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EXAMINING THE DETERMINANTS OF RENEWABLE ENERGY PRODUCTION IN ASEAN COUNTRIES

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ABSTRACT

This study investigates the determinants of renewable energy production in ASEAN countries, focusing on the factors influencing the transition to sustainable energy sources in the region. By utilizing the panel data from 2000 to 2020 with Pooled OLS, Random Effect model and Fixed Effect model, the research explores the explainatories of renewable energy production in ASEAN. The findings reveal that renewable energy consumption, economic growth and FDI have a positive and significant relationship with renewable energy production, while trade openness and urbanization have significant association with REP. It suggests the importance of suitable policy design to support renewable energy production in ASEAN, emphasizing the role of government-backed energy policies. Overall, this research contributes valuable insights for policymakers and stakeholders in the renewable energy sector, offering guidance for promoting sustainable energy practices and addressing climate change challenges in ASEAN countries.

Keywords: *Renewable energy production, ASEAN.*

1. INTRODUCTION

Fossil fuels have historically been the key determinant of industrialization since the Third Industrial Revolution (Ritchie et al., 2024). Crude oil, natural gas, coal, etc., constitute the primary energy sources utilized across all economic sectors. This has led to global climate and health issues. Specifically, three-quarters of global greenhouse gas emissions stem from fossil fuel combustion for energy production. The use of fossil fuels is deemed a contributor to air pollution, resulting in at least 5 million premature deaths annually worldwide (Ritchie et al., 2024).

Recently, the global commitment to achieving net-zero emissions has gained unprecedented momentum in recent years, with numerous countries, businesses, and organizations pledging to reach this ambitious target. According to Oxford Net Zero - Net Zero Tracker (2023), among 194 countries committing to achieve net zero, 26.8% set their target to achieve net-zero before 2050, about 66% sign the commitment of achieveing net zero by 2050 and only 13 countries commited to get net-zero after 2050. With these target set, every country has integrated the net-zero goal into specific actions in the national laws and policies. The development of renewable energy is one of feasible solutions to help countries to move towards the commitments.

Renewable energy, also known as clean/green energy, derives from continuously replenished natural sources or processes such as sunlight, wind (which are intermittent and weather-dependent sources (NRDC, 2022), hydroelectric power, and biomass energy. Some common renewable energy sources are solar, wind, hydroelectric, and biomass, offer a sustainable alternative to fossil fuels.

According to the (EPA, 2020), renewable energy holds potential economic, social, and environmental benefits. Firstly, transitioning to a renewable energy-based economy helps diversify energy supply sources and reduces reliance on imported fossil fuels. Such a shift can stimulate

economic growth and investment. Secondly, renewable energy significantly reduces harmful emissions like SO2, NO2, PM2.5, generated from fossil fuel consumption, thus leading to cleaner air and improved human health.

Additionally, the renewable energy sector fosters significant job creation. Developing, manufacturing, installing, and maintaining RE infrastructure require skilled labor, generating employment opportunities across various sectors. IRENA (2019) estimates employment in this sector could rise from 10.3 million in 2017 to nearly 29 million by 2050. This field offers diverse opportunities along the value chain, demanding various skills and talents. Therefore, prioritizing renewable energy development at the national level is paramount in accelerating the transition to a low-carbon future and achieving global net-zero targets.

Painuly (2001) underscore the significance of various factors in assessing RE development, encompassing resource availability, technology costs, financial viability, environmental impacts, socio-economic implications, and the spectrum of centralized and decentralized options. They delineate six types of RE potential, spanning theoretical, geographical, technical, techno-economic, economic, and market aspects. While studies have delved into technical methodologies and tools for assessing RE potential, a limited number have applied statistical approaches to scrutinize the determinants of such development within the ASEAN context.

ASEAN faces urgent issues related to energy demand due to rapid population growth and economic expansion, making diversification of energy sources imperative for energy security. Renewable energy offers a sustainable alternative to fossil fuels, reducing dependency on imported energy and mitigating the risks associated with volatile oil prices. Renewable energy would presents substantial economic opportunities for the ASEAN region. It fosters innovation, stimulates job creation, and attracts investment in green technologies, driving economic growth and enhancing regional competitiveness. Therefore, aim of the study is to identify the main determinants of RE development in the ASEAN countries, from 2000 to 2020.

Renewable energy consumption and renewable energy production

Marques et al. (2010) posit that energy consumption traditionally serves as a vital factor of development and reveals a nation's energy requirements. As consumption increases, it exerts significant pressure on energy utilization levels, which needs the higher volumn from multiple sources: traditional fossil fuels, renewable energy (RE) sources, or a hybrid of both. The energy consumption demands will be met via conventional energy sources, clean alternatives, or a blend of the two. Understanding this dynamic relationship is facilitated by the forces of demand and supply, as described in Keynesian theory (Chamley, 2013).

At the national level, there exists a complex and dynamic relationship between the consumption and production of renewable energy. An increase in the consumption of renewable energy typically corresponds with a concurrent rise in its production. This symbiotic relationship is influenced by several factors. Firstly, heightened consumption stimulates investment in renewable energy infrastructure and technology, thereby enhancing the capacity for production. Secondly, policy frameworks, such as feed-in tariffs and renewable energy mandates, serve to incentivize growth in renewable energy production to meet escalating demand. Moreover, technological advancements in renewable energy, alongside economies of scale, contribute to improved production efficiency and cost-effectiveness, consequently reinforcing consumption levels.

Bourcet (2020) provide valuable insights into the factors influencing the relationship between energy consumption and renewable energy production by reviewing empirical studies relating to determinants of RE deployment at country level. The energy indicators – including energy consumption, energy security and other type of energy mixed. Previous studies found that the increase in energy or electricity consumption could be met by both renewable and conventional energy sources, leading to an unclear expected influence on renewable energy deployment. There is no clear consensus on the relationship between energy demand and renewable energy deployment. A positive influence is found when considering all renewable energy sources for energy production.

H1. Renewable energy consumption has a positive and significant relationship with renewable energy production

Economic growth and renewable energy production

The ability to produce renewable energy cannot be separated from the level of economic development. Thus, the relationship between GDP and renewable energy production has been widely discussed in the academic literature. Sovacool (2016) provides substantial evidence supporting the notion that economic development drives greater investment in renewable energy technology and infrastructure. This is echoed by the findings of (Wei et al., 2022), who conducted a comprehensive analysis in many countries and concluded that GDP growth will significantly stimulate renewable energy production. Similarly, Stern (2004) study highlights how economic prosperity can lead to enhanced policies and incentives for renewable energy adoption, further boosting production. Furthermore, the work of (Bhattacharya et al., 2016) emphasizes the importance of economic factors such as income levels and industrial structure in shaping the trajectory of renewable energy development within a country. Collectively, these empirical studies contribute to an in-depth understanding of the relationship between GDP growth and renewable energy production, highlighting the multifaceted influences driving this connection. As countries strive to achieve sustainable economic growth, leveraging renewable energy sources is becoming increasingly urgent, with GDP growth both the driver and outcome of this transition. The above findings lead to the first hypothesis:

H2. Economic growth has a positive and significant relationship with renewable energy production

Unemployment rate and renewable energy production

Research conducted by Carley et al. (2017) delves into the link between unemployment and renewable energy, showing that high unemployment rates can stimulate governments to implement policies to promote development. develop renewable energy as a means of creating jobs. Conversely, prolonged periods of unemployment can reduce consumer demand for renewable energy technologies and investments (Kumar et al., 2010). Furthermore, studies by Ritter & Schopf (2014) highlight that fluctuations in unemployment rates can affect the availability of highly skilled labor, important for renewable energy projects, with ability to influence production levels. This view is echoed by the findings of Kappner et al. (2023), who emphasize the importance of training and workforce development programs in reducing barriers related to unemployment. industry for renewable energy deployment. Additionally, research by Kalkuhl et al. (2017) highlights the role of policy certainty in bolstering investor confidence amid unemployment fluctuations, ultimately influencing the pace and scale of renewable energy production. Thus, second hypothesis is formulated as follows:

H3. Unemployment rate has a significant relationship with renewable energy production.

Inflation rate and renewable energy production

Gasmi et al. (2020) suggests that moderate inflation rates can positively influence renewable energy investments by reducing the real cost of capital and fostering economic growth. However, excessive inflation may lead to uncertainty and financial instability, potentially hindering long-term investment in renewable energy infrastructure (Labandeira et al., 2017). Moreover, fluctuations in inflation rates can affect the affordability of renewable energy technologies for consumers and businesses, influencing demand dynamics and investment decisions, as highlighted by research conducted by DeCarolis & Keith (2006). Additionally, the work of Laldjebaev & Sovacool (2015) emphasizes the importance of stable macroeconomic conditions and clear regulatory frameworks in mitigating inflation-related risks to renewable energy projects. The above findings lead to the third hypothesis:
H4. Inflation rate has a significant relationship with renewable energy production.

Urbanization and renewable energy production

Seto et al. (2014) have highlighted the potential for urbanization to drive increased demand for renewable energy solutions in urban areas, driven by the need to mitigate environmental impacts and address energy security concerns. Conversely, rapid urbanization may also pose challenges such as increased energy consumption and infrastructure constraints (Angel et al., 2011). Moreover, research by Kammen & Sunter (2016) emphasizes the role of urban planning policies and regulatory frameworks in shaping the integration of renewable energy sources into urban infrastructure, highlighting the importance of proactive measures to support sustainable energy transitions in urban environments. Additionally, Solecki et al. (2019) underscores the significance of local governance structures and community engagement in fostering renewable energy production within rapidly urbanizing regions. Thus, the fifth hypothesis is formulated as follows:
H5. Urbanization has a significant relationship with renewable energy production.

Trade openness and renewable energy production

Grossman & Helpman (1993) show the potential for trade openness to facilitate the cross-border transfer of renewable energy technology, allowing countries to access a wider range of clean energy solutions. In contrast, Heyl et al. (2021) argue that trade liberalization can promote competition and innovation in the renewable energy sector, reduce costs, and accelerate deployment. In addition, the impact of free trade agreements on domestic renewable energy industries has a potential negative impact on local production and job creation (Monkelbaan, 2014). Furthermore, Nilsson et al. (2018) emphasize the importance of aligning trade policies with renewable energy goals to maximize the benefits of international trade while protecting domestic sustainability goals. Thus, the fifth hypothesis is formulated as follows:
H6. Trade openness has a significant relationship with renewable energy production.

Foreign direct investment and renewable energy production

Empirical research has extensively examined the impact of foreign direct investment (FDI) on renewable energy production, uncovering multifaceted drivers that influence the development and deployment of energy technologies clean. Zhang et al. (2021) state the important role of FDI in promoting renewable energy capacity expansion, especially in emerging markets where domestic investment may be insufficient. Foreign investment inflows can provide access to capital, technology and expertise, facilitating the implementation of renewable energy projects and

contributing to overall industry growth. Conversely, there have been concerns about the potential for FDI to lead to dependence on external actors and weaken domestic control over renewable energy sources (Mlecnik et al., 2020). In addition, Hamid et al. (2022) emphasize the importance of the legal framework and governance structure in shaping the impact of FDI on renewable energy production, emphasizing the need for transparency and stability investment environment to maximize the benefits of foreign investment while protecting national. Thus, the sixth hypothesis is formulated as follows:

H7. Foreign direct investment has a positive and significant relationship with renewable energy production.

CO2 emissions and renewable energy production

Previous studies have extensively investigated the relationship between carbon dioxide (CO2) emissions and renewable energy production, revealing crucial insights into the role of renewable energy in mitigating greenhouse gas emissions. Zhang et al. (2021) suggests that increased investment in renewable energy infrastructure is associated with reductions in CO2 emissions, as renewable sources replace fossil fuels in electricity generation. Similarly, Wei et al. (2022) emphasize the potential of renewable energy technologies to decouple economic growth from carbon emissions, offering pathways toward sustainable development. Moreover, Ertugrul et al. (2016) state the importance of policy interventions and market incentives in promoting the adoption of renewable energy and curbing CO2 emissions. However, challenges remain, Hamid et al. (2022), which identifies barriers to renewable energy integration and emphasizes the need for comprehensive strategies to address systemic issues. These empirical insights show the critical role of renewable energy production in mitigating CO2 emissions, underscoring the urgency of transitioning to cleaner energy sources to combat climate change effectively. Thus, the seventh hypothesis is formulated as follows:

H8. CO2 emission has a significant relationship with renewable energy production.

2. RESEARCH METHOD

Following Bayale et al. (2021), Przychodzen & Przychodzen (2020) and Bourcet (2020), the renewable energy production in this study is explained by (list of variable) as shown in equation (1)

$$lnREP_{it} = \alpha + \beta_1 lnREC + \beta_2 lnGDPpc_{it} + \beta_3 Unemp_{it} + \beta_4 Infla_{it} + \beta_5 Urban_{it} + \beta_6 Trade_{it} + \beta_7 FDI_{it} + \beta_8 CO_{2_{it}} + \nu_i + \varepsilon_{it}$$

In which $lnREP_{it}$ is the renewable energy production of country i in year t (in log form), $lnREC_{it}$ is the renewable energy consumption of country i in year t (in log form), $lnGDPpc_{it}$ is the GDP per capita of country i in year t (in log form), $Unemp_{it}$, $Infla_{it}$, $Urban_{it}$, $lnPop_{it}$, $Trade_{it}$, FDI_{it}, $CO_{2_{it}}$ are unemployment rate, inflation rate, urbanization, population, trade, FDI inflow and Co2 emmission per capita of country i in year t, respectively. ν_i and ε_{it} constitute the error terms in which ν_i captures the time-invariant unobserved factors and ε_{it} are the other unobserved regressors.

Previous studies focus mainly on determinants of renewable energy consumption or renewable energy transition, which limit the understanding regarding the capacity of RE from country perspective. Recently, (IRENA, 2019) emphasize the importance of understanding factors associated with renewable energy development from supply- side. Because findings may help

government-backed energy policies impede renewable energy investment, thus promoting suitable policy design to support RE production.

In Kilicarslan (2019), he used total Electricity production from renewable sources (excluding hydroelectric, % of total) is used as an indicator of renewable energy production to explore the o investigate the relationship between foreign direct investment (FDI) and renewable energy production in Brazil, Russia, India, China, South Africa (BRICS) countries and Turkey. In this study, the hydropower is available in most ASEAN countries, thus we decide to use total renewable energy production from all sources as the variable of interest.

Data of renewable energy production is derived from Our World in Data for 10 ASEAN countries from 2000 – 2020 which is the most updated data and include the Covid-19 time span (2019 – 2020).

The explanatory variables are collected from Our World in Data (renewable energy consumption, CO2 emission, urbanization and population) and the World Development Indicators (GDP per capita, unemployment rate, inflation rate, foreign direct investment net inflows). Details on the variable names, description, and summary statistics are presented in Table 1.

Table 1. Summary statistics of variables used in the regression
Source: The author's calculation by STATA 17

Variable	Description	N	Mean	Std. dev.	Min	Max
Dependent variables						
lnrep	Renewable energy production (TWh) - (log)	210	0.618	3.612	-6.908	4.478
Independent variables						
lnrec	Renewable energy consumption (% of total energy consumption) (log)	210	2.127	3.035	-6.908	4.452
Infla	inflation, consumer prices (annual %)	209	4.581	6.676	-2.315	57.075
lngdppc	gdp per capita (constant 2015 US$)	210	8.278	1.369	5.697	11.025
un	inflation, consumer prices (annual %)	149	3.181	2.144	0.141	11.189
urban	Unemployment, total (% of total labor force) (national estimate)	210	49.350	24.147	18.586	100.000
fdinif	Foreign direct investment, net inflows (% of GDP)	210	5.304	5.929	-2.757	29.761
open	Trade (% GDP)	185	136.612	90.565	32.972	437.327
co2pc	Annual CO2 emissions (per capita)	210	4.547	5.901	0.163	25.133

According to Baltagi (2008), panel data has many advantages over time series data or cross-sectional data, specifically: (i) panel data can take into account the influence of unobserved factors; (ii) panel data is more information, high variability, and less collinearity.

Panel data are often estimated using three popular methods: (1) Pooled Ordinary Least Square (POLS); (2) Fixed Effects Model (FEM); and (3) Random Effects Model (REM).

3. RESULTS AND DISCUSSIONS

Table 1 provides summary statistics of variables used in the regression analysis. The dependent variable, lnrep (Renewable energy production in Terawatt-hours), has a mean of 0.618 and a standard deviation of 3.612. The values range from -6.908 to 4.478, indicating a wide variation in renewable energy production across the observations. This variable is transformed using the natural logarithm, which suggests that the original data might be positively skewed.

Moving on to the independent variables, lnrec (Renewable energy consumption as a percentage of total energy consumption) has a mean of 2.127 and a standard deviation of 3.035. The values range from -6.908 to 4.452, showing a similar wide dispersion as the dependent variable. This variable is also log-transformed, indicating potential skewness in the original data distribution.

The variable infla (inflation, consumer prices) has a mean of 4.581 and a standard deviation of 6.676. With values ranging from -2.315 to 57.075, there is substantial variability in inflation rates across the observations. This variable is essential for understanding the economic context in which the renewable energy production and consumption data are situated.

Lastly, lngdppc (GDP per capita in constant 2015 US dollars) has a mean of 8 and a standard deviation that is not provided in the excerpt. The minimum and maximum values are not shown either, but this variable is crucial for exploring the relationship between economic development and renewable energy trends.

Table 2. Results of POLS, RE and FE models
Source: The author's calculation by STATA 17

	(1)	(2)	(3)	(4)
VARIABLES	**pols-nor**	**pols-rb**	**re**	**fe**
lnrec	1.037***	1.037***	1.037***	1.591***
	(0.393)	(0.391)	(0.393)	(0.375)
lngdppc	2.720***	2.720***	2.720***	5.088***
	(0.554)	(0.616)	(0.554)	(0.585)
unemp	-0.253**	-0.253**	-0.253**	0.058
	(0.100)	(0.106)	(0.100)	(0.069)
infla	0.036	0.036	0.036	-0.023
	(0.043)	(0.052)	(0.043)	(0.022)
urban	0.001	0.001	0.001	-0.121***
	(0.025)	(0.025)	(0.025)	(0.034)
trade	-0.022***	-0.022***	-0.022***	-0.014***
	(0.003)	(0.004)	(0.003)	(0.004)
fdinf	-0.122***	-0.122***	-0.122***	0.073**
	(0.035)	(0.044)	(0.035)	(0.028)
co2pc	-0.278**	-0.278**	-0.278**	-0.060
	(0.135)	(0.130)	(0.135)	(0.087)
Constant	-18.628***	-18.628***	-18.628***	-37.452***
	(4.234)	(4.790)	(4.234)	(4.352)
Observations	143	143	143	143
R-squared	0.780	0.780		0.676

Number of id	9	9
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1		

Table 2 provides the results of the regression analysis using different estimation methods: Pooled Ordinary Least Square (POLS), Pooled OLS with robust standard errors, Random Effects Model (REM), and Fixed Effects Model (FEM). The Hausman test is used to determine whether the random effects assumption is valid, and in this case, the test statistic is significant (χ^2 = 466.65, p = 0.000), indicating that the random effects model is inconsistent. Therefore, the Fixed Effects Model (FEM) is more appropriate for this regression analysis as it accounts for individual-specific effects and provides more reliable estimates. Thus, the interpretation of estimation result will mainly based on the FEM (in Column 4 – Table 2). Overall, FEM estimation suggests that renewable energy production in ASEAN is positively explained by renewable energy consumption, real GDP per capita, and foreign trade investment inflow. On the other hand, urbanization and trade openness have negative association with the renewable energy production. In addition, the data from ASEAN countries during the 20 years from 2000 – 2020 do not support the significant relationship between unemployment rate, inflation and Co2 emission and REP.

Specifically, 1% increase in the ratio of renewable energy consumption would increase the REP by 1.5% and the estimation is statistically significant at the 1% level of significance. This result is understandable as mentioned in the Chamley (2013) which states that higher consumption leads to higher production growth. Studies by Przychodzen & Przychodzen (2020) in 27 transition countries in Central and Eastern Europe and the Caucasus and Central Asia over the year 1990 – 2014 and Bayale et al. (2021) research in WAEMU countries in the period 1990 – 2017 also find similar relationship between REC and REP. It is probably because, due to the volatile nature of fossil fuels prices, households and firms are formulating an increasing demand for renewable energy. By responding to this high demand, renewables production increases.

There exists empirical evidence that economic growth (GDP per capita) is positively and significantly associated with renewable energy production. This indicates that higher GDP per capita is associated with higher levels of renewable energy production. Mohsin et al. (2021) also stated that positive correlation between economic growth and energy renewable generation in 25 developing Asian countries in period 2000 – 2016. In contrast, Marques et al. (2010) conducted in European countries from 1990 to 2006, shows that GDP has negatively impact to renewable energy production. This can be explained by the fact that developed countries have high income levels, leading to a large demand for energy while electricity capacity from renewable energy does not meet it promptly. This leads to the need to still supplement the energy shortage coming from non-renewable energy sources.

Regarding the relationship between FDI and REP, the result confirms that increase in FDI may promote the REP in ASEAN. This positive association is explained in Zhang et al. (2021) and Kilicarslan (2019) such that FDIs are important for the development of energy sector in general and renewable energy in particular because it may related to the transfer of capital, technology and expertise from the home countries to the host countries.

The coefficient for urban (Urbanization) is statistically significant at the 1% level, with a coefficient of -0.121, suggesting that higher levels of urbanization are associated with lower levels of renewable energy production. Additionally, analysis for ASEAN countries shows that trade openness may reduce the REP. It can be understood that the more open the trade is, ASEAN countries have to trade off their barriers and requirement for the sustainable target.

The summary of conclusion regarding hypothesis test for the determinants of REP in ASEAN countries are presented in Table 3.

Table 3. Summary of the conclusions for hypothesis testing

Hypothesis	Conclusion
H1. Renewable energy consumption has a positive and significant relationship with renewable energy production	Supported
H2. Economic growth has a positive and significant relationship with renewable energy production	Supported
H3. Unemployment rate has a significant relationship with renewable energy production.	Not supported
H4. Inflation rate has a significant relationship with renewable energy production.	Not supported
H5. Urbanization has a significant relationship with renewable energy production.	Supported
H6. Trade openness has a significant relationship with renewable energy production.	Supported
H7. Foreign direct investment has a positive and significant relationship with renewable energy production.	Supported
H8. CO2 emission has a significant relationship with renewable energy production.	Not supported

4. CONCLUSIONS AND SUGGESTIONS

The paper delves into the factors associated with renewable energy production in ASEAN countries. The findings shed light on the complex relationship between various determinants and renewable energy production, offering key takeaways and recommendations for fostering a greener energy landscape in ASEAN.

One of the significant findings highlighted in the study is the positive and significant relationship between renewable energy consumption and renewable energy production. This underscores the importance of increasing the utilization of renewable energy sources to drive production levels. Policymakers in ASEAN countries should focus on implementing measures that encourage the consumption of renewable energy, such as incentivizing the use of solar panels or wind turbines in residential and commercial settings.

Moreover, the research emphasizes the impact of economic growth on renewable energy production. Higher GDP per capita is associated with increased levels of renewable energy production, indicating the need for sustainable energy solutions to support economic development in the region. Policymakers should prioritize investments in renewable energy infrastructure and technologies to align with the growth trajectory of ASEAN countries.

Foreign trade net inflow plays a crucial role in promoting renewable energy production in ASEAN countries by facilitating access to capital, technology, and expertise essential for the development and deployment of renewable energy projects. The findings underscore the significance of aligning trade policies with renewable energy goals to maximize the benefits of international trade while advancing domestic sustainability objectives. To enhance this impact, policymakers should encourage technology transfer, offer investment incentives, promote knowledge exchange, and align trade policies with renewable energy goals. By implementing these recommendations, ASEAN countries can leverage foreign trade partnerships to accelerate the transition towards sustainable energy practices, drive innovation in the renewable energy sector, and strengthen their energy security for a greener future.

Urbanization emerges as a factor negatively impacting renewable energy production, with higher levels of urbanization associated with lower production levels. This finding underscores the

importance of integrating renewable energy solutions into urban planning and development strategies. Policymakers should consider incorporating renewable energy technologies into urban infrastructure projects to enhance energy efficiency and sustainability in rapidly urbanizing areas.

Trade openness is identified as another factor that may reduce renewable energy production in ASEAN countries. Policymakers and stakeholders should focus on balancing the benefits of trade openness with the need for sustainable energy practices. Implementing policies that promote renewable energy investments and collaborations while addressing trade-related challenges can help create a conducive environment for renewable energy production in the region.

In conclusion, o enhance renewable energy production in ASEAN, policymakers should prioritize measures that incentivize renewable energy consumption, invest in renewable energy infrastructure, integrate renewable energy solutions into urban development plans, and strike a balance between trade openness and sustainable energy goals. By implementing these recommendations, ASEAN countries can accelerate their transition towards a greener and more sustainable energy future, contributing to global efforts to combat climate change and promote environmental sustainability.

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