Empowerment model of biomass in west java

C Mulyana¹, N I Fitriani¹, A Saad¹ and Y Yuliah¹

¹Physics Department Faculty of Mathematical and Natural Science, Padjadjaran University, Bandung, Indonesia

E-mail: c.mulyana55@yahoo.com

Abstract. Scarcity of fossil energy accelerates the search of renewable energy sources as the substitution. In West Java, biomass has potential to be developed into bio-briquette because the resources are abundant. The objectives of this research are mapping the potency of biomass as bio-briquette in West Java, and making the model of the empowerment biomass potential involving five fundamental step which are raw material, pre-processing process, conversion mechanism, products, and end user. The main object of this model focused on 3 forms which are solid, liquid, and gas which was made by involving the community component as the owner biomass, district government, academics and researcher communities, related industries as users of biomass, and the central government as the policy holders and investors as a funder. In the model was described their respective roles and mutual relationship one with another so that the bio-briquette as a substitute of fossil fuels can be realized. Application of this model will provide the benefits in renewability energy sources, environmental, socio economical and energy security.

1. Introduction
The increase of energy consumption in many sector of industries and the shortage of fossil energy source drives some countries to make strategy mix energy in fulfilling the energy need. At the same times the world need of clean energy accelerates some countries to find new alternative energy source which is not pollutif or green energy. The share of biomass in meeting current word’s primary energy mix is at model level 10% [1], but the rising concern about global warming and sustainability, this share is very likely to rise. Indonesia is agrarian countries, there are abundance of biomass energy source, one of them is in West Java. West Java has fertile soil, some region is cultivate with agriculture and plantation. Waste product from agriculture and plantation so far is used only for animal feeding and compost.

Biomass is formed from living species like plants and animal. Unlike fossil fuels, biomass does not take millions of years to develop. Althoug only 5% (13.5 bilion metric tons) it can be potentially mobilized to produce energy about 26% of the world’s energy consumption, which equivalent to 6 billion tons of oil [2]. Biomass is one of renewable energy source which has potency to be developed to substutue fossil energy. The main problem of using bulk biomass as energy source is the low energy
density and the inconvenient form of biomass are major barriers to a rapid transition from fossil to biomass. Unlike gas or liquid, biomass cannot be handled, stored, or transported easily. This provides a major motivation for the conversion of solid biomass into liquid and gaseous fuel, which are more energy dense and can be handled and stored relatively easily. There are three types of primary fuels that could be produced from biomass and are as liquid fuels, gaseous fuels, and solid fuel. For a long time Indonesian uses biomass as energy and combustion, and it is the most utilization means of biomass in Indonesia. The other motivation for biomass conversion to commercial energy product because of three factors, Renewability benefits, Environmental benefits, and Socioeconomical benefits. Three potential sources of revenue for biomass conversion plant are as follows: a). Energy production through heat or electricity, b). Production of chemical or metallurgical feedstock. c). Production of solid fuel for cofiring or transport fuel as an alternative to diesel and gasoline.

In Indonesia, studies of biomass as energy source have been developed by researcher in higher educational institution and research institution. The research are about converting biomass become solid fuel (bio briquettes carbonized and non carbonized), liquid fuel (ethanol, biodiesel, methanol, vegetable oil, and pyrolysis oil) and gaseous fuel (methane, carbon diokside, hidrogen, and carbon monoxide). BPPT and LIPI are two prominent research institutions which have developed biomass reactor. Padjadjaran University (Unpad) also developed some research in bio briquettes: (1). The heat content of rice husk, corn cob, coffee bean shell, hemp wood decortication’s waste, (2). Physics properties of bio briquettes, (3). Chemical gass product of carbonized bio briquettes, (4). Prototype of manual, strew and hydraulic pressing machine has been developed, (5). Design and construct calorimeter bomb, (6). Measuring the performance of the existing bio briquettes stove, (7). Modified and developed the existing biobriquettes stove, (8). Prototype of carbonized has been developed. The research in bio fuel and biogass also developed. Unpad also has net working with bio briquettes based machine product such as burner, cattle, and steamer. Based on those facts, it is important to develop integrated and comprehensive study of biomass as national issues that biomass can substitute the fossil energy.

West Java is one of the Indonesia province which has area of agriculture and plantation about 1.394.900 Ha. After harvest, 40-60% of waste product can be used as biomass energy source. Rice husk, rice straw, corn cob, coffee bean shell are typical of biomass in West Java. In some province there are local specific potency of biomass. The industrial plant of biomass like calandra, pine, hemp wood also grows in West Java. The sources of biomass are abundance. Converting biomass to bio energy product which can substitute fossil fuel need six related elements, there are: 1). Availability of biomass to supply the bio energy plan and market for the biomass derived product. 2). Society readiness to involve and participate in collecting the biomass and also ready to involve in production process. 3). There are skillfull human resource as expert and technology and expert to produce biomass energy product. 4). Financial structure including cost of money, government subsidy if any, and loan guarantee. 5). Capital and operating cost plant. 6). Study of environmental impact and applicable regulation and the approval process [3].

There are two objective of this research, first is to make the map of biomass potency in West Java province with the biomass from rice husk, corn cob, coffee bean shell with addition the specific local biomass potency from each region. The result is converted energy unit each year. Second, the empowerment models of biomass conversion substitute fossil energy is developed by integrating the six elements above.

The map of biomass potency is very useful especially for West Java district government. The potency data of biomass in each district can be used to mobilize the society to use biomass as energy source. The empowerment model of biomass conversion is important for West Java government. The model can be used as reference in making the integrated programme to develop biomass as commercial energy
substituting the energy fossil. The model also can be applied in other provinces in Indonesia. The other benefit of this model, it can generate income for society and self-sustained energy.

2. Methodology
This research was started by searching the data of the availability of biomass to serve as product of energy either liquid, solid, or gas. The object of this research is West Java in connection with the diverse of biomass species, fertile soil, many farms, plantations, and forests. These data were taken from the local government, technology information, and direct survey to the village. These data include type of biomass, the amount of dry biomass in ton/years, the existing and potential land, rainfall, the properties of plant growth, the available transportation in the observe village. The next was analyzing the data to obtain minimum three seed biomass species. These data was expressed in kg of dry biomass per years, and then converted to kJ/kg, including fuel consumption. The result is potential distribution of biomass in every county and city in West Java. The types of product to be made were determined by considering the economic revenue. There are three main revenue sources of biomass conversion products, energy revenue, revenue from chemical product, and revenue from transport fuel.

The next step was continued with determining biomass conversion process plant equipment and cost. It started with biomass collection system, pre processing, biomass conversion, gas cleaning/product treatment, and product utilization. After all the data of operating cost was available, the financial analysis of the plant could begin. The viability of project was measured in terms of several items, there are: 1). Cost of electricity or product. 2). Internal revenue requirement and return on investment. 3). Net present value. 4). Benefit cost ratio. 5). Pay back period. And 6). Life-cycle cost. The goal of a financial analysis is to determine one or many of above indices to judge the economic viability of the project.

The next was measuring the owned carrying capacity of technology and capacity building which can be seen in how far the research of biomass conversion was done in Indonesia, who was involved, and how the product was marketed by community or low or moderate class industry. Because the objective of this research is to involve the community so that they can take a role as buyer and business people, the study of readiness of the community was conducted. The social engineering was prepared to make the community as biomass collector, and to make a small-scale industry. The socialization for community was done to change the mindset, from fossil fuel user to biomass fuel user. In this program, the local and central government hold a role not only as facilitators, but also as provider of policy tools and loan fund provider so that the program can work well.

3. Results and Discussions

3.1. Biomass Potential Map in West Java
The model of community empowerment in West Java as energy commodity started with study of biomass availability in West Java. Selection of biomass species, which would be converted into energy, was done depending on the total of availability of biomass in certain district, availability of area, biomass heat content, and community characteristic that included in the biomass supply process. Biomass availability was designed by the college by including the local government. Data of biomass availability was provided by local government (Agriculture Department and Forest Department), mass media with direct reviews to the field. Product of research potency is map of biomass potency in West Java, shown in Figure 1., depending on potency priority which converted into energy units. Data of biomass potency is very needed for local government when developing the biomass as energy source.
Figure 1. Planting area of rice paddy in West Java [5].

Figure 2. Productivity of paddy in West Java [6].

Figure 2 Shows map of productivity of paddy in West Java. The data from the map was used for calculating the availability of energy in West Java.
Table 1. Biomass potential from wasted paddy in West Java [6].

| No | Area            | Rice shell production (10^6 quintal/years) | Bio-briquette (10^6 quintal) | Energy (10^11) kkal |
|----|-----------------|--------------------------------------------|------------------------------|---------------------|
| 1  | Dist. Bandung   | 1.75                                       | 0.702                        | 2.59                |
| 2  | Dist. West Bandung | 0.87                                   | 0.350                        | 1.29                |
| 3  | Dist. Bekasi    | 2.43                                       | 0.974                        | 3.60                |
| 4  | Dist. Bogor     | 2.07                                       | 0.829                        | 3.07                |
| 5  | Dist. Ciamis    | 2.95                                       | 1.181                        | 4.37                |
| 6  | Dist. Cirebon   | 2.15                                       | 0.863                        | 3.19                |
| 7  | Dist. Cianjur   | 3.01                                       | 1.206                        | 4.46                |
| 8  | Dist. Garut     | 3.41                                       | 1.365                        | 5.05                |
| 9  | Dist. Indramayu | 5.45                                       | 2.180                        | 8.06                |
| 10 | Dist. Karawang  | 4.78                                       | 1.914936                     | 7.08                |
| 11 | Dist. Kuningan  | 1.47                                       | 0.590                        | 2.18                |
| 12 | Dist. Majalenga | 2.26                                       | 0.906                        | 3.35                |
| 13 | Dist. Purwakarta | 0.81                                    | 0.325                        | 1.20                |
| 14 | Dist. Subang    | 4.27                                       | 1.710                        | 6.32                |
| 15 | Dist. Sukabumi  | 2.83                                       | 1.132                        | 4.19                |
| 16 | Dist. Sumedang  | 1.87                                       | 0.751                        | 2.78                |
| 17 | Dist. Tasikmalaya | 3.37                                   | 1.348                        | 4.98                |
| 18 | Bandung City    | 0.028                                      | 0.0112                       | 0.0415              |
| 19 | Banjar City     | 0.17                                       | 0.0689                       | 1.25                |
| 20 | Bekasi City     | 0.019                                      | 0.0078                       | 0.029               |
| 21 | Bogor City      | 0.037                                      | 0.0149                       | 0.055               |
| 22 | Cimahi City     | 0.014                                      | 0.0056                       | 0.020               |
| 23 | Tasikmalaya City | 0.336                                   | 0.134                        | 0.497               |
| 24 | Cirebon City    | 0.013                                      | 0.0556                       | 0.0205              |
| 25 | Depok City      | 0.020                                      | 0.0083                       | 0.0307              |
| 26 | Sukabumi City   | 0.088                                      | 0.035                        | 0.131               |

The process was done by calculating the potency of wetland area, production of waste in each district in ton per years, converted into total of bio-briquette which resulted in quintal. By knowing the heat content from rice shell, the potential energy can be produced in West Java.

Table 1. explains the potential of biomass from wasted paddy which converted into energy unit in each district in West Java. It assumed that the heat content of wasted paddy is 3700kkal/kg. The same thing was done for corn commodity. The data was collected from six district, District Majalengka, District Sumedang, District Garut, District Sukabumi, District Tasikmalaya, and District Bandung as shown in Table 2. It assumed that the heat content of corn is 4500kkal/kg. The total amount of energy resulted in wasted corn in West Java is 11.7 x 10^10 kkal.
Table 2. Biomass potential from wasted corn in West Java.

| No. | Area | Wet waste | Dry waste | Bio-briquette | Energy |
|-----|------|-----------|-----------|--------------|--------|
|     | Area | (10^4 ha) | (10^4 ton)| (10^6 kg) estimated 30% | (10^6 kg) | (10^10 kkal) |
| 1   | Majalengka | 1.9 | 2.81 | 8.446 | 3.378 | 1.520 |
| 2   | Sumedang | 1.9 | 2.81 | 8.446 | 3.378 | 1.520 |
| 3   | Dist. Garut | 7.0 | 1.03 | 31.11 | 1.244 | 5.601 |
| 4   | Sukabumi | 1.51 | 2.24 | 6.748 | 2.699 | 1.214 |
| 5   | Tasikmalaya | 1.05 | 1.56 | 4.692 | 1.877 | 0.844 |
| 6   | Dist. Bandung | 1.31 | 1.94 | 5.842 | 2.336 | 1.051 |

Total of Energy 11.75

In addition to potency of wasted paddy and corn, West Java has biomass potency from coffee skin. The data was obtained from Central Bureau of Statistic (BPS), and it was the total of data in West Java. According to the data, plantation area in West Java reaching 494,900 hectare, or 13.28% of total West Java area, which is 3.7 million hectare. The production of coffee in West Java has increased. In 2008, resulted 9,840 ton of coffee, as in 2014 reaches 12,943 ton [6]. In every 100kg processing of coffee can be produced 15.95kg (55%) coffee beans and 13.05kg (45%) skin dry logs. So the total of wasted skin of coffee reaches 5824.35ton. The next step to produce the bio-briquette is drying process of biomass. From the wet skin, it can be produced 22.31% of dry skin coffee. So the total is 1200.413ton. The heat content from coffee skin is 4427kkal/gram. The total energy of the wasted coffee skin is around 5.752 x 10^{12} kkal.

3.2. Biomass Empowerment Model as Energy Commodity

The biomass empowerment model as energy source in West Java was developed based on five processes which are raw material, pre-processing process, conversion mechanism, products, and end user as shown in Figure 3. There are five parts of process started by biomass selection which converted into energy. The results are the products that are ready to be marketed to the end users. There are specific treatments in every parts of process which involving the results of research, government roles, and public society and industry.

3.2.1. Raw Biomass

First step is collecting raw biomass. In this step the research of biomass potency in west Java had been done. Various types of plant / animal waste was researched and calculated in order to know both its quantity and its availability within one year. In this study we obtained various candidate of bio mass that would be collected. Furthermore, each type of biomass would be determined and converted to energy products which are divided into solid, liquid and gas and also would be calculated its heat content. The result was the datas of mass quantity and heat content of each raw biomass which had been collected before. In addition we also conducted a research which focused on the readiness of the society itself who involved in this process. This is necessary because the program is predicted to succeed if local society participate in. They were who have role in this stage are researchers from universities and research centers, a central statistics bureau which has the data that is needed, and the community that is around the location of biomass is located.
3.2.2 Pre-processing Process
Pre-processing process was started by biomass collection which involving the community, classification process, sorting, handling, and drying the biomass. Pre-processing process done by local community in order to empower the community. It has two advantages, reduce the pre-processing cost and creates jobs for the community. To realize this process, it is needed the social engineering which designed by the college and full assistance from the government.

3.2.3 Conversion Mechanism
The biomass conversion process into energy other economical commodity is a part which has complex strategy because it involves many parties. The core of this process is setting the most appropriate technology in order to produce the product which has high economical value. There are two types conversion process. The first is thermochemical conversion including combustion, carbonization/torrefaction, pyrolysis, gasification, and liquefaction. The second is biochemical conversion including digestion (anaerobic and aerobic), fermentation, and enzymatic or acid hydrolysis. Researches from the colleges and researchers have a lot of results about this process. As an example the result of research in heat content of several biomass which is converted into bio-briquette, or the research in biogas and biodiesel from vegetables materials. The next is research in the form of prototype such as molding machine, carbonization machine, and small scale biodiesel reactor. The results of this research should be upgraded into the technology product which converted the biomass in large scale, so that can be used in this empowerment program. The involvement of private parties is also needed in order to manufacturing and procurement of tools. Each type of biomass conversion has own unique tools, although there are some product of biomass which used the equipment at the same time.

3.2.4 Cost Analysis
This process was started by calculating the procurement cost, procurement of biomass, human resources, and the availability of area. The owner of the capital is needed in this step. The next is finance analysis started by calculating the revenue from various biomass. The role of the government is so important because they should make appropriate regulations to support this program, such as subsidy, determining the selling price for the products, etc. The viability of any such project is measured in terms of following several terms: cost of electricity or product, internal revenue requirement and return on investment, net present value, benefit – cost ration, payback period, life cycle cost.

Figure 3. Diagram of biomass empowerment model as energy source.
3.2.5 Production
There are three kinds of biomass product, solid fuel, liquid fuel, and gas fuel. The solid fuel consists of carbonization and non-carbonization, while the liquid fuel consists of bio-ethanol, bio-oil, etc. The gas fuel consists of methane, synthetic gas, and any other derivation products. The most important thing in this process is availability of the row material (low cost, easy to get, and sustainable), human resources, quality controls, selection of the appropriate technology, and market availability which will determine how much products will be produce.

3.2.6. End User
To get to the end users, this takes appropriate selling strategy, distribution channels, and community preparedness to for accepting the products through socializations and promotions. Biomass conversion products will be consumed by community and low and moderate industry.

4. Conclusions
The biomass potential map for biomass conversion (rice shell, corn, and coffee skin) into energy in West Java was successfully made. The energy total produced from wasted rice shell is $6.892 x 10^{11}$ kcal, $1.175 x 10^{11}$ kcal for wasted corn, and $57.52 x 10^{12}$ kcal for coffee skin. The total energy from all wasted biomass is $127.616 x 10^{11}$ kcal.

The integrated model of biomass empowerment in West Java was made by involving community, government, college and researchers, and industry. In this model, the biomass will be converted into solid fuel, liquid fuel, and gas fuel. If this model is realized, the potency of biomass in West Java will increase because the biomass used in the first conclusion it just involving three commodity of biomass.

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