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The Impact of Fossil Energy Transition towards Renewable Energy on Economic Development Sustainability

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Abstract:- The energy transition from fossil energy to renewable energy is an important discussion for each country along with the decreasing supply of fossil energy due to the increasing dependence on fossil energy demand. The shift towards decentralized renewable energy provides added value in encouraging the sustainability of economic development, especially in ASEAN. This study aims to analyze the impact of fossil and renewable energy consumption on the sustainability of economic development and measure the speed of adjustment of the energy transition. The analytical method used is the Panel Vector Error Correction Model (VECM Panel) covering 8 ASEAN countries. The results showed that renewable energy and natural resource rents variables were significant for economic growth, while fossil energy consumption was not statistically significant. The response of economic growth to fossil energy shows a small deviation compared to renewable energy with a positive and negative relationship pattern and reaches a steady state. This indicates the increasing commitment of countries in ASEAN 8 to the use of renewable energy in development. The increase in consumption of fossil energy is responded to by a deviation in the response of renewable energy that is greater than if there is an increase in consumption of renewable energy to fossil energy. It takes 6 periods of time horizon time to reach steady state conditions for the transition from fossil energy showing renewable energy.

Keywords:- *Energy Transition, Fossil Energy, Renewable Energy, Sustainable Economic Development.*

I. INTRODUCTION

The sound of green taxonomy at the Conference of Parties (COP26) in Glasgow after the Paris Agreement of 2015 became a milestone in countries' commitment to mitigating climate change, namely the target of reducing global temperatures below 2 to 1.5 degrees Celsius. The global energy sector is responsible for 80% of anthropogenic and coal emissions. Energy crisis in Asia and Europe with a super cycle of fossil energy prices that have skyrocketed post-pandemic due to the lack of supply and high demand for fossil energy. The energy commodity market corrected so deeply that the price of Liquefied Natural Gas (LNG) skyrocketed by 40% to the highest level of US$ 56.33 per million British thermal units (mmBtu) or equivalent to US$ 320 per barrel of crude oil which is currently at the level of US$ 81 per barrel.

Efforts to transition clean energy or zero-carbon emissions are the goals of many countries. At the end of 2019, renewable energy capacity reached 2,537 GW, an increase from 176 GW compared to the previous year (IRENA, 2020) [1]. Singapore is the leading country in Southeast Asia to transition energy from fossil to renewable sources. In a World Economic Forum (WEF) report, Singapore has an energy transition index of up to 67 points, thus placing it in the first position of Southeast Asia or 21 out of 115 countries of the world. Malaysia and Thailand followed with 64 and 60 points. Singapore, Malaysia, and Thailand's ETI were above the global average of 59.3 points. Meanwhile, Vietnam and the Philippines bagged the same score of 57 points. Indonesia is 56 points, sixth in Southeast Asia or 71st globally (https://databoks.katadata.co.id/). The right energy transition policy will make it easier to reduce the pace of climate change in regional regions such as Southeast Asia. Therefore, every country should consider capabilities based on energy potential, technological maturity, economic feasibility, investment opportunities, and job creation such as green jobs. Planning for the energy transition to clean energy is based on the needs of each country specifically to mitigate climate change.

ASEAN is among the regions with rapid eco-economic growth where electricity demand in ASEAN has risen 6 percent annually in the last 20 years, according to an Electricity Market report from the International Energy Agency (IEA) in December 2020. ASEAN has a regional target of achieving 23% of the NRE mix in the Total Primary Energy Supply (TPES) by 2025 where since 2019 the newly installed power generation capacity has mostly come from water and solar PV. However, the dependence on fossil energy in ASEAN is still quite high as an energy source that accounted for 31.4% of installed power capacity in 2020. Therefore, it is necessary to continue to develop New and Renewable Energy (EBT) massively such as Solar PV, Wind, Biomass, Geothermal, Battery Energy Storage Systems (BESS), construction of transmission interconnections and smart grids, development of electric vehicles, and reducing the use of fossil energy resources.

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On the other hand, when the world technological developments continue to grow, demand fossil energy was high, including the greenhouses which is also needed along with the increase in their existence. Technology is improving and the number of greenhouses is increasing in the world. The existence of a greenhouse has an influence in addition to the process of providing plants with a stable temperature, it also keeps the earth's temperature warm and prevents infrared from escaping into the earth's space. So a greenhouse is needed for future production (Kweku, D. W. (2018**) [2].** However, the increase in the number of greenhouses also affects the pollution produced in the world. The relationship between greenhouse gas (GHG) emissions and economic growth has been intensively analyzed on Environmental Kuznets Curve of Greenhouse Gas Emissions Including Technological Progress and Substitution Effect by Liobeikiene, G. & Butkus, M. (2017) **) [3].** The said when the classical EKC function is modified, can find that if other growth factors was constant, and an increase in energy use efficiency of 1% will result in a direct GHG pollution reduction of 0.87% and an indirect increase in pollution through induced economic growth effects of 0, 87%. Meanwhile, if the share of renewable energy sources in total final energy consumption increases by 1% point, this will reduce GHG pollution by 0.92% while taking into account other factors. Therefore, increasing energy efficiency and promoting renewable energy consumption is one of the main tools for realizing EKC at the world level.

The Energy Transition Mechanism (ETM) program, one of which is through the termination of coal-fired power plant operations, has received support from various parties. Each country will establish ETM facilities and accelerate the purchase of coal-fired power plants to accelerate the end of the plant. The effects of increased carbon emissions in the future, without the Energy Transition Mechanism (ETM) could affect financial stability. This happens as a result of the company registering the risk of carbon emissions and later claiming insurance which is largely responsible in future Carney, M. (2015)) [4]. In addition to ETM, there are 3 (three) strategies prepared by the Indonesian government for the energy transition. First, the energy transition must be adjusted to the capacity and circumstances of each country. Second, innovative low-emission technologies such as CCS/CCUS technology can in some ways be applied to existing fossil power plants to accelerate emissions reductions and switch to cleaner, greener energy. Finally, the importance of cooperation with ASEAN countries in developing interconnected energy transition paths. In Indonesia, the signal of a decline in coal demand has entered a sunset phase and is referred to as stranded assets.) This can be seen from the initiation of the State-Owned Enterprise (PLN) which is committed to stopping steam power plants (PLTU) by 2030 as a decarbonization step in the electricity sector. Not to mention, the International Energy Agency (IEA) said that the target of zero-carbon emissions by 2050 will be achieved if there are no more coal-fired power plants and new mines by 2021. The coal moratorium must be followed by a coal exit policy through the coal retirement mechanism (CRM) for a period of 15 years (IESR, 2021) **[5].** Acquisition of the transition of steam power plants to renewable energy development. At this level, the combination of sustainable energy is increasingly inevitable. Renewable energy diversification is increasingly massive and even a trigger for energy investment after the COVID-19 pandemic. Although the demand for renewable energy is still relatively slow in realizing the global climate towards net zero by 2050.

This shift opens space as well as opportunities for the private sector and investors to anticipate a decline in global market demand for coal commodities. Moreover, there is a significant price increase. Even the energy transition puts an asocial, economic, and environmental perspective on the urgency of energy transition planning policies. Challenges in responding to fossil energy investment risks and financial system stability, discussion of stranded assets, and diversification of local economies in affected areas are important issues that will be discussed at the G20 meeting in 2022. Currently, the government is focused on synchronizing energy planning policies. The National Energy Plan (RUEN) and Regional Energy Plan (RUED) must be more ambitious in achieving clean energy targets by 2030 and 2050. Decarbonization is not just a shift from fossil fuels to renewables but gives room for modernization and restructuring of energy markets, ownership of energy infrastructure and investment, and new socioeconomic dynamics of society.

Renewable energy is shifting the geopositioning of political and economic power. The decentralized statistics inherent in renewable energy are capable of democratizing energy systems and presenting new actors and business models. The low cost of solar Photo Voltaics (PV) and wind power, is an example of the independence of people's sources of electrical energy. Referring to the McKinsey report (2021) that the local energy ecosystem is becoming more diverse. Similarly, the cost of generating electricity from renewable energy is increasingly competitive. The green economy is the absolute choice of sustainable development. So, in this position, it is necessary to optimize energy efficiency and mitigate climate change. The energy transition is at the core of achieving sustainable development goals (SDGs). Therefore, energy institutions must be able to ensure the accessibility, affordability, availability, equality, and reliability of clean energy. This includes reforming energy subsidies while maintaining the affordability and security of energy supplies. The objectives of this study are (1) to analyze the impact of fossil and renewable energy consumption on the sustainability of economic development in ASEAN; (2) to measure the speed of adjustment of the transition from fossil energy to renewable energy in ASEAN.

II. LITERATURE REVIEW

A. Sustainable development

Sustainable economic development has become a concept that has begun to be accepted by the global and implemented for a long time. The overall goal of sustainable development is long-term economic and environmental stability that can be achieved through the integration and recognition of economic, environmental, and social issues during the decision-making process. Sustainable development has traditionally been defined as building aimed at meeting

the needs of the present generation without compromising the availability and capability of needs of future generations (Jaramillo-nieves and Río, 2010)) [6].

The concept of sustainable development has become a new global agenda consisting of 17 core goals of the SDG's agenda (Navarrete et al, 2020)) [7]. Among these goals, about 169 targets are distributed in critical areas that are a priority for humanity and the planet. There are as many as 230 indicators with the overall goal of ensuring that no one is left behind in addressing development problems by 2030. SDGs are a complex development priority of all interconnected lifelines. One of the grand goals of SDGs is to protect the earth from environmental degradation including through sustainable consumption and production, managing natural resources sustainably, and taking prudent actions for climate change and so on so that it can support the preservation of the earth's existence to meet the needs of future generations (Navarette et al. 2020) [7].

The SDGs reflect ambitious development goals with a transformative vision and support by each of the 193 UN countries. So elementary schools provide opportunities as well as great challenges for developing countries around the world (Bhattacharya et al. 2016)) [8]. . The SD also reflects a global consensus on the desired future for long-term goals. The global economy is recovering, and the emergence of new crises both social and economic tends to dictate many development policies. This condition makes it difficult for developing countries to properly implement the SDG. Based on the study of Bhattacharya et al, (2016) [8] presented a series of recommendations that can be made to realize the implementation of the SDGs in developing countries. Implementation at the national level relies heavily on the accuracy of integration of the global agenda. This happens because there are national and sectoral development figures in each country so SDG integration can be achieved by comparing planned national development and identifying and reducing gaps that arise.

Kyn, P. (2020**) [9]** on their study "Composite index as a measure on achieving Sustainable Development Goal 9 (SDG-9) industry-related targets: The SDG-9 index" was found the SDG-9 index as a measurement of any country progress to achieving industry-related targets of Sustainable Development Goal 9 (SDG-9). The SDG-9 index represents a comprehensive and broad approach to assessing the extent to which countries' industrialization processes support social inclusiveness and minimize the use of natural resources and environmental impacts. The selection of indicators is based on the global indicator framework for the Goals and targets of the 2030 Agenda adopted by the United Nations General Assembly. The resulting SDG-9 index benchmarks inclusive and sustainable industrial development in 128 economies over the period 2000–2016. Thus, the SDG-9 index forms a valuable tool for policy makers and analysts.

The successful implementation of SDG targets, targets, and indicators requires a public role, one of which is the provision of public goods that can occur through public sector policies so there needs to be clear coordination. Innovation and a future-oriented mindset must be a priority so strong support and motivation for the provision of public services are needed (Winnie, 2015) **) [10].** We can call it "green sustainable economy" towards the study from Volz, U. (2017) [11]. To achieve a green transformation towards low-carbon, sustainable growth and development, The involvement of the financial sector and other supervisory authorities is essential. The central banks and other financial authorities may play in ensuring and selection financial activity are green sustainable economi or not.

In China, as the largest carbon emitter in the world, has a Low Carbon Model Policy (CLCP), which is able to reduce carbon dioxide emissions significantly. Then research was carried out by Yang, F. (2019) [12] which sought to find out the relationship between the CLCP policy and regional economic growth. First, the CLCP policy significantly encourages regional economic growth and encourages greater economic growth in the future. Then, although CLCP increases production costs, on the other hand it can increase output productivity and business benefits. The existence of the CLCP regulations also brings innovations carried out by producers so that production costs do not increase further.

Whereupon, what happens if policy makers and banking authorities doesn't take action on environmental issues? Research in Turkey in the period 1960-2011 using the Johansen cointegration test, resulted in their testing that there was a cointegration relationship between income and CO2 emissions. The results by reading the EKC graph show an N or U-inverted shape, which in turn implies that the EKC hypothesis is not supported by the reality in Turkey. Basically, increasing income and economic growth do not bring about social environmental issues, and awareness of the environment and pollution improves. In fact, by not adopting environmental policies with an inverted U curve, Turkey continues to have high pollution at a time of high economic growth (Yurttagüler, I.M. & Kutlu, Sinem, 2017) [13].

B. Environmental Kuznets curve (EKC)

The relationship between environmental degradation and economic development is described in the hypothesis of the Environmental Kuznets Curve (EKC) with the shape of the Inverted-U curve. It is stated that a country's economic growth encourages an increase in the concentration of gas pollution emissions and will experience a turning point after the optimal point where increased development will reduce environmental degradation. Kurueger (1991) was the first study to develop the EKC hypothesis from Kuznets (1955)) [14]. Several other empirical studies on testing the EKC hypothesis have been widely carried out in various countries, and most use CO2 emissions as a proxy for environmental degradation because it has the largest concentration of emission contributors, which is 92 percent. EKC is essentially an empirical phenomenon, but most of the EKC model's estimates are not statistically robust.

The Kuznets curve represents a new existence populated by environmental degradation (environmental quality) and per capita income moving along with an inverted U-curve. This relationship of reflected economic growth to per capita

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income with environmental quality indicators is known as the Environmental Kuznets Curve (EKC). The EKC hypothesis is to show a long-term relationship between environmental impact and economic growth. Along with the rapid and rapid development of the economy with the intensification of several sectors that are at the stage of takeoffs such as the agricultural sector and other resource extraction resulting in a depletion of resource availability. This results in the availability of resources greater than the regeneration resources which in turn will cause the quantity of waste to increase. At this point, there will be structural changes in the industry so that there will be an increase in awareness of the environment accompanied by technological developments and environmental enforcement regulations.

Kumar's study (2011)) [15] examines the causality between energy consumption, CO2 emissions, and economic growth in Indonesia which states that energy consumption, capital, and population have an impact on economic growth but not vice versa. CO2 emissions have an impact on energy use and capital but are inversely proportional to population and GDP. Meanwhile, energy consumption has a positive effect on CO2 and GDP but not on capital and population. Meanwhile, the study of Benavides et al (2017)) [16] analyzed the relationship between methane emissions (CH4), GDP, electricity production, and trade openness using an autoregressive distributed lag method model. The results of the analysis show that in the long run, the U-shaped EKC pattern is inverted and there is an indirect relationship between CH4 and other variables. So, the implication is the importance of development planning in mitigating climate change.

Acheampong (2018)) [17] using the vector autoregression (PVAR) panel examined the dynamic relationship between economic growth, carbon emissions, and energy consumption in 116 countries during 1990–2014. The results of the study show that at the global and regional level, economic growth does not cause energy consumption, except for the Caribbean-Latin America global, economic growth has no impact on carbon emissions. Carbon emissions have a positive effect on economic growth in Sub-Saharan Africa and negatively on the global level, Middle East, and North Africa (MENA), Asia-Pacific, and Caribbean-Latin America. Energy consumption positively affects MENA's carbon emissions but negatively in sub-Saharan Africa and Caribbean-Latin America. Except in MENA and globally, carbon emissions have no effect on energy consumption. The Environmental Kuznets curve (EKC) hypothesis is proven on a global and sub-Saharan African scale.

The relevance idea of the Environmental Kuznets Curve (EKC) with the Interved-U form in the new world conditions, was discussed by Gill, A.R., et.Al (2017) [18]. , they showed that this concept is not relevant today. That concept was relevance just on 1990. Especially for developing countries where natural damage during economic development with EKC concept is becoming a problem, bigger in the future. In fact, the world may no longer experience such natural damage again. The point recommendations of Gill Study are that developing country shouldn't follow EKC concept for their sustainable economic development. They should choose a growth economic path that isn't detrimental to the environment. So that stock of pollution created by advanced countries can be contained and advanced countries should make green technologies affordable to developing countries.

Other research also shows the irrelevance of the EKC concept to Ghana in the 1970s until 2010. Studies show that Ghana is actually experiencing a U-Shape concept Environtment, where increasing for per capita income is also driven by an increase in gas emissions. Then the increase in per capita in 1996 to 1997 was not able to overcome the carbon emissions increased (Twerefou, D.K. et Al, 2016) [19].

In tests in ten European Union (EU) countries from Central and Eastern Europe (CEE) in the period 1990-2014, the ARDL test showed that the use of renewable energy consumption was feasible to European Union. Both in the short term as a new energy paradigm, while the long-term approach is related to the long-term balance of the factors analyzed (Marina, M. (2020) [20].

Aye (2017)) [21]. investigates the effect of economic growth on CO2 emissions in 31 developing countries. The results show that economic growth has a negative impact on CO2 emissions for low-growth countries but vice versa for high-growth countries. So the EKC hypothesis is not proven and instead the curve pattern is U. Energy consumption and population have a positive and significant influence on CO2 including the development of the financial sector does not prove the EKC hypothesis. So, the transformation of technology with low carbon concentrations is very important in reducing emissions and the sustainability of economic growth including energy efficiency and renewable energy.

On the other hand, the study by Williamson, C. (2017) [22]. Looking for evidence of the environmental existence of the Kuznets Curve for greenhouse gases consisting of carbon dioxide and methane. This research also suggests additional measuring tools to determine the impact of the EKC shift, namely from education and politics as represented by GDP per capita figures.

III. RESEARCH METHOD

The type of data used in this study is secondary and panel data from ASEAN countries. The analysis method used is the Panel Vector Error Correction Model (P-VECM) panel. The P-VECM describes short-term interactions between individuals or cross-sections and the temporary effect of long-term balance individuals on other individuals in the panel, changes in the rank of cointegration between individuals.

Here is the Vector Error Correction (VECM) panel model.

$$\Delta z_{it} = \Gamma_1 \Delta z_{it-1} + \ldots + \Gamma_{p-1} \Delta z_{it-p+1} + \Pi z_{it-p} + u_{it} \quad (1)$$

$$\Gamma_n = -(I - A_1 - \ldots - A_i), n = 1, \ldots, p-1 \quad (2)$$

$$\Pi = -(I - A_1 - ... - A_p) = \alpha\beta' \quad (3)$$

Where:
Z is an endogenous set of variables consisting of
CF = Fossil energy consumption
GDP Growth = GDP growth
CR = Renewable energy consumption
Rent = Natural resource rent

α is a matrix of adjustment speed
β is a matrix of long-term coefficients

Some of the variables used in this study are:

- Fossil energy consumption includes coal, oil, petroleum, and natural gas in units of a percent (%)
- Renewable energy consumption is the share of renewable energy to the total final energy consumption (%)
- Total natural resource rent is the amount of profit income from oil, natural gas, coal, minerals, and forest rents (% of GDP)
- Economic growth as measured by gross domestic product (GDP) growth based on constant prices.

The source of data is obtained from the statistical data of the World Bank.

IV. RESULT

The VECM estimation aims to look at the interrelationships of endogenous variables in the long and short term. Based on the results of long-term estimates, only the variable consumption of fossil energy does not have a significant effect on economic growth at α=10%, while the variables of renewable energy and natural resources rent have a significant effect.

Table 1 Long-Term and Short-Term VECM Estimation Results

GROWTH(-1)	**1.000000**			
FE(-1)	**-0.099852**			
	(0.08863)			
	[-1.12661]			
RE(-1)	**-0.139719**			
	(0.07953)			
	[-1.75685]			
NR(-1)	**0.139547**			
	(0.06789)			
	[2.05563]			
C	**4.909965**			
Error Correction:	**D(GROWTH)**	**D(FE)**	**D(RE)**	**D(NR)**
CointEq1	**-0.593858**	**-0.046312**	**0.066293**	**-0.094136**
	(0.08311)	**(0.04464)**	**(0.03583)**	**(0.03846)**
	[-7.14575]	**[-1.03743]**	**[1.84996]**	**[-2.44778]**
D(GROWTH(-1))	**-0.024624**	**0.016083**	**-0.015573**	**0.075981**
	(0.07701)	**(0.04137)**	**(0.03321)**	**(0.03564)**
	[-0.31974]	**[0.38878]**	**[-0.46896]**	**[2.13205]**
D(FE(-1))	**-0.077690**	**0.282127**	**-0.083373**	**0.062428**
	(0.22833)	**(0.12265)**	**(0.09846)**	**(0.10566)**
	[-0.34025]	**[2.30026]**	**[-0.84681]**	**[0.59082]**
D(RE(-1))	**-0.007783**	**-0.232719**	**0.267898**	**-0.030130**
	(0.24553)	**(0.13189)**	**(0.10587)**	**(0.11362)**
	[-0.03170]	**[-1.76452]**	**[2.53042]**	**[-0.26518]**
D(NR(-1))	**-0.092643**	**0.012131**	**0.012284**	**0.070740**
	(0.13243)	**(0.07113)**	**(0.05710)**	**(0.06128)**
	[-0.69958]	**[0.17053]**	**[0.21513]**	**[1.15437]**
C	**-0.014565**	**0.342661**	**-0.492085**	**-0.082214**
	(0.28968)	**(0.15561)**	**(0.12491)**	**(0.13405)**
	[-0.05028]	**[2.20211]**	**[-3.93952]**	**[-0.61329]**
R-squared	**0.320439**	**0.154229**	**0.127438**	**0.059323**
Adj. R-squared	**0.299335**	**0.127962**	**0.100340**	**0.030109**
F-statistic	**15.18356**	**5.871750**	**4.702819**	**2.030653**

Source: Processed, 2022

However, renewable energy to economic growth shows an inversely proportional parameter direction where the increase in renewable energy consumption, has not been followed by an increase in economic growth, and vice versa. This shows that in the long run, it is a major concern for countries in ASEAN 8 (Indonesia, Malaysia, Singapore, Philippines, Brunei Darussalam, Thailand, Vietnam, and Myanmar) in driving the impact of renewable energy on economic growth. It is necessary to restructure the concept and program of economic development sustainably in all

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aspects. Renewable energy investments need to be increased to replace or reduce dependence on fossil energy. Natural resource rent is significant and directly proportional to economic growth. These results show that the existence of profit income from natural resources is one of the drivers of economic growth movements, which can also be a booster in the management of renewable energy resources. Meanwhile, in the short term, all variables do not significantly affect economic growth. There is a process of adjustment in the transition period that previously provided a very high dependence on fossil energy and lasted so long with such a large investment that it required a considerable lag in reducing fossil energy dependence. The sustainability energy taxonomy is the main agenda, including green financing-based financial financing as in Indonesia there are blended finance schemes, SDGs Indonesia One, Network for Greening the Financial (NGFS) by Bank Indonesia, and Sustainable Finance Roadmap by the Financial Services Authority (OJK).

Alternatives through the creation of renewable energy that is still minimal are also the focus of policymakers in carrying out regulations. Renewable energy is very poorly contributing, especially to sectors that are predominantly used by humans in carrying out their activities such as transportation. Less supportive regulation is one of the obstacles to the slowdown in the development of new technologies. This is enough to reflect and revise policies for policymakers so that in 2018 there was a decarbonization framework developed at the sub-national level which experienced an increase in numbers. Developing countries continue to increase the spread of renewable energy, and distributed renewable energy helps spread energy access to households in remote areas. In addition, the private sector also plays a key role in driving the spread of renewable energy through its procurement and investment decisions. The role of the private sector as a source of investors through renewable energy investment has more than doubled during 2018, and renewables have spread by significant amounts around the world.

Global investment in renewable energy declined from the previous year, developing and developing countries again provided more than half of all investments in 2018. The renewable energy sector is used both directly and indirectly reaching around 11 million people worldwide in 2018. In 2017, renewable energy accounted for about 18.1% of total final energy consumption (TFEC). Modern renewable energy supplies 10.6% of TFEC, with expected demand growth reaching 4.4% compared to 2016. The opportunity continues to grow the increasing use of renewable electricity in the end-use sector. The integration sector is attracting the attention of policymakers, and the market for enabling technologies such as battery storage, heat pumps, and electric vehicles is increasing.

The results of the analysis using impulse response showed that the response of economic growth to energy showed a small deviation compared to renewable energy with a pattern of positive and negative relationships and achieved a steady state. Meanwhile, renewable energy shows a positive relationship with a considerable deviation and is permanent. This indicates the growing commitment of countries in ASEAN 8 to the use of renewable energy in development. Meanwhile, natural resource rents show a negative pattern towards growth even though they are ascending and permanent. The relationship pattern between fossil energy and renewable energy is inversely proportional. The increase in fossil energy consumption is responded to by a greater deviation in the response of renewable energy than if there was an increase in renewable energy consumption of fossil energy. So, this pattern is a major concern in the formulation of transition policies from fossil energy to renewable energy. It takes a time speed of 6 or six periods of time horizons to steady-state conditions over the transition of fossil energy indicating renewable energy.

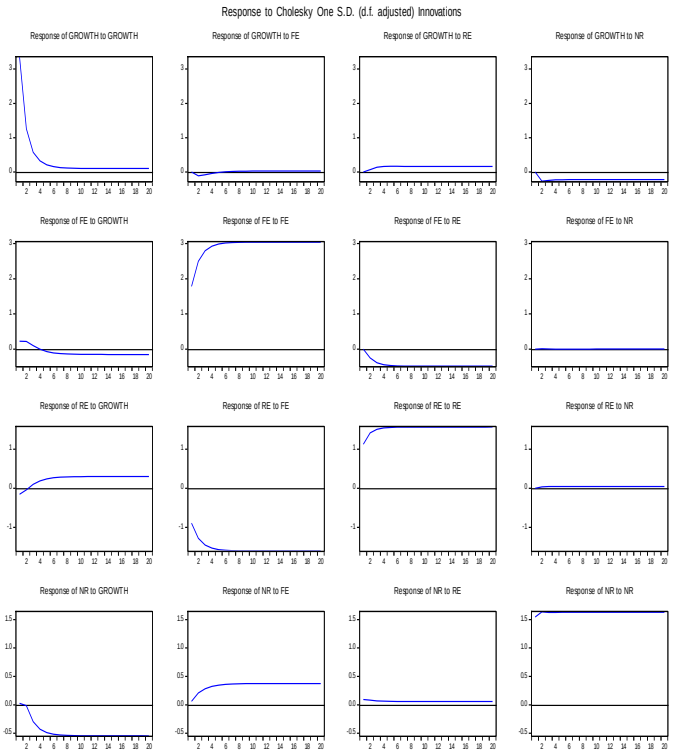

Fig. 1 Impulse Response Analysis

The energy transition is the latest issue that is discussed in the world development agenda for the purpose of achieving sustainable development and more conducive earth conditions. The issue of the energy transition is also one of the priority issues on the agenda of the G20 Presidency in addition to other important issues such as digital transformation and global recovery. To achieve the acceleration of energy transmission, three important things are needed, namely investment, access, and technology that can synergize in supporting the use of new and renewable energy. The commitments of regional countries such as ASEAN have also reached agreements to support the implementation of various policy packages to accelerate the energy transition to promote sustainable development. Singapore is one of the countries in ASEAN that shows the fastest and best progress in the energy transition program, indicated by the highest use of new renewable energy compared to using fossil energy. This is confirmed by the report of the World Economic Forum with the energy transition index reaching 67 points. This encourages policymakers in ASEAN countries to be more

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active in participating and implementing the energy transition to new and renewable energy. Judging from the historical data on the use of renewable energy, compared to other ASEAN countries, Singapore has a significant increase in the use of renewable energy from the entire total energy used while other countries tend to experience an uptrend in renewable energy consumption.

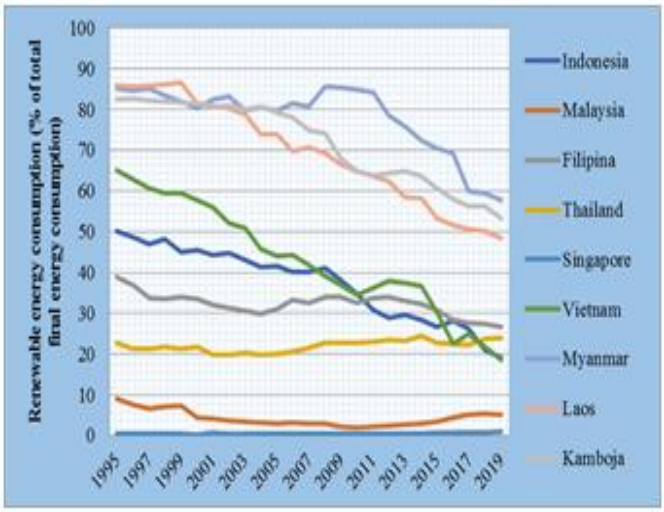

Fig. 2 Renewable Energy Consumption Trends in ASEAN
Source: World Bank (2022)

The use of new and renewable energy in almost all ASEAN countries except Singapore shows a downward trend even though when viewed from the percentage of renewable energy use in Singapore and Malaysia tends to be very small compared to other countries but shows positive progress with an increase in its use. Over the past 2.5 decades, the use of new and renewable energy in the ASEAN region has generally fluctuated until in 2019 almost all countries showed a downward trend in the use of renewable energy. In the mid-19th century Myanmar, Laos and Cambodia became countries with renewable energy use above 80% of the total energy used until the mid-20th century to be precise in 2005 or for a decade it experienced a decline in the use of renewable energy. Cambodia and Laos showed a consistent downward trend during the period 1995-2019 although compared to other countries the use of renewable energy in these countries is still very high. In 1995 the use of renewable energy in Cambodia reached 82.5% of the total energy use meaning that only 17.5% of its activities used non-renewable energy over time this condition decreased until in 2019 the use of renewable energy only reached 58% of all energy use in Cambodia. Meanwhile, in Laos, the use of renewable energy in 1995 reached 85.9% and there was a consistent downward trend until 2019 the use of renewable energy only reached 48%. This shows a huge decline compared to other countries. On the other hand, in Myanmar, the use of renewable energy is very dominant compared to other ASEAN countries but also experienced a decline in trends until 2019 even though there was also fluctuation in the early 20th century. In 1995, the use of renewable energy in Myanmar reached 85.2% and experienced fluctuations but was still consistent at 80% until 2001. This means that the use of renewable energy in Myanmar is still very dominant among other countries that have experienced a shift where energy use is dominated by non-renewable energy until in 2011 the use of renewable energy in Myanmar was the highest compared to other countries reaching 84%. Furthermore, there is a downward trend until 2019 the use of renewable energy in Myanmar decreased to 57.8% although this figure is still relatively large when compared to other countries and energy consumption in Myanmar in total is still dominated by renewable energy.

Meanwhile, Vietnam was in fourth place with the use of new and renewable energy in the mid-19th century until 2005 when the use of renewable energy reached 50-60% of the total energy consumption required in the country. However, over time until the period of 2019, these countries experienced a decline in the use of renewable energy, meaning that total energy consumption was dominated by non-renewable energy such as coal and fossils for production driving supplies in the country. In Indonesia, the use of renewable blended energy is also decreasing, this can be seen from the trend in Gambar_. In 1995 the use of renewable energy to meet energy supply reached 50% and another 50% was met from non-renewable energy (coal, petroleum, fossils, and so on). However, in 1996 it decreased to 48% until 2019 only reached 19%. This condition confirms that there is a decline in the use of renewable energy and there is precisely a predominance of energy use from fossil materials which can adversely affect the sustainability of development and growth.

Thailand and the Philippines show a trend that tends to fluctuate in the two major terms indicated by Figure _ above. From 1995 to 2001 there was a tendency to decrease the use of renewable energy in Thailand from 22.7% in 1995 to slowly decrease to 19.8% in 2001. Then again experienced an increase in the use of renewable energy until 2014 reaching 24.4% for the country of Thailand and experienced a decrease again in 2017 to 22% and the next 2 years in 2019 the use of renewable energy in Thailand increased to 29.98%. In the Philippines, the decline in the use of renewable energy from 1995 reached 38% decrease with a significant decrease until 2004 it reached 29% in the use of renewable energy. From 2005 to 2012 termin, it showed an increasing trend in energy use to reach 34% and again there was a significant downward trend until 2019 with renewable energy consumption only reaching 26.7%. The same is shown by Malaysia where there has been a prolonged decline in renewable energy consumption over the past 2.5 periods. In 1995 the use of renewable energy in Malaysia reached 9% although it is relatively small when compared to other countries. Then it experienced a decrease in the trend until 2010 at 1.96% in renewable energy consumption from total energy consumption so 98.04% was dominated by non-renewable energy. Then in the early 21st century, it showed a drastic increase in the use of renewable energy to 5% until 2019. Unlike other ASEAN countries, although the use of renewable energy in Singapore is very small, it only reaches 0.84% of the total energy used, this condition shows an increasing trend meaning that Singapore can show a positive contribution to the energy transition. Judging from the historical data in 1995 that energy use only amounted to 0.4% of the total energy used until 2019 reached 0.84%.

The massive decline in the use of renewable energy experienced by most countries in the ASEAN region further encourages strong reasons for efforts to achieve an accelerated energy transition. Because it is known that most countries in the ASEAN region are also contributors to the global economy. The increasing production process can also have an impact on increasing the need for energy so that the focus on meeting these needs is directed to the use of renewable energy. Some countries with abundant natural wealth are the majority unable to manage their sustainability properly. Natural wealth that is sufficiently exploited to achieve maximum income without regard to environmental aspects often arises and becomes a problem in sustainable development. The existence of natural resources, the majority of which can be used as non-renewable energy sources, can be a driver of high environmental degradation in the future. The optimization of the use of natural wealth which has been tending to lead to exploitation is seen in several countries in ASEAN that have natural abundance and are managed by foreign companies to become energy raw materials and countries can get income from the lease of using these natural resources. Over time, the lease of this natural resource also shows a downward trend because this non-renewable natural wealth is massively exploited and results in environmental sustainability and the supply of natural wealth which is also running low. Most ASEAN countries have abundant natural resources where these sources become raw materials in energy supplies such as petroleum, natural gas, minerals, and forests Indonesia which has a large wealth of natural gas, petroleum, Brunei Darussalam with its abundance of natural gas sources, and several other countries. However, in the 22nd century, there is a decline in performance which has an impact on reducing natural resource rental income caused by the capacity of natural resources in generating productivity also decreasing. This condition can be observed from the history of Worldbank data during the period 1995-2020 where the average income from natural resource rentals decreased.

Fluctuations and trends have decreased total natural resource (SDA) rents in their contribution to GDP in several ASEAN countries. Brunei Darussalam, a country that has an abundance of abundant sources of oil and natural gas, has the highest number of natural resource leases against GDP in the country compared to other countries. In Brunei, the contribution of total natural resource leases to GDP was highest at 36% in 2006 and experienced a deep downward trend in 1998 where there was a decrease from 18% to 12%. Furthermore, it tends to experience fluctuations up and down until in 2020 it has decreased compared to the previous year, reaching 3.5% whereas in 2019 it reached 26% decreased in 2020 to 22.6%. Similar conditions are experienced by several other countries such as Malaysia, Indonesia, and Vietnam which show a relatively large contribution of natural resource leases to their country's GDP. In Malaysia, the performance of natural resource lease contribution to GDP was the highest in 2008 reaching 13.7% and experienced the largest decline in 2009 where there was a decrease of up to 3.5% until fluctuations continued to occur and in 2020 the contribution of natural resource rents to Malaysia's GDP also tended to decrease to 5%. Indonesia also shows something similar where the deepest decline occurred in 2009 where there was a decrease of 5.4% compared to the previous year so that the contribution only reached 6.7% and further tended to fluctuate where in 2020 it tended to experience an increase trend compared to the previous year with a contribution of 3.4% from the previous year only reaching 3%. Similar conditions are also shown by other ASEAN countries where it can be concluded that most natural resource rental contributions to GDP in their countries are because of a decrease in capacity and productivity in producing production output from natural resources such as petroleum, natural gas, minerals, forests, and so on. This condition is also a signal that the environment has begun to erode its productivity so that recovery and other alternative sources derived from renewable energy are needed and cut off the dependence on non-renewable natural resources.

Across the renewable energy sector, focus on clear targeting and synergistic planning to provide supply and transmission to avoid some of the challenges seen in each region. On the planning side, the use of larger modeling is used by some countries, such as Thailand in collaboration with the IEA, to develop scenarios as a strategy that allows decision-makers the opportunity to consider various sector development options more effectively. In addition, Vietnam has also established long-term cooperation with Denmark to develop scenarios for the development of the country's energy system, including a power system has broken down into six regions (EREA and DEA, 2019). The ASEAN Centre for Energy also provides regional-related support through the development of the ASEAN Energy Outlook and the ASEAN Interconnection Master Study (AIMS), which provides a blueprint for the development of cross-border transmission lines in the form of the ASEAN Power Grid for the acceleration of renewable energy transmission.

V. CONCLUSION

The renewable energy and natural resource rents variables were significant for economic growth, while fossil energy consumption was not statistically significant. The response of economic growth to fossil energy shows a small deviation compared to renewable energy with a positive and negative relationship pattern and reaches a steady state. This indicates the increasing commitment of countries in ASEAN 8 to the use of renewable energy in development. The increase in consumption of fossil energy is responded to by a deviation in the response of renewable energy that is greater than if there is an increase in consumption of renewable energy to fossil energy. It takes six periods of time horizon time to reach steady state conditions for the transition from fossil energy showing renewable energy.

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