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Policy Analysis: Solar Substitution with Biodiesel

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Abstract

Industrial development and use of biodiesel in Indonesia is currently hampered by the cost of biodiesel for export opportunities. Manufacturers prefer to export biodiesel at a better price than selling in the country. The approach used in this research is qualitative. This study has produced a system dynamics models the behavior of the biodiesel industry in Indonesia. With this model, a formulated policies and strategies can be tested through simulation run that will show or predict system behavior biodiesel industry into the future. By formulating policies and strategies in various scenarios, each of which will give the results of system behavior biodiesel industry in the future, can be selected as optimal policy formulation strategy, in the sense of providing the most appropriate behavior with the desired behavior of the biodiesel industry.

Perkembangan industri dan penggunaan biodiesel di Indonesia saat ini terhambat oleh biaya peluang biodiesel untuk ekspor. Produsen lebih suka mengekspor biodiesel dengan harga yang lebih baik daripada menjual di dalam negeri. Penelitian ini menggunakan pendekatan kualitatif. Penelitian ini menghasilkan model sistem dinamik perilaku industri biodiesel di Indonesia. Dengan model ini, kebijakan dan strategi yang dirumuskan dapat diuji melalui simulasi yang akan menunjukkan atau memprediksi perilaku sistem industri biodiesel ke masa depan. Dengan merumuskan kebijakan dan strategi dalam berbagai skenario, yang masing-masing akan memberikan hasil perilaku sistem industri biodiesel di

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masa depan, dapat dipilih strategi perumusan kebijakan yang optimal, dalam arti memberikan perilaku yang paling tepat dengan perilaku yang diinginkan dari industri biodiesel.

Introduction

Energy is a necessity that cannot be separated from human life. Energy has a very important role in social, economic and environmental (E. Bjorndal et al, 2010). The world's energy consumption is still dominated by fossil fuels, such as oil, natural gas, and coal (Topal, 2009). The use of oil has increased from year to year, resulting in the fossil fuel reserves disappear from the face of the earth about 35 years (Topal, 2009).

In Indonesia, the reserves of petroleum fuels continue to decline 10% per year (Bambang, 2006) with an average increase of oil consumption of 6% per year (Suroso, 2005). If there is no oil field discovery and exploration of new oil reserves estimated to be only sufficient to meet consumption needs until the year 2053 (Kuncahyo et al, 2013). Currently oil and gas still dominate the domestic energy market, a greater dependence on the type of renewable energy that does not make the national energy security fragile, so that diversification of energy is becoming more crucial to increase the resilience of the national economy.

Energy consumption is correlated with economic growth (Shahbaz, 2013; Sadorsky, 2013; Bloch, 2012) is very strong, the increase in economic activity is usually followed by increased energy consumption (Huang, 2008). Based on the official news BPS 2016 economic growth in Indonesia increased by 5:06% per year resulting in the growth of energy consumption increased by 6.62%. Such relationships can be defined that changes in the growth of energy consumption because of changes in economic activity.

The use of fuel oil has always increased with increasing vehicle population is rapidly increasing. For that reason, a lot of research on the use of non-petroleum fuels that can be updated (Weitemeyer, 2014; Ahmad, 2014; Bhattacharya et al, 2012). In addition to the dwindling availability, alternative fuels should be considered to minimize damage to the global environment due to emissions of fuel oil (Shafiullah et al, 2012; Sharafi et al, 2014).

To overcome the scarcity of energy needed an alternative energy or renewable energy that can meet and replace energy derived from fossil fuels, one of which is a biomass energy (Manan et al, 2012). Biomass energy is categorized as one of the future energy (Batidzirai, 2013; Nielsen, 2013) because this energy is environmentally friendly (Gandhi, 2013).

The production of biodiesel from palm oil has become an interesting research topic for researchers to find new alternative resources for conventional transport fuels (Remschmidt 2006; Malero, 2010). Biodiesel is a biofuel biodiesel energy manifold and is like diesel fuel, so that biodiesel can replace diesel fuel in transport and power generation (Demirbas, 2007; Stephenson, 2008). Biodiesel resources widely available in Indonesia and Malaysia. However, biodiesel energy utilization in Indonesia is still lagging Malaysia, the Philippines, and Thailand.

Table 1 Top 10 Countries in Terms of Biodiesel Potential

Rank	Country	Biodiesel potential (ML)	Production ($/L)
1	Malaysia	14,540	0.53
2	Indonesia	7595	0.49
3	Argentina	5255	0.62
4	USA	3212	0.70
5	Brazil	2567	0.62
6	Netherlands	2496	0.75
7	Germany	2024	0.79
8	Philippines	1234	0.53
9	Belgium	1213	0.78
10	Spain	1073	1.71

Source: (Etabani, 2012)

Indonesia as the country second in the world that has the potential of biodiesel, but the ability to produce them are at the level of the lowest (Table 1). Seeing the importance of energy and support resources available biodiesel in Indonesia, the research focuses on the development, role, and policy constraints associated with biodiesel.

Literature Review

Crude Palm Oil (CPO) and Energy Biodiesel

Biodiesel is a fuel that is a growing concern in line with the depletion of oil resources. Biodiesel is a fuel that is a growing concern in line with the depletion of oil resources. Renewable energy is derived from vegetable oils and animal fats through a transesterification process between fat with alcohol monohydrate (Meher, 2006). The use of vegetable oil as an alternative fuel has been discovered 100 years ago, by Rudolph Diesel, with peanut oil as an ingredient testing ignition (Shay, 1993).

Plant oils typically contain free fatty acids, phospholipids, sterols, water, and other impurities odourants (Murugesan, 2009). To use it required chemical modification mainly pyrolysis and transesterification emulsification (Demirbas, 2005; Meher, 2006; Gandhi, 2013). Transesterification is the primary process to produce clean fuel and environmentally friendly (Gandhi, 2013). Biodiesel from vegetable or algal oil in combination with alcohol is usually methanol or ethanol (Leung, 2010) so that it can be classified as homogeneous or heterogeneous catalysts (Ellis, 2010).

Biodiesel is the monoalkyl esters of long chain fatty acids derived from renewable feedstocks, such as vegetable oils or animal fats, for use in compression ignition engines. Biodiesel, which is considered as a possible substitute for conventional diesel fuels generally, composed of fatty acid methyl esters that can be made from the triglycerides in vegetable oils by transesterification with methanol. Biodiesel produced quite like conventional diesel fuel in its main characteristics (Meher, 2006).

Soybean oil as a raw material to produce biodiesel contains fatty acids that palmitic acid, oleic acid and linolenic acid, linoleic acid, and stearic acid (Briggs et al, 2008). Moreover, according to some studies, biodiesel can be produced with the use of Crude Palm Oil (Malero et al, 2010; Benjumea et al, 2008; Bari et al, 2002).

CPO is one of the vegetable oils that have the potential to be used as fuel for diesel engines. As a form of renewable energy that is safe and easy to handle although at room temperature (30-32 ° C) has a viscosity of about 10 times higher than diesel (Bari, 2002). CPO has a high viscosity, causing blockage in the fuel lines, filters and injectors (Williams et al, 1990). The high viscosity led to weak fuel atomization spray, surgery is less accurate and deposition of fuel (Masjuki, 2012), thereby reducing the cone angle of the spray and droplet diameter and narrowing penetration (Pandey et al, 2012).

Indonesia has the potential to develop biodiesel because it has the resources enormous palm. Indonesia as the world's number one producer with a production of 25.20 million tonnes in 2011 and amounted to 27.25 million tons in 2012. The installed capacity to produce biofuels from crude palm oil (CPO) amounting to 4.5 million kiloliters, but produced new 2.5 million kilo liters. Of the production, as many as 1.5 million liters exported and 1 million liters of rest for domestic consumption. There remains much as 2 million kiloliters of biofuel which has not been utilized.

National energy policy is targeting in 2025 the use of energy from biofuels is expected to reach 5%, equivalent to 4.7 million kiloliters. These rates are like 22:26 million kiloliters of biofuel, biodiesel supply at 10:22 million kiloliters.

CPO can be processed into biodiesel and foodstuffs (non-biodiesel) such as cooking oil, butter, and other benefits (Dumont et al, 2015). To be a biodiesel fuel that can be mixed with diesel oil with a certain ratio for commercial diesel vehicles (Rokapolos et al, 2008). Biodiesel can also be used as boiler fuel power plants (Swayama, 2005; Kadam, 2002). Besides, the export market is currently very promising biodiesel.

Distillation is done for cleaning and deodorizing through the process refined, bleached and deodorized palm oil (RBDPO), later described again become dense palm oil and palm oil production of liquid (Santori, 2012). Overall the palm oil refining process that can produce 73% olein, stearin 21%, 5% PFAD (palm fatty acid distillate) and 0.5% effluent. The transesterification process of oil refining and oil refined into biodiesel process was successful and resulted in mass conversion efficiency of 75% and 78% energy conversion efficiency (Kongkasawan, 2012).

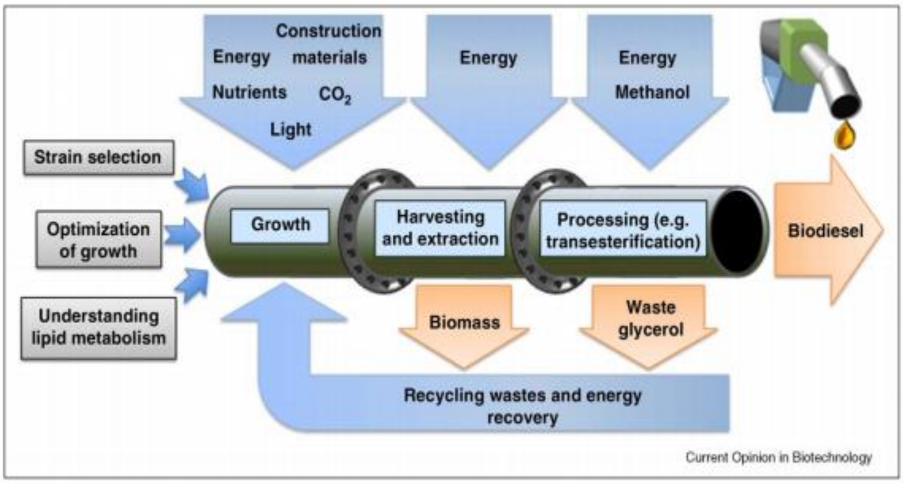

Figure 1. Algal biofuel pipeline, showing the major stages in the process, together with the inputs and outputs that must be taken into consideration by life-cycle analysis (Scott, 2010)

Biodiesel has several advantages including low carbon dioxide is emitted (Rakopoulos, 2008) and a high cetane number (Crookers, 2006). Cetane number indicates the size of the delay time of combustion of fuel (fuel ignition), where the figure higher cetane number indicates a shorter time between the entry of fuel and combustion.

Biodiesel produces less carbon monoxide at 100% combustion and emissions of sulfur dioxide and hydrocarbons burn completely so as biodiesel capable of reducing air pollution (Gandhi, 2013). For pure biodiesel (B100) its CO2 emissions could be reduced by up to 73%, the methane emissions reduced by 51%, unburned hydrocarbons reduced by 67%, emissions of carbon monoxide down 48% and sulfur oxides can be reduced up to 100% and the reduction of waste and potential pollution other environments.

Biodiesel has a higher burning point than petroleum diesel so it is relatively more secure, because it is not flammable due to a lower pressure. Lubricating power of biodiesel is better for very low sulfur content (EPA, 2006). Another advantage of biodiesel is degraded and renewable by nature, and can extend engine life.

Research Method

The approach used in this research is qualitative, i.e. a process of research and understanding based on a methodology that investigates a phenomenon of social and human problems. Qualitative research is one method for getting at the truth and classified as scientific research built on the theories that developed from research and controlled based on empirical. Thus, in this qualitative study not only shows data as it is but also seeks to interpret a correlation as a factor that is applicable include viewpoints or ongoing processes. Moleong (2012) states that qualitative research method is based on a foundation of research, the research paradigm, research question, the stages of research, research techniques, criteria and inspection techniques of data as well as analysis and interpretation of data. The research methodology for achievement in the utilization and use of biodiesel as in figure 2 below.

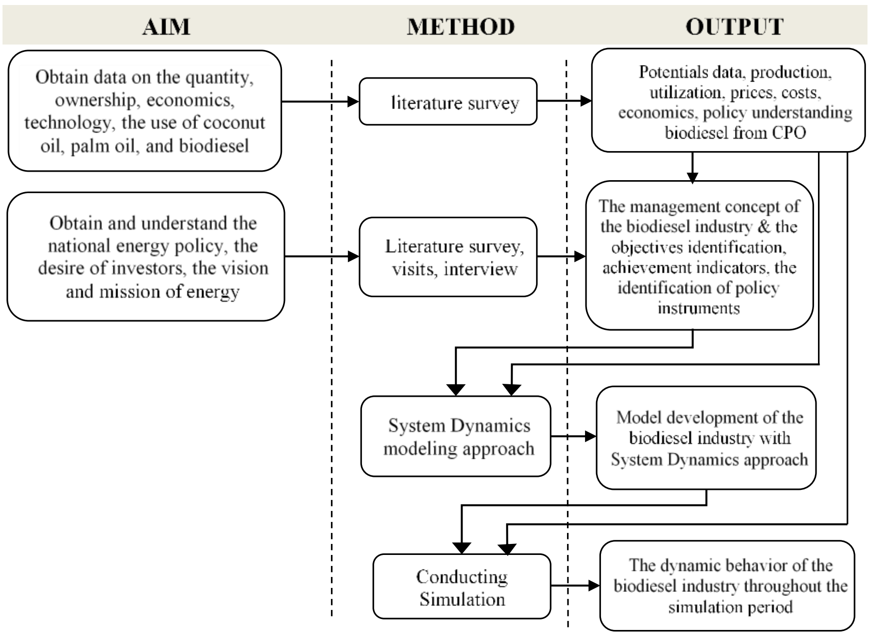

Figure 2. The framework

To gather the necessary data, then made visits to agencies such as the data source: a) Government Institutions: EBTKE, Research and Energy, Director General of Agro Industry, BPPT (Serpong); b) Companies (Pertamina, Wilmar Group, Sinar Mas); c) c. Biodiesel Association, and Indonesian Renewable Energy Society; and d) Research Institute (UI, ITB). In this research to obtain valid data, it is obtained through a. Deployment, spacious and ownership of oil palm plantations, CPO mills and biodiesel plants; b. Statistics of production and utilization of BTS, palm oil, biodiesel and diesel oil; c. The development plan CPO mill and biodiesel by the company; d. Government policy towards biodiesel; e. Barriers to the development of the biodiesel industry; f. The demographic data, economic Dumai city and its surroundings.

Result and Discussion

Biodiesel development in Indonesia

Biodiesel as an alternative fuel is important in the energy crisis. In 2005, demand for solar energy and kerosene reached 42 million kiloliters, or 65% of total consumption of petroleum annually. In 2005-2007, the consumption of diesel oil in Indonesia has reached around 13 million tons per year. Two percent of the diesel oil consumption in 2007 biodiesel derived from palm oil and castor oil.

The Indonesian government has predicted that by 2025, biofuels are expected to contribute at least 5% of National Energy Mix. As a medium-term goal, by 2010 biofuels target take on a partial source of household energy and commercial sectors, transport and power generation sectors and the role of biofuels will replace fossil oil. Other policies issued by the government in support of energy policy is the Presidential Decree (Decree) No. 5/2006 on National Energy Policy and then followed up by Minister of Energy and Mineral Resources No. 32 Year 2008 concerning Supply, Utilization and Administration of Commerce Biofuels (Biofuel) as an alternative fuel. Then to support increased biodiesel production capacity for biodiesel industry.

PPKS noted that prices of palm oil biodiesel Rp5.700 / l, with the CPO price level of US $ 375-US $ 400 per ton. Meanwhile, the price of diesel for industrial Rp5.500 / l. The government continues to promote the use of biodiesel. Along with these efforts, some companies have invested into the biodiesel industry. The government itself had planned to build four biodiesel plants in Kalimantan and Sumatra, which will produce 6,000 tons of biodiesel per year with an investment of 300 billion. Per BPPT, producing biodiesel from palm oil requires additional new area of 600,000 ha.

In a way, the development of the biodiesel industry is facing various challenges. This time investment is constrained by high prices of raw materials (CPO), weakening the price of biodiesel in the international market, and their export levies 2%. To overcome the challenges and obstacles in the development and production of biodiesel, the government published a policy of Presidential Decree No. 45 of 2009 on the Supply and Distribution Specific Fuel Type which is a revision of Presidential Decree No. 71 of 2005 governing the granting of subsidies on biofuels which is one of Indonesia's efforts to increase the use of biodiesel through the provision of subsidized biodiesel.

Table 2 Sources of Bioenergy in Indonesia

Plant	Land (HA)	Productivity (Ton/HA)	Biodiesel potential (kl)
Palm Oil	8,036,000	3.6 – 4.0	31,914,475
Coconut	3,807,000	0.2 – 0.5	4,076,116
Castor Oil	39,000	0.5 – 1.0	39,222
Hazelnut Oil	1,400	14.85	21,029
Total			**36,050,842**

Source: Ministry of Industry, 2010

Ministry of Industry said that in 2010 the amount of palm oil is the most extensive in Riau mainland is more than 1.3 million hectares. Although the use of biodiesel in Indonesia is still limited, it turns out the private sector has seen an exciting prospect in the biodiesel industry. Some companies acquire land for oil palm trees that produce palm oil as a source of raw material for biodiesel.

Dynamics Model Systems

To obtain the production system model framework biodiesel industry to determine the relationship and influence of one variable by variable, has described a model as follows.

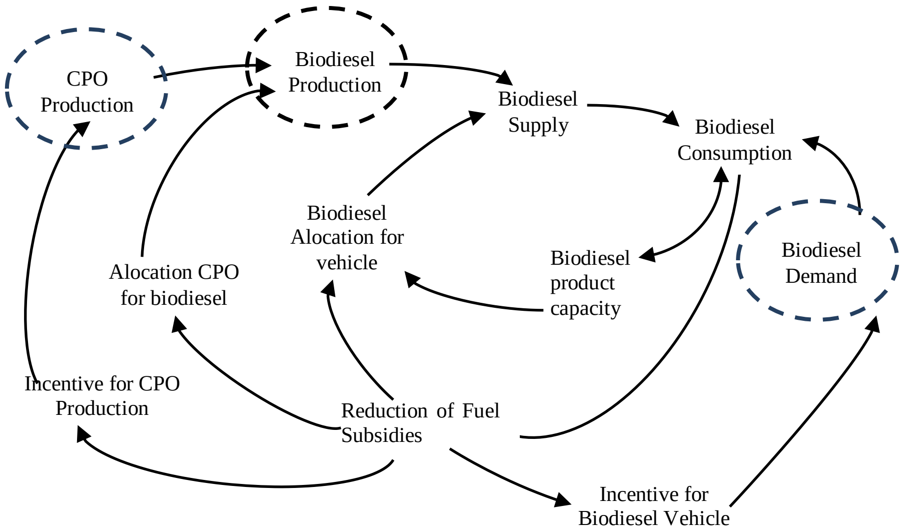

Figure 3. Model Production System of The Biodiesel Industry

CPO Production Model

Biodiesel production chain begins one of the palm trees produce TBS, then further processed into palm oil and processed again into biodiesel. Biodiesel production system represented by the model as shown in Figure 4 below. Fulfillment of biodiesel in the country a top priority. CPO is required fulfilled DMO (domestic market obligation) CPO producers, which in this study assigned 10% of the production of CPO with compensation worth 60% of the price of palm oil exports. CPO-DMO is processed into biodiesel with the applicable fees (e.g. IDR 1000 / liter) (see figure 5). If the biodiesel demand for transport is still higher than the biodiesel derived from CPO-DMO, shortcomings purchased by the Government with the market price of biodiesel. Cost of procurement of biodiesel by the Government is the number of purchases of CPO-DMO and processing into biodiesel and biodiesel shortage purchases (figure 6).

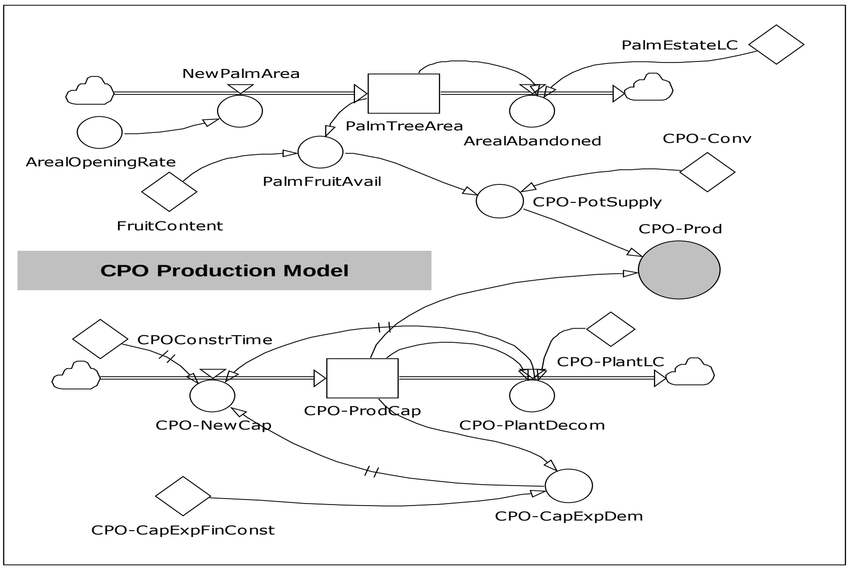

Figure 4. CPO Production Model

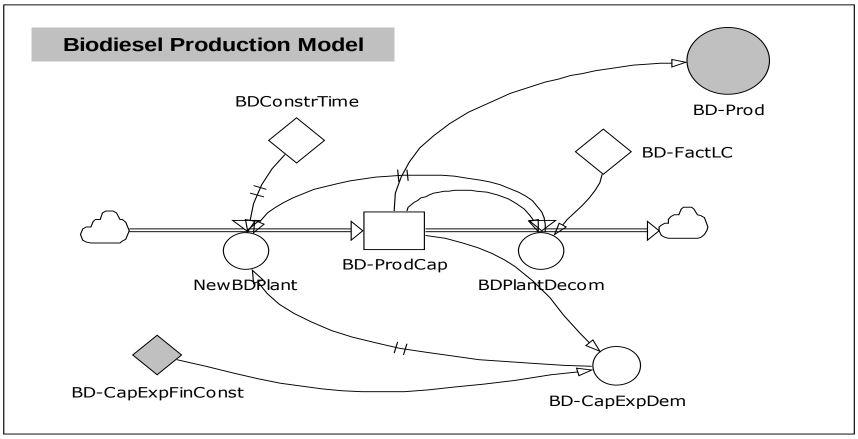

Figure 5. Biodiesel Production Model from CPO

Areal Abandoned	=	Reduction extensive palm gardens (ha / year)
CPO CapExpDem	=	CPO plant capacity expansion Demand (Tons / year)
CPO-CapExp FinConst	=	Max additional new plant due to funding limitations (tons / year)
CPO Constr Tim	=	CPO plant construction time (years)
CPO-Conv	=	Converting from oil palm fruit into palm oil (CPO ton / ton FFB)
CPO-NewCap	=	Additional production capacity (tons / year)
CPO-PotSupply	=	CPO supply potential (Tons / year)
CPO-ProdCap	=	CPO production capacity (tons / year)
CPO-Plant Decom	=	Reduction of production capacity (tons / year)
CPO-Plant LC	=	CPO plant life cycle (years)
Fruit content	=	Palm fruit yields per spacious gardens (Ton / ha / year)
New Palm Area	=	Extra spacious palm garden (ha / year)
Palm Estate LC	=	oil palm plantation age (years)
Palm Fruit Avail	=	Availability of palm fruit (Tons / year)
Palm TreeArea	=	Extensive oil palm plantations (ha)

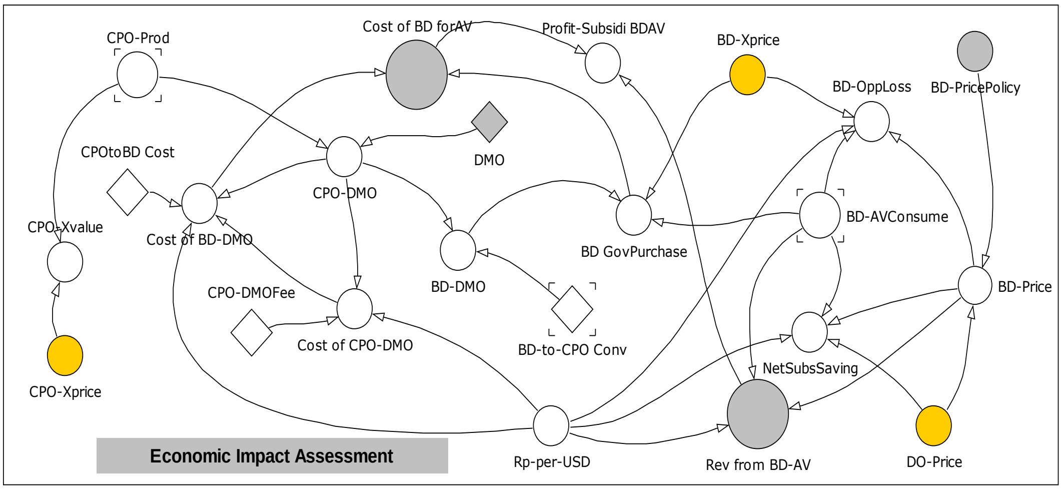

Figure 6. Model of Business Economics of Biodiesel.

Economic benefits Use Biodiesel

In this study, will be the effect of the application of the policy of oil substitution of diesel with biodiesel through a mixing mechanism, namely mixing biodiesel into diesel fuel that has been used in diesel-powered vehicles, gradually. The basic scenario is to add as much as 5% by volume of biodiesel starting next year for 2 years, then raised to 20% in the next 2 years, and the start of the following year to 5 mixture of biodiesel and diesel is 50-50 (This scenario is shown in figure 7).

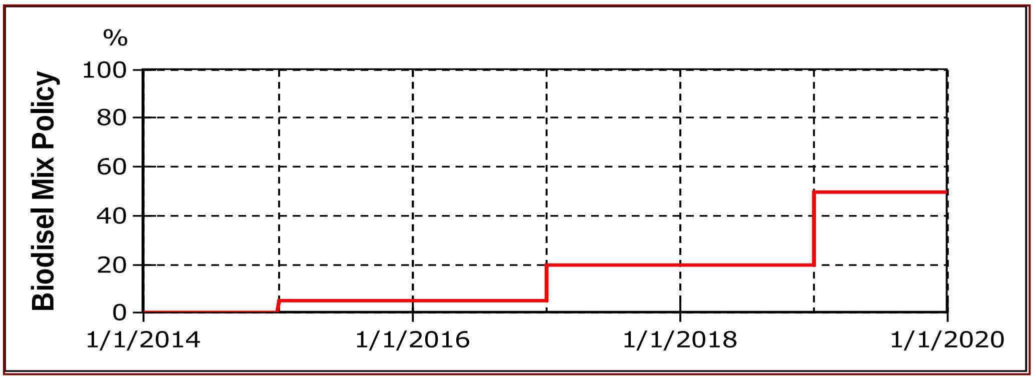

Figure 7. Scenario Basic scheduling mixing biodiesel and diesel

The simulation results, shown in Figure 8, showing the demand for biodiesel to increase in line with growth in the number of users of diesel vehicles. In 2017 biodiesel demand soared for policies to raise to 20% biodiesel blends, as well as a surge in 2019 with the addition of biodiesel to 50%.

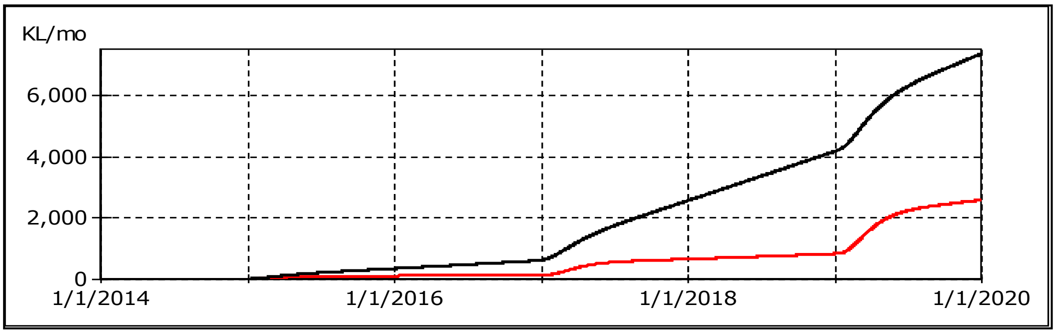

Figure 8. Demand biodiesel for transport

Biodiesel is mixed with diesel oil for diesel engine vehicles derived from processing the oil obtained from the DMO (amounting to 10% of production with a reimbursement of 60% of the export price) and its shortcomings are covered through the purchase of biodiesel to the market price. Biodiesel is then sold at a subsidized price lower than the market price (export). It turns spending a bit bigger than the reception as shown in Figure 9 below. This deficit indicates the subsidy given to the use of biodiesel in the transport sector.

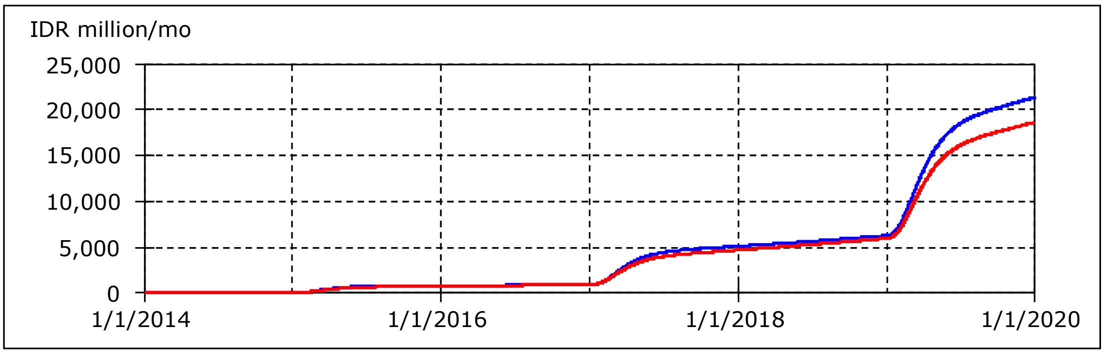

Figure 9. Income and expenses biodiesel project

Every liter of biodiesel use will replace imports of diesel in equal amounts; meaning that the greater use of biodiesel, the greater the savings over diesel subsidy. Figure 10 shows the solar subsidy savings resulting from the use of biodiesel in diesel vehicles. If the biodiesel subsidies are considered, the net profit obtained from the use of biodiesel.

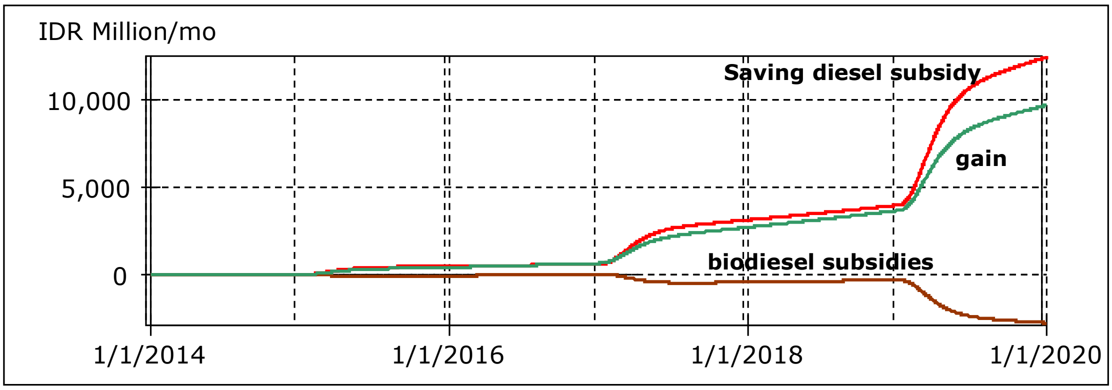

Figure 10. Subsidies biodiesel, diesel subsidy savings, and net gain

Accumulated net profit from the use of biodiesel during the simulation period 2014 - 2020 is shown in Figure 11.

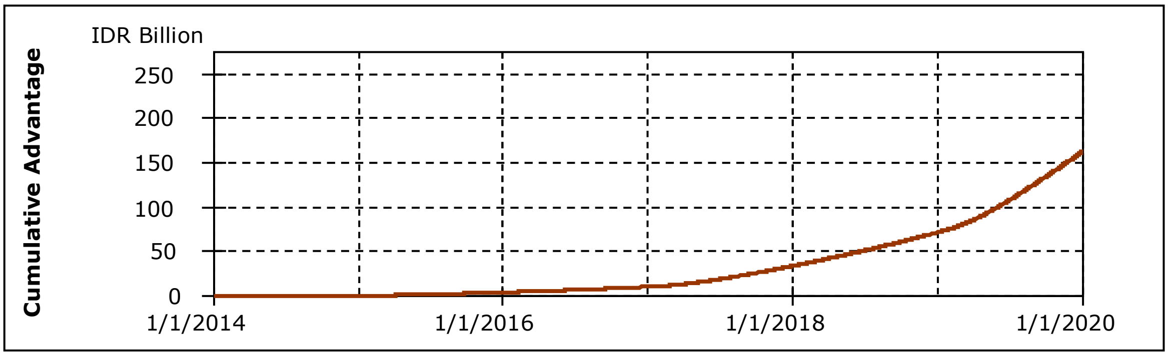

Figure 11. Cumulative Gains

Effect of Application Time Use of Biodiesel

In this study examined the effect of time of application of biodiesel usage policy in the transport sector. Submitted 1 year time schedule as shown in Figure 12 below. Scenario "Early" represents the application of the use of biodiesel one year earlier than the Basic scenario.

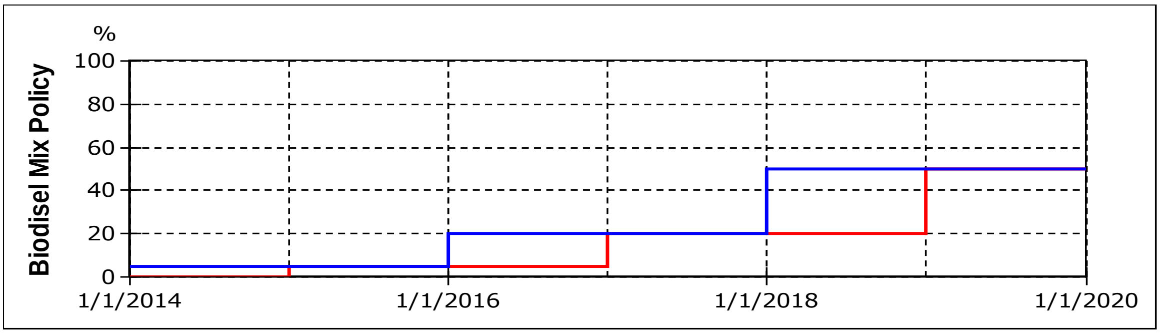

Figure 12. Basic Scenario and Scenario "Early"

Scenario "Early" provides cumulative gains outweigh the Basic scenario. It is easy to understand because the slower the policy is applied, gain opportunity to be delayed (see figure 13).

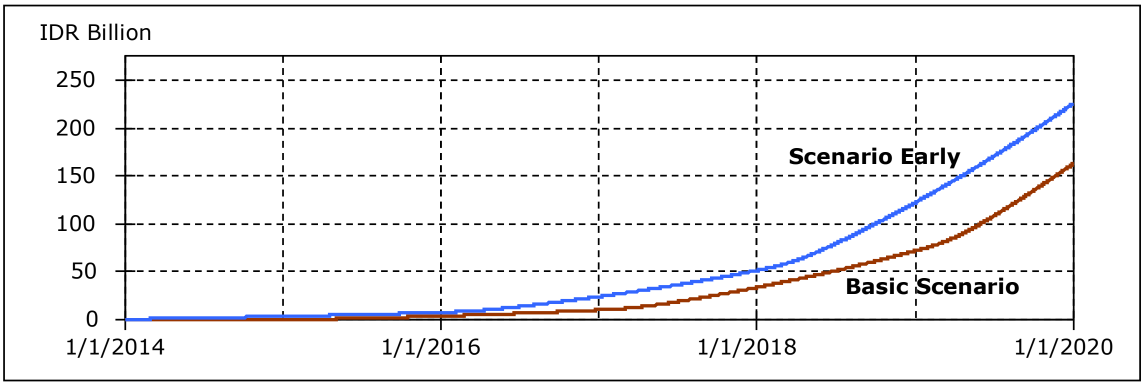

Figure 13. Cumulative Advantage and Basic Scenario "Early"

Conclusion

Biodiesel has the potential of strengthening national energy security due to the availability of resources abundant palm trees in Indonesia. Development and use of biodiesel industry in Indonesia currently constrained by opportunity cost of biodiesel for export. Manufacturers prefer exporting biodiesel at a better price than selling in the country.

On the domestic biodiesel used as a mixture of diesel oil in a minor percentage of 5%. Pertamina as the purchaser of biodiesel must be losers because it sells at prices below the cost of purchase. Besides, biodiesel face the competition get a supply of CPO by another user, for example for food (cooking oil, butter) or cosmetic ingredients.

This study has produced a computer program that models the behavior of the biodiesel industry in Indonesia. With this program, a policy and strategy formulated can be tested through simulation run that will show the predicted behavior of the system or the biodiesel industry into the future.

By formulating various policy scenarios and strategies, each of which will give the results of system behavior biodiesel industry in the future, may be selected formulation of policies and strategies are optimal, in the sense of providing the most appropriate behavior with the behavior desired biodiesel industry.

By using the program, obtained the policies and strategies that support the strengthening of the biodiesel industry which transfer the purchase of imported diesel oil to biodiesel production in the country of purchase. This means that subsidies given to the use of diesel fuel were transferred to the use of biodiesel. In this study is used as a biodiesel mixture of diesel oil in the road transport sector by 5%.

Recommendation

The government should divert some subsidized diesel to biodiesel. Purchases of imported diesel oil at market prices just to increase supply to meet the needs, while the purchase of biodiesel were produced in the country in addition to increase supply and strengthen energy security will also provide multiplier and spillover effects on the national economy.

Model biodiesel industry developed in this study need to be further developed to include the impact of the development of the biodiesel industry in the macro outlook, the multiplier and spillover effects such as growth of the industry and support activities, the creation of employment, and of course the tax revenues which are important factors for national development.

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