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Lessons from Brazil: Opportunities of Bioethanol Biofuel in Indonesia

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Abstract

Brazil has a long tradition of bioethanol production from sugarcane. Following the Middle East crisis in the 1970s, the oil price increased twofold, doubling Brazil's spending on oil imports. As a result, the country had to find an alternative type of fuel to reduce its expenditure on conventional petrol fuels. With its vast tropical land conditions, the Brazilian government then put massive effort to establish the infrastructure and research of bioethanol from 1975 and 1989. Research plays a pivotal role in the success of Brazil's ethanol industry. The country was heavily criticised at the beginning of the programme, but today, Brazil is the second-largest ethanol producer after the USA. Brazil produces the cheapest ethanol in the world and does not depend on fossil fuel to supply its energy demand. Indonesia and Brazil share the same landscape and geographical advantages. This paper aims to discuss the success of the Brazilian bioethanol industry and draw important lessons from it. In a nutshell, Indonesia should increase bioethanol production from renewable sources. Also, the modernization of distilleries facilities, the establishment of new production plants, the introduction of subsidies and the reduction of taxes for ethanol producers are needed. In summary, apart from massive research and development, we concluded that effective and strong long-term government commitment play important role in shaping the future of the Indonesian bioethanol industry.

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Lessons from Brazil: Opportunities of Bioethanol Biofuel in Indonesia

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A B S T R A C T

Brazil has a long tradition of bioethanol production from sugarcane. Following the Middle East crisis in the 1970s, the oil price increased twofold, doubling Brazil's spending on oil imports. As a result, the country had to find an alternative type of fuel to reduce its expenditure on conventional petrol fuels. With its vast tropical land conditions, the Brazilian government then put massive effort to establish the infrastructure and research of bioethanol from 1975 and 1989. Research plays a pivotal role in the success of Brazil's ethanol industry. The country was heavily criticised at the beginning of the programme, but today, Brazil is the second-largest ethanol producer after the USA. Brazil produces the cheapest ethanol in the world and does not depend on fossil fuel to supply its energy demand. Indonesia and Brazil share the same landscape and geographical advantages. This paper aims to discuss the success of the Brazilian bioethanol industry and draw important lessons from it. In a nutshell, Indonesia should increase bioethanol production from renewable sources. Also, the modernization of distilleries facilities, the establishment of new production plants, the introduction of subsidies and the reduction of taxes for ethanol producers are needed. In summary, apart from massive research and development, we concluded that effective and strong long-term government commitment play important role in shaping the future of the Indonesian bioethanol industry.

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1. INTRODUCTION

Despite its insignificant growth, the transportation sector remains one of the biggest end-users of the world's energy. The number is expected to increase steadily, while on the other hand, the energy reserve is decreased due to constant demand across the globe. Petroleum, which is extracted from fossil fuel, is the most common fuel used for automobiles, motorcycles, and aeroplanes. Numerous research aims to find alternative energy that can replace such dominating non-renewable fuels.

Although the rise of advanced combustion technology (Katijan et al., 2019; Shim et al., 2020) and electric vehicles (Barkenbus, 2020; Mierlo et al., 2021; Veza, Roslan, Said, & Latiff, 2020) have attracted recent attention, the use of biofuels as renewable energy sources remain attractive for near future (Hossain et al., 2019; Mohammed et al., 2021; Saad et al., 2019; Veza, Said, et al., 2020). Alternative fuel is often divided into first- and second-generation biofuel. First generation of biofuels are produced from edible crops such sugarcane and corn. These biofuels offer great promises to replace fossil fuel. However, since they are extracted from edible sources, they compete for human food supply and may consequently increase the food prices. This dilemma has resulted in the extensive research of biofuels that can be produced from non-edible plants, agricultural waste or lignocellulosic biomass (Ge et al., 2021; Mitra et al., 2021; Pattanaik et al., 2019; Rozina et al., 2017; Veza, Roslan, Said, Latiff, et al., 2020; Veza, Said, Latiff, et al., 2021). This type of fuels is commonly known as the second generation of biofuels. **Figure 1** shows the basic route for bioethanol production from lignocellulosic biomass.

2. SECURING INDONESIA'S RENEWABLE ENERGY FUTURE

Renewable energy is defined as the energy that occurs naturally and continually in the environment. The supply of renewable energy is abundant and will not come to an end compared to energy from fossil fuels. Sources that are available on earth such as waves, wind, the sun, geothermal heat, wood and crops are considered renewable energy. Apart from that, the by-product of certain processes can produce organic fuel sources that can eventually be converted to renewable energy.

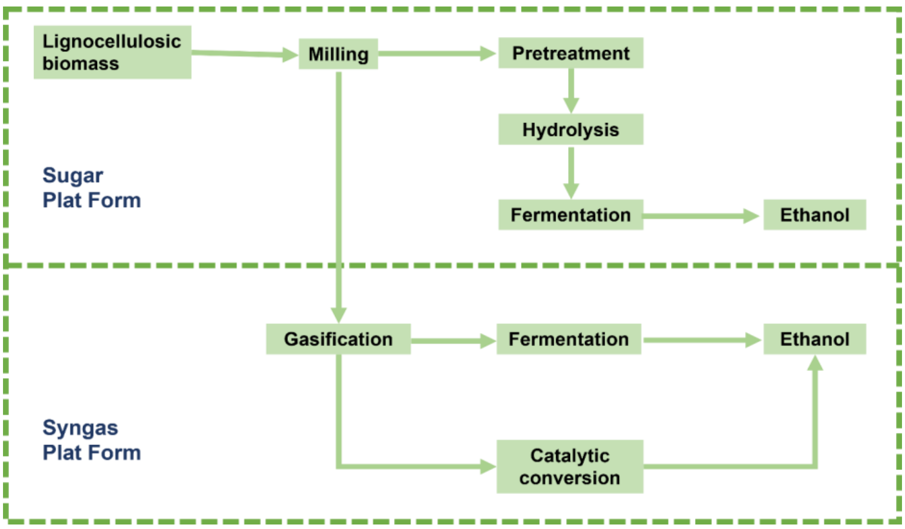

Figure 1. Bioethanol production from lignocellulosic biomass.

Besides contributing to the environment by lowering carbon emissions, developing renewable energy sources is of great importance in terms of economic point of view (Ben Jebli et al., 2020; Lv et al., 2019; Pizarro-Alonso et al., 2018; Rusli et al., 2021; Sim, 2018; Trovato & Kantharaj, 2020; Veza, Muhammad, Oktavian, Djamari, et al., 2021), thus offering substantial environmental and financial benefits. It is the reason why the Indonesian government eager to implement the renewable energy.

Renewable energy is believed to play an important role in the coming future around the globe. Patents in renewable energy have been skyrocketing in the past 10 years. They are backboned by governments and industry findings in the R&D sector. In China, number of patents for renewable-energy technology have been sharply increasing in the past few years.

Indonesia has massive renewable energy potential. The opportunities vary greatly from biomass, solar photovoltaic, wind power, to geothermal energy. Yet, despite those prospects, numerous challenges exist. The government's commitment itself has been considered as the major impediment to the development of renewables in the country. With limited current electricity generation being from renewable sources, Indonesia has lots of homework to be done to achieve its target of 26% of electricity generation from renewable sources by 2025.

3. WHY BIOETHANOL?

Ethanol has attracted more attention due to its superior octane number, approximately 99, and is therefore often blended with gasoline fuel. The high octane also allows the fuel to be used in engines with higher compression ratios such as diesel engines (Li et al., 2021; Roslan et al., 2020; Veza, Said, et al., 2019; Zhen et al., 2020). Ethanol is more energy-efficient, allowing the cars using ethanol to travel a greater distance than using conventional gasoline engine. Ethanol is also oxygenated, thereby providing the potential for particulate emissions reduction in diesel engines (Datta & Mandal, 2016; Shi et al., 2006; Veza, Roslan, Said, Latiff, et al., 2021).

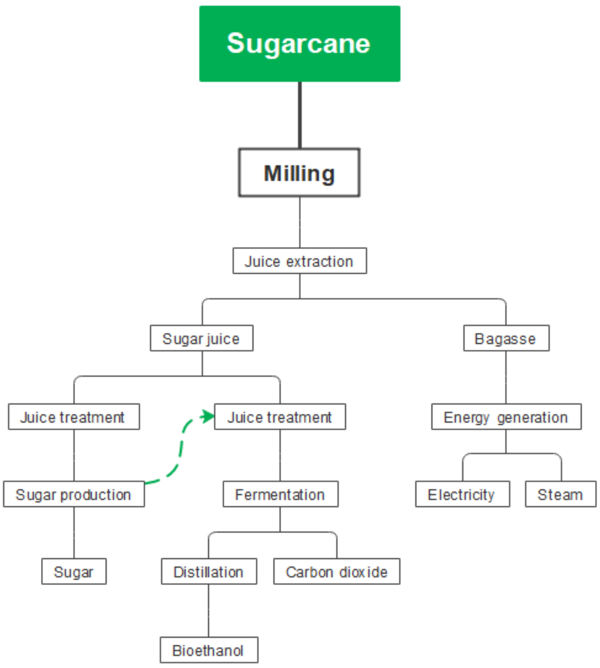

Figure 2. Bioethanol production from sugar-

Some studies have proved that the use of ethanol can reduce carbon monoxide, particulate matter (PM), and nitrogen oxides (NOx) in diesel engines (Veza, Zaid, et al., 2019). As the result, ethanol is widely used as an additive or alternative fuel in some countries including the United States, Brazil, China, etc. Brazil can produce inexpensive bioethanol fuel from the sugarcane fermentation to supply one-quarter of its ground transportation fuel, while the US produces bioethanol from corn. **Figure 2** shows the typical bioethanol production from sugarcane.

The progress of ethanol has moved towards non-edible plants or agricultural waste (Veza, Said, & Latiff, 2021). The main benefit of using such sources for bioethanol is their abundant supply. Furthermore, sugar used for ethanol production may eventually compete with food supplies. Besides reusing waste that are useless, the use of cellulosic waste allows ethanol production in several regions whose climates are unsuitable for crops production.

4. LESSONS FROM THE SUCCESS OF BRAZILIAN ETHANOL INDUSTRY

Brazil has a long tradition of sugarcane production due to its vast tropical land conditions. Upon this competitive advantage, the government then put massive effort to establish the infrastructure and research of ethanol from 1975 and 1989. The ethanol industry was initiated in the 1930s. With excess production of ethanol, the government proposed the addition of ethanol to the gasoline engine. However, it was after 40 years that the industry had a breakthrough.

4.1. The Breakthrough

In 1975, Brazil introduced the National Alcohol Programme known as Pro-Álcool to boost its ethanol production as an additive for gasoline fuel. The programme focused on the raise of ethanol production, the modernisation of distilleries facilities, the establishment of new production plants, the introduction of subsidies and the reduction of taxes for ethanol producers. The result was staggering. From 1975 to 1990, the production jumped nearly twenty-fold, from 0.6 to 11 billion litres in just 15 years.

In the early phase of the programme, the water had to be removed from ethanol using an additional processing step. To solve this issue, the General Command for Aerospace Technology, Brazil's research centre for aviation and space flight, proposed the use of alloys in the engine internal parts and fuel tanks to protect them from corrosion caused by ethanol. As the result, by 1979, ethanol containing five per cent water was allowed to be used directly in cars fuelled by 100% ethanol. The period between 1986 and 1989 was the pinnacle of the programme in which nine out of 10 cars sold in Brazil can run using ethanol fuel.

4.2. Massive Investment in Research

Research plays a pivotal role in the success of Brazil's ethanol industry. It was the research at Campinas Agronomic Institute and Agriculture Luiz de Queiroz of University of São Paulo that advanced sugarcane production. They used breeding techniques and improved the genetic varieties of sugarcane. As the result, varieties of sugarcane could be produced that were able to adapt to various land and climate with better production rates. Moreover, the varieties had the strength to water scarcity and dangerous fungus that resulted in sugarcane rot in the 1980s.

In order to improve ethanol production, a private research institute namely The Sugarcane Technology Centre had also invested around US$20 million annually. In the 1980s, Sugarcane Technology and Braunbeck established a transportation system to transfer the vinasse waste, a corrosive liquid from ethanol distillation, from the distilleries to the fields. Previously, the vinasse waste was thrown into the rivers and led to environmental pollution. It turned out that the vinasse was a good fertiliser. The utilisation of the waste has motivated researchers in Brazil to maximise bagasse, leftover sugarcane fibre, to produce energy such as generating turbines for electricity generation. As the result, more energy could be produced, leading to lower the production cost of bioethanol from sugarcane.

5. OPPORTUNITIES OF BIOETHANOL IN INDONESIA

Biomass supplies a third of energy demand in Indonesia. In addition to improving energy security, biomass offers a socio-economic advantage by modernising the production facilities, creating more jobs, and decreasing the poverty rate. The Indonesian government has set the policy for biofuels.

Biofuels have been attracting numerous attentions in Indonesia. As the biggest palm oil producer in the world, Indonesia can play a significant role in the development of biodiesel. However, the utilisation of biodiesel from palm oil creates another issue such as deforestation and its associated problems such as damage to the habitat of endangered species.

Note that sugarcane is not considered as an attractive crop to Indonesian farmers because of the economic and market issues. Moreover, the lack of modern plant infrastructures has made it even less preferred. The goals for sugar and ethanol production have also not yet been established clearly, resulting in uncertain demand development.

Indonesia has been producing sugarcane since the seventeenth century. Despite hundreds of years of experience, sugar production in Indonesia is still low. With its vast geographical advantage, the sugarcane is only harvested in 340,000 ha. Consequently, Indonesia still imports sugar to meet its domestic demand, thus using ethanol as biofuel is not a feasible option. In order to increase sugar production, the Indonesian government had increased the area of plantations in several islands aiming to be self-sufficient by 2014. Several efforts have been done to evaluate the sources, the economic potential, and technological aspects of ethanol production. However, the coordination between several industries and organisations that are involved in the production of ethanol has not yet been coordinated accordingly.

Indonesia and Brazil share the same landscape and geographical advantages. Both are developing countries with tropical climate conditions. However, Brazil has reduced its dependency on its oil import. The success of the ethanol industry in Brazil is a result of wholehearted investment in infrastructure and research. In the 1970s, the country depended on oil imports to supply the energy demand for its transportation sector. Like many other countries, the decision on using fossil fuel is sensible as the price of gasoline fuel at that time was cheap. Biofuel such as ethanol had not yet been considered as an option. One litre of gasoline was sold only one-third of the price of ethanol. However, today, Brazil is the second-largest ethanol producer after the USA. Brazil produces the cheapest ethanol in the world and does not depend on fossil fuel to supply its energy demand.

6. RECOMMENDATIONS

Most countries would not have considered ethanol to be used as an additive in internal combustion engines, yet Brazil invested enormously in the production of ethanol. Research plays a pivotal role in the success of Brazil's ethanol industry. There are several lessons that Indonesia could take from Brazil. In short, Indonesia should increase bioethanol production from renewable sources. Also, the modernisation of distilleries facilities, the establishment of new production plants, the introduction of subsidy and the reduction of taxes for ethanol producers are also needed.

In addition to the technical issues mentioned above, the real key to accelerating bioethanol production is a more effective execution practice. Lack of synchronisation between government agencies, along with conflicting policies, has made the entire process long-winded and labyrinthine. Also, land acquisition processes have been unsuccessful to obtain public acceptance.

The Indonesian government should improve the effectiveness of the implementation process for important projects. Administrative processes have long been known as complicated and extensive with poor coordination between agencies and different government's levels. Regulations are often conflicting with each other. Therefore, effective and strong long-term government commitment is of substantial importance.

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