Financial engineering to promote renewable energy in Indonesia: Case study bioethanol

Purwoko
1 Senior Researcher, Ministry of Finance, Jakarta, Indonesia
E-mail: denmase.purwoko@gmail.com, purwoko@fiskal.depkeu.go.id

Abstract. In line with the improving economy, fuel consumption in Indonesia is increasing. Unfortunately, the production of fossil-based fuels is declining, and oil reserves are running low. If there is no serious effort from the government, it is predicted that national energy security will be disrupted. The government has set up an energy mix policy, with targets such as reducing the consumption of fossil fuels and increasing the consumption of renewable fuels, including bioethanol. Government program on bioethanol is currently unworkable, since its cost of production is more expensive than the price of fossil fuels. This study aims to find policies to encourage the bioethanol production. This study uses secondary data analyzed by the qualitative descriptive approach.

The results of this study indicate that financial engineering can be used by the Government to accelerate the bioethanol programs, by using excise tax and subsidies as instruments. Excise tax for fossil fuel will increase prices, and are expected to reduce the consumption of fossil fuels. The excise revenue can be earmarked to provide subsidies for bioethanol producers. This policy will make the bioethanol production cost lower and is expected to attract producers to produce bioethanol.

1. Introduction
Indonesian fuel consumption continues to increase in line with the increasing number of motor vehicles. There are at least two factors that trigger the increasing number of vehicles in Indonesia. First, the number of population continues to increase from year to year. Secondly, Indonesia's economy grew at around 5% in the last decade, increasing people's purchasing power. As a consequence, the number of people who can afford to buy motor vehicles also increases.

The Special Unit for Upstream Oil and Gas Business Activities (SKK Migas), as quoted in Warta Ekonomi daily (2017), reports that the national fuel consumption in 2017 reached 1.6 million barrels per day. Meanwhile, production capability reached only 0.834 million barrels per day. Consumption deficit of 0.766 barrel per day is filled with imported fuel [1]. The decline in fuel production in Indonesia is due to the declining production capacity of existing oil wells. Meanwhile, the discovery of new oil wells is rarely to happen, in line with the declining new investment in the oil and gas sector.

Recognizing that fuel scarcity could threaten national energy security, in 2006 the government has created a national energy policy roadmap, setting the energy mix target for 2025, which includes petroleum, gas, coal and renewable energy. There are several types of renewable energy referred to in the national energy mix, such as geothermal energy, biofuel, hydropower, solar power, wind power and
sea wave power. The biofuel consists of biodiesel for diesel engines and bioethanol for gasoline-based engines.

The government realizes that it is not easy to achieve the targeted energy mix in 2025. In 2006, fossil fuel was subsidized by the government. Meanwhile, renewable energy has not attractive to the investors, because prices for consumers, which is set by the government, are far below the cost of producing renewable energy.

In the era of President Joko Widodo's administration, fossil fuel subsidies have been reduced gradually, which has made the price of fossil fuels slightly increased. However, the cost of renewable energy production is still higher than the selling price of fossil fuels.

At present, biodiesel is available on the market, because the price of biodiesel products is subsidized by the government. Funds for subsidies are collected from export levies for CPO. The funds are managed by the Palm Oil Plantation Fund Management Agency, an independent institution under the control of the government. Meanwhile, bioethanol is not available on the market yet, because the cost of production is still too high for consumers, and there are no subsidies available for bioethanol products.

The use of bioethanol in renewable energy program has a strategic role for the Indonesian economy. Besides being able to push related sectors upstream, this policy will also reduce dependence on imported fossil fuel, and strengthen the country's foreign exchange reserves. The main issue to be discussed in this study is what kind of policies can be implemented by the Government to encourage the use of renewable energy, particularly bioethanol.

2. Research Methodology

The data used in this study is secondary data, obtained from several parties through a focused group discussion and literature study, both from printed and online media. The analysis is done by qualitative descriptive approach, which aims to analyze and interpret data descriptively and formulate conclusions based on existing data analysis. According to Moleong, qualitative research put more emphasis on process aspect than on output [2]. This causes the relationship between the sections being studied to be clearer if examined in the process.

3. Literature Review

3.1. Indonesia's Fuel Production and Consumption Growth

At the beginning of its independence, Indonesia was known as an oil producing country. Oil production was abundant, while the number of vehicles was not so much, so oil consumption was relatively low. At that time Indonesia was known as one of the oil exporting countries. At its peak, during the era of President Suharto, Indonesia's Minister of Mining once held the post of OPEC Chairman, the Association of Petroleum Exporting Countries.

Oil has been a major source of government revenue in financing the state budget. Oil production and exports were carried out on a large scale. But over time, the country's development process continues and domestic fuel needs are increasing. As non-renewable energy resources, continuous oil mining makes petroleum production decreases and petroleum reserves depleted. The climax occurred in 2004 when domestic oil consumption exceeded domestic production. As seen in figure 1, the gap between oil production and consumption widened over time.
Since 2004, Indonesia's dependence on imported fossil fuel has been higher and higher. If this situation continues, national energy security may become weaker. In order to maintain national energy security, the government needs to reduce the use of fossil fuel, and encourage the use of biofuel as a replacement. This policy will reduce the volume of fossil fuel imports, as well as create economic value added from community activities to produce biofuels.

3.2. Energy Mix Policy
In order to achieve long-term energy security, the government needs to determine the direction of the national energy policy. Some of the considerations underlying the need for a national energy policy includes:

- Fossil energy production is declining, while energy demand is increasing;
- The fossil fuel reserves are running low, therefore fossil energy needs to be used efficiently;
- The need for the government to pay attention to environmental sustainability;
- The need for the government to develop domestic capability in national energy management, including technological capability, human resources, and funding
- Increasing the role of communities in national energy supply;
- Increasing the role of alternative energy as part of the national energy supply.

In order to realize the national energy security, the government has issued Perpres no. 5 of 2006 on National Energy Policy. In this policy, the Government has set targets in 2025, among others:

- Achieving energy consumption per capita of at least 10 Equivalent Barrel Oil (Setara Barrel Minyak/SBM);
- Achieving the electrification ratio of 95%);
- Achieving less than one energy elasticity;
- Establishment of the optimal primary energy mix by 2025, with the following proportions:
  - Petroleum is lowered to a maximum of 20%
  - Natural gas is increased to a minimum of 30%
  - Coal is increased to a maximum of 33%
  - Geothermal is increased to a minimum of 5%
  - Biofuels increased to a minimum of 5%
  - Other new renewable energies is increased to a minimum of 5%
  - Diluted coal is increased to a minimum of 2%.

Up to now, Some policies have been pursued by the government in order to achieve the energy policy target, such as gradual reduction of fuel subsidies, reduction of electricity subsidies, and the imposition
of export duties for coal exports. These policies succeeded in shifting the proportion of primary energy use to total national energy use. In figure 2 Riza Azmi and Hidayat Amir shows the progress of the national energy mix from the year 2000 up to the year 2011 [3].

This figure shows that petroleum and coal are heading in the right direction towards the energy mix target of 2025. The proportion of petroleum is declining, while the proportion of coal is increasing. The policy to reduce petroleum subsidies has put pressure on the use of oil, and the policy of imposition of export duty has successfully reduced coal exports, and increased domestic use of coal.

For new and renewable energy (Energi Baru dan Terbarukan/EBT) and gas, however, have not shown the right direction. Both types of energy are expected to increase in the proportion of energy use in 2025, but so far it shows the opposite direction. Therefore, government policy is needed to boost the use of new and renewable energy and gas.

3.3. Bioethanol and its Problems
Biofuel is a fuel produced from organic materials, such as agricultural waste, corn, sugarcane, palm etc. In contrast to fossil fuel that once taken from the wild directly discharged because it can not be renewed, the raw material for biofuels can be produced continuously. Raw materials for biofuels can be renewed, therefore, biofuels belong to the renewable energy group.

Biofuel can be produced from two groups of plants. First, plants containing sugar such as sugar cane, sugar beet, and sweet sorghum or plants containing starch / polysaccharide (corn). Through the yeast fermentation process, the material can be converted to ethyl alcohol or ethanol. In the application, ethanol is mixed with premium, pertalite, or pertamax in certain proportions, used for gasoline-based engines. Second, plants that have high vegetable oil content such as oil palm, soybeans, algae, or jathropa. Through the heating process, the material can be converted into biodiesel. In the application, biodiesel is mixed with diesel oil in certain proportions, used for diesel-based engines.

The problem that arises in producing biofuels is the price of biofuel raw material that is too high compared to the price of fossil fuel. Basically, most of biofuel raw material are foodstuffs or animal feeds. There is a conflict of interest, between the use of materials for foodstuffs, animal feeds, and energy. Because of expensive raw materials, biofuels can be produced at substantially higher prices than fossil fuel prices. Under these conditions, no investors is interested in producing biofuels. It is more profitable for them to use the raw material as foodstuffs or animal feeds.

4. Analysis

4.1. Bioethanol Profile
Ethanol is a chemical in liquid form, clear, and easily evaporate. In the market, ethanol is known as alcohol. The use of ethanol as a fuel is usually mixed with gasoline, known as bioethanol. Ethanol industry is a low-tech industry. The process of producing ethanol can be done by the community without having to attend special education. They can produce ethanol, but they do not know where to sell and
sold at what price. The ethanol producer size varies from household scale to large scale industries. They
quite sure that one day bioethanol will be able to replace the role of fossil fuel.
Two countries that have used bioethanol as a fuel on a large scale are the United States and Brazil.
About 88% of the world's bioethanol production is currently used in both countries. Indonesian National
Council on Climate Change reported that the United States develop corn-based bioethanol, while Brazil
develops sugarcane-based bioethanol [4].
Several neighboring countries have also moved to utilize biofuels as a substitute for fossil fuel. Malaysia is intensively conducting research and building biofuel industry. The Philippines already uses
bioethanol with a composition of 10% ethanol. In 2018, the Philippines plans to increase the proportion
of ethanol from 10% to 20%.
Indonesian government has designated bioethanol as one of renewable energy. Together with biodiesel,
bioethanol is expected to contribute 5% of the primary energy mix in 2025. But until now, the use of
bioethanol as a fuel mixture has not been exist in the market.
Research on machines performance using bioethanol has been done by Joko Winarno. In this study,
ethanol having octane 118 was mixed with pertamax with octane number 98. The ethanol mixed in this
bioethanol was 5%, 10%, 15%, and 20%. This mixture produces bioethanol with an octane of 93.3; 94.5;
95.8; and 97. The results show that ethanol mixture up to 20% in bioethanol can improve engine
performance in low to medium engine rotation (<7000RPM). However, when the machine is at high
rotation (> 7000RPM), only bioethanol with 5% ethanol blend shows stable performance, while for
ethanol blends of 10%, 15%, and 20%, its performance decreases [5]. The result of Wiratmaja's study
also showed a similar conclusion. With the composition of 90% pertamax and 10% ethanol gives better
machine performance than 100% pertamax without ethanol blend [6].

4.2. Economic Aspects of Bioethanol
One of raw material used to produce ethanol, available in large quantities today, is molasses. Molasses
is a by-product of sugar mills. Currently, molasses is widely used as raw material for animal feed, soy
sauce and flavored cooking (Monosodium Glutamate/MSG). The high demand for molasses causes its
price to be high enough in the market.
PT Energi Agro Nusantara (Enero) is one of the ethanol producers in East Java, using molasses as raw
material. Its production capacity is 30,000 kilo liters of ethanol per year. The company is able to
produce ethanol with octane number 117. In this company, one kilogram of molasses can be converted
into 0.294 liters of ethanol. Thus, to produce one liter of ethanol, it takes raw materials as much as 3.4
kilograms of molasses [7].
Based on Ministerial Decree No. 2026 K / 12 / MEM / 2017 on Price Index of Biofuel Fueled into
Petroleum Fuel, Ministry of Energy and Mineral Resources (MEMR) stipulates bioethanol price of Rp
10,090, - per liter. Meanwhile, the price of molasses is Rp.1.625, - per kilogram plus US $ 0.25, so if it
is totaled to about Rp.5.066, - per kilo gram [8].

4.3. Problems With Economic Price
To produce one liter of ethanol, it needs 3.4 kilograms of molasses as raw materials. If the price of
molasses is Rp.5.066, -, it is required minimum Rp.17.223, - to purchase raw materials. Other
production costs are required, such as labor cost, supporting material, and asset depreciation. If ethanol
prices are set at Rp 10,090 then ethanol producers will not interested to produce ethanol. If they have
molasses, it is more profitable to sell it as it is, or processed into other more profitable products.

4.4. Financial Engineering for Bioethanol
Under such conditions, financial engineering can be used to encourage the use of ethanol as a bioethanol
mixture in Indonesia. Excise is a fiscal instrument that can be used to raise funds from the fuel user, for
their contribution have polluted the environment with CO2 emissions. In his study titled “The Potential
and Feasibility Analysis of Excise Tax on Fuel”, Purwoko stated that fuel is feasible to be subject to
excise, because it meets the criteria as taxable goods, that is the consumption of fuel can cause negative
impact for society or environment [9].
The rate of excise duty charged can be set varies according to the quantity of CO2 emitted. The study of Prasetyo and Patriayudha (2009) showed that the greater the ethanol mixed in the fuel, the smaller the resulting CO2 emissions [10]. It can be used as a basis for determining excise tariffs.

One of the unique characteristics of excise tax is the possibility of earmarking, which can be used to reduce the negative impact of products subject to excise [11]. Similarly, in the case of imposition of excise on bioethanol, earmarking results may be used as subsidies for ethanol producers. With subsidies, it is expected that ethanol prices can be set above the cost of production, making it attractive for producers to produce ethanol.

4.5. Benefits of the Proposed Policy
If the proposed policy on renewable energy usage (bioethanol) can be implemented, this policy will have the following benefits:

- Reduced fossil fuel consumption, so that the existing reserves can be used for a longer period;
- The availability of business opportunities to produce ethanol, which means there will be added value in the economy;
- There will be an additional labor absorption;
- There is an opportunity for community to produce ethanol from raw materials other than molasses, such as sorghum, nipah, and corn;
- The policy can accelerate the achievement of Mix energy policy targets by 2025;
- The government does not need to issue subsidies from the state budget to encourage renewable energy usage (bioethanol). Subsidies will be obtained from bioethanol price made by independent agencies.

The policy on renewable energy usage (bioethanol) can accelerate the process of reducing CO2 emissions in the transportation sector.

5. Conclusions and Suggestions
Based on the above analysis, this study can be summarized into several conclusions as follows:

- Implementation of ethanol pricing policy in this study is believed to be able to achieve many governmental objectives, among others (1) to reduce the use of fossil fuels, (2) accelerate the achievement of mixed energy policies, especially the use of renewable energy, (3) reduce CO2 emissions, 4) increase labor absorption, (5) increase energy security, and (5) improve the economy.
- Currently, policies on ethanol usage in renewable energy cannot be implemented because the selling price set by the Government is too low compared to ethanol production cost. There is no sweeteners for ethanol producers to produce ethanol. Accordingly, ethanol producers do not interested in producing ethanol.
- The excise policy on fossil fuel can be used as an instrument to reduce CO2 emissions on the use of fossil fuel for motor vehicles. The higher the CO2 emitted by the motor vehicle, the higher the tariff applied. A certain portion of excise duties can be earmarked, and the earmark can be used to subsidize the price of ethanol products. With this policy, subsidies for ethanol products do not burden the state budget.

In order to obtain the better output in the implementation of this study, the following recommendations are proposed:

- Further studies are needed to determine the proper independent agency for the management of earmarked excise fund. The scope of research includes, among others, type or form of the agency, legal aspect of the agency, the parties to be represented, the main tasks and functions of the independent agency, as well as independent performance monitoring mechanisms.
- Socialization of bioethanol policy needs to be arranged by involving relevant stakeholders, among others, Ministry of Energy and Mineral Resources, Ministry of Environment and Forestry, Pertamina, potential renewable energy producers, automotive manufacturers, and consumer representatives. A good understanding of the bioethanol policy of the parties
concerned will facilitate the implementation of the proposed bioethanol policy.

- Further studies are needed to determine the amount of emissions at each level of ethanol portion in fossil fuel, as well as the amount of excise tariffs at each level of ethanol proportion.

6. References

[1] --- “SKK Migas: Masyarakat Indonesia Rakus Konsumsi BBM”, Wartaekonomi.co.id. August 30, 2017

[2] Moleong, Lexy J. *Metode Penelitian Kualitatif Edisi Revisi*. Bandung: PT Remaja Rosdakarya. 2010

[3] Azmi, Riza and Hidayat Amir (2014). Ketahanan Energi: Konsep, Kebijakan dan Tantangan bagi Indonesia. *Buletin Info Risiko Fiskal Edisi 1 Tahun 2014*. Available at: https://www.kemenkeu.go.id/sites/default/files/energy%20security. pdf

[4] --- (2010) Peluang dan Kebijakan Emisi Sektor Transportasi. Laporan Teknis. Dewan Nasional Perubahan Iklim. 2010. Available at: https://esmap.org/sites/default/files/esmap-files/ID%20Low%20Carbon%20Transport%20-%20Indonesian%20-%209%202010.pdf

[5] Winarno, Joko, “Studi Eksperimental Penambahan Bioetanol pada bahan Bakar Pertamax Terhadap Unjuk Kerja Motor Bensin” *Jurnal Teknik* no 1, vol. 1. pp 33-39, April 2011

[6] Wiratmaja, I Gede (April 2012) Analisa Unjuk Kerja Motor Bensin Akibat Pemakaian Biogasoline. *Jurnal Energi Dan Manufaktur*, [S.l.], nov. 2012. ISSN 2541-5328. Available at: <https://ojs.unud.ac.id/index.php/jem/article/view/2313>.

[7] Faisal, Achmad “Pabrik Bioetanol Berbahan Baku Tetes Dibangun di Kediri.” Kompas.Com. February 16, 2015.

[8] ---. (2017) Surat Keputusan Menteri ESDM No. 2026/K/12 /MEM/2017 tentang Harga Indeks Pasar Bahan Bakar Nabati (Biofuel) yang Dicampurkan ke Dalam Bahan Bakar Minyak. Available at http://ebtke.esdm.go.id/post/2017/05/09/1653/sk.mesdm.nomor.2026.k12mem2017.tentang.perubahan.atas.keputusan.mesdm.nomor.6034.k12mem2016.tentang.harga.indeks.pasar.bahan.bakar.nabati.biofuel.yang.dica.

[9] Purwoko. “Analisis Potensi dan Kelayakan Pengenaan Cukai Atas BBM.” in *Bunga Rampai Menggali Potensi Penerimaan Negara di Tengah Lesunya Ekonomi Global*. Badan Kebijakan Fiskal Kementerian Keuangan. 2016.

[10] Prasetyo, Devanta Bayu, and Ajar Patriayudha. “Pemakaian Gasohol pada Bahan Bakar Kendaraan Bermotor.” Seminar Tugas Akhir S1 Jurusan Teknik Kimia Undip. 2009.

[11] Purwoko, et al. “Pengenaan Pungutan Atas Emisi Kendaraan Bermotor.” Presented at Fiscal Policy Agency, Ministry of Finance, 2012

Acknowledgments

Special thanks forwarded to Prof. Suahasil Nazara, Head of the Fiscal Policy Agency, Ministry of Finance of the Republic of Indonesia, which has encouraged researchers to take part in international conferences.