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BALANCING THE NEEDS OF ENERGY SECURITY, ECONOMIC GROWTH, AND CLIMATE SUSTAINABILITY IN ASEAN

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Abstract

This paper provides an integrative review of the energy landscape and cross-sectoral energy-related policies in the ASEAN Member States (AMSs) in balancing the needs of energy security, economic growth, and climate sustainability. To achieve this broad objective, the paper aims *to investigate the changing structure of the economy by comparing it with the changing trends of energy sources in ASEAN*. The analysis will use the historical data from 2005 to 2020 and the projection data from 2021 to 2050 from the 7th ASEAN Energy Outlook. This will reveal insights into whether, and if so how, net-zero emissions will be realized in ASEAN by or around the middle of the century. Given the important role of governments, we argue that a comprehensive review of national energy policies stated in official documents within the region is also essential to investigate the capability of AMSs to accelerate energy transition while securing energy supply. These official publications represent the voice of regime actors. Providing a novel contribution to the research, the second aim of the paper is *to assess national policies in ASEAN related to energy transition away from coal, using horizontal integrated policy analysis*. This will exhibit the ASEAN policymakers' perspective on how to accelerate energy transition while securing economic structural transformation. Structural transformation and the energy trilemma are the theoretical frameworks that motivate this study. It was found that coal will still be an important fuel in the ASEAN energy mix by 2050, making it challenging for the region to entirely phase out coal and achieve the decarbonization target. The region could stabilize its baseload renewable energy, such as hydro, geothermal, and bioenergy, while increasing its variable renewables intake through enhancing grid infrastructure, interconnection, and rural off-grid systems. A collaborative approach among cross-sectoral policymakers and support from the international community, especially in financing climate change mitigation, will be crucial for the region to balance its energy security, economic growth, and environmental sustainability.

Keywords: structural transformation, energy trilemma, energy security, economic growth, climate sustainability

JEL Classification: Q48

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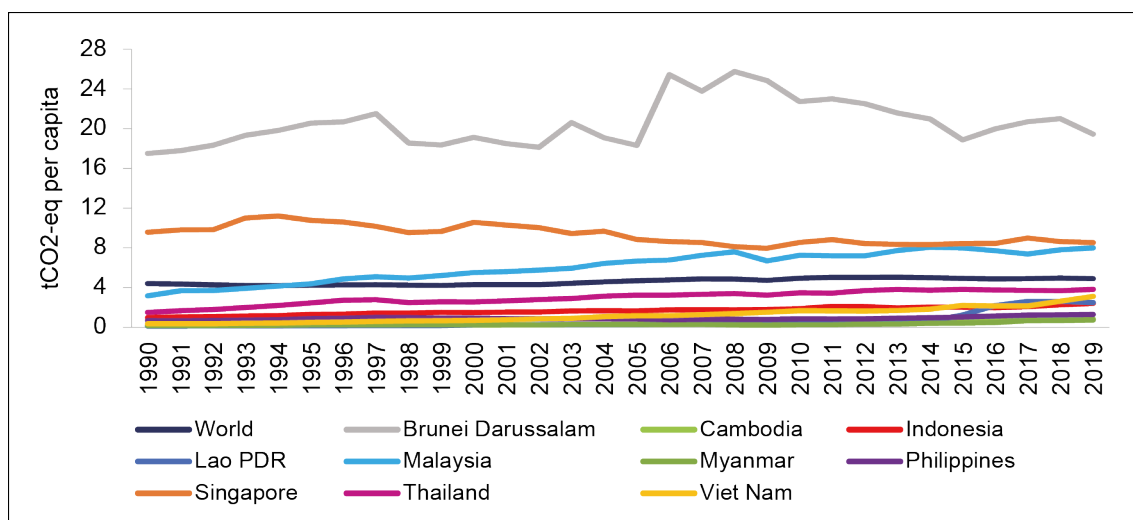
1. INTRODUCTION

The international community has recognized the need to fight climate change. The implications of climate change are extremely serious and affect every aspect of life in all regions worldwide (EC n.d.). The global Paris Agreement treaty has set goals to keep global warming well below 2°C and pursue efforts to limit it to 1.5°C, compared to preindustrial levels (UNFCCC 2015). The Intergovernmental Panel on Climate Change (IPCC) had reported, by 2017, that human-induced activities have warmed the earth by about 1°C since preindustrial times (IPCC 2018).

Decarbonizing the energy sector is a crucial step toward meeting these international climate goals. When fossil fuels like coal, oil, and gas are burned to generate electricity, they release large amounts of greenhouse gases (GHGs) that could blanket the earth and trap the sun's heat in the atmosphere, causing global warming. Fossil fuels, which supply about 80% of energy worldwide (SEI, IISD, ODI, E3G, and UNEP 2020), are by far the largest contributors to global climate change, accounting for 76% of global GHG emissions and about 90% of all carbon dioxide (CO₂) emissions (SEI, Climate Analytics, E3G, IISD, and UNEP 2019). Coal alone is the largest fossil fuel source of the global temperature increase, responsible for over 0.3°C of the 1°C rise (ClientEarth Communications 2022). Hence, the energy system transition away from fossil fuels, especially coal, is deemed essential.

ASEAN¹ is one of the most dynamic regions in the world, contributing to significant emissions. Based on data from Climate Watch, the total GHG emissions in 2019 from the ten ASEAN Member States (AMSs) accounted for just 4.6% of the global energy-related GHG emissions. Only three Member States produced emissions per capita above the global average value, namely Brunei Darussalam, Singapore, and Malaysia (see Figure 1).

Figure 1: GHG Emissions per Capita of the ASEAN Member States and the World in the Energy Sector



Data Source: ClimateWatch; <https://www.climatewatchdata.org/ghg-emissions>.

¹ The Association of Southeast Asian Nations, established in 1967, comprises ten countries, namely Brunei Darussalam, Cambodia, Indonesia, the Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam.

As seen in Figure 1, out of ten AMSs, only Singapore and Brunei Darussalam experienced declining GHGs emitting trends in the energy sector, with peaks in the years 1994 and 2008, respectively. The rest of the bloc are developing countries with rapid economic growth that depends greatly on the energy system. This is especially true when the country transforms its structural economy from agriculture to industry or service sectors.

Energy equity is one of the important factors affecting economic growth. The World Energy Council (WEC) defined energy equity as a country's ability to provide universal access to reliable, affordable, and abundant energy for domestic and commercial use across the population (WEC 2021). A growing number of studies have examined the relationship between economic growth and energy access (Lee, Miguel, and Wolfram 2017; Stern, Burke, and Bruns 2019; Milin, Mungiu Pupazan, Rehman, Chirtoc, and Ecobici 2022). It is argued that energy access is a critical driver for increasing GDP (Walton 2018) and a precondition for improving income inequality (Acheampong, Dzator, and Shahbaz 2021). For low- and middle-income countries in particular, energy equity had the largest impact on economic growth (Kang 2022).

Not only in terms of universal electrification, but the region also lacks (even has lower) achievement on providing inclusive clean cooking access for all. As of 2020, an estimated 8 million ASEAN households (5%) did not have access to electricity, and 200 million people (30%) did not use clean cooking methods (ACE 2022b). This means more effort is needed by the region to accomplish the 100% energy access target by 2030 as directed by Sustainable Development Goal (SDG) 7, "Affordable and Clean Energy."

To satisfy the ever-growing demand for fulfilling the region's energy access and hence boosting economic growth, ASEAN's total primary energy supply (TPES) has grown rapidly and is expected to continue rising sharply. The 7th ASEAN Energy Outlook (AEO7) reported that the TPES reached 654 Mtoe in 2020, approximately 1.5 times the 2005 level, with an 83% share of fossil fuels (ACE 2022b). Although Brunei Darussalam was still a net exporter of oil in 2020, from a region-wise perspective, ASEAN has been a net importer of oil since before 2005. Following the region's historical trend of heavy reliance on fossil fuels and without any significant national and aspirational policy interventions, AEO7 forecast ASEAN to also be a net importer of natural gas and coal by 2025 and 2039, respectively.

The high dependency on importing fossil fuels would harm energy security in the future because their price is volatile, especially during shocks like financial crises, pandemics, and geopolitical wars. For example, during the Covid-19 pandemic, the surprise rise in the oil prices was driven by the unprecedented drop in transport and slowdown in economic activity worldwide. In April 2020, the world recorded that for the first time in history, US crude dropped to negative figures as storage had reached its maximum capacity (ACE 2022a). The situation might benefit importers temporarily, as several countries, including the Philippines and Thailand, were seen to harness the momentum by stockpiling oil and liquefied natural gas (Safrina and Rosalia 2021). However, the price soared higher when countries began lifting their lockdown restrictions, creating instability in the financial system (Shi and Zheng 2022).

By considering the importance of energy transition and resilience while maintaining energy security, accessibility, affordability, and sustainability for all, the region has set aspirational targets under the ASEAN Plan of Action for Energy Cooperation (APAEC). Now in its second phase, APAEC 2016–2025 reaffirms the strong commitment of AMSs to accelerating the energy transition and strengthening energy resilience through greater innovation and cooperation. APAEC covers seven program areas, namely:

ASEAN Power Grid (APG), Trans-ASEAN Gas Pipeline (TAGP), Coal and Clean Coal Technology (CCT), Energy Efficiency and Conservation (EE&C), Renewable Energy (RE), Regional Energy Policy and Planning, and Civilian Nuclear Energy.

The regional targets include increasing the RE share in TPES by 23% and in installed power capacity by 35%, as well as reducing energy intensity (TPES/GDP) by 32% compared to 2005 levels, all by 2025 (ADC 2020). With the target year approaching soon, concerns have arisen as to whether the region will be able to achieve the said targets, and whether it will raise its ambitions during the drafting of the next APAEC cycle (2026–2035). The WEC found that most Asian countries, including those in Southeast Asia, still struggle with energy security and sustainability (WEC 2021). Another study also discovered that both energy equity and energy security were positively related to economic growth, while environmental sustainability was negatively associated with economic growth (Kang 2022).

Against this backdrop, there is a need to balance environmental sustainability, as stressed by the international community, with economic growth while ensuring energy security in ASEAN. To better understand the potential of different energy sources in ASEAN toward a low-carbon future, it is essential to analyze the economy and energy systems in long time series. To achieve this broad objective, this paper aims to *investigate the changing structure of the economy by comparing it with the changing trend of energy sources in ASEAN*. The analysis will use historical data from 2005 to 2020 and projection data from 2021 to 2050. This will reveal insights into whether, and if so how, net-zero emissions will be realized in ASEAN by or around the middle of the century.

Given the important role of governments, a comprehensive review of national energy policies stated in official documents within the region is also essential to investigate the capability of AMSs to accelerate energy transition while securing energy supply. These official publications represent the voice of regime actors. Providing a novel contribution to the literature, the second aim of the paper is to *assess national policies in ASEAN related to energy transition away from coal, using horizontal integrated policy analysis*. This will exhibit the ASEAN policymakers' perspective on how to accelerate energy transition while securing economic structural transformation.

Structural transformation and energy trilemma theoretical frameworks underline the basis of this study. Economic growth relies heavily on the structural transformation of a country and needs to be balanced with the energy trilemma challenges. Since the three economic structures—agriculture, industry, and services—are final energy consumers, the structural transformation in each of these sectors has implications for the shifts in the final energy consumption. A study has assessed the associated impact of structural transformation from agriculture to industry to services on the decline of final energy intensity (Schäfer 2005). The energy policy, especially in the area of EE&C, must thus be adapted based on the changes in the shares of a particular sector in the final energy use. Pettinger (2019) suggested that “it is possible economic growth will be compatible with an improved environment, but it requires a very deliberate set of policies and willingness to produce energy and goods in the most environmentally friendly way.”

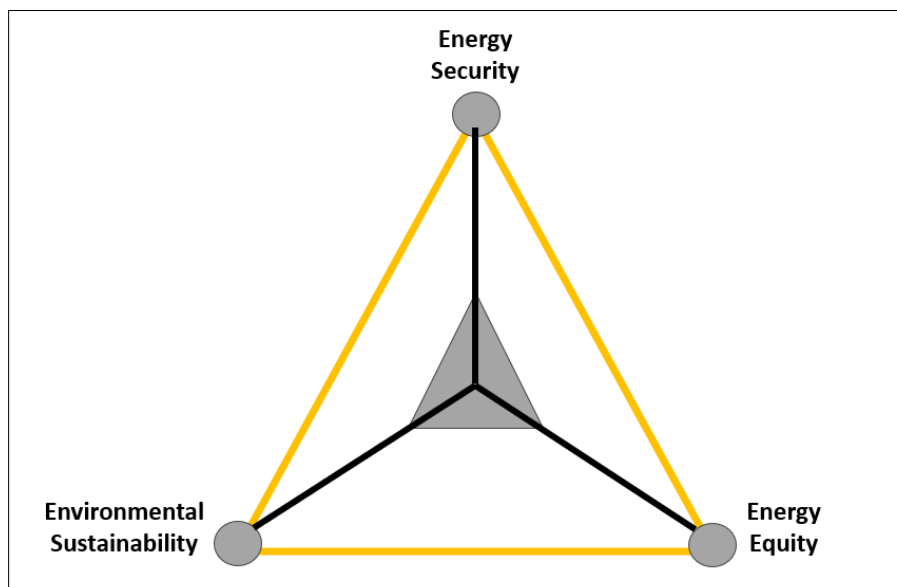
Sustaining energy supply is just one of many challenges in the ASEAN region when it comes to energy perspectives. Not only is it facing a growing energy demand due to structural transformation, but ASEAN also needs to balance its energy trilemma (energy security, energy affordability, and energy sustainability). The role of fossil fuels, such as coal, will remain critical considering their relatively low cost and their proven capacity to provide dispatchable baseload power. On the other hand, ASEAN countries also acknowledge the need to transition into a low-carbon economy to contribute to the

global action of keeping the rise in the global average temperature well below 2°C and to pursue efforts to limit the temperature increase to 1.5°C since the ASEAN region is home to countries that are most vulnerable to climate impact.

The energy trilemma involves the competing demands of energy security, energy equity, and climate change mitigation (Gunningham 2013). Energy security is defined as “the nation’s capacity to meet current and future energy demand reliably, withstand and bounce back swiftly from system shocks with minimal disruption to supplies” (WEC 2021). APERC (2007) identified several factors that can influence the security of energy supply, including: (1) the availability of fuel reserves, both domestically and through external suppliers; (2) the ability of an economy to acquire sufficient supply to meet the projected energy demand; (3) the level of an economy’s energy resource diversification and energy supplier diversification; (4) accessibility to fuel resources, in terms of the availability of related energy infrastructure and energy transportation infrastructure; and (5) geopolitical concerns surrounding resource acquisition.

On the other hand, energy equity concerns a nation’s ability to afford access to energy for its people. Finally, the third part in the complex energy trilemma represents the transition of a nation’s energy system towards mitigating potential environmental harm and climate change impacts. The three components are sometimes conflicting since different stresses are placed on each part of the trilemma depending on a country’s economic interests over time (see Figure 2). Managing these three pillars is challenging and should be considered carefully in every policymaking process in the energy sector.

Figure 2: Energy Trilemma



Source: WEC (2021).

The following section outlines the data used for the analysis. Next, Section 3 explains the results and findings of the long-run trends analysis, including the transformation in the structural economy and transitions in the energy system in ASEAN. In light of the analysis, the final section then draws conclusions and makes policy recommendations.

2. DATA

This section outlines the data used to analyze the energy trends in ASEAN, and their correlation with AMSs' structural transformation. The study combines data from secondary and primary sources published by authorities in AMSs, international organizations, and other sources.

The primary data for this study are the historical and projection data of the regional energy landscape in ASEAN, collected from AEO7. This component will provide a snapshot at the regional level and a detailed analysis of the country's context in the development of the energy and clean energy sector in ASEAN. AEO7 outlines four future scenarios: (1) Baseline Scenario, following historical ASEAN energy trends without any policy interventions; (2) AMS Targets Scenario (ATS), incorporating the stated national policies from all ten Member States; (3) APAEC Targets Scenario (APS), considering more ambitious targets and efforts set in the APAEC blueprint; and (4) Least-Cost Optimization, taking into account the neutral technologies that it is viable to implement in ASEAN.

The first component is total final energy consumption (TFEC), which is defined as the sum of energy consumption by end-use sectors, excluding nonenergy use and international transportation. Secondly, the study requires TPES, which historically is the total amount of energy production and imports, less exports. It includes nonenergy uses and stock changes but excludes international transportation. For the projection years, energy supply is calculated as the energy use as the inputs to transformation plus energy demand and imports, minus energy exports.

The other important energy data surrounding energy security are in the power sector, including installed power capacity and power generation. Meanwhile, for energy equity, the study assesses ASEAN electrification and the clean cooking access rate. The GHG emissions data are used to analyze environmental sustainability. Cross-validation and a critical review among sources were conducted during the development of AEO7 to ensure the validity of the data prior to data analysis.

All aforementioned components of the energy trilemma are being compared with economic growth indicators (i.e., GDP) to provide the context of energy demand and supply. The macroeconomics consists of GDP data, including total and by sector for every AMS, which were collected from the Key Indicators Database of the Asian Development Bank². Within the scope of GDP growth, the economic structures are considered. The original TFEC data from AEO7 were divided into five sectors: agriculture, industrial, transportation, commercial, and residential. Since this paper aims to compare the trends with economic growth (i.e., GDP), three sectors—transportation, commercial, and residential—are combined into services to match the sectoral GDP categorization. This should be noted because it creates a sectoral share in TFEC that might differ from what is mentioned in AEO7.

In addition, several other socio data, such as the population and number of households, were also collected for all ten AMSs, to calculate the cumulative electrification and clean cooking access rate as a region, as well as GDP and energy per capita.

² <https://kidb.adb.org/>.

3. FINDINGS AND DISCUSSION

This section elaborates the findings by discussing them in the three energy trilemma challenges: energy security, energy equity including economic growth, and environmental sustainability including climate.

3.1 Energy Security

The data analysis shows that the ASEAN energy demand in 2020 had increased by 1.5 times compared to the 2005 level, following the rapid rise of population and economic growth. TFEC in 2020 was recorded at 385 Mtoe, compared to 259 Mtoe in 2005. Fossil fuels have dominated the historical TFEC mix. In 2020, oil contributed 44% of TFEC, followed by electricity (23%) and coal (12%).

The Baseline Scenario of AEO7, which uses the historical trend, projects that the ASEAN TFEC in 2050 will grow by 3.3 times within 30 years (see Figure 3). The same growth for GDP is observed during the same period, showing a strong correlation with energy demand projection. All types of fuel and sectoral consumption are also seen to be growing in the same pattern as TFEC, though much slower for agriculture. Fossil fuels continue to predominate the energy demand. Despite the decreasing growth rate, oil still has the largest share in TFEC. Meanwhile, natural gas consumption is growing the fastest because of its massive utilization in the ASEAN industrial sector. The industry and transportation sectors, both under services structure, lead this growth. This shows that the ongoing reliance on fossil fuels will still be seen to secure energy consumption in the region.

In order to improve energy security, each AMS has established a set of substantial EE&C policies as the first effort to curtail the growing energy demand. The targets are varied in terms of baseline and focused sectors (see Table 1). Several AMSs also introduced stringent policies in fuel shifting to biofuel and electric vehicles to reduce oil consumption and dependency in the transportation sector, one of the most energy-consuming sectors in ASEAN.

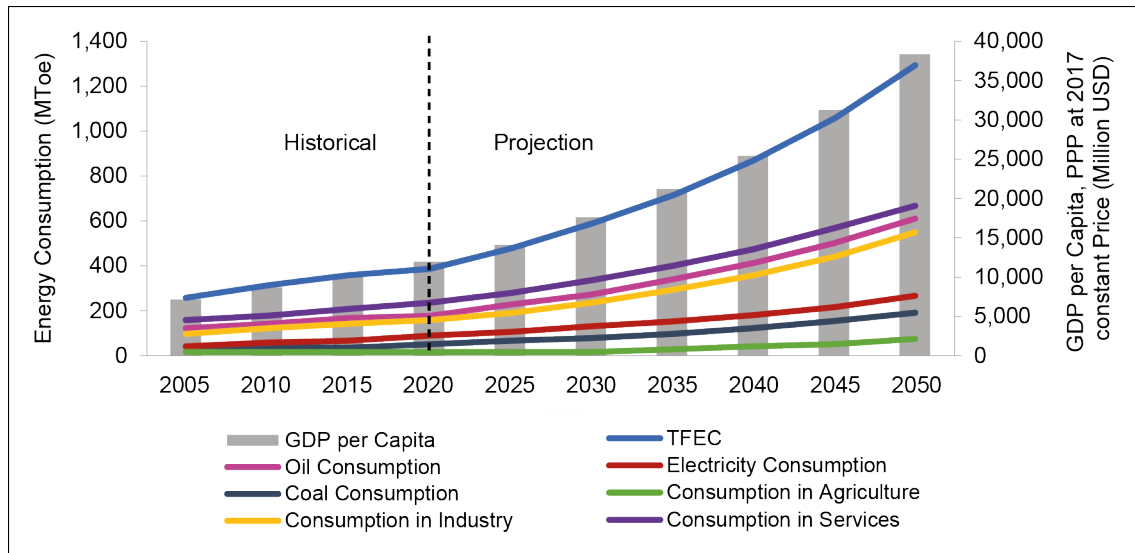
By taking into account the above-stated policies (in ATS), it is predicted that ASEAN as a whole region could save around 40% of energy by 2050 compared to the Baseline Scenario. The savings could even reach 54% in the same period by implementing more ambitious EE&C policies (in APS). Figures 3 and 4 provide a comparison between TFEC and GDP per capita in the Baseline Scenario and APS, respectively. It shows a considerable gap between ASEAN energy consumption and the GDP growth projection. Oil consumption, as well as demand in industry and services, decrease significantly in APS, which could enhance the energy security situation in the region.

Table 1: Energy Efficiency/Intensity Targets of ASEAN Member States

Country	Energy Efficiency/Intensity Target			Source
	All Energy	Sectoral Consumption	Electric Transport*	
Brunei Darussalam		Reduce GHG emissions by at least 10% through better supply and demand management of electricity consumption by 2035	Increase the total share of EVs to 60% of the total annual vehicle sales by 2035	(Brunei Darussalam 2020)
Cambodia	Reduce energy consumption—thermal and electrical—by 19% by 2030	Reduce energy consumption by 34% in the residential sector, 29% in public services, 25% in commercial buildings, 20% in the industrial sector, and 5% in the transport sector by 2030	Achieve 70% electric motorcycles and 40% electric cars and urban buses by 2050	(Kingdom of Cambodia 2021, 2022)
Indonesia	Reduce energy intensity (TPES per GDP) by 1%/year through 2025		Achieve 2 million units of electric cars and 13 million units of electric motorbikes by 2030	(Ministry of Energy and Mineral Resources 2021; Republic of Indonesia 2014)
Lao PDR	Reduce TFEC by 10% by 2030 as compared to the baseline (with international support)	Introduce 50,000 energy-efficient cookstoves by 2030		(Lao PDR 2021)
Malaysia		Reduce energy demand by 8% compared to baseline by 2025	Achieve 100,000 electric cars by 2030	(Malaysia 2018)
Myanmar	Achieve energy savings of 20% by 2030 (with international support)	Improve energy efficiency of the residential sector by 7.8%, the industrial sector by 6.63%, the commercial sector by 4%, and other sectors by 1.36% by 2030 (with international support)		(The Republic of the Union of Myanmar 2021)
Philippines	Save 5% energy from oil products and electricity by 2040 as compared to baseline		Reach 10% penetration rate for EVs for road transportation (motorcycles, cars, jeepneys) by 2040	(Department of Energy 2020)
Singapore		Green 80% of Singapore's buildings (by gross floor area) and reduce energy consumption in existing HDB towns by 15% by 2030	Achieve 100% cleaner-energy public bus fleet and taxis by 2040 (electric or hybrid vehicles)	(Singapore 2021)
Thailand	Reduce energy intensity (TFEC/GDP) by 30% by 2037 relative to the 2010 level		Achieve 30% electric vehicles manufactured by 2030	(Thailand 2018)
Viet Nam	Reduce energy intensity in TFEC by 5%–7% in 2025 and by 8%–10% in 2030	Reduce fuel and oil consumption by 5% in transportation		(Viet Nam 2019)

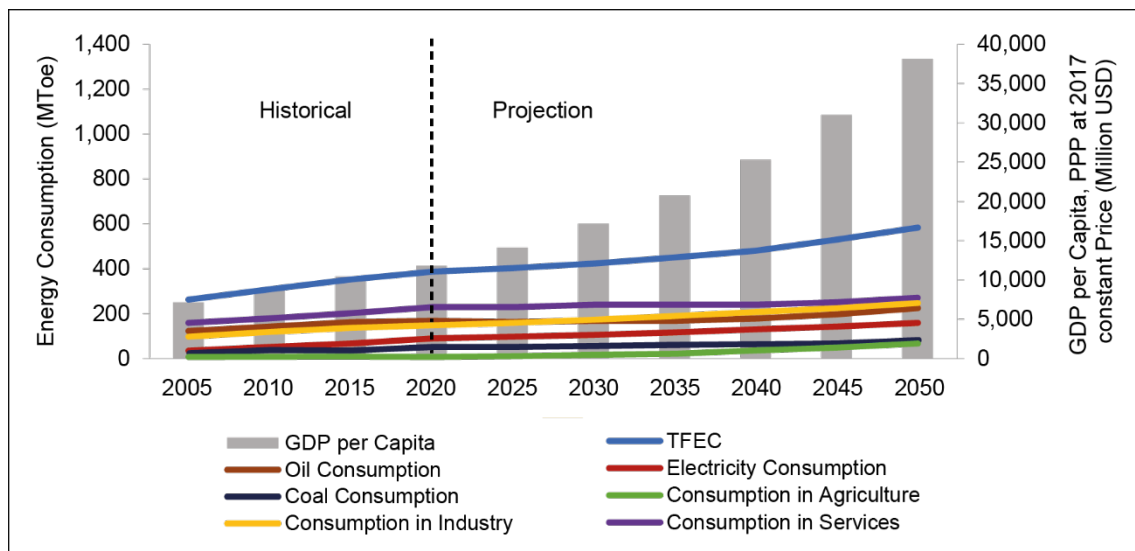
* Electric transportation is being categorized as energy efficiency and conservation effort because of its potential in reducing oil consumption.

Figure 3: ASEAN Total Final Energy Consumption vs. GDP per Capita, Historical and Baseline Scenario



Data Source: ACE (2022b). Note: Services include transportation, commercial, and residential.

Figure 4: ASEAN Total Final Energy Consumption vs. GDP per Capita, Historical and APAEC Targets Scenario



Data Source: ACE (2022b). Note: Services include transportation, commercial, and residential.

Fossil fuels also dominated the region's energy supply, accounting for about 82% in 2020, compared to 14% for renewables (ACE 2022b). ASEAN has been a net importer of oil since before 2005 and is projected to be a net importer of natural gas in 2025 and coal in 2039. With a growing increasing dependence on fossil fuel imports, ASEAN could face an energy security issue in the future.

The promotion of fuel switching to bioenergy in the transportation sector would reduce oil imports and improve energy security. Several AMSs, including Indonesia, Malaysia, and Thailand, have already adopted biofuel blending policies to replace oil products. Biofuel acceleration for more potential countries up to B40³ and E30⁴ could be the key measure for achieving the APAEC targets. Extensive research and development is needed to leverage more production of high-quality biofuels, ensure the sustainability of feedstocks, manage the competition with land use, and avoid deforestation. Bioenergy could also be utilized for co-firing in coal power plants.

Not only policies related to biofuel but other targets were also implemented by the AMSs in the past that have driven the large uptake of RE and clean technologies (see Table 2). The RE policies include increasing the renewables share in TFEC, TPES, and installed power capacity, specifically anticipating increased residential electricity demand coming from EVs. Each AMS has its own untapped potential. Solar photovoltaic (PV) is the most viable option in Brunei Darussalam and Singapore. Cambodia is just beginning to tap into its solar and wind potential after the recent development of large hydropower. Indonesia, the region's largest energy consumer, is also looking to diversify its hydro-based renewable electricity mix.

Table 2: Renewable Energy Targets of ASEAN Member States

Country	Renewable Energy Share Target			Source
	in TPES	in TFEC	in Installed Power Capacity	
Brunei Darussalam			30% by 2035	(Brunei Darussalam 2020)
Cambodia			3% of residential electricity demand met by rooftop solar PV by 2035	(Kingdom of Cambodia 2021)
Indonesia	23% by 2025 and 31% by 2050			(Republic of Indonesia 2014)
Lao PDR		30% by 2025	20% by 2025	(Lao PDR 2021)
Malaysia			31% by 2025 and 40% by 2035	(Malaysia 2018)
Myanmar			12% by 2030	(The Republic of the Union of Myanmar 2021)
Philippines			will triple the 2010 level by 2030	(Department of Energy 2020)
Singapore	solar energy deployed will be five times the 2021 level by 2030			(Singapore 2021)
Thailand		30% by 2037		(Thailand 2022)
Viet Nam	32.3% by 2030 and 44% by 2050			(Viet Nam 2022)

Under the APAEC Phase II, AMSs are committed to promoting stronger policies to increase the share of RE as an effort to improve energy accessibility through APG and rural electrification. The conception of APG was in the earliest version of APAEC: 1999–2004. The scenario to maximize the adoption of RE in the regional power grid had been evaluated through the ASEAN Interconnection Masterplan Study (AIMS) III, which had also been endorsed in the 39th ASEAN Ministers on Energy Meeting (AMEM) in 2021.

³ 40% palm oil and 60% diesel fuel.

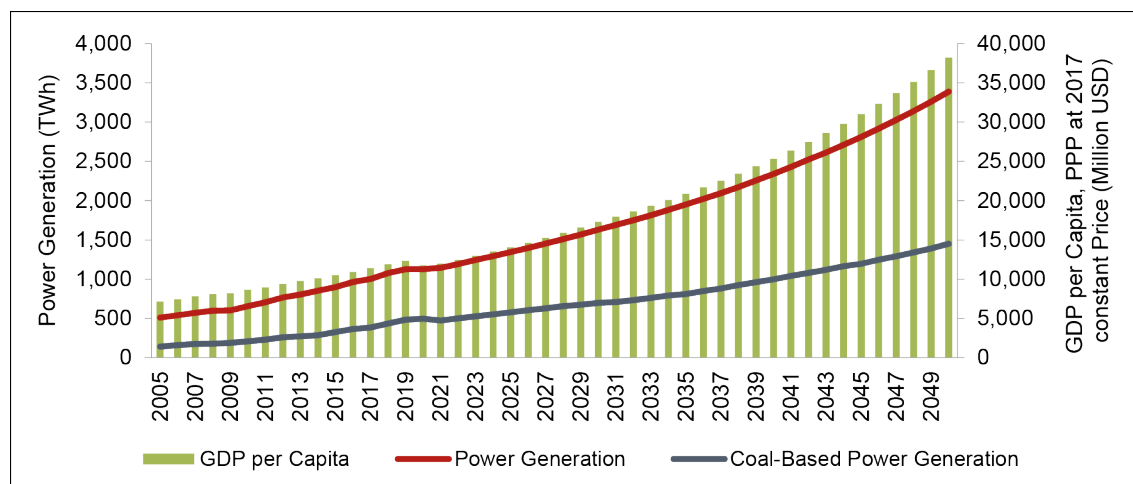
⁴ 30% ethanol and 70% gasoline.

The APG consists of several cross-border grid infrastructures that are categorized into three systems. They are the northern, southern, and eastern corridors. The northern system comprises the Lao PDR-Thailand-Malaysia-Singapore power integration project (LTMS-PIP) and the other interconnections between Mekong countries. The southern system refers to the cross-border transmission between peninsular Malaysia and Sumatra Island of Indonesia. The eastern corridor is the infrastructure development to connect the Philippines with Sabah and Sarawak of Malaysia, the Kalimantan grid of Indonesia, and Brunei Darussalam's power system. Among the three corridors, the LTMS-PIP is the only transmission project that has been effectively channeling the bilateral power transactions, mainly from Lao PDR to its neighboring Mekong countries.

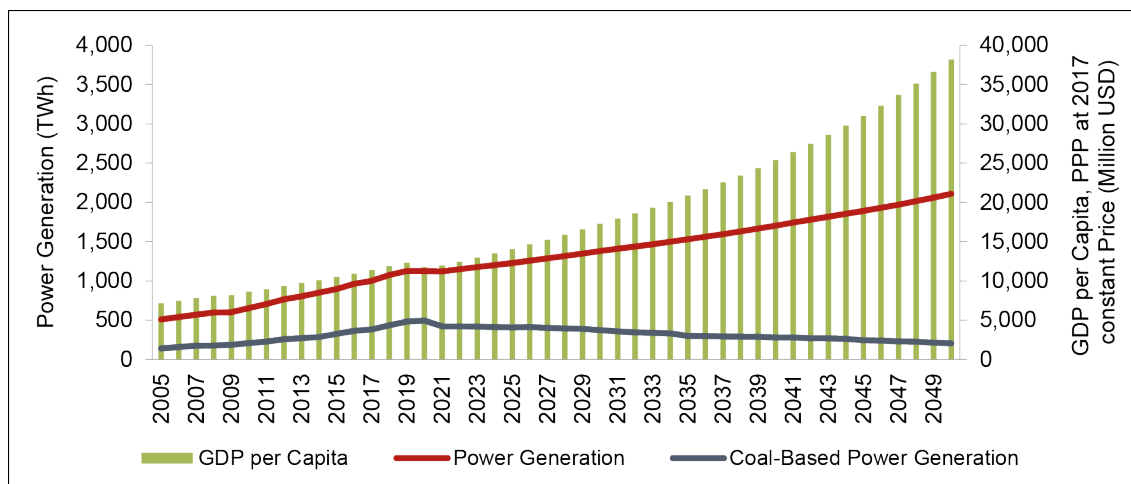
Lao PDR's vision of becoming the "Battery of Asia" has spearheaded regional power trading. By the third quarter of 2021, Lao PDR had reported earnings of USD2 billion, an increase of 12% compared to the preceding year. In the same year, the other Member States were still recovering from the profit loss due to falling power demand caused by the Covid-19 pandemic. Furthermore, Lao PDR is committed to continuing the capacity expansion of power export, albeit already having the committed capacity of 6.4 GW, of which more than 80% is sourced from hydropower. Lao PDR's export plan includes an increase from 320 to 1.8 GW by 2027 with Cambodia, from 100 MW to 300 MW with Malaysia, from 10 MW to 200 MW by 2025 with Myanmar, from 5.4 GW to 10.1 GW by 2027 with Thailand, and from 572 MW to 2 GW with Viet Nam. The latest export deal was signed in August with the Electricity Generating Authority of Thailand, the new 1.2 GW long-term purchase contract. The year 2022 also marked significant progress in the development of APG, with the first 100 MW electricity export being transmitted via the LTMS-PIP.

Figures 5 and 6 display the historical and projection data of ASEAN power generation in the Baseline Scenario and APS, respectively, compared to GDP. Until 2050, coal is projected to still play an essential role in the ASEAN electricity generation mix, even in its most ambitious scenario, making it difficult for the region to commit to their decarbonization targets. Carbon capture, utilization, and storage (CCUS) could be the temporary solution to absorb the emissions resulting from coal power plants until the region can phase out coal entirely.

Figure 5: Power Generation vs. GDP, Historical and Baseline Scenario



Data Source: ACE (2022b). Note: Historical 2005–2020, Projection 2021–2050.

Figure 6: Power Generation vs. GDP, Historical and APAEC Targets Scenario

Data Source: ACE (2022b). Note: Historical 2005–2020, Projection 2021–2050.

3.2 Economic Growth and Energy Equity

The affordability of energy significantly impacts the economic growth of a nation since energy, mainly in the form of electricity, is consumed to create products and services. Moreover, the capacity to purchase electricity improves the quality of life of households since it allows the use of appliances and devices that provide essential functions such as lighting, heating, and cooling. Energy affordability remains a growing issue in most AMSs, along with energy security and environmental sustainability.

Cambodia and the Philippines have the highest electricity prices among the ASEAN economies, exceeding the global median electricity price (Suryadi et al. 2020). Many factors impact the prevailing electricity rate of a specific country – the cost of the fuel used in the generation, the efficiency of the generation technologies, the transmission and distribution losses, and the imposed tax and levy, to name just a few. In the case of Cambodia and the Philippines, these countries are significant importers of fossil fuels as feedstocks for power production, making the generation cost higher than in neighboring countries that sourced these feedstocks indigenously. In fact, almost 95% of the cost of the electricity supply in Cambodia is associated with the cost of fuel used in power generation (Poch and Tuy 2012).

Subsidies in household connections and tiered electricity pricing have long been implemented in several economies to make electricity more affordable (UNESCAP 2021). Brunei Darussalam, which has the lowest electricity costs in Southeast Asia, highly subsidizes its electricity prices. Imposing subsidies places the fiscal burden on the government, which benefits from the country's revenue from its large natural gas resource. The country implemented the increasing block tariff to allocate these subsidies to the residential sector. This scheme ensures that low-income households enjoy a larger share of the total electricity subsidies while high-income households still enjoy a substantial portion (Pacudan and Hamdan 2019).

The ASEAN region incorporates countries with diverse economies and energy challenges, as illustrated above, but the common denominator in the different circumstances of Brunei Darussalam, Cambodia, the Philippines, and other member states is that increased utilization of indigenous resources makes the cost of electricity cheaper. It also addresses the issues of energy security since it lessens the dependency on fuel imports, which are susceptible to price volatility.

Although distributed unevenly across the region, ASEAN is rich in fossil fuel and RE resources. While Brunei Darussalam takes advantage of its gas resource, Viet Nam and Indonesia develop their coal resources for electricity production. The domestic price of coal in these countries is kept below the global price, which encourages its use in the power sector.

The reliance on coal in the past in Viet Nam and Indonesia has led to a relatively lower electricity price. But in recent years, the need to transition to low-carbon power generation has become more relevant in response to the global threat to the climate. The high-efficiency low-emission (HELE) technology, such as supercritical and ultra-supercritical coal-fired power plant technologies, allowed the sustainable use of coal with reduced emissions compared to the older and less efficient subcritical technology. The improved operational efficiency generates the same MWh of electricity with a lower amount of coal, resulting in reduced emissions.

Another emission reduction strategy for existing coal plants that are being explored in the region is biomass co-firing, wherein coal feedstock is blended with 5% to 20% biomass (e.g., bagasse, rice husk, coconut fiber) (ACE 2022b). Biomass is considered a carbon-neutral substance. Hence its application to coal plants is a direct and effective mitigation measure for CO₂.

The ASEAN region has relied on fossil-based power generation to deliver cheaper electricity to respective Member States. The region's energy demand had grown fast in previous years and is expected to increase more than threefold the 2017 level by 2050 to sustain the region's economic growth (ACE 2022b). However, despite the reliability of fossil-based generation in filling the growing energy gap, access to electricity remains an issue in far-flung areas in several ASEAN countries. The barriers to the electrification of these areas include the high investment requirements for electricity transmission due to their location. An option for an off-grid system is viable but usually comes with higher electricity rates than in urban areas (ADB 2016). In addition, the inhabitants of these remote areas usually have a low ability to pay for utilities and services, which makes grid extension even less economically feasible.

According to IRENA (2020), RE offers a cost-effective solution to the issue of rural electrification. It maximizes the local resource potential and ensures that remote areas achieve a sustainable and reliable energy supply away from the central grid. The falling cost of RE technologies and energy storage components makes the generation from renewables a more viable option than grid extensions (UNESCAP 2021). Moreover, financial support and subsidies are also provided by several AMS governments to increase the uptake of renewables in the off-grid systems.

3.3 Environmental Sustainability

ASEAN has realized the urgency of a low-carbon future. During and after the 2021 United Nations Climate Change Conference of Parties (COP26), almost all AMSs declared their decarbonization target year, either for carbon neutrality or net-zero emissions (see Table 3). Indonesia has set a net-zero emissions target by 2060 or sooner. Meanwhile, Singapore has recently raised its climate ambition from previously stating it would reach net-zero emissions "by or around mid-century" to "by 2050" (NCCS 2022). Only the Philippines has not yet stated any target, as this paper is written, while the rest of the Member States set a decarbonization target of 2050.

Table 3: ASEAN Member States' Energy-Related Climate Commitments

Country	Coal Phase-Out Pledge	Global Methane Pledge	Decarbonization Target
Brunei Darussalam	Yes	No	Net-zero emissions by 2050
Cambodia	No	Yes	Carbon neutrality by 2050
Indonesia	Yes (partial)	Yes	Net-zero emissions by 2060 or sooner
Lao PDR	No	No	Net-zero emissions by 2050 conditionally
Malaysia	No	Yes	Carbon neutrality by 2050
Myanmar	No	No	Carbon neutrality by 2050
Philippines	Yes (partial)	Yes	No target set
Singapore	Yes	Yes	Net-zero emissions by 2050
Thailand	No	No	Carbon neutrality by 2050 and net-zero emissions by 2065
Viet Nam	Yes	Yes	Net-zero emissions by 2050

Source: ACE (2022b), NCCS (2022).

Several Member States pledged energy-related climate commitments during COP26, including a phasing out of coal and reduction of methane. Major coal producers and consumers in ASEAN, such as Indonesia, the Philippines, and Viet Nam, are among those to commit to shifting away from coal. In addition, more than half of AMSs have now committed to cutting global emissions of methane, a potent GHG, by at least 30% by 2030 from the 2020 levels. This shows the ambitious commitments of ASEAN to reduce GHG emissions from the energy sector, despite contributing fewer emissions than other countries in the world. These ambitions have been backed by international support, such as the Energy Transition Mechanism (ETM) of ADB and the Just Energy Transition Partnership (JETP) (ACE 2023). Both partnerships aim for early retirement of coal power plants, including Indonesia and the Philippines for ETM, as well as Indonesia and Viet Nam for JETP. JETP targets specifically making power sector emissions peak in the two AMSs by 2030.

Under APAEC 2016–2025 Phase II: 2021–2025, which was endorsed by the 38th AMEM in November 2020, the AMSs agreed to set the regional targets of achieving 23% RE share in TPES and 35% in installed power capacity by 2025. However, despite the collective efforts of the AMSs, fossil-based generation is still projected to dominate the energy mix in the region to secure its energy demand. The portion of RE in TPES will only take about 17.5% and 23% in the Baseline Scenario by 2025 and 2050, respectively. AMSs need to set more ambitious policies to reach the regional target.

In the RE and EE&C program areas, APAEC supports the conducting of energy research and capacity building to increase the uptake of renewable and efficient technologies and their application in the power sector, industry, and transport. The APG is another strategic program under APAEC that aims to facilitate electricity trading among the Member States through strategic interconnections and enhance the integration of their power systems, built to accommodate higher variable renewable energy (VRE) penetration cost-effectively and reliably.

APAEC also acknowledges the specific circumstances of AMSs throughout its implementation. Since coal serves as the primary commodity in several AMSs, it promotes the deployment of CCT and CCUS into the region's transition towards a low-carbon economy under its CCT program area. The technology-neutral approach allows APAEC to explore the feasibility of deploying available technologies, including nuclear energy. Overall, it ensures that the national energy policy and planning of Member States are in alignment with the attainment of regional energy targets and energy cooperation goals.

Beyond the notable progress in 2021, the APG could offer more solutions to the challenges of decarbonizing the ASEAN power system. Specifically, the abundant RE sources are often far from the demand within the same country but might be closer to a bordering country. The APG could also open access to the immense RE potential, in which, if aggregated regionally, the gross capacity of solar could reach 8 TW and wind 342 GW – not to mention that the APG is a reasonable alternative to accommodate the flexibility needed due to the intermittency of an accumulated large share of RE generation.

AIMS III estimated that the APG could accommodate an additional solar and wind capacity of 83 GW and 12.3 GW, respectively, to reach the 23% regional RE target by 2025. With this, the needed interconnection capacity is 20.3 GW to ensure the system's flexibility and the uptake of RE in the power markets. To realize both the generation and transmission facilities, the required investment is around USD770 billion, a comparable value to realizing the existing power development plan (PDP).

Besides supporting the regional RE aspiration, the APG could induce multiplier effects on social, economic, and environmental aspects. The number of RE-related jobs created could reach 100,000 to 200,000 by 2040. The avoided use of coal could reach approximately 259 million tons, with oil at 11.2 million tons, and gas at 77 million m³ in 2040. This fuel saving implies emissions reduction and improved energy security due to the lower need for imported fuel.

Unlike the APG, rural electrification has received less attention in regional energy cooperation. It was just recently considered the key strategy for increasing the share of RE in APAEC Phase I: 2016–2020. Even APAEC Phase II: 2021–2025 has no action plan that addresses the rural electrification issue. However, it does not mean that the off-grid RE projects do not thrive at the national level. In fact, the use of RE to electrify rural and remote areas has been incentivized in Cambodia, Indonesia, Lao PDR, the Philippines, and Thailand.

Cambodia has implemented the rural electrification fund since 2004 through Royal Decree No. NS/RKT/1204/408. As part of the Bright Indonesia Program, the government and the state-owned utility PLN prioritize the renewables-based power plants, mini-grids, and grid extensions as their core strategy to achieve a 100% electrification rate by 2022 (MEMR 2021). In Lao PDR, the Rural Electrification Master Plan stipulates the implementation plan through on-grid and off-grid systems using mini or micro hydropower and solar home systems. In the Philippines, the Republic Act 9135 mandated the state-owned National Power Corporation to implement missionary electrification. The most advanced RE-based rural system will soon be running in Thailand, where in May 2021, the largest private-owned microgrid in Sriracha equipped with a battery storage and control system to back up the 214 MW hybrid gas-solar power plants was announced.

4. CONCLUSION AND POLICY IMPLICATIONS

Heavy reliance on fossil fuel-based energy will be a crucial challenge for ASEAN's energy security and sustainability. It becomes more urgent with the risks of global crises, including pandemics, geopolitical war, and climate change. Tackling this issue by fuel shifting towards low-carbon sources can satisfy two dimensions of the energy trilemma: security and sustainability.

On the supply side, policy intervention could boost the RE beyond the current share. With the existing national energy policies, based on the projection of AEO7, ASEAN might not be able to achieve its aspirational target of a 23% RE share in TPES by 2025, with a 5.5% gap. In order to achieve this remaining gap with the target year "fast approaching, each member state can begin by elevating its target to deploy more RE baseload using hydropower, geothermal, and bioenergy, according to the country's untapped potential. For example, Indonesia should increase its hydropower development from the current 6 GW capacity, out of its 75 GW potential. These types of renewables are considered stable and not intermittent in producing energy.

In parallel, an improvement in the electricity grid will be required to accommodate more VRE injection. There is the potential for additional solar and wind sources based on RE resources assessment, although they are still limited to 20% penetration. The power grid needs to be enhanced with flexibility in order to manage the intermittency nature of VRE. Flexibility may include the use of digitalization, demand response management, and storage. Not only from technological side, enabling policy and regulatory framework should be improved to integrate more VRE from independent power producer into the central grid, such as through Feed-in-Tariff and power sector reform. Leveraging private participation through public-private partnership, risk mitigation, and market-based instruments, such as renewable energy certificates and carbon offset, is also recommended to attract more funding to VRE projects.

When the resources are insufficient, supplying clean energy through interconnections and multilateral power trade within the region under APG is highly recommended. In addition, the rural off-grid system is a viable complement to accelerate RE adoption. The rationales for rural electricity are: (i) ASEAN consists of small and remote islands; (ii) ASEAN is blessed with abundant and indigenous RE, such as solar; and (iii) the cost of an RE-powered off-grid system is significantly cheaper than extending transmission lines. Not only does it tackle energy security and sustainability dimensions, but it also solves energy equity by providing more energy access to remote populations. Therefore, it is reasonable for ASEAN to pursue its efforts to increase RE share through both APG and decentralization of the power system. The improved accessibility and affordability of energy will be followed by the achievement of economic growth.

Although half of AMSs have already pledged to phase out coal, its existence will not vanish entirely in the near future. Due to its mature technology and low price, coal will still play a significant role in the ASEAN energy mix. Establishing biomass co-firing and implementing the more efficient coal power plant (HELE technology), including exploring CCUS, will be promising options to pursue on the supply side while transitioning to renewables.

Meanwhile, on the demand side, energy efficiency measures should be taken firmly on the two end users with the highest energy consumption in the region: industry and transportation. This is also in line with the structural transformation of most AMSs, which are moving their economy from agriculture towards industry and services. In the industrial sector, energy efficiency measures through labeling and

implementing Minimum Energy Performance Standards are crucial to accelerating the energy transition.

Fuel switching in the transport sector, which consumes a lot of diesel, is strongly recommended to ensure energy security and resilience in the region amidst the volatility of oil prices. A more significant biofuel penetration mandate beyond the country target, through sustainable biofuel production, will play a substantial role in RE share. In addition, introducing EVs can also be an option, even though ASEAN is still in the initial stage. Both possibilities could reduce oil consumption.

Although ASEAN's energy demand in the residential sector is projected to increase much slower than that of industry and transportation, there is an opportunity to further curtail consumption. Households should be encouraged to use efficient lighting, air conditioning, and refrigeration units. Shifting to clean cooking methods, such as electric stoves and biogas, should also be accelerated. This will not only help in reducing energy intensity but also increase the air and health quality in the residential environment due to less pollution from traditional cooking.

With solid commitments in a holistic approach by the ASEAN energy policymakers to implement measures both on the supply and demand sides, balancing the needs of energy security, energy equity, and climate sustainability can be realized while the region is moving towards an energy transition era away from coal and other fossil fuels.

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