



## Analysis of Energy Transformation Through Biofuel Energy Downstream to The National Economy

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### Abstract

*This research discusses energy transformation through downstream biofuel energy to the national economy in terms of how biofuels reduce the use of fossil energy and encourage national economic growth. Biofuel energy transformation is proposed because of its increasing popularity amid increasingly high climate change and world oil prices have increased due to world political uncertainty. The choice of biofuel energy transformation is the right way to find out how significant the energy transformation from fossil energy to biofuel energy has impact on energy availability and the national economy. This study analyzes Indonesia's energy transformation through downstream biofuel energy using the concept of energy transformation in looking at the integration of biofuel energy into the national economy. This study uses an integrative review method of presenting non-experimental data, a systematic approach, and uses a detailed search strategy in an effort to identify relevant evidence for biofuel energy and its impact on the Indonesian national economy. The energy transformation policy through downstream biofuel energy has not had a positive impact on Indonesia's national economy even though biofuel energy is cheap and environmentally friendly. The energy needs of the Indonesian people are very large and have not been able to be supported by biofuel energy with the same raw materials as the people's staple food. Meanwhile, food waste, such as tofu production waste and sugar production waste, is only able to sustain the energy needs of small-scale communities. The reallocation of fossil energy subsidies to biofuel energy has not yet contributed to the national economy.*

**Key words :** Energy Transformation, Biofuel Energy, Fossil Energy, National Economy

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### INTRODUCTION

The urgency of energy transformation analysis to see how the impact of fossil energy transition to biofuel energy for the national economy. The use of biofuel energy can be a challenge as well as an opportunity for develo-

ping countries such as Indonesia. The goal is to become one of the policy considerations in the economic field on the processing of biofuel raw materials that are found in Indonesia. So that the integration between economic strength and biofuel transition becomes balanced. According to

Khatiwada, Indonesia wants to reduce energy dependence by increasing energy source options so that the government begins to look at Natural Resources as biofuels.

Energy is an important requirement to boost industrial growth. Currently, this energy needs from each country tend to increase especially from oil, gas, and coal as a result of fossil energy. Fossil energy itself is energy that cannot be renewed with unstable prices and has a detrimental impact on the environment including air pollution, greenhouse gas emissions, and global warming. Fossil energy also shows that there is no stability in the balance between demand and supply so that the price is increasing, especially in the midst of the current geopolitical crisis. In the last 10 years, fossil energy production has decreased due to old oil production wells and relatively limited production of new wells. The ever-increasing demand to boost the country's industry is not matched by the availability of sufficient energy and even causes scarcity. Therefore, there is a need for alternative energy sources and policies that can support the transition from fossil energy to biofuel energy in supporting industrial growth.

An effective means to save fossil energy as the main energy source is to find and utilize other renewable alternative energy sources. The development of the world has sought a shift towards alternative energy sources made from plant-based materials that are renewable, one of which is biofuel. Biofuel is fuel derived from vegetable materials and/or produced from organic materials. Some vegetable materials can be a source of energy used in replacing fossil energy such as bioethanol as a substitute for gasoline, biodiesel as a substitute for diesel, geothermal power, micro-hydro, solar power, wind power, even waste materials can be processed and used to generate electricity (Ermawati, 2015). Thus, the transition from fossil energy to biofuels is an energy pol-

icy that should be carried out by the government.

Given the dwindling supply of fossil energy, the international community must pay a better attention to save it because it requires a long process with the aim of reducing carbon emissions. The transition process is also a common mission of each country in the use of clean energy which continues to increase. Indonesia is one of the countries promoting this energy transition. To accelerate the implementation of industry 4.0, meeting the energy needs of each industrial sector is closely related to the national priorities in Making Indonesia 4.0, especially meeting the new and renewable energy mix targets (Khatiwada, Palmen & Silveira, 2018).

Indonesia has been active in encouraging the use of biofuels in recent years and has set a target of achieving Net Zero Emissions (NZE) in 2060 or sooner (UNEP, 2022). In fact, Indonesia through the G20 Presidency has invited all G20 member countries to produce a global solution to the problem of the energy crisis in the midst of a geopolitical crisis by making the energy transition one of the priority issues of the Indonesian G20 Presidency (Limanseto, 2022). Indonesia has adopted an ambitious biofuel policy with increased but different targets for biofuel use in various sectors. Even though it is in a transitional period, the government still uses fossil energy temporarily until zero emissions are achieved at the power plant in the specified year (EBTKE, 2022a).

There are many challenges faced by Indonesia in optimizing the utilization of domestic biofuel energy. This challenge is on the supply side where private investment in the renewable energy sector is still low, especially in types of energy with a high-risk factor. In addition, there is no incentive system that is creative and can attract the biofuel energy industry to normalize in society. The lack of technological innovations that can support the development of renewable energy is also a scourge of stagnation in this process, especially when various products do not meet the standards to be used as efficient fuels. In fact,

Indonesia has great renewable energy potential such as solar energy, hydro, wind, geothermal, bioenergy, and biomass. This potential is 3,600 gigawatts (GW) with utilization of only 11.15 GW or 3% of the total renewable energy potential (EBTKE, 2022b). It is hoped that this potential can be maximized in order to achieve the primary energy mix target in accordance with Government Regulation No. 79 of 2014 concerning the National Energy Policy, the target for the new and renewable energy mix in 2025 is at least 23% and 31% in 2050 (ESDM, 2019).

In 2019, biofuel production increased by 418% compared to 2015 and reached a total of 8.39 million KL. Consumption of biofuels for domestic needs continues to increase in line with the policy of expanding incentives imposed by the Government (MESDM, 2020). However, Indonesia is still trying to optimize its potential so that the demand for biofuel energy can increase and society can reduce on a large scale the use of fossil energy which is seen as more accessible, especially with subsidies (ESDM, 2019). Indonesia can also encourage the use of various types of agro-industrial waste, such as sugar cane and tofu waste, which can be processed into biofuels. This utilization offers alternative energy materials that are cheaper, more abundant, and renewable (Prasetya, 2014).

Fossil energy subsidies in its development have made the oil and gas balance deficit even bigger and have burdened the state budget due to the very high fluctuations in world crude oil prices. In addition, fossil energy subsidies are also considered not to be on target because they are mostly enjoyed by the upper middle class. Thus, the government needs to divert the fossil energy subsidy budget to biofuels so that the price of biofuel produced by producers can be purchased at an economical price for the community, and the price of biofuel subsidies is optimized so that it can compete with fossil energy. The government

through the Ministry of Energy and Mineral Resources has issued Decree of the Minister of Energy and Mineral Resources No. 150.K/EK.05/DJE/2021 regarding volume allocation of biofuels in mixing fossil energy.

This allocation is the first step in 2022 in breaking away from fossil energy and integrating the use of biofuels (MESDM, 2021). Biofuel energy has great prospects for development besides being able to reduce dependence on fossil energy, the development of biofuel energy can also increase the availability of national energy supply (MESDM, 2020). However, the reallocation of subsidies from fossil energy to biofuels will certainly have an impact on the State Budget and the national economy, especially in the midst of the geopolitical crisis and global economic recession in 2023. This article refers to a research question: what is the impact of relocating the budget for fossil fuel subsidies to activities for the development and provision of biofuels (low emission fuel) on the state budget and the national economy?

## METHOD

In analyzing the impact of relocating the budget for fossil fuel subsidies to the development and supply of biofuels (low emission fuel) on the state budget and the national economy, this research will be analyzed using an integrative review. Integrative review itself is research that uses non-experimental data presentation, a systematic approach, and uses detailed search strategies as an effort to identify relevant evidence that can be used to answer the research question. Such evidence may come from various studies such as randomized controlled trials, observational studies, qualitative research, clinical experts, and other relevant evidence (Souza & Silvia, 2010). This method also aims at advancing and contributing to theory development (Cronin, Ryan, & Coughlan, 2008) and learning an elaborate description of the topic as much as possible as the most important purpose. By conducting this method, it portrays, describes, and

explains the dynamics of energy transformation through biofuel energy downstream to the national economy of Republic of Indonesia. Most of the integrative literature reviews are intended to discuss new topics that arise in the times as to energy transformation is a crucial topic around this time. Furthermore, it helps to understand as to what influence does the energy transformation subsidies have on the country's national economy. By finding all the relevant evidence, the data can help answer the research question regarding the impact of relocating the budget for fossil fuel subsidies to activities for the development and provision of biofuels (low emission fuel) on the state budget and the national economy.

This method requires detailed insights and frameworks with the aim of summarizing or evaluating various broad research fields (Noble & Smith, 2018). In the case of this topic, the aim of using an integrative review method is to critically review the knowledge base and potentially re-conceptualize, as well as broaden the theoretical foundation of a particular topic as it develops (Snyder, 2019). Therefore, this method can help researchers examine new policies implemented by the government along with future impact findings. Thus, an integrative review approach is the most appropriate method in analyzing the coverage of all published works. It helps to see the subsidies shifting made by the government and their impacts to the national economy and provide insights for the readers.

This research will focus on presenting evidence of analysis and evaluation with qualitative data in a narrative manner. Qualitative research is an approach to explore and understanding the impact of a symptom (Moleong, 2013) and involves a systematic process of collecting, analyzing, and interpreting non-numerical data (Tenny, Brannan, & Brannan, 2022). The data was obtained from different databases such as official reports from Indo-

nesian Government. The data was collected from The Audit Board of The Republic of Indonesia, The Ministry of Energy and Mineral Resources, Ministry of Agriculture of Republic of Indonesia, and the United Nations Environment Programme. These official reports are the main references with supporting data obtained through academic sources such as books, google scholars, journals, scientific reports, and credible websites and articles. Subsequently, we searched for data that was relevant to the keywords: "Energy Transformation," "Biofuel Energy Transition," and "National Economy". The identified sources included in this review were screened for relevance based on the research question: "what is the impact of relocating the budget for fossil fuel subsidies to activities for the development and provision of biofuels (low emission fuel) on the state budget and the national economy?".

This research used memoing as the analysis techniques and reflect on the document insights and thoughts. Discuss the findings and implications of the identified case and the result will be explained starting from the impact of the transformation of fossil energy into biofuel energy on the availability of national energy, to reallocation of fuel subsidy budget and its implications for the national economy. Thereafter, the data can provide the answer to the research question through the dynamics of the energy transition and the relocation of fuel subsidy budget so the result revered to the implication of this dynamics to national economy. Aside from answering the research question, this method aims to investigate the different ways of knowing the mapping of renewable energy transition discourse nowadays. As an interesting topic to discuss at this time, a narrative literature review will give a critical review on this matter.

## **RESULTS AND DISCUSSION**

The development of biofull fuels has recently become important to study. This is influenced by the depletion of fossil fuel reserves and increasing global efforts to reduce global carbon

emissions (Atadashi 2015). Where the world realizes that one of the causes of global climate change is caused by the use of fossil fuels that are not environmentally friendly. In addition, fossil fuel reserves are dwindling and are considered a burden to the state due to large subsidies for their domestic fuel oil needs, including Indonesia. The depletion of fossil fuel reserves and the danger to increasing global carbon seek the development of non-petroleum, renewable, non-polluting and sustainable fuels (Yigezu & Muthukumar, 2015). The importance of transforming to biofuel energy as an alternative in reducing long-term carbon dioxide emissions, producing fuel and securing a sustainable supply (Sengupta, Bhattacharya & Mukhopadhyay, 2020). Biofuels have a positive impact on the environment when compared to fossil energy which contributes to pollution, environmental damage and also public health (Choudhary et al., 2020).

In a world political condition that is still unstable due to the Ukraine-Russia conflict, this has caused oil and gas prices to soar. So that biofuel energy production is the right solution. Bioethanol as energy derived from food waste, agriculture and landfills. The transformation of biofuel energy encourages energy supplies that are cheaper, cleaner and less dependent on world political conditions (Extence & Pinchbeck, 2022). Renewable energy transformation was emphasized by the United Nations as stated by Secretary General Antonio Guterres at the COP26 meeting in Glasgow England on the energy transition that all countries end fossil fuel subsidies, set carbon prices, divert taxes from society to overcome pollution and end construction of power plants coal (United Nations, 2022b).

Biofuels are gaining world attention as an alternative fuel option to replace the use of mineral diesel derived from conventional

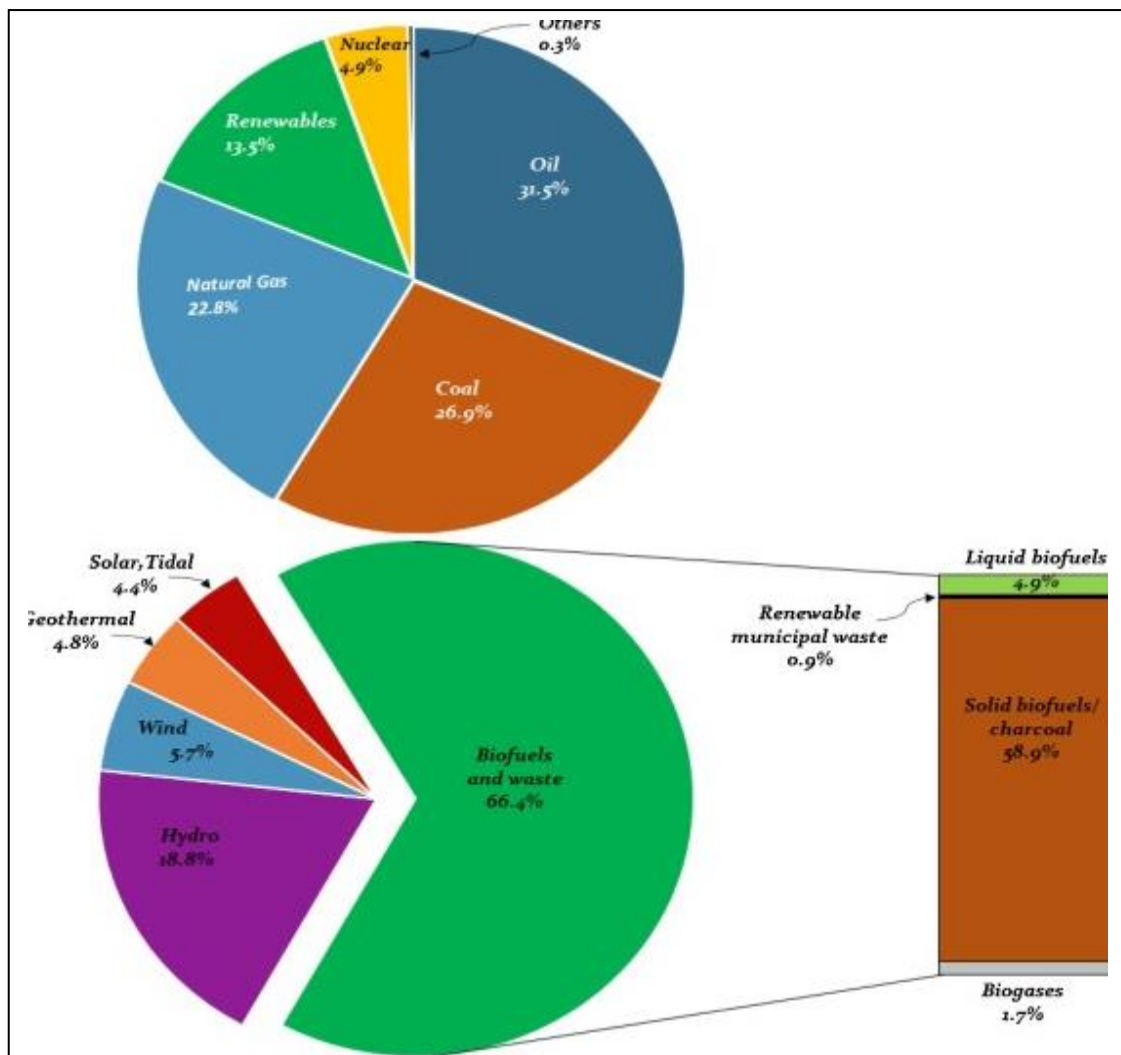
fossil sources. Sludge from food manufacturing companies is considered as a potential feedstock because of its low cost through transesterification or pyrolysis of biofuels. Biofuels are fuels made from vegetable waste (Bora, Gupta & Durbha, 2020). Biofuel is considered as an alternative energy source that can be used to reduce consumption of fossil fuels. Biofuel as an energy source that can reduce greenhouse gas emissions and is non-toxic (Naji, Tye, & Abd, 2021) (Figure 1).

Global energy demand continues to increase, fossil fuel reserves are dwindling with enormous environmental consequences forcing the search for alternative energy sources that are renewable and sustainable (Sainger et al., 2017). The production of bioethanol is highly dependent on the availability of raw materials to meet production demands. The United States and Brazil are global producers of bioethanol derived from seed oil and sugarcane (Cooper et al., 2020) (Figure 2).

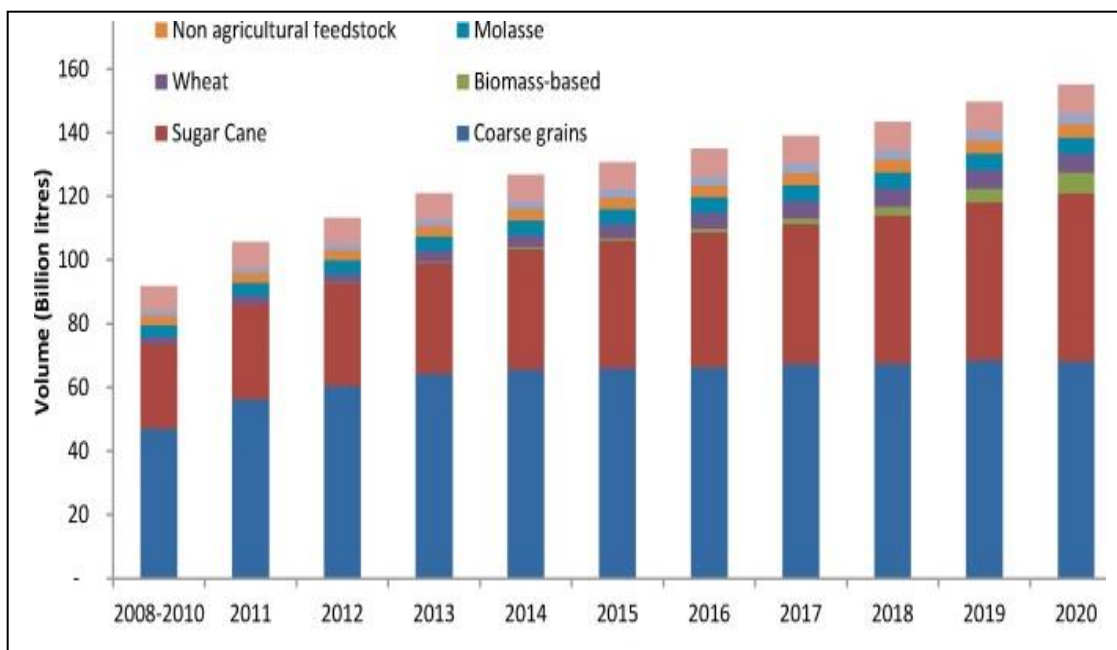
In addition, biofuel energy sources can also use alternative raw materials to produce bioethanol derived from food waste (Ma & Liu, 2019). The transformation of energy into biofuel energy has an easy-to-obtain energy source, for example it is produced with food waste and so on. So that besides being able to provide alternative energy, it can also reduce waste that is not functional and of value. However, biofuel energy is still small enough to provide raw materials and information on quality and processing is lacking (Cooper et al., 2020). Thus a country with a large population requires higher energy production. Indonesia as a G20 member country with large economic development and high energy. Strong economic growth followed by rapid increase in population is contributing to the increasing demand for energy. On the one hand, Indonesia will benefit from using fossil fuels because Indonesia is rich in natural resources for mining fuels such as coal, crude oil and natural gas. One of the big mines that manages fossil fuels with modern te-

chnology is PT. Industrial Park Indonesia Morowali (IMIP) and various other fossil energy industries. PT IMIP as a company that produces fossil energy with modern technology to convert nickel into batteries. The use of batteries is considered as a solution from the industrial revolution that is environmentally frie-

ndly. But in practice, the provision of the battery industry as a steam of green energy reverses the demand for energy that must be provided on a fossil basis while simultaneously increasing carbon emissions (Cetin, 2017).



**Figure 1.** Distribution of World Energy Supply and Contribution of Renewable Energy



**Figure 2.** Presentation of Bioethanol Production

Indonesia has carried out the stages of changing energy towards clean and environmentally friendly energy so that it seeks to convert fossil energy into renewable fossil energy or known as "green energy". Indonesia seeks to create environmentally friendly energy through cooperation with various countries, one of which is China to provide high technology so that it is able to create energy with waste made in such a way that negative consequences for the environment can be minimized. However, behind these efforts, there are many studies which state that economic growth and development together are difficult to synergize because they simultaneously cause pollution and are a significant cause of environmental degradation (Rehman et al., 2021). Environmental degradation that occurs will lead to failure of agricultural products, which triggers poverty, disrupts public health (United Nations, 2022a). To achieve green energy-based economic development requires modern technology and energy-efficient technologies to minimize emissions (Tripathy et al., 2022). However, dependence on fossil fuels will lead to increased CO<sub>2</sub> emissions and poor air quality. Therefore, renewable fossil energy still has a lot of

negative impacts because efforts to make renewable energy with products such as batteries generate large chemical waste which cannot be excluded. In addition, the production process still uses coal-fired power plants. Thus it is difficult to get out of the challenge of environmentally friendly fossil energy.

Energy transformation has been carried out by the Indonesian government from the stage of using fossil energy with conventional methods, using fossil energy with modern technology known as green energy and using biofuel energy known as sustainable energy. In the context of green energy, it has not removed Indonesia from the logic of fossil energy, even though it uses modern energy transformation. Indonesia's green energy policy has not yet reached downstream. As the goal of green energy policy is to create a good environment and encourage people to live well on earth in the future. The components of fossil base materials are not environmentally friendly at all because the waste chemicals are disposed of in the sea. Meanwhile, the process of extracting coal and nickel has caused a number of areas, such as Sulawesi, as the largest nickel-producing area in Indonesia, to lose forests. Nickel mining activities cause deforestation. Deforestation efforts, disposal of

waste in the sea and the use of coal which is not environmentally friendly are increasing air temperatures, increasing sea pollution. Thus the complex problems that arise from the development of green energy which is still based on fossils provide a domino effect in which energy consumption and environmental growth affect environmental quality. A fundamental change from the dominance of fossil energy, trying to transform it into renewable fossil energy, still has a negative impact on various sectors of life including the environment, social and economy (Yang et al., 2021).

Economic and environmental dependence makes many countries including Indonesia experience big obstacles. In order to achieve sustainable energy, it requires efforts to reduce the use of fossil energy and switch to sustainable energy or known as biofuel energy. However, this effort is still difficult, there are still many fossil energy mines in Indonesia that are still operating actively which are planned to produce sustainable energy. There are many mines managed by the Indonesian government to achieve energy independence but are still trapped in the context of fossil energy with sustainable energy status. In 2020 Indonesia will still rely on fossil energy (Ministry of Energy and mineral Resources, 2022) in the context of encouraging sustainable fossil energy development to achieve large energy demand.

The high energy demand is caused by very high population growth so that the community's energy needs are also very high. To be able to switch or transform to biofuel energy requires quite high resources which require large state funding to be able to meet biofuel energy raw materials. If you only rely on environmental waste resources or production waste such as tofu and sugar cane, this transition will not guarantee energy availability. On the other hand, the increasing demand for vegetable oil makes it difficult to

produce biofuel energy. Vegetable oil prices are still fluctuating in the international market. So that Indonesia as a country that produces vegetable resources and fossil energy resources experiences high demand from countries in the world.

Renewable energy or biofuels have big challenges because they are not yet competitive with fossil energy. Even though it was proven in Presidential Regulation No. 79 of 2014 concerning Energy Policy (BPKRI, 2022) and Presidential Regulation No. 22 of 2017 concerning the National Energy General Plan have targets for the use of New and Renewable Energy in 2025 and 2050 with a presentation reaching 23% of the total use of renewable energy (BPKRI, 2017). There are a number of countries including Indonesia that have a net-zero emission policy. The renewable energy sector is a capital-intensive energy sector because the cost of infrastructure, start-up and operation of renewable energy projects is higher than that of fossil fuels (Bamati and Raoofi, 2019). Thus achieving sustainable energy development requires regulations and the country's Gross Domestic Product (GDP) must be high to encourage infrastructure development as well as promote the renewable energy transition.

Financial Development facilitates the redistribution of funds from traditional energy with low production efficiency to sustainable energy development (Anton & Afloarei, 2019). Referring to research conducted by Kiam Hank Nguyen and Makoto Kakinaka, it is stated that long-term consumption of renewable energy with carbon emissions depends on the level of state income. Renewable energy consumption is negatively related to carbon emissions in developed countries while the opposite relationship is for low-income countries or developing countries. Renewable energy consumption has a positive correlation with the output of high-income countries, while developing or low-income countries will have a negative impact (Nguyen & Kakinaka, 2019).



Thus it can be said that Indonesia's efforts to transform energy into renewable energy or from fossil energy to biofuel energy are still very difficult to implement. This difficulty will lead to a shortage of domestic energy because the production of renewable energy requires capital and adjustments to society. Biofuels have not been significantly able to meet the energy needs of the Indonesian people on a large and long term basis due to the availability of production raw materials. Where the current condition of Indonesia's biofuel energy development still depends significantly on the development stage. In the long term, it will have a positive impact on Indonesia. However, in the short term, infrastructure development at a very high cost in the midst of a world condition that is experiencing an economic crisis requires very long policy considerations. So the authors can draw the argument that the transformation of energy from fossil energy to biofuel energy will have a major impact on domestic energy availability if forced and reallocated in the hope that Indonesia will depend on renewable energy. Although in the long run biofuels are the best energy policy to achieve clean energy. Energy transformation in 34 OECD (Organization for Economic Co-operation and Development) countries explains that there is a positive impact from increasing renewable energy but in the inclusion of renewable energy supply can increase production costs (Inglesi-Lotz & Thopil, 2019).

Efforts to reallocate the budget are considered not effective for Indonesia if it is carried out in the midst of the world economic crisis which is still a scourge for every country. The energy reallocation policy from fossil energy to biofuel energy will have an impact on state revenues because Indonesia as a fossil energy producing country will suffer huge losses. In 2015 Indonesia seeks renewal of energy with a green energy policy in which fossil energy is produced using high techn-

ology to produce low-carbon energy which has not yet achieved maximum results. The policy of creating battery energy from Indonesia's nickel resources has not been achieved while on the other hand the government wants to integrate new energy policies with a significant transition cost. This policy transformation will significantly affect state revenues if Indonesia forces large-scale changes.

Consequences in the financial sector and energy availability will be a challenge that will be obtained by Indonesia. There are many developing countries that have not been able to achieve a biofuel energy policy because of the efficiency in use and the availability of very little raw material. In addition, if Indonesia insists on providing budget subsidies for the development of energy from vegetable oils such as palm oil, the procurement of waste infrastructure and so on will result in a significant increase in budget allocations. Meanwhile, referring to the tofu and sugar waste management policy, biofuel energy can only achieve household energy production, not for large-scale energy needs. The policy of reallocating subsidies from fossil energy to biofuel energy from upstream to downstream will be difficult for Indonesia, especially since a transformation will be carried out in the midst of a world that is experiencing an economic crisis due to the Covid-19 pandemic.

Indonesia needs to consider that energy is one of the international market commodities that has a high value chain. So that a significant change by allocating subsidies on a large scale will cause economic losses where Indonesia is a country that produces fossil energy such as coal and other natural gas. With market fluctuations, the development of renewable energy cannot be separated from the traditional fossil fuel sector. Indonesia must be able to assess inclusively the problems arising from the transformation to biofuel energy. Fluctuations in changing to renewable energy will require very high costs in infrastructure development and a very long process. If the development of higher re-

renewable energy can lead to a reality when the price of fossil energy is low (Xia et al., 2019). There is a strong competitive relationship between fossil energy sources and renewable energy because integrated carbon and energy markets are interrelated (Ji, Zhang & Geng, 2018). Indonesia must pay attention to global political and economic conditions to integrate large-scale changes towards renewable energy or the transition from fossil energy to renewable energy.

According to Richard York and Shannon Elizabeth Bell that during the transition period what should be done is not to eliminate fossil energy directly because developing infrastructure and expanding the production of new energy sources can be seen as additional energy efforts. In addition, the transition means a reduction in the use of fossil energy which in the long term is believed to be able to replace fossil energy that is not environmentally friendly (York & Bell, 2019). Therefore, diverting the subsidy budget to renewable energy will actually lead to energy scarcity because renewable energy or biofuels are still in the process of transition. In this case it is still in the development stage so it is necessary to take into account long-term policy patterns. Thus, if the reallocation of resources is carried out as a whole and refers to energy renewal, it will lead to a scarcity of domestic energy sources.

However, one thing that needs to be excluded is that if financial resources are sufficient to make a quick change to renewable energy, this is a good consideration. Support from a number of G20 countries will greatly help Indonesia to utilize renewable energy development that does not depend on fossil energy alone. In addition, Indonesia must also look for other renewable energy alternatives with the required resources that are not the same as the raw materials for people's staple food. This will lead to high prices of basic commodities such as grain because

they are not only used as food ingredients but also as raw materials for renewable energy. However, if you only rely on waste management, it is very difficult for Indonesia to survive with this energy while the community's energy needs are very high.

Even though biofuel energy is a new alternative energy in order to reduce the use of fossils that affect global climate change. But Indonesia is also developing other renewable energies such as wind energy and hydropower energy. This is what China, the United States and Japan have done. Thus the need for energy for the Indonesian people is so great that dependence on one source of energy is a major energy problem for the country. So if it is assessed that biofuel energy can have an impact on the APBN partially, it can be said that it agrees because state subsidies for fossil energy are very large. Indonesia does not have other alternative energy to support the development of biofuel energy. Fuel subsidies place a heavy burden on the state budget, but if the state decides to make biofuel energy the main energy source, it can trigger a domestic energy crisis. Furthermore, that there are many challenges in biofuel energy that must be considered by the Indonesian government.

The development of biofuel energy is not without economic challenges for the country. The economic development of the biofuel industry also relies on state subsidies. Production and processing, market creation through government procurement, price control and tariffs as well as foreign trade quotas and various investments in agriculture, ecology to support the development of biofuel energy. Here we agree with the opinion of Oliveira, Mc Kay and Plank (2017) that biofuel policy must be understood in its historical and socio-economic context because state and economic relations determine how policies can be implemented. Biofuel energy policy must be understood inclusively so that it requires wider interaction of production, trade

and agro-ecological processes (Oliveira, McKay, & Plank, 2017).

Fuel subsidies continue to be debated among academics and policymakers, considering that government subsidies can affect the price dynamics of various commodities and the economy. The Indonesian government allocates many subsidy funds in the form of energy subsidies, including fuel. Based on data from the International Energy Agency (IEA), Indonesia's vehicle fuel subsidy is the 6th largest in the world, namely USD 2.44 billion (2020) (Muta, 2022). In line with the ranking, the Ministry of Energy and Mineral Resources (ESDM) noted the swelling of the fuel subsidy budget in 2022, which reached IDR 502.4 trillion. This figure is up sharply from the previous five-year subsidies, which averaged below IDR 153.5 trillion. The causes vary, ranging from rising world oil prices and the weakening rupiah exchange rate to an increase in the volume of subsidized fuel (GoodStats, 2022).

With such a subsidy, Global Petrol Prices recorded that Indonesia became the second country to set the lowest fuel prices after Malaysia in Southeast Asia. Indonesia sells for IDR. 16,500/ liter, while the highest is Singapore with IDR. 30,208/ liter (Gasoline Petrol Prices, 2022). Based on the countries in the world, Hong Kong has the highest price, with IDR. 44,370/ liter. Global Petrol Prices says that the average fuel price in the world is 1,36/ liter. Generally, developed countries have relatively high fuel prices compared to developing countries and significant producing countries with lower prices, except for the United States, which is a developed country with low fuel prices (GoodStats, 2022). All countries in the world have equal access to the international oil market. This price difference is based on fluctuations in government subsidies and taxes.

In 2014, the National Planning and Development Agency (BAPPENAS) gave options

regarding fuel subsidies. First, set a fixed subsidy or so-called fixed Subsidy for each liter of subsidized fuel. However, this option is only appropriate if you follow the current world oil prices in 2022, which are increasing. So the price of subsidized fuel is challenging to follow the economic movement. The second option periodically increases the price of subsidies once every six months. The advantage of the second option, if the price increase occurs gradually, the increase in subsidized fuel prices can be predicted and anticipated. If these options can be implemented, the fuel subsidy budget can be allocated to other assistance and biofuel planning (Rivani, 2014).

Biofuels are becoming a discussion as a replacement for fossil fuels. 'Bio' in biofuels refers to wood-based plant raw materials such as sugar, rice husks, corn, and wood waste processed into fuel. For developed countries, biofuels offer the prospect of meeting emissions reductions as mandated by the Kyoto Protocol. For developing countries such as Indonesia, biofuel can be a solution and a new economic field because it has abundant natural resources as raw materials for biofuel (Arshad, 2018). Fermentation of ethanol from glucose is the oldest technique and is also used to produce alcoholic beverages. Agricultural-based ingredients containing sugar, starch, and cellulose are used as raw materials. Usually, the fermentation process by yeast occurs at room temperature (Huang, 2012).

Biofuels have been well thought of as an alternative and even a substitute for fossil fuels for transportation since the oil crises of 1973 and 1979. Attention to biofuels bounced back in the early 2000s due to heavy pressure on climate change, depletion of fossil oil reserves, and fluctuations in world oil prices. Today, biofuel production has exploded into a massive conversation about biofuel policies, programs, and production. There are a variety of biofuels today, including biodiesel, bioethanol, and biogas (Negm, 2017). The economic aspect of biofuels is primarily determined by the value of the raw materials

used for their production downstream biofuel energy by the availability of biofuel raw materials in the regions of Indonesia. In addition, biogas production and its use in electricity can further reduce production costs. The cost of grain ethanol production can be lowered using waste raw materials. For example, producing ethanol from sugarcane molasses is cheaper than sugarcane (Gheewala, 2013).

As an alternative, biodiesel is one of the biofuels that can be used as energy in the transportation sector to replace fuel. Biodiesel is highly biodegradable, has low toxicity, and can be used in diesel engines. Therefore, biodiesel can replace the use of fuel in diesel and engines without significant modifications, plus it can significantly reduce particulate matter and carbon monoxide emissions (Sahin, 2011). There are several raw materials for biodiesel production to start the biodiesel industry. The availability of raw materials depends on several factors, such as the region's climate, geographical location, soil conditions, and agricultural practices country. At this point, agrarian countries such as Indonesia benefit from producing large quantities of agricultural commodities. Generally, biodiesel production raw materials are classified into four main categories (Arshad, 2018), namely: (1). Edible vegetable oils such as soy and palm oil; (2). Inedible vegetable oils include castor plants, Calipari trees, and rubber seeds; (3). Waste or recycled oil; (4). Fats of farm animals and poultry.

Speaking of the reallocation of the fuel subsidy budget to biofuel, it is necessary to analyze the allocation of the fuel subsidy budget of IDR 502.4 trillion (in 2022) to be on target. Financial support, price interventions, and trade barriers are essential in developing biofuels. With government subsidies, biofuels can be cheaper than fossil fuels, as in Thailand, the retail price for E85 was 30-40% cheaper than premium gasoline in 2008. Meanwhile, Indonesia plans to subsidize biofuels if the price exceeds fossil fuels. However, even with government subsidies, the competitiveness of biofuels is very volatile and depends on raw materials and oil prices. For example, the price of cassava, an essential raw material for ethanol production in Southeast Asia, doubled between 2006 and 2008. The high cost of raw materials in 2007 and 2008 proved to erode the profitability of biofuel production in China (Gheewala, 2013).

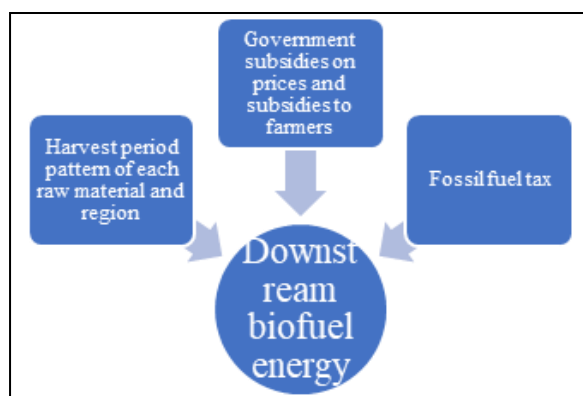
In addition, seasonal patterns of raw materials, and thus their prices, can cause problems for biofuels because raw material prices often rise in the non-harvest season. In Thailand, the state subsidizes 0.30 baht (1 US cent)/L for B2 producers, and the government allocates 3 billion baht in soft loans to oil palm farmers. To meet government mandates for biofuel consumption, consumers may also have to pay higher retail prices for fossil fuels. For example, many countries levy taxes on fossil fuels and use them to support renewable energy, as in Thailand (Gheewala, 2013).

**Table 1** Biofuel Raw Materials, Harvest Period, and 5 Provinces with the Largest Harvest in Indonesia 2018

Biofuel Raw Materials	Waiting Time	Provinces with the largest harvests (2018)	Ethanol Yield (L / Ha)
Sugarcane	11-12 months	East Java, Lampung, Central Java, South Sumatra, South Sulawesi	6190-7500
Cassava	6-12 months	Lampung, West Java, Central Java, East Java, NTT	3310
Corn	3-4 months	East Java, Central Java, Lampung, North Sulawesi, South Sulawesi	1050-1400
Soybean	3-4 months	West Java, Central Java, East Java, NTB, Lampung	2590

Source: (Kementan, 2018) (Rodionova, 2017)

Referring to the Thailand case study and the formulation of biofuel production, downstream biofuel energy is carried out by focusing on raw material-producing regions. The fluctuating competitiveness of biofuels based on the availability of raw materials can be overcome by optimizing the central provinces producing raw materials, then:



**Figure 3.** Biofuel Energy Downstream Scheme  
Source: Gheewala (2013)

In addition to raw materials, biofuel production technology is in the conversation. The main problem is that higher production costs are a significant drawback in commercialization (Hochman, Rajagopal, & Zilberman, 2011). Various biofuel technology development studies have been conducted to find the optimal conditions for biodiesel production. The primary method for making biodiesel is directly using and mixing vegetable oils. This financing can be filled by the reduction of fuel subsidies and then allocated to the development of biofuels (Gheewala, 2013).

Based on a survey of Indonesian political indicators published by GoodStats, people expect compensation for rising fuel prices. 19.8% of the people voted for the government to reduce the price of basic foodstuffs, followed by 16.5% asking for social assistance for the poor such as necessities and scholarships. In the third order, the community asked for the provision of jobs. They were followed by business assistance and infrastructure improvements. There were 1.9% of the population who requested compensation for the provision

of agricultural subsidies. Based on the survey shows that fuel subsidies can not be withdrawn directly as a whole. However, fuel subsidies can be allocated to other assistance as needed by the community (Janda, Kristoufek, & Zilberman, 2012).

In terms of policy aspects, Indonesia, through the mandate of the Minister of energy and Mineral Resources, has set in No. 252.K/10/MEM/2021 concerning the determination of fuel oil business entities and biodiesel biofuel business entities and the allocation of Volume quantities for mixing Diesel Oil fuel types for the January - December 2021 period. The Ministry of energy and mineral resources has determined the allocation of biodiesel for 2022 at 10,151,018 kL through Minister of energy and mineral resources Decree No. 150.K/EK.05/DJE/2021 shows that the transition from fuel to biofuel has begun (Eka Satya, 2022)

**Table 2.** Social, Economic, and environmental impacts and long-term preparation of biofuels

Social Economic Impact	<ol style="list-style-type: none"> <li>1. Food security</li> <li>2. Food prices and poor household solutions</li> <li>3. Creating jobs at the local level</li> </ol>
Environmental Impact	<ol style="list-style-type: none"> <li>1. Potential reduction in GHG emissions</li> <li>2. Effect on soil quality</li> <li>3. Effects on biodiversity</li> <li>4. Effects on water</li> </ol>
Long-term Preparation	<ol style="list-style-type: none"> <li>1. Establish an appropriate support policy framework based on trade-off assessments.</li> <li>2. Protection of vulnerable groups</li> <li>3. Improving agricultural productivity, process, and Practice Innovation</li> <li>4. Develop regionally agreed criteria and standards</li> <li>5. Adopting second-generation biofuel technology</li> </ol>

Source: Gheewala (2013)

The economic analysis of biofuel impacts uses a partial equilibrium structure model that considers other impacts besides economic ones. Based on the model, the U.S. Department of Agriculture examined the impact of biofuel progra-

ms and found a correlation between energy commodities and agriculture. There is an increase in the agricultural clearing of corn as a biofuel feedstock previously used for other crops. This study estimates that the increase in grain needs will rise by 25%. They also expect grain prices to rise by nearly half their starting price due to market demand shocks. Referring to the analysis, optimizing agrarian land in Indonesia becomes a breath of fresh air for farmers of sugar cane, corn, palm oil, rubber, and other biofuel raw materials (Janda, Kristoufek, & Zilberman, 2012).

Granger's economic causality test results showed that economic growth did not significantly affect fuel prices. In contrast, fuel prices are a statistically significant effect on economic growth. Furthermore, inflation has no significant effect on fuel prices. However, fuel prices have a significant effect on inflation. In addition, poverty has no significant effect on fuel prices, and fuel prices statistically do not significantly affect poverty in Indonesia. The allocation of fuel subsidies to biofuel energy can be started even though it will cause shock in the community but has no significant effect on poverty. Poverty has no significant effect on economic growth. On the contrary, economic growth has a significant effect on poverty. Because of this, the biofuel industry has the opportunity to influence economic growth in regions producing environmentally friendly fuel raw materials. Ultimately, it is expected to reduce poverty (Arshad, 2018).

Based on the analysis, economic experts view the shocks that occur against the increase in fuel prices due to the allocation of subsidies to biofuel energy as will impact economic growth and will continue in the long term permanently. This indicates that rising fossil fuel prices are causing slow economic growth. In addition, the increase in fuel prices also positively impacts inflation and continues in the long term. In addition, rising fossil fuel prices impact poverty in the short term. This shows

that the increase in fossil fuel prices leads to an increase in the number of poor people in Indonesia in the short term. The results showed that the increase in fossil fuel prices generally harms the Indonesian economy.

Therefore, the government and all stakeholders need to work together to reduce the negative impact of rising fossil fuel prices with a long-term solution, namely biofuel energy development. With high world fossil fuel prices, oil imports will increase and burden the country and society. Therefore, it is time for the government to switch to alternative energy sources that are available and abundant. In addition, the government also needs to switch to using energy sourced from renewable energy sources, such as water, wind, biofuels, and other renewable energy sources.

Supported by a literature review, this research identifies that energy transformation through downstream biofuel energy in Indonesia provides a major interaction in increasing renewable energy. Increasing sustainable energy or biofuels into a new energy alternative that has the advantage of being cheap and environmentally friendly has been implemented in Indonesia. Energy transformation through downstream biofuel energy increases the comparison of environmental impacts. The use of conventional energy, especially energy systems for generating energy based on fossil fuels is not environmentally friendly causing an increase in the earth's temperature and a tendency to experience high price fluctuations following political changes causing a number of countries to experience obstacles in obtaining energy supplies. Therefore, the need for alternative energy to be carried out by Indonesia through downstream biofuel energy. Biofuel energy transformation has a competitive advantage because it is cheap and environmentally friendly. However, in the process of implementing it to meet domestic energy needs, it still poses clear challenges.

The use of fossil energy is a challenge for all countries, especially developing countries with unstable economic systems. Energy transformation through downstream biofuel energy is a big challenge for Indonesia where the development of biofuel energy infrastructure requires a large amount of money. Meanwhile, the goal of downstreaming biofuel energy is as a national policy effort to increase added value to energy where biofuel is believed to be energy that has low costs and is environmentally friendly. On a small scale, biofuel energy is able to support household energy needs. However, on a large scale, biofuel energy has not been able to support the energy needs of the Indonesian population at large, so that the allocation of large subsidies aimed at developing biofuel infrastructure is still too fast. Meanwhile, biofuel energy is still in a transitional scale or development process.

In the context of eliminating fuel subsidies to maximize the reallocation of subsidies to biofuel development it is a burden to the community while the existence of biofuel energy is still very scarce. In addition, the transformation to biofuel energy requires the public's willingness to accept the existence of this energy. Analysis of the impact of biofuels must ensure that it has a balanced economic impact on society. The author has a similar argument with Richard York and Shannon Elizabeth Bell that during a transitional period what should be done is not to eliminate fossil energy directly because developing infrastructure and expanding the production of new energy sources can be seen as additional energy efforts (York & Bell, 2019). Situations of rising fuel prices or fuel poverty have an impact on financial difficulties (Burlinson et al., 2021). If the reallocation of fuel subsidies is carried out massively for the development of biofuel energy, it will result in a lack of domestic energy availability.

The reallocation of fossil energy subsidies to biofuel energy is a good policy for the

Indonesian government to have two forms of energy sources. In the long term, it will generate added value for the state budget and the national economy. In the short term, this reallocation policy cannot yet show that biofuel energy has a positive impact on the state budget and the national economy because the transition to biofuel energy requires state finances and income stability. Another consideration for biofuel energy efficiency is that energy raw materials come from food sources so that biofuel energy production in the long term and on a large scale will increase the price of raw materials for grains, corn, soybeans and so on which cannot be planted due to a shortage of garden land. Meanwhile, energy raw materials and food sources come from the same resources. It is difficult for Indonesia to depend on energy needs only on biofuel energy. The development of Indonesia's biofuel energy with a densely populated composition cannot depend on the use of waste or organic waste. So it requires other biofuel energy sources from food raw materials and does not eliminate the use of green fossil energy. On the other hand, Indonesia as a country that produces fossil fuels will experience a decrease in income due to the principle of developing new energy. Therefore the development of biofuel energy will lead to a decrease in state revenue budget. In addition, the government must also look at biofuel energy development studies and biofuel energy trade politics in the long term. The development of biofuel energy in an inclusive manner requires the availability of sufficient food or raw materials to sustain energy production.

Even so, energy transformation through downstream biofuels should be carried out but does not eliminate the use and subsidies of fossil energy because biofuels are still not able to meet the needs of the Indonesian people and have a long-term impact on energy independence. Subsidies on fossil energy are not eliminated immediately because the government's efforts for green fossil energy must also be another consideration so that subsidy reallocations can be

carried out periodically. Consideration of the policy of reallocating subsidies to biofuel energy as an effort for Indonesia not to experience dependence on global energy prices. The high global oil prices require the development of biofuel alternative energy. Biofuels as an alternative energy means to reduce the world's energy crisis by using various grains and biomass that enable energy independence are still in the process of transition or development (Bhattarai et al., 2011). Even though biofuel production is cheap if it uses food production waste, Indonesia's need for energy is not a small and short-term scope of needs. Thus it can be said that downstream biofuel energy has not yet achieved a significant impact on the State Budget and the national economy even though the study stated that biofuel energy is cheap and environmentally friendly. Biofuel energy is still an alternative energy, not the main energy source in Indonesia. Imagining biofuel energy as energy that supports the long-term state budget is quite wrong.

The author's argument refers to other renewable energy efforts, not only to biofuel energy. If you want a renewable energy source, don't just transform biofuel energy but build other energy such as hydroelectric energy and wind power. Steps to increase the use of water turbines and wind turbines for power generation are more likely because they are supported by Indonesia's abundant water resources. Water used as a source of electrical energy does not affect the availability of domestic water sources when compared to biofuel energy consisting of bioethanol, biomass and biodiesel originating from community needs. While the construction of wind turbines or wind power energy to support biofuel energy and eliminate fossil energy. The development of hydroelectric and wind power can be carried out in various regions in Indonesia with geographical conditions consisting of mountains and broad grasslands. Therefore, the Indonesian government needs further studies

and studies on the advantages and disadvantages of developing biofuel energy compared to fossil energy, especially its impact on the state budget, social and environment. Several studies have shown that the energy transition to first-generation biofuels will have a negative impact on global biodiversity, regardless of the type of feedstock used and where production takes place (Elshout et al., 2019).

## CONCLUSION

The ESDM ministry's policy regarding the allocation of 2022 APBN funds for biodiesel shows that energy transformation has begun. Even though the data shows that fuel subsidies in 2022 are still high, reaching IDR 502.4 trillion. Consideration of the biofuel energy downstream scheme needs to take into account the pattern of the harvest period for each raw material and the region, government subsidies on prices and taxes on fossil fuels. Indonesia as an agrarian country has a promising opportunity to make biofuels a substitute for fossil fuels and transform into renewable energy. On the other hand, Indonesia's very large population also produces more and more waste that can be managed into biofuel energy. Biofuel energy can encourage increased energy security in Indonesia.

In the long term, the reallocation of fuel subsidies to biofuels has a positive impact such as adding value to the State Budget, the national economy and downstream by focusing on areas producing biofuel raw materials. However, the development of biofuels has several challenges such as an unstable economic system, infrastructure, public shock due to the switch from fuel to biofuels. Therefore, downstream has not yet achieved a significant impact on the state budget and the national economy even though it is said that biofuel energy is cheap and environmentally friendly. Biofuel energy is still an alternative energy, not the main energy source



for Indonesia. The development of biofuel energy must consider the impact of fossil-based green energy development which is managed with high technology which has not yet achieved significant results.

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