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Powering a Sustainable ASEAN: Regional Integration and Renewable Energy Policy Innovation for Clean Energy in ASEAN

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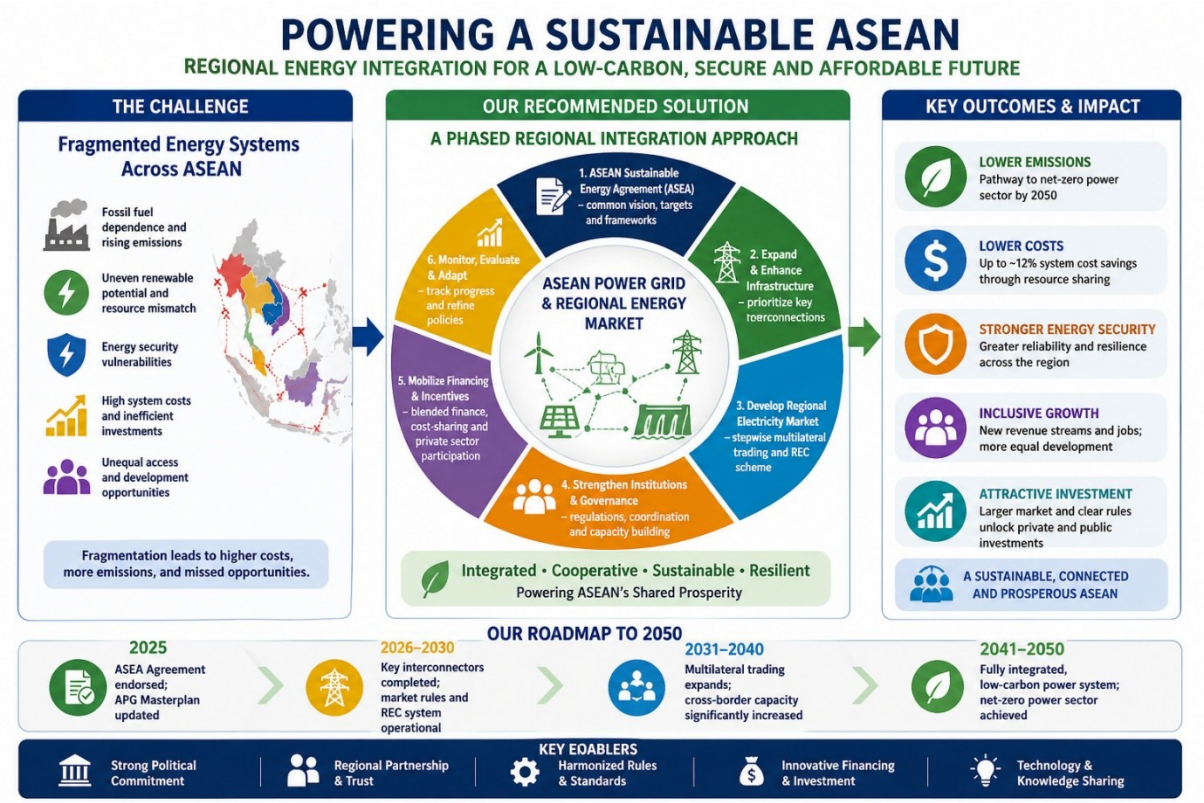
HIGHLIGHTS

- Phased regional integration model proposed for ASEAN power system
- Integrated grid can cut electricity system costs by up to 12%
- Regional trade enables higher renewable energy utilization
- Policy framework combines agreements, markets, and grid harmonization
- Approach strengthens energy security and supports low-carbon transition

GRAPHICAL ABSTRACT



ABSTRACT

Southeast Asia's rapidly rising electricity demand—projected to increase by more than 40% by 2030—poses a critical challenge to the region's climate commitments and long-term energy security. This challenge is compounded by continued reliance on fossil fuels, uneven renewable resource distribution, and persistent gaps in regional infrastructure and policy coordination. Although the vision of the ASEAN Power Grid (APG) has existed for decades, progress remains limited, with only 8 of the 18 priority interconnections completed, constraining the potential for efficient cross-border electricity trade and renewable energy integration. This policy paper, developed using William N. Dunn's public policy analysis framework, examines the structural, institutional, and financial barriers to ASEAN energy integration and evaluates three strategic policy alternatives. It identifies a phased regionalism strategy—supported by targeted policy innovation—as the most viable pathway, balancing ambition with political and institutional feasibility. The proposed approach includes the establishment of an ASEAN Sustainable Energy Agreement (ASEA), development of harmonized grid codes and regulatory frameworks, implementation of a regional electricity market platform, and introduction of renewable energy certificate (REC) trading. The strategy is structured across three phases from 2025 to 2050, beginning with foundational agreements and pilot initiatives, followed by market expansion and institutional strengthening, and culminating in a fully integrated regional energy system. Forecasting analysis indicates that deeper regional integration could reduce overall electricity system costs by up to 12%, significantly lower carbon emissions, and enhance energy security through resource sharing and system flexibility. The paper emphasizes the importance of institutional capacity building, equitable cost-sharing mechanisms, and robust monitoring and evaluation frameworks to ensure effective

implementation. With sustained political commitment and support from regional institutions such as ERIA and ACE, ASEAN has the potential to transition into a low-carbon, resilient, and economically integrated electricity market, advancing both regional cooperation and sustainable development goals.

Keywords: ASEAN energy integration; ASEAN power grid; Regional electricity market; Southeast Asia energy transition; Renewable energy ASEAN; Cross-border power trading.

1. Problem Structuring

Rapid economic growth in Southeast Asia has significantly increased energy demand, while the region simultaneously faces challenges in ensuring energy security and transitioning toward low-carbon energy systems [1, 2]. The Association of Southeast Asian Nations (ASEAN) is projected to see a 41% increase in electricity demand by 2030 (from 2023 levels) [3], driven by industrialization, data centers, and urban growth. However, current energy production in ASEAN remains dominated by fossil fuels, which met all the recent demand growth in 2023 [3]. This reliance on coal and gas is at odds with ASEAN's climate commitments—all member states except two have pledged to reach net-zero emissions by 2050 (Indonesia targets 2060, and the Philippines has yet to set a date) [4]. ASEAN collectively also set a goal of a 23% renewable energy share in total primary energy supply (TPES) by 2025, but this target is unlikely to be achieved under present trajectories [5]. The core problem, therefore, is how to power ASEAN's growth sustainably, aligning energy development with climate goals and energy security needs.

A critical barrier to a sustainable energy transition in ASEAN is the fragmented state of regional power integration, reflected in heterogeneous electricity market structures and the need for harmonization to enable cross-border power trade [6]. Despite nearly three decades of discussion about an ASEAN Power Grid (APG) to interconnect member states' electricity networks, progress has been slow [3]. Out of 18 priority cross-border interconnection projects identified for the APG, only eight had been completed as of 2023, yielding about 7.7 GW of cross-border transmission capacity [3]. Figure 1 illustrates the envisioned ASEAN Power Grid network, highlighting both existing connections (in operation) and proposed links that remain unrealized. Table 1 outlines ASEAN's planned grid interconnections and integration efforts, while Table 2 presents projected growth in capacity, electricity generation, and renewable energy shares to 2030 and 2050.

The limited connectivity means most ASEAN countries still rely on domestic energy resources and bilateral power deals rather than a robust regional grid. For example, Laos has leveraged its abundant hydropower to become the region's leading electricity exporter—earning over USD 2.3 billion in 2022 by selling power to China, Thailand, Vietnam, Cambodia, and Singapore [3]. Yet these trades are confined to bilateral power purchase agreements (PPAs) and a handful of linked networks, rather than an integrated market. The lack of an integrated ASEAN grid and electricity market leads to inefficient resource utilization, as countries must independently expand generation capacity, while limiting opportunities to exploit geographically uneven renewable energy resources through cross-border trade [7].

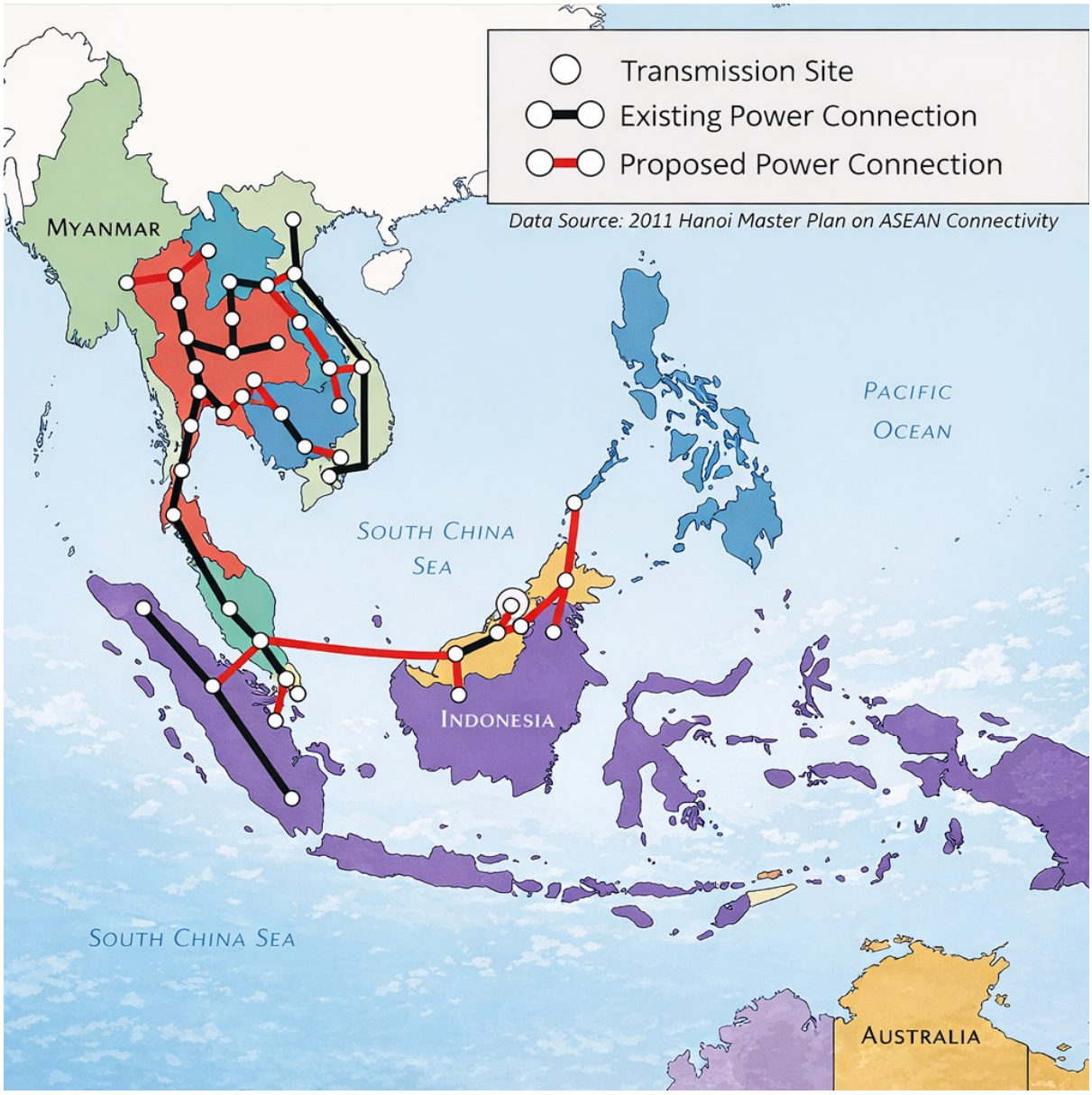


Figure 1. Map of Southeast Asia depicting ASEAN power grid plan.

Table 1.Overview of planned initiatives in the ASEAN power grid [4].

Interconnector	Route	Voltage (kV)	Total line length (km)	Subsea length (km)	Transfer capacity (MW)	Year of commissioning
Sarawak–Sabah–Brunei	Kuala Belait–Miri/Tudan	275	45	-	100	2025
Sarawak–Brunei	Kuala Belait–Miri/Tudan	275	45	-	100	2025
Sarawak–Sabah	Lawas–Mengalong, Sipitang	275	31	-	150	2025
Lao PDR–Vietnam	Mae Chan–Ton Phueng	115	60	-	400	2025

Interconnector	Route	Voltage (kV)	Total line length (km)	Subsea length (km)	Transfer capacity (MW)	Year of commissioning
Thailand–Cambodia	Prachin Buri–Siem Reap	500	300	-	Up to 250	2025
Vietnam–Cambodia	Banhat–Stung Treng	-	85	-	Up to 200	2030
East Sabah–North Kalimantan	Malinau–Kalabakan	275	140	-	Up to 200	2030
Singapore–Batam / Singapore–Sumatra	Parana–Singapore	250	260	100	Up to 1,600	2030
Indonesia internal lines	-	-	-	-	-	-
Sumatra–Java	Muara Enim (Sumatra) to Bogor, Java	500	500	40	Up to 6,200	2030
Kalimantan–Java	Kalimantan–Java	-	-	-	-	-
Peninsular Malaysia–Sumatra	Telok Gong Malaka–Perawang	500	234	50	2,000	2030
Cambodia–Vietnam	Savy Antor–Tay Ninh	500	300	-	250	2035

Table 2. Projected ASEAN installed capacity, electricity generation, and share of renewables by 2030 and 2050 [4].

Particulars	Historical data	Baseline Scenario (BAS)		AMS Targets Scenario (ATS)		Regional Aspiration Scenario (RAS)		Carbon Neutrality Scenario (CNS)	
	2022	2030	2050	2030	2050	2030	2050	2030	2050
Installed capacity (GW)	315	434	818	485	1,115	549	1,436	583	1,586
Share of RES in installed capacity (%)	33.6	35.9	37.9	44.1	69.4	49.3	71.7	50.4	73.1
Electricity generation (TWh)	1,270	1,659	3,036	1,472	2,769	1,548	2,920	1,665	3,528
Share of RES in generation (%)	29.2	31.2	33.6	44.7	71.9	50.2	84.7	55.2	90.9

Several policy and structural factors underlie the slow progress in ASEAN's energy integration, including weak policy coordination, institutional limitations, and financial

and market barriers [8]. First, political and regulatory misalignments pose a fundamental challenge. ASEAN operates on principles of national sovereignty and non-interference, without a multinational authority like the EU [9]. Energy policies, market structures, and pricing mechanisms vary widely: for instance, Singapore runs a fully liberalized power market with multiple generators and an exchange, while neighbors like Malaysia and Thailand use a single-buyer model with state-owned utilities [10]. These discrepancies complicate harmonization. In the pilot Lao-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP), this divergence was evident: Singapore's market and its neighbors' monopolies required creative coordination rather than full consolidation of markets [10]. Regulatory frameworks for cross-border trading (such as wheeling charges or grid codes) are not yet standardized across ASEAN, meaning each new interconnection or power trade has to navigate ad-hoc agreements. As Dr. Mirza Huda of ISEAS observed in 2023, the lack of transparency and agreed pricing principles for wheeling power leads to conflicting perceptions of fairness – some stakeholders deem transit fees too low (discouraging infrastructure investment), while others see them as too high (discouraging power generation) [5]. This indicates an urgent need for equitable cost-sharing mechanisms in regional projects.

Second, infrastructure gaps and financing barriers hamper integration. Many ASEAN grids remain physically unconnected or weakly linked [11]. Large investments are required to build new high-voltage transmission lines, including potential submarine cables to connect archipelagic Southeast Asia (e.g. Indonesia, Philippines) to mainland grids. The ASEAN Centre for Energy (ACE) estimates that about USD 200 billion in power infrastructure investment is needed by 2030 to support renewable integration and interconnectivity goals [5]. However, mobilizing this financing is challenging, given varying levels of economic development and creditworthiness among member states. Less-developed members may struggle to justify expensive grid projects primarily benefiting neighbors or regional goals. Cost allocation becomes contentious: as noted by experts, in a region with contrasting income levels, splitting project costs "50-50" is not viable [5]. Without innovative funding approaches (e.g. joint investment funds, development bank support, or private sector participation with guarantees), critical interconnectors may remain on the drawing board. The ASEAN Power Grid concept identified 18 priority lines with a combined capacity of ~33 GW by 2040, but delay in execution partly stems from uncertainty over who pays for these multi-country projects and how to ensure returns. Additionally, existing multilateral development programs (like the ASEAN Infrastructure Fund) have been modest relative to needs, and regulatory barriers often deter private investors from cross-border ventures [5].

Third, technical and institutional capacities need strengthening. Effective regional power trade demands not only hardware (lines, substations) but also software: harmonized technical standards, grid codes, and operating procedures, as well as institutions to coordinate planning and resolve disputes. ASEAN has bodies such as the Heads of ASEAN Power Utilities/Authorities (HAPUA) and the ASEAN Power Grid Consultative Committee (APGCC), but these are coordinating platforms rather than empowered regulators. There is no regional system operator or market operator to optimize generation dispatch across borders. While the LTMS-PIP trial successfully used a Working Group and multiple task forces to synchronize operations among four countries, this was a bespoke solution [10]. Broader application requires institutionalized frameworks. Encouragingly, lessons from LTMS-PIP show

that intensive technocratic cooperation (hundreds of meetings among utilities, regulators, and officials) can bridge differences in protocols and build trust [10]. The project also highlighted the importance of capacity building: ASEAN's energy officials and engineers have improved their expertise through such pilots and international support (e.g. Germany and Vietnam cooperation on wind power generation development) [10]. Scaling up integration will require expanding these efforts so all member states have the technical know-how and institutional readiness to participate in a more integrated market.

In summary, the problem structured here is one of insufficient regional energy integration in ASEAN, which constrains sustainable development. On one hand, ASEAN needs clean, affordable power to fuel its growth and meet climate targets. On the other hand, the lack of a unified regional grid and policy framework leads to suboptimal outcomes: countries cannot easily trade power to balance supply and demand differences; renewable energy-rich areas (like Lao PDR or Kalimantan) remain underutilized while others plan new fossil capacity; and collective energy security is weaker (each nation acting alone). The gap between ASEAN's ambitions (as articulated in plans like the ASEAN Power Grid and the ASEAN Plan of Action for Energy Cooperation, APAEC) and the on-ground reality points to a clear need for policy innovation. Figure 2 shows a conceptual framework illustrating ASEAN energy integration as a central node influenced by four interconnected domains: problem structuring, policy and structural factors, technical and institutional capacities, and infrastructure and financing barriers.

The following sections will forecast what the future may hold under current trends versus integrated scenarios, then propose and evaluate innovative policy alternatives to bridge the integration gap. The analysis is structured per William Dunn's public policy analysis framework [12]: after defining the problem, we examine future scenarios (Forecasting), formulate and compare Policy Alternatives, advance a Policy Recommendation, outline how to Monitor and Evaluate its implementation, and develop a Policy Argumentation to persuade decision-makers of the recommended course of action, before concluding.

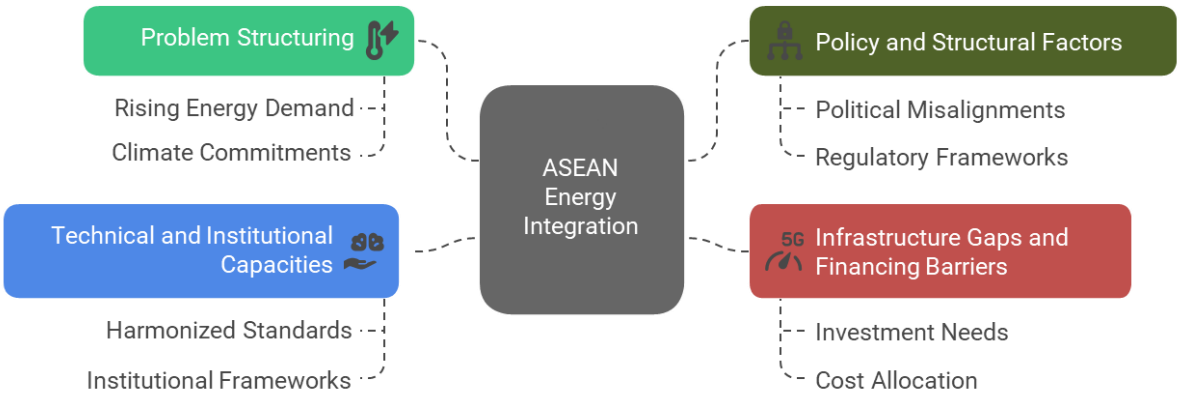


Figure 2. ASEAN energy integration challenges and solutions.

2. Forecasting

To inform policy choices, it is crucial to anticipate the future landscape of ASEAN's energy sector under different scenarios. Forecasting involves exploring how current trends might evolve ("business-as-usual") versus how an integrated, cooperative

approach could alter outcomes. We consider two broad scenarios to 2030 and 2050: (1) a continuation of limited integration (incremental progress only), and (2) an accelerated regional integration scenario aimed at sustainability (with robust policy innovation and infrastructure development). The forecasting draws on recent modeling studies and energy outlooks for ASEAN, incorporating data-supported scenario analysis as requested.

2.1. Business-as-Usual (Limited Integration) Scenario

In this scenario, ASEAN member states largely pursue national energy strategies, with regional integration progressing gradually through bilateral and limited multilateral cross-border initiatives rather than a fully integrated regional market [13]. Many planned interconnections remain delayed. According to recent ASEAN Energy Outlook projections, regional energy demand will continue to climb steeply, reaching around 1,740 Terawatt-hours (TWh) of power consumption by 2050, more than triple 2020 levels [4]. If integration remains limited, each country will tend to meet demand by expanding its own generation capacity, often leaning on familiar fossil-fuel assets. Indeed, under current policies, fossil fuels could still comprise roughly 70% of ASEAN's power mix well into the 2030s, undermining climate goals [4].

Renewable energy deployment would grow (ASEAN is on track to have ~39% of installed capacity from renewables by 2025) [4], but integration bottlenecks mean renewable-rich areas might face curtailment while deficit areas burn coal/gas. A key forecast metric is regional emissions: without strong integration and policy shifts, the power sector's CO_2 emissions would likely peak around 2040 in a moderate policy scenario [14], at a level inconsistent with net-zero by mid-century. By 2030, electricity demand in ASEAN is expected to be 41% higher than 2023 [3]; meeting this with mostly domestic, fossil-based generation would result in higher system costs and emissions. Energy security challenges may intensify too: countries like Vietnam and the Philippines, if isolated, could face supply shortfalls or volatile costs, whereas with integration they could import surplus power from neighbors.

Crucially, in a fragmented scenario, the economic burden on each country is higher. Without pooling resources, ASEAN states must individually invest in backup capacity and expensive technologies. For example, some might turn to carbon capture and storage (CCS) for their coal or gas plants to meet climate pledges—an option that is capital-intensive. Given the significant barriers, ASEAN staying with bilateral trade and slow integration through 2030 may be a pragmatic near-term path, but it also delays the full benefits of a regional market [15]. ASEAN's own Interconnection Masterplan shows that achieving all 18 planned lines by 2040 would enable 33 GW of exchange capacity; at the current pace (8 lines, 7.7 GW as of 2023), the region will fall far short of that, constraining the share of electricity trade (presently only a few percent of total generation). Without new policies, the 2030 renewable target of 23% TPES will be missed [5] and renewable penetration might stagnate in the 30-40% range of capacity, as excess renewable energy in one country cannot easily flow to others. In summary, the BAU forecast suggests higher costs, higher emissions, and missed opportunities for ASEAN if integration remains disconnected.

2.2. Regional Integration for Sustainability Scenario

This scenario envisions proactive policy innovation and investment leading to a well-connected ASEAN power system. Cross-border transmission infrastructure is expanded significantly by 2030, and multilateral trading arrangements begin to take

shape (building on pilots like LTMS-PIP). Integrated resource planning allows ASEAN to tap its diverse renewable endowments more efficiently [16]: large-scale solar in Indonesia's eastern islands, wind in Vietnam or Laos, and hydropower in the Mekong basin can be developed in excess of local demand and exported regionally. A recent capacity expansion model for ASEAN's power sector provides quantitative insight into such a scenario [14]. In a coordinated ASEAN decarbonization pathway aiming for net-zero emissions by 2050, the study finds that cross-border transmission, while only accounting for ~0.5% of total system costs, yields substantial economic and environmental benefits [14]. Specifically, an integrated grid scenario can reduce cumulative power system costs by up to 11.9% compared to a country-by-country "go it alone" approach [14]. This is a striking finding: even modest investments in interconnection (under $5 billion total through 2050 in the model's least-cost scenario) unlock nearly 12% savings in total generation costs by enabling countries to share resources [14]. The unit cost of electricity in ASEAN could be around 12% lower (140 USD/MWh vs 160 USD/MWh) in 2050 under an ambitious integration and renewables scenario, relative to a fragmented scenario [14]. These cost savings come from improved efficiency: integration means the cheapest power available in the region (e.g. solar at noon in one country, or wind at night in another) can be shipped to where it's needed, displacing expensive fuel-based generation.

Environmentally, the integrated scenario aligns with sustainability goals: ASEAN's power sector CO_2 emissions would peak earlier and then decline on a trajectory consistent with net-zero by 2050 [14]. By 2050, renewable energy (solar, wind, hydro) could contribute roughly 63% of ASEAN's electricity generation [4] – a drastic transformation from ~71% fossil in 2022. Notably, cross-border grids facilitate this by redistributing natural resources: Laos and Myanmar, for example, could become major clean electricity exporters (relative to their domestic needs) under integration, given their hydro and wind potential [14]. The modeling suggests Laos remains the largest exporter in a regional grid scenario, while Indonesia (with its vast solar potential in eastern provinces) could also become a significant exporter by volume [14]. On the import side, countries like Thailand, Vietnam, and Singapore could rely on imports for up to ~50-60% of their demand at times [14], allowing them to avoid building excessive fossil capacity or expensive backup plants. In fact, by importing clean power instead of building new coal/gas plants, Thailand, Vietnam, Brunei, and Singapore can forego or defer investments in fossil infrastructure and carbon capture to meet their climate targets [14]. This points to integration as a strategy for avoiding lock-in of carbon-intensive assets and minimizing stranded asset risk.

Integration also enhances energy security and reliability in the forecast. A more interconnected ASEAN grid would be more resilient to localized shocks (e.g., if one country faces a power shortfall due to drought affecting its hydropower or an outage at a large plant, neighbors can supply emergency power). It reduces reserve margin requirements because countries can share peaking capacity. As a concrete example, a recent analysis noted that better interconnectivity could reduce the need for costly solutions like grid-scale battery storage or hydrogen backup by allowing the pooling of reserves – potentially avoiding an estimated 1.2 TWh of storage and 16 TWh of hydrogen by 2040 if the ASEAN grid is optimized [3]. Additionally, an integrated market could spur private investment in renewables: developers in one country would have the confidence that surplus generation can be sold region-wide, not curtailed. The ASEAN Power Grid vision, long-term, is to enable multilateral power trade where electricity is bought and sold across borders as a commodity. If this vision is pursued,

by 2040 we could see an ASEAN power exchange platform, harmonized rules, and perhaps 20-30% of electricity in the region being traded across borders (for comparison, in the European Union's internal market, cross-border trades are on the order of 15-20% of electricity consumption). Figure 3 shows that isolated, uncoordinated energy systems are inherently inefficient—driving up costs and emissions—whereas coordinated, cross-border integration and joint planning transform the system into a more efficient, resilient network that lowers costs and strengthens energy security.

In summary, forecasting indicates that deepening regional energy integration yields significant benefits: lower overall costs (nearly 12% savings), higher renewable uptake (on track for net-zero), and improved energy security and flexibility. Conversely, a lack of integration keeps ASEAN on a costlier, higher-emission path with potential shortfalls in meeting sustainability targets. These scenarios underscore the policy relevance: proactive measures to integrate ASEAN's power systems could be a game-changer for sustainable development. The next section will consider what policy alternatives exist to move from the current limited integration trajectory towards the more optimistic scenario outlined here.

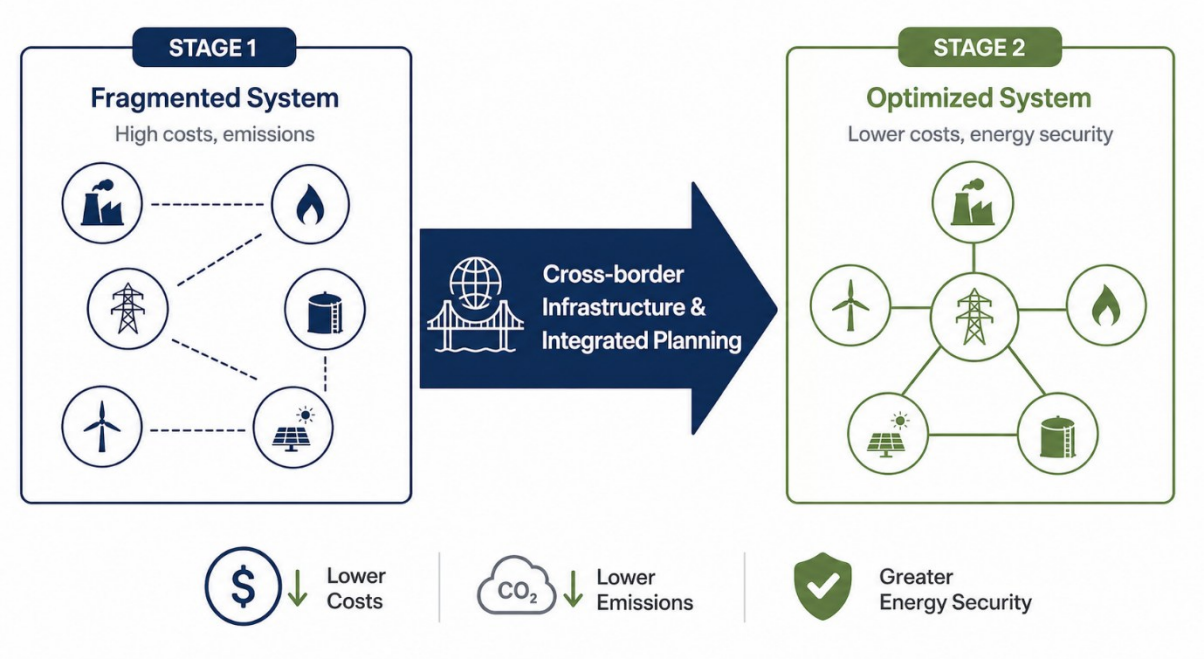


Figure 3. Transition from a fragmented to an optimized energy system through cross-border infrastructure and integrated planning, enabling lower costs, reduced emissions, and enhanced energy security.

3. Policy Alternatives

Addressing the problem of insufficient regional energy integration requires evaluating multiple policy approaches. This section outlines and assesses three strategic policy alternatives for ASEAN: (1) Status Quo Incrementalism, (2) Full Market Integration ("ASEAN Power Pool"), and (3) Phased Regionalism with Innovative Frameworks. Each alternative represents a different level of ambition, speed, and institutional change in pursuing ASEAN energy cooperation. We examine their content, feasibility, and potential impact on the goals of sustainability and integration.

3.1. Status Quo Incrementalism (Bilateral and National Focus)

Under this alternative, ASEAN would continue largely with its current approach as reflected in APAEC 2016-2025 – i.e., encouraging cooperation in principle but relying on bilateral agreements and national initiatives to advance projects. Integration would progress in a piecemeal fashion: countries pursue cross-border connections only when mutually convenient, and power trade remains governed by long-term PPAs between national utilities. The ASEAN Power Grid is treated as a general vision, but without new binding commitments or institutions. For example, additional projects akin to LTMS-PIP could be bilaterally negotiated (e.g., Singapore importing from Indonesia or Vietnam via dedicated cables, or Malaysia-Thailand increasing exchanges) on a case-by-case basis. ASEAN bodies (HAPUA, ACE) would continue to play a coordinating and information-sharing role, producing studies like the ASEAN Interconnection Masterplan (AIMS) but not enforcing implementation. The advantage of this approach is political ease – it respects national sovereignty and existing structures, avoiding complex multilateral treaties. It also aligns with the cautious stance suggested by some analysts who argue that, given significant barriers, "it remains premature for ASEAN to pursue a strong form of power market integration" at present [15]. By focusing on bilateral PPAs and renewable investments through 2030, countries build experience and trust step by step [15]. However, the shortcomings are clear: this approach is too slow to deliver transformational change. It likely perpetuates the current trajectory (as described in the BAU forecast): only a handful of new interconnections might come online by the early 2030s, leaving the region far from an integrated grid. Each project would require protracted negotiations on pricing and wheeling, with no overarching framework. Thus, while incrementalism poses low political risk, it also yields limited gains – ASEAN would risk falling short of its sustainability and energy security goals.

3.2. Full Market Integration ("ASEAN Power Pool" Model)

This ambitious alternative draws inspiration from the European Union's integrated energy market and other power pools (e.g., the Nordic Nord Pool and Southern African Power Pool, SAPP). ASEAN would move to establish a fully integrated regional electricity market with multilateral trading mechanisms. Key features would include a centralized or harmonized power exchange platform where utilities (and possibly private generators) can buy/sell electricity across borders in real time or day-ahead markets; a common grid code and regulatory framework applied region-wide; and dedicated institutions, perhaps an ASEAN Regional System Operator or Market Authority, to oversee cross-border dispatch and ensure open access to the grid. This could be underpinned by a new ASEAN Sustainable Energy Treaty or Agreement, in which member states legally commit to market integration and climate-aligned energy targets. The ASEAN Power Grid infrastructure would be rapidly completed and expanded to allow free flow of power (akin to Europe's Trans-European Networks).

To manage governance, ASEAN might establish a strong regulatory network or expand the mandate of ACE/AERN (ASEAN Energy Regulators Network) to enforce rules and resolve disputes – potentially even a supranational regulator in the long term. The benefits of a full integration model are conceptually large: it directly addresses market fragmentation, could maximize efficiency and renewables integration, and send a strong signal to investors (a truly unified market of 680 million people). It would also emulate successful aspects of the EU, where cross-border trade and competition have lowered prices and enhanced security of supply. However, feasibility is a major

concern here. ASEAN's political structure (consensus-based, no binding authority) and diversity of domestic systems make a sudden leap to a single market extremely challenging. Without a strong central institution or political union, a full ASEAN power pool may not be realistic in the short term. As Do and Burke (2022) note, the barriers – political, economic, technical – are still "sizeable" [15]. Members may be reluctant to cede control over national energy assets or to expose their state-owned utilities to regional competition. There are also questions of equity: would less-developed grid systems be left behind? This alternative thus scores high on ambition but low on near-term political viability. It might be seen as a long-term vision (2040s) rather than a practical 5-10 year policy. Implementing it would require an unprecedented level of ASEAN integration and possibly changes to the ASEAN Charter to allow binding energy agreements.

3.3. Phased Regionalism with Innovative Frameworks (Recommended Hybrid Approach)

This alternative seeks a middle path – more ambitious and structured than the status quo, but grounded in ASEAN's consensus-driven, stepwise integration style. It involves policy innovation to create new frameworks and institutions gradually, enabling a transition toward a fully integrated market over time. The approach can be summarized in phases:

Phase 1 (2025–2030)

Foundation Building: ASEAN would negotiate and adopt an "ASEAN Sustainable Energy Agreement" (ASEA) – a high-level pact affirming commitments to regional energy cooperation, clean energy targets, and an outline for multilateral trade rules. While not immediately creating a single market, this agreement would establish principles and organize pilot initiatives. For instance, it could formalize arrangements for wheeling charges, drawing on best practices (e.g., SAPP's standardized pricing formula for transmission usage [5]). It would also mandate the development of a common ASEAN Grid Code to harmonize technical standards for interconnection (frequency control, safety, etc.). During this phase, ASEAN should strengthen or create supportive institutions: e.g., elevate the role of the ASEAN Energy Regulators Network (AERN) to begin aligning regulatory policies, and set up an ASEAN Power Pool Task Force under HAPUA to design market trial mechanisms. Infrastructure investments in this phase would accelerate—supported by joint financing innovations. One idea is an ASEAN Green Energy Infrastructure Fund, perhaps capitalized by ASEAN governments, multilateral development banks, and private capital, dedicated to cross-border grid projects (for example, helping fund priority links like Malaysia–Sumatra, or Thailand–Myanmar interties identified as critical). Member states would also continue bilateral projects but within a multilateral framework — e.g., expanding LTMS-PIP beyond 100–200 MW to higher capacity and inviting additional countries to join (transforming it from a 4-country pilot into a mini regional market). Phase 1's goal is to put in place the rules of the road and initial physical links needed for deeper integration.

Phase 2 (2030–2040)

Market Expansion and Institutionalization: Building on the foundation, ASEAN would gradually introduce multilateral trading mechanisms. By the early 2030s, one could see the establishment of an ASEAN Power Exchange Platform (possibly starting as a voluntary marketplace or a "Day-Ahead Market" for any utility with excess power to

sell to any other in ASEAN, with transactions subject to the agreed rules from Phase 1). This could begin with subsets of countries that are ready – for example, the Mekong region countries plus Singapore and Malaysia might start trading in a coordinated market, effectively forming the core of an ASEAN Power Pool. Over time, more countries join as they upgrade their systems. To facilitate this, Phase 2 would likely require strengthening governance: the ASEAN Sustainable Energy Agreement might be augmented with additional protocols that specify market operations, data sharing, and a dispute resolution mechanism for cross-border trade (learning from LTMS-PIP, which had to keep some agreements confidential; a formal mechanism would increase transparency) [5]. By this phase, ACE or a new Regional Power Coordination Center would actively monitor trades, grid stability, and ensure compliance with rules. Another innovation here is Regional Renewable Energy Certificates (RECs) Trading: ASEAN could establish a system where renewable generation in one country can earn certificates that another country (or corporate buyers) can purchase to meet clean energy targets. This provides a market-based incentive for investing in renewables where they are most cost-effective, effectively decoupling location from consumption (e.g., a solar farm in Laos could sell RECs to Singapore to satisfy Singapore's renewable portfolio requirement, alongside physical power trade). International comparisons support this phased approach – the Nordic power market integrated gradually, starting with bilateral arrangements in the 1990s and evolving into the multilateral Nord Pool, all without a binding supranational mandate but through trust and demonstrated benefits [17]. Similarly, parts of Southern Africa implemented an auction-based trading platform under SAPP even though not all members fully participate initially. By 2040, Phase 2 aims for an effectively functioning ASEAN Power Pool covering most members, albeit one that coexists with national markets (much like EU countries trade power but still have national regulators and companies).

Phase 3 (2040–2050)

Full Integration and Consolidation: In the long term, the structures created in Phase 2 can be consolidated into a robust integrated regional energy system. With most physical interconnections in place and a decade of multilateral trading experience, ASEAN could formalize a Common Energy Market. This might involve refining the ASEAN Sustainable Energy Agreement into a binding treaty that all members sign on to by 2040, committing to open grids and possibly common decarbonization timelines. Institutions could evolve into an "ASEAN Energy Agency" with departments for electricity market oversight, much like the EU's ACER (Agency for Cooperation of Energy Regulators) or a regional system operator coordinating with national control centers. By this phase, policy innovation might also bring joint climate-energy initiatives: for example, an ASEAN-wide carbon pricing or cap-and-trade system for the power sector, which would further encourage low-carbon trade (countries with cheaper renewable surplus sell to those facing carbon prices on fossil generation). Ideally, by 2050 ASEAN would operate almost as a unified grid with diversity in generation but unity in purpose – ensuring energy security, affordability, and sustainability for all members. This phase completes the vision, but it crucially depends on the success of earlier phases to build trust and demonstrate mutual gains.

The phased regionalism with innovative frameworks alternative thus balances ambition with pragmatism. It is adaptive, allowing ASEAN to start with politically feasible steps (Phase 1's non-binding agreement and pilots) and ratchet up

cooperation as confidence grows. It directly addresses key barriers: for instance, by introducing a regional wheeling charge formula early on, it removes one thorny issue (as SAPP did by having members agree on how to compensate transit countries [5]). By establishing joint financing mechanisms, it recognizes and shares the cost burden, making projects viable that a single country would not undertake alone. By proposing REC trading and common targets, it aligns national efforts with regional goals and creates win-win outcomes (countries with limited renewables can pay neighbors for green power rather than miss targets). And importantly, it retains ASEAN's cherished principle of incremental consensus—no country is forced to liberalize or integrate faster than it is comfortable, but the framework coaxes all forward. Given these characteristics, Alternative 3 (Phased Approach) is poised to be the most politically acceptable and effective route and will be the basis for the policy recommendations in the next section. Figure 4 shows a comparative matrix outlining three ASEAN energy integration policy alternatives—status quo incrementalism, full market integration, and phased regionalism—across key dimensions including approach, speed, institutions, feasibility, impact, and timeline.

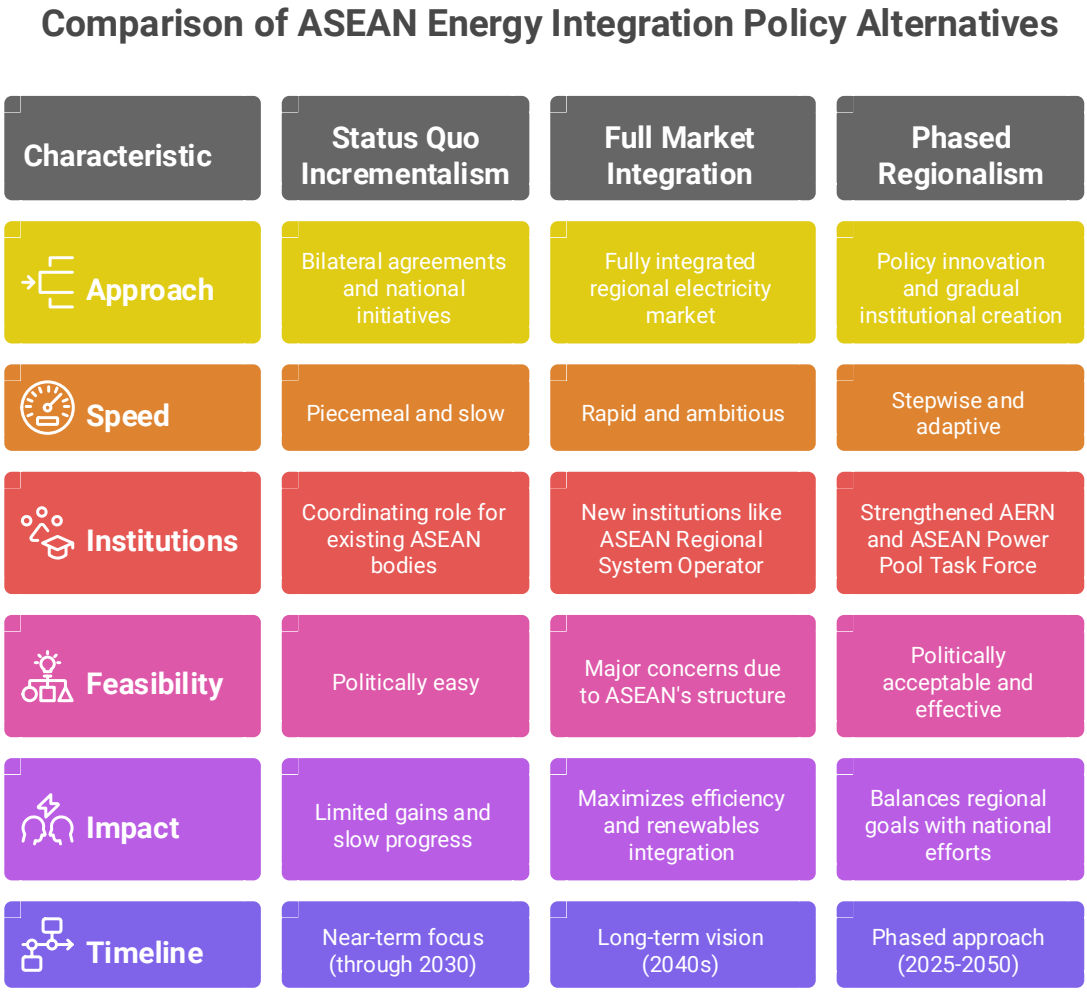


Figure 4. Comparison of policy pathways for ASEAN energy integration highlighting trade-offs between ambition, feasibility, and implementation timelines.

4. Policy Recommendation

After weighing the alternatives, this paper recommends the Phased Regionalism approach (Alternative 3) as the optimal policy strategy to power a sustainable ASEAN through regional energy integration. In brief, the ASEAN Member States should jointly adopt a phased plan that establishes new cooperative frameworks and gradually builds toward an integrated regional electricity market by mid-century. This recommendation is anchored in the understanding that ASEAN's diversity and political context necessitate an incremental buildup of trust and capacity, yet it is ambitious enough to meet the urgency of climate and energy security obligations. Below is a detailed breakdown of the key components of the recommended policy and the actions needed in the short, medium, and long term:

4.1. ASEAN Sustainable Energy Agreement (ASEA) by 2025

ASEAN should draft and endorse a high-level agreement that codifies collective goals and lays the groundwork for integration. This ASEA or ASEAN Sustainable Energy Agreement would be a landmark political statement similar to how the ASEAN Charter set the stage for the ASEAN Economic Community. It should include:

- Shared Vision and Targets: A commitment to achieve a sustainable, interconnected ASEAN power system, including updated regional targets (e.g. setting a new renewable energy target for 2035 and 2045 beyond the current 23% by 2025). For example, leaders might agree on a target like 35% renewable share in primary energy by 2035 and net-zero power sector by 2050 for ASEAN as a whole, aligning with the ASEAN Ministers of Energy vision of accelerating decarbonization [4].
- Principles for Integration: Confirmation of principles such as mutual benefit, equitable cost sharing, national sovereignty over resources (to reassure members), and commitment to open cross-border infrastructure. The agreement can explicitly state that stronger interconnectivity is central to energy security and resilience [4], echoing the 42nd AMEM declaration that the APG is "central to achieving a more resilient and sustainable energy future for ASEAN" [4].
- Institutional Mandates: The ASEA should task relevant ASEAN bodies with specific deliverables. For instance, instruct Senior Officials Meeting on Energy (SOME) and HAPUA to finalize an enhanced APG Masterplan and updated Memorandum of Understanding (MoU) by 2025 [4] (given the current APG MoU from 2017 will expire in 2025). It should also formally empower the ASEAN Energy Regulatory Network (AERN) to develop harmonization guidelines for grid codes and regulatory practices by a set date.
- Framework for Multilateral Trading: Even if details come later, the agreement should outline the intent to move from bilateral to multilateral power trading in stages, and call for a "roadmap to multilateral power trade (MPT)" (notably, ASEAN ministers in 2024 have already initiated framing a roadmap towards multilateral trade by 2045 [4]). The ASEA can require that a basic multilateral trading mechanism (perhaps a trial power exchange for a subset of countries) be operational by, say, 2030.

4.2. Enhance and Expand Physical Infrastructure (Accelerate ASEAN Power Grid projects)

On the hardware side, the recommendation is to fast-track priority interconnections through regional cooperation:

- ASEAN, possibly via the ASEAN Infrastructure Fund or a new Green Energy Fund, should co-finance critical projects identified in AIMS (ASEAN Interconnection Masterplan Study) III. For example, the model results highlighted a few high-impact lines that account for the bulk of benefits: the Indonesia–Malaysia interconnection (e.g. Sumatra to Peninsular Malaysia), Indonesia–Singapore subsea cable, Laos–Vietnam, and Malaysia–Thailand upgrades were found to comprise 98% of needed transmission investment in a cost-optimal scenario [14]. These specific projects should be treated as priority flagships. Given that ASEAN ministers have agreed to develop a framework for subsea cables by end of 2024 [4], the recommendation is to leverage that to kickstart the Indonesia-Singapore (or Borneo-Singapore) link with international support (e.g., the recently announced feasibility study by Singapore and the US on regional grid connectivity can feed into a real project [18]).
- Implement a regional approach to cost-sharing: use models like SAPP's wheeling charge formula or EU's Projects of Common Interest funding to distribute costs. For instance, if Indonesia–Malaysia link benefits Singapore as an eventual transit route, Singapore and Malaysia could jointly invest with Indonesia. ASEAN could also solicit funding from the Asian Development Bank (ADB) and AIIB with guarantees that span multiple governments – de-risking projects. An example for immediate action: upgrade the Thailand-Malaysia interconnection and Thai-Lao links to increase capacity, which can allow more Lao hydro exports (currently Laos' capacity to export is limited by grid capacity) [10]. Singapore and Malaysia have already agreed in late 2023 to double LTMS-PIP trade to 200 MW [4]; building on that, this paper recommends aiming for at least 500 MW multilateral trade by 2025 (perhaps by including Vietnam or other Lao exports) and 2-3 GW by 2030 through new lines (like importing 1 GW from Laos or China's Yunnan into Thailand/Malaysia, etc.).
- Monitoring Infrastructure Progress: To ensure accountability, ASEAN should institute a transparent tracking mechanism for APG projects – possibly an ASEAN Power Grid Scorecard updated annually, showing how many kilometers of lines or MW of cross-border capacity have been added vs planned. This aligns with ERIA suggestions on monitoring integration and can feed into the APAEC progress reports [19]. The target could be set to achieve, for example, 20 GW of cross-border transmission capacity by 2030 (up from 7.7 GW in 2023), as an interim step toward the 33 GW vision by 2040.

4.3. Develop a Regional Electricity Market Platform (Stepwise)

A cornerstone of this recommendation is to start small-scale multilateral trading mechanisms by the late 2020s:

- ASEAN should support ACE and HAPUA in creating an ASEAN Power Exchange pilot platform. This could initially be a "market simulation" or a facilitated trading arrangement where, for example, excess power from Laos

can be offered to multiple buyers in Malaysia, Singapore, or Thailand via a common interface, rather than just one-to-one PPAs. The LTMS-PIP Working Group model can be replicated: form a Regional Market Working Group composed of system operators and regulators from each member, which will design trading rules and operating protocols (e.g., scheduling, settlements, and emergency support) [10].

- Standardize Rules and Codes: By 2026, finalize the ASEAN Grid Code and wheeling tariff guidelines. All countries would agree to these technical and financial rules, which will reduce uncertainty for any future project. An example guideline might be: "Wheeling charges for transit countries shall be computed based on a transparent formula considering infrastructure usage and losses, subject to periodic review by AERN," thereby addressing current ad-hoc approaches [5].
- Regional Renewable Certificate (REC) Scheme: Launch an ASEAN-wide REC trading system by 2026 under ACE's coordination. This system would allow a generator in any ASEAN country to register renewable generation and for an industrial consumer or government in another country to purchase those certificates. It supports integration by providing a non-physical means of exchange that can later dovetail with physical trading. Notably, Singapore is already developing frameworks to import renewable energy and count it toward its goals; a unified REC scheme could simplify such accounting and ensure no double-counting across borders.
- Subregional "Power Poollets" as interim steps: Encourage sub-groupings of ASEAN to move faster if ready. For instance, the BIMP-East ASEAN Power Integration (involving Brunei, Indonesia (Kalimantan), Malaysia (Sabah/Sarawak), and the Philippines) is already being studied [4]. Support this with technical expertise and possibly integrate it with the broader ASEAN market once established. Similarly, the Mekong region (Thailand, Laos, Vietnam, Cambodia) can deepen their existing grid ties (Laos-Thailand, Thailand-Cambodia, Vietnam-Cambodia lines) and experiment with multilateral exchanges on a small scale. These "minipools" can serve as test beds for the ASEAN Power Pool concept.

4.4. Institutional Strengthening and Governance

To implement and sustain the above, ASEAN's institutional capacity must be bolstered:

- Empower ASEAN Center for Energy (ACE): Expand ACE's mandate to include acting as a technical secretariat for the APG and market integration. ACE could host a centralized data hub for regional grid operations and convene the technical task forces. As recommended by policy experts, technocratic coordination is key; ACE can facilitate the hundreds of meetings and training sessions needed to align all parties [10].
- Establish an ASEAN Energy Integration Committee: This could be a high-level committee under the ASEAN Ministers on Energy Meeting (AMEM), comprising energy ministers or senior officials specifically tasked with overseeing integration progress, troubleshooting political issues, and ensuring cross-sector coordination (e.g., linking energy integration with the ASEAN Economic Community and ASEAN green finance initiatives).

- Dispute Resolution Mechanism: Create a formal mechanism to resolve any disputes arising from cross-border projects or trades – for instance, disagreements on wheeling costs or liability for outages. One idea is to adapt the ASEAN Protocol on Enhanced Dispute Settlement Mechanism to energy, or set up an arbitration panel of energy experts. This provides confidence that if something goes wrong (like a contractual dispute), there's a fair process, which in turn encourages participation by both governments and investors [5].
- Capacity Building and Knowledge Sharing: Continue and expand programs to train ASEAN energy professionals in integrated grid planning, market operations, and regulatory harmonization. Partners like the EU, international energy agencies, and development banks should be invited to contribute expertise (as has been done with Germany-Vietnam cooperation noted for improving workforce skills [10]). ASEAN could set up a regional Energy Integration Scholarship/Exchange whereby engineers from, say, Cambodia's utility spend a year with Thailand's or Malaysia's grid operator to learn about cross-border operations firsthand.

4.5. Financing Mechanisms and Economic Incentives

Implement policies that make integration financially attractive:

- Joint Investment Vehicles: As mentioned, an ASEAN Green Energy Infrastructure Fund can pool resources. Additionally, encourage Public-Private Partnerships (PPPs) for cross-border lines: for example, a consortium of utilities from two or three countries could jointly invest in an interconnector, sharing costs and profits. To kickstart this, ASEAN might provide viability gap funding or guarantees for the first few projects.
- Tariff Design for Integration: Work towards electricity tariff reforms that reflect the cost of carbon and the value of flexibility. If countries price carbon (or even implicitly through avoiding subsidies to fossil generation), it will make imported renewables more competitive economically. While carbon pricing is sensitive, ASEAN can at least agree to gradually remove distortive fossil fuel subsidies and allow market-based pricing for cross-border traded power.
- Promote Private Sector Role: Simplify regulations to allow independent power producers (IPPs) to sign cross-border PPAs under the regional framework. Currently, most cross-border trades are government-to-government. If, for instance, a wind farm developer in Laos can contract directly with Singapore's power retail market under agreed rules, it could unleash new investment. The recommendation is to pilot such arrangements on a small scale under ASEAN oversight, paving the way for market-driven integration.

The above recommendations constitute a comprehensive package. It is important to note that policy recommendation is not just about a document or a single decision; it is about setting in motion a series of coordinated actions and reforms. By following this phased, multi-faceted plan, ASEAN can expect to see—within the next 5 to 10 years—tangible progress such as more interconnectors commissioned, initial multilateral trades occurring, and stronger institutional frameworks in place. This will build momentum and confidence, allowing more difficult steps (like deeper market integration) in the 2030s. The recommended policy is thus an integrated approach for integrated energy: it combines infrastructure, regulatory, financial, and institutional

innovations to achieve the desired outcome of a sustainable, interconnected ASEAN power system. Figure 5 shows a timeline diagram illustrating ASEAN's staged roadmap toward regional energy integration from 2025 to 2050, highlighting key policy, infrastructure, and sustainability milestones.

Figure 5. ASEAN's pathway to a fully integrated, low-carbon regional energy system by mid-century.

5. Monitoring and Evaluation

Effective monitoring and evaluation (M&E) is vital to ensure that the recommended policies are implemented properly and are on track to achieve their objectives. Given the long-term and multi-stage nature of ASEAN energy integration, a robust M&E framework should be put in place, aligning with ERIA and ASEAN best practices for policy oversight. The M&E plan will track inputs (actions taken), outputs (tangible results like projects built), and outcomes (impact on sustainability, integration, and economic metrics) over time, and allow for iterative adjustments. Key elements of the monitoring and evaluation framework include:

5.1. Establishment of Integration Indicators

ASEAN should define a set of key performance indicators (KPIs) to quantitatively measure progress toward regional energy integration. These could include:

- Infrastructure KPIs: Cross-border transmission capacity (MW or GW) installed and operational, number of interconnection projects completed vs. planned, and increase in connectivity (e.g., number of ASEAN countries physically linked to at least two neighbors' grids). For instance, a target might be to raise cross-border capacity from 7.7 GW in 2023 to, say, 15 GW by 2030 [3], and eventually 30+ GW by 2040. Progress on this could be reported annually in an ASEAN Power Grid status report.
- Market KPIs: Volume of electricity traded multilaterally (in GWh/year) and as a percentage of total ASEAN electricity generation. Initially, this figure is near zero for true multilateral trade (beyond bilateral PPAs). A realistic KPI could be to achieve at least 5% of ASEAN's electricity consumption via cross-border trade by 2030, growing to 15% by 2040. Additionally, tracking the number of active participants in regional trading platforms (utilities or countries) can indicate market integration depth.
- Sustainability KPIs: Share of renewables in the ASEAN power mix (% of generation) and CO_2 emissions from power sector (absolute or intensity). As integration is meant to enhance sustainability, improvements here signal success. The KPIs should be tied to goals; for example, if ASEAN integration helps renewables reach 63% of generation by 2050 as forecasted [4], interim milestones like ~40% by 2030 can be set and monitored. Emissions intensity (tCO_2 per MWh) declining over time in each country and region-wide can also be tracked.
- Energy Security KPIs: These might include reserve margin reduction (if countries can rely on neighbors, they might safely reduce domestic spare capacity), frequency of emergency power assistance (how often countries help each other in outages, a positive integration outcome), and price convergence (difference in electricity generation cost or tariffs across countries narrowing, which would indicate a more integrated market).

5.2. Data Collection and Reporting Mechanisms

A centralized mechanism within ACE or a dedicated M&E unit should collect relevant data regularly from member states and any regional market operator. This includes technical data (power flows, outages, capacity factors) and market data (prices, traded volumes, etc.). Annual or biennial progress reports should be published, possibly as part of the APAEC monitoring. For example, the APAEC Phase II mid-term review could include a chapter on APG integration metrics [4, 20]. An ASEAN Energy Integration Dashboard could be developed online to visually display progress on the key indicators, promoting transparency and stakeholder awareness.

5.3. Institutional Oversight and Evaluation

The recommended ASEAN Energy Integration Committee (from the Policy Recommendation section) or an equivalent body should convene at least yearly to review progress. In these meetings:

- They would evaluate whether milestones are being met (e.g., “Has the ASEAN Grid Code been drafted by the target date?”, “Did we initiate the multilateral trading pilot on schedule?”, “How many MW of interconnection were completed this year versus planned?”).
- Identify bottlenecks or delays. For instance, if a project is stalled due to financing or local opposition, the committee can task someone to troubleshoot or seek technical assistance.
- Use independent evaluations: It would be prudent to engage external evaluators (such as ERIA researchers, or the ASEAN+3 energy cooperation secretariat, etc.) every few years to objectively assess the effectiveness of integration efforts and recommend course corrections. These independent assessments can be published as ERIA or ACE research papers, ensuring rigorous analysis of what is or isn’t working.

5.4. Feedback Loops and APAEC Alignment

Monitoring results should feedback into policy adjustment. APAEC is formulated in phases (next cycle 2026-2035 will be under preparation soon [4]). The findings from M&E should directly inform the priorities and targets in APAEC 2026-2035 and beyond. For example, if by 2025 the M&E shows slower than expected progress on interconnectors, the next APAEC might incorporate stronger measures or incentives. If some pilot trading schemes prove successful, APAEC can upscale those. This ensures a dynamic policy process where integration efforts are iteratively improved.

5.5. Stakeholder Engagement in M&E

A lesson from policy literature is that monitoring should not be a top-down bureaucratic exercise alone; it should involve stakeholders who are affected. For ASEAN power integration, stakeholders include national utilities, regulators, investors, and even consumer groups (large industrial power users, etc.). The M&E framework should incorporate consultations or surveys of these stakeholders – for example, an annual “Power Integration Barometer” where major power companies and independent experts rate progress and identify challenges anonymously. If investors still feel a “lack of transparency and clarity” is hampering project development [5], that feedback must be captured and addressed in policy tweaks (like clarifying regulations or improving communication of plans).

5.6. Monitoring of Risks and Unintended Consequences

As integration proceeds, monitor for any negative effects or risks:

- One risk is that stronger interconnections could lead to unequal benefits – perhaps larger countries benefit more or one country becomes overly dependent on imports. M&E should include checking that all participating countries see improvements in their metrics (like reduced costs or improved reliability) so that political support remains broad. If imbalances are found, ASEAN may consider compensatory mechanisms (e.g., technical assistance or sharing savings).

- Grid stability and cybersecurity in a larger grid should be monitored. A blackout or cyberattack could have cross-border impacts in an integrated system. ASEAN's monitoring should thus extend to shared reliability standards and incident reporting. Creating a regional reliability council under HAPUA could be considered.
- Environmental and social impacts of new transmission lines (such as impacts on communities or forests) should also be tracked, to ensure the sustainability aspect includes responsible infrastructure development. If issues arise, adjustments (route changes, community benefit-sharing programs) can be recommended.

5.7. Evaluation of Policy Efficacy

Finally, beyond tracking outputs, evaluation must address effectiveness: are the policies actually yielding the intended outcomes of more sustainable and integrated energy? By around 2030, ASEAN should commission a thorough evaluation (possibly with academic partnership) of whether the integration initiatives have, for example, measurably lowered electricity costs region-wide, or increased renewable utilization beyond what would have happened otherwise. One could use scenario modeling as was done in forecasting – compare actual data to a counterfactual. If outcomes lag expectations, evaluate why: was it insufficient implementation, flawed policy design, or external factors (like global economic conditions)? This evaluation will inform mid-course corrections.

In summary, Monitoring and Evaluation for this initiative is a continuous process built on clear metrics, regular reporting, institutional oversight, stakeholder input, and adaptive management. By keeping a close eye on progress and challenges, ASEAN can ensure the policy recommendations are effectively translated into action and adjusted as needed to stay on the path toward a fully integrated and sustainable regional energy system. Figure 6 shows a circular framework depicting the six-step ASEAN energy policy evaluation process from initiation to continuous improvement.

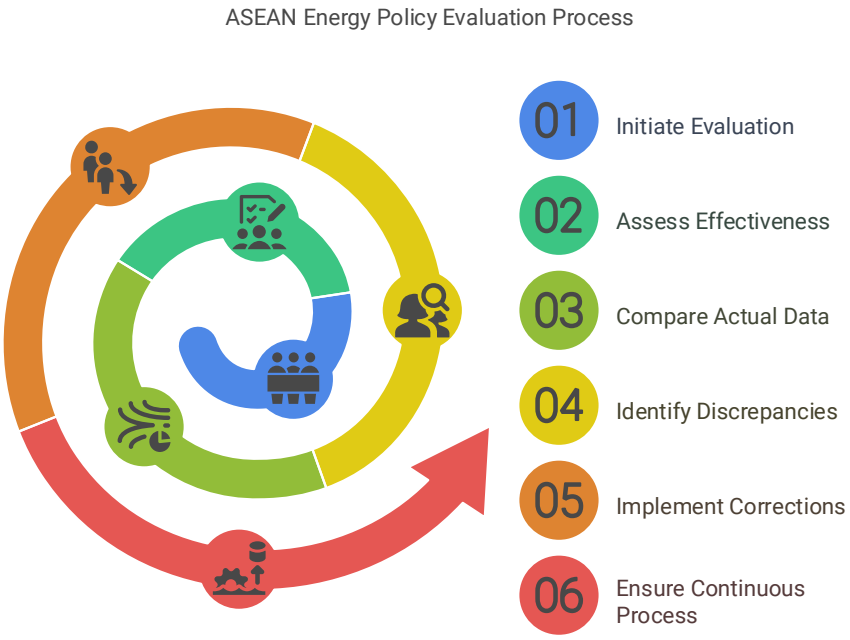


Figure 6. Iterative process for assessing and refining ASEAN energy policies.

6. Policy Argumentation

To persuade policymakers and stakeholders to embrace this recommended policy course, a compelling policy argumentation must be presented. This involves not only grouping evidence of the benefits and feasibility of the plan, but also addressing concerns and counterarguments head-on. Below, we articulate the case for "Powering a Sustainable ASEAN through Regional Energy Integration" and demonstrate why the phased, innovative approach is the choice for ASEAN's future. The argument is structured around key criteria typically used in policy analysis – effectiveness, efficiency (cost-benefit), equity, political acceptability, and sustainability – and draws comparisons with the alternatives to show why the recommendation stands out.

6.1. Effectiveness in Achieving Goals

The primary goal is to ensure a sustainable, secure, and sufficient energy supply for ASEAN's development. The recommended policy is demonstrably effective in this regard, as it directly tackles the root problems:

- By expanding interconnections and enabling power trade, it allows clean energy to flow from where it's abundant to where it's needed, effectively unlocking idle sustainable resources. Evidence shows this will have a meaningful impact: modeling indicates ASEAN can avoid up to 11.9% of system costs and significantly reduce emissions with integrated planning [14]. No other approach (certainly not the status quo) can claim such potential gains in system-wide performance.
- The phased approach ensures incremental goals (like hitting renewable targets, improving energy access) are met along the way. Already, successes like the LTMS-PIP pilot demonstrate feasibility – it has been hailed as a "pathfinder" that proves multilateral projects can work [4]. Building on this, our approach would multiply such successes region-wide. In contrast, Alternative 1 (status quo incrementalism) would be too sluggish to meet pressing needs – it has not so far delivered the renewable share or integration ASEAN aspired to by 2025 [5].
- When compared to Alternative 2 (full immediate integration), our approach is more effective in the real world because it is implementable. A grand plan that fails to be agreed or executed is ineffective by definition. Our recommendation breaks down the vision into manageable steps that ASEAN governments are more likely to actually carry out, thus achieving results rather than remaining aspirational.

6.2. Economic Efficiency and Cost-Benefit

The argument that integration makes economic sense is strong:

- The current fragmented system leads to redundancy and waste – each country building power plants for peak demand that might only run occasionally, or curtailing renewables while a neighbor burns fuel. The integrated approach pools resources, smoothing out demand and supply. Think of it like ASEAN creating a shared reserve tank of energy instead of ten separate small tanks. Studies confirm significant cost savings from this synergy [14]. Those savings (nearly 12% of cumulative costs) can be redirected to other development needs.

- Moreover, integration will attract investment. Why? Because a larger, unified market is more attractive to investors than ten fragmented ones. An investor in a solar farm in Indonesia, for instance, will be more keen if they know they can sell to Singapore or Malaysia when local demand is low. This reduces risk and the cost of capital. The recommended policies like REC trading and common grid codes reduce transaction costs and uncertainty. We have already seen interest from private players – e.g., companies like EDP Renewables looking for clarity in ASEAN to invest [5]. By clarifying the plan (a clear roadmap, transparent pricing, etc.), we unlock private financing, which means less burden on government budgets.
- One might argue that building interconnectors and new institutions is expensive. However, the cost is modest relative to benefits. Transmission investment needed is a small fraction (0.3-0.5%) of total power investment [14], yet yields outsized benefits. Additionally, costs can be shared – not borne by one country alone. The policy ensures fairness in cost allocation (through joint funding and wheeling agreements). Contrast this with each country trying to achieve 100% self-sufficiency in energy: they would need to invest in possibly redundant capacity and expensive backup solutions (like batteries or LNG storage) that integration could minimize.
- Importantly, not integrating has hidden costs: continuing status quo may lead to more severe impacts from climate change (due to higher emissions), energy supply crises, and missed economic opportunities. The argument here is preventive: invest in integration now to avoid larger costs later. In economic terms, this is about avoiding the opportunity cost of inaction.

6.3. Equity and Inclusive Development

A concern in any regional scheme is: do all members benefit, or do some lose out? The recommended approach specifically addresses equity:

- Smaller or less-developed ASEAN countries stand to gain disproportionately from integration. For example, Laos (population ~7 million) can earn revenue by exporting renewable power to its larger neighbors – a development opportunity it wouldn't have otherwise. The $2.3 billion revenue Laos got in 2022 from power exports [3] shows how transformative this can be for a small economy. Similarly, studies suggest Myanmar and Lao PDR would see increased utilization of their resources with integration [14], fostering growth there.
- Consumers across ASEAN would benefit from more stable and potentially lower electricity prices over time, because a larger market dilutes local shocks (like a drought in one country or a gas shortage in another) and allows competition. We argue that integration helps avoid undue burden on consumers: if each country had to go it alone on clean energy, some might face very high costs (e.g., Singapore's cost of solar is high due to land scarcity; but if Singapore can import cheaper solar power from its neighbors, Singaporean consumers get cleaner energy at lower cost). This sharing of advantages embodies equity.
- The policy recommendation also explicitly calls for fair cost-sharing and support: richer member states or international donors help fund the necessary

grid investments in poorer countries, recognizing the common benefit. This echoes the point made by experts that with varying development levels, one cannot simply split costs evenly; instead, creative financing is needed so no country feels unfairly strained [5]. By proposing an ASEAN Infrastructure Fund expansion and development bank engagement [5], we ensure that even less-resourced countries can participate without undue fiscal burden.

- Additionally, our approach is sensitive to national sovereignty and pace, which is an equity issue in political terms. Each country has equal say and can progress when ready, avoiding the scenario where stronger countries impose on weaker ones. This fosters a sense of ownership and fairness.

6.4. Political Acceptability and Feasibility

For a policy to be viable, it must navigate political realities. The recommended phased approach is crafted to be politically palatable:

- It respects ASEAN norms of consensus and non-interference by not immediately pushing supranational authority or market liberalization on unwilling states. Instead, it sets collective goals but allows flexibility in implementation. This incremental trust-building is crucial. We can point to the Working Group of LTMS-PIP as an example where countries cooperated without ceding control: “the structure allowed equal participation, without the need to cede control of national energy infrastructure” [10]. Our proposal expands that principle ASEAN-wide.
- Many elements of the recommendation are already gaining political traction in ASEAN forums, which enhances acceptability. The fact that energy ministers in 2024 explicitly acknowledged the APG’s importance and ordered the finalization of a new APG MoU [4] shows willingness at the top level. By aligning with these stated commitments (e.g., using the AMEM decisions as a mandate), we’re not introducing something alien, but giving substance to agreed goals. The policy recommendation can be framed as fulfilling the ASEAN Leaders’ vision as per the ASEAN Vision 2020 and subsequent blueprints, reinforcing its legitimacy.
- Alternative 1 (status quo) is politically easy but fails effectiveness; Alternative 2 (full integration now) would likely face pushback from countries fearing loss of control. In contrast, our approach can be championed as balancing national and regional interests. Politicians can sell it domestically as gaining access to more energy options (a positive) rather than giving up sovereignty. For example, an official in Thailand can say: “We’re not handing our grid to ASEAN; we’re simply gaining the ability to sell excess power and buy cheap power when needed, under rules we helped set.”
- The recommendation also includes communication and consensus-building measures: stakeholder consultation, transparency in how decisions are made, and incremental legally-nonbinding steps initially. This addresses the transparency concerns highlighted by industry stakeholders like Nikita Yu regarding unclear plans discouraging investment [5]. By making the roadmap clear (with targets and platforms for input), we actually bolster confidence among both governments and investors.

6.5. Sustainability and Regional Leadership

Implementing this policy would assert ASEAN's leadership in sustainable development and climate action:

- ASEAN has the opportunity to show that regional cooperation can enable emerging economies to leapfrog to cleaner energy pathways. This is a powerful narrative in global climate forums. The ASEAN Way of consensus combined with innovative market mechanisms could become a model for other regions (like how SAPP in Africa or initiatives in Latin America might learn from ASEAN's approach).
- Achieving the renewable energy and emission goals through integration will substantially contribute to global efforts to mitigate climate change, given ASEAN's growing carbon footprint. This aligns with ASEAN's own declarations and international commitments (Paris Agreement NDCs). Thus, supporting our policy is in line with broader sustainability pledges that member states have made.
- Additionally, the environmental co-benefits strengthen the argument: reduced air pollution, preservation of biodiversity by optimizing which power plants run (potentially allowing closure of the dirtiest coal plants as cleaner imports take their place), and avoiding overbuilding in fragile ecosystems. For example, better use of Lao hydro and Indonesian geothermal could avoid the need for new coal plants in, say, Vietnam or Philippines, which has direct health and environmental benefits for those societies. Such positive impacts can be highlighted to win public support.

6.6. Addressing Counterarguments

It's important to acknowledge and rebut likely counterarguments:

- "Integration will threaten energy security – what if a country becomes too dependent on imports and others cut it off?" Our response: The policy is designed to enhance energy security mutually. With formal agreements and institutions, the risk of politically motivated cut-offs is minimal (and ASEAN's history shows strong respect for agreements). Diversification is key: a country importing power will typically have multiple sources via the grid, not reliance on a single supplier. Moreover, each country will maintain some domestic generation for reliability – integration is a supplement, not a total replacement of national capacity. The situation is analogous to the EU, where countries trade electricity but also have domestic plants; none has been left dark because neighbors refused to export (even at the height of political disputes, the power market functioned). We can also incorporate redundancy in grid design so that no single line's loss cripples a country. Thus, integration is a net booster of security by providing alternatives, not a vulnerability.
- "National utilities and vested interests might resist integration due to fear of competition or loss of market share." Indeed, state-owned enterprises used to monopolies may worry. The policy argument to them is that integration is an opportunity, not just a threat: their companies can become regional players, selling excess generation for profit. Also, the phased approach does not immediately introduce full competition; it allows them time to adapt. Governments can compensate or retrain workers if certain inefficient plants

close due to cheaper imports – these transitional issues are manageable and are outweighed by the economy-wide gains (like cheaper electricity for industry, which creates jobs elsewhere). The recommendation includes stakeholder engagement precisely to bring utilities on board, showing them the business case (for instance, EVN of Vietnam or PLN of Indonesia could earn revenue by optimizing generation and trading).

- "Why not just focus on each country developing renewables internally and skip the complexity of integration?" This isolationist approach is less efficient and in some cases not feasible (e.g., Singapore can't produce all its needed renewable energy domestically due to land limits). Integration allows optimization: wind and solar have variability that is better managed over a larger geographic area. We can cite the complementarity analysis: e.g., wind in Laos complements solar in Malaysia and demand peaks in different places [3]. Without integration, each country would need more storage or backup – an expensive proposition. So while domestic RE is crucial, the grid integration is the force multiplier that makes high RE penetration achievable at lower cost. It's not an either/or, it's a both/and synergy.
- "This sounds good on paper, but ASEAN's track record on economic integration (like AEC) has been mixed; can we realistically do this in energy?" True, ASEAN integration can be slow. But energy might actually be an area where concrete gains are easier to realize (power flows are physics; if the line is built, electrons will flow, yielding immediate benefits). Also, there is precedent: ASEAN has successfully cooperated on smaller energy projects (e.g., the Trans-ASEAN Gas Pipeline saw numerous bilateral links built). The recommendation builds on existing momentum (APAEC, LTMS-PIP success, AIMS studies). The argument is that now is the opportune moment: the technology (renewables, transmission tech) is ripe, political will is coalescing around climate action, and even external partners (like the EU or US via the Indo-Pacific frameworks) are eager to support ASEAN energy transitions [21]. So, while skepticism due to past slow progress is understandable, the circumstances have aligned to give this initiative a real shot at success. With ERIA and other think-tanks providing research support, ASEAN can implement evidence-based adjustments rather than stumbling blindly.

In conclusion of the argumentation: the recommended policy stands as a well-founded, balanced, and future-proof path. It promises to deliver tangible improvements in sustainable energy supply (effectiveness), does so in a cost-effective manner (efficiency), shares benefits broadly and fairly (equity), aligns with political realities and has growing buy-in (feasibility), and advances ASEAN's long-term interests and international commitments (sustainability and leadership). By contrast, maintaining the status quo would leave ASEAN ill-prepared for the energy and climate challenges of the coming decades, and a reckless push to full integration without groundwork could backfire. The phased innovation strategy threads the needle between these extremes, making it not only the optimal technical solution but the only viable political solution to achieve the goals. Thus, policymakers should feel confident that supporting this policy is both the right thing to do and the smart thing to do for ASEAN's collective future. Figure 7 shows a comparative diagram outlining the key advantages and disadvantages of regional energy integration across performance and implementation dimensions.

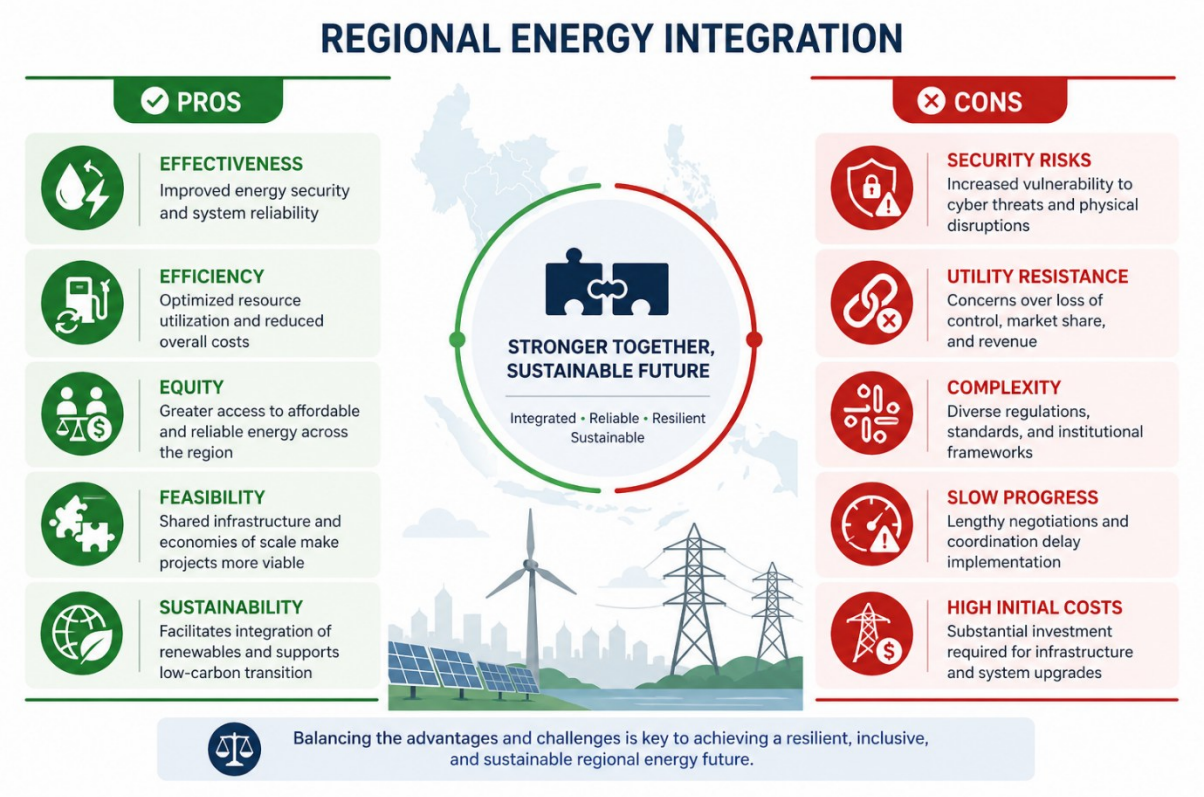


Figure 7. Benefits and challenges associated with regional energy integration.

7. Conclusion

This paper presents a comprehensive strategy to transform ASEAN's energy landscape in line with sustainable development and regional integration ideals. Through the lens of Dunn's policy analysis framework, we have structured the problem of ASEAN's fragmented energy systems, envisioned future scenarios, proposed and evaluated alternatives, and put forth a detailed recommendation accompanied by a plan for monitoring and a persuasive argument for its adoption. The analysis demonstrates that enhancing regional energy cooperation is not just an aspirational slogan from ASEAN communiqués, but a practical and necessary pathway to address multiple urgent priorities: meeting growing energy demand reliably, accelerating the transition to clean energy to combat climate change, and strengthening economic resilience through shared infrastructure.

The recommended phased approach marries ambition with pragmatism. In the next five years, ASEAN can lay the groundwork by solidifying political commitments (via an ASEAN Sustainable Energy Agreement) and initiating tangible projects like new interconnectors and pilot trading platforms. In the subsequent decade, these foundations can blossom into a multi-country power market that allows electricity to flow where it is needed most, bringing cost savings and environmental benefits. And by mid-century, ASEAN has the potential to become a fully integrated regional power system – a feat of cooperation among diverse nations, showing the world a model of how regional blocs can tackle climate and energy challenges collectively.

The policy paper underscores several key insights and takeaways:

- Regional Integration as a Force Multiplier: ASEAN's diversity in resources – from hydro-rich Laos to gas-rich Malaysia to the solar potential of Indonesia – is a collective strength that remains underutilized. Integration turns diversity into complementarity. It enables load sharing, resource sharing, and ultimately a more balanced and secure energy supply for all. The scenario analysis vividly illustrated how integration can cut costs and emissions significantly [14], an opportunity cost too large to ignore.
- Importance of Policy Innovation and Institutions: Technical potential alone will not unify ASEAN's grid; imaginative policy design and institution-building are the linchpins. Innovations like a regional wheeling tariff formula (learning from SAPP [5]), common grid codes, and an ASEAN power exchange are the "software" that must accompany the "hardware" of transmission lines. Equally, empowering institutions such as ACE, AERN, and regional committees to coordinate and enforce agreements is critical. This paper, in line with ERIA's mission, highlights that policies and institutions can unlock the benefits that pure market forces or bilateral MOUs have left on the table.
- Balancing Sovereignty and Integration: ASEAN's history and political context mean that pushing too hard on sovereignty can backfire. The recommended approach carefully balances national interests with regional good. It shows that countries can maintain control (for instance, no country is forced to supply if it risks its own needs) while still committing to help each other and benefit together. The LTMS-PIP case study served as a microcosm: it succeeded by fostering coordination without requiring any country to relinquish authority over its grid [10]. Our proposal scales that lesson up, suggesting that trust and voluntary cooperation can pave the way to what is effectively a tightly knit network.
- Learning from International Comparisons: We've drawn parallels with the European Union's energy integration, which took decades but has achieved a high level of market coupling and security. We also looked at the Nordic Power Pool as an example of deep integration led by a subset of countries, and the Southern African Power Pool for solutions like common wheeling charges. These comparisons were not to imply one-size-fits-all, but to adapt relevant best practices. They teach us that regional energy integration is a complex journey everywhere, but one that yields dividends in the long run. ASEAN can leapfrog by adopting what worked elsewhere and avoiding what didn't (for instance, the EU's lesson that strong institutions like ACER matter; SAPP's lesson that having an independent coordination center helps build trust among utilities).
- Sustainability and Regional Integration are Mutually Reinforcing: ASEAN's sustainable energy goals (such as the renewable energy share and energy intensity reduction targets under APAEC) and its integration goals (APG, AEC) need not be pursued in isolation. In fact, this paper demonstrates they can be achieved together: integration makes sustainability more attainable (by opening access to renewables, as the complementarity of solar/wind across countries shows [3]), and the pursuit of sustainability can drive integration (as countries realize they need each other to reach climate targets). This synergy should be embraced in ASEAN's strategic planning.

Finally, the policy relevance of this paper is underscored by its timing. As ASEAN formulates its APAEC for 2026-2035 and looks ahead to a post-2025 agenda, there is a window of opportunity to embed these ideas into official policy. The Economic Research Institute for ASEAN and East Asia (ERIA) and ASEAN Centre for Energy (ACE) are well-placed to champion such integrated approaches, providing the evidence base to ASEAN leaders. This paper can serve as a background document or even a draft blueprint for discussions on the ASEAN Power Grid 2.0, multilateral power trade frameworks, and green finance collaboration in the region.

In conclusion, a sustainable, integrated ASEAN energy future is within reach if bold but measured actions are taken. The journey will require foresight, solidarity, and sustained commitment – qualities that ASEAN has shown in other arenas. By implementing the recommendations herein, ASEAN can ensure that in the coming decades, lights stay on across Southeast Asia with green electrons flowing through a web of interconnections, symbolizing not just power lines but the power of regional unity. The result will be a more resilient ASEAN Economic Community and a cleaner, brighter future for its 680 million citizens. It is a vision worth striving for, and the time to act is now.

Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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I.V.: Conceptualization, Methodology, Writing – original draft
D.W.D.: Methodology, Writing – review & editing.
K.S.: Investigation, Data curation.
F.A.: Formal analysis, Visualization.
A.M.H.S.L.: Validation, Writing – review & editing.
A.K.R.: Resources, Data curation.
I.: Investigation, Project administration.

All authors have read and agreed to the published version of the manuscript.

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