Increase Electricity Supply to the Community to Support Sustainable Development by Minimizing House Load in Geothermal Power Plant

Raity Arief Hidajat¹, Suyud Wamoro Utomo², Iwa Garniwa³, Mahawan Karuniwasa⁴
¹,²,⁴ School of Environmental Science, Universitas Indonesia
³ Department of Electrical Engineering, Faculty of Engineering, Universitas Indonesia
{raity.arief@gmail.com}

Abstract. Recently, electricity consumption in Indonesia continue to increase rapidly along with the increase in development, economic growth and also the increase in the population. One potential source of electrical energy comes from geothermal energy, where Indonesia has enormous potential. According to data from the Geological Agency, Ministry of Energy and Mineral Resources, until the end of 2016 there were at least 331 geothermal energy source locations throughout Indonesia, where most of the potential was on a volcanic track with a potential of 28,579 MW and this is the largest geothermal energy in the world. In its operation, power plants need energy to supply their own needs (house load) which amounts up to 10 % of the electrical energy produced. Own electricity needs are used to drive brine and condensate pumps, fan drive motors in cooling towers, lamps and electronic appliances in well pad and offices. The use of this energy can be minimized to increase electricity production which is distributed to users. The methodology used in this research is lean sigma process through the Define-Measure-Analyze-Improve (DMAI) steps. The first step is to define the problems regarding opportunity from electricity use for own needs that can be saved and constraints faced, the next step is to measure the electrical usage as baseline data, then analyze to find the causes of inefficiencies in electricity use and the last make improvement programs. From a case study conducted at the Gunung Salak geothermal power plant in West Java, the energy efficiency of house load can be minimized by up to 7.5%-10% in 2018-2019. Greater energy supply to the community will have an impact on improving the economy of the community to support production activities that require electrical energy.

1. Introduction
Population and economic growth make demand for electricity supply continue to increase. This is what makes the development of renewable energy power plants considered a national need that can no longer be delayed. Electrical energy has now become a major need in people's lives, the need for electricity in Indonesia which continues to increase rapidly along with the increase in development, economic growth and also the increase in the population in Indonesia. One potential source of electrical energy comes from geothermal energy, where Indonesia has enormous potential source. According to data from the Geological Agency, Ministry of Energy and Mineral Resources, until the
end of 2016 there were at least 331 geothermal energy source locations throughout Indonesia, where most of the potential was on volcanic lines with a potential of 28,579 MWe with details of 11,073 MWe and estimated reserves around 17,506 MWe and installed capacity of 1,534 MWe [2]. The utilization of geothermal energy is currently used entirely for electricity generation.

The connection with sustainable development is to maximize the use of energy from renewable sources, low emissions, waste and low operating costs because it does not use fuel, so that environmental aspects can be maintained from environmental damage. Greater energy supply to the community will have an impact on improving the economy and social activity on the community that require electrical energy.

Since 1987 the world has introduced the concept of sustainable development by the World Commission on Environment and Development, chaired by Gro Harlem Bruntland, the Norwegian Prime Minister at the time. This commission produced a report known as "The Brundtland Report" which added economic aspects to the ecological and social aspects [7]. Sustainable development is a development process that has the principle of meeting current needs without compromising the fulfillment of future generation’s needs [1]. The factor that must be faced to achieve sustainable development is how to improve environmental destruction without sacrificing the needs of economic development and social justice. The 2005 World Summit outlined that sustainable development consists of three main pillars, namely economic, social, and interdependent and strengthening environments.

Geothermal power plants (PLTP) are known as environmentally friendly power plants. Like photovoltaic and wind, power generation from geothermal power produces air pollution which is little compared to using fuel oil. Land use for geothermal power plants is smaller per megawatt than other types of power plants [5].

For this research, the sample location was a geothermal power plant on Mount Salak, West Java province.

![Fig 1. Geothermal Power Plant Process](image)

### 2. Methodology

House load is the amount of electrical energy used for own needs to support operations in the geothermal plant itself, such as for lighting and running equipment in offices and operating facilities, street lighting and running pumps and other supporting equipment. Research conducted to the usage of house load to be lowered to increase electricity distribution to the community. Research is a scientific activity to solve problems systematically using certain methods and techniques. In this research the method used is using the lean sigma that is a method on a collaborative team effort to improve
performance by systematically removing waste and reducing variation to eliminate the eight kinds of waste [4]: Defects, Over-Production, Waiting, Non-Utilized Talent, Transportation, Inventory, Motion, Extra-Processing. There are four steps in the lean sigma process, namely: Define-Measure-Analyze Improve (DMAI). The first step is to define the problems regarding opportunity from electricity use for own needs that can be saved and constraints faced, the next step is to measure the electrical usage as baseline data, then analyze to find the causes of inefficiencies in electricity use and the last make recommendation for improvement programs.

Table 1. Research Question (RQ)

| Research Question | Motivation |
|-------------------|------------|
| Can house loads in geothermal power plants be minimized? | Identify opportunities for minimizing house load so that electricity distribution to the community can be increased. |

3. Result and Discussion

3.1 Define the problem

The use of house load among geothermal power plants in Indonesia, Gunung Salak power plants, including the largest house load users with house load ratio reached 7.16% or 14.1 MW. This is because the electricity generation process with 2 phases where many pumps are needed to drain brine to the separator and drain condensate to the injection wells. If only 50% of this house load is distributed to the public, it will be able to illuminate an additional 7,800 houses with 900 Watts of power. This is an opportunity to reduce or streamline the use of electricity for their own needs so that the electricity produced can be distributed more to the community to support their economic and social activities.

Table 2. Utilize House Load on Geothermal Power Plant in Indonesia

| No | Geothermal Plant | Total Gross Load (MW) | Average House load (MW) | Ratio House Load (%) |
|----|------------------|-----------------------|-------------------------|----------------------|
| 1  | Salak            | 196.8                 | 14.1                    | 7.16%                |
| 2  | Karaha           | 30                    | 1.8                     | 6.00%                |
| 3  | Dieng            | 60                    | 3.5                     | 5.83%                |
| 4  | Patuha           | 55                    | 2.8                     | 5.09%                |
| 5  | Kamojang         | 100                   | 4                       | 4.00%                |
| 6  | Wayang Windu     | 227                   | 9                       | 3.96%                |
| 7  | Darajat          | 216                   | 8.28                    | 3.83%                |
| 8  | Ulubelu          | 110                   | 3.5                     | 3.18%                |
| 9  | Lahendong        | 40                    | 1.2                     | 3.00%                |
| 10 | Ulumbu           | 10                    | 0.224                   | 2.24%                |

3.2 Measure the electrical usage as house load

The identification of the use of house load in the Gunung Salak geothermal power plant obtained the following data in the table 3.

Table 3. House load usage at Salak Geothermal Power Plant

| Unit  | Gross Load Capacity (MW) | Total Gross Load (MW) | Average House load (MW) | Ratio House load (%) |
|-------|--------------------------|-----------------------|-------------------------|----------------------|
| Unit 1| 65.6                     | 196.8                 | 4.7                     | 7.16%                |
| Unit 2| 65.6                     |                       | 4.7                     | 7.16%                |
| Unit 3| 65.6                     |                       | 4.7                     | 7.16%                |
3.3 Analyze to find the causes of inefficiencies in electricity use

The purpose of analyze is to find the causes of inefficiencies in electricity use and identify, validate and select root cause for elimination. A potential root causes of the problem are identified via root cause analysis. Root cause analysis is done by Why Tree tools that can be used on all levels of events, but primarily on complex events. The top potential root causes are selected based on priority of minimal effort and cost are categorized into 3 levels:

a. Low category for effort that can be executed with operating cost.

b. Medium category for efforts that require capital expenditure.

c. High category for efforts that require capital expenditure and involve external parties.

Opportunity analysis to minimize house load is by brainstorming method which involves several functions in power plants such as engineering, operation and maintenance. Minimizing houseload can be done in 2 ways:

a. Minimize the use of electrical energy for their own needs, and or

b. Identify opportunities for increasing electricity generation for the use of own needs.

3.4 Recommendation for improvement programs

The results of the brainstorming, there is an opportunity to reduce the house load as in table 4.

| No | Opportunity | MW Reduction | Effort |
|----|-------------|--------------|-------|
| 1  | Switch off outdoor lighting in certain well pad and Cooling Tower and replace the current HPS lamps with LED lamps | 0.06 | Low |
| 2  | Stop one Condensate Pump | 0.12 | Low |
| 3  | Stop one Cooling Tower Fan (CTF) | 0.35 | Low |
| 4  | Run One Auxiliary Water Pump (AWP) | 0.88 | Low |
|    | **Total** | **1.41** |       |
| 5  | Change diesel pump with steam turbine for operating Condensate Pump (long term program) | 0.11 | Medium |
|    | **Total** | **0.11** |       |
|    | **Grand Total** | **1.52** |       |

4 Conclusion

The results of this study identified opportunities to minimize house load by giving priority to effort Low and Medium, obtained a decrease in house load of 1.41 MW for short term and low effort and an additional 0.11 MW for long-term projects with medium effort so that in the first year reducing the house load ratio by 10% and increasing to 11% when the long-term project is completed.

A decrease of house load or an increase in electricity distributed to the community by 1.52 MW means that it can provide an additional lighting of 1,689 homes with 900 Watts of power to drive the economy and increase social activities of the community.

Based on of this research can answer the research question that house load can be minimized by identifying savings opportunities that can be done by considering effort and cost.

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