RICE HUSK AS BIOMASS FOR POWER PLANT, OGAN KOMERING REGENCY ULU TIMUR, SOUTH SUMATERA, INDONESIA: REVIEW

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ABSTRACT

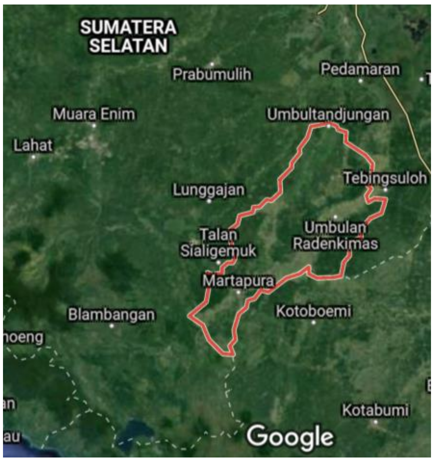
Ogan Komering Ulu Timur (OKUT) regency is a national rice-producing in South Sumatra Province. The use of modern agricultural technology has resulted in a significant increase in rice yields, namely: in 2019, 2.60 million tons of paddy dry milled grain will become 2.74 million tons in 2020. This number increases every year, which has an impact on increasing solids. Waste by paddy dry milled grain is husks straw. The percentage of husk is 20% by paddy dry milled grain. In 2020, OKUT produced 548,000 tons of husks. This husk is a potential source of biomass energy for power generation. This paper reviews the possibility of constructing a biomass power plant from rice husks in OKUT. In 2030, it is estimated that the amount of electricity that can be sold to PLN is 1.05 GW, equal to IDR. 1419.6 B or USD 97.903.

Keywords: Ogan Komering Ulu Timur, rice husk, biomass, power generation, electricity

1 INTRODUCTION

OKUT regency is located in South Sumatra Province with the capital city Martapura. This district is located in 103°33' East Longitude′ to 104°40′ East Longitude (Grid UTM 9,655 Kilometres to 9,799 Kilometres) and 3°45′ to 4°55′ South Latitude (Grid UTM 320 Kilometres to 404 Kilometres) with an area of 3,370.00 Km2 [1]. in Figure 1. the map of OKUT is shown scanned via Google Map.

(a)



(b)

Figure 1 OKUT regency is shown scanned via Google Map: (a) This district is part of the Province of South Sumatra (b) Martapura city position

OKUT was formed based on the Law of the Republic of Indonesia Number 37 of 2003 concerning the Establishment of OKUT, Ogan Komering Ulu Selatan (OKUS) regency, and Ogan Ilir, which are divisions of Ogan Komering Ulu regency. This district consists of 20 sub-districts and 332 villages, 7 sub-districts with 670,272 people. The livelihoods of the majority of

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the population are farmers. The rests are labourers and traders.

OKUT has a tropical climate and tends to be dry, with daily temperatures varying between 22 °C to 31°C. Some areas become dry (famine) in the dry season, and vice versa; floods occur in the rainy season.

The area of OKUT is one of the rice barns in South Sumatra Province; this is supported by the existence of an excellent technical irrigation network and covers a wide area. Its natural state consists of forest potential, rice fields, rubber plantations, and other gardens. Figure 2 is a description of the condition of rice fields in OKUT. In this place, there is also a large river, namely the Komering river, which is a water source for rice fields. In addition, the Perjaya Dam and an adequate irrigation network in this area can be seen in Figure 3.

Figure 2 Agricultural fields in OKUT

Figure 3 Perjaya Dam in OKUT

Along with the increase in agricultural technology, rice production will continue to increase. This will cause an increase in rice husk waste where as much as 20% of the total grain produced will become husk. The husk is a good source of biomass energy for power generation [2][3]. This paper examines the prospect of building a power plant from rice husk in the OKUT.

2 POPULATION GROWTH AND INCREASE IN RICE HARVEST

Population growth data from 2011 to 2020 [4], [5] shows that the annual population increase is approximately 10,000 people. Table 1 is the population of OKUT.

Table 1. Human population data in OKUT [1], [4]

Year	Human Population
2011	619460
2012	628830
2013	N/A
2014	N/A
2015	649390
2016	656570
2017	664020
2018	670000
2019	677000
2020	649853

Population data in 2013 and 2014 are not available. However, from the table, it appears that in 2020 there was a decline in the population of 27147 people. Since the fact that some residents have moved to cities and the COVID-19 pandemic has hit them.

Based on Regional Statistics data, rice harvests increase every year. The data can be seen in Table 2. Regarding rice harvest data in OKUS. These results produce solid waste in the form of potential sources of renewable energy from biomass, namely:

1. Rice Husk
2. Rice straw

The data in Table 2 shows that in 2019 there was a significant increase in crop yields of 2,600,000 tons of rice compared to the harvest in 2017. In contrast, the 2020 harvest was 2,700,000 tons.

Table 2. Rice harvest (tons) at OKUT

Year	rice husk (ton)	milled dry paddy grain (ton)	rice (ton)	eff (%)
2011	394,548	1972,74	986,37	0,5
2012	283,308	1416,54	708,27	0,5

2013	292,056	1460,28	730,14	0,5
2014	N/A			
2015	344,496	1722,48	861,24	0,5
2016	430,992	2154,96	1077,48	0,5
2017	368,792	1843,96	921,98	0,5
2018	N/A			
2019	520000	2600000	1400000	0,54
2020	548000	2740000	1570000	0,57

Rice husk as a biomass fuel provides additional benefits because of the ash content after the rice husk is burned. Rice husk ash (RHA) contains very high silica (Si), an important raw material for many purposes.

Some of the uses of Silica are identified below:

1. Aggregates in concrete production
2. Oil and chemical absorbent
3. Soil repairer
4. Silicon source
5. Mould in the steel casting process
6. Release agent in ceramic industry

Rice husk causes relatively low amounts of corrosion, fouling, and sintering compared to other biomass fuels. It is, therefore, a technologically viable fuel (Figure 4). Every 1 million tons of rice husk as biomass fuel predicted can be generating 147 MW of electricity.

Figure 4 Rice husk

Rice husk contains more than 75% ash and SiO_2, but it can contain more than 90% in most cases. The potassium and calcium in rice husk ash are lower than rice straw, containing 15% K_2O and 3.5% CaO. Another factor is that the melting temperature of rice husk ash is very high, around 1500 °C, which means that rice husks are relatively not a problem in terms of fouling, sintering, and slagging. Furthermore, the chlorine content in rice husk is relatively low, generally below 0.1 w-%. In rice straw, the chlorine content can reach 0.7%; this means that rice husk has a relatively low corrosion value compared to rice straw. Table 3 shows the chemical composition of husks and straw [6].

Table 3. The composition of rice husk and straw [6]

Item	Rice husk (%)	Rice straw (%)
Cellulose	34.4	44.3
Hemicellulose	29.3	35.5
Lignin	19.2	20.4
Fixed carbon	16.22	15.86
Volatile matter	63.52	65.47
Ash	20.26	18.67
Carbon	38.53	38.24
Hydrogen	4.75	5.20
Oxygen	35.47	36.26
Nitrogen	0.52	0.87
Sulphur	0.05	0.18

As a fuel, the high heating value (HHV) of rice harvest waste is shown in Table 4.

Table 4. HHV of rice harvest waste [6]

Types of rice harvest waste	HHV MJ/kg
Rice Husk	13,8072
straw	11,7152
rice straw	13,3888

3 RESULTS AND DISCUSSION

3.1 The Trend of Population Growth

Based on the statistical data above, a graph of the population growth trend in the OKUT can be drawn, shown in Figure 5.

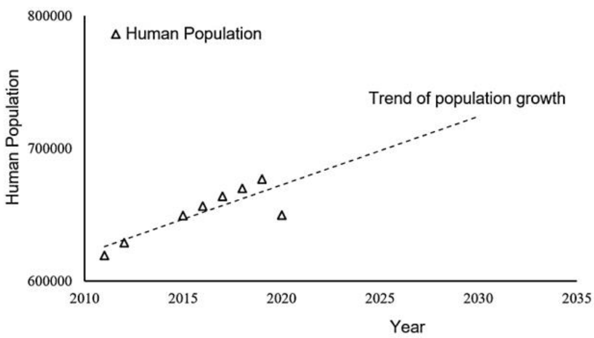

Figure 5 The trend of population growth in OKUT

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The increasing population every year causes the need for electricity to increase. However, in 2020, there was a significant decline in the population. It was coupled with the COVID-19 pandemic, which causes daily office activities and meetings to be carried out at home, namely: works from home (WFH), children learning from home, and everyone using the internet. Hence the electricity demand increased. Figure 6 shows a graph showing the increase in population and estimated electricity consumption until 2030.

The electricity source used is the normal line net from PT. PLN (Persero) from the power plant in the Lahat regency. Increasing the production of rice husks every year as a by-product of increasing rice yields, it is possible to build your generator using biomass fuel from rice husk. Figure 7 shows the trendline for rice production growth and its by-products based on regional statistical data [1], [4].

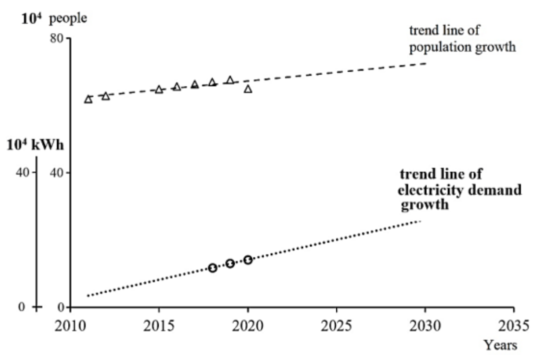

Figure 6 The increase in population and the estimation of the increase in electricity consumption until 2030.

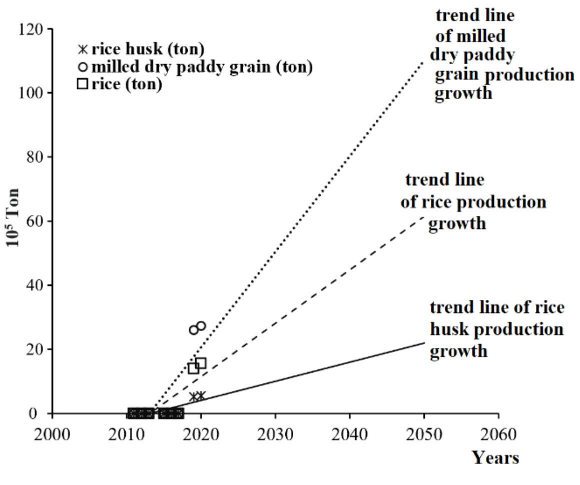

Figure 7 The growth trend of paddy, rice, and husk production

When the increase in rice harvests is considered constant, the increase in rice husks will be constant every year. Estimates of the production of rice husks up to 2040 are shown in Table 5.

Table 5. Estimation of rice husk yields from rice harvests in the coming year in OKUT

Year	rice husk (ton)
2019	520000
2020	548000
2025	688000
2030	828000
2035	968000
2040	1108000

The rice husk yield data shown in Table 5 can be graphed as a linear line shown in Figure 8. This linear line forms a slope with a slope of 23°.

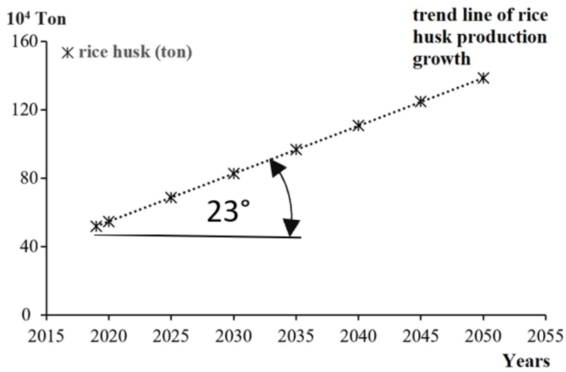

Figure 8 Linear line that describes the estimated increase in rice husk production each year

The Equation of the line in Table 5 will occur if the agricultural technology used remains the same as the condition of the equipment that is well maintained. So that production takes place continuously. Concluded that rice husk production each year is a function of the agricultural technology used, and the line will form an angle of 23°. Therefore, it can be said that the number of rice husks produced per year at OKUT is a function of the agricultural technology used, Equation (1).

rice husk (ton) = *f*(agriculture Technology) (1)

From Figure 8 and Equation 1, the performance of the agricultural technology used decreases so that angle that is smaller than 23°, while, if increases, the trend line of rice husk production growth will form an angle greater than 23°.

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Table 6. Estimation of electrical energy that can be generated using rice husk biomass energy sources

Year	rice husk (ton)	Energy MJ	Electrical Energy GW	Electrical Energy GW, eff $_{\text{Power Generation}}$ = 40%
2019	520000	7179744000	2,060586528	0,824234611
2020	548000	7566345600	2,171541187	0,868616475
2025	688000	9499353600	2,726314483	1,090525793
2030	828000	11432361600	3,281087779	1,312435112
2035	968000	13365369600	3,835861075	1,53434443
2040	1108000	15298377600	4,390634371	1,756253748
2045	1248000	17231385600	4,945407667	1,978163067
2050	1388000	19164393600	5,500180963	2,200072385

Using the Conversion of MJ to kWh is 1 MJ = 0.278 kWh is estimated future electricity generation in OKUT shown in Table 6.

Table 6, in 2030, the community's electricity demand is 250 MW. In the same year, the electricity provided using biomass fuel from rice husks was 1.3 GW with a system efficiency of 40%. The excess electricity sold to PLN is 1.05 GW. PT owns the price of 1 kWh of electricity from the network. PLN for 900 VA power is IDR. 1352; 1.05 GW equal to IDR. 1419.6 B, currency IDR 14,500 for USD 1, equal to USD 97.903.

In the OKUT, many other biomasses are produced from plantation products other than agricultural products in rice fields, namely: waste from palm oil, corn, vegetables, sugarcane, and other crops. Biomass waste from this plantation is also a potential energy source to generate electricity. Therefore, the prospect of generating electricity using energy sources from biomass is very large.

4 CONCLUSIONS

Based on mathematical calculations, rice husk in the OKUT can be used as a biomass raw material. The increase in rice husk production is an advantage because of the increase in raw materials, which is accompanied by an increase in population. The increasing population means the electricity consumption increases. Further, based on calculation, in 2030, estimated that the amount of electricity that can be sold to PLN is 1.05 GW, which this equal to IDR. 1419.6 B or USD 97.903.

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