

# Powering the Global South: Dynamics of Energy Security in Southeast Asia and Implications for India

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**Abstract-** As the world undergoes a transformative shift from agriculture to industrialization, its rapid economic growth becomes a key driver for global economic expansion and heightened energy demand. With a projected population increase and a burgeoning regional GDP, Southeast Asia is poised to face challenges such as energy security risks, escalating energy costs, and accelerated climate changes. This paper delves into the critical examination of energy dynamics in the Southeast Asian countries against the backdrop of global energy trends. It also highlights the imperative for emerging economies and developing countries to play a more rapid role in decarbonization and energy transition as it has been contributing significantly to global carbon dioxide emissions by relying heavily on fossil fuel consumption. Underscoring the interconnectedness of Southeast Asian countries, the paper analyses regional policies and their profound socioeconomic impacts through the functioning of the Association of Southeast Asian Nations (ASEAN). India's significant role as a regional power reflecting its prospects as leader of the Global South through various diplomatic, economic and strategic initiatives contributes to stability, cooperation, and sustainable development in the region. The paper aims to provide insights into the intricate web of regional energy vitality, fostering a comprehensive understanding of the challenges and opportunities for greater integration in the pursuit of sustainable energy practices.

**Keywords:** Energy Security, Southeast Asia, ASEAN, India, Global South.

## OBJECTIVES:

1. To investigate the current energy landscape of Southeast Asia with respect to the per capita energy consumption.
2. To analyse the progress of the energy transition and decarbonisation in coherence with the policy initiatives launched by the ASEAN
3. To justify India's role to ensure energy security in Southeast Asia and its implications as a leader of the Global South

## I. INTRODUCTION

*"Energy may be likened to the bending of a crossbow; decision, to the releasing of a trigger."* [1]

-Sun Tzu (*Art of War*)

The region of Southeast Asia, a subregion of the southeastern Asian continent expands between the Indian Ocean to the south and southwest and the Pacific Ocean to the east. It shares its land borders with East Asia and South Asia and contributes to be a diverse and dynamic region known for its rich cultural heritage, natural resources and economic significance. With a projected surge in population and burgeoning regional GDP, Southeast Asia faces a confluence of energy security risks, escalating costs, and accelerated climate change crisis. Against the backdrop of these pressing concerns, a critical examination of the energy landscape within Southeast Asian countries, contextualised within the broader canvas of global energy trends has become the mandate.

The imperative for emerging economies and developing nations to accelerate their roles in decarbonisation and energy transition looms large, given their significant contributions to global carbon dioxide emissions fuelled by heavy reliance on fossil fuel consumption. Therefore there is an urgent need for a paradigm shift towards sustainable energy practices, emphasising the interconnectedness of Southeast Asian nations and the pivotal role of regional cooperation in addressing these challenges with a particular focus on the relevance of the Association of Southeast Asian Nations (ASEAN). Central to the discussion is the examination of the policies and their socioeconomic impacts which the ASEAN has mutually agreed upon to ensure energy security in the region. The organisation has sought assistance from major regional powers like India and China for technology sharing, infrastructural development and capacity building

to achieve its goals. As a regional powerhouse, India's strategic initiatives in Southeast Asia accentuate its leadership potential within the Global South contributing to stability, cooperation and sustainable development.

With an investigative analysis of the regional energy vitality it can be understood that there is an intricate web of challenges and opportunities which Southeast Asia faces. By fostering a comprehensive understanding of the complexities at play, India seeks to pave way for greater integration and collaboration in the pursuit of sustainable energy practices, vital for the regions prosperity and resilience in the face of evolving global energy dynamics. There is a vast potential for sustainable renewable energy development which can contribute to a more prosperous and resilient future in the coming years.

## II. ENERGY LANDSCAPE OF SOUTHEAST ASIA:

The Southeast Asian region possesses, abundant, conventional energy resources, such as oil, gas and coal, although the distribution among countries is uneven, and sometimes distant from demand centres. According to ACE (2017), in 2015, the region produced a total of 2.4 million barrels of oil per day with oil production expected to decline at a rate of 1.4% annually from 2015 to 2040, reaching 1.6 million barrel per day by 2040. Decline is primarily due to mature oilfield, entering the decline phase in terms of natural gas production,[2] the region produce 205,000,000,000 m<sup>3</sup> of natural gas in 2015, with production expected to decrease by 0.6% annually, reaching one 77,000,000,000 m<sup>3</sup> by 2040, in the case of natural gas production trend, the member countries expected a stable production in Brunei Darussalam, a slight decrease expected in Indonesia, and an increase expected in Vietnam. Additionally, coal production in the region is projected to increase to 487 million tons in 2040 from four 34 million tons in 2015 with the majority of coal production coming from Indonesia in addition to conventional fossil fuels region also possesses renewable energy sources, particularly in hydro and solar energy. All the level and type of renewable energy may vary among countries region set target to derive 23% of his primary energy supply from the renewables for 20, 2025 (IRENA & ACE, 2016). Achieving the target poses a challenge, and it is essential to say how member countries of ASEAN can contribute to meeting this goal.

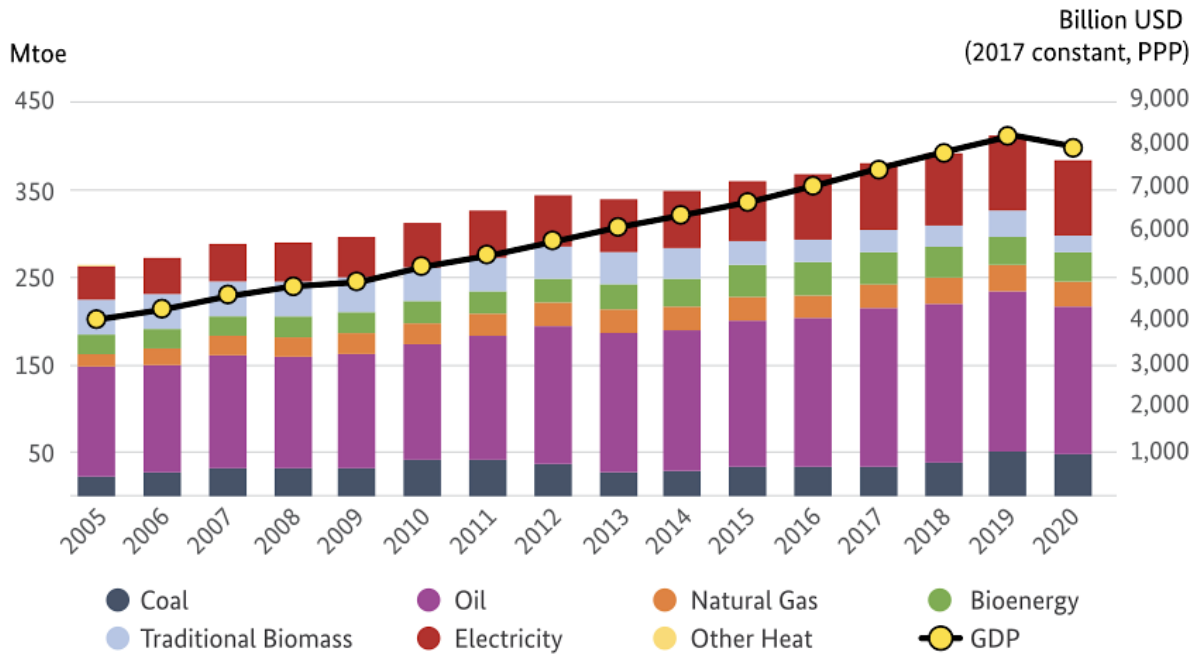
The primary drivers of increasing energy demand in the Southeast Asian region are the economy, measured by GDP and population growth over recent decades. the region has experience robust economic expansion at trend expected to continue. the coming decades to projections indicate the GDP will quadruple from 2015 to reach USD 10,003 90,000,000,000 by 2050 an average annual growth rate of 4.2% concurrent population growth is estimated at 0.6% annually from 2015 to 2050.[3] this is in economic activity and population will drive a substantial increase in total primary energy supply projected to rise from six 21 million tons of oil equivalent (Mtoe) 2015 to 1544 Mtoe in 2050, representing an average annual growth rate of 2.6%. Despite efforts to diversify, energy, sources, the region is expected to remain heavily reliant on fossil fuel, which are projected to contribute almost 80% of the total primary energy supply in 2050. Given dwindling domestic fossil fuel reserves, the member countries of ASEAN will increasingly rely on imports, potentially at high market prices due to the volatility in fuel prices. Without careful, consideration of balanced fuel mixed diversification this dependence on fossil fuels could post challenges.

Despite the rise of renewable energy forces is expected to remain the primary fuel source with a decreasing share from 38% in thousand 15 to 32% in 2050, declining at the rate of 2.5% per year. Natural gas is projected to increase 13% and 2015 to 22% and 2050, growing at a rate of 2.6% per year by consumption is experienced to grow at a higher rate of 3.6% per year, due to its significant demand in the power sector. It has been noted that renewable energy is expected to experience the fastest growth rate in the region,[4] reflecting active deployment efforts because the total final energy demand is projected to increase from 436 Mtoe in 2015 to 1006 Mtoe in 2050, growing at an average rate of 2.4% annually by 2050, the industrial building sector expected to contribute the highest energy energy demand, each accounting for 32% of the regions energy energy demand, driven by rapid industrialisation transfer sectors will follow closely at 27%.

We ought to address the socioeconomic conditions represented by factors such as, population and GDP which significantly influence energy consumption patterns. In Southeast Asia, the total final energy consumption (TFEC) surged by 1.6 times in 2019 compared to the levels recorded in 2005.[5] However, during the onset of the COVID-19 pandemic in 2020, a decline in the consumption of oil to 385 million tonnes of oil equivalent (Mtoe) was still figured to be 1.5 times higher than the data in 2005. There have been efforts to improve energy efficiency (EE) over the last decade which has somewhat mitigated the overall demand growth. Despite an average annual GDP growth of 4.6% from 2005 to 2020, TFEC's average yearly growth stood lower at 2.7% during the same period. This was the reason why the ASEAN member states (AMS) had to implement various energy saving measures, which included promoting efficient methods of cooking and lighting and enforcing a minimum energy performance standards (MEPS) for appliances which are specifically for utilised for air-conditioning.

The countries in Southeast Asia have historically relied heavily on fossil fuels to meet energy demands. Although the share of the oil had decreased from 47.8% in 2005 to 43.8% in 2020, it remained as the largest contributor to TFEC. Analysing these figures, the AMS achieved in its efforts to look towards electrification which saw an increase from 14.6% in 2005 to 22.7% in 2020. This was done to shift the region's dependency on fossil fuels towards sustainable

alternatives like electricity and biofuel. The consumption of Biofuel surged with AMS leveraging their potential to replace oil and gas. Concurrently, traditional Biomass demand for household use significantly decreased following commitments to accelerate access to clean cooking technology.

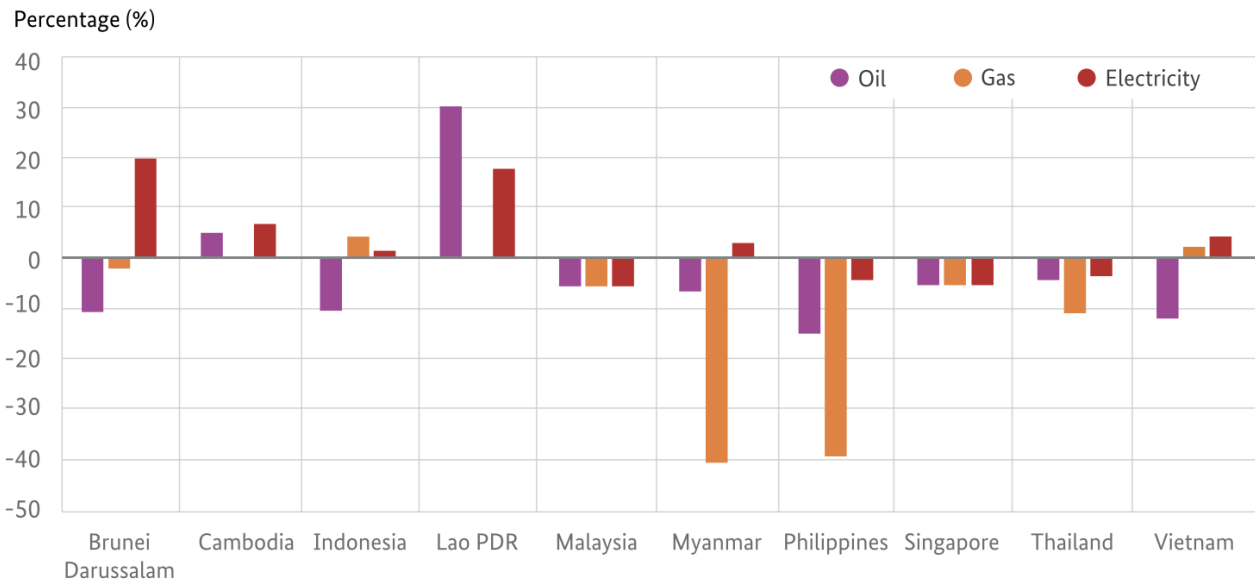


The Demand of Fuel in Respect to the GDP in Southeast Asia, 2005-2020 (ACE)[6]

The industrial sector remained the largest energy-intensive sector, which accounted for approximately 39.1% of ASEAN TFEC in 2020, followed by the transportation sector ranging at 34.8%. The industrial demand in 2020 saw a growth by 1.6 times compared to the 2005 levels, while the transportation sector saw the energy consumption increase by 1.8 times, nearly doubling its 2005 levels before the COVID-19 pandemic.

**III. IMPACT OF THE COVID-19 PANDEMIC:**

The COVID-19 pandemic had impacted the energy sector profoundly. In Southeast Asia due to travel restrictions and mandatory quarantine imposed by domestic governments, the industrial, transportation and technological sectors witnessed a sharp decline in energy consumption. The transportation sector during the pandemic saw the lowest oil consumption and demand.[7] Among all the AMS, Philippines experienced a steep decline of 15% and Vietnam a 12%. This caused the output of the transportation sector drop down to 8.2% in 2020. As the world grappled under the measures taken during the lockdown, the AMS also imposed restrictive measures to curb the transmission of virus which



disrupted those sectors which were contact-intensive. In addition, the market slump and the stagnant labour force was caused due to the limited demand of manufactured goods by the general public.

**Fuel Consumption of ASEAN Member States in 2020 (ACE)[8]**

The pandemic also had a notable impact on the gas market in the region, albeit less severe than its effects on the oil market. Gas consumption across the AMS declined by an average of approximately 9.8% in 2020, with Myanmar experiencing the most significant decline at -40.8%. This decline exacerbated the region’s ongoing trend of decreasing gas production, with 2020 production levels falling below those of 2010. The reduction in gas production was primarily driven by decreased demand and the suspension of projects in various fields.

The coal consumption in some areas of Southeast Asia saw a growth in 2020. Half of the AMS experienced an increase in coal consumption compared to the previous year, with particularly notable growth in Laos PDR, where coal consumption surged by approximately 220%. However, disruptions in coal production were observed, notably in Indonesia, one of the world’s largest coal-producing countries, which saw a 9% reduction in coal production. This decline exceeded Indonesia’s ten-year average growth rate, reaching 9.2%. The disparity between coal consumption and production during the pandemic contributed significantly to a global coal price surge. Simultaneously, electricity demand in Southeast Asia increased by an average of 3.5% in 2020 while four Southeast Asian countries experienced a decrease in electricity consumption, which included the Philippines and Thailand, which represent the larger economies in the region, Brunei Darussalam, Laos, and Vietnam saw increased demand for electricity. Notably, Brunei Darussalam experienced a 19.9% increase, Laos saw a 17.9% increase and Vietnam recorded a 4.2% increase in electricity consumption in 2020.

Amidst the pandemic, the renewable energy (RE) sector demonstrated remarkable resilience,[9] as evidenced by the contribution of RE sources to the installed capacity of electricity in AMS. While installed capacity from other sources mostly declined or remained stagnant in 2020, there was an increase in RE-based power plants, including biomass, solar, wind and geothermal. Several factors contributed to the resilience of the RE sector, such as the long-term contracts and the continued installations of new plants. Nearly all countries, with the exception of Myanmar, managed to increase installed capacity from RE sources. Vietnam and Cambodia particularly excelled during the pandemic, with RE-sourced growth in installed capacity which reached 42.5% and 13.1% respectively. The additional installed capacity of RE in Vietnam significantly contributed to the overall installed capacity of the country’s electricity sector, which saw a notable increase in 22.3%. Singapore also recorded a substantial growth in installed capacity of renewable, with solar photovoltaic (PV) alone growing by 21.2%.

While the COVID-19 virus’ strain was combated with the mandatory doses of vaccinations issued by the governments of every country, people found themselves immune to the extreme affects of it. Steadily, travel restrictions and quarantines were lifted up and the world geared up for a post-pandemic lifestyle and pressing issues were addressed, one of which is Climate Crisis. The 26th United Nations Climate Change Conference of the Parties (COP26) convened in Glasgow in the late 2021. This summit catalysed significant actions on the part of governments worldwide by yielding crucial outputs, including updated Nationally Determined Contributions (NDCs), signatories to the Glasgow Climate Pact, and commitments to the Global Coal to Clean Power statement, all of which are pivotal in achieving climate goals. These committees, particularly in the updated NDCs, are intended to delineate concrete actions that surpass previous target, aiming for more ambitious emissions reductions. Before COP26, there were five ASEAN member states (AMS)

which had submitted their updated NDCs in 2020, with the remainder completing their in 2021. Notably nine AMS set unconditional targets for reducing emissions, demonstrating a significant commitment to climate change, but Cambodia's target remained conditional which reflected various levels of ambition and capacity among AMS. In terms of sector coverage, all AMS identified the energy and agriculture sectors as primary contributors to emissions deduction targets. Additionally, industrial processes and product use (IPPU) and waste were designated as contributors by all AMS, except Myanmar. While land use, land use change and forestry (LULUCF) were not designated as contributors by the Philippines and Thailand, other AMS recognised their importance in emissions reduction efforts. Furthermore, the NDCs detailed the coverage of greenhouse gas (GHG) emissions, with Malaysia and Singapore, demonstrating the most comprehensive coverage. These NDCs encompasses range of GHGs, including carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF<sub>6</sub>), and nitrogen trifluoride (NF<sub>3</sub>). Conversely, Myanmar's NDC only covers CO<sub>2</sub> emissions. However, CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O were noted by nine AMS, indicating a broad recognition to the importance of addressing multiple GHGs in emissions reduction strategies.

The Glasgow Climate Pact which was signed by nearly 200 nations during the COP26 emphasised the imperative of limiting global warming to 1.5°C, and addressing range of urgent topics, such as:[10]

1. Emphasising science based decision making an its integration into large-scale policymaking.
2. Urging government to develop adaptation plans, integrated into local, national and regional planning, while scaling up actions and support for finance, capacity building and technology transfer.
3. Calling on developed countries to climate adaptation, finance through initiative like Adaptation Fund and Least Developed Countries Fund to support adaptation-based initiatives in developing countries.
4. Stressing the need for rapid deep and sustained reductions in global greenhouse gas emissions through accelerated technology deployment, policy adoption, and efforts to scale up clean power generation while facing out, fossil fuel subsidies and reducing unabated coal power.
5. Encouraging develop developed countries to provide enhanced support, including financial, technological, and knowledge transfers, to assist developing countries in achieving their mitigation and adaptation goals. The pact requests an annual USD, hundred billion climate finance fund from 2025 onwards, along with measures to simplify access for develop developing countries.
6. Recognising the urgent need for collaboration among stakeholders at the local, regional, and international levels to minimise the predicted, onset of worsening damage and losses due to climate change.
7. Urging parties to fulfil their pledges and national targets under the convention and advocating for an integrated approach to address, national and local policy issues to ensure just transitions. Financial support is highlighted as crucial for reducing greenhouse gas emissions and promoting climate resilient development.
8. The importance of international collaboration and cooperation in innovative climate action, including technological advancement, while considering social aspects such as gender equality. The contributions of civil society, indigenous peoples, local communities, youth, children, local and regional governments, and other stakeholders are acknowledged and supported, with a particular emphasis on facilitating youth and indigenous communities' participation in making processes at national and local levels.

#### IV. ASEAN'S POLICY INITIATIVES FOR A GREEN TRANSITION:

*"I believe it is important that ASEAN should continue to give key priorities to what I consider as the "Six P's... third, focusing on the PLANET, especially the environment, climate change and the green economy, which has gained great momentum in recent years, remains necessary to ASEAN."*

**-H.E. Dr. Kao Kim Hourn (Secretary General, Association of Southeast Asian Nations)[11]**

To ensure a smooth supply of energy in Southeast Asia which includes both energy-exporting and energy-importing countries, ASEAN in 1997 had developed framework known as *Vision 2020* which aimed at ensuring energy cooperation through a dynamic economic relationship which would manifest into forging a close-knit developed region. [12] The *Vision* emphasised for an improved energy collaboration through interconnected electric grids and gas pipelines in the region, placing a greater emphasis on renewable energy and advancing energy efficiency. Consequently, the ASEAN Plan of Action for Energy Cooperation (APAEC) was established for the periods 1999–2004, 2004–2009, 2010–2015, and 2016–2025, with the current focus directed by APAEC 2016–2025. The ASEAN Plan of Action for Energy Cooperation (APAEC) is a comprehensive set of policy documents aimed at fostering multilateral energy collaboration to achieve the goals of the ASEAN Economic Community (AEC). It serves as a platform for cooperation within ASEAN, as well as with Dialogue Partners (DPs) and International Organisations (IOs), to enhance energy security, accessibility, affordability, and sustainability in alignment with the AEC framework.

#### APAEC Phases:

1. **APAEC 1999-2004:** Aligned with the ASEAN Vision 2020, it introduced six Programme Areas, laying the foundation for robust policy frameworks and cooperative partnerships with DPs and IOs.[13]
2. **APAEC 2004-2009:** Aligned with the 2004 Vientiane Action Plan, notable achievements included the signing of the MOU for the ASEAN Power Grid and the introduction of the annual ASEAN Energy Awards. The Programme Area on "Regional Energy Outlook, Energy Policy and Environmental Analysis" progressed into "Regional Energy Policy and Planning (REPP)."[14]
3. **APAEC 2010-2015:** Aligned with the AEC Blueprint 2015, achievements included the MOU between ASEAN and the International Energy Agency, extending the Trans-ASEAN Gas Pipeline (TAGP), and surpassing aspirational targets for energy intensity reduction and renewable energy share.[15]
4. **APAEC 2016-2025:** Divided into two phases, Phase I (2016-2020) focused on strategies with the theme "Enhancing Energy Connectivity and Market Integration in ASEAN" which could be applied in different levels of durations. Phase II (2021-2025) continues with higher aspirational targets and a new sub-theme, "Accelerating Energy Transition and Strengthening Energy Resilience through Greater Innovation and Cooperation." It considers the impacts of the COVID-19 pandemic, global economic trends, climate change, energy investment, and emerging technologies.[16]

This plan represents a strategic and evolving framework for ASEAN's collaborative efforts in the energy sector, adapting to contemporary challenges and fostering innovation and resilience for a sustainable energy future to achieve:[17]

**Energy Security:** Southeast Asia is rich in natural resources and as per the 6th ASEAN Energy Outlook, the region is projected to heavily rely on fossil fuels despite a predicted rise in 768 million people by 2040. Therefore, for a secure energy supply, ASEAN must embrace various alternative resource options to levy the burden on non-renewable energy resources.

**Energy Accessibility:** There have been continuous efforts by ASEAN Member States to achieve 100% electrification ratio. Having proper access to energy is vital for economic and social development and clean cooking remains a challenge for ASEAN as they strive to achieve a transformation from traditional smoke stoves towards those which function on electricity, biogas, LPG etc.

**Energy Affordability:** For the inhabitants of Southeast Asian countries, affordability is a key factor in ensuring a desirable quality of life. While fossil fuels currently dominate the energy supply, the decreasing cost of renewable energy technologies provides an opportunity for a transition to cleaner energy at an affordable cost.

**Energy Sustainability:** Sustainability, especially in the context of climate change, is crucial for economic development. The electricity and transport sectors are significant contributors to CO<sub>2</sub> emissions, and without reductions, the region could face serious climate change impacts.

Some of the key achievements Under the ASEAN Power Grid (APG) as part of the APAEC, was the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP) which facilitated the first successful multilateral power trade.[18] A total of 30.2 GWh of electricity was traded under LTMS-PIP Phases I and II. The three countries agreed to increase committed energy capacity trading from 100 MW to 300 MW, with discussions ongoing for further expansion. Several studies on multilateral power trade, such as ASEAN Power Grid Transmission System Operator (ATSO) and ASEAN Generation and Transmission System Planning Institution (AGTP), have been conducted. Another successful project which advocated regional economic integration was the Trans-ASEAN Gas Pipeline (TAGP) program, wherein 13 interconnection pipelines with a total length of 3,631 km and nine LNG re-gasification terminals with 38.75 MTPA capacity links six ASEAN Member States. Notable studies on this project include Model LNG Sales and Purchase Agreement (SPA), Gas Advocacy White Paper (GAWP), and studies on small-scale LNG (ssLNG) and LNG bunkering. The Coal and Clean Coal Technology (CCT) the third successful project under APAEC initiative aims to increase cleaner coal technology deployment, with a total installed capacity of 10,021 MW of supercritical and ultra-supercritical coal-fired power plants in 2019. Efforts include capacity building, workshops, and publications like the ASEAN CCT Handbook for Power Plants and Feasibility Study on Coal Upgrading. In Energy Efficiency and Conservation (EE&C), ASEAN achieved a 21% Energy Intensity reduction by 2018, surpassing the aspirational 20% target by 2020. Policy documents on harmonization of Minimum Energy Performance Standards (MEPS) and guidelines for integrating energy efficiency into ASEAN Electrical and Electronic Equipment Mutual Recognition Arrangement (MRA) were endorsed. Initiatives on green building codes, zero energy building awards, and EE financing were promoted, along with publications like ASEAN Regional Efficient Lighting Market Assessment and ASEAN ESCO Report. Under Regional Energy Policy and Planning (REPP), ASEAN Energy Outlooks (AEO5 and AEO6) highlighted key trends,[19] and a MOU was signed with the International Renewable Energy Agency (IRENA). The first ASEAN Energy Cooperation Report (AECR) showcased achievements, and a Capacity Building Roadmap on Energy Investments and Financing for ASEAN was developed. The Civilian Nuclear Energy (CNE) program focused on capacity building in domestic as well as regional policy-making, technological advancements, and regulatory aspects. Publications include Pre-Feasibility Study on Establishment of Nuclear Power Plant and Study on Nuclear Legal and Regulatory Framework. Capacity-building seminars were conducted, and the ASEAN Nuclear Energy Portal was developed in 2020.

The APAEC 2016-2025 serves as a dynamic and evolving document designed to provide guidance for the effective implementation of outcome-based strategies and action plans. It aims to expedite the energy transition and bolster energy resilience within ASEAN, aligning with the overarching goals of achieving energy security, accessibility, affordability, and sustainability for all under the framework of the AEC. Building upon the foundation laid by APAEC Phase I: 2016-2020, the second phase, APAEC Phase II: 2021-2025, encompasses comprehensive strategies tailored to address the challenges presented by the evolving global energy landscape. Clean electrification of energy end-use sectors is pivotal efforts to decarbonise, unlimited global warming to below 1.5°C.[20] By increasing electricity usage across various sectors, we can enhance an energy energy, security, improve energy, energy, efficiency and power consumers, and facilitate the transition to clean energy within the power system once strategy, gaining traction is sector coupling, which involves integrating the power sector with other sector such as transportation, buildings and industry to utilise renewable energy as a substitute for fossil fuels. This approach is becoming increasingly feasible to the declining cost of wind and solar energy instalments.

The transition towards energy is characterised by emerging trends known as the four Ds:[21] decarbonisation, digitalisation, decentralisation and democratisation. these are reshaping bought used sold and supplied within societies as electricity becomes a primary energy so decarbonised economy digitalisation becomes crucial for synchronising supply and demand. Furthermore, decentralisation introduces new actors in the energy market both in generation and consumption, leading to a more interconnected and democratised system. Set a couple lies at the heart of these trends as it enables reflects the transition towards cleaner and more flexible and allergy systems. As the share of variable renewable energy (VRE) sources, like wind and solar increases, depart system phases, greater variability and uncertainty, successfully integrating, higher shares of VRE requires enhancing power system flexibility. This flexibility refers to the systems ability to manage sudden fluctuations and supply and demand across different timescales. While dispatchable power-plants, traditionally provided flexibility, other system components such as interconnected grades storage and demand site management are becoming increasingly important.

In the industrial sector, demand-side flexibility involves adapting manufacturing processes to respond to system needs. Many industries that already rely on electricity, particularly for mechanical processes, are technologically prepared to provide demand flexibility with minimal operational disruption. additionally, the electrification of heating processes can further offer flexibility options. However, unlocking additional flexibility may require the option of new technologies like controllable heat pumps and thermal storage systems. Assessing the potential for demand-side, flexibility in various industrial sectors requires careful analysis, considering natural circumstances and energy markets and the specifics of individual processes. Strategies such as industrial load, shedding, and load. Shifting can help ensure power adequacy and stability during critical situations without compromising operations. These strategies involved either reducing energy consumption, temporarily, or shifting energy usage off-peak hours to take advantage of lower prices. [22] Furthermore, leveraging the inherent inertia within industrial processes can provide additional flexibility for load, following, and frequency support contributing to a more resilient and efficient power system.

Various barriers are hindering the exploitation of flexibility in the electrification of industrial processes, encompassing, technical economic and political challenges from a technical standpoint. Certain industrial processes may have limited flexibility due to the inherent design and operational requirements. Processes involving high temperatures or continued energy consumption such as those in metal production may be difficult to moderate to accommodate fluctuations and energy demand. Moreover, adjustments made to enable flexibility could potentially lead to increased wear and equipment, raising concerns about its longevity and product quality. Economically there are barriers related to the potential reduction in efficiency and the investment required in development. While flexibility cause may be manageable. If they do not disrupt primary production processes, significant impacts on production and quality could result in higher cause however, these challenges can be mitigated through optimal operational practices and efficient compensation for flexibility or services to offset any decreases in production. Additionally, investing in your equipment may oppose a financial obstacle to all the technologies, enabling industrial electrification and flexibility also offer long-term efficiency improvements from a political perspective, the influence of the energy and industrial sectors on the development of demand flexibility strategies can present challenges the support or resistance from specific industries influence by the vision and role in the international economy may affect the implementation of sector coupling measures this can manifest as subsidies or instruments to mitigate risk associated with prize volatility potentially limiting the effectiveness of price for active demand response, coordinating the interest of both the system and industrial sector approved to be complex and could serve as a significant bottleneck in advance in demand-side flexibility initiatives.

The transportation sector as a major electricity consumer can significantly enhance power system, flexibility through strategies like electric vehicles (EVs) and sector coupling[23]. ASEAN member states (AMS) have demonstrated considerable interest in EV development setting specific targets for adoption. EVs are anticipated to increase electricity demand, but particularly during off-peak hours when vehicles are charged necessitating, a redefinition of peak and off-peak energy demand. While EVs offer grid management solutions, such as peak, curtailment, and balancing variable, renewable energy (VRE), their effectiveness relies on user participation and smart grid systems for efficient energy management. Although EB technology has progressed to address past challenges like slow, charging and limited

mileage charging stations and structures remain in sufficient across Southeast countries like Brunei Darussalam, Malaysia, and Indonesia. Integrating EVs into the grid, particularly if powered by coal-fired plants, yields comparable efficiency to internal combustion engine vehicles (ICEVs), emphasising the importance of transitioning to low-carbon grid power sources. Aligning with ASEAN's push for increased renewable energy deployment fuelling EVs with RE resources can substantially improve their efficiency. The concept of vehicle-to-grid (V2G) holds promise for optimising EVs, charging behaviour, and enhancing grid operations by enabling users to sell surplus energy back to the grid during peak hours. However, V2G implementation faces challenges, such as battery degradation, high cost, and connectivity issues. Additionally, EVs remain relatively expensive compared to conventional vehicles in Southeast countries, especially where transportation fuel costs are subsidised. But we can say that the transition from conventional transportation to EVs is expected to occur gradually over the decades, even though there are challenges that need to be overcome. The integration of EVs and V2G technology presents significant opportunities for enhancing power systems, flexibility, and efficiency in the region.[24]

Despite their greenhouse gas emissions, oil and gas play a crucial role in the energy transition by providing reliable and affordable energy, that supports economic growth. These resources due to their stability and mature supply chain serve as strategic reserves and show energy resilience against unexpected events. In the Southeast Asian region, they still dominate the energy mix projected to contribute 66% by 2050, highlighting their importance in meeting growing energy demands. As the region's population grows and demands, more energy, oil and gas remain vital for ensuring energy security, while gradually transitioning to renewable energy options. Oil is the primary fuel for transportation, while natural gas dominates power generation in the power system. Natural gas ensures stability and complements variable renewable generation options serving as a low emission fossil fuel alternative.

To meet regional RE targets, ASEAN needs to develop significant solar and wind power capacity with gas playing an important role in balancing supply and demand due to the intermittency of renewable power output. Gas-fired power plants are economical for mid-merit and peak applications, reducing system costs and providing crucial peak services during high RE penetration. Efforts to decarbonise the oil and gas industry are essential to mitigate emissions, including measures like methane leak reduction, minimising gas flaring, and increasing the use of low-carbon electricity.[25] Additionally, the industry supports the development of low-carbon technology like carbon capture storage and utilisation (CCUS), low-carbon hydrogen, and biofuels to minimise emissions from hard-to-abate sectors. Overall, the oil and gas industry in collaboration with governments and stakeholders can accelerate the deployment of low-carbon technologies and support the transition to a low-carbon economy while ensuring reliable energy supply and economic growth.

The ASEAN Transmission System (ATS) is shaped by each member state's national policy and power development plan. The transition from traditional to renewable energy sources is reflected in the ASEAN Energy Outlook (AEO) reports. AEO6 based on earlier plans when fossil fuels were more heavily relied upon, contrasts with AEO7, reflecting the shift towards renewables, like biomass, hydro, geothermal solar, and wind power. A comparison between AEO6 and AEO7 reveals a slight decrease in projected installed capacity in AEO7, with a corresponding increase in utilisation rate due to the rise in renewable energy capacity. Despite this, total power generation decreases in AEO7, indicating more efficient utilisation. Notably, geothermal and hydro are expected to see significant growth while solar power growth rate is projected to slow. While coal and LNG are being balanced with renewable energy sources, considerations for supply security from a geopolitical standpoint are necessary.[26] The share of coal-fired power generation decreases remarkably in AEO7, with gas-fired power also experiencing a decline. Hydropower generation increases alongside a slight rise in solar power generation because overall the total renewable energy capacity which includes biomass and thermal is expanding to facilitate energy transition in the Southeast region.

Efforts to enhance flexibility, crucial for accommodating variable renewable sources are underway, according to Japan Coal Frontier Organisation's Grid Fluctuation Index (GFI) which indicates that there is an increased flexibility, with the integration of biomass and other variable renewables. Collaborative efforts among ASEAN institutions particularly the Heads of ASEAN Power Utilities/Authorities (HAPUA), are essential to ensure grid cooperation and supply security for fossil fuels across the region. Factors such as fuel supply stability, grid multi-layering, and reserve margin expansion should be considered in energy policies at both ASEAN and individual member state levels.

Several ASEAN countries are considering the proliferation of nuclear power, although as of now, no nuclear power plants are operational in the region.[27] Countries such as Indonesia, the Philippines, Thailand, and Vietnam have advanced plans for nuclear energy while others have all expressed interest in exploring this option. Indonesia has substantial experience with nuclear technology and is in the process of developing infrastructure for a nuclear program it is to have its first large reactor operational by 2045, and it is also considering the construction of a demonstration high temp reactor along with discussions about acquiring floating nuclear plants and thorium reactors from various vendors. In the Philippines, the construction of the Bataan Nuclear Power Plant (BNPP), a 620 pressurised water reactor (PWR) unit, began in 1976 but was never commissioned despite completion. In 1985. The country is revisiting the possibility of a nuclear energy programme, including the potential revival of the BNPP and the construction of Small Modular Reactors (SMRs), as indicated by the signing of Executive Order 164 in February 2022.



Thailand has operated a research reactor since 1977, and have shown interest in this technology for various applications. Plans in a 2015 power development, strategy, and vision introduction of two 1000 MWe plants by 2035-2036 to diversify fuel sources, but site selection has been hindered by public acceptance issues. Vietnam has explored nuclear energy since 2006 and plans for a 2000 Mae plant, all were put on hold in 2016 in favour of gas and coal assets. However, in June 2022, Vietnam national assembly, economic committee proposed reviving plans to develop, develop to nuclear reactors in Ninh Thuan province. Building public trust in government and institutions responsible for implementing the nuclear programme is crucial given recent declines in trust levels for public institutions. Governments increasingly engage in consultation processes to incorporate stakeholders' views and gain public support, recognising that openness and transparency are essential for successful implementation. The involvement of stakeholders aims to foster understanding, rather than merely seeking public acceptance, emphasising the importance of building and maintaining trust.

## **V. IMPLICATIONS FOR INDIA AND ITS LEADERSHIP IN THE GLOBAL SOUTH:**

In January 2018, the leaders of ASEAN nations and India issued the Delhi Declaration on the occasion of the 25th anniversary of ASEAN-India Partnership. In this declaration, they emphasise the need to strengthen cooperation in agriculture and energy sectors to ensure long-term food and energy security in the region.[28] Additionally, they highlighted the importance of collaborating to promote the development of renewable energy technology, particularly through platforms, like the International Solar Alliance (ISA).

Renewable energy has emerged as a focal point of ASEAN-India energy cooperation due minimal, or global warming emissions, which aligns with the goal of transitioning towards low-carbon growth pathways. ASEAN aims to achieve 23% of its primary energy from renewable sources by 2025, while India targets, 40% of its capacity, based on non-fossil fuels and reducing emission intensity by 33-35% by 2030. These shared objectives leaders from ASEAN and India have called for stronger collaboration to enhance energy security and contribute to meeting the Sustainable Development Goals (SDGs). Given the commitments of both ASEAN and India, under SDG 7, which focuses on ensuring access to affordable, reliable, sustainable and modern energy for all by 2030, expanding energy access is crucial. This entails and enhancing energy efficiency and investing in renewable energy. While these targets may seem ambitious, close cooperation between ASEAN and India can make them achievable. strengthening and collaboration in renewable energy will not only help in meeting the SDG targets, but also addressed the challenge of climate change with India, sharing both land and maritime borders with ASEAN countries and having access to various renewable energy sources, such as ocean, wind and solar power, regional cooperation, whole significant potential. while India's is already connected with Myanmar to some extent, several ASEAN nations have joined India's International Solar Alliance (ISA).[29] For an extended period, ASEAN nations, like Malaysia, Indonesia, Thailand, and Brunei have been significant suppliers of crude oil to India. However, recent years have witnessed noticeable shifts in India's energy trade dynamics while India has emerged as a major importer of coal. It has also become a significant exporter of refined petroleum products.

Presently petroleum products constitute India's largest export item with commodities like high-speed diesel (HSD) being exported to south east, Asian countries such as Singapore, Thailand and Myanmar, as well as to regions like the EU, UAE and South Africa. Myanmar boasts an estimated hydropower potential of 39,720 make a watt, with only a small fraction currently utilised. India and Myanmar have agreements for the development of hydro project, such as Sedawyagi and Yeyaw, with India expressing interest in projects like the Tamanti multipurpose project. India has been investing in energy infrastructure development in the ASEAN region, in CLMV (Cambodia, Laos, Myanmar and Vietnam) countries, focusing on project such as power, transmission facilities.[30] Indian firms, particularly ONGC Videsh Ltd. (OVL), have made significant investments in Myanmar's oil and gas sector, comprising a substantial portion of India's total investment in the country.

OVL has also ventured into the oil and gas sector in Vietnam, securing stakes in various exploration blocks. The company aims to bolster India's oil and gas security through overseas participation in exploration and production activities. India, heavily relies on crude oil imports to meet its energy, demands with a significant portion of its school requirements, sourced from countries, like Indonesia, Australia, and South Africa, and this expansion of India's refining capacity has facilitated its emergence as a major exporter of petroleum products.[31]

An energy trade has been more limited within South Asia. There is potential for increased rate between India and the ASEAN countries. ASEAN has established extensive, regional energy corporation program, while India's regional corporation with South Asia remains primarily bilateral. Despite the significant potential in Southeast Asia India has yet to fully explore the regions energy resources, particularly natural gas and hydro power. However, India has been actively involved in energy infrastructure development in ASEAN through projects such as hydro facilities, power transmission lines, and oil and gas pipelines. There is substantial potential for trade in energy sector machinery, equipment, and goods between India and ASEAN. India being the fourth largest energy, consumer globally, imports, 80% of its crude oil and 25% of its naturally gas.[32] However, there is also a leading investor and renewable energy, particularly solar and wind power. The Indian garments initiatives, such as the National Solar Mission and significant

incentives for wind energy projects, has stimulated substantial investments in renewable energy. India's commitment to renewable energy is exemplified by ambitious targets, including achieving 100 GW of solar energy and 175, GW of renewable energy in 2022, as well as reducing emission intensity by, 33-35% by, 2030. The International Solar Alliance (ISA), initiated by India, aims to promote solar power, utilisation, and low carbon growth among its member countries, including many ASEAN nations. ASEAN and India had implemented the third Plan of Action which included priorities and measures to deepen their cooperation in various areas, including energy. renewable energy cooperation was the focal point of discussion with both parties. Emphasising complimentary policies to address and energy needs. India has expertise in and solar energy while countries like Indonesia.

The Philippines and Singapore have developed capacities in geothermal energy and waste-to-energy. establishing a coordinating organism for knowledge and expertise sharing between ASEAN and India could further enhance renewable energy cooperation but for this there needs to be an expanding electricity exchange between India and ASEAN through Myanmar which could promote greater energy market integration in the region. India's G20 presidency aims to amplify the voices of developing world and foster human-centric globalisation.

Established in 1999 after the Asian Financial Crisis, the Group of Twenty (G20) has transformed into a premier forum for international economic cooperation, representing a significant portion of global GDP trade and population. Similarly, ASEAN has evolved into one of the most successful integumental organisations in the developing world, aiming to harness the untapped potential of Southeast Asia through united action. The current troika of the G20 consists of Indonesia, India and Brazil, with India's presidency, providing an opportunity for ASEAN member states to address their concerns on the global stage. The ASEAN-India partnership's focus areas aligned with India's priorities for its G20 presidency, emphasising green development, inclusive growth, sustainable, developmental goals, technological transformation, and multilateral institutions.[33] Mr Alok Kumar, Secretary of the Ministry of Power, Government of India, emphasise the significance of identifying collective measures to foster fair inclusive, and balanced growth among G20 members to cooperate and cultivate a sense of stewardship to realise the transition towards clean energy.[34] Furthermore, he accentuated the key initiatives outline by the Government of India, which includes the Green Hydrogen Mission, Energy Transition Projects, Green Credit Program, PM-PRANAM, Coastal Shipping, Vehicle Replacement Schemes, et cetera.

India has established funds to support corporation activities between ASEAN and India, highlighting its commitment to its Comprehensive Strategic Partnership, which is rooted in the cornerstone of India's Act East Policy. Given India's vast coastline, and ASEAN's maritime significance, the partnership naturally extends to the projects under ASEAN Outlook on Indo-Pacific.

## VI. CONCLUSION AND WAY FORWARD:

Both ASEAN and India are formally committed to achieving the sustainable development goals, particularly in ensuring universal access to affordable, reliable, sustainable and modern energy by 2030, also striving to reduce global warming emissions through the promotion of various renewable energy sources. The synthesises depressants need for deeper energy cooperation between ASEAN and India. There are ample business opportunities for the private sector in both conventional and renewable energy sectors across ASEAN and India. Some recommendations which can guide this enhanced energy energy cooperation are:[35]

1. Clean and green energy products crucial for transitioning towards a low carbon growth path, India's oil company, such as oil can expand the presence in ASEAN to facilitate this.
2. India could establish a framework for a regional exchange, outlining operational procedures and regulatory requirements for cross-border energy trade with ASEAN with a scope of P2P engagements between India and the region.
3. Training and capacity building in the renewable energy sector present significant opportunities with India, being a potential source of expertise for ASEAN countries
4. Establishment of an ASEAN-India Energy Forum and energy thing tanks can facilitate regular dialogues and knowledge exchange between energy stakeholders from both regions.
5. Collaboration in the renewable energy sector encompass, energy efficiency, technology sharing and joint research and development endeavours, which will require harmonising legal and regulatory framework, and considering an Energy Charter Treaty which can enhance security for cross-border energy investments and transactions.

In conclusion, the Southeast Asian region faces, both challenges and opportunities and his journey towards sustainable and resilient energy future. Despite possessing abundant, conventional energy sources, such as oil, gas and coal, the region is experiencing a gradual decline in production and faces, uneven distribution among its member countries. This necessitates a shift towards renewable energy sources, particularly hydro and solar energy, to meet the regions energy demands while mitigating the impacts of climate change. Even though the COVID-19 pandemic has posed additional challenges by disrupting energy consumption patterns and highlighting the need for an innovation in the energy sector, the renewable energy sector has demonstrated remarkable development with increased investments and installations

and various renewable energy sources across region. By leveraging, regional cooperation fostering innovation, and prioritising sustainability, south east, Asia can overcome its energy challenges and emerge as a leader in the global transition towards a cleaner, more resilient, energy system.

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