THE CURRENT STATUS AND FUTURE DEVELOPMENT OF BIODIESEL IN INDONESIA

Palm Oil today - Jatropha Oil tomorrow

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Abstract
Di Indonesia terdapat bermacam-macam sumber bahan baku biodiesel, tetapi hanya beberapa yang punya potensi untuk dikembangkan sebagai bahan baku biodiesel karena alasan ekonomi, seperti minyak kelapa, minyak sawit dan minyak jarak. Saat ini, minyak sawit telah menjadi sumber utama biodiesel karena kapasitas produksinya telah mencapai 19 juta ton per tahun, dan hanya kurang lebih 25% untuk konsumsi dalam negeri. Kelebihan kapasitas produksi telah merangsang pengembangan pabrik biodiesel dengan bahan baku minyak sawit. Pabrik biodiesel telah mencapai kapasitas terpasang sekitar 3,3 juta ton per tahun pada tahun 2010. Pada beberapa test, biodiesel dengan bahan baku minyak sawit menunjukan dapat menggerakan mesin diesel sebaik menggunakan minyak diesel. Sejak minyak sawit adalah minyak untuk makanan (edible oil) dan memanfaatkan tanah-tanah atau lahan-lahan subur maka hal ini akan menjadi masalah dikemudian hari. Oleh karena itu jarak pagar yang dikenal sebagai tanaman subtropic mungkin satu-satunya sumber minyak yang dapat digunakan sebagai bahan baku biodiesel dimasa depan. Menurut beberapa peneliti, jarak pagar (Jatropha curcas L.) mempunyai beberapa keuntungan, seperti bukan untuk makanan (non edible), mengandung rendemen minyak biji yang tinggi (30-50%) dan produksi minyak per hektar cukup tinggi, dan tumbuh di marginal land, dll. Beberapa proyek memanfaatkan jarak pagar telah dikembangkan di Indonesia, salah satunya adalah Desa Mandiri Energi (energy sufficient villages).

Kata kunci : biodiesel, palm oil, jatropha curcas oil, transesterification, energy sufficient village.

I. INTRODUCTION

Currently the world is seeking to develop a fuel that is environmental friendly in accordance with the implementation of their commitment into Kyoto Protocol and global issues about CDM (Clean Development Mechanism)[(1)]. One of the alternatives is to use biodiesel fuel processed from vegetable oil which has characteristics similar to diesel oil. In Europe, the use of biodiesel has reached about 50% and will increase steadily with the implementation of Kyoto Protocol for reducing the use of fossil oil.[(2)] Generally European countries use rapeseed as feedstock for biodiesel, however USA uses soybean as feedstock. As the biggest producers of palm oil in the world, Malaysia and Indonesia have already developed palm oil based biodiesel since oil crisis, but it has been exploited commercially since 2003.[(3,4)] Since 2004, Indonesia has become net oil importer, of which diesel oil is about 40% from the total oil import mix. Indonesia is at the turning point - changing from an oil exporter to a net oil importer (see figure 1.)[(5)]. This situation is the main reason why Indonesia is very active in developing renewable energy.

In accordance with energy security in domestic supply, the Indonesian President published President Regulation no 5, 2006 regarding national energy policy.[(6,7)] In 2025, the supply of biofuel must reach minimum 5% of the need of national energy. As the implementation of this regulation, the Indonesian Government has published President Instruction no. 1, 2006 about the preparation and utilization of vegetable oil as biofuel to 13 Ministries, all governors and mayors and regent governments to speed up the supply of biofuel as an alternative energy. The development of plants that are able to produce vegetable oil has also been promoted. There are many plants producing vegetable oils in Indonesia such as

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palm, coconut, palm sugar, corn, jatropha curcas, etc. Since palm oil and coconut oil and corn are edible oils, jatropha curcas oil being non-edible oil that has an opportunity to be developed particularly in the marginal lands.

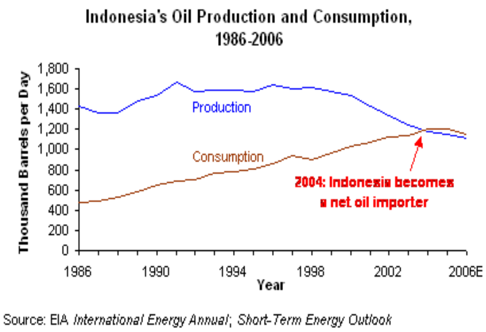

Figure 1. (5)
Indonesia's Oil Production and Consumption, 1986-2006

Government policy in developing biofuel through the development of jatropha curcas has several purposes, such as to fulfil the supply of sustainable feedstock particularly in remote area, to create new economic centres in eastern part of Indonesia, to increase farmer income, to support environmental conservation by introducing jatropha plant in marginal land and to produce jatropha seed oil as biodiesel feedstock.

As shown in Figure 2, the current energy mix comprises 5 sources of energy such as natural gas (28.5%), coal (15.34%), oil (51.68%), geothermal (1.32%) and hydro power (3.1%). It shows that fossil oil is still the primary source of energy in Indonesia. As Presidential Decree applied, the targets of energy mix in 2025 are 4 main sources of energy, they are coal (33%), natural gas (30%), oil (20%) and renewable energy (17%). In this figure, the target of oil contribution is going to decrease to about 40% from the current energy mix. The important thing is the target of renewable energy in 2025 to replace fossil oil. The target of renewable energy in 2025 is about 17% comprising of biofuel (5%), geothermal (5%), coal liquefaction (2) and 5% for a mixture of biomass, nuclear, solar, hydro and wind. As based on scenario with a respective replacement of 13 and 25% of transport energy demand by biofuels,[8,9] the total mitigation potential of biofuel in the transport sector is expected to range from 1800 to 2300 Mt CO_2.

The target energy mix in 2025 for biofuel is 5%, which is about 150 million BOE. If biodiesel supplies about 50% of the target, it will be equal to 75 million BOE per year. To fulfil this target, Indonesia will need about 12 million tonnes of vegetable oil per year.

However there are some serious debates about whether the wider use of biofuel contributes to the mitigation of GHG's emission, or in the contrary biofuels are actually net carbon emitters. Reserachers argue that most of biofuels production processes are not efficient enough to cut emissions by more than it takes to produce fossil fuel[10]. The widespread of biofuel production has also raised some other serious concerns and problems. Although it is still debatable, the issues appeared about the widespread conversion to biofuel feestock crops plantion and production, which is causing serious environmental problems in many places, such as deforestation and soil degradation. Since the first generation feedstock is edible oil, it might affect long-term food security. Therefore the development of second generation of feedstock, such as non edible jatropha oil has attracted attention in many countries for development purposes.

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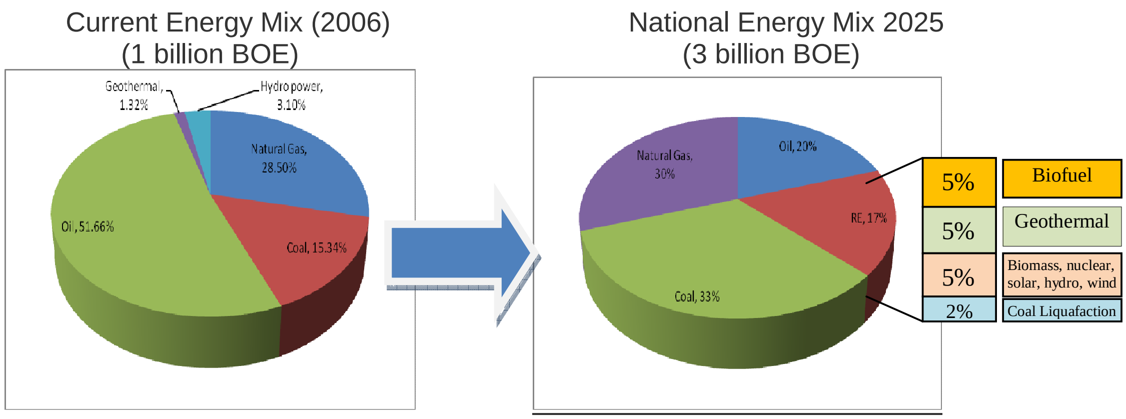

Figure 2. Target of Energy Mix 2025
The Presidential Decree No. 5, 2006 [6,7]

2. MATERIALS AND METHODS

Biodiesel is a compound of methyl ester derived from esterification and or trans-esterification process of various types of vegetable oils or animal fats.

Biodiesel is one of the alternative energy that is sustainable and environmentally friendly. Biodiesel has several advantages compared to diesel fuel, as follows[11]; (1) it is environmentally friendly due to the production of good quality of emission (sulphur free and low smoke number), (2) has high cetane number (>60) as a result having high efficiency of ignition, (3) has lubrication characteristics, (4) biodegradable, (5) renewable, and (6) can be produced locally. Those can increase independency of fuel.

The opportunity to develop biodiesel might be speeded up because, in Indonesia, transportation sector is the highest consumer of energy followed by industry and household use with the ratio of 37.7%, 36.16% and 26.05% respectively. About 99% of energy for transportation was from fossil fuel and only about 1% from natural gas[12]. By utilizing palm oil for biodiesel feedstock, Indonesia could reduce the use of fossil fuel and overcome the excess production of palm oil.[1]

2.1. Vegetable Oil As Biodiesel Feedstock

In Indonesia, there are more than 40 species of plants that have potency as biodiesel feedstock, such as coconut, soybean, palm sugar, kapok seed oil, palm oil, *jatropha curcas* (jarak pagar)[1], and also *calophyllum inophyllum* (nyamplung), *pongamia pinnata* (mabai), *Azadirachta indica* (nimba)[13], and they live spreading in many regions. Therefore biodiesel development will assist growth of the region. According to Gerpen[14], biodiesel can be produced from several plants, such as corn, rapeseed, kapok seed, palm oil, mustard oil, waste frying oil, animal fat, waste lubricant. Table 1 shows that several sources of feedstock are edible and non-edible. Although several second generation of feedstock could be used as biodiesel feedstock, the entire characteristic of feedstock should be considered.

Table 1. Several Sources of Fatty Oil Raw Material for Biodiesel in Indonesia[13]

Indonesian Name	Latin Name	Source	Oil, % w-dry	E/NE
Sawit	*Elais guineensis*	Pulp + Kernel	45-70 + 46-54	E
Kelapa	*Cocos nucifera*	Kernel	60-70	E
Jarak Pagar	*Jatropha curcas*	Seed Kernel	40-60	NE
Kapok	*Ceiba pentandra*	Seed Kernel	24-40	NE

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Mabai	*Pongamia pinnata*	Seed	27-39	NE
Rubber Seed	*Hevea brasiliensis*	Seed	40-50	NE
Lumbang	*Aleurites trisperma*	Seed Kernel	50-60	NE
Winged Bean	*Psophocarpus tetrag.*	Seed	15-20	E
Kelor	*Moringa oleifera*	Seed	30-49	E
Kusum	*Sleichera trijuga*	Seed Kernel	55-70	NE
Nyamplung	*Callophyllum inophyllum*	Seed Kernel	40-73	NE
Corail Tree	*Adenanthera pavonina*	Seed Kernel	14-28	E

Note : E= edible, NE = non edible

It is unfair to say that the deforestation in Indonesia is caused by burning the forest for palm plant development, however the palm plant has existed since the 70s and developed steadily, now has reaching 7,824,623 ha or about 7.5% from the total area of forestry. And companies that developed palm plants are mainly multinational companies while most of the excess production of crude palm oil or palm oil has been exported to other countries, such as counterparts in the European countries, etc. So it is not wrong for Indonesia to use this opportunity to take profit from a situation where many contries need palm oil as raw material for industry including biodiesel. In most cases, the biofuel feedstock crops are also food crops. This condition has created some conflict between the supply of food and the supply of energy.

2.2. Palm Oil Potecy As Biodiesel Feedstock

Indonesia as the largest producer of crude palm oil (CPO) or palm oil in the world has the potential to become a major biodiesel producer by utilizing CPO or palm oil as biodiesel feedstock.

As shown in table 2, the development of palm plant in Indonesia was started in 1967 with the area of 105,808 ha and the production only about 167,669 ton/year, where the Government through a state owned company and the private sector was also a main player. The production increased steadily year by year, and in 2009, the area of palm plant had reached about 7.8 million hectares with the total production about 18.6 million tonnes. Since 1979, small holders have also been involved to develop this business, and in fact their contribution has exceeded the contribution of the state owned company.

With production per hectare reaching about 15-20 ton/ha/year of palm seeds, it would produce about 4 tonnes palm oil per hectare per year. However considering the total area of palm plant is about 7.8 million hectares with a total production volume of about 19.8 million tonnes in 2010 (see table 1), this means the average productivity of palm seeds is only 2.54 tonnes per hectare, and it is still far from optimum efficiency.

World palm oil (CPO) consumption tends to increase steadily. The growth of palm oil demand increased in average about 9.92% in the last 5 years.(16) China and Indonesia and Eropean countries are the biggest consumers of palm oil in the world.(17)

Along with the increase of world consumption, the export of CPO also increased with an average growth about 11% in the last 5 years. Malaysia and Indonesia are the biggest exporters of CPO in the world, these two countries have dominated about 91% of palm oil market. Papua Nugini is the third largest producer, although its production only reached about 1.3% share oil market.(17,18)

Table 2. Area and Production of Palm plant in Indonesia(15)

Year	Area (Ha)				Production (tonnes)			
	Small holder	Government	Private	Total	Small holder	Government	Private	Total
1967	-	65,573	40,235	105,808	-	108,514	59,155	167,669
1979	3,125	176,408	81,406	260,939	760	438,756	201,724	641,240
1990	291,338	372,246	463,093	1,126,677	376,950	1,247,156	788,506	2,412,612
2000	1,166,758	588,125	2,403,19	4,158,07	1,905,653	1,460,954	3,633,90	7,000,508

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2005	2,356,895	529,854	2,567,068	5,453,817	4,500,769	1,449,254	5,911,592	11,861,615
2006	2,549,572	687,428	3,357,914	6,594,914	5,783,088	2,313,729	9,254,031	17,350,848
2007	2,752,172	606,248	3,408,416	6,766,836	6,358,389	2,117,035	9,189,301	17,664,725
2008	2,881,898	602,963	3,878,986	7,363,847	6,923,042	1,938,134	8,678,612	17,539,788
2009*	3,013,973	608,580	3,885,470	7,508,023	7,247,979	1,961,813	9,431,089	18,640,881
2010**	3,314,663	616,575	3,893,385	7,824,623	7,774,036	2,089,908	9,980,957	19,844,901

Some analysts predicted that the consumption and export of palm oil would continue to increase in the future, triggered by many factors, such as population growth, growth of downstream industry that uses palm oil as feedstock or additives, development of alternative energy, etc. Habibie identified that the domestic consumption of CPO is only about 5 million tonnes per year in 2009, while the rest is exported to several countries mainly European countries and China.[19]

By applying message from the Presidential Decree No. 5/2006, the development of renewable energy in Indonesia has to meet several purposes, such as mitigation of CO_2 emission, energy security, food security, job creation and poverty alleviation. This means that all potency have to be utilized to fulfil all the above purposes. Therefore the potency of palm oil production that has excess about 15 million tonnes per year must be utilized to produce biodiesel. This will create jobs and also reduce poverty.

In 2008, there were several biodiesel factories that have installed a capacity about 2 million tonnes per year, as shown in figure 3. The factories locate mainly in Sumatera and Java islands near to the sources of feedstock. All of these factories have used palm oil as feedstock. Table 3 shows fatty acid composition in several vegetable oils. Palm oil comprises of mainly palmitic acid (32-45%) which is saturated fatty acid and oleic aicd (38-52%) which is unsaturated fatty acid.[14] In Indonesia, the Centre for Palm Coco Research has successfully developed palm based biodiesel from CPO, refined bleached deodorised palm oil (RDPO) and other fractions such as stearine and olein. Palm fatty acid destilled (PFAD) that is a by-product from frying oil factory and waste frying oil from home industry can be utilized as feedstock for palm biodiesel[21].

Through esterification and transeterification processes, triglyceride and alcohol (methanol/ethanol), involves the catalytic conversion to ester and glycerol. The reaction of alcohol with fatty acids will form mono-alkyl ester or biodiesel and glycerol, if using methanol will produce methyl-ester and using ethanol will produce ethyl-ester with catalyst of NaOH, KOH or $NaOCN_3$.[22]

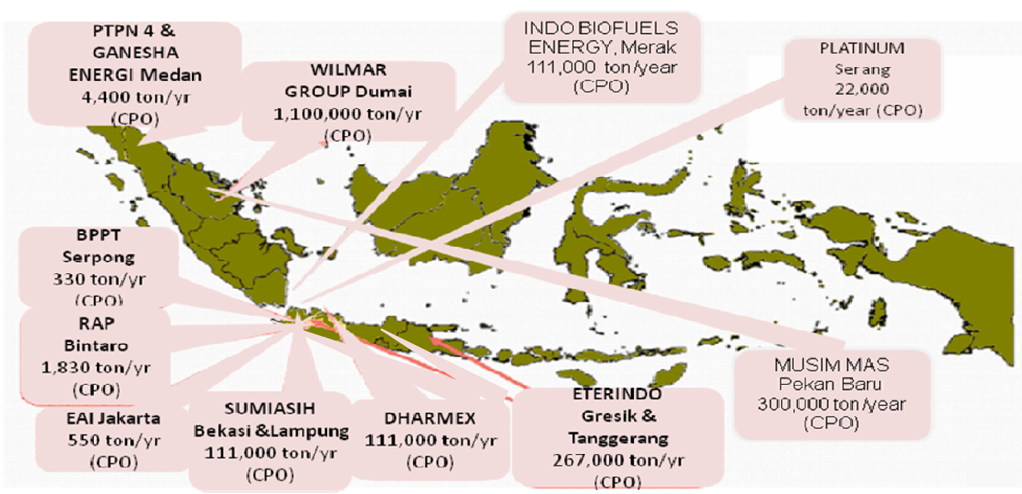

Figure 3. Installed Capacity for Biodiesel Production[6]

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(June 2008, capacity 2.029 million tonnes/year)

Table 3. Fatty Acids Compositions in Several Vegetable Oils(14)

Fatty Acids	Palm	Soybean	Rapeseed	Corn	Jatropha curcas*)
Pamitic acid (16:0)	32-45	7-11	1-3	8-12	12-17
Stearic Acid (18:0)	2-7	2-6	0.4-3.5	2-5	6.7
Oleic Acid (18:1)	38-52	15-33	12-24	19-49	37-63
Linoleic Acid (18:2)	5-11	43-56	12-16	34-62	19-41
Linolenic Acid (18:3)	-	5-11	7-10	-	-

Sources : Gerpen, 2004

*) Habibie, 2010[20)]

Gerpen said that full chemical conversion reaction of biodiesel methyl-ester is found from the reaction of fatty acids and methanol with the excess of methanol(14). He said in order to keep the reaction continuous and to completion, the use of excess of methanol in the process is necessary. And the transesterification reaction tends to slow down as the concentration of alcohol increases (methanol, ethanol, propanol).

After the transesterification reaction is completed, there are two main products in the mixture – these being biodiesel and glycerol with the presence of methanol and catalyst. Since glycerol separates from biodiesel, it is easy to separate by using centrifuge(21). After separation of glycerol and biodiesel, then the excess alcohol in biodiesel is removed by evaporation or distillation methods. It might be possible to remove alcohol first then separation of biodiesel and glycerol.(14)

To find the pure biodiesel, biodiesel is subjected to a further purification process by washing with hot water, although this step process is not necessary. End product of biodiesel is a clear liquid with light yellow colour and a viscosity not that dissimilar to petrodiesel. There are methods to produce less coloured biodiesel, one of them involves a distillation process.(23,21)

According to Widowati,(17) palm oil based biodiesel can be used in a mixture with conventional diesel fuel. When a 30 % blend of biodiesel and petroleum diesel (B30) is used as a substitute for diesel fuel to run diesel engine, the engine runs as well as using pure diesel fuel (B0) in term of its maximum power, torsion and petroleum diesel requirement. The treatment on wet and dry field showed that B30 seems also to be similar with B0 in term of its capacity, slip and petroleum diesel requirement.

The exhausted emissions from palm biodiesel are lower than regular diesel fuel, and this will contribute to less impact on global warming and pollution compared to diesel fuel.(17) The increasing content of biodiesel on mixture with diesel fuel will increase the reduction of net emissions of hydrocarbon (HC), carbon monoxide (CO), carbon dioxide (CO_2) and particulate emission compared to the regular diesel fuel.

2.3. Palm Oil Constraint As Biodiesel Feedstock

According to World Commission on Environment and Development (WCED), the environmentally sustainable development, there is a need for development to fulfil the need of the current generation without sacrificing the capability and the interest of future generations. The Round Table on Sustainable Palm Oil (RSPO) has launched the certification process of green label that put the commitment to protect rainforest and wild animal and to avoid conflict with indigenous community with respect to forests. Green groups and palm oil companies that comply with a request by RSPO can sell their certified products in the global market. In Malaysia, the second largest producer of palm oil, has already had four certification institutions approved by RSPO.

Indonesia, as the largest producer of palm oil in the world, has planned to apply clear measurements according to RSPO requirement in order palm oil companies to fulfil a strong standard requirement before giving their products with environment friendly label. This might be the solution to reduce the refusal of green groups to the products of palm oil from Indonesia.

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2.4. Future Development

Although the development of biofuel based palm oil in Indonesia has been based on the environment sustainable development program, many non-governmental organizations (NGOs) argue erroneously that palm oil companies do not meet the RSPO requirement yet. As palm oil is also edible oil, it may be difficult to be developed as biodiesel feedstock due to food security reason. However many researchers have been trying to develop second generation feedstock that are non-edible, such as calophyllum inophyllum, jatropha curcas, micro algae and ligno-cellulose. The availability and sustainability of sufficient supplies of less expensive feedstock will be a crucial point causing a competitive biodiesel to the commercials market. Fortunately, non-edible vegetable oils, mostly produced from fruit seed of trees and shrubs can provide alternatives. With no competing food uses, this characteristic turns attention to *Jatropha curcas*, which grows in tropical and subtropical climates across the developing world.(24,25)

2.4.1. Jaropha Based Biodiesel

In Indonesia, many species of plant can be utilized as biodiesel feedstock but *Jatropha curcas* has several advantages such as high yield of oils, easy to grow, growth in marginal land and its productive untill 50 years.

Jatropha curcas Linn or physic nut is a plant that has been familiar to local communities since the Japanese colonialism era. Jatropha oil has been used as lubricant and fuel for Japanese airplanes. In Indonesia, this plant has been used as a fence plant and for medicine and few for fuel and lubricants. Currently *Jatropha curcas* plant has spread throughout the world from Central America where jatropha originally came from to Africa and Asia. This faster spread of *Jatropha curcas* is due to the easy growth of this plant. According to Hambali(26), jatropha can grow in low land until high land, rainfall from low to high (300-2380 mm/year) and temperature range about 20-26^{0}C. With these characters, since *Jatropha curcas* is able to grow at land with more sands, stones and clay, so this plant can be developed for growth on marginal land.

The plant can also be used to prevent and to control erosion, to rehabilitate land, grown as a live fence, especially to contain or exclude farm animals and be planted as a commercial crop.(27) The fact that jatropha oil cannot be used for nutritional purposes without detoxification makes its use as energy or fuel source very attractive for biodiesel production.(28)

Jatropha curcas produces fruits (see figure 4) that consist of meatfruit, skin seed and core seed. Core seed is the component of the plant that is used to produce oil as feedstock for biodiesel. Oil content of the seed is between 30-50% of dry weight of the seeds(29). *Jatropha curcas* plant can produce seeds about 7.5 to 10 tonnes seeds per hectare per year depending on seed quality, agroclimate, fertility of land and maintenance during growing.(26)

Since the launching of Presidential Decree in 2006, the research and development on jatropha curcas has been prioritised as future feedstock for biodiesel production. In addition, many companies have built jatropha plantations in several locations around the Indonesian archipelago, see figure 5.

Figure 4. Fruit, Seeds and Cake of Jatropha Curcas

The area of jatropha plantation is expected to increase to about 1.5 million Ha in 2010.(6) The area used is mainly marginal land in Eastern Part of Indonesia, such as Sulawesi, East and West Nusa Tenggara. Some ex-mining areas will be used to grow *Jatropha curcas* in Java, Sumatera and Kalimantan. This might be solution to avoid the use of arable land for biodiesel production.

2.4.2. The Advantages Of Jatropha Curcas Linn

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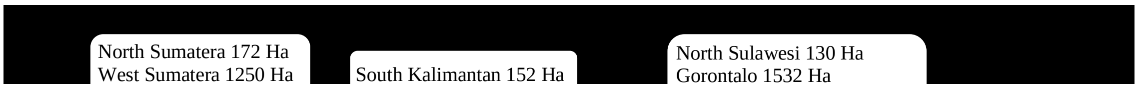
Many researchers have mentioned that Jatropha curcas L. is a future plant for biodiesel feedstock. Professor Reihard Henning, a pioneer in Jatropha, recently concluded that jatropha grown on marginal land will lead to an improvement of soil fertility and in a long term view to rehabilitation of the land.[30] It has also to be mentioned that jatropha can produce economic yield even under marginal conditions but with proper care. Jongschaap added that "marginal land" indicates areas with unsuitable conditions for crop production due to soil and climate constraints.[31,32] He indicates that jatropha grows on marginal land and can reach reasonable production if proper care is given to boost plant growth in the initial growth phases and maintain production by additional inputs. He added that at least 3-4 months with adequate growth conditions is needed to secure crop growth, flowering and ripening of seeds, and prolong water supply results in prolonged and continuous seed formation.



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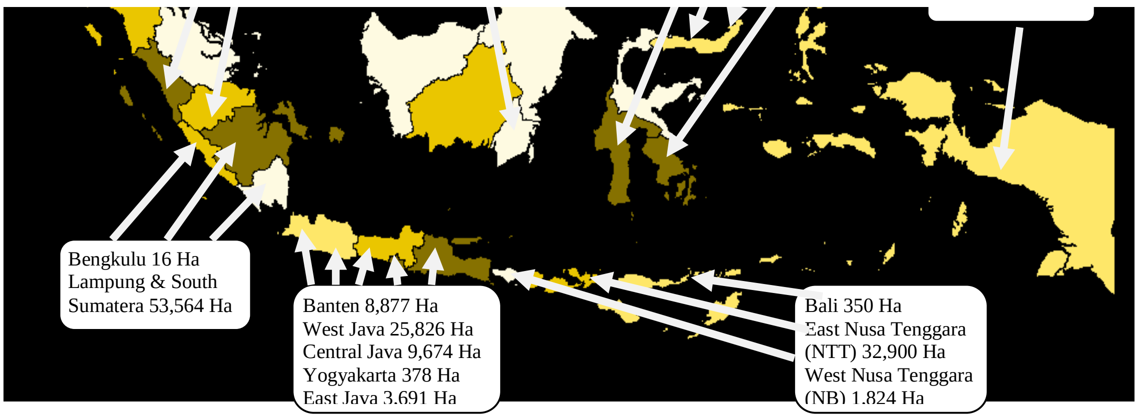

Figure 5. Land Utilization for Jatropha curcas
(Realization up to June 2008 = 151, 240 Ha)[6]

Jatropha is also resistant to drought and can be planted even in desert climates, and it thrives on any type of soil, grows almost anyware; in sandy, gravel and saline soils. Jatropha growth needs minimum input or management. However some researchers claim that jatropha will not produce high yields on marginal land, but it is a perfect plant to prevent soil from erosion and has the ability to rehabilitate the marginal land.

However jatropha will survive at 200 mm rainfall[33] and grows well with more than 600 mm rainfall rate.[34] Many things could be mentioned about the advantages of jatropha as it is an easy crop to grow, start yielding from the second year and obtain continuous yields for 50 years, producing seeds round the year if irrigated, but the important thing is that it does not influence food security. Beside the seeds for producing oil, jatropha leaf and bark can also be used for various industrial and pharmaceutical uses.

The cultivation of jatropha can also be carried out in massive scale because there is no difficulty on planting. There are several methods to propagate jatropha, such as by seeds, cutting and stem. According to Kale, jatropha can be planted at space 2x2m that is about 2,500 plants in one hectare and it will produce about 5 tons of seeds per hectare or about 1.5 tons of oil.[35] Manurung predicted

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optimisticly that the productivity of jatropha can reach up to 25 tons seed/ha/year, it means that oil production would be about 10 tons/ha/year. If this is realistic, then the cultivation of jatropha can be used to stimulate the economy of the villages farmers and more sustainable supply of oil.[36]

2.4.3. Supporting Technology

Technology for biodiesel production has been in existence for many years, such as Lurgi process, Conneman process, Campa process, etc.[37] In Indonesia, biodiesel factories have used existing technology from many countries. However, there are several institutions and engineering companies which have developed small scale biodiesel based process, such as LEMIGAS (Oil and Gas Institute), Bandung Institute of Technology (ITB), Agricultural Mechanization Research Centre, Bogor Institute of Agriculture, BPPT (Biotechnology Centre and Engineering Centre) and Centre for Plantation Research and Development. But they are mainly producing small scale batch process system. For example : ITB can produces biodiesel plant with capacity of 500 lt/day, PT Tracon Industri 500 lt/day, PT Pindad 500 lt/day, PT Energy Alternatif Indonesia 1.5 ton/day, BPPT 3 ton/day.[37]

The development of biodiesel process technology with higher capacity has become a challenge for Indonesian local institutions and engineering companies. It is hoped looking forward to the future will see many biodiesel factory standing with the local technology base.

2.4.5. "Energy Sufficient Villages" Project

Indonesia has more than 70,000 villages, and around 45% of them are catagorized as having fallen behind an acceptable community standard and are classified as poor. These "poor" villages have minimum infrastructure, high unemployment rate, and poor supporting facilities such as education, water sources, electricity and also the supply of fuels. Therefore, this condition has an impact to the food security and clean water supply.

Through the implementation of Development Program of Natural Fuel, Government started to support local government and communities to develop "Energy Sufficient Villages" (ESV) or "Desa Mandiri Energy" (DME in Indonesia).[38] Technically, ESV will be developed from upstream to downstream process in the villages. The activity in the upstream step will be cultivation of plant that is suitable for the village according to its agroclimate. However the activity in the downstream step will be focussed on the application of technology that could be reached out by local communities in term of vegetable oil production.

ESV is a job creation program to reduce the poverty in remote areas by supporting the capability of the community to meet its need for energy in their area. Therefore, one of the targets for this program is to release communities in remote area from the dependency on fossil fuel that is currently trending up, unacceptably in price. If communities in the villages can fulfill their energy need, it can be predicted that other economic activities will be activated. This will stimulate a trickle down effect to communities as the whole with a positive job creation impact, thereby reducing poverty. This condition will affect the reduction of urbanization of people to city due to availability of jobs in their local villages.

Therefore, in recent years several researchers have studied the use of vegetable oils as biodiesel fuel.[39] Furthermore, vegetable oil-based products hold great potential for stimulating rural economic development because farmers

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that would benefit from increased demand for vegetable oils. Various vegetable oils, including palm oil, soybean oil, sunflower oil, rapeseed oil, and canola oil have been used to produce biodiesel fuel and lubricants.[40] The wood and fruit of *Jatropha* can be used for numerous purposes including fuel. The seeds of *Jatropha* contain viscous oil, which can be used for manufacturing of candles and soap, in cosmetics industry, as a diesel/paraffin substitute or extender. This latter use has important implications for meeting the demand for rural energy services and also exploring practical substitutes for fossil fuels to counter greenhouse gas accumulation in the atmosphere. These characteristics along with its versatility make it of vital importance to developing countries.[41]

4. CONCLUSION

To meet the target of energy mix in 2025, the Indonesian Government has focused to develop bio-energy through the implementation of Presidential Instruction No 1, 2006 on the preparation and utilization of vegetable oil as biofuels. This policy should be followed by strong monitoring about not only the target in year but also the impact of the implementation of regulation. Currently the palm oil has been utilized as biodiesel feedstock due to its excess production and the availability of technology. In long term, the palm oil feedstock may have constraints, particularly competing with food uses and using arable land while growing.

Jatropha might be the only feedstock that is ready to be utilized as biodiesel feedstock in the future. It is non-edible oil, easy to grow even in very limit of water or grow in marginal land. It has high yield of oil (30-50%) and has high oil production for every hectare of growth, and it will produce seeds until 50 years old with minimum maintenance.

Regarding to the development of biodiesel in Indonesia, although Indonesia has many choices of feedstock, jatropha may well become a priority due to its easy to grow, ability to grow on marginal land and an ability to rehabilitate land in long-term. Therefore the Government has launched “Energy Sufficient Villages” Project that will focus the development of *Jatropha curcas* in remote area where there is a minimum availability of infrastructure, jobs, and supporting facilities such as education, water sources, electricity and also the supply of fuels. This project was started in 2006 and is expected to supply the need of fuel in villages, create jobs and grow the economy of villages. In the end it is hoped that this technology will increase the prosperity of people in remote areas, thus encouraging people to because of the availability of job in the villages.

In term of the future development, it is expected that the development of biodiesel based jatropha oil will start from those villages and will spread to other villages and become the main supply of biodiesel in district and in city. However this situation will only be achieved by serious and genuine implementation of the program.

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