Integrated model of utilization of organic waste into bio briquettes with community empowerment in West Java

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Integrated model of utilization of organic waste into bio briquettes with community empowerment in West Java

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Abstract. Scarcity of fuel gas causes an obstacle of small and medium enterprises (UKM) acceleration. West Java has abundant biomass energy resources, but not yet utilized. Bio-briquette is a biomass product that has high energy content and can substitute LPG. In this research, converting biomass into bio briquette from upstream to downstream, a community empowerment model is engineered. The program begins with collecting potential biomass data in several districts in West Java. Furthermore, encouraging the public to participate in the collection and manufacture of biomass into bio-briquettes. Bio-briquettes making technique was adopted from the research that has been done in various universities. Similarly, prototype chopping-machines, briquette molding, and simple oven have been made in university. The market is households and UKM that have been using LPG. In terms of economic, value of briquette selling more profitable than LPG. The problem is, burning bio briquettes traditional wasteful energy. To overcome this, cooperation with the manufacture of stoves, burners, steamer, and kettle is done and it's more energy efficient. In each stage, mentoring is done. The plan of this program will be completed within two years. The hope, this model can be adopted in other areas, given the biomass resources spread throughout Indonesia.

1. Introduction

Elpiji is a life necessity of many people, both households or small and medium enterprises (SMEs). The use of LPG in Indonesia increases with time. This is related to the success of the government's policy of replacing the use of kerosene into LPG. However from 2007 until 2014 the price of LPG significantly increase, from Rp. 4,250/kg to Rp. 13,000/kg [1].Economic growth accompanied by the increase of LPG demand, resulted in the imbalance between the LPG need and its availability. This is due to the scarcity of oil and gas. In line with presidential rules no. 5 of 2006 concerning national energy policy to develop alternative energy sources as substitution of oil and gas, by diversifying energy the supply and utilization of various energy sources. In addition, a framework for developing energy availability was made by optimizing affordable prices for the community. This policy opens up opportunities for the use of renewable energy sources such as geothermal energy sources, biomass, solar energy as a substitute for oil and gas. Since 1994, coal briquettes have been developed in Indonesia [2]. Coal briquettes have succeeded in substituting the use of oil and gas. This is because coal briquettes heat content is high enough above 5000 calories/gram. But the use of coal briquettes has the disadvantage such as high carbon emissions that pollute the air. This coal briquette so far replaces some of the roles of oil and gas as fuel used in the industry. Indonesia has abundant agricultural commodities such as rice tree (padi), corn tree, palm oil tree, rubber, cocoa coffee and forestry. That biomass wasted are leading commodities

for acceleration bio briquette product. Coal briquettes have a high level of heat with low levels of air pollution. Therefore biomass has great potential to be an alternative energy source that is utilized in the form of briquettes.

Some countries have applied the utilization of biomass briquettes as an energy source [3]. Indonesia itself has started to use bio briquettes as an alternative fuel source other than LPG. However, the use of bio briquettes in Indonesia still has weaknesses. Utilization of biomass in the form of briquettes in Indonesia is still not well developed because the management system is not good. Management and distribution of biomass feedstock supply from source to briquette producers until the user has not been well organized. Then there is no cooperation between the government or institutions with the community. Involvement is good in the supply of raw materials briquettes, making biomass into briquette forms, and provision of equipment both for the manufacture of briquettes and for the utilization of the briquette itself. Another weakness is the equipment that people use to utilize briquettes is still simple. So that the use of briquettes still cannot be effective because it has a high level of heat loss. In addition to high level of heat loss, the use of biomass with simple equipment has a weakness by showing by the unfavorable combustion properties, among others, many smoke, ash, and efficiency is very low. Besides, there is no research that is well integrated and serious about briquettes, both research on briquette quality and research on strategic way of briquette utilization in Indonesia.

The potency of bio briquettes in Indonesia, especially in West Java, is very large, especially from plantation and forestry sources such as Kab. Garut (rice, corn, rubber, hemp, wood, coffee), Kab. Sukabumi (timber, coffee, corn) [4]. This potential has not been fully utilized by the government or the community. Along with the rising prices of gas fuel, there are many entrepreneurs who are turning from the production base of gas production base to bio briquettes base production equipment. But the increase in bio briquettes demand is not balanced with its production. This is because the acceleration of utilization of biomass resources as the raw material of bio briquettes is still slow.

In general, this study provides a solution to the problem of bio briquette utilization. The problem of bio-briquette management starts from the provision of material source, manufacture, and distribution of bio-briquette from producer to consumer, as well as the provision of an effective bio briquette tool. The problem of the study in this study is how the strategy of sustainability of supply of raw materials of various biomass through the empowerment of community groups along with the business scheme, how the strategy and implementation of bio briquette production by the community through community empowerment program, how the business briquette scheme produced by the community group is applied by productive community groups and small and medium enterprises, and how to approach and utilize production systems (machines / equipment) by SMEs by using production-based production machine and equipment bio briquettes.

This research has a general purpose that is to create an integrated production system ranging from briquette production to bio-briquette based SMEs production equipment and its utilization by the community along with briquette based business scheme. The specific objective of this research is to develop the community in the form of SMEs Collectors as a provider of biomass sources of raw materials bio briquettes, community empowerment in the form of SMEs Bio-briquettes production as bio briquette producers that will meet the needs of users. The next step develops of an efficient bio briquette system through the development of bio briquettes production machines ranging from spraying machine, printer, author and packaging, approach to productive society to use bio briquettes and stove as alternative energy, development of bio briquettes based production system through development of burner, boiler and kettle, approach to SME producers to implement new briquette-based production system is the production of a community of its own, and establishes a briquette-based community business management system. This research can increase community productivity and energy independence so that ultimately improve the welfare of local communities to SMEs.

2. Literature review

2.1. Biomass briquettes

Biomass is an organic material produced by photosynthesis in the form of products and waste, which then these organic materials are used as a fuel source. With the process of photosynthesis, plants store solar energy and storage of solar energy is used as energy. Biomass consists of several components: moisture content, volatile matter, fixed carbon, and ash. The biomass burning mechanism consists of three stages: drying, devolatilization, and charcoal combustion. The drying process will remove the water content, devolatilization which is the pyrolysis stage will release volatile, and charcoal burning which is the reaction stage between carbon and oxygen will release the heat. The rate of charcoal burning depends on the reaction rate between the carbon and oxygen at the surface and the rate of oxygen diffusion in the boundary and inner layers of the charcoal. The surface reaction mainly forms CO. Outside the particles, the CO will react further to form CO_2. The burning process will leave the material ash. The carbon contained in the charcoal reacts with oxygen on the surface to form carbon monoxide according to the following reaction [5]:

$$C + ½\ O_2 \rightarrow CO \quad (1)$$

The carbon surface also reacts with carbon dioxide and water vapor with the reduction reaction as follows:

$$C + CO_2 \rightarrow 2CO \quad (2)$$

$$C + H_2O \rightarrow CO + H_2 \quad (3)$$

During the carbonization process, flammable gases such as CO, CH_4, H_2, formaldehyde, methane, formic acid, and acetic acid and non-combustible gases such as CO_2, H_2O and liquid tar are released. The gases released in this process have a calorific value that can be used to meet the heat requirements of the carbonization process [5]. Various biomass can be used as bio-briquette through the process of briquettes such as hemp tree [6], corn stalks and cobs [7], wood processing waste, coconut shell, coconut husk, stem and peanut skin, straw, rice husk, durian skin, banana peel [8]. Each biomass source has a diverse energy content. The coconut shell content of about 5,780 cal/gram is the highest non-coalic biomass (Table 1). While the highest content of heat is coal that has been carbonized for 6,158 cal/gram.

Table 1. Biomass content [9].

No	Type	Heat Values (cal/g)
1	Coconut shell	5780
2	Sawdust teak wood	5479
3	Rice husk	3073
4	Coal is carbonized	6158
5	Non-carbonized coal	6058
6	Corncob	5351
7	Wood charcoal	3583

Some parameters determine the quality of bio-briquette ie moisture content, ash content, volatile substances, carbon-bound, heating value, density, and compressive strength. The briquetting pressure can control the combustion rate of the bio briquette. The greater busting pressure slows the rate of combustion and reduces the rate of COB of corncob bio briquette [7]. As a glue, many researchers use starchy starch. Maryono [10] reported 1-2% starch content producing bio briquettewith ash content below 8% according to SNI standard. Mixing of variations in biomass materials determines the quality of the bio briquette. Cow manure mixed with biomass in the form of husk, straw, and shell (in the ratio of 1:3) can increase the heat content to near the SNI standard [11]. Bio briquette made from mixed biomass between durian and banana peels is reportedly still needing an effort to increase its calorific

value [8]. In fact, biomass water hyacinth mixed with coal briquettes and carbonized at temperatures of 400 - 600 ° C can increase the content of briquette heat [12]. The biomass type also determines the combustion characteristics, such as the ignition time (to ash), the amount of smoke and initial startup time. Jamilatun [13] reported that it takes a long time to ignite 116.1 minutes for a coconut shell weighing 220.51 grams, longer than sawdust teak, rice husk and coal. However, coconut shells produce more smoke and require a longer initial start-up time.

2.2. Bio briquette stove

The performance of combustion is determined by various parameters of the biomass briquette production process and the characteristics of the bio briquettes itself. The result of this briquette can be used for the actual combustion process on the stove but to obtain efficient combustion it needs a furnace in accordance with the characteristics of the bio briquettes. An efficient furnace can provide the right combustion air supply so that briquette burning is perfect. With an appropriate furnace, the resulting briquettes can be used for real applications. Saputro [14] performed stove testing by measuring combustion temperature, mass reduction rate during combustion and combustion rate; and reported that the fastest combustion rate and the highest temperature of the bio briquettes (corncob with a starch adhesive) were achieved at an airflow velocity of 0.6 m/s. Therefore, the combustion temperature and length of briquette combustion in operation can be controlled by air flow rate.

2.3. Social engineering

The effort to handle a social problem depends on how we view or the glasses used to observe it. Let's look at the general view of the authorities/government against the community. Some time ago, the view of the community still revolves around that the community needs to be helped, the community has many needs that need to be met, people spend the State's money because it needs to be given many public facilities and others. This is a problem-based or needs-based perspective. The implication is that community issues must be solved and or the needs of the community must be met. This view assumes that the community is not able to solve the problem and can't fulfil its own needs so it must always be assisted, and fulfilled its needs. As long as the approach used is still like this, so long as that society considers itself a party to be met needs, so that would never think to do something for themselves and for the closest social environment.

Gary Paul Green [15] reminds us of a new worldview (though practiced quite a bit in Indonesia), which he named Asset Based Community Development. This is a mindset that assumes that almost every community group has assets or resources that have not been maximally utilized, rather than having needs or problems to be met / solved. This is a view that believes that every member of society actually has the power to overcome its own problems and empowers its potential instead of having weaknesses and shortcomings that result in them always shackled in various difficulties.

So, if the first thing to try to see or map is the weaknesses, problems and needs that exist in the community, then the development of the asset-based community would like to focus on the potential, assets or resources of any existing in the community that can be developed. As for assets that try to be described further in this case include community capital such as human capital, physical capital, social capital and including environmental capital.

This approach will encourage us to map the community in different ways. For example, instead of describing the number of poor people, we are trying to identify potential opportunities for skilled-based economic development and work experience of people in an area. Or, instead of identifying the damage to natural resources, we can describe what natural potentials have not yet been maximized and can still be cultivated for value enhancement.

In general, Asset Based Community Development classes, will encourage us to think about all the potential that exists in society. By using this asset-based approach, we will not see the residents are those who are unemployed, some have narcotic abuse, some are vulnerable, some dropout and others. But we will view them as a group of individuals who have different skills, varying work experiences, different

network ownership etc., so it only needs to be synergized to produce a great 'power', including to cultivate their own garbage.
Furthermore, this view will encourage us (government, private or other individual societies) who want to help, can choose the role appropriately. The government, no longer necessarily acts as a 'sanner' who distributes aid, but may act as (1) facilitators who facilitate their own independent forces, or (2) as mediators, who can mediate works and initiatives has been generated by the community to add value, or (3) as advocates, who are reminded of their rights and their potential and resources.

3. Methods

This program will be conducted with several steps, namely:

3.1. Mapping biomass potential to become bio briquettes in West Java

Mapping biomass potential into biobriquette has been carried out by Cukup Mulyana [4]. West Java has the potential to produce biobriquettes because it has a variety of plants beside it has forests whose waste can be converted into bio briquettes. From rice husk energy will be equal to 68,921 1011 kcal while from corn cobs the energy is equivalent to 11.75 1010 kcal, and from the coffee bark it is equivalent to 5,752 x 1012 kcal.

3.2. Sorting raw materials of biomass

In this stage, biomass is selected according to its quality. Biomass that is suitable for making biobriquettes is separated and then molded into biobriquette. In West Java, the potential for bio-briquettes is almost found in every district. The process of biomass sorting is carried out by the community. There are two types of biomass, first biomass from agricultural waste such as stem and head of maize, rice husk, and coffee skin; the second is biomass which is intentionally planted as industrial plants, such as from kaliandra trees, rami trees.

3.3. Designing social engineering

Social engineering is needed to involve the community in the processes, it's start with collecting biomass, making and marketing of bio-briquettes, and changing the habits of using fossil fuel to renewable energy bio briquette. The process is done in the form"Appreciative Inquiry Application for the development of potential community ". In general, activities will be conducted in four stages:

1. Asset Social Assessment: with the aim to uncover the potential of social assets that exist in the community
2. Socialization of assessment results: conducted to sensitize the public related potential
3. Appreciative Inquiry: done to generate a positive atmosphere among community members, share dreams and also design things that can be done in the future
4. Follow-up with plan and group formation

The expected outcomes from these social activities are:

1. There is a change in people's mindset about the benefits and potential use of briquettes in the future
2. There is a desire to maximize the use of briquettes, both for personal and business needs
3. A jointly agreed action plan is formed, namely groups, and if possible a management system of collectors producer and user can be created

3.4. The supply system of the bio briquette production machine

The supply system of bio briquette machines should involve capital owners as funders, society and government as determinants of policies. Parties from universities, research institutions and polytechnics and contribute to the design of making bio briquette prototypes, machines/tools to produce small-scale bio-briquettes and stoves, as well as industrial scale. Some examples of products can be found in bio briquette manufacturers, but the numbers are still very few with poor quality. Manufacturing is needed that is able to prepare machines such as crushing machines, drying machines with good quality but the

price is still affordable. To meet these needs, capital suppliers are needed, community involvement and positive support from the local government.

3.5. Manufacture of biomass products

In the process of making biomass products involved the role of universities (PT), outside agencies, local governments, and communities that must be mutually beneficial to each other. The procedure for making bio briquettes is done with the following steps:

1. Milling
   Milling is done by feeding the raw materials alternately into the grinding machine to form the powder. Milling is done again using a blender to form a finer powder.
2. Preparation of adhesive material
   Adhesives that are prepared to bind the powder to make it easy to print. Adhesive of tapioca added hot water then stirred until the dough becomes sticky.
3. Mixing of raw materials and adhesives
   Before mixing the material first weigh the powder, the powder of the composition variant and the adhesive material corresponds to a certain concentration for different variants.
4. Molding process
   The molding process is done by inserting the mixture into the briquette pressing device with the pressure and temperature varied.

3.6. Provision of bio briquette production equipment and machinery

The supply of machine and equipment to produces bio-briquettes is done by prototypes that have been designed by researchers in higher education and researchers then collaborate with small-scale machine-making industries that usually work with SMEs. The equipment is in the form of a chopper, drying machine, molding machine, bio briquette stove for use in the household, a burner for use in SMEs and a kettle for processing products (food).

3.7. The design of distribution channels

Distribution channels for the manufacture of bio-briquettes from biomass include channels for the supply of biomass that are ready to be made bio-briquettes. For this channel to be formed, cooperation between bio-briquette producers and the community is needed as the owner of biomass waste. While the channel for the manufacture of bio briquettes is formed by bringing together the owners of capital, the community and the local government so that the mechanism for making bio-briquettes is cheap, involving the community but still of economic value. While marketing channels are formed by producers of bio-briquette makers and consumer consumers and consumers of SMEs, which are quite large in West Java.

4. Results and discussion

The well-integrated briquette management system is depicted in Figure 1. The management consists of three major activities. It's begin with the provision of raw material briquettes and then bio briquette production and finally selling activities with the market targets community group such as *pesantren*, household need and small + medium industry (SME's) such as tofu Industry etc- the box with dot line. In developing activity of biomass collector need social engineering program because it's involves communities, need an expert for guiding, funding and government policy.

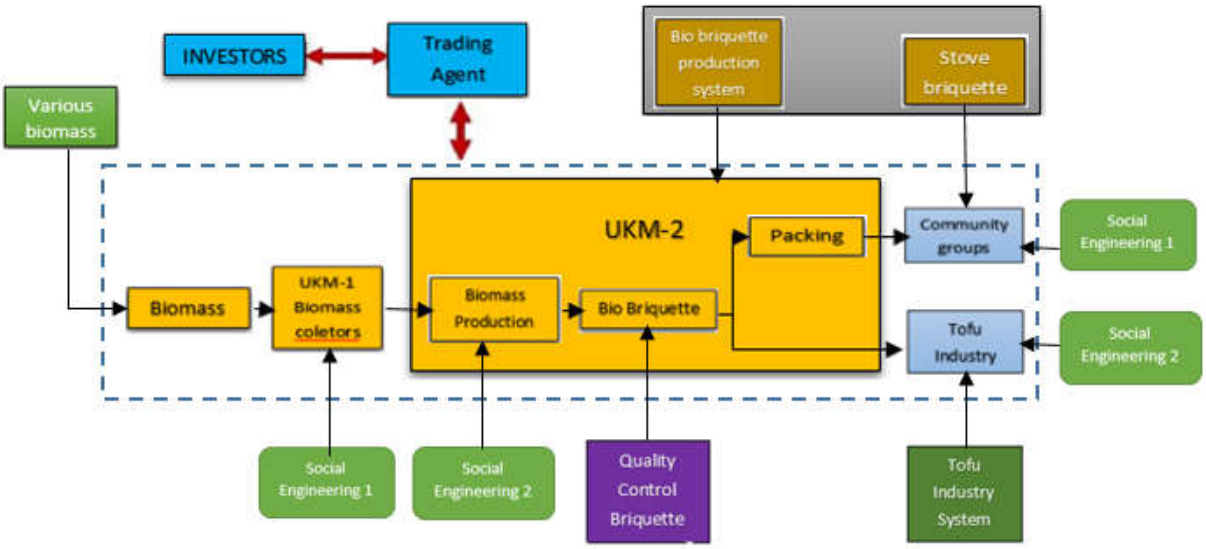

Figure1. Flowchart of biomass management.

4.1. Provision of biomass raw materials

The type of biomass chosen to be bio briquette depends on the availability in each district. From the results of previous studies the types of biomass that will be made into bio briquettes for each. For each district, the type has been determined. The process of collecting biomass includes transportation from the field to the location of collecting, sorting and winding. This activity involves people who were previously unfamiliar with industrial processes. Therefore social engineering is needed to change attitudes and paradigms. This program was designed and prepared by a team involving plant waste experts, social science experts, communications and teams from psychology. In addition, there are economists to calculate the price of biomass to remain economically valuable when it has been converted to bio briquettes.

4.2. Bio briquette production

After the biomass is dry, the biomass is cut to a certain size and then dried again under the sun. Then there are carbonized, mashed, filtered, mixed with adhesive, then molded and dried to reduce the water content. For making bio briquettes, a chopper machine is needed, molded machines, and carbonized machine. All necessary equipment and machinery are prepared from the results of research and development by workshops that have been tested for their functional abilities and costs. The process of making bio briquettes requires standardization of the heat content, density, compressive strength, ash content, and gas content that appears when burned. Also in the burning time test. Standardization and quality control continue to be carried out and accompanied by researchers and authorized institutions.

4.3. Bio briquette support equipment

Bio-briquette support equipmentis bio-briquette stove, burner, steamer, and kettle. The bio briquette stove is different from a gas stove. To get a stove that works efficiently requires good design and engineering. Likewise, for other components, the Bio Briquette Stove has been designed and has been made a prototype. Its performance has been measured but it hasn't been made on an industrial scale. Whereas for steamer,burner and kettle there are already manufactured and have started to be marketed. The market demand is small industries, such as tofu factories, crackers or various food products produced by SMEs not only those that are located around West Java and even across islands in Indonesia.

4.4. Investor and trading agent

To run a biobriquette program from biomass, the employers need funding. Even though its potential is wide open, a supportive business atmosphere is needed, government policies that provide opportunities supporting biobriquette programs as a substitute for LPG fuel and provide economical benefits. A good synergy from various parties are needed in order to success the integrated model of bio briquette management from upstream to downstream

5. Conclusion

A well-integrated bio briquettes management system is done by involving the role of the community in it. Thus, there is good cooperation between communities, universities, institutions external, and governments. The community is empowered from starting the gathering of biomass raw materials and then making the briquettes to the distribution system. Utilization of bio briquettes is maximized by designing equipment that suits the needs of consumers. The designed equipment is briquette stove, burner, boiler, and kettle. Indonesia has an abundant source of biomass that has not been utilized so far. This program can be duplicated in other provinces in Indonesia, so if this program is realized it will increase the energy independence of each province and become a new source of income for the community.

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