GEOTHERMAL DIRECT USE APPLICATION FOR COFFEE COMMODITIES IN MATALOKO, EAST NUSA TENGGARA

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ABSTRACT

Flores island is located in eastern Indonesia and part of East Nusa Tenggara Province. Known with the big potential geothermal reserves spreading into 17 locations with approximately 402.5 MWe and 527 MWe reserve. According to the potential reserve, government arrange Flores as the island of geothermal. The aim of this arrangement is to fulfill the electricity demand with maximize the potential geothermal reserve, also direct utilization to increase the agriculture, plantation, and tourism result. Geothermal energy can be utilized for indirectly or directly use. Geothermal can be indirectly used to produce electricity. Meanwhile, the direct-use applications exist on a scale ranging from heating and cooling. The direct use of geothermal energy has significant economic, environmental, and social benefits, chiefly because it reduces electricity demand as it replaces electric-driven heating and cooling applications.

Mataloko is one of the areas in East Nusa Tenggara Province where there is a geothermal power plant operating with 2.5 MW capacity. In addition to geothermal sources from the powerplant, there is a geothermal resource which is coming from surface manifestation around the powerplant. Other than that, beside geothermal resource, Mataloko is an agricultural and plantation area. Coffee become one of the biggest plantation commodities with the cumulative harvest in every year reaching 3,000 tonne in Mataloko. Nowadays, the coffee farmers have a challenge to drying the coffee beans or cherry in the open air (conventional method). This conventional drying practice has also impact to the cost and requires significant time for producing high quality green beans. The purposes of studies are describing about coffee commodities as the biggest local commodities in Mataloko, analyze and assest the geothermal source in Mataloko and finally implement the geothermal direct use of drying system that designed for coffee commodity in Mataloko.

1. INTRODUCTION

Indonesia is one of the countries in the world with greatest geothermal energy potential. From Sabang to Merauke, Indonesian archipelago are surrounded by hotspots. With large number of hotspots, Indonesia is known as “Ring of Fire” country. Therefore, with the geothermal potential in Indonesia, this is very exceptionally large to be implemented and very important for exploration and production acitivities. According to ESDM (ESDM, 2020), the geothermal potential in Indonesia reached 23,900 Mega Watt (MW) or 23.9 Giga Watt (GW). However, 8.9% has only been utilized or equal to 2,130.6 MW. This number is too low. The fact in 2020, geothermal utilization in Indonesia is still below 10%. According with this situation, Indonesian Government plans to increase the geothermal energy utilization up to 7,241.5 MW or increasing 16.8% in 2025.

One of the locations with largest geothermal potential in Indonesia is Flores Island. There are sixteen geothermal locations in Flores Island. Based on those locations, Mataloko is the location that has installed a powerplant with 2.5 MW capacity since 2011. However, on current situation, the powerplant is not operating. Hence, applying the geothermal source in Mataloko powerplant as a geothermal direct use is the best option since there is no operation activity for electricity needs

2. METHODOLOGY

This paper includes a literature review and site visit in Mataloko to collect data regarding coffee commodity. The results showed that coffee is the biggest production in Golewa district and has a big impact to the community. Other than that, coffee commodity can be implemented for the drying. So, in this case coffee has been chosen for geothermal direct use in Mataloko which will be implemented as coffee drying system.

Thereafter, a selection for geothermal heat source that could be used is carried out, whether it be sourced from the wells in the powerplant or coming from surface manifestation. The figure of workflow can be seen in Figure 1.

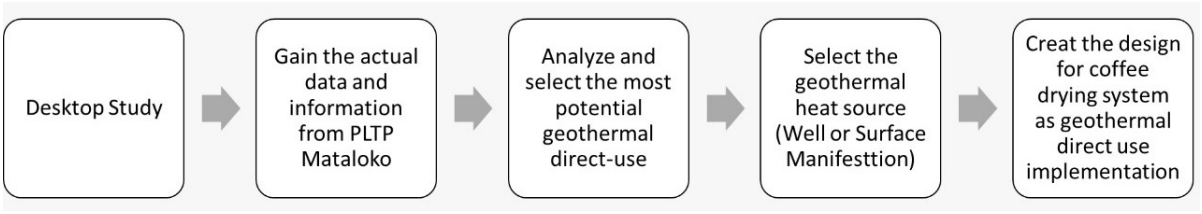


Figure 1 - Methodology Workflow

3. COFFEE COMMODITIES IN MATALOKO

Coffee is the biggest local commodities in Golewa. This is because the location of Golewa district is including the highland area. According to the Figure 2, coffee is the highest production of plantation commodities in Golewa with 854 ton in 2018. Moreover, in 2019, the production of coffee was still the highest production among other plants.

Meanwhile, the definite reason on decreasing coffee production in Figure 2 from 2018 to 2019 was unknown. But it could be because the data obtained was in different resource. And based on the interview with the local government, they were focusing on other commodities.

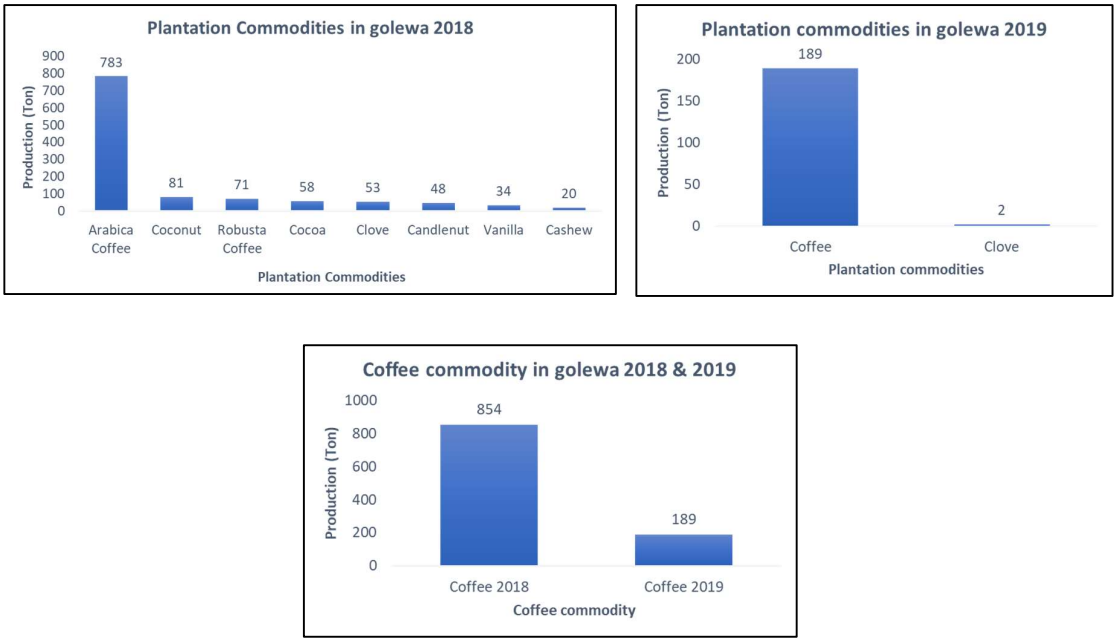


Figure 2 - Coffee Commodity in Golewa 2018 (Ngada, 2019) and 2019 (BPS Kecamatan Golewa, 2020)

3.1 Mataloko Local Community (MPIG Flores Bajawa Arabica Coffee)

MPIG Flores Bajawa Arabica Coffee is a representative institution for Bajawa and Flores Island community whose role to maintain the production and quality of arabica coffee. This institution consists of 128 UPH (Unit Pengelola Hasil) in which there are 1,000 of farmers. MPIG Flores Bajawa Arabica Coffee is covering three districts: Bajawa, Golewa, and West Golewa. This institution is able to produce the coffee in Ngada Regency up to 3,000 tonne cumulatively in a year. According to the farmers, they are using the conventional method for coffee drying. To produce the best quality of coffee beans, the coffee must be drying until the moisture content become 12%. Meanwhile, it takes 20-25 days in fine weather to get the number of moisture content through the conventional drying. This period of time is needed to dry 500 kg of cherry beans.



Figure 3 - MPIG Flores Bajawa Arabica Coffee (Bajawa, 2011)

4. MATOLOKO GEOTHERMAL SOURCES INFORMATION

4.1 Powerplant Information

Based on PLN data (PLN, 2019), WKP Mataloko have six wells. Those wells in PLTP Mataloko were exploration well in the beginning. But after that, the six wells are then developed and changed into delineation, development, andinjection well. The first well was A-1 (not flowing) which is the exploration well type. It is 207.3 meters depth and was drillied in year 2000. A-2 (not flowing) well drilling, which is the second exploration well done in February 2001 with 180 meters depth. The next drilling done was for A-3 (flowing) well. This well is meant to be a delineation well, which was drilled in 2003 and reached 613 meter in depth.

Drilling for A-4 (flowing) well was also done in the same year. A-5 (flowing) well is the fifth well drilled in 2005 in WKP Mataloko with 378.2 meter in depth and was meant for development well. Then, A-6 (not flowing) well is the last well drilled in 2005 with 123.3 meter in depth. Please note that all of the wells drilled for PLTP Mataloko haven't reached reservoir zone. The deepest well drilled is A-4 well with 756.5 meter while the reservoir zone is located 800-900 meter below surface. A-4 temperature and pressure is 104 ºC and 10 barg. The pressure gauge is claimed to be accurate and representative, but there is a leak in the cellar so it needs a rework on the substructure.

4.2 Powerplant Information

Table 1 show the information regarding surface manifestation in Mataloko

Table 1 - Surface Manifestation Information (Rigsis Energi Indonesia, 2021)

Name	Temperature (°C)	Additional Information
Wae Luja Hot Stream	91	• pH: 2.93 • TDS: 765 ppm • EH: 292.6 mV
Ratogesa Crater (Wogoalo) Mud Pool	94	-

5. COFFEE DRYING SYSTEM DESIGN

Based on the heat source available and the required temperature of coffee drying process, the Process Flow Diagram (PFD) for Mataloko geothermal direct use application can be seen on Figure 4.

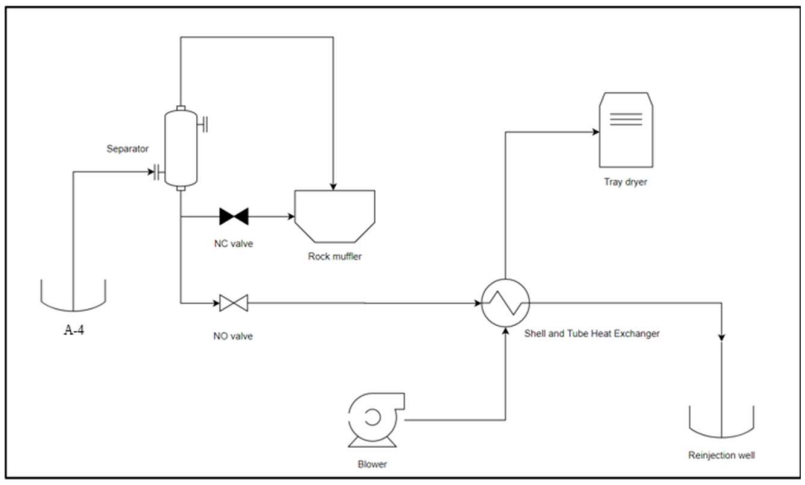


Figure 4 - Process Flow Diagram

This direct use application will utilize the brine from A-4 production well to dry coffee beans. The brine from the well will be separated by the separator, where the steam separated in this equipment will be released with a Rock Muffler (RM). This steam is not used for the direct use application because it is projected to be used by the Mataloko Powerplant when the power plant has finished its reparation. The drying media used for the coffee drying process is air, which are blown by a blower through a heat exchanger where its temperature rises to 50 ºC. The brine will be reinjected to the reservoir by an injection well after it passes through the heat exchanger.

5.1 Heat Exchanger

As the area provided for the heat exchanger is quite narrow in Mataloko, it can be concluded that the most suitable type of heat exchanger used is the shell and tube. Shell and tube have been chosen due to relatively easy for maintenance and working fluid can accommodate liquid and steam. Furthermore, shell and tube have flexibility of temperature and pressure that will be used, and the cost is relatively medium.

Table 2 - Shell and Tube Design Result

Shell and Tube Heat Exchanger				
	Parameter	**Unit**	**Brine (Tube Side)**	**Air (Shell Side)**
Line Sizing	Dimension	mm	Outer Diameter: 26.7 Inner Diameter: 20.96 Length: 2000 1,25 pitch/diameter	Inner Diameter: 320
	Mass flow	kg/s	3.5	1.56
	k	W/m.K	52 (Carbon Steel 0.5% C)	
Calculation	Fluid Velocity	m/s	0.46	21.86
	U	$W/m^2.K$	50.5	
	Number of pipes in 1 bundle	pipe	90 (4 tube passes)	
	Pressure drop	bar	0.023	0.00002
	Overdesign	%	1.01	

5.2 Dryer

Tray Dryer is choosen due to the consideration of several parameters such as relatively smaller production capacity that can be adjusted to the needs, relatively low cost, and easy to operate for the community. To determine the target of this drying process, the initial moisture content of the coffee to be used and the environmental conditions at the drying location must be known. The type of coffee to be dried is the type of Arabica coffee (Coffee arabica L.) which grows in Mataloko highlands. Based on a study conducted by (Chandrasekar V & Viswanathan R, 1999), Arabica coffee that has gone through the washing process and is in the form of parchment coffee has an average water content of 60.9%.

This water content can be used as a reference in drying calculations so that it can be seen the amount of air needed to dry 500 kg of coffee. Furthermore, it is also necessary to target the water content to be achieved in coffee drying. Referring to (Indonesia Patent No. 2907:2008) , green coffee beans that are ready to be packaged and stored must have a water content of 12.5%. For environmental data, it was found that the average temperature in Mataloko was 23.8 ^oC and the average humidity was 61%.

Table 3 - Air Properties

Psychometric Properties of Air at Each Point			
Parameter	**Before Heat Exchanger**	**After Heat Exchanger/ Before Drying Process**	**After Drying Process**
Temperature	23,8 ^oC	50 ^oC	26 ^oC
Relative Humidity	61%	15%	100%
Moisture content	0,0114 kg water/kg dry air	0,0114 kg water/kg dry air	0,0214 kg water/kg dry air
Enthalpy	54,25 kJ/kg dry air	82 kJ/kg dry air	82 kJ/kg dry air

From the data obtained, the maximum capacity of water that can be evaporated is obtained by reducing the moisture content of the air before entering the tray dryer and saturated air during the drying process.

6. CONCLUSION

Based on data from Mataloko, there are 2 options for utilizing the geothermal sources; wells at PLTP Mataloko, and surface manifestations. Of these options, the most suitable geothermal source is the well at PLTP Mataloko, namely A-4 Well.

Coffee become the most suitable of commodity that can be applied for the geothermal direct use application in Mataloko. The highest of cumulative production in every year for local commodities, most people are coffee farmers and the suitability of temperature with geothermal heat source from well A-4 in Mataloko Powerplant are some considerations in selecting coffee commodity.

Moreover, the A-4 is the only well in the PLTP Mataloko that can supply the needs of a coffee drying system designed with a capacity of 500 kg. The problem is in the flowrate of brine from Well A-4 which is only 0.036 tons/hour. This is due to the well that did not reach the reservoir target thus the current condition of the well is in steam pocket. However, the temperature that comes out of the well is 102.4oC. With this temperature, it is still able to accommodate the drying requirement of 50 ^oC.

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