Penerbit Akademia Baru

Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage: www.akademiabaru.com/araset.html
ISSN: 2462-1943

Renewable Energy of Rice Husk for Reducing Fossil Energy in Indonesia

Open Access

Hamzah Lubis[1,2,3,4,*]

[1] Regional Council for Climate Change, North Sumatera Province, Indonesia
[2] Bending and Climate Change Institutions of Nahdlatul Ulama, North Sumatera, Indonesia
[3] Environmental Impact Assessment Commission, North Sumatera Province, Indonesia
[4] Marine Partnership Consortium of North Sumatra Province, Indonesia

ARTICLE INFO

Article history:
Received 17 January 2018
Received in revised form 28 February 2018
Accepted 28 March 2018
Available online 1 April 2018

Keywords:
Rice husk, renewable energy, heating value, economic value

ABSTRACT

Indonesia as an agricultural country with staple food of rice, has huge rice husks resources. Rice husk production in 2006 was 10,891,980 tons and in 2015 was 15,079,560 tons with growth rate of 3.85% per year. The purpose of this study is to examine rice husks as an alternative to renewable energy fuels. According to Indonesia's renewable energy policy, the target of renewable energy application is 23% out of total energy by 2025. Nevertheless, the average percentage of renewable energy using is just 0.19% per year in the last ten years. Rice husks need to be dried before burning it to obtain heat value. In this study, the rice husks were dried by solar heat. Measurement of water content of rice husks were performed by gravimetric method at Research and Standardization Laboratory, Medan, Indonesia. Dried rice husk samples were burned in calorimeter bomb to acquire the burning temperature and heat value and the tests were performed at Basic Phenomenon of Mechanical Engineering Laboratory, Institute Technology of Medan.The results showed that High Heating Value (HHV) was 11.03 MJ / kg. Rice husks energy generated according to production in 2015 equivalent to 5,075,588,554 liters of Pertamax gasoline which worth US $ 3,182.003,594. Furthermore, if rice husks were utilized for electricity power generation, 25,635,252,000 kWh of electricity will be achieved and it is worth US $ 2,665,912,362.It is concluded that the rice husks can be developed as one of potential renewable energy fuel to accomplish 23% target of renewable energy application by 2025.

1. Introduction

Resilience of a country, influenced by energy security. Much of the world's energy comes from fossil fuels, owned by a few countries, at prices that fluctuate and damage the environment. To overcome energy dependence and reduce environmental damage, many countries turn to renewable energy. One of them is biomass [1].

* *Corresponding author.*
E-mail address: Hamzah Lubis (hamzahlubis@yahoo.com)

Regarding to Indonesia's renewable energy policy, the target of renewable energy application will be 23% by 2025. The growth rate of renewable energy is only 1.98% per year within the past 10 years. The growth rate in 2010 and 2015 were 4.42 % and 6.2 %, respectively. The potential of renewable energy resources estimated 800 GW and utilized about 1 % up to now. Geothermal Renewable Energy resource is about 16,502 MW and utilized 1,341 MW. In addition, hydro energy is 75.000 MW and consumed 7,059 MW. While micro hydro, wind, sun energy are 769.7 MW, 950 GW and 4.8 kWh / m2 / day (112 GW peak) and utilized 512 MW, 1.33 MW and 452.78 MW, respectively. Furthermore, 453 MW from coal methane gas, 574 TSCF from shale gas, 28,8 GW from geothermal. Also, ocean current can generate 60GW and biomass at 32,654 MW which newly exploited at 5.2 percent [2]. Biomasses are in the form of rice straw, rice husk, cotton stalk, corn cob, wood chips and others [3].

As an agricultural country with staple food of rice, rice and rice husk production continue to increase. Increased rice production is supported by the expansion of planting area from 11,786,400 ha in 2006 to 14,116,600 ha in 2015 with an expansion rate of 19.77 percent. Production of paddy [4], [5], [6] in 2006 reached 54,459,900 tons and in 2015 reached 75,397,800 tons, with production rate of 3.84% per year.
Graph of the relationship between planting area and rice production in 2006-2015 is presented in Figure 1.

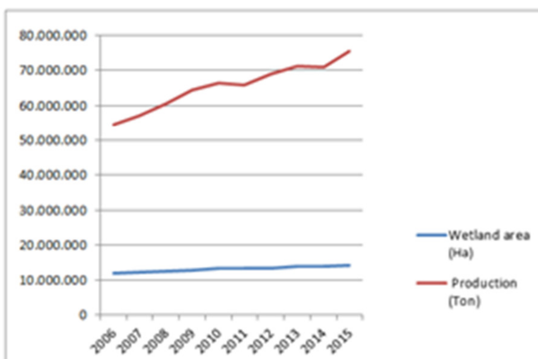

Fig. 1. Graphic of harvested production of paddy in 2006-2015

The rice mill produces 72 percent rice, 5-8 percent rice bran, and rice husk 20-22 percent [7], 20 percent [8] , 18-23 percent [3], 20-25 percent [9], and 14% -27% [1] of rice weight. Grain burning rice value 7.81 MJ / kg [10], 12.1-15.2 MJ / kg [1], 13.24 MJ / kg [11] , 13,481 MJ / kg [12] and 17.4 MJ / kg [9].

Rice husk utilized for household fuel and 10% [8] burning of the soil [7], polluting the air [9] with methane gas [13]. CH4 gas is 72 times more dangerous than CO2 gas to global warming [14]. Caloric energy of rice husk can be obtained by open burning, gasifier stove [3], rice husk briquettes [15]. In its application 1.6-1.8 kg of rice husk is converted to 1 kilowatt-hour [8]. The cost of producing electrical energy from fuel rice husk is much lower (3.75) than coal fuel (10,260) and diesel (94,000) [3]. The reduction of CO2 of rice husk (75 g CO2eg / kWh) is smaller than the straw fuel (180 g CO2eg / kWh), low fossil (600 g CO2eg / kWh) and high fossil (995 g CO2eg / kWh) [16].

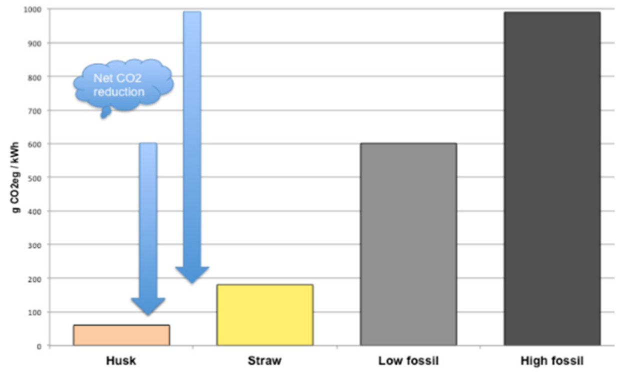

Fig. 2. Clean Development Mechanism of various fuels [16]

CO_2 emissions can be reduced by perfect combustion [17]. Burning ash from 17-26% [9], can be used for brick making, cement [13], concrete additives [9], natural agricultural fertilizer [18] and poultry incubation [13].

Biomass power generation has feasible engineering [19], economic feasibility [7], gross fuel solution [9], as renewable energy [9,15], environmentally friendly [13,15,18] and meeting the needs of local communities [13]. The rice husk power plant is included in the Clean Development Mechanism (CDM) [16].

2. Methodology

Testing of rice husk water content has done by gravimetric method at Laboratory of Research and Industrial Standard Center of Medan, Climate and Industrial Policy Assessment Office, Ministry of Industry Republic of Indonesia in Medan. Testing the calorific value of rice husk using calorimeter bombs at Phenomenon Laboratory, Department of Mechanical Engineering, Faculty of Industrial Technology, Medan Institute of Technology.

The highest heating value (HHV) is calculated by the equation: HHV = (T_2 - T_1 - T_{kp}) x cv (kJ / kg), where Cv = hot bomb type calorimeter 73,529.6 (J / gr.°c) and T kp = temperature rise due to ignition wire = 0,05°C. The lowest heating value (LHV) is calculated by the equation: LHV = HHV - 3.240 (kJ / kj). T_1 = cooling water temperature before turn on (^oC). T_2 = the cooling water temperature after being turned on (^oC). Tkp = increase of igniter wire temperature (^oC). cv = heat type tool (73.529.6 kJ / kg.^oC).

3. Results and Discussion

3.1 Heating Value of Rice Husks Samples

Testing of heating value has done by 3 times repetition with calorimeter bomb obtained an average HHV of 11.03 MJ / Kg. This fuel value is still above 7.81 MJ / kg [10] and below 12.1-15.2 MJ / kg [1], 13.24 MJ / kg [11], 13,481 MJ / kg [12] and 17.4 MJ / kg [9].

3.2 Heating Value of Rice Husks in Indonesia

The average percentage of rice husk 20 percent of the weight of paddy, the rice husk obtained in 2006 reached 10,891,980 tons and in 2015 reached 15,079,560 tons with an average increase of

418,758 tons per year. Fuel value of rice husk 120.138.539x103 MJ and 166.327.547 x103MJ in 2015 with growth of 4,618,900.8 x103MJ per year. The production data and the rate of rice husk production and the data and the calorific value of rice husk in 2006-2015 are presented in figure 3.

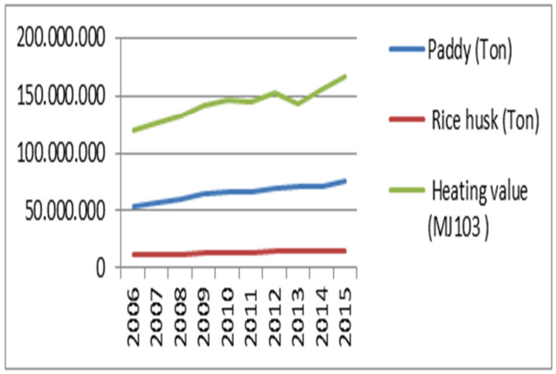

Fig. 3. Graphic of production of the rice husk and heating value in 2006-2015

By the fuel gasoline Pertamina - Pertamax type (Octan 92) the calorific value of 10.575 cal / gram, the specific gravity of 0.74 kg / liter, then the calorific value of rice husk husk in 2006 (3.666.102.240 liter) and in 2015 (5,075,588,554 liter) with the growth of 140,948 .631.4 liters of year. Price Pertamax (Octan 92) Rp.8.150 / liter equivalent to US $ 0.62 , then the value of equivalent rice husk worth in 2006 (US$.2.289.364.097) and in 2015 (US$ 3.182.003.594).

3.3 Electric Energy Equivalent and Sale Value

The increase in rice equivalent of rice husk with Pertamax fuel and increased Pertamax purchase price for 10 years reached 38.45 percent or 3.85 percent per year. The data of Pertamax equality and rate as well as the data and rate of purchase of pertamax in 2006-2015 are shown in figure 4.

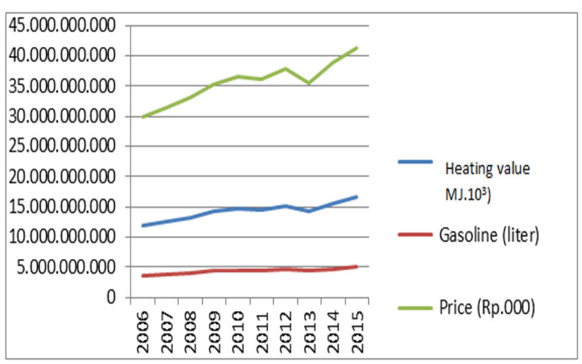

Fig. 4. Graphic of equivalent value of calories, gasoline and price, 2006-2015

3.4 Electrical Value and Selling Value

Rice husks can be synchronized with the electrical energy generated from the biomass power plant. Each kilogram of rice husk produces an average of 1.7 kwh. The equivalent of electric energy from rice husk in 2006 reached 18,516,366,000 kWh and in 2015 reached 25,635,252,000 kWh with growth of 7,118,886,000 kWh in 10 years or 711,888,600 kWh per year.

The lowest non-subsidized electrical energy in Indonesia (900 VA) is sold in Indonesia Rp.1.352 / kWh). The selling value of electric energy from rice husk in 2006 reached US$ 1,925,702,062 and in 2015 reached US$ 2,665,912,362 with the growth of US$ 740,210,300 in 10 years or US$ 74,021,030 per year. The increase of electrical energy and the selling value of electrical energy for 10 years reached 38.45 percent or 3.85 percent per year.

The data of electrical energy, the rate of electrical energy and the data of selling value and the rate of sale value of electric energy in 2006-2015 are presented in figure 5.

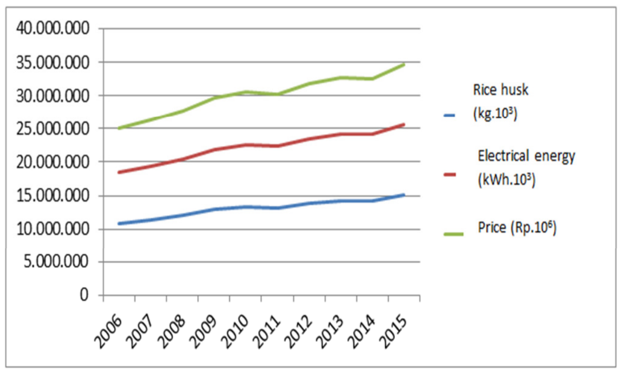

Fig. 5. Calorific value of rice husk, electric energy and money value 2006-2015

4. Conclusion

Rice production was 54,459,900 tons in 2006 and 75,397,800 tons in 2015 with production rate of 38.45 percent. Production of rice husk in 2006 was 10,891,980 tons and 15,079,560 tons in 2015 with production rate 418,758 tons per year.

The caloric value of rice husk is 11.03 MJ / kg. Consequently, the rice husk production in 2006 generated 120.138.539x103 MJ which is equivalent to 3,666,102,240 liters of Pertamax gasoline and in 2015 produced 166,327,547 x103MJ equivalent to 5,075,588,554 liters of Pertamax gasoline. If rice husks are applied as a source of electrical energy, it will produce 18,516,366,000 kWh of electricity in 2006 and 25,635,252,000 kWh in 2015.

The economic value of rice husk, its energy equivalent to the Pertamax gasoline purchase in 2006 was US $ 2,289,364,097 and in 2015 was US $ 3,182,003,594. When rice husks were utilized to produce electrical energy, in 2006 equal to US $ 1,925,702,062 and in 2015 US $ 2,665,912,362 with growth of US $ 74,021,030 per year. Rice husks are very prospective as an alternative renewable energy fuels in Indonesia.

References

[1] Rodrigo, Asanka, and Shantha Perera. "Potential and Viability of Rice Husk Based Power Generation in Sri Lanka." *Engineer: Journal of the Institution of Engineers, Sri Lanka* 46, no. 4 (2013).

[2] Lubis. H. 2016. Energi Terbarukan, Energi Masa Depan -Renewable Energy, Energy of the Future, Perestasi Reformasi Newspaper, Medan-Indonesia, No.506, 28th of November 2016, page 6, column 1-7

[3] Mirani, Asif A., Munir Ahmad, Shabbir Ahmed Kalwar, and Tanveer Ahmad. "A rice husk gasifier for paddy drying." *Science and Technology Development* 32 (2013): 120-125.

[4] BPS.2017. Statistical Yearbook of Indonesia 2017. Jakarta.BPS-Statistics Indonesia

[5] BPS.2013. Statistical Yearbook of Indonesia 2013. Jakarta. BPS-Statistics Indonesia

[6] BPS.2011. Statistical Yearbook of Indonesia 2011. Jakarta.BPS-Statistics Indonesia

[7] Patel H.K, Manish P, Abdul K, and Om P.P.2015. Rice Husk, its Application, Power generation & Environmental Impact – An Overview. *Journal for Studies in Management and Planning* 1, no. 4 (2015).

[8] Nguyen, Hong Nam, and Minh Ha-Duong. *Rice husk gasification for electricity generation in Cambodia in December 2014*. No. hal-01107615. HAL, 2014.

[9] Ramdutt, Ashwin, Remy Meghoe, Armand Bipat, and Rudi Henri van Els. "POTENTIALS FOR ELECTRIC ENERGY GENERATION FROM RICE HUSK RESIDUE IN SURINAME." (2013).

[10] Thao, Pham Thi Mai, Kiyo H. Kurisu, and Keisuke Hanaki. "Greenhouse gas emission mitigation potential of rice husks for An Giang province, Vietnam." *biomass and bioenergy* 35, no. 8 (2011): 3656-3666.

[11] Mhilu, Cuthbert F. "Analysis of energy characteristics of rice and coffee husks blends." *ISRN Chemical Engineering* 2014 (2014).

[12] Ismail, Onchoke, Mutwiwa Urbanus, Hunja Murage, and Ochieng Francis. "Conversion of Rice Husks into an Energy Source through Gasification Technology."

[13] Chungsangunsit, Thipwimon, Shabbir H. Gheewala, and Suthum Patumsawad. "Emission assessment of rice husk combustion for power production." *World Academy of Science: Engineering and Technology* 53 (2009): 1070.

[14] Lubis, Hamzah. "Effect of temperature on sea water surface increment in north sumatera indonesia."

[15] Mulyana, Cukup, Asry Peni Wulandari, Darmawan Hidayat, and Bambang Mukti Wibawa. "Development of Indonesia corncob and rice husk biobriquette as alternative energy source." In *AIP Conference Proceedings*, vol. 1712, no. 1, p. 050014. AIP Publishing, 2016.

[16] Siemers, W. "Technical and economic prospects of rice residues for energy in Asia." In *Sustainable Bioenergy Symposium, Bangkok; Sustainable Bioenergy in Asia: Improving Resilience to High Food Prices and Climate Change*, pp. 31-36. 2011.

[17] Shackley, Simon, Sarah Carter, Tony Knowles, Erik Middelink, Stephan Haefele, Saran Sohi, Andrew Cross, and Stuart Haszeldine. "Sustainable gasification–biochar systems? A case-study of rice-husk gasification in Cambodia, Part I: Context, chemical properties, environmental and health and safety issues." *Energy Policy* 42 (2012): 49-58.

[18] Pandey, R. S., K. Sar, and Ashish Kumar Bhui. "Feasibility of installating rice husk power plant in Chhattisgarh to meet sustainable energy demands." *International Journal of Advance Engineering Research Studies* 1, no. 4 (2012): 57-60.

[19] Narváez Cueva, Ricardo Andrés. "Use of rice crops waste for energy production in Ecuador." Master's thesis, Universität Kassel/2011, 2011.