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Analysis of Green Economic Growth, Biofuel Oil Consumption, Fuel Oil Consumption and Carbon Emission in Asia Pacific

Anggi Putri Kurniadi, Hasdi Aimon*, Syamsul Amar

Faculty of Economics, Universitas Negeri Padang, Padang 25132, West Sumatra, Indonesia

Corresponding Author Email: hasdi_aimon@fe.unp.ac.id

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ABSTRACT

This study expands research to analyze green economy, separated energy consumption and environment to achieve sustainable development in selected countries in Asia Pacific during the period 2006-2020 by using two-stage least square. The contribution of this study is to consider the use of green economic growth, which studies are still limited in terms of energy consumption indicators that have a substitution effect. This study found that green economic growth increased due to an increase in fuel oil consumption and technological innovation, as well as decreased fuel oil consumption, carbon emission and militarization. Furthermore, biofuel oil consumption increased due to an increased in green economic growth, fuel oil consumption, carbon emission, real oil prices, foreign direct investment and trade openness. In addition, fuel oil consumption increased due to an increase in biofuel oil consumption and population, as well as a decrease in green economic growth, carbon emission and trade openness. Finally, carbon emission increases due to an increase in fuel oil consumption and poverty. The government should implement a green economy program policy to reduce fuel oil consumption and carbon emissions, as well as increase biofuel oil consumption in Asia Pacific.

1. INTRODUCTION

Sustainable development in the energy sector has been formulated in the seventh goal on the Sustainable Development Goals (SDGs). The background of this agreement is to overcome the impact of the high use of non-renewable energy in the global energy mix, which causes an increase in carbon emission [1-3]. This condition is resulting in environmental problems and green economic growth, such as in Asia Pacific. The phenomenon that occurs is when green economic growth declines, the condition of fuel oil consumption growth tends to decrease, which should contribute to increasing green economic growth and reducing carbon emission growth [4-6]. The relationship between these conditions occurs because a decrease in fuel oil consumption will have implications for increasing the carrying capacity of the environment. Furthermore, the decrease in fuel oil consumption growth actually resulted in a decrease in the growth of biofuel oil consumption [7-12].

Literature reviews in recent years have carried out numerous studies about this topic, but they have not considered the impact of energy separated on economic and envieonment. There is the development of the relationship between variables as the novelty of our study. We refer to several relevant studies on this topic as the basis of our novelty. Studies on the group of developed countries, they found that renewable energy encourages economic growth, while not for non-renewable energy [13]. Furthermore, a study in Thailand, they found that consumption of non-renewable energy leads to carbon emissions, so modern technology is needed to streamline energy use [14]. While, studies in Latin America and the Caribbean, they found that environmental degradation occurs due to the role of fossil fuel consumption, oil import and urbanization [15]. Different conditions for United States, they found that there is a long-term relationship between the economy, energy consumption and the environment [16], in addition this result also occurs in Tunisia [17] and in CIS (Commonwealth of Independent States) [18]. Then, a study at BRICS (Brazil, Russia, China, India, and South Africa), they found that economic growth in the long term is driven by capital, labor and non-renewable energy consumption, while emission is driven by per capita income and non-renewable energy consumption, while not for renewable energy consumption [19]. Furthermore, a study in China, they found that carbon emission and high economic growth are due to the encouragement of non-renewable energy consumption, while consumption of renewable energy increases carbon emission but not for economic growth [20]. Later, a study in India, they found that there is a U-shaped pattern for renewable and non-renewable energy consumption, which is related to economic growth [21]. Then, different results for studies on BRICS, they found that causality is unidirectional from economic growth to carbon emission [22]. Different studies conducted in Asia Pacific, they found that green growth will be high if there is technological innovation, cleaner energy and energy conventions. Apart from that, environmental quality can be maintained if a green growth target is set and a shift in energy consumption is made [23]. The same study was continued in Asia Pacific, they found that the series of consumption and production activities of biofuels energy greatly determines the conditions for green growth and environmental damage [24]. Based on the background of several studies that have discussed

about this topic, there is an interplay between economic growth, consumption of biofuel oil as renewable energy, consumption of fuel oil as non-renewable energy and carbon emission.

First, the interplay between green economic growth and biofuel oil consumption can be reviewed using the green growth concept, where green economic growth is a positive sustainable economic growth that is realized by ensuring the efficient use of renewable resources after reduce damage from greenhouse gases, exploitation of natural resources and other negative externalities [1]. The calculation of green economic growth considers the cost of natural resource depreciation and the cost of damaging carbon emissions to environment. Based on this explanation, green economic growth will contribute to increasing biofuel oil consumption, because it must be supported by the use of environmentally friendly inputs to achieve a high level of green growth [3]. Furthermore, the biofuel oil consumption will also contribute to increasing green economic growth because the consumption of biofuel oil will not cause depreciation costs of natural resources and the cost of CO_2 emission damage, which it has implications for the high value of the calculation of green economic growth [8].

Second, the interplay between green growth and fuel consumption can also be examined using the green growth concept described previously. Green growth will increase consumption of non-renewable energy because to achieve a high level of green growth, one must avoid the use of inputs that cause environmental damage such as increased air pollution [10]. Furthermore, consumption of non-renewable energy will also contribute to reducing green economy emissions because consumption of non-renewable energy will lead to depreciation costs of natural resources and costs of carbon breakdown which have implications for the low calculation of green growth [15].

Third, the interplay between green growth and carbon emission can also be reviewed using the concept of green growth described previously. Green growth will contribute to reducing carbon emission because green growth is realized by the use of environmentally friendly inputs [11]. Furthermore, the increase in carbon emissions will contribute to lowering the quality of the environment as a result of development activities that do not take into account environmental components. In addition, carbon emission will result in environmental damage costs that must be paid such as natural resource depreciation costs and carbon emission damage costs, so it will lead to low green economic growth [18].

Fourth, the interplay between renewable energy consumption and non-renewable energy consumption. The empirical study conducted by Kahia et al. [7] found that there is a short-term causality between the consumption of renewable and non-renewable energy, resulting in substitution between the two energy sources in the 80 countries analyzed. In addition, the same results were also found in a study conducted by Apergis and Payne [9] in the MENA Clean Oil Exporting Country (Middle East News Agency). Furthermore, Chen et al. [20] also found the same results for China, they found that very high consumption of renewable energy could increase the demand for non-renewable energy.

Fifth, the interplay between renewable energy consumption and carbon emission has been carried out by various researchers, they found that renewable energy is a solution for mitigating environmental damage from emissions in Malaysia [13], as well as the case in Algeria [19] and the case for the United States [4]. Whereas a more complex analysis by Balsalobre-Lorente [16] was carried out for Germany, France, Italy, UK, and Spain, they found that renewable energy consumption, energy innovation and abundance of natural resources improve the environment. Furthermore, various studies have also been conducted to understand the impact of carbon emission on renewable energy consumption, such as [6] for the case of the European Union group of countries, they found that high carbon emissions will encourage renewable energy consumption to comply with the emission limits that have been set by government.

Sixth, the interplay between non-renewable energy and carbon emission has been carried out by various researchers, such as [2] for Pakistan, they found a positive impact between energy intensity on carbon emission. Furthermore, Gorus and Aydin [25] also found the same results. In addition, studies on developed countries also support the increase in emission levels caused by consumption of non-renewable energy. An empirical study by Gülden and Mert [26] on a group of Union countries, they found that consumption of non-renewable energy increases environmental degradation through high carbon emission. The same result was found by Farhani and Shahbaz [12] for the MENA country group analysis. In a recent study, [9] also provides strong evidence of the positive effect of non-renewable energy consumption on carbon emission in an analysis of 131 countries. Furthermore, various studies have also been carried out to understand the impact of carbon emissions on non-renewable energy consumption, several previous studies conducted on this topic such as Anser et al. [27], they found long-term and short-term causal relationships between variables were not uniform across sectors. Kang et al. [21] reviewed the evidence of carbon emission, consumption of non-renewable energy and economic growth in India, they found that increased carbon emissions have a negative impact on the use of non-renewable energy because the use of non-renewable energy in the production process has implications for reducing environmental quality.

Based on the interplay that has been explained, we also try to find a literature review regarding each of the determinants of green economic growth, biofuel oil consumption, fuel oil consumption and carbon emission to support our analysis.

1.1 Determination of green economic growth

Empirical studies have found several determinants of green economic growth, including technological innovation as an important foundation in reducing carbon emissions through increasing energy efficiency and productivity [23]. Furthermore, clean energy is an important component in supporting sustainable economic development [24]. In addition, militarization activities are related to competition between countries which results in environmental problems due to the land, air and sea infrastructure used [28].

1.2 Determination of biofuel oil consumption

Empirical studies have found several determinants of renewable energy consumption, including real oil prices resulted in the shift of the use of non-renewable energy to renewable energy [29]. Furthermore, foreign direct investment encourages new energy-efficient technologies, that increase the supply of renewable energy [7]. Then, trade openness is harmful to the quality of the environment, so its implementation must use clean energy sources [15].

1.3 Determination of fuel oil consumption

Empirical studies have found several determinants of non-renewable energy consumption, including trade openness encouraging economic growth, but limited demand for non-renewable energy to reduce environmental degradation [22]. Furthermore, the capital stock drives the supply of non-renewable energy [26]. Then, the population has a very strong dependence on non-renewable energy [30].

1.4 Determination of carbon emission

Empirical studies have found several determinants of carbon emission, including population growth puts pressure on demand for natural resources and pressure on environmental functions that cause environmental degradation due to high carbon emission [31]. Furthermore, the import of fuel oil causes the accumulation of carbon emission to occur very quickly [32]. Then, the poor tend to use low-quality non-renewable energy sources, which is resulting in high carbon emission [26].

Based on the description of the related literature, that there is a gap in the latest studies, so our study needs to be done because in order to produce economic and environmental policies in a sustainable manner, it is impossible to analyze the role of energy consumption without considering their alternatives. This is important because a separate study of energy consumption has a relationship with green economic growth to determine the policy direction of the energy convention in reducing carbon emission to achieve sustainable development.

2. METHODOLOGY

2.1 Data and variable

This study uses secondary data from several related agencies. The time series in this study is the period 2006 to 2020, meanwhile the cross section in this study is Asia Pacific countries (Australia, China, India, Indonesia, South Korea and Thailand).

Furthermore, the main variables in this study consist of four types, besides that we also consider the determinants that affect them. The relationship between variables is summarized in Figure 1.

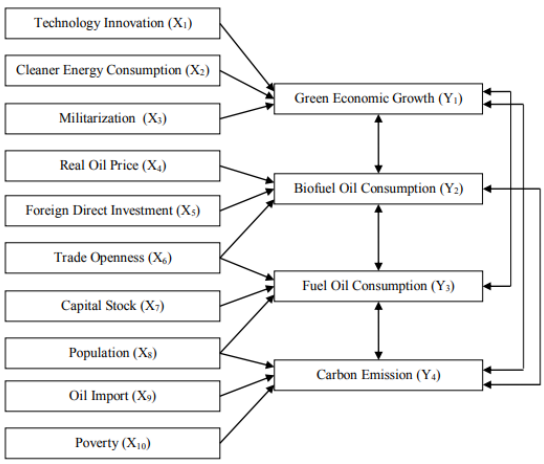

Figure 1. The relationship between variables

Based on Figure 1, the measures and sources for the variables in this study are:

Green Growth (Y_1) → Economic growth that internalizes environmental values, such as natural resource depreciation costs and emissions costs, measured in percent and data calculated by the author from the World Bank.

Biofuel Oil Consumption (Y_2) → Biomass consumption, measured in thousands barrels per day and data obtained from the BP Statistical Review of World Energy.

Fuel Oil Consumption (Y_3) → Fossil energy consumption, which is measured in thousand barrels per day and data obtained from BP Statistical Review of World Energy.

Carbon Emission (Y_4) → Carbon dioxide produced by energy consumption activities, which is measured in metric tons per capita and data obtained from World Bank.

Technology Innovation (X_1) → Development of environmentally friendly technologies, which is measured in citizen application patents and data obtained from World Bank.

Cleaner Energy Consumption (X_2) → The role of renewable energy in final energy, which is measured in percent and data obtained from International Energy Agency.

Militarization (X_3) → Spending on capital goods of the armed forces, which is measured in percent of GDP and data obtained from World Bank.

Real Oil Price (X_4) → Crude oil price, which is measured in US dollars per barrel and data obtained from BP Statistical Review of World Energy.

Foreign Direct Investment (X_5) → Net funding by foreign investors, which is measured in percent of GDP and data obtained from World Bank.

Trade Openness (X_6) → The ratio of exports and imports, which is measured in percent of GDP and data obtained from World Bank.

Capital Stock (X_7) → Growth in capital formation, which is measured in percent of GDP and data obtained from World Bank.

Population (X_8) → De facto residents regardless of legal status or citizenship, which is measured in souls and data obtained from World Bank.

Oil Import (X_9) → Annual import of petroleum product, which is measured in terra joules and data obtained from International Energy Agency.

Poverty (X_{10}) → The total number of poor people, which is measured in percent of population and data obtained from World Bank.

2.2 Analysis model

The equations to be analyzed in this study are obtained from the information in Figure 1.

$$Y_{1it} = \alpha_{1.0} + \alpha_{1.1}Y_{2it} + \alpha_{1.2}Y_{3it} + \alpha_{1.3}Y_{4it} + \alpha_{1.4}X_{1it} + \alpha_{1.5}X_{2it} + \alpha_{1.6}X_{3it} + \varepsilon_{1it} \quad (1)$$

$$Y_{2it} = \alpha_{2.0} + \alpha_{2.1}Y_{1it} + \alpha_{2.2}Y_{3it} + \alpha_{2.3}Y_{4it} + \alpha_{2.4}X_{4it} + \alpha_{2.5}X_{5it} + \alpha_{2.6}X_{6it} + \varepsilon_{2it} \quad (2)$$

$$Y_{3it} = \alpha_{3.0} + \alpha_{3.1}Y_{1it} + \alpha_{3.2}Y_{2it} + \alpha_{3.3}Y_{4it} + \alpha_{3.4}X_{6it} + \alpha_{3.5}X_{7it} + \alpha_{3.6}X_{8it} + \varepsilon_{3it} \quad (3)$$

$$Y_{4it} = \alpha_{4.0} + \alpha_{4.1}Y_{1it} + \alpha_{4.2}Y_{2it} + \alpha_{4.3}Y_{3it} + \alpha_{4.4}X_{8it} + \alpha_{4.5}X_{9it} + \alpha_{4.6}X_{10it} + \varepsilon_{4it} \quad (4)$$

where, α: constant, t: time series, i: cross section, ε: residual.

Based on Eqns. (1) to (4), this study methodology uses a simultaneous equation model, which is a model that has more than one related equation and has a causal relationship between variables. The main requirement in carrying out this methodology is an identification test using the order condition, which is obtained by comparing the difference between the exogenous variables in the model and in the equation against the difference in the endogenous variables in the equation minus the number 1. The conclusion of the comparison of the order condition is that if it is greater then it is overidentified, if it is the same then it is exactly identified and if it is smaller, it is underidentified. Furthermore, the estimation can be continued if the order condition is overidentified using Two-Stage Least Squares (2SLS) and exactly identified using Indirect Least Squares (ILS).

The 2SLS method is implemented through the use of Ordinary Least Square (OLS) in two stages. In the first step, each endogenous variable is regressed against all pre-determined variables of a system so that we get the reduced form equation. The second stage, the forecast value is used to estimate the structural equation of the model. The estimated value or forecast of the endogenous variable is obtained by entering the observed value of the exogenous variable into a simple equation of the form. The estimated values of the endogenous variables do not correlate with the confounding error, so 2SLS produces consistent estimates of structural parameters.

The ILS method follows three steps. First, make an equation of a simple reduced form, in which the dependent variable in each equation is only the endogenous variable Y, as a function of the predetermined variables. Second, using the OLS method for each equation individually. This is allowed, because the explanatory variables in these simple form equations have predetermined values and are not correlated with confounding errors. Third, obtain an estimate of the coefficient of the simple form which is the result of the second step, meaning that an estimate of the coefficient of the simple form produces an estimate of the structural coefficient.

3. RESULTS AND DISCUSSION

The order condition calculation that we have done for all equations is overidentified (2SLS), which is shown in Eqns. (5) to (8).

$$Y_1 \rightarrow 10-3>4-1 \quad 7>3 \tag{5}$$

$$Y_2 \rightarrow 10-3>4-1 \quad 7>3 \tag{6}$$

$$Y_3 \rightarrow 10-3>4-1 \quad 7>3 \tag{7}$$

$$Y_4 \rightarrow 10-3>4-1 \quad 7>3 \tag{8}$$

Furthermore, the interpretation of the simultaneous equation model for each equation is shown in Eqns. (9) to (12). We determine the significance of the variable from the probability value, which value can be seen in ( ), if the value is smaller than 0.01 (α=1%), 0.05(α=5%) and 0.10 (α=10%), then the variable has a significant effect.

$$\begin{aligned} Y_{1it} = {} & -37.25519\ (0.0027) + 8.802967\ (0.0000)Y_{2it} \\ & -6.153964\ (0.0001)Y_{3it} - 1.202035\ (0.0087)Y_{4it} \\ & + 4.756133\ (0.0104)X_{1it} + 0.061329\ (0.3193)X_{2it} \\ & - 0.418528\ (0.0465)X_{3it} \end{aligned} \tag{9}$$

The information in Eq. (9) are the influence of increasing biofuel oil consumption, technological innovation and cleaner energy consumption will increase green economic growth. Contrasting conditions for increasing fuel oil consumption, carbon emission and militarization will reduce it.

The characteristic of biofuel oil is renewable and environmentally friendly energy, so this consumption can encourage green economic growth because it does not incur environmental damage costs [25]. These results support the investigation of Kurniadi et al. [24], they found that the use of biofuel oil is one of the supporting factors for sustainable development.

Fuel oil consumption will reduce the carrying capacity of the environment because it produces high carbon emissions from its combustion, so that it will cause emission damage costs and reduce green growth [26]. These results support the investigation of Aimon et al. [23], they found that the use of non-renewable energy would cause various costs of environmental damage.

Carbon emissions will damage the environment from its pollution and reduce environmental quality because it does not internalize environmental values, thereby reducing green economic growth [27]. These results support the investigation of Aimon et al. [23], they found that emissions must be controlled in order to achieve sustainable development.

Technological innovation is the main key in reducing carbon emissions for the development of alternative energy, which is cleaner and modern [28]. These results support the investigation of Liu and Dong [29], they found that technological innovation could create more environmentally friendly ways of consuming energy to promote green growth.

Cleaner energy consumption does not contribute to green economic growth because the energy consumption mix is still dominated by non-renewable sources [30], so the effect of cleaner energy has not played a significant role. These results support the investigation of Kurniadi et al. [24], they found that the contribution of renewable energy must be increased in achieving the success of cleaner energy consumption.

The attributes of military activity vehicles produce high air pollution because they use large amounts of non-renewable energy, so this condition reduces green economic growth [31]. These results support the investigation of Sohag et al. [32], they found that militarization causes environmental damage and reduces green growth.

$$\begin{aligned} Y_{2it} = {} & -0.407770\ (0.4247) + 0.043297\ (0.0000)Y_{1it} \\ & +0.868187\ (0.0000)Y_{3it} + 0.097254\ (0.0000)Y_{4it} \\ & +0.1098280\ (0.0493)X_{4it} \\ & +0.014720\ (0.0567)X_{5it} + 0.040389\ (0.0000)X_{6it} \end{aligned} \tag{10}$$

The information in Eq. (10) are the influence of increasing green economic growth, fuel oil consumption, carbon emission, real oil price, foreign direct investment and trade openness technological innovation and cleaner energy consumption will increase biofuel oil consumption.

Green growth can help a country to make energy shifts towards cleaner ones [33], because the condition can be achieved if the input used is renewable energy sources, such as biofuel oil. These results support the investigation of Kurniadi et al. [24], they found that they found that the use of

renewable energy should be prioritized for a green economy.

The type of energy between fuel oil and biofuel oil has a substitution effect because it is a need-satisfying item that can replace each other [34]. The level of demand for an item such as energy consumption affects each other, so that these two types of energy demand will also affect their respective price levels. These results support the investigation of Güney [35], they found that increase in demand for fuel oil demand will be diverted to biofuel as an alternative.

Carbon emission is a crucial environmental issue, so a strategy is needed in the form of prioritizing biofuel oil energy to increase environmental carrying capacity [36]. These results support the investigation of Akram et al. [37], they found that carbon emissions should be reduced by increasing the energy use of biofuel oil.

The increase in crude oil prices resulted in a shift in energy consumption towards alternative energy [38]. These results support the investigation of Zhao et al. [39], they found that an increase in real oil prices will have an impact on the development of renewable energy conversion.

Foreign direct investment actors are multinational companies, where they are accustomed to strict environmental regulations to maintain environmental quality. Foreign direct investment will encourage the use of energy-efficient technologies and new production methods that have the potential to increase renewable energy such as biofuel oil in investment destination countries [40]. These results support the investigation of Aimon et al. [23], they found that foreign investors will prioritize environmental quality because of the culture of their home country.

Trade openness between countries demand the use of renewable energy at the global level to avoid increasing emissions at the global level, which is in line with the seventh goal of the SDGs [5]. These results support the investigation of Abbas et al. [8], they found that trade openness would promote energy conversion to maintain the global climate.

$$\begin{aligned} Y_{3it} = {} & -1.432164\,(0.1686) - 0.032918\,(0.0030)Y_{1it} \\ & + 0.935415\,(0.0000)Y_{2it} - 0.094947\,(0.0305)Y_{4it} \\ & - 0.002948\,(0.0440)X_{6it} - 0.011369\,(0.1190)X_{7it} \\ & + 0.195523\,(0.0210)X_{8it} \end{aligned} \quad (11)$$

The information in Eq. (11) are the influence of increasing biofuel oil consumption and population will increase fuel oil consumption. Contrasting conditions for increasing green economic growth, carbon emission and trade openness will reduce it.

The use of fuel oil has the potential to cause air pollution, which is one part of environmental damage and reduces green growth [41]. These results support the investigation of Aimon et al. [23], they found that fuel oil consumption must be reduced to achieve green growth.

Biofuel oil consumption has a substitution effect on fuel oil energy. If a country has a high total demand for biofuel oil, which it will cause the price of biofuel oil to rise, so that country will switch to using alternative energy [9]. These results support the investigation of Akadiri and Adebayo [11], they found that the energy of biofuel oil and fuel oil is interchangeable.

Carbon emissions that occur on an ongoing basis result in limited fuel oil consumption to maintain air quality [42]. These results support the investigation of Aimon et al. [23], they found that carbon emissions must be addressed by shifting clean energy consumption.

Trade openness will reduce the demand for fuel oil consumption because as long as the need for the consumption sector and the production of goods and services is traded between countries, this activity will involve the use of effective energy sources to avoid increasing emissions globally [20]. The use of fuel oil energy in trade openness activities will trigger environmental damage because the impact caused by the use of fuel oil is an increase in emissions that trigger global warming so that its use must be limited. These results support the investigation of Han et al. [43], they found that trade openness does not contribute to fuel oil consumption.

Capital stock does not contribute to fuel oil consumption because the target on the SDGs to achieve increased investment in energy efficiency towards clean energy [18]. These results support the investigation of Banday and Aneja [22], they found that a country needs to shift investment activities to alternative energy to cope with the high energy demand in the future.

The population's need for the energy sector cannot be avoided because energy is an important commodity for the community to support various activities. A high population indicates a large population which will increase the demand for fuel oil consumption because the energy sector is a basic need for the population [30]. These results support the investigation of Shen et al. [28], they found that an increase in population would be accompanied by an increase in the demand for non-renewable energy consumption.

$$\begin{aligned} Y_{4it} = {} & 7.908345\,(0.0000) - 0.022400\,(0.6989)Y_{1it} \\ & - 0.205547\,(0.7450)Y_{2it} + 1.199419(0.0289)Y_{3it} \\ & + 0.902115\,(0.0000)X_{8it} + 0.193563\,(0.0379)X_{9it} \\ & + 0.039311\,(0.0397)X_{10it} \end{aligned} \quad (12)$$

The information in Eq. (12) are the influence of increasing fuel oil consumption, population, oil import and poverty will increase carbon emission.

Green economic growth does not contribute to carbon emission because the growth trend is negative because the cost of environmental damage is relatively high [21]. The low green economic growth indicates that the environmental carrying capacity has not been fully considered in encouraging high economic growth. These results support the investigation of Aimon et al. [23], they found that that carbon emission reductions can be achieved through green growth programs, one of the strategies is using alternative energy.

Biofuel oil consumption does not contribute to carbon emission because the proportion of renewable energy to total energy consumption is still small, so it will be difficult to have an impact on reducing emissions [33]. These results support the investigation of Kurniadi et al. [24], they found that increasing the use of biofuel oil in the energy mix is important for reducing carbon emission.

Fuel oil energy is a type of energy that is not environmentally friendly, so the temperature of the planet earth will increase because carbon gas is trapped in the atmosphere [19]. These results support the investigation of Kurniadi et al. [24], they found that people tend to use conventional energy sources such as fuel oil because public awareness of using alternative energy is still low, which causes air pollution.

The population that continues to grow will require a large supply of energy and most people currently still use a lot of energy that is not environmentally friendly, such as fuel oil. Its use in meeting the needs of the community has caused air pollution [38]. These results support the investigation of Yang

and Wang [44], they found that a growing population will require large amounts of energy sources such as fuel oil, which leads to environmental degradation such as increased gas emissions.

Oil import are related to the purchase of energy from fossils, which are part of energy that is not environmentally friendly because its use will produce CO_2 emissions [29]. These results support the investigation of Gyamfi [45], they found that oil import is activities to purchase non-renewable energy sources from countries exporting non-renewable energy sources such as fuel oil, which have an impact on environmental quality.

The most of the poor people use conventional energy such as burning wood and use low-quality fuel oil, which will cause air pollution and will have an impact on climate change such as global warming [33]. These results support the investigation of Kurniadi et al. [24], they found that the poor had a very high dependence on the environment and poor conventional energy, thus increasing carbon emission.

4. CONCLUSIONS AND POLICY IMPLICATION

Green economic growth in Asia Pacific is achieved due to the increase in biofuel oil consumption and technological innovation. On the other hand, reducing of fuel oil consumption, carbon emission and militarization can also increase green economic growth.

The strategy that can be taken by policy makers for green growth is to implement a green economy program in a series of economic activities to encourage public policy in creating a green economic system that balances economic growth and environmental protection by taking into account the carrying capacity of the economy. environment. This program needs to be carried out so that every development can maintain a good ecological function, such as implementing a policy of energy transition to clean and sustainable energy through the development of alternative energy to encourage sustainable green economic growth. In addition, it is also necessary to develop technological innovations because this is the key to developing renewable energy towards the energy transition in achieving increased sustainable green economic growth.

Biofuel oil consumption in Asia Pacific is achieved due to the increase in green economic growth, fuel oil consumption, carbon emission, real oil prices, foreign direct investment and trade openness.

The strategy that can be taken by policy makers for the consumption of biofuel oil is to strengthen coordination between domestic institutional structures to support investment in energy conventions, such as joining the Clean Energy Demand Initiative (CEDI), which is an initiative of the United States Government that is willing to invest in energy sector. This is important because the public and private sectors must work together to achieve common goals related to climate and energy at the global level. Through CEDI, a country can send a clean energy demand signal.

Fuel oil consumption in Asia Pacific is achieved due to the increase in consumption of biofuel oil and population. On the other hand, reducing of green economic growth, carbon emission and trade openness can also increase fuel oil consumption.

The strategy implemented by the government to reduce fuel oil consumption is to develop alternative energy in the form of biofuel oil to replace the use of fuel oil energy. This step needs to be taken because the use of alternative energy is one of the efforts to reduce the use of hydrocarbon energy which causes pollution and has the potential to damage the environment, so that alternative energy is more environmentally friendly and able to prevent environmental damage. The use of alternative energy sources will also reduce people's dependence on fossil fuel sources such as fuel oil, which is limited in number and must be imported from other countries to meet domestic needs.

Carbon emission in Asia Pacific s achieved due to the increase in biofuel oil consumption, population, oil import and poverty.

The strategy implemented by the government to reduce carbon emission is to actively participate in the net zero emission program, which is a condition where the amount of carbon emissions released into the atmosphere does not exceed the amount of emissions that can be absorbed by the earth. To achieve this requires a transition from the energy system used today to a clean energy system in order to achieve a balanced condition between human activities and the balance of nature. Furthermore, the steps that can be taken by the government to implement a net zero emission program include creating a legal framework to reduce short-term and long-term emissions through legal instruments: laws, contracts, regulations, which have the dimension of sanctions so that they become a reference in policy.

The study on the analysis of green economic growth, biofuel oil consumption, fuel oil consumption and carbon emission in Asia Pacific that has been carried out has several limitations, which limitations in this study become recommendations for future research. The limitations of this research are in terms of methodology. The analysis resulting from the applied methodology cannot produce analysis for the short and long term, even though the separation of this time period is very important to produce more specific policy recommendations for each time period in achieving sustainable development goals based on the agreement on the SDGs (Sustainable Development Goals). Furthermore, the limitations of this study are also in terms of variable placement. Poverty as one of the variables used in this study is positioned as an exogenous variable, poverty should be positioned as an endogenous variable because poverty is not a causal variable, but is one of the economic problems caused by various factors that influence it.

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