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The Potential Of Rice Husk For Electrical Energy Generation In South Sulawesi, Indonesia

Yusran, Hanser Aprusmin, Untung S. Rumengan, Gassing, Indar Chaerah G, Tajuddin Waris, Ikhlas Kitta
Departement of Electrical Engineering, Hasanuddin University
Makassar, Indonesia, yusranibnu@yahoo.com

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***Abstract*—The alternative energy searching for electrical generation should be pursued, along with fossil fuel reserves reducing. The rice husk is a biomass type with very abundant avaibility in South Sulawesi and had not been utilized optimally for electrical generation. Currently, the average production of rice husk in South Sulawesi around 964,359.64 tons/year and increases every year. Based on linear regression method, the rice husk production in 2024 estimated at 2,055,762 tons. The results showed that 1 kg of rice husk is able to generate 1.3 kWh of electrical energy. For South Sulawesi, rice husk can generate 305 MW electrical power in 2024.**

***Index Terms*—biomass, rice husk, electrical energy, South Sulawesi**

I. INTRODUCTION

The population growth and economical development in an area will correlate with the electric energy consumption growth. Now, the regional development is largely determined by the availability of electrical power infrastructure. The development acceleration in South Sulawesi requires the availability of electrical power in sufficient quantities. The new industrial park development will contribute for large electrical power supply. The growth of electrical power needs indicates increasingly year to year. The electrical peak load projection in South Sulawesi Province for year 2016 – 2024 is shown in Table 1.

TABLE 1 SOUTH SULAWESI LOAD PEAK GROWTH PREDICTION 2016-2024 [1]

No	Year	Economic Growth (%)	Load Peak (MW)
1	2016	8.9	941
2	2017	9.4	1.128
3	2018	9.7	1.383
4	2019	9.9	1.502
5	2020	9.5	1.683
6	2021	9.5	1.822
7	2022	9.5	1.975
8	2023	9.5	2.143
9	2024	9.5	2.326
10	2025	9.5	2.527
Growth		11.9 %	11.7 %

The average of South Sulawesi economic growth projection is 11.9 %. The economic growth have a correlation with the electrical load growth. In 2016, the projection of peak load will reach 1,002 MW. In 2024, the peak load will reach more than twice comparing to 2016 year. The value is around 2,449 MW.

The increasing needs of electrical power annually, of course require a solution in the form of electrical infrastructure development. The action consider such as power plants, transmission lines, substations and distribution networks development.

For electrical power plant, it takes effort to find new and renewable energy-source. The alternative energy sources are basically widely available. For example: solar energy, wind energy, hydropower, ocean energy, geothermal, etc. The alternative energy sources searching for electrical energy generation must be pursued, along with fossil fuel reserves reducing.

In addition there is an alternative energy source that may be less known, namely biomass. The biomass is one of alternative energy to generate electrical power [2]. The rice husk is a biomass type with very abundant avaibility in South Sulawesi, Indonesia.

Fig 1. The rice husk

The rice husk is the coating of seed or grain of rice. The husk protects the seed during the growing season, since it is formed from hard materials, including opaline silica and lignin. The husk is mostly indigestible to humans. The rice husk is hard layer covering kariopsis which consists of two parts, called lemma and palea that are interlocked. In the process of milling, paddy will be separated from the grain of rice and are made of waste grinding. At each millers, we will see piles of rice husk mountains even higher and higher.

The rice husk waste in South Sulawesi are generally not utilized, more than 80%. The small portion of rice husk had been used for industry fuel (± 12%), and compost/fertilizer (± 3%). Approximately, less than 3% used for the base of the enclosure, especially for the chicken coop, heap and household using. The detail data are shown in Table 2.

TABLE 2 PERCENTAGE OF RICE HUSK UTILIZATION IN SOUTH SULAWESI [3]

No	Utilization	Percentage (%)
1	Fertilizer	3.29
2	Small Industrial Fuel	12.40
3	Other	2.82
4	Not Utilized	81.49
	Total	100

The rice husk industrial users as a fuel mainly rice mill, corn dryers, industrial bricks, and ceramics. The waste husk was found piled in locations millers, left such a way and can be taken for free by the public or users. Based on the interview, the rice milling industry and maize dryers have utilized husk as fuel and willing to pay compensation for the price about Rp 200,000/ton.

From the rice milling process usually acquired approximately 20-30% of rice husk. The rice husk has 3300-3600 kcal/ kg calorie content. Currently, rice husk as fuel only used in the rice milling, corn dryers, industrial bricks, and ceramics.

This study aimed to determine the rice husk potential as an alternative energy source for steam power plant in South Sulawesi. The paddy and rice husk production forecasting performed by linear regression method.

II. THE RICE HUSK POTENTIAL

The South Sulawesi Province is the fourth largest rice producer in Indonesia and thus also has very large potential production of rice husk. From the total paddy production, we can get around 20% rice husk production. In 2010,2011, 2012 and 2013 paddy production reached each 4,345,806, 4,478,915, 4,941,264, and 4,916,911 tons. The paddy production indicated increasing every year.

Finally in 2014, South Sulawesi paddy production increased to 5,426,096 tons. The paddy production data in South Sulawesi Province are shown in Table 3. The rice husk production data are shown in Table 4. The data of of rice husk production is obtained through data processing based on below formula:

Production of Rice Husk = 20% x Paddy Production (1)

TABLE 3 THE PADDY PRODUCTION IN SOUTH SULAWESI PROVINCE 2010-2014 [4]

No	Year	Paddy Production (Ton)
1	2010	4,345,806
2	2011	4,478,915
3	2012	4,941,264
4	2013	4,916,911
5	2014	5,426,096

TABLE 4 THE RICE HUSK PRODUCTION IN SOUTH SULAWESI PROVINCE 2010-2014

No	Year	Rice Husk Production (Ton)
1	2010	869,161
2	2011	895,783
3	2012	988,253
4	2013	983,382
5	2014	1,085,219

Source : Calculation Result

The paddy and rice husk production forecasting in South Sulawesi until 2024 conducted by simple linear regression of Y and X, using the least square method. The forecasting using trend analysis based on the dependent variable and X as specific variable.

If the variable of X is already known, it can be used to predict or estimate the Y value. The trend analysis using simple linear regression coefficient, in which a set of data is a number that was obtained within a certain period. The trend analysis may yield curve a straight line/simple linear Y and X, formulated by:

$$Y = a + bX \quad (2)$$

With Y as the dependent variable, the amount of power connected forecasting results in a given year, and X as a determinant variable is a variable year. The values a and b calculated by the formula:

$$a = \frac{\Sigma Y.\Sigma X^2 - \Sigma X.\Sigma X.Y}{n\Sigma X^2 - (\Sigma X)^2} \quad (3)$$

$$b = \frac{\Sigma Y.\Sigma XY - \Sigma X.\Sigma.Y}{n\Sigma X^2 - (\Sigma X)^2} \quad (4)$$

The using of the formula (3) and (4) needed a pair of data of the X and Y. The data prepared in the table. The columns X and Y can be written according to their meanings. The column X contains x_1, x_2, x_3,...x_n which in fact contains a number of the observations determinant variables X. Similarly with the column Y, the value of X and Y in the form of a couple pairing with y_1 x_1, x_2 y_2 , x_n y_n.

The South Sulawesi paddy and rice husk production forecasting are shown in Table 5. In 2016, paddy production estimated 8,199,947 tons and rice husk production around 1,639,989 tons. In 2024, the paddy production will increase to 10,278,808 ton. The rice husk will increase to 2,055,762 ton.

Based on the forecasting, the paddy and rice husk production increase every year.

TABLE 5 THE RICE HUSK PRODUCTION FORECASTING IN SOUTH SULAWESI 2016-2024

Year	Paddy Production (Tons)	Rice Husk Production (Tons)
2016	8,199,947	1,639,989
2017	8,459,804	1,691,961
2018	8,719,662	1,743,932
2019	8,979,520	1,795,904
2020	9,239,377	1,847,875
2021	9,499,235	1,899,847
2022	9,759,093	1,951,819
2023	10,018,950	2,003,790
2024	10,278,808	2,055,762

III. THE ELECTRICAL ENERGY FROM RICE HUSK

The rice husk has 3300 kcal / kg calorific value. For 1 kWh of electrical energy need 0.8 kg rice husk. Thus, 1 kg of rice husk can produce 1.3 kWh electrical energy. From the prediction of rice husk, the prediction of electrical energy generating was made. The prediction of electrical energy that can be generated by rice husk is shown in Table 6.

TABLE 6 THE RICE HUSK PRODUCTION FORECASTING IN SOUTH SULAWESI 2016-2024

Year	Energy (GWh)*	Equivalent of Power (MW)*	Peak Load (MW)**	Power Percentage* (%)
2016	2,064	243	941	25.8
2017	2,131	251	1,128	22.3
2018	2,199	259	1,383	18.7
2019	2,267	266	1,502	17.7
2020	2,334	274	1,683	16.3
2021	2,402	282	1,822	15.5
2022	2,469	290	1,975	14.7
2023	2,537	297	2,143	13.9
2024	2,604	305	2,326	13.1
Average	2,334	274.1	1,655.9	17.5

*Source : The calculation results
** Source : PLN Electricity Supply Business Plan 2015-2024 [4]

IV. THE FLUIDIZED BED COMBUSTION TECHNOLOGY

The fluidized bed combustion (FBC) technology has advantage to convert various types of material like rubbish, waste, biomass or fossil fuels low calorie. The FBC is one of the best technology to convert rice husk into electricity. The FBC have operating temperatures between 800-900^{o}C so it is an environmentally friendly technology [5].

The higher combustion efficiency may be obtained from FBC technology when compared to conventional combustion systems. This is caused by very good heat transfer process in the system. In the energy conversion process with FBC technology, the combustion chamber initially heated externally to near operating temperature. The overlay material (bed material) that using commonly to heat absorbing is silica sand [5],[6].

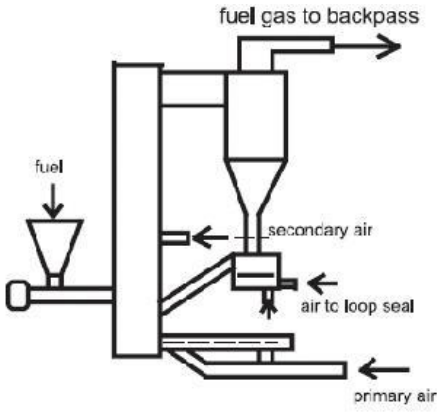

Fig 2. The FBC schematic diagram for rice husk fuel [5]

V. THE RICE HUSK UTILIZATION CHALLENGING FOR ALTERNATIVE ENERGY SOURCES

The rice husk has enormous potential as an alternative energy source for electricity generation in South Sulawesi Province, but there are some challenging for utilization as follows:

1. Collection and Transport Processes
   The rice husk existence in South Sulawesi are scattered in various areas on small-scale mills. This of course would pose an obstacle in the collection process. The rice husk collection also entails substantial costs given the rice husk properties (bulky). This is further complicated by the lack of rice husk compaction means more efficient and easier. So that the transport process requires more transportation vehicles.
2. Storage
   The rice husk storage would require a very large warehouse considering very light weighting (low bulk density), amount of 70-110 kg/m3. The rice husk storage in a long time also require additional costs to maintain the rice husk condition.

From these challenging, it is suitable to develop electrical power plant with distributed generation model rather than central generation [7],[8].

VI. CONCLUSION

1. The rice husk potential production in South Sulawesi Province is very large. The rice husk production in 2024 was predicted 2,055,762 tons. The rice husk can be used as an alternative fuel for steam power plant.
2. The electrical energy consumption of South Sulawesi will be increase year to year and rice husk assumed supplying 305 MW electrical power in 2024.

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