# Comparative Analysis of Electrical Energy Potential from Coconut Dregs Biobriquettes Using the Pyrolysis Method with Biomass and Direct Burning Types

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***Abstract* – Riau is the province that produces the largest coconut in Indonesia, in 2019 coconut production in Riau reached 417,172.00 tons / year with coconut production of that amount producing a lot of waste as well, one of which was coconut pulp waste of 56,943 tons. If left alone, coconut pulp waste can have a negative impact on the environment. The purpose of this study is the use of coconut pulp waste as biobriquettes and the potential of electrical energy generated in Riau. The method of making biobriquettes uses the Pirolysis method with different types of combustion, namely biomass combustion and direct combustion, the results of this study are experiments conducted from 500 grams of coconut pulp to produce biobriquettes in biomass combustion which is 360 grams and in direct combustion of 240 grams. Characteristic testing is carried out manually, using biomass stoves and biobriquettes as fuel. Biomass combustion is obtained calorific value of 229.16 cal / gram, thermal efficiency of 7%, electrical energy conversion of 0.26655 kWh and electrical energy produced in Riau Province in 2019 which is 173,432,957.3 kWh. Meanwhile, direct combustion obtained a calorific value of 216.6 cal / gram, thermal efficiency of 6%, electrical energy conversion of 0.2518 and electrical energy in Riau province of 109,314,879.6 cal / gram. It can be concluded that biomass combustion is better than direct combustion.**

**Keywords: Coconut Dregs, Biobriquettes, Pyrolysis Method, Biomass Burning, Direct Combustion**



## I. INTRODUCTION

Biomass is a byproduct of solid objects that can be used as fuel. Biomass energy can be an alternative energy source to replace fuel because it is renewable. Biomass is a very abundant energy source that can be utilized and conserved continuously. Sources of biomass energy are plants, plantation waste, animal waste, and so on [1]. Plantation waste is one of the by-products that has a low selling value and also lacks further utilization. If these wastes can be optimally utilized, they can have great benefits in life. One of them is waste from coconut plantations, which can be used as an alternative energy source.

In Indonesia, coconut plantations grow very well because they are located in tropical and sub-tropical areas, which have the largest area of coconut plantations in the world, namely 3.7 million ha [2]. Riau is one of the provinces that produces the largest coconut plantations in Indonesia; namely, in 2019, it produced 417,172.00 tons. The highest production is in Indragiri Hilir district, with a production of 361 348.00 tons in 2019 [3].

The coconut plant is a plant with a thousand benefits, because from the roots and stems to the shoots, it has great benefits in everyday life [4]. One part of the coconut plant that is often used and has also become a basic need for humans is the flesh of the coconut, which is processed into coconut milk [5]. Coconut milk is a thick, white solution obtained from grated and squeezed coconuts. Indonesian citizens are no strangers to coconut milk because it has become one of the ingredients that is often used for food and drink needs in everyday life [6]. In making coconut milk, several wastes are produced, such as coconut fiber, coconut shells, and coconut dregs. Coconut fiber is used as doormats and brooms, which have a fairly high selling price [7]. Coconut shells have also been widely used as handicrafts and are also made into charcoal [8]. Coconut dregs are waste that is rarely used, usually as animal feed or even just thrown away. These efforts have been very good in overcoming environmental pollution, but their low quality, cheap prices, and continuous availability [9] 150 kg of coconut can produce 19.5 kg of coconut dregs, so in a year, Riau Province can produce 56,943 tons of coconut dregs [10]. With that much coconut waste, in the long term, it can cause pollution to the earth, such as polluting water sources and soil, and it can also cause air pollution.

Therefore, there is a need for a solution to be able to deal with coconut dreg waste [11]. One way that can be done to deal with coconut dreg waste is to use it as alternative energy, namely by making it into briquettes.

Briquettes are a type of biomass that can be a solution today as a substitute for fossil fuels because they are sourced from biomass, which is economical, environmentally friendly, and also waste management friendly. Coconut pulp is one of the raw materials that can be used as briquettes [12]. In making briquettes, there are two methods, namely the prilososo and carbonissi methods. Pyrolysis is a method that is often used in the combustion process. Pyrolysis is the process of burning a raw material in the absence of oxygen or with little oxygen. This pyrolysis method has advantages compared to carbonization, namely that in the manufacturing process there is little combustion smoke entering the environment because the combustion site is closed, whereas carbonization produces a lot of smoke and causes air pollution. In this pyrolysis combustion method, there are different types of combustion, namely biomass combustion and direct combustion. Biomass burning is burning that is carried out using a container as a burning container, tree branches, or wood as fuel, and the source of fire comes from under the burning container, while direct burning uses a container as a burning container but does not use fuel but burns the raw material directly in the burning container. The difference between this type of burning is that burning biomass uses fuel and the fire does not come into direct contact with the raw material, whereas direct burning fire comes into direct contact with the raw material. This pyrolysis process produces three outputs, namely solids, liquids, and gases [13] and [14].

Combustion using the pyrolysis method with a type of biomass burning has been carried out in several previous studies. In research [15], waste from coconut dregs was used as material for briquettes. For residents of Kalisari sub-district, the aim of this research was to introduce the manufacture and use of coconut dreg waste as environmentally friendly energy. Research [16] discusses the quality test of coconut dregs based on their water content. This research only discusses the use of coconut dregs by examining the water content. Briquettes are said to be good if they have a water content below 8%. The smallest water content was found in a sample weight of 25 grams with a water content of 5.559%. Research [17] discusses making briquettes from coconut dregs mixed with corn cobs in various mixtures. The best results were found in a mixture of 250 grams of coconut dregs and 250 grams of corn cobs, with a calorific value of 6417.251 cal/gram. In research [18] discussing the use of household waste as an alternative energy source by focusing on the calorific value, the content obtained was The calorific value is 115.66 cal/gram, and the electrical energy produced is 0.134 kWh. The best experiment was a mixture of durian skin waste and coconut dregs, with a calorific value of 126.72 cal/gram, and the energy produced was 0.147 kWh/kg.

In this pyrolysis method, apart from using biomass burning, there is also another type of burning, namely direct burning. Research [14] discusses the influence of the pyrolysis combustion method on the characteristics and efficiency of the charcoal and liquid smoke produced. The results of this research show that in terms of the charcoal produced by combustion, the lowest combustion efficiency is from burning biomass (14.33%), the highest from direct burning (30.00%), the lowest fuel efficiency is from burning biomass (27.27%), and the highest is from burning LPG (75.71%). The longest time is 450 minutes for LPG combustion, and the shortest for direct combustion is 300 minutes. The lowest charcoal yield from burning biomass is 4.3 kg; the largest is from burning LPG, namely 9 kg. For charcoal characteristics, the lowest calorific value is 6,341.70 cal/g burning LPG, and the highest is 7,631.87 cal/g burning biomass.

Based on several studies above, the use of coconut dregs waste as biobriquette energy, made using the pyrolysis method with a type of biomass burning, results from research on the characteristics of biobriquettes such as calorific value, water content, and potential electrical energy produced. In the pyrolysis method, there are other types of combustion besides biomass burning, namely direct combustion. In previous research, no one has carried out combustion using direct combustion or the thermal efficiency of biobriquettes when they have been burned. Therefore, this research aims to find out the differences between making biobriquettes using the pyrolysis method with biomass burning and direct burning, as well as the comparison of the electrical energy they produce. This research will also discuss the amount of electrical energy from coconut pulp biobriquettes produced from coconut plantations in Riau Province.

This research uses a pyrolysis method with different types of combustion, namely biomass burning and direct burning, as well as testing the characteristics of the biobriquettes, namely the calorific value content and thermal efficiency. Researchers also studied the comparison of heat energy and electrical energy produced from the two types of biomass burning and direct burning.

## II. METHOD

This research was conducted to discuss the electrical energy potential of coconut pulp biobriquettes using the pyrolysis method with biomass burning and direct combustion. The pyrolysis method is a combustion process that takes place in a closed combustion container without any air or little outside air entering. In this research, we varied the combustion process with biomass burning and direct burning. Biomass burning is burning that is carried out using a container as a burning container, tree branches, or wood as fuel, and the source of fire comes from under the burning container, while direct burning uses a container as a burning container but does not use fuel but burns the raw material directly in the burning container. and the container is closed.

In this research, the locations that will be the source of raw materials for coconut dregs are Riau Province and each district or city. Riau Province has the largest coconut plantation production in Indonesia. So it is very suitable to discuss how much potential electrical energy is produced from coconut pulp waste produced from coconut plantations in Riau Province and each district or city.

1. Data Type

   In this research, researchers used quantitative data types, where they carried out direct experiments on research objects and directly made biobriquettes. Testing and calculations were carried out manually using formulas or equations. The data needed in this research uses primary and secondary data. Primary data is obtained by conducting a direct survey of the market, and secondary data is obtained from related sources. Primary data is in the form of coconut dregs obtained directly from coconut milk sellers in the market. Secondary data is how much coconut pulp is produced in 150 kg of coconut, namely 19.5 kg, in Riau Province and each district or city.

2. Tools and Materials

   The tools needed for this research are a pyrolysis furnace as a combustion place, a briquette-making tool in the form of a paralon pipe, a 40-mesh filter, a biomass compressor, a pan, a stopwatch, and a thermometer. Meanwhile, the materials used are 500 grams of coconut dregs, 25% tapioca flour as adhesive, and wood or tree branches as fuel.

3. Data collection technique

   The data collection technique used in previous research found that 150 kg of coconut produces 19.5 kg of coconut dregs, so it can be assumed from the production of coconut plantations in 2019 in Riau Province and each district or city how much coconut dregs were produced. Can be seen in the following table:

Table 1. Coconut Plantation Production in Riau Province [3]

| Regency/ City | Plantation Production Coconut 2019 (tons) | Coconut pulp (ton) |
|---|---|---|
| Kuantan Singingi | 1 924,00 | 250,12 |
| Indragiri Hulu | 250,00 | 32,50 |
| Indragiri Hilir | 361 348,00 | 46.975,24 |
| Pelalawan | 15 297,00 | 1.988,61 |
| Siak | 333,00 | 43,29 |
| Kampar | 418,00 | 54,34 |
| Rokan Hulu | 474,00 | 74,62 |
| Bengkalis | 3 273,00 | 425,49 |
| Rokan Hilir | 4 277,00 | 556,01 |
| Kepulauan Meranti | 29 283,00 | 3.807,79 |
| Pekanbaru | 9,00 | 1,17 |
| Meranti | 436,00 | 56,68 |
| Riau | 417 172,00 | 54.232,360 |

4. Collection and Research Results

   In this research, data collection was carried out by conducting experiments on making biobriquettes using the pyrolysis method with different types of combustion, direct testing using a biomass stove and coconut dregs biobriquettes as fuel, and manual calculations using the equation. It can be seen as follows:

A. Making Biobriquettes

Making biobriquettes using the pyrolysis method can be seen as follows:

- Drying the coconut dregs for 3 days will reduce the water content of the dregs.
- Next, burn or roast the coconut dregs using the pyrolysis method. The pyrolysis method is a combustion process that takes place with little or no air in the combustion container. This research uses two types of combustion, namely biomass burning and direct burning

Burning coconut dregs uses a burning container and tree branches or wood as fuel. 500 coconut dregs and 10 kg of tree twigs or wood were used. After the fuel has burned, the combustion container is placed on top of the furnace, and the combustion container is closed so that no air from outside enters. The burning continues until the coconut dregs become charcoal,which can be seen in the following picture.

Figure 1.Burning Coconut Dregs by Biomass

This direct burning uses a container as a burning place. 500 grams of coconut dregs were used. This direct burning does not use fuel to burn the coconut dregs but burns the coconut dregs directly in a burning container. After the coconut dregs are burned, the burning container is covered so that no air from outside enters. The burning continues until the coconut dregs become charcoal. It can be seen in the following

Figure 2. Making Coconut Dregs Directly

The next stage is grinding the coconut dregs into charcoal until they become fine granules, and then filtering them using a 40-mesh sieve. The mesh size used refers to previous research; the smaller the particle size, the better, because the particle size will affect the calorific value produced.

Next, mix the charcoal with adhesive, namely tapioca flour, in a ratio of 20% of the raw material. The flour is first heated using water until it becomes thick, then mixed with charcoal and stirred until evenly distributed.

The next stage is printing, which is done with a simple tool, namely a paralon pipe. The briquettes are molded into circles with a diameter of 26 mm and a weight of 25 grams.

The final stage is drying in the sun for 3 days and also drying in an oven for 5 hours. Drying using an oven is done to further reduce the water content in the briquettes because the less water content the briquettes have, the better they are.

Figure 3 Coconut Dregs Briquettes Biomassa burning

Figure 4. Coconut Dregs Briquettes Direct Burning

B. Biobriquette Testing

Testing the characteristics of biobriquettes in this research was a manual method using a biomass stove and coconut dreg biobriquettes as fuel. The tools used are pans, biomass stoves, digital thermometers, stopwatches, and scales. The materials used are biobriquettes and water. The experimental stage was 25 grams of biobriquettes and 250 grams of water. The coconut dreg biobriquettes are burned on a biomass stove and used to heat water. After the water boils but the fire from the biobriquettes is still burning, the water is reheated until the fire on the biobriquettes goes out. The parameters to be measured are the initial temperature of the water, the final temperature of the water, the biobriquettes used to heat the water, and the length of burning time to heat the water. From this test, after obtaining the data, the calorific value content and thermal efficiency can be searched.

The experiment on the biomass stove was carried out twice using different biobriquettes, namely biobriquettes with biomass burning and biobriquettes with direct burning. It can be seen in figure 4 below:

Figure 5. Briquette Testing Using Biomass Stove

After obtaining the test results, the next stage is analyzing the characteristics of the coconut pulp biobriquettes using manual calculations using equations, which can be seen as follows:

A. Calculation of Calorific Value Content

After the biomass stove experiment has been carried out and the necessary data has been obtained, namely the initial final temperature and the final temperature of the water, the calorific value content of the two types of biobriquettes with biomass and direct combustion can be calculated using the following equation:

$$Q = m \cdot c \cdot \Delta T \quad (1)$$

Information:

Q = amount of heat to raise the water temperature (cal)

C = specific heat of water (cal/grams°)(C = 1 cal/grams°C)

m = mass of water (grams)(1 gram of water = 1 ml of water)

ΔT = change in temperature (°c)

T1 = initial temperature (°c)

T2 = final temperature (°c)

Before calculating the calorific value of biobriquettes, you must first know the amount of heat needed to boil water. After obtaining the amount of heat needed to boil the water, you can then find the calorific value content of the biobriquettes using the following equation:

$$LHV = \frac{Q}{\mathrm{m}} \quad (2)$$

Information

LHV = lower calorific value of biobriquettes (cal/gram)

Q = amount of heat to boil water (cal)

m = biomass fuel

1. Thermal Efficiency Calculation

$$\eta_{th} = \frac{m_a \ x \ cp_{air}(\Delta T)}{m_{bb} \ \mathrm{x} \ LHV} \quad (3)$$

Information:

Ugh = thermal efficiency (%)

Qair = heat energy used to heat water (cal)

Mbb = mass of fuel used (kg)

LHV = lowest heating value of fuel (kJ/kg)

Ma = mass of heated water (kg)

Cp water = specific heat of water (kJ/kg°C) (1.8723 kJ/kg)

B. Conversion of Generated Electrical Energy

The calculation of electrical energy in this research is done by converting the heating value to kWh. The calorific value of the coconut dreg briquettes that have been obtained previously can be converted into electrical energy. According to James Prescott Joule in 1914, 1 kWh is equal to 859.9 kilocalories. Can be calculated using the following equation:

$$\mathrm{kWh} = \frac{\text{caloarofic value of briqquetes}}{1 \text{ kWh}} \quad (4)$$

C. Potential Electrical Energy Produced from Coconut Dreg Biobriquettes Using the Pyrolysis Method with Biomass and Direct Burning Types in Riau Province

After carrying out an experiment to calculate the conversion of electrical energy from coconut dregs biobriquettes using the pyrolysis method with biomass and direct combustion, it can be calculated how much potential electrical energy is produced in Riau Province and each district or city using the equation (4).

D. Comparison of electrical energy produced from coconut dreg briquettes using the pyrolysis method with direct and biomass burning types and electrical energy potential in Riau Province

After obtaining the heat energy and electrical energy from the experiments that have been carried out and also the potential heat energy and electrical energy produced from coconut plantation production in Riau Province, a comparison can be made between the heat energy and electrical energy produced using the pyrolysis method with the combustion type biomass and direct.

## III. RESULTS AND DISCUSSION

Burning coconut dregs uses the pyrolysis method with different types of combustion, namely biomass burning and direct burning. The raw materials used were 500 grams. Biomass burning uses wood or tree branches as fuel, while direct burning does not use fuel but burns the coconut dregs directly. The combustion results can be seen in Table 2 below:

Tabel 2. Combustion Results and Resulting Coconut Dregs Biobriquettes

| Burning type | Dregs off class (gr) | Burning time (minutes) | produced biobriquettes(gr) | Briquette unit weight (gr) | The resulting briquettes |
|---|---|---|---|---|---|
| Biomass Burning | 500 | 50 | 360 | 15grams/ puck | 24 |
| Direct Burning | 50 | 30 | 270x | 15grams/ puck | 18 |

During combustion, biomass burning occurs for 50 minutes, while direct combustion occurs for 30 minutes. Direct burning is faster, namely 30 minutes, because direct burning does not use fuel as a source of fire but instead burns the coconut dregs directly, and from the start of burning there is direct contact between the raw material and the fire so that the burning of the coconut dregs occurs more quickly, whereas biomass burning uses a stove as a place to burn the coconut dregs, and the source of fire comes from under the stove so that the process of burning the coconut dregs takes longer. The biobriquettes produced by burning biomass are 360 grams and 270 grams by direct burning. Burning biomass produces more biobriquettes compared to direct burning because, in direct burning, the coconut dregs come into direct contact with the fire, so a lot of coconut dregs burn and become ash. The results of this research are the same as research [14] which states that pyrolysis combustion using biomass burning produces more charcoal than direct burning. The weight of the biobriquette unit is the same, namely 15 grams. The biobriquettes produced by burning biomass are 24 pieces and by directly burning 18 pieces. The difference in the amount of biobriquettes produced is due to the charcoal used; burning biomass uses more charcoal.

A. Briquette Burning Test Results Using a Biomass Stove

This briquette test uses a biomass comopor and coconut pulp briquettes into fuel by heating 250 grams of water. Experiments were carried out 6 times, 3 experiments using briquettes with biomass combustion and 3 experiments using briquettes with direct combustion.The length of time to heat each experiment is different,

Tabel 3. Biomass Stove Characteristics Test Results

| Burning type | Briquette Burning Time (menute) | Mass of Briquettes Used (grams) | Temperature Beginning (°C) | Final Temperature (°C) |
|---|---|---|---|---|
| Biomass burning | 75 | 40 | 28 | 83 |
| Biomass direct | 70 | 43 | 28 | 80 |

Table 3 is the test result of boiling water using a biomass stove with coconut pulp biobriquettes as fuel. There were two biobriquette samples tested with different types of combustion, namely biomass burning and direct burning. 60 grams of biobriquettes were used as fuel and 250 grams of heated water. When trying to boil water, you can boil it three times with 250 grams of water in one try. In the type of biomass burning, the first experiment boiled water in 6.55 minutes, the second experiment took 5.12 minutes, and the third experiment took 7.55 minutes, while in direct combustion, the first experiment boiled water in 6.55 minutes, the second experiment took 5.30 minutes, and the third attempt took 8.30 minutes.

B. Results of Calculation of Briquette Characteristics

The calculation of briquette characteristics that will be looked for in this research includes heating value and thermal efficiency, which can be seen as follows:

1. Calculation of Calorific Value Content

Calculation of calorific value is done manually, namely by knowing the initial temperature and final temperature when boiling water. You can see in Table 2 above the results of the experiments that have been carried out. Once the initial and final temperatures are known, the heating value can be calculated using equation 2. Before calculating the heating value, you must first know the amount of heat needed to increase the temperature of the water using equation 1. The calculation results can be seen in the following table:

Table 4. Calculation Results of Calorific Value Content

| Biomass type | CalorificValue Content (cal/gram) |
|---|---|
| Biomass burning | 229,16 |
| Biomass direct | 216,66 |

Table 4 shows the results of the calorific value from the experiments that have been carried out. In burning biomass, the calorific value produced is 229.16 cal/gram, and in direct combustion, it is 216.6 cal/gram. The calorific value of biomass burning is higher than that of direct combustion. The factors that influence the calorific value of a biobriquette in the water boiling experiment are the heat energy produced from the biobriquette and the final temperature of the water during the experiment. The greater the heat energy produced in the biobriquettes, the higher the final temperature, so that the calorific value produced will be higher. In this study, the calorific value test was carried out manually, the calorific value obtained did not meet SNI standards, in contrast to research [17] which met SNI standards.

2. Thermal Efficiency Calculation

In this research, the thermal efficiency calculation uses a biomass stove with coconut dregs briquettes as fuel by comparing the heat energy used to boil water and the heat energy produced from the coconut dregs briquettes. The calculation can be done using equation 3. Before that, you must first know the specific heat of the water (cpair), it can be calculated using equation (4). You can see in the graph below the thermal efficiency results obtained from 2 briquette samples with different types of combustion that have been tested, namely as follows:

Table 5. Thermal Efficiency Calculation Results

| Biomass type | Thermal Efficiency (%) |
|---|---|
| Biomass burning | 7 |
| Biomass direct | 6 |

Table 5 shows the results of experiments on the thermal efficiency of biobriquettes using a biomass stove. In burning biomass, the thermal efficiency obtained is 7%, and in direct burning, the thermal efficiency is 6%. The thermal efficiency of biomass burning is greater than that of direct combustion. The thing that influences the amount of thermal efficiency produced is the ratio of the input and output energy. The input is the ratio of the heat produced by the fuel to the output of the heat received by the water to increase the water temperature. The higher the input value of the fuel, the more it will affect the thermal efficiency resulting from it.Electrical Energy Conversion

3. Electrical Energy Conversion

In table 5, the calorific value of biobriquettes has been obtained from two different samples, namely biomass burning and direct burning. The mass of briquettes used in the experiment weighed 60 grams. After obtaining the calorific value, biobriquettes can be converted into electrical energy using equation 4. The calculation results can be seen in the following graph:

Table 6. Electrical Energy Conversion Results

| Biomass type | Electrical Energy Conversion (kWh) |
|---|---|
| Biomass burning | 0,266 |
| Biomass type | 0,251 |

In Table 6, there is a graph of the results of the conversion of electrical energy from coconut dregs biobriquettes with two different types of combustion, obtained by burning biomass. The electrical energy produced is 0.266 kWh, and direct combustion produces electrical energy of 0.251 kWh. The electrical energy produced by burning biomass is greater than by direct combustion. Usually biobriquettes are used as fuel in thermal power plants, but in steam power plants, the electricity produced depends on the heat energy produced from the fuel. The higher the heat energy produced by burning biobriquettes, the working fluid in the plant collected in steam has a higher temperature. The high steam will spin the turbine and produce mechanical energy, which will be converted into electrical energy.

C. Potential of Heat Energy and Electrical Energy of Coconut Drip Biobriquettes in Riau Province and every District/City

The experimental results of making biobriquettes from coconut dregs and the calorific value calculations that have been carried out show that when burning biomass from 500 grams of coconut dregs, 360 grams of biobriquettes are obtained with a calorific value of 2,749.92 cal/gr. When directly burning 500 grams of coconut dregs, 240 grams of biobriquettes are obtained with a calorific value of 1,733.28 cal/gr. So it can be assumed how much calorific value is obtained from coconut dregs waste in each district or city of Riau province, which can be seen in the following table:

Table 7. Briquette Results in Each District/City

| Regency/city | Produced Biobriquettes (gr) | Produced Biobriquettes (gr) |
|---|---|---|
| Kuantan Singingi | 180.086.400 | 120.000.000 |
| Indragiri Hulu | 23.400.000 | 15.600.000 |
| Indragiri Hilir | 33.822.172.800 | 22.548.115.200 |
| Pelalawan | 1.431.799.200 | 9.545.328 |
| Siak | 31.168.800 | 20.779.200 |
| Kampar | 39.124.800 | 26.083.200 |
| Rokan Hulu | 53.726.400 | 35.817.600 |
| Bengkalis | 306.352.800 | 204.235.200 |
| Rokan Hilir | 400.327.200 | 266.884.800 |
| Kepulauan Meranti | 2.741.608.800 | 1.827.739.200 |
| Pekanbaru | 842.400 | 561.600 |
| Meranti | 40.809.600 | 27.206.400 |
| Riau | 39.047.299.200 | 26.031.532.800 |

Table 8. Calorific Value of Briquettes in Each Regency/City

| Regency/city | Produced Biobriquettes (gr) | Produced Biobriquettes (gr) |
|---|---|---|
| Kuantan Singingi | 687.809.990, 4 | 433.527.993,6 |
| Indragiri Hulu | 89.372.400 | 56.331.600 |
| Indragiri Hilir | 129.178.151.980,8 | 81.421.243.987 |
| Pelalawan | 5.468.518.411 | 3.446.817.941 |
| Siak | 119.044.036,8 | 75.033.691,2 |
| Kampar | 146.680.732,8 | 92.453.155,2 |
| Rokan Hulu | 205.199.030,4 | 129.337.353,6 |
| Bengkalis | 1.197.562.661 | 754.826.107,2 |
| Rokan Hilir | 1.528.983.019 | 963.721.012,8 |
| Kepulauan Meranti | 10.471.117.877 | 6.599.966.251 |
| Pekanbaru | 3.217.406,4 | 2.027.937,6 |
| Meranti | 155.865.465,6 | 98.242.310,4 |
| Riau | 1.147.189.626.240 | 730.017.626.240 |

It can be seen in Table 8 above that the calorific value content of biobriquettes in Riau Province and each district or city, produced from coconut dregs waste for a year in 2019, is 1,147,189,626,240.00 cal/gr by burning biomass and 730,017,626,240 cal/gr in direct combustion. The district with the highest calorific value is Indragiri Hilir, with a biomass burning of 129,178,151,980.8 cal/gram and direct combustion of 81,421,243,987 cal/gr; the lowest is in the city of Pekanbaru, with a calorific value of 3,217,406.4 cal/gram in combustion of biomass and 2,027,937.6 cal/gr in direct combustion. After obtaining the calorific value of biobriquettes from each district or city in Riau Province, it can be converted mathematically into electrical energy (kWh) using equation 4. The following is the conversion of electrical energy produced in each district or city in Riau Province:

Table 9. Electrical Energy Conversion Results in Each District/City of Riau Province

| Regency/city | Electrical Energy Conversion (kWh) | |
|---|---|---|
| | Biomass burning | Biomass direck |
| Kuantan Singingi | 799.872,067 | 504.160,8 |
| Indragiri Hulu | 103.933,48 | 65.509,4 |
| Indragiri Hilir | 150.224.444,7 | 94.686.875,2 |
| Pelalawan | 6.359.481,8 | 4.008.393,9 |
| Siak | 132.876,4 | 83.752,3 |
| Kampar | 170.578,8 | 107.516,1 |
| Rokan Hulu | 238.631,2 | 150.409,7 |
| Bengkalis | 1.392.676,6 | 877.806,8 |
| Rokan Hilir | 1.778.093,9 | 1.120.736,1 |
| Kepulauan Meranti | 121.77.134,4 | 7.675.271,8 |
| Pekanbaru | 3.741,6 | 2.358,3 |
| Meranti | 181.259,9 | 114.248,5 |
| Riau | 173.432.957,3 | 109.314.879,6 |

In Table 9 above, we have found the potential for electrical energy from coconut dreg waste in Riau and each district or province. In 2019, a year can produce 173,432,957.3 kWh of electrical energy by burning biomass, while direct combustion produces 109,314,879.6 kWh of electrical energy. The district or city that produces the largest amount of heat energy and electrical energy is the Indragiri Hilir area, burning biomass with electricity amounting to 150,224,444.7 kWh and direct combustion electricity amounting to 94,686,875.2 kWh. The area with the lowest production of heat energy and electrical energy is the city of Pekanbaru. Burning biomass produces electrical energy of 3,741.6 kWh, while direct combustion produces 2,358.3 kWh. The difference in electrical energy produced is because coconut production varies every year from district to city.

D. Comparison of the electrical energy of coconut dregs biobriquettes using the pyrolysis method with the types of biomass burning and direct burning and potential electrical energy produced in Riau Province

Table 10 is a comparison of the potential heat energy and electrical energy produced from coconut dregs biobriquettes using the pyrolysis method with biomass burning and direct burning from coconut plantation production in Riau Province in 2019. It can be seen from these two types of burning that biomass burning produces heat energy and large electrical energy compared to direct combustion.

Table 10. Comparison Of Heat Energy And Electrical Energy Of Biobriquettes Produced From Biomass And Direct Combustion In Riau Province

| Biomass type | Electrical Energy Conversion (kWh) |
|---|---|
| Biomass burning | 173.432.957,3 |
| Biomass direct | 109.314.879,6 |

## IV. CONCLUSION

After carrying out experiments on making biobriquettes from coconut dregs using the pyrolysis method with different types of combustion, namely biomass burning and direct burning, we obtained different characteristic results and electrical energy. From the results of experiments using 500 grams of coconut dregs as raw material, burning biomass resulted in a calorific value of 229.16 cal/gram, a thermal efficiency of 7%, and an electrical energy conversion of 0.26655 kWh. The energy potential of electrical energy produced in Riau Province in 2019 is 173,432,957.3 kWh. Meanwhile, direct combustion produces a calorific value of 216.6 cal/gram, a thermal efficiency of 6%, and an electrical energy conversion of 0.2518. Electrical energy in Riau Province in 2019 was 109,314,879.6 kWh. It can be concluded that burning biomass is better than direct burning.

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