Biomass potential resources identification in Togean Islands, Central Sulawesi

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Abstract. Togean Islands is one of remote area in Central Sulawesi Province, Indonesia. Togean has been already well known for its great underwater scenery which fascinating many foreign tourists stay there. The large number of visits to Togean doesn’t mean at the same time it brings much improvement to local economy. People in Togean was used to live with limited utilities. Water and electricity are the two major problems that have been faced by the communities for many years. On the other hand, Togean has a very good potential for the development of biomass as a renewable energy source. This paper evaluated the potency of each resources using some parameters including availability, social support, technology feasibilities and sustainability aspect. Biomass potential resources that were investigated are hardwoods and forestry product, agro-industrial waste and by-products, and also household waste. Advanced analysis has concluded that the most feasible resources that eligible to be considered as future biomass resources is household waste followed by agro-industrial and agricultural waste then hardwood and forestry products.

1. Introduction

Togean Islands is an islands located in the middle of the Tomini bay and administratively belongs to the region of Central Sulawesi. This islands consist of 494 island and grouped into six districts which belonged Tojo Una-Una Regency. The districts are Batudaka, Una-Una, Togean, Talatako, Walea Besar and Walea Kepulauan.
Comparing to other Indonesian area, Togean islands was classified as Frontier, Outermost and Disadvantaged islands in Indonesia. One of the main problems in such type areas is the lack of facilities and infrastructure so that economic development is lagging and left behind. Togean consisting of land and sea territory with a population of 30,000 peoples where 72.01% of these populations have an average spending 400-749 thousand per capita per month. This value when compared with the population on the island of Java is very much different. The value will also be smaller for a specific area, as they have more limited job and works. Most of them depend on fishing activity to survive.

One of the main factor that being the causes of the prosperity problems in Togean is the lack of infrastructure facilities which is needed as a part of production activity. Electricity and water as the main utility for production activity is a major obstacle that faced by the community.

In Togean islands, electricity come from diesel power generators, only operate for 18 hours a day from 6.00pm to 12.00am. This conditions affects the whole activities of the people. As one example, because the fishing activity is the main activity, then the fish is the main commodity that have a huge potency to be used as raw material for food products. However, the six-hour electricity power cut make the performance of related equipment such as freezers, refrigerator and also ice maker becomes unable to function properly. The quality of preserved fish finally could not match the standard of fish product.

Closely related to the lack of electricity supply is the availability of clean water. At some point near Wakai, the largest city in Togean, there is a water source that sufficient enough to supply Wakai City and some areas around. However, there are many people live in small islands around the main island that require the electricity as a power to distribute water to the rest of the region. The lack of electricity and water supply should be handled carefully in order to let the activities of community run well.

As a resource-rich islands, Togean should be able to develop and growth into an independent island of the electric needs. Some of the available resources are forest products including hard wood and other forest products (forestry residue, grass, etc.), Agroindustrial activity waste and household waste. The objectives of this study is to examine the possibility of development of
biomass as an alternative energy feedstock for producing electricity in Togean. This study will show data results of an exploratory study and a review of some of the existing literature.

2. Methods
Some of the commodities in the islands Togean has been investigated as a potential source of biomass development. The simple method Multi Criteria Decision Making is used to defined most feasible commodities based on determined parameters. Several factors are the subject of assessment is the continuity and availability of raw materials, supporting facilities, the availability of human resources, regulatory support, the level of difficulty of application and alternative technology that already mastered. Each parameter weighted by the extent of its influence on the total score of each alternative source. Assessment done by the related stakeholders which have special interest with the development of alternative energy in Togean, including academics, businesses, governments and communities.

3. Results and Discussion

3.1. Forestry Products and Residue
Most of the islands of Togean is a region with a high proportion of forest where its products can be developed well. Unfortunately, the limitations of sustainability make the use of the forest must be maintained in order not to damage the existing forest ecosystems. Most of the forests in Togean located in mountainous terrain. Extensive mountainous terrain in six districts in Togean can be seen in Figure 1.

![Figure 2. Mountainous Area in Togean Islands. source: BPS - Statistics of Tojo Una-Una Regency [1]](image)

The forest area in Togean, is a conservation area which is named as Togean Islands National Park, so the utilization of forest timber and non timber product must consider the principles of environmental sustainability.

Forests in all districts in the region Togean are available in a very good condition. Although it was not designated as production forests, but forests also already become a part of the daily life of the community and the forest produce forestry residue that can be used as biomass feedstock. Nevertheless, the forestry residue which can be used as raw material for biomass production will be available in a number that is not equal with forestry residue produced from production forest, and that is why these kind of forestry residue often not to be considered [2].
Technological difficulties may be encountered due to the material characteristics of the hardwood. Some alternative technologies that can be applied to obtain the energy content of hardwood, among others, based on thermochemical conversion such as direct combustion [3], charcoal production [4], pyrolysis [5,6] and gasification [7]; biological; fermentation [8,9] and anaerobic digestion [10,11]. Direct combustion is the application of technology with lowest level of difficulty, compared with other technologies. Nevertheless, most of the conversion rate only reached 20% of the total energy contained would cause the application of this technology to be very wasteful. It is feared, these technology will lead to a reduction in forest area significantly. Application that allows to obtain large amounts of energy recovery is the advanced technology which, undeniable, has much bigger cost consequences. This coupled with the difficulty of obtaining skilled personnel (HR) who mastering the technology.

Considering the regulation, the development of biomass energy using forestry products as raw material seems to be hampered by conservation forest regulatory itself.

3.2. Agro-industrial and Agricultural Waste

Agroindustry and agricultural waste is one of the high potential raw materials that can also be used as biomass feedstock to generate energy. Some of the activities that are carried out Togean people as Agroindustry activities include manufacture of palm sugar, processing of plantation products and also routine agricultural and farming activities. Availability of Agroindustry and agriculture waste in the region of Togean varies depending on the activity of the peoples. Agroindustry and agriculture is the second work activity after fishing. The number of Agroindustry and agriculture activities is largely determined by the availability of agricultural land and raw materials of Agro-industrial activity in each district. Agro-based industrial activity is still relatively rare compared to agricultural activities. Thus, the quantity of agricultural waste will be greater than the waste of Agroindustry. Availability of agricultural waste in Togean relatively large because many agricultural activities associated with the presence of crop production such as cocoa, coconut, cloves. Each of these commodities either during the planting, maintenance and harvesting of agricultural waste such as stems and leaves that can be used as biomass feedstock.

Utilization of these organic materials as biomass feedstock will not reduce environment quality and people’s daily activities. The more agricultural and agro-industrial waste used, the cleaner activity will be achieved. The part of tourism aspects that still not well maintained in Togean Islands is people awareness on waste management. Even though the characteristic of organic waste doesn’t harm the sea, land and other environment, but when the huge amount of the waste disposed directly to the environment, it will become a serious threat. Amount of agricultural waste was calculated based on the type of each plant. Yields of each agricultural (ton per units area) were varied depend on the plants and activities [2]. Potency identification of biomass production from agricultural waste and by-products were conducted as already been perfectly reported by Wang et al.[12]. Coconut, Clove, Cocoa and Coffee was the most cultivated in Togean. Each productivity in 2015 displayed as follows.
Assuming the agricultural waste and residue was only 50% for coconut and coffee, at least we will get 402,286.6-ton biomass feedstock a year. These number equal with more than 1.1-ton production scale per day along the year continuously. We still couldn’t find that scale for biomass production in Indonesia. However, the amount of resulted energy will be varied depend on the type of applied technology and the characteristic and composition of the feedstock. As in forestry residue processing, biomass production using agricultural waste and residue also offered many modifications. In fact, some of agricultural residue will be easily to be converted than hardwood. Some initial decomposition is often to be founded than hardwood. Current regulation fully supports the use of agro-industry and agricultural waste as the use of those both types of biomass sources will reduce environmental damage.

3.3. Household Waste
The opportunities in developing biomass feedstock that also reasonable to be considered came from the use of household waste. In addition to produce biomass, the use of household waste will reduce more pollution that has been happening in the area of Togean islands. The availability of household waste which can be used as biomass feedstock is highly dependent on the number of population in an area. With a population of approximately 30,000 people in Togean, wherein assuming that each family produces an average of 0.33 kg of household waste per capita per day [13], then at least Togean will produce household waste by 3.3 tons per day. The next possible obstacles faced is the geographical situation of the islands. This islands consist of almost 500 island that complicate the collection of household waste to be processed into biomass.

3.4. Potency analysis
Each raw material then being analyzed to determine which material that can be considered as the most potential source for biomass development in Togean. Information gathered from stakeholders involved survey in the Togean islands and related experts resulted in the following results. It is seen that the most potential to be used as raw material for biomass development is Agroindustry and agricultural waste and household waste.
Figure 4. Radar Diagram of Potential Development of Biomass Feedstock from Various Materials

To refine the analysis, the analysis then continued by weighting each parameter according to the significance of its effect on the success of the development of biomass in Togean. The proportion are defined in accordance with the agreement of stakeholders is the availability of raw materials (25%), the availability of facilities (10%), capability of human resources (20%), supporting regulations (15%), difficulties level of application (10%) and technology support (20%). After further analysis conducted based on previous percentage of each parameter, the result shows that household waste ranks first as the most potential raw material for biomass development.

Figure 5. Assessment Result of Each Alternative Raw Materials
The development of biomass-based household wastes considered to be the most potential biomass feedstock comparing to the others as it only requires simple technology to convert into biomass and also available in largest quantity.

4. Conclusion
Selection of local raw materials as biomass feedstock development will differ in one place to another. Conditions in the local area (social, technology, sustainability, etc.) must be the primary consideration in the development of biomass as a renewable energy source. Biomass development in the islands area would not be similar to the development in the region of the main island.

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