2 altogether.

150 kV Substation

The Lahendong Power plant is connected to two transmission lines; one to the Tomahon substation and the other to the Kawangkoan substation. The LH2 substation has two circuit breakers on the main transformer side and two circuit breakers on the line side. Each circuit breaker has line and bypass disconnect switches. Redundant protection against transmission line failure is provided.

Figure 5. Photo of Power station.

DCIS and Plant Operation/Control System

The plant operating conditions are monitored and controlled by DCIS. The DCIS itself is a fully double redundant configuration. In addition to the DCIS, a back-up desk is furnished. The main purpose of the back-up desk is to provide safe plant shut-down / start-up without turbine tripping in case

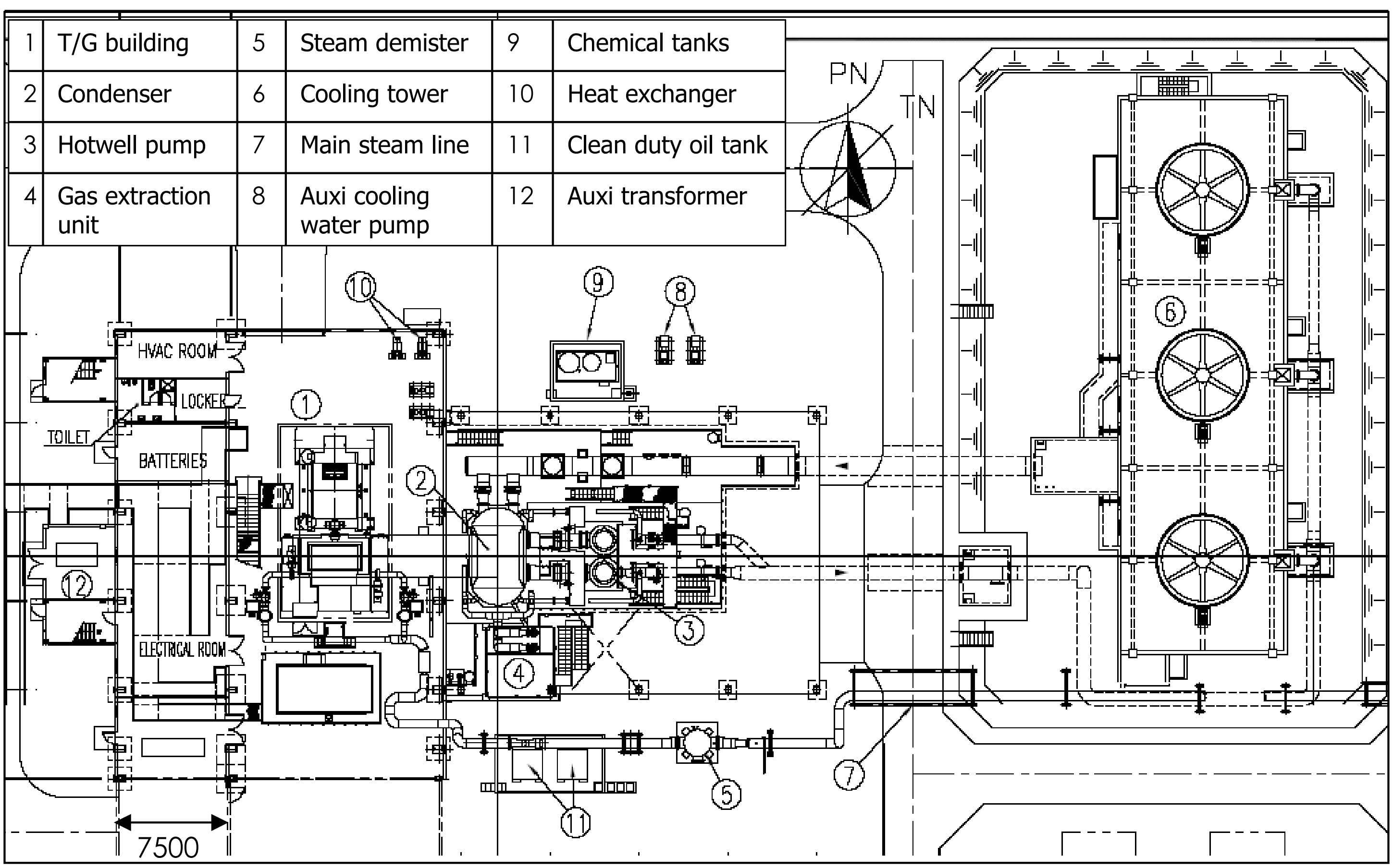

Figure 4. General arrangement of the plant.

of serious DCIS system failure. The DCIS system consists of three operating stations and one engineering work station that are located in the central control room.

Conclusions

The electrical generating capacity of North Sulawesi Island falls 150 MW short of peak daytime demand. The Lahendong II plant will contribute to solving this power shortage problem in this part of Indonesia. Beyond LH1 and LH2, another new geothermal plant development project (the Lahendong III Geothermal Power Plant Project) is underway. It is located 5 km from the LH1 / LH2 power station. Commercial operation will begin in 2009. This project is also being carried out by the same team that successfully completed LH2.

We believe that the Lahendong I, II and III plants will help to demonstrate that utilization of geothermal energy can be one of important solutions to the Indonesian energy shortage problem.