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Layered Market Approach to ASEAN Power Grid Development

By

Economic Research Institute for ASEAN and East Asia (ERIA)

Indonesia National Energy Council

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Layered Market Approach to the ASEAN Power Grid

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Contents

List of Figures

List of Tables

List of Abbreviations and Acronyms

ACE	ASEAN Centre for Energy
AGC	automatic generation control
AGTP	APG Generation and Transmission Planning
AIMS	ASEAN Interconnection Masterplan Study
AMS	ASEAN Member State
APAEC	ASEAN Plan of Action for Energy Cooperation
APG	ASEAN Power Grid
APGCC	ASEAN Power Grid Coordinating Council
ATSO	APG Transmission System Operator
CBES-RE	cross-border electricity sales for renewable energy
DA	domestic auction
DAM	day-ahead market
DPBE	direct bilateral power exchange
EC	Energy Commission
EDL	Electricité du Laos
EGAT	Electricity Generating Authority of Thailand
EMA	Energy Market Authority
ERC	Energy Regulatory Commission
ERIA	Economic Research Institute for ASEAN and East Asia
EVN	Vietnam Electricity
GSO	grid system operator
GW	gigawatt
HAPUA	Heads of ASEAN Power Utilities and Authorities
HVDC	high-voltage direct current
IEA	International Energy Agency
IPP	independent power producer
Lao PDR	Lao People's Democratic Republic

LBT	linked bilateral trade
LTMS-PIP	Lao PDR–Thailand–Malaysia–Singapore Power Integration Project
MEMR	Ministry of Energy and Mineral Resources
MOIT	Ministry of Industry and Trade
MW	megawatt
NEMS	National Electricity Market of Singapore
NGCP	National Grid Corporation of the Philippines
PLN	Perusahaan Listrik Negara
PPA	power purchase agreement
PSO	power system operator
REC	renewable energy certificate
SAPP	Southern African Power Pool
STEM	short-term electricity market
TNB	Tenaga Nasional Berhad
TSO	transmission system operator
VWEM	Viet Nam Wholesale Electricity Market
WESM	Wholesale Electricity Spot Market

Executive Summary

The power-trading landscape of the Association of Southeast Asian Nations (ASEAN) is undergoing a strategic shift. Whilst long-term bilateral power purchase agreements (PPAs) have long underpinned regional electricity exchange, growing renewable penetration, rising system flexibility needs, and strengthened interconnections are creating momentum for a new short-term layer of cross-border power trade. This report assesses ASEAN's readiness for shorter-term trading and outlines a phased roadmap for introducing short-term bilateral trading as part of the transition towards regional market evolution under the Layered Market Approach.

Layered Market Approach

The Layered Market Approach offers an incremental, step-by-step, and voluntary pathway for advancing multilateral electricity trade in ASEAN, enabling each ASEAN Member State (AMS) to participate according to its own readiness, regulatory maturity, and national priorities. Rather than imposing a uniform market design, the approach recognises the diversity of energy policies and market structures across the region, allowing countries to engage at different levels whilst still contributing to broader regional integration.

A defining feature of this approach is the coexistence of multiple trading mechanisms. Long-term bilateral PPAs can continue to operate alongside emerging short-term trading platforms and regional balancing arrangements, providing flexibility and supporting renewable-energy integration without disrupting existing contracts or policy frameworks. *Short-term bilateral electricity trading* is expected to evolve organically as a first step, driven by the needs and capabilities of individual AMS rather than regional mandates. Countries with established cross-border power-exchange arrangements are likely to adopt these mechanisms first, piloting short-term bilateral trades, testing operational protocols, and demonstrating their commercial viability. These early efforts will create a learning pathway and build confidence, paving the way for wider participation in multilateral trading across the region over time.

A critical part of the Layered Market Approach is the transition pathway, which proposes establishing a *harmonised bilateral trading model* as an intermediate step before moving towards a full regional secondary market. This model provides a straightforward and cost-effective way to pilot short-term power trading, allowing utilities to use familiar contractual and operational practices with minimal enhancements. Whilst the medium- to long-term goal is to develop a day-ahead market and a more sophisticated regional trading framework, achieving this will require regulatory, institutional, and technical strengthening across ASEAN. Therefore, implementation of the harmonised short-term bilateral model should occur alongside preparatory work for a secondary trading

model's advanced market structure, including detailed market design, aligned grid and market codes, common rules, governance systems, and capacity-building initiatives. This dual-track approach allows ASEAN to gain early experience and benefits from simplified short-term bilateral trading whilst laying the foundation for a fully functioning regional electricity market in the future. A summary of the Layered Market Approach concept is presented in the Table.

Table 1: Summary of the Layered Market Approach Concept

Topic	Summary
Purpose of the approach	Provides an *incremental, voluntary, readiness-based* pathway for ASEAN Member States to participate in multilateral power trading without requiring uniform market structures.
Key principle	Recognises ASEAN's *diverse energy policies, regulatory maturity, and market structures*, enabling different levels of participation at different speeds.
Alignment with regional roadmaps	Fully consistent with the *IEA Study* and *AIMS III Phase 3*, which outline a transition from long-term bilateral PPAs through short-term bilateral trade, to harmonised bilateral trade and to secondary short-term trading.
Co-existence of trading mechanisms	Long-term PPAs remain essential (security, financing) for operation alongside new short-term trading platforms and balancing mechanisms.
Participation dynamics	*Bottom-up evolution*, participation driven by national readiness and priorities, not mandated regionally.
Early movers	Countries with existing cross-border PPAs and bilateral flows (e.g., LTMS-PIP, CBES-RE, Viet Nam–Malaysia–Singapore Corridor) will pioneer *short-term bilateral exchanges and operational tests*.
Transition pathway (stages)	1. Current state: Long-term PPAs. 2. Transitional: Harmonised bilateral short-term trading. 3. Future: Secondary market (DAM/spot trading).
Benefits of harmonised bilateral stage	*Straightforward and efficient way to start short-term bilateral trade*; uses familiar contractual structures; lower institutional/technical requirements.
Parallel capacity-building track	In parallel with harmonised short-term bilateral trading implementation, conduct studies, develop governance frameworks, align market and grid codes, strengthen

Topic	Summary
	institutions, and carry out simulations and pilot trials for the secondary trading model.
Final vision for the ASEAN market	A *layered, dynamic, decentralised but coordinated* regional ecosystem where long-term, short-term, and spot transactions operate across multiple cross-border corridors.

CBES-RE = Cross-border Electricity Sales for Renewable Energy, LTMS-PIP (Lao PDR–Thailand–Malaysia–Singapore Power Integration Project.
Source: Authors' elaboration.

Current state of regional power trading

ASEAN's cross-border electricity exchange is facilitated through three main mechanisms:

- *Direct bilateral power exchange*, in which power is traded directly between two physically adjacent utilities or countries under a single PPA framework (e.g. Lao PDR–Thailand, Thailand–Malaysia, Malaysia-Indonesia).
- *Linked bilateral trade*, in which power is traded between two non-adjacent countries through multiple interconnected bilateral agreements, enabling electricity to transit via a third country or form part of a broader regional trade pathway (most prominently the LTMS-PIP pilot between the Lao PDR, Thailand, Malaysia, and Singapore).
- *Domestic auction mechanism*, in which electricity intended for export is procured through competitive domestic bidding processes, and the traded power may flow between either adjacent or non-adjacent countries (e.g. Malaysia's Cross-border Electricity Sales for Renewable Energy (CBES-RE) Scheme, enabling competitive renewable-energy exports).

Around 7.5 gigawatts (GW) of generation-to-grid interconnector capacity is currently operational, with more than 13.7 GW planned interconnector capacity by 2040 (ACE, 2025d). Pilot projects, including Cambodia–Singapore RE exports, Monsoon Wind (Lao PDR–Viet Nam), and the Viet Nam–Malaysia–Singapore (VMS) Clean Energy Corridor, demonstrate increasing commercial appetite for cross-border clean energy trade.

However, no ASEAN country currently practices short-term (hourly or day-ahead) bilateral electricity trading, and enabling frameworks remain underdeveloped.

Rationale for short-term bilateral trading and layered markets

The rapid growth of variable renewable energy in several AMS is creating a stronger need for operational flexibility, cross-border balancing, and mechanisms to manage solar and wind variability. Introducing short-term bilateral electricity trades, ranging

from hourly to weekly or seasonal products, would help reduce curtailment and allow utilities and independent power producers to optimise generation portfolios beyond the constraints of long-term PPAs. These short-term products also provide a practical stepping stone towards a more integrated regional electricity market.

To enable such trading without disrupting existing contracts or compromising national sovereignty, the study proposes the Layered Market Approach, which emphasises the coexistence of long-term PPAs and emerging short-term bilateral trades, the adoption of a Harmonised Bilateral Trading Model as the transitional framework, and a gradual, readiness-based evolution towards a Secondary Trading Model (focusing on a regional day-ahead market initially) for willing and prepared participants.

Under this approach, the Harmonised Bilateral Trading Model serves as a bridge towards future multilateral power trading within the ASEAN Power Grid. It allows AMS to undertake both long-term PPAs and short-term bilateral exchanges within a shared framework that enhances consistency, transparency, and coordination whilst maintaining full national control over dispatch and system operations. By standardising trading rules, operational procedures, and technical requirements, the model establishes the minimum common conditions needed for short-term bilateral exchange. Its built-in flexibility enables any combination of AMS to participate, provided interconnections, regulatory alignment, and operational capabilities are in place.

Short-term bilateral trades are expected to evolve through existing mechanisms (direct bilateral power exchanges, linked bilateral trade, and domestic auction platforms), leveraging current infrastructure and institutional arrangements. This incremental approach allows AMS to gain hands-on operational experience, test harmonised procedures, and build institutional confidence, all whilst maintaining compatibility with existing regulatory frameworks. It also enhances system flexibility, supports renewable integration, and improves utilisation of cross-border infrastructure. Participation will remain voluntary and readiness-based, enabling frontrunner countries to advance early whilst others continue relying primarily on long-term PPAs until they are prepared to engage in short-term trading.

Readiness for short-term bilateral trading

A five-dimension readiness index (infrastructure, regulation, system operation, institutional commitment, and project pipeline) (1 = minimal, 5 = fully ready) shows ASEAN's overall readiness for short-term bilateral trading is moderate (average 3.2/5), with a clear subregional divide.

- *High readiness* (4.5–5.0): Singapore, Malaysia, Lao PDR, Thailand. Strong interconnections, proven pilots (LTMS-PIP), and advanced regulatory frameworks.
- *Moderate readiness* (3.0–4.4): Viet Nam, Cambodia. Expanding renewable pipelines but facing grid constraints and evolving regulations.

- *Low readiness* (<3.0): Indonesia, Philippines, Myanmar, Brunei Darussalam. Limited interconnections, diverse regulatory systems, or geographic isolation.

In terms of subregional grouping, the patterns are the following:

- *Peninsular ASEAN* (Thailand, Malaysia, Singapore) (4.5): Most advanced; ready for early short-term bilateral pilots.
- *Mekong subregion* (Lao PDR, Thailand, Cambodia, Myanmar, Viet Nam) (3.8): Strong renewable-export base; growing cross-border opportunities.
- *Borneo Island* (Sarawak, Brunei, Kalimantan) (2.8): Emerging clean-energy hub with future potential.
- *Archipelagic ASEAN* (Indonesia, Philippines) (2.0): Most limited due to geography and system fragmentation.

Regional pathway (layered market roadmap)

A progressive phased transition is proposed to facilitate gradual, voluntary, and readiness-based participation:

- *Phase 0: Pioneer short-term bilateral trading*. Launch voluntary pilot exchanges amongst frontrunners (Lao PDR–Thailand–Malaysia–Singapore), leveraging existing interconnectors and operational arrangements.
- *Phase 1: Develop a harmonised bilateral framework*. Introduce standardised short-term contract templates, harmonised wheeling-charge methodologies, aligned operational protocols, and a regional coordination function (via APGCC/HAPUA/ACE).
- *Phase 2: Scale regional participation*. Expand short-term bilateral trading to additional AMS, strengthen operator coordination, increase trade volumes, and deepen regulatory convergence.
- *Phase 3: Develop a Secondary Trading Model*. Develop foundations for a future regional platform (day-ahead/intraday) aligned with ongoing AIMS III Phase 3 studies; participation remains voluntary and readiness-based.

Conclusion

- ASEAN's assessment of current power-trading arrangements, readiness levels, and transition pathways shows that *the region is structurally prepared to introduce a new 'short-term trading layer' of cross-border electricity trading*. With growing interconnection capacity, proven pilots such as LTMS-PIP, Malaysia's CBES-RE, and emerging corridors like VMS and Cambodia–Singapore, ASEAN has demonstrated that multi-jurisdictional power flows can be coordinated reliably. These developments signal that short-term bilateral trading is now technically feasible and increasingly essential for integrating renewable energy, reducing curtailment, and improving system-wide flexibility. Whilst regulatory alignment

and operational modernisation are still required, the region has a sufficiently strong foundation to begin with voluntary, limited-scale short-term trading amongst ready participants.

- The analysis also concludes that *harmonised bilateral trading is a practicable initial step to expanding power trade*. A harmonised bilateral approach allows ASEAN Member States to trade short-term products using familiar contractual structures and adapted operational rules, whilst regional institutional capacity, market rules, and robust information technology governance infrastructure are developed to support a regional day-ahead market. This model preserves national dispatch sovereignty whilst enabling the adoption of standardised contracts, harmonised wheeling methodologies, and coordinated procedures. By reducing implementation risks and allowing incremental capability building, this framework serves as a pragmatic bridge towards a future Secondary Trading Model once readiness and political appetite increase.
- Finally, ASEAN's *market evolution will be corridor-based, AMS-driven, and layered on top of existing long-term PPAs*. The Mekong–Peninsular corridor, comprising the Lao PDR, Thailand, Malaysia, and Singapore, with Viet Nam and Cambodia close behind, forms the region's natural early-mover cluster due to its strong interconnections, active trading relationships, and major renewable-export projects. Participation will remain voluntary, enabling frontrunners to advance whilst other subregions, such as Borneo and the archipelagic systems of Indonesia and the Philippines, build readiness over time. Crucially, short-term bilateral trading will complement rather than replace long-term PPAs, adding a flexible operational layer that enhances interconnection utilisation, supports renewable balancing, and strengthens system reliability without disrupting established investment frameworks.

Recommendations

Based on the Layered Market Roadmap and readiness assessment, the study recommends the following:

- *Adopt a Harmonised Bilateral Trading Model as the transitional framework* by standardising short-term contracts, wheeling methodologies, and operational procedures, supported by a light-touch regional coordination function that enhances transparency and consistency without requiring a centralised market operator.
- *Launch Phase 0 pilot trades* amongst frontrunners (Lao PDR, Thailand, Malaysia, Singapore) using existing direct bilateral power exchanges, linked bilateral trade, and domestic auction mechanisms and expand participation as readiness grows.
- *Implement Phase 1 harmonisation and capacity building* through aligned contracting terms, mutually recognised technical rules, enhanced coordination

via ACE/HAPUA/APGCC, and targeted training for regulators and system operators.

- *Prepare for Phase 2 scaling and Phase 3 secondary trading* by increasing participation and trading volumes whilst continuing AIMS III work on future regional market rules, governance, and information technology systems.
- *Support lower-readiness AMS and subregions* through tailored transition plans, technical assistance, and concessional financing to strengthen interconnections, regulatory frameworks, and operational readiness.

Chapter 1
Introduction

The ASEAN Power Grid's Long-term Vision

The long-term vision of the Association of Southeast Asian Nations (ASEAN) for the regional power grid is to evolve from a collection of nationally operated electricity systems into a fully interconnected and meshed regional network capable of facilitating multilateral, multi-seller, and multi-buyer electricity trade across all member states. This future ASEAN Power Grid aims to function as an integrated regional power market characterised by transparent market mechanisms, open and non-discriminatory grid access, coordinated transmission planning and system operations, and robust congestion management, enabling power to flow efficiently and reliably across borders. Crucially, this vision supports the strategic pooling of ASEAN's diverse renewable resources, hydropower in the Mekong Basin, large-scale solar potential in Indonesia, Malaysia, Viet Nam, and Thailand, and emerging offshore wind in coastal economies, to enhance system flexibility, reduce curtailment, lower long-term power costs, and strengthen collective energy security.

Recent Developments

ASEAN has made meaningful progress towards regional power-market integration. Eight out of ten ASEAN member states are now physically interconnected, and more than one-third of the region's priority cross-border transmission projects are operational, supporting steady growth in regional power exchanges and demonstrating the technical feasibility of shared grid operations. The Lao PDR–Thailand–Malaysia–Singapore Power Integration Project (LTMS-PIP) represents a landmark breakthrough as the region's first real multilateral electricity-trade pilot, proving that clean power can move across multiple jurisdictions under structured commercial and system-operation arrangements. In parallel, domestic electricity-sector reforms continue to advance, with Singapore and the Philippines operating competitive power markets, and Indonesia, Malaysia, and Viet Nam expanding private-sector participation and market readiness.

Recent commercial and policy developments have further accelerated momentum towards regional integration. Malaysia's Cross-border Electricity Sales for Renewable Energy (CBES-RE) scheme has created a structured platform for renewable electricity exports, linking physical delivery to renewable certificate issuance. Currently, Malaysia exports 50 megawatts (MW) of power from solar and hydropower projects under this scheme. The Lao PDR's 600 MW Monsoon Wind Project, now exporting to Viet Nam,

marks ASEAN's first large-scale cross-border wind power flow and demonstrates the viability of renewable-energy transmission corridors. Singapore's target to import 6 gigawatts (GW) of low-carbon power by 2035 has catalysed a pipeline of export proposals from Cambodia, Indonesia, Malaysia, and Viet Nam, whilst a tri-country renewable-energy partnership amongst Singapore, Malaysia, and Viet Nam is advancing the subsea transmission of Vietnamese clean power. These developments collectively signal a shift beyond isolated bilateral deals towards multi-country, renewable-driven, commercially structured power trade, laying the groundwork for a future integrated regional market.

Trading Mechanisms

Cross-border electricity trade under the ASEAN Power Grid (APG) is currently anchored in long-term bilateral power purchase agreements (PPAs). Yet, within this bilateral framework, ASEAN utilises three distinct trading mechanisms that facilitate the movement of electricity across borders. The first is direct bilateral exchange, where power is traded between neighbouring countries under a single PPA. The second is linked bilateral trade (LTMS-PIP), which enables electricity to flow between non-adjacent countries through a chain of wheeling arrangements, allowing power to transit through a third country's grid. The third mechanism involves domestic auction-based procurement (CBES-RE Scheme), where electricity intended for export is competitively sourced through domestic bidding schemes, with traded power able to flow to either adjacent or non-adjacent markets. Collectively, these arrangements show that although ASEAN's power trade remains primarily bilateral, the region is already employing multiple and increasingly sophisticated transaction pathways.

Key Barriers

Despite this progress, ASEAN remains in an early phase relative to its long-term objectives. The region faces significant institutional, technical, financial, and legal barriers. Politically, commitments to cross-border integration vary, and without a centralised regional authority, grid and market decisions must be made by consensus, slowing progress on harmonised standards and regional planning. Technically, ASEAN power systems operate under divergent grid codes, operational practices and regulatory regimes, complicating efforts to harmonise rules and build advanced interconnection infrastructure, such as long-distance subsea cables. On the commercial front, regional power corridors require large capital investment and bankable commercial frameworks, yet negotiating pricing structures, wheeling tariffs, and risk-allocation mechanisms remains challenging. Finally, establishing compatible legal frameworks, contractual standards, and dispute-resolution systems across multiple jurisdictions is complex and resource-intensive, particularly for countries still developing domestic market institutions.

Market Development Pathway

The barriers outlined above can be more effectively addressed when viewed through the lens of ASEAN's long-term power market development pathway. A key reference point is the International Energy Agency's framework (IEA, 2019), which proposes a stepwise, flexible, and sovereignty-respecting transition towards regional power trading. Rather than pushing for immediate full-market integration, the IEA recommends a staged evolution: first, a harmonised bilateral model that standardises contracts and wheeling rules and introduces a regional coordination function; second, a secondary trading model that overlays a regional trading platform on top of existing national systems, allowing voluntary participation; and, ultimately, a primary trading model for willing member states, enabling a fully integrated multi-buyer, multi-seller market with unified rules. This sequencing recognises differing national priorities and readiness whilst ensuring progress towards a common end-state.

Consistent with this approach, the ASEAN Interconnection Masterplan Study (AIMS) III Phase 3, conducted by the ASEAN Centre for Energy (ACE), establishes a structured foundation for multilateral market operations under the ASEAN Power Grid. The study's objectives include: (i) defining the minimum institutional, regulatory, technical, and market prerequisites for multilateral power trading; (ii) developing a region-wide integrated resource and resilience planning framework to harmonise national planning with cross-border infrastructure, renewable integration, and system resilience requirements; and (iii) harmonising grid codes and technical standards to ensure interoperability, consistent operations, and reliable power flows across ASEAN. Importantly, AIMS III Phase 3 operationalises these objectives by prioritising the creation of a secondary trading model, a foundational and practical step towards a future regional electricity market that balances system reliability, commercial viability, and national sovereignty.

Institutional Development

Given the already complex APG institutional landscape, ASEAN Member States (AMS) prefer to strengthen and restructure existing bodies, notably the ASEAN Energy Regulators Network, the Heads of ASEAN Power Utilities and Authorities (HAPUA), and the ASEAN Power Grid Coordinating Council (APGCC), by expanding their mandates and updating their terms of reference to integrate APG Generation and Transmission Planning (AGTP), an APG Transmission System Operator (ATSO), and market-operation functions needed for multilateral power trading. In line with this, ERIA (2024) recommends a decentralised approach for operationalising the AGTP and ATSO functions, rather than creating new central organisations. Under this model, a decentralised secretariat within the APGCC would house coordinators for the AGTP, ATSO, the ASEAN Market Operator, and related secretariat functions, whilst technical work would be carried out by AMS-nominated working groups. This decentralised

structure offers a practical balance of commitment, flexibility, coordination efficiency, and alignment with international best practices.

Layered Market Approach Concept

Whilst AIMS III Phase 3 focuses on the minimum requirements needed to establish multilateral power trade in ASEAN, the Layered Market Approach provides a practical pathway for transitioning from existing bilateral arrangements to secondary market trading within the regional power market. It adopts an incremental, step-by-step, and voluntary framework for developing multilateral electricity trade, enabling each AMS to participate according to its level of readiness, regulatory maturity, and national priorities. Rather than imposing a single uniform market design, the approach recognises the region's diverse energy policies and market structures, allowing countries to engage at varying levels of participation whilst still contributing to deeper regional integration.

This approach is consistent with the phased market-development vision set out by the IEA and currently advanced under the AIMS III Phase 3 programme, which charts a progression from today's long-term bilateral power exchanges towards harmonised bilateral frameworks and, ultimately, a secondary trading model that enables voluntary short-term cross-border trading on top of existing national markets. In contrast, the primary trading model, which assumes fully liberalised electricity markets and unified regional rules, remains impractical in the near term given ASEAN's institutional diversity and prevailing single-buyer structures.

A key feature of the Layered Market Approach is the co-existence of multiple trading mechanisms at each stage of development. Long-term bilateral PPAs, which remain essential for system planning, energy security, and financing, will continue to operate alongside emerging short-term cross-border trading platforms and regional balancing mechanisms.[1] This layered structure allows ASEAN to expand market flexibility, enhance renewable-energy integration, and build market experience gradually, without disrupting existing contracts or national policy frameworks.

Another important feature of the Layered Market Approach is that the introduction of short-term electricity trading is driven organically by interested AMS, rather than mandated at the regional level. Participation emerges from countries' own needs, priorities, and readiness, reflecting the maturity of their domestic power markets, regulatory frameworks, and system-operation capabilities. This bottom-up evolution ensures that market development remains practical, politically acceptable and aligned

[1] A regional balancing mechanism is a cross-border system for maintaining real-time electricity supply–demand balance by allowing neighbouring countries to share reserves, exchange power on short notice, and coordinate grid operations. It enables short-term or intraday electricity trading, supports renewable variability, and helps ensure regional grid stability across interconnected power systems.

with national energy-transition strategies. As a result, short-term cross-border trading is expected to first emerge amongst member states that already have active bilateral power-exchange channels, such as direct cross-border PPAs, linked bilateral flows, and domestic auction or competitive procurement mechanisms. These early movers can pilot short-term exchange arrangements, test operational protocols, and demonstrate commercial viability, creating a learning pathway and confidence-building foundation for broader regional participation over time.

The transition pathway is a critical element of the Layered Market Approach. One alternative pathway, rather than shifting directly from today's long-term bilateral trade arrangements to a regional secondary trading platform, is to first establish a harmonised bilateral trading model (Figure 1.1). This stage represents a straightforward and cost-effective way to stimulate and pilot short-term power trading, as it allows participating utilities to conduct short-term bilateral exchanges using familiar contractual structures and operational practices with only modest institutional and technical enhancements. Transition to a secondary trading model will require the introduction of a more sophisticated market environment, complete with common market rules, coordinated governance structures, advanced market management and settlement systems, and robust data-sharing protocols. Moving first through a harmonised bilateral stage would allow ASEAN to build capability progressively, reduce implementation risks, and generate early trading experience before transitioning to a more formalised regional market framework.

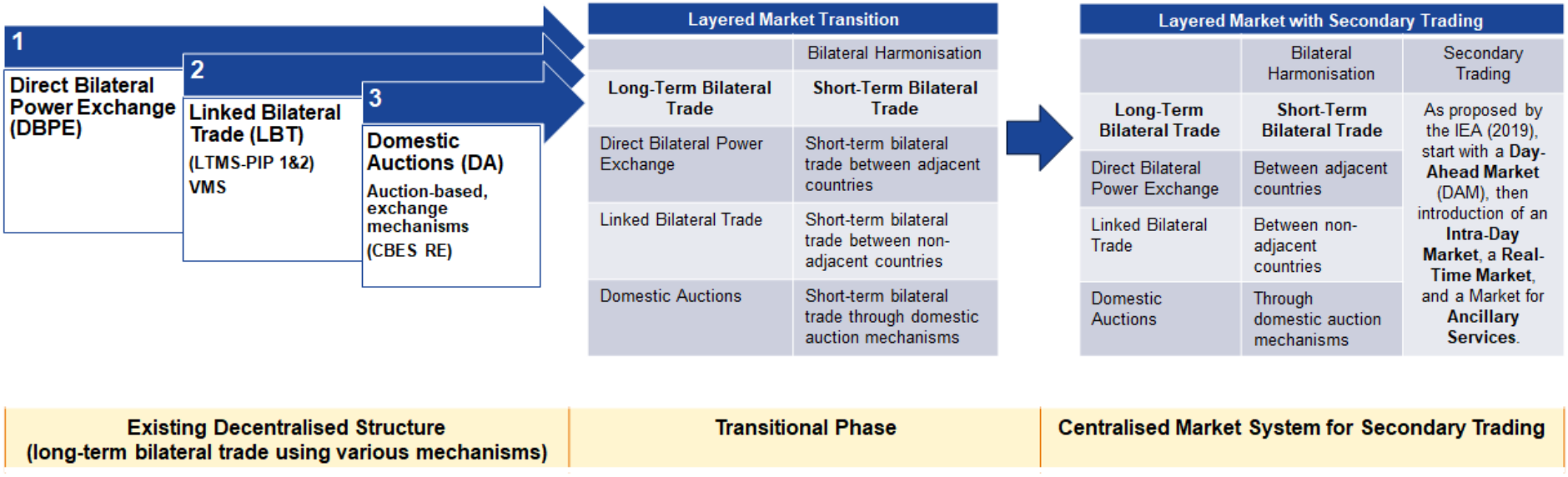
The Layered Market Approach recognises that the harmonised bilateral trading model is a transitional phase rather than an end-state. Whilst harmonised bilateral trade provides a pragmatic and low-risk entry point for short-term power exchange, the ultimate ambition for ASEAN is to progress towards a day-ahead market (DAM) and broader secondary market framework that enables more liquid, competitive, and transparent regional electricity trading. Achieving this future state will require a significant strengthening of institutional, regulatory, and technical foundations across participating jurisdictions.

Accordingly, the deployment of the harmonised bilateral model should run in parallel with a structured programme of preparatory work for a secondary trading model. This includes undertaking detailed market-design and feasibility studies, drafting and aligning market and grid codes, creating common operational and settlement rules, developing and trialling governance and oversight arrangements, and building the regulatory, institutional, and technical capabilities needed to operate a short-term power market. Capacity-building and knowledge-exchange initiatives, including simulation exercises, pilot platforms, and utility-to-utility partnerships, should also be prioritised. This dual-track strategy ensures that ASEAN can capture early operational and economic benefits from simplified bilateral trading whilst simultaneously laying a

robust foundation for a fully functioning regional DAM and other markets in the medium-to-long term.

Under the Layered Market Concept, the future ASEAN Power Market can be characterised as a dynamic ecosystem in which multiple centralised and decentralised, but coordinated, trading arrangements operate simultaneously. At any point in time, the market would encompass a continuum of transaction types, from long-term contractual exchanges to short-term and spot-based mechanisms, distributed across different cross-border trading corridors within the region. This layered and geographically dispersed structure allows ASEAN to accommodate diverse market maturities, national priorities, and system capabilities whilst progressively advancing towards greater regional market integration.

Figure 1.1. Layered Market Approach Transition



Source: Authors' elaboration.

Chapter 2

Electricity Market Structures, Governance, and Regional Power Integration Frameworks

As the foundation for developing the Layered Market Approach, this section presents a regional synthesis of the electricity-market structures, governance arrangements, and national policy and regulatory frameworks across ASEAN that shape and influence regional power-system integration. Understanding these institutional and market characteristics, as well as the extent of sector liberalisation, regulatory independence, system-operation models, transmission access regimes, and cross-border trading rules, is essential for identifying the enabling conditions, constraints, and opportunities that will guide the phased evolution towards multilateral power trade in the region. This analytical baseline provides the reference point upon which the Layered Market Approach is formulated, ensuring that the proposed roadmap aligns with ASEAN's diverse market realities and builds on existing institutional strengths and reform trajectories.

2.1. Electricity Market Structure

The structure of electricity markets can be broadly categorised into four main models: (i) vertically integrated monopoly, (ii) single-buyer model and its variants, (iii) wholesale competition, and (iv) retail competition.

- Vertically integrated monopoly. This is the traditional model. A single utility is responsible for all stages of the electricity supply chain – generation, transmission, distribution, and retail. Consumers have no choice in suppliers, and the sector is usually regulated by the government.
- Single-buyer model and its variants. Under this model, multiple generators may operate, but all power must be sold to a single, central purchasing entity (usually a government-owned utility). This buyer then supplies electricity to consumers. Some variants allow limited competition or independent power producers (IPPs) with long-term contracts.
- Wholesale competition. Electricity generators compete to sell power in a wholesale market, often through auctions or bilateral contracts. Retailers or large consumers can choose from multiple suppliers, promoting efficiency and competitive pricing at the wholesale level.

- Retail competition. The most liberalised model, where end-users, including households and businesses, can choose their electricity provider. This model encourages innovation, better customer service, and price competition across the entire value chain.

Across ASEAN, the dominant electricity industry model remains the single-buyer or vertically integrated structure, with seven out of ten member states still operating under state-controlled utilities that handle generation, transmission, and distribution. This centralised model is most prevalent in Brunei, Cambodia, the Lao PDR, Myanmar, Indonesia, Thailand, and Viet Nam, where government-owned utilities act as both system operators and bulk power purchasers. This is shown in Table 2.1.

Private sector participation has increased, but primarily in power generation, particularly through IPPs. Countries such as Malaysia, Indonesia, the Philippines, and Viet Nam have actively encouraged IPP development to meet growing electricity demand and diversify investment sources. However, private participation remains limited in transmission and distribution, which are still largely state-owned and regulated sectors across the region.

In terms of wholesale market competition, only the Philippines and Singapore operate fully competitive wholesale electricity markets – the Wholesale Electricity Spot Market (WESM) and the National Electricity Market of Singapore (NEMS), respectively. Viet Nam has introduced the pilot Viet Nam Wholesale Electricity Market (VWEM) as part of its phased market reform, whilst other ASEAN members continue to rely on centrally dispatched single-buyer systems.

At the retail level, Singapore has achieved full retail competition through its Open Electricity Market, allowing consumers to choose their suppliers. The Philippines has implemented partial retail competition under the Retail Competition and Open Access regime for eligible consumers, and Malaysia has taken initial steps towards liberalisation through programmes such as the Green Electricity Tariff and the Cross-Border Electricity Sales scheme. In most other ASEAN countries, retail tariffs remain regulated, with little or no consumer choice.

Overall, the reform trajectory across ASEAN reflects a gradual, uneven transition from vertically integrated monopolies towards unbundled and more competitive market structures. Whilst the pace and depth of liberalisation vary significantly, the regional trend is towards greater transparency, private participation, and regulatory independence

Table 2.1. Industry Model, Utilities, Private Sector Participation, Wholesale Market, and Retail Competition

Country	Industry Model	Key State Utility	Private Sector Participation	Wholesale Market	Retail Competition
Brunei Darussalam	Vertically integrated public monopoly	Department of Electrical Services; Berakas Power Company	Very limited (mainly service contracts)	None (administered pricing)	None (single buyer)
Cambodia	Vertically integrated single buyer	Electricité du Cambodge	High (many independent power producers, or IPPs, in generation)	None (bilateral power purchase agreements, or PPAs)	None (state distribution monopoly)
Indonesia	Vertically integrated single buyer	Perusahaan Listrik Negara (PLN)	High in generation (IPPs; limited in transmission and distribution, or T&D)	None (PLN dispatch)	None (tariffs regulated by PLN)
Lao PDR	Vertically integrated single buyer	Electricité du Laos	Moderate (IPPs for export projects)	None (long-term PPAs)	None
Malaysia	Vertically integrated single buyer through Single Buyer Department of	Tenaga Nasional Berhad	High (IPPs supply ~50% of generation)	No spot market (central dispatch by Single Buyer)	Partial (only for large consumers) (Green Electricity Tariff, Cross Border Electricity Sales)

Country	Industry Model	Key State Utility	Private Sector Participation	Wholesale Market	Retail Competition
	Tenaga Nasional Berhad				
Myanmar	Vertically integrated state-owned system	Electric Power Generation Enterprise (EPGE) / Department of Power Transmission and System Control (DPTSC) / Electricity Supply Enterprise (ESE) / Yangon Electricity Supply Corporation (YESC)	Low (limited IPPs)	None	None
Philippines	Liberalised competitive market (unbundled)	National Grid Corp.; no single dominant generator	High (private generators and retailers)	Yes (Wholesale Electricity Spot Market)	Yes (Retail Competition and Open Access for eligible users)
Singapore	Fully liberalised wholesale and retail market	SP Group (transmission and distribution, or T&D, only)	High (private participation across all segments)	Yes (National Electricity Market of Singapore, or NEMS)	Yes (Open Electricity Market for all consumers)
Thailand	Enhanced	Electricity	Moderate	None	None (retail

Country	Industry Model	Key State Utility	Private Sector Participation	Wholesale Market	Retail Competition
	single-buyer	Generating Authority of Thailand (EGAT)	(independent power producers, or IPPs, small power producers, or SPPs, very small power producers, or VSPPs, in generation		monopolies) (Metropolitan Electricity Authority, or MEA, Provincial Electricity Authority, or PEA)
Viet Nam	Single buyer transitioning to competitive wholesale	Vietnam Electricity	Moderate (independent power producers, or IPPs, Build-Operate-Transfer Schemes in generation)	Pilot wholesale market (Vietnam Wholesale Electricity Market) since 2019	None (retail market under development)

Source: Authors' compilation from various references.

2.2. Electricity Market Governance

Within ASEAN's electricity sector, institutional roles and governance structures, as shown in Table 2.2, differ markedly across member states, yet several broad patterns can be observed.

First, formal market operators, entities responsible for managing electricity trading, scheduling, and settlement, exist only in Singapore, the Philippines, and Malaysia. In Singapore, the Energy Market Company operates the NEMS, a fully competitive wholesale market governed by transparent market rules. The Philippines established the Independent Electricity Market Operator of the Philippines to oversee the Wholesale Electricity Spot Market (WESM), ensuring neutrality and fair access to market participants. In Malaysia, whilst a full market has yet to emerge, a transitional market framework exists through the Single Buyer model operated by Tenaga Nasional Berhad (TNB). The Single Buyer manages generation scheduling, contracting, and settlement between IPPs and TNB, serving as a transitional platform towards more market-based reforms.

Second, system operation functions, such as real-time dispatch, grid control, and reliability management, are mostly embedded within incumbent state utilities. Entities like the Electricity Generating Authority of Thailand (EGAT) (Thailand), Perusahaan Listrik Negara (PLN) (Indonesia), Electricité du Laos (EDL) (Lao PDR), and Vietnam Electricity (EVN) (Viet Nam) perform both asset ownership and operational roles, reflecting limited unbundling of system operation from transmission ownership. Only a few countries, notably Singapore (through its independent Power System Operator (PSO) division under the Energy Market Authority (EMA)) and Malaysia (through TNB's Grid System Operator (GSO)), have introduced clearer institutional separation between system operation and market or policy functions.

Third, independent regulatory agencies, important for ensuring neutrality, investor confidence, and consumer protection, are present only in a subset of ASEAN members: Singapore, the Philippines, Malaysia, Thailand, and Cambodia. These regulators, the Electricity Market Authority of Singapore, Energy Regulatory Commission of the Philippines, Energy Commission of Malaysia, Energy Regulatory Commission of Thailand, and Electricity Authority of Cambodia, operate separately from government ministries, with statutory authority to set tariffs, issue licences, and enforce compliance. In contrast, in countries such as Indonesia, Myanmar, the Lao PDR, Viet Nam, and Brunei, regulation remains ministerial in nature, meaning that tariff-setting and sector oversight are directly managed by energy ministries, often resulting in less regulatory independence and transparency.

Finally, policy-making responsibilities across ASEAN consistently rest with national energy or trade and industry ministries, which define long-term strategies, approve infrastructure plans, and coordinate regional initiatives, such as the ASEAN Power

Grid (APG). For instance, the Ministry of Energy Transition and Water Transformation in Malaysia, the Ministry of Energy and Mineral Resources (MEMR) in Indonesia, and the Ministry of Industry and Trade (MOIT) in Viet Nam, play central roles in guiding national energy policy.

Overall, the governance landscape across ASEAN reflects a hybrid institutional model, with some members progressing towards clear functional separation amongst market, system, regulatory, and policy roles, whilst others continue to operate under vertically integrated and ministry-led frameworks.

Table 2.2. Market Operator, System Operator, Regulator, and Policy Making Bodies

Country	Market Operator	System Operator	Regulator	Policy Maker
Brunei Darussalam	None (vertically integrated monopoly)	Department of Electrical Services	Department of Electrical Services (acts as regulator)	Ministry of Energy
Cambodia	None (single-buyer) (Electricité du Cambodge)	Electricité du Cambodge	Electricity Authority of Cambodia	Ministry of Mines and Energy
Indonesia	None (PT Perusahaan Listrik Negara acts as single buyer)	PT Perusahaan Listrik Negara	Directorate General of Electricity under the Ministry of Energy and Mineral Resources	Ministry of Energy and Mineral Resources
Lao PDR	None (no formal market)	Electricité du Laos (EDL)/EDL-Transmission	Ministry of Energy and Mines (oversight)	Ministry of Energy and Mines
Malaysia	Single Buyer Sdn. Bhd. (TNB subsidiary)	Grid System Operator – TNB	Energy Commission	Ministry of Energy Transition and Water Transformation

Country	Market Operator	System Operator	Regulator	Policy Maker
Myanmar	None (administered by the Ministry of Electric Power, or MOEP)	Department of Power Transmission and System Control, or DPTSC (Transmission), Electric Power Generation Enterprise, or EPGE (Generation)	No independent regulator	MOEP
Philippines	Independent Electricity Market Operator of the Philippines	National Grid Corporation of the Philippines	Energy Regulatory Commission	Department of Energy
Singapore	Energy Market Company (EMC)	Power System Operator (division of Energy Market Authority (EMA))	EMA	Ministry of Trade and Industry
Thailand	None – single-buyer model	Electricity Generating Authority of Thailand	Energy Regulatory Commission	Ministry of Energy
Viet Nam	Electricity Regulatory Authority of Vietnam (ERAV) (market supervision under Ministry of Industry and Trade (MOIT))	National Load Dispatch Centre under Vietnam Electricity (EVN)	ERAV (MOIT)	MOIT

Source: Authors' compilation from various references.

2.3. Transmission Network Ownership, Third Party Access, and Pricing

In most member states, transmission and system operations are bundled within national utilities (Table 2.3). Open and regulated third-party access is available only in Singapore and the Philippines. Other countries permit grid access mainly via bilateral PPAs or pilot trading arrangements. On the other hand, ASEAN's transmission pricing and access frameworks are undergoing a gradual transition from bundled cost recovery mechanisms towards unbundled, transparent, and harmonised tariff structures (Table 2.4).

2.3.1. Ownership pattern

Across ASEAN, transmission infrastructure ownership remains overwhelmingly state-dominated, with nine out of ten member states maintaining state-owned transmission assets under vertically integrated or single-buyer models. National utilities such as EGAT (Thailand), PLN (Indonesia), EDL (Lao PDR), EVN (Viet Nam), and TNB (Malaysia) both own and operate the majority of transmission networks. The Philippines represents the sole exception, where transmission assets are publicly owned but operated under a private concession model by the National Grid Corporation of the Philippines (NGCP), regulated by the Energy Regulatory Commission (ERC). This arrangement demonstrates a hybrid structure that combines private operational efficiency with continued state asset ownership, representing a unique public–private partnership model in the region.

2.3.2. Operational structure

In most ASEAN countries, transmission and system operation remain bundled within the main state-owned utility, reflecting limited unbundling and corporatisation of grid operations. These utilities, such as EGAT, PLN, EDL, and EVN, typically manage both the physical grid and real-time system operations under a centralised dispatch framework. Exceptions include Singapore, where the PSO operates independently under the EMA, and Malaysia, which has introduced partial unbundling through TNB's Grid System Operator. However, in most ASEAN members, institutional separation between asset ownership and system operation remains limited, hindering the development of transparent grid access and competitive power markets.

2.3.3. Third-party access

Only Singapore and the Philippines have implemented fully regulated third-party access regimes, allowing licensed market participants to connect to and use the transmission network on non-discriminatory and tariff-regulated terms. Malaysia provides limited regulated access through its Single Buyer system, where IPPs and renewable energy exporters can obtain grid access via System Access Agreements

approved by the Energy Commission (Suruhanjaya Tenaga). In contrast, other ASEAN members, such as Thailand, Viet Nam, the Lao PDR, and Indonesia, permit restricted or negotiated access through bilateral PPAs or pilot frameworks, without a unified open-access regime. This restricts transparent price discovery and limits the scalability of regional power exchange.

2.3.4. Operational profile summary

Across the ASEAN region, transmission pricing remains predominantly regulated, with most member states applying cost-based or incentive-based methodologies to ensure revenue adequacy and network reliability. Countries such as Thailand, Indonesia, Viet Nam, and the Lao PDR use cost-of-service or revenue-cap regulation, whereby national utilities recover allowable operational and capital costs plus a regulated rate of return. This traditional model provides investment security but offers limited incentives for efficiency gains or cost minimisation.

By contrast, only Singapore and the Philippines have adopted performance- or incentive-based regulatory frameworks that link allowed revenues to measurable performance indicators such as reliability, service quality, and efficiency. In Singapore, the EMA regulates the Transmission Licensee (SP PowerGrid) under a price-cap and performance-based regime, incorporating Use-of-System charges that reflect locational and temporal cost differences. The Philippines applies a Performance-based Regulation methodology to the NGCP, administered by the ERC under the Electric Power Industry Reform Act. These performance-based models align with international best practices and encourage continuous improvement in operational efficiency and service delivery.

2.3.5 Tariff design

The 'user pays' principle is gaining traction in several ASEAN countries, particularly Malaysia, the Philippines, and Singapore, where transmission tariffs are becoming more unbundled and cost reflective. In these systems, network users, such as generators, large consumers, and retailers, pay explicit transmission-use charges that reflect their grid usage. For example, Malaysia's Incentive-based Regulation framework, implemented by the Energy Commission (ST), determines Transmission Use-of-System charges based on cost allocation and load contribution, with periodic reviews to reflect efficiency improvements.

In contrast, most other ASEAN members, such as Brunei Darussalam, Cambodia, Indonesia, Myanmar, and Viet Nam, continue to socialise transmission costs through bundled retail tariffs managed by vertically integrated utilities. In these markets, end-users pay a single electricity tariff that covers generation, transmission, and distribution costs, often influenced by government subsidies or social policy objectives.

Whilst this approach supports affordability, it limits price transparency and weakens investment signals for transmission development and regional interconnection.

Table 2.3. Transmission Ownership and Operation, Ownership Models, and Third-party Access

Country	Transmission Owner and Operator	Asset Ownership Model	Third-party Access (TPA)
Brunei Darussalam	Department of Electrical Services	100% state-owned and operated	No TPA (vertically integrated, closed system)
Cambodia	Electricité du Cambodge (EDC)	State-owned; some build–operate–transfer/private transmission lines for independent power producers (IPPs)	No formal TPA (EDC controls access)
Indonesia	PT Perusahaan Listrik Negara (PLN)	100% state-owned (state-owned enterprise (SOE) monopoly)	Limited (IPPs connect via PLN power purchase agreement (PPA) only; no regulated open access).
Lao PDR	Électricité du Laos (EDL)/EDL-Transmission Co. Ltd (joint venture with China Southern Power Grid)	Hybrid (majority state ownership with foreign joint venture in EDL-Transmission)	Limited/negotiated (access via EDL approval; no open access regulation)
Malaysia	Tenaga Nasional Berhad (TNB) (Grid System Operator)	Predominantly state-owned (listed SOE, government majority)	Partial/regulated access – available through System Access Agreements under the Single Buyer framework (e.g. CBES-RE exports)
Myanmar	Department of Power	100% state-owned	No TPA (single state operator)

Country	Transmission Owner and Operator	Asset Ownership Model	Third-party Access (TPA)
	Transmission and System Control (DPTSC, under MOEP)		
Philippines	National Grid Corporation of the Philippines	Private concession (privately operated under 25-year franchise; assets owned by government)	Full TPA (mandated under the Electric Power Industry Reform Act for all qualified generators and suppliers)
Singapore	SP Power Assets/SP PowerGrid (SP Group, Temasek-owned)	100% state-owned corporate group (government-owned holding company)	Full open access (all licensed participants have non-discriminatory access under EMA regulation)
Thailand	Electricity Generating Authority of Thailand	100% statutory SOE (ministry-run)	Limited (IPPs connect via EGAT PPAs; no general open access)
Viet Nam	National Power Transmission Corporation (EVN subsidiary)	100% state-owned (under EVN)	Limited/pilot access (grid access allowed under Vietnam Wholesale Electricity Market rules; full TPA not yet implemented)

Source: Authors' compilation from various references.

Table 2.4. Transmission Pricing

Country	Transmission Pricing Methodology	Tariff Design/'Who Pays'
Brunei Darussalam	Administered cost recovery (no formal methodology)	Transmission bundled in end-user retail tariffs; costs recovered via DES
Cambodia	Cost-plus/negotiated under EDC	Transmission costs embedded in PPAs and retail tariffs; EDC pays and recovers via tariffs
Indonesia	Regulated cost-based (MEMR) within PLN monopoly	Transmission costs socialised through PLN's revenue requirement; 'postage-stamp' tariff applied to all PLN customers
Lao PDR	Negotiated cost-plus (EDL internal)	Wheeling and transmission charges negotiated in bilateral PPAs (e.g. for export)
Malaysia	Incentive-based regulation (approved by ST)	Unbundled transmission tariff; 'user pays' principle (generators and large consumers pay via Grid Connection and System Access Agreements)
Myanmar	Administered tariff by MOEP	Transmission cost bundled in retail tariffs and PPAs
Philippines	Performance-based regulation under ERC	Unbundled Transmission Use-of-System charges; 'user pays' basis for generators, distributors, and large customers
Singapore	Regulated cost-reflective (EMA)	Locational Use-of-System charges; users pay based on voltage and connection point

Country	Transmission Pricing Methodology	Tariff Design/'Who Pays'
Thailand	Regulated cost-based (revenue cap) under ERC	Uniform postage-stamp tariff; EGAT recovers costs through bulk supply charges to MEA/PEA
Viet Nam	Regulated cost-based (ERAV)	Uniform national tariff; EVN/National Power Transmission Company recovers costs from generators and distributors

Source: Authors' compilation from various references.

2.4. Policies and Regulations Promoting Cross-Border Trade

Table 2.5 presents the policies and regulations that facilitate cross-border electricity trade across ASEAN Member States (AMS). The regional trends are summarised as follows:

- Legal readiness. Almost all ASEAN member states now have enabling legal or regulatory provisions that permit the import and export of electricity, though the scope, clarity, and degree of implementation vary significantly. Whilst some frameworks explicitly define procedures for licensing and cross-border power exchange, others remain broad policy statements that require further regulatory detailing and institutional coordination.
- Advanced frameworks. Singapore, Malaysia, the Lao PDR, and Thailand demonstrate the most mature and operational frameworks for cross-border electricity trade. These countries have established explicit regulatory pathways, designated competent authorities, and implemented active interconnection projects such as the Lao PDR–Thailand–Malaysia–Singapore Power Integration Project (LTMS-PIP) and Malaysia's Cross-Border Electricity Sales Renewable Energy (CBES-RE) scheme. Their experience provides a practical foundation for advancing regional multilateral power trade within ASEAN.
- Private participation. Several countries, notably Cambodia, the Philippines, Viet Nam, and Malaysia, have introduced public–private partnership and IPP-friendly laws that facilitate private and foreign investment in generation and grid infrastructure. These frameworks enhance regional investment attractiveness and support financing for cross-border interconnection projects, consistent with the ASEAN goal of mobilising private capital for energy connectivity.

- Integration alignment. Most ASEAN electricity laws and policies now explicitly reference or align with the ASEAN Power Grid (APG) objectives, highlighting a shared commitment to regional energy cooperation and power system integration. These alignments demonstrate growing policy convergence, where national regulations are progressively harmonised with ASEAN's broader vision of a connected, secure, and sustainable regional electricity market.

Table 2.5. Policies and Regulations Facilitating Cross-Border Trade

ASEAN Member State	Policies/Regulations that Facilitate Cross-Border Trade	Information on the Respective Regulations
Brunei Darussalam	Code of Practice (COP) for Large-scale Solar (LSS) PV Connection to Distribution Grid	Permits large-scale solar PV developers to connect to the national grid following technical assessment and compliance with the National Grid Code and Distribution Service Provider.
	Electricity Order (2017)	Authorises the authority, with ministerial approval, to grant licences for generation, transmission, and distribution (potentially enabling private participation and future cross-border supply).
Cambodia	Law on Concessions (2007)	Enables public–private partnership models (Build-Operate-Transfer, Build-Own-Operate, Build-Transfer-Operate, etc.) for infrastructure, including power generation, transmission, and distribution; allows foreign participation.
	Electricity Law (2001, amended 2015)	Mandates the Ministry of Mines and Energy to oversee electricity planning, including agreements for export and import of power.
Indonesia	Government Regulation No. 42 (2012) on Cross-Border Electricity Trade	Allows electricity exports/imports if domestic needs are met, electricity is unsubsidised, and reliability is not affected; trade must be reported to the Ministry of Energy and Mineral Resources every six months.

ASEAN Member State	Policies/Regulations that Facilitate Cross-Border Trade	Information on the Respective Regulations
	Policy on Renewable Energy Export Restriction	Restricts renewable energy electricity exports to ensure self-sufficiency and national renewable energy targets.
Lao PDR	Law on Electricity (2017)	Encourages regional cooperation in electricity activities (generation, transmission, distribution, export-import); provides concession framework for grid and power projects; forms legal basis for Lao PDR's exporter role under LTMS-PIP.
Malaysia	Electricity Supply Act (1990)	Section 9 requires licensing for cross-border generation, transmission, and grid facilities, forming the legal foundation for interconnection projects.
	Policy on Renewable Energy Export Ban (lifted 2021)	Lifting of the renewable energy export ban allows regulated renewable energy exports under Cross-Border Electricity Sales (CBES) and CBES-RE schemes.
Myanmar	Electricity Rules (2016)	Articles 62–63 authorise the Ministry of Electrical Power to issue permits for electricity exports/imports after assessing system reliability, costs, and security impacts.
Philippines	Republic Act No. 9136 (Electric Power Industry Reform Act, 2001)	Establishes a liberalised electricity market through the Wholesale Electricity Spot Market, enabling bilateral trading and future cross-border participation.
	Executive Order No. 30 (2017)	Streamlines investment coordination for energy projects of 'national significance', including interconnections.
	DOE Circular DC2022-11-0034 (Amendment)	Removes foreign equity limits in renewable energy development, allowing up to 100% foreign

ASEAN Member State	Policies/Regulations that Facilitate Cross-Border Trade	Information on the Respective Regulations
		ownership to support export-oriented renewable energy projects.
Singapore	Electricity Act (2001)	Authorises the Energy Market Authority to regulate electricity import/export, licensing, and installations.
	Electricity Import Policy & RFP2 (2023–2024)	Implements competitive tendering for importers, targeting 1.2 GW of imports by 2027 and 4 GW by 2035 under Singapore's regional import framework.
Thailand	EGAT Act, B.E. 2511 (1968)	Grants EGAT authority to generate, acquire, transmit, and trade electricity with neighbouring countries, and to invest in or collaborate with domestic and international entities.
Viet Nam	Electricity Law (2004, amended 2012)	Article 28 authorises cross-border power trade upon approval by competent state bodies and inclusion in operators' licences.
	Public–Private Partnership Law (2020)	Enables private and foreign investment in power plants and grid infrastructure, including cross-border electricity projects.

Source: ERIA (2024), ERIA Research Project Report FY2024, No. 23.

2.5. Regional Power Interconnection Status

A summary of the regional power interconnection status is shown in Table 2.6. As of 2024, eight of the ten AMS were physically interconnected through at least one cross-border transmission line. The Philippines and Brunei remain the only non-interconnected system, primarily due to the archipelagic geography, though several high-voltage direct current (HVDC) submarine interconnection projects, linking to Borneo (Malaysia) and Indonesia's Sulawesi system, are under conceptual or feasibility assessment.

Within the regional network, Thailand, Malaysia, and the Lao PDR have emerged as key transmission hubs, each maintaining interconnections with three or more

neighbouring countries. Thailand functions as the central node in the Greater Mekong Subregion, facilitating Lao PDR power exports to both Malaysia and Cambodia. Malaysia plays a dual role, acting as a transit and recipient country for electricity flows under the LTMS-PIP, whilst also advancing cross-border renewable trade through the CBES-RE mechanism with Singapore. The Lao PDR, meanwhile, continues to strengthen its position as a regional exporter of hydropower, with multiple interconnections to Thailand, Viet Nam, and Cambodia, and transmission extensions planned towards Malaysia and Singapore.

Of the 18 priority APG interconnection projects, 9 are operational, 5 are under construction, and 4 are at the feasibility or planning stage. The technical composition of these links remains dominated by grid-to-grid interconnections using high-voltage alternating current (HVAC) systems, which are cost-effective and well-suited for short- to medium-distance transmission. However, HVDC technology is increasingly being adopted for long-distance and submarine connections, particularly for inter-island and renewable energy export corridors, such as the Malaysia–Indonesia (Sumatra–Peninsular Malaysia) and Singapore–Cambodia links. These evolving interconnection types signify a gradual shift from bilateral, utility-based exchanges towards a regionally interoperable transmission network, forming the physical foundation for future multilateral power trade across ASEAN.

Table 2.6. Regional Power Interconnection Status

Country	Interconnection Partners	Number of Existing Links	Type of Interconnection	Status Progress (2024)	Key Projects
Brunei Darussalam	Malaysia (Sarawak)	0 (planned)	Internal/ sub-regional	Feasibility stage	Brunei–Lawas 275 kV link under Brunei Darussalam–Indonesia–Malaysia–Philippines East ASEAN Growth Area (BIMP-EAGA) initiative; aims to integrate northern Borneo grids.
Cambodia	Thailand, Viet Nam	2	Grid-to-grid	Operational/ expanding	115 kV (TH-KH) and 230 kV (VN-KH) lines operational; new interconnections planned under ASEAN Plan of Action for Energy Cooperation (APAEC).
Indonesia	Malaysia (Sarawak, Peninsular), Singapore	2 (1 operational, 1 planned)	Inter-island/grid-to-grid	Operational (Sarawak-Kalimantan); feasibility stage (Sumatra-Peninsular, Batam-SG)	Sarawak–West Kalimantan 275 kV link operational since 2016; HVDC Sumatra–Peninsular and Batam–Singapore links under feasibility.
Lao PDR	Thailand, Viet Nam, Cambodia, Malaysia,	4+	Grid-to-grid/multilateral	Operational/ expanding	Major power exporter; part of LTMS-PIP; new 500 kV lines to Viet Nam

Country	Interconnection Partners	Number of Existing Links	Type of Interconnection	Status Progress (2024)	Key Projects
	Singapore		corridor		under construction.
Malaysia	Thailand, Singapore, Indonesia, Brunei Darussalam (future)	3+	Grid-to-grid/sub-regional	Operational/ expanding	Linked to Thailand and Singapore (CBES-RE); Sarawak–Kalimantan active; new Sumatra–Peninsular link planned.
Myanmar	Thailand, China (non-ASEAN)	1+	Border interconnection	Planned/early stage	Mae Sot–Myawaddy 230 kV link in study; long-term integration with the Greater Mekong Subregion grid.
Philippines	None (island system)	0	Internal (island grid development)	Planned/ conceptual	Exploring interconnections with Borneo (Malaysia) and via HVDC under long-term APG roadmap.
Singapore	Malaysia, Lao PDR (via LTMS-PIP), Indonesia, Cambodia (future)	2+	Grid-to-grid/multilateral corridor	Operational/ expanding	Receives up to 100 MW from LTMS-PIP; CBES-RE enabling regulated RE imports; future HVDC links planned.
Thailand	Lao PDR, Cambodia, Malaysia, Myanmar	4	Grid-to-grid/border interconnections	Operational/ expanding	Central hub for regional trade; key transit country in LTMS-PIP and APG corridors.
Viet Nam	Lao PDR,	2+	Grid-to-grid	Operational/expa	230–500 kV Lao PDR–Viet Nam and

Country	Interconnection Partners	Number of Existing Links	Type of Interconnection	Status Progress (2024)	Key Projects
	Cambodia, China (non-ASEAN)			nsion planned	Cambodia–Viet Nam lines support bilateral exchange; capacity upgrades ongoing.

Source: Authors' compilation from various references.

2.6. Grid Code Interconnector Requirements

The grid code interconnector requirements for each AMS are shown in Table 2.7. Out of the 10 AMS, Brunei, the Lao PDR, Malaysia's three systems (Peninsular, Sabah, and Sarawak), and Singapore, have incorporated explicit interconnector requirements within their respective grid codes, primarily covering HVAC systems. These provisions typically define technical parameters such as frequency and voltage operating ranges, spinning reserve obligations, automatic generation control (AGC) tolerances, N-1 contingency criteria, and metering accuracy standards, which are essential for stable cross-border operations.

Amongst these, Singapore stands out as the only ASEAN country with formal HVDC interconnection standards. Its grid code specifies frequency and voltage limits, power and frequency control, reactive power flow management, and minimum short-circuit capacity, positioning it as the most technically advanced and HVDC-ready system in the region. Malaysia also demonstrates high readiness across its three independently managed grids, Peninsular Malaysia, Sabah, and Sarawak, each of which has detailed provisions for interconnector operation, system protection, and real-time coordination, reflecting its growing role as both a regional importer and exporter of power.

In contrast, Cambodia, Myanmar, Viet Nam, and to some extent Lao PDR, remain at an early stage of regulatory and technical harmonisation. Whilst these systems are physically interconnected, they lack comprehensive HVDC provisions and continue to rely largely on utility-level coordination or bilateral PPAs to manage cross-border exchanges.

Overall, ASEAN's interconnection readiness ranges from 'low', where no formal grid code coverage exists, to 'very high', where HVDC-compatible and regionally harmonised frameworks are already established. This variation underscores the need for greater regional alignment of technical standards, particularly to enable multilateral power trade and seamless grid integration under the APG initiative.

Table 2.7. Grid Code Interconnector Requirements

Country	Interconnector Requirements Specified in Grid Code	Coverage Type	Key Technical Provisions	HVDC Requirements	Readiness Rating	Remarks
Brunei Darussalam	Yes	HVAC	Frequency and voltage excursion limits; spinning reserve; protection; reactive power compensation; metering accuracy	No	Moderate	Well-defined HVAC standards; suitable for future Borneo subregional links.
Cambodia	No	—	—	No	Low	No defined interconnector provisions in the national grid code.
Indonesia	No (partial)	Intra-country only	Intra-island interconnection rules (Sumatra, Kalimantan, etc.); limited reference to external systems	No	Low–moderate	Domestic framework exists but lacks clear inter-country provisions.
Lao PDR	Yes	HVAC	Frequency and voltage limits (normal and N-1); spinning reserve; emergency support; data exchange	No	Moderate–high	Foundational HVAC standards in place; strong exporter; no HVDC yet.

Country	Interconnector Requirements Specified in Grid Code	Coverage Type	Key Technical Provisions	HVDC Requirements	Readiness Rating	Remarks
Malaysia – Peninsular	Yes	HVAC	Frequency and voltage excursions; spinning reserve; ACE control; emergency operation; metering	No	High	Comprehensive HVAC code; supports LTMS-PIP and CBES-RE participation.
Malaysia – Sabah	Yes	HVAC	Frequency and voltage ranges; spinning reserve (AC/DC); AGC control; metering	No	High	Detailed technical coverage; suitable for interconnection with Kalimantan.
Malaysia – Sarawak	Yes	HVAC	Frequency and voltage limits; N-1 contingency; Under-Frequency Load Shedding; grid restoration; metering	No	High	Robust grid code; supports Sarawak–West Kalimantan interconnection.
Myanmar	No	—	—	No	Low	No HVAC or HVDC interconnector requirements specified.
Philippines	No	—	—	No	Low	No cross-border provisions; islanded grid with planned HVDC feasibility studies.

Country	Interconnector Requirements Specified in Grid Code	Coverage Type	Key Technical Provisions	HVDC Requirements	Readiness Rating	Remarks
Singapore	Yes	HVAC and HVDC	Frequency and voltage limits; N-1 contingency; AGC; telecoms; reactive power flow; short-circuit level	Yes	Very high	Only AMS with HVDC standards; fully open-access grid for regional trading.
Thailand	No	—	—	No	Low–moderate	No grid code section on interconnectors; relies on bilateral PPA coordination.
Viet Nam	No	—	—	No	Low	No explicit interconnector standards; bilateral trade managed via PPAs.

Source: ADB (2022).

2.7. Renewable Energy Policies

2.7.1. Renewable Energy Policies and Cross-Border Trade

ASEAN's renewable energy landscape reflects a rising ambition and growing alignment across the region. Nearly all AMS now have clear RE targets (Table 2.8). Regional coordination under the ASEAN Plan of Action for Energy Cooperation (APAEC) Phase II 2021–2025 and the 2030 Action Plan, which aims for 45% of installed capacity from renewables, has brought national policies into closer alignment.

However, ASEAN's transition has two main trends. Leading countries such as Viet Nam, Malaysia, the Philippines, Thailand, and Indonesia are aggressively expanding large-scale solar and wind power, supported by clearer regulatory frameworks and investment incentives. Meanwhile, Cambodia, the Lao PDR, Brunei, and Myanmar continue to rely heavily on hydropower or are developing smaller, export-oriented renewable markets. Singapore stands out as a clean energy hub, leveraging electricity imports to achieve its decarbonisation goals.

The region is also undergoing a shift from hydropower to solar and wind as the dominant sources of new renewable capacity. Whilst early growth was driven largely by hydro resources in countries like the Lao PDR, Myanmar, and Cambodia, the next wave centres on solar in Malaysia, Indonesia, Viet Nam, and Thailand, with rising wind potential, such as Viet Nam's offshore projects and the Lao PDR's Monsoon Wind farm, adding further diversity.

The emergence of enabling trade frameworks marks a shift in ASEAN's renewable energy transition from national projects to a truly interconnected regional market. Several countries have now established formal policies to govern the cross-border exchange of clean electricity. Malaysia's CBES framework (2024) provides clear legal grounds for renewable power exports to neighbouring countries, whilst Singapore's EMA Import Framework (2022) sets a structured licensing system for up to 6 GW of low-carbon electricity imports by 2035. Complementing these, Indonesia's bilateral MoUs with Singapore open pathways for solar and battery projects in the Batam and Riau Islands to export clean power across the Strait, positioning Indonesia as a future renewable exporter. Meanwhile, the Lao PDR and Viet Nam have incorporated cross-border PPAs into their national electricity laws, institutionalising electricity trade as a core component of their energy strategies.

Table 2.8. Renewable Energy Policies, Targets, and Cross-border Initiatives

Country	Main Renewable Energy Policy/Plan	Renewable Energy Targets	Cross-Border Initiatives	Policies Facilitating Cross-Border Power Trade
Brunei Darussalam	Brunei National Climate Change Policy; Renewable Energy Roadmap	≥30% RE in generation by 2035	Planned Sarawak–Brunei 275 kV link; part of BIMP-PIP	Working through BIMP-PIP MoUs and HAPUA grid-code alignment.
Cambodia	RE Development Strategy; Power Development Plan 2040	≈70% RE share by 2030	Member of APG; approved to export 1 GW to Singapore	EAC licensing framework for export PPAs; independent power producers allowed to trade regionally.
Indonesia	National Energy Policy (KEN); RUPTL 2025–2034	23% RE in primary energy by 2025 → ≈34% by 2030	Solar export projects to Singapore (Batam/Riau); member of BIMP-PIP	Cross-Border Electricity Export Regulation (MEMR Regulation No. 2/2024): authorises export of renewable electricity if domestic supply is adequate.
Lao PDR	RE Development Strategy; Green Growth Strategy	>80% RE generation (mainly hydro); export hub model	LTMS-PIP (100 MW); Monsoon Wind 600 MW export to Viet Nam	Electricity Law (2021) + bilateral PPAs authorised for exports under ADB regional framework.
Malaysia	National	31% RE	Interconnections	Energy

Country	Main Renewable Energy Policy/Plan	Renewable Energy Targets	Cross-Border Initiatives	Policies Facilitating Cross-Border Power Trade
	Energy Transition Roadmap; MyRER	capacity by 2025, 40% by 2035, 70% by 2050	with Thailand, Singapore, Sarawak, Brunei; participant in VMS Clean Power Exchange (2025)	Commission Guide for Cross-border Electricity Sales (CBES, 2024) – explicit RE Export Scheme for private developers; basis for VMS trade.
Myanmar	Draft Renewable Energy Policy; National Electrification Plan	≈39% RE generation by 2030 (hydro-dominant)	Member of APG; prospective links to Thailand and China	Electric Power Law (2014) permits exports; HAPUA technical alignment.
Philippines	Philippine Energy Plan 2023–2050; RE Act 2008 (Amended 2022)	35% RE by 2030; 50% by 2040	BIMP-PIP feasibility; study on Philippines–Sabah link	Amended RE Act (2022) allows RE exports and 100% foreign equity in RE projects.
Singapore	Green Plan 2030; EMA Low-carbon Energy Import Framework	≥2 GW solar by 2030; 6 GW imports by 2035	LTMS-PIP imports (100 MW); VMS Renewable Electricity Trade Agreement (2025) with Viet Nam and Malaysia	EMA Import Framework (2022) sets licensing rules for cross-border imports; supports ASEAN RECs standardisation.
Thailand	Draft AEDP 2024–2037; Power Development Plan	51% RE power mix by 2037 (37% of Total Final Energy Consumption)	APG hub connecting Lao PDR, Cambodia, Malaysia, Myanmar; LTMS-	Enhanced Single Buyer Model and ERC rules enable wheeling and regional power

Country	Main Renewable Energy Policy/Plan	Renewable Energy Targets	Cross-Border Initiatives	Policies Facilitating Cross-Border Power Trade
			PIP transit country	trading.
Viet Nam	Power Development Plan VIII (2023–2030)	30%–36% RE by 2030 (≈47% incl. hydro)	Imports from Lao PDR; VMS Clean Power Exchange (2025) for RE exports to Singapore via Malaysia	Electricity Law (2023 draft) permits cross-border trade; MoUs with Malaysia and Singapore (2025) define VMS renewable electricity exchange framework.

Source: Authors' compilation from various references.

2.7.2 Renewable energy certificates

ASEAN's renewable energy certificate (REC) landscape has become increasingly diverse and interconnected (Table 2.9). Domestic registries now operate in the Philippines (REM), Indonesia (PLN), and Malaysia (MyRECs), whilst international systems such as I-REC and TIGR remain dominant in Singapore, Viet Nam, and Thailand. To promote regional cohesion, the ASEAN Centre for Energy (ACE) is advancing the RECAP platform, which aims to harmonise REC issuance and recognition across borders by 2026–2027.

From a policy perspective, only the Philippines enforces a compliance-based REC system through its Renewable Portfolio Standards linked to the Renewable Energy Market (REM). Almost all other ASEAN countries maintain voluntary REC markets, primarily fuelled by corporate decarbonisation commitments, sustainability reporting, and RE100 initiatives.

Malaysia and Singapore have emerged as regional leaders in corporate REC activity. Malaysia's MyRECs platform and Sarawak Energy Exchange provide domestic REC liquidity, whilst Singapore functions as the region's demand hub, supported by strong corporate participation and import-based renewable energy strategies. Both countries are actively working with ACE to align REC standards and integrate certification into regional electricity trade mechanisms such as the VMS and LTMS power corridors.

Looking ahead to 2025–2030, the ASEAN RECAP is expected to serve as the regional REC clearinghouse, linking domestic registries and international systems (like I-REC) to enable

cross-border REC trading, notably between the Lao PDR–Singapore and Viet Nam–Malaysia–Singapore. Over time, several ASEAN countries, including Malaysia, Viet Nam, and Thailand, are likely to adopt hybrid REC systems that blend voluntary corporate demand with compliance obligations aligned to national renewable energy targets.

Table 2.9. Renewable Energy Certificates: Framework, Market Status, and Policies

Country	REC/EAC Framework	Registry/ Certification System	Market Status	Voluntary Vs. Compliance	Recent Developments (2024–2025)
Brunei Darussalam	Participating in ACE's Renewable Energy Certificate and Attribute Platform (RECAP) pilot for BIMP-EAGA region	*Regional*. RECAP (under ACE and BIMP-EAGA); no national registry	Nascent; preparatory phase	Voluntary	2024: Joined RECAP pilot to explore regional REC exchange for BIMP sub-region.
Cambodia	No domestic REC system; involved in ASEAN feasibility work for REC verification for solar exports	*Regional*. RECAP feasibility studies	Conceptual; early coordination stage	Voluntary	2024: ACE assistance on REC accounting for Cambodia–Singapore solar export approvals.
Indonesia	PLN REC Program launched in 2020 for certified renewable generation	*Domestic*. PLN REC Registry (state-utility managed); linked to I-REC standards	Active; corporate-driven REC sales	Voluntary	>300 GWh of PLN RECs sold (2024). Integration with I-REC and BIMP-PIP projects under review.
Lao PDR	No standalone REC registry; exploring linkage through cross-border power trade.	*Regional*. ASEAN RECAP/potential use of I-REC	Early stage	Voluntary	2025: ACE study proposes REC issuance for hydro exports under LTMS-PIP.
Malaysia	Comprehensive corporate REC ecosystem: TNB Green Energy Tariff, MyRECs digital platform, I-REC Malaysia, Sarawak Green Energy Exchange	*Domestic* + *International*. MyRECs (local), I-REC, Sarawak Energy REC Exchange	Most mature corporate REC market in ASEAN	Voluntary (corporate)	2024–2025: launch of MyGreen+, MyRECs marketplace; Sarawak Energy offering export-certified RECs. Govt. assessing hybrid compliance model.

Country	REC/EAC Framework	Registry/ Certification System	Market Status	Voluntary Vs. Compliance	Recent Developments (2024–2025)
Myanmar	No formal REC market; limited technical groundwork	*Regional*. ACE RECAP participation (future phase)	Conceptual	Voluntary	2025: Identified for ACE capacity-building on REC registry design.
Philippines	Renewable Portfolio Standards (RPS) linked with Renewable Energy Market (REM) for certificate trading	*Domestic*. DOE REM Registry, administered by the Philippine Electricity Market Corporation	Operational; compliance market	Compliance-based	RPS requires 2.52% RE share (2023); REM REC trading expanded nationwide.
Singapore	Singapore Standard SS 673 (2021) governs REC practice; uses multiple international registries	*International*. I-REC, TIGR (APX), and EnergyTag-aligned systems	Mature; widely used by corporates	Voluntary	2025: EMA integrating REC tracking into import-licensing; supports ASEAN cross-border REC interoperability.
Thailand	REC issuance via EGAT Green Tariff pilot and APEC EAC programme	*International*. I-REC Thailand (through EGAT partnership)	Emerging; industrial focus	Voluntary	2024: Pilot REC sale for industrial parks; MoE exploring REC use in future carbon pricing policy.
Viet Nam	I-REC adoption widespread; domestic registry under development for DPPA projects	*International* + *Developing Domestic*. I-REC; draft MOIT REC Registry (2025)	Developing market	Voluntary, moving towards partial compliance	2025: Draft rule establishes national REC registry linked to Direct PPA mechanism; I-REC transactions > 2 TWh.

Sources: ASEAN Centre for Energy (2025a); APEC Energy Working Group (2024).

Chapter 3
ASEAN Power Market Trading Mechanisms

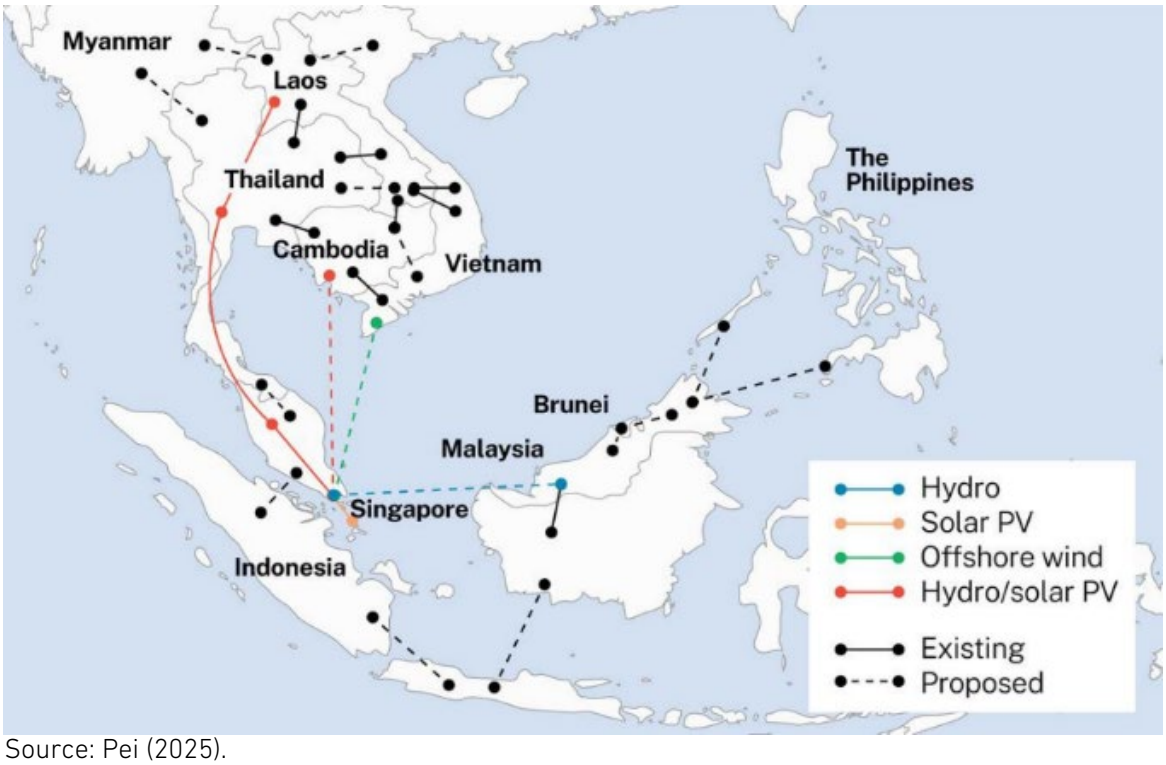
This section reviews the current landscape of power interconnections across ASEAN and analyses the cross-border electricity trading arrangements presently in operation. At this stage, all regional power transactions are conducted under long-term PPAs. A closer examination shows that these long-term bilateral exchanges are facilitated through three main mechanisms: direct bilateral power transfers between neighbouring systems, linked bilateral trades that transit through third countries, and domestic auction-based procurement schemes for cross-border supply.

The findings confirm that no short-term electricity trading mechanisms are yet in place in the region, highlighting a critical gap in ASEAN's market-integration trajectory. Building on this assessment, the section further explores the drivers supporting a shift towards shorter-term trading whilst also identifying the institutional, regulatory, and technical barriers currently constraining progress. In addition, the review addresses prevailing stakeholder perceptions and misconceptions that may impede reform efforts. Together, these insights establish the baseline context and motivation for introducing short-term electricity trading under the Layered Market Approach.

3.1. ASEAN Power Grid Interconnections and Trading

The ASEAN Power Grid (APG) interconnections are shown in Figure 3.1 and a summary of the information, status, and trading arrangement are shown Table 3.1.

Figure 3.1. ASEAN Power Grid Interconnections



Source: Pei (2025).

Table 3.1. ASEAN Power Grid Interconnections and Trading Arrangements

ASEAN Country	Participation In Cross-Border Trade	Main Trade Partner(S)	Interconnections (Existing and Planned)	Indicative Capacity (MW)	Arrangement Type	Key Features/ Status
Brunei Darussalam	Potential importer/exporter	Malaysia (Sarawak, Sabah)	Sarawak–Brunei 275 kV HVAC (planned); Brunei–Sabah link (concept)	30–50	Bilateral/long-term PPA (planned)	Feasibility under BIMP-EAGA; part of Borneo Grid renewable integration.
Cambodia	Importer/emerging exporter	Thailand, Viet Nam, Lao PDR, Singapore (planned)	Thailand–Cambodia 115 kV AC; Viet Nam–Cambodia 220 kV; Lao PDR–Cambodia 230 kV (planned); Cambodia → Singapore HVDC renewable export (planned)	200–500	Bilateral/long-term PPA (imports); bilateral/short-term pilot export (RE)	2025 MoU with Singapore for solar + hydro exports (phase 1,100 MW by 2028).
Indonesia	Importer and exporter (Borneo and Riau)	Malaysia (Sarawak, Sabah), Singapore	Sarawak–West Kalimantan 275 kV (230 MW); Sarawak–North Kalimantan (planned); Sabah–North Kalimantan (planned); Sumatra–Peninsular Malaysia HVDC (planned); Riau–Singapore 1 GW subsea link (2025 JV)	230–3,000 + 1,000	Bilateral/long-term PPAs (Sarawak–PLN, SG RE)	Active since 2015; Rangsang Island 1 GW solar-plus-battery export to Singapore by 2029 (TotalEnergies + RGE JV).
Lao PDR	Major exporter	Thailand, Viet Nam, Cambodia, Singapore	Lao PDR–Thailand 230/500 kV (> 4 GW); Lao PDR–Viet Nam 220/500 kV (5–8 GW expanding); Lao PDR–Cambodia 115 kV;	> 4,000 existing +5,000–8,000	Bilateral/long-term PPAs (Thailand, Viet Nam, Cambodia);	>20 PPAs; Monsoon Wind exports to Viet Nam 2026 under

ASEAN Country	Participation In Cross-Border Trade	Main Trade Partner(S)	Interconnections (Existing and Planned)	Indicative Capacity (MW)	Arrangement Type	Key Features/ Status
			Monsoon Wind ⟶ Viet Nam (600 MW); LTMS-PIP (Lao PDR–TH–MY–SG 100–200 MW)	planned	multilateral/short-term pilot (LTMS-PIP)	25-year PPA; LTMS-PIP Phase 2 expanding to 200 MW.
Malaysia	Importer/exporter/ transit hub	Thailand, Singapore, Indonesia, Brunei Darussalam	Thailand–Malaysia HVDC 300 MW; Sarawak–West Kalimantan 275 kV 230 MW; Malaysia–Singapore (LTMS-PIP 200 MW); Cross-Border Electricity Sales (CBES) RE Scheme to Singapore (2024–); Sarawak–Brunei 50 MW (planned); Sarawak–Sabah 500 kV 600 MW (under construction); Sumatra–Malaysia HVDC (~3 000 MW study); Sarawak–Singapore 1 GW subsea (planned); Viet Nam–Malaysia RE trade (planned)	200–3,000 + 1,000 (planned Sarawak–SG)	Bilateral/long-term PPAs (Thailand, Indonesia); bilateral / commercial PPAs (CBES exports to SG); multilateral/short-term pilot (LTMS-PIP)	Under CBES Scheme (launched 2024), Malaysia licences RE exports to Singapore (Phase 1 1 GW applications approved 2025); Sarawak–SG HVDC study (~2030).
Myanmar	Potential exporter	Thailand, China	Rural 230 kV tie to Thailand; Tasang–Mae Moh 500 kV (planned); Myanmar–China–Thailand corridor (concept)	~1,500 (planned)	Bilateral/long-term PPA (planned)	Hydropower export corridor under AIMS III feasibility; limited current exchange.
Philippines	Not yet connected	Malaysia (Sabah), Indonesia	Sabah–Palawan subsea HVDC (300–500 MW planned); Mindanao–Sulawesi (100–200 MW	300–500 + 100–200	Bilateral/long-term PPA (planned)	Under BIMP-EAGA study; first international

ASEAN Country	Participation In Cross-Border Trade	Main Trade Partner(S)	Interconnections (Existing and Planned)	Indicative Capacity (MW)	Arrangement Type	Key Features/ Status
		(Sulawesi)	concept)			renewable links target early 2030s.
Singapore	Importer/multilateral participant	Lao PDR, Malaysia, Indonesia, Viet Nam, Cambodia, Australia	LTMS-PIP (Lao PDR→Thailand→Malaysia→Singapore 100–200 MW); direct imports from Indonesia (1 GW 2029), Malaysia (CBES Scheme), Australia; Viet Nam–Singapore RE trade (planned via Malaysia); Cambodia–Singapore RE (planned); Sarawak–Singapore 1 GW subsea (planned)	100–200 (existing) + >3,000 (planned)	Multilateral/short-term pilot (LTMS-PIP); bilateral/long-term commercial PPAs (Indonesia, Viet Nam, Cambodia, Malaysia CBES, Sarawak)	6 GW import target by 2035; mix of LTMS-PIP trades and CBES-licensed bilateral renewable imports from Malaysia, Viet Nam, Indonesia, and Sarawak.
Thailand	Importer/exporter /transit hub	Lao PDR, Malaysia, Cambodia, Myanmar, Singapore (transit)	Lao PDR–Thailand 500 kV > 4 GW; Thailand–Malaysia HVDC 300 MW; Thailand–Cambodia 115 kV; Thailand–Myanmar 500 kV (planned); LTMS-PIP transit role	>4,000 (existing) + 1,500 (planned)	Bilateral/long-term PPAs (Lao PDR, Malaysia, Cambodia); multilateral/transit (pilot LTMS-PIP)	Regional hub; imports Lao PDR hydro under 25-year PPAs; transits power to Singapore via LTMS-PIP.
Viet Nam	Importer/exporter	Lao PDR, Cambodia, Malaysia, Singapore	Viet Nam–Cambodia 220 kV (export 200 MW); Lao PDR–Viet Nam 220/500 kV (import 5–8 GW by 2030); Lao PDR–Viet Nam 500 kV (under construction); Viet	200 (existing) + 2,000–8,000 (planned)	Bilateral/long-term PPAs (Lao PDR, Cambodia); bilateral/commercial PPAs (planned	2025 MoUs for 25-year offshore wind & solar exports to Malaysia and

ASEAN Country	Participation In Cross-Border Trade	Main Trade Partner(S)	Interconnections (Existing and Planned)	Indicative Capacity (MW)	Arrangement Type	Key Features/ Status
			Nam–Malaysia and Viet Nam–Singapore renewable exports (planned)		Malaysia, Singapore	Singapore via HVDC corridor under study.

Source: Authors' compilation from various references.

Despite the slow progress in the full integration of the APG, it has evolved into a dynamic framework of interconnected national systems facilitating both bilateral and multilateral power exchanges across Southeast Asia. Cross-border participation is now widespread, with the Lao PDR, Sarawak (Malaysia), and Viet Nam emerging as the region's principal exporters of renewable energy, primarily hydropower, wind, and solar. Thailand and Malaysia serve as key transit and balancing hubs, whilst Singapore and Cambodia are developing into major importers of clean electricity. Meanwhile, Indonesia, Brunei, Myanmar, and the Philippines are at varying stages of integrating into regional trade, driven by new interconnection studies and renewable projects.

In terms of interconnections, ASEAN now operates 7.5 GW (generation-to-grid interconnector capacity) and 2.8 GW (grid-to-grid interconnector capacity) of existing cross-border capacity, mainly through bilateral AC and HVDC links such as Lao PDR–Thailand, Thailand–Malaysia, and Sarawak–West Kalimantan (ACE, 2025d). The only operational multilateral exchange, the LTMS-PIP, currently trades 100–200 MW and demonstrates the technical and commercial feasibility of cross-border power trade through multiple networks. A further 20 GW of interconnections are planned or under construction, including the Lao PDR–Viet Nam 500 kV corridor, Borneo Grid links (Sarawak–Sabah–Brunei–Kalimantan), Sumatra–Malaysia HVDC link (~3 GW), and a series of renewable export corridors, such as Sarawak–Singapore (1 GW), Indonesia–Singapore (1 GW), Viet Nam–Malaysia–Singapore (2+ GW), and Cambodia–Singapore solar and hydro exports.

Most exchanges operate under bilateral long-term PPAs lasting 20–25 years, providing investment certainty and stable supply for importing countries. These include Lao PDR–Thailand, Lao PDR–Viet Nam, and Sarawak–Indonesia. Emerging trades, such as those under Malaysia's CBES-RE Scheme and Cambodia–Singapore pilot projects use bilateral commercial PPAs, allowing flexible renewable exports. Meanwhile, multilateral and transit arrangements like LTMS-PIP represent the early foundations of a regional electricity market.

3.2. Existing Trading Mechanisms

As discussed earlier, the trading arrangements within the APG are primarily governed by long-term bilateral PPAs. A closer examination, however, reveals that these bilateral arrangements operate through three distinct mechanisms that facilitate power exchange across borders. These include:

- Direct bilateral power exchange (DBPE), in which power is traded directly between two physically adjacent utilities or countries under a single PPA framework.
- Linked bilateral trade (LBT), in which power is traded between two non-adjacent countries through multiple interconnected bilateral agreements, enabling

electricity to transit via a third country or form part of a broader regional trade pathway.

- Domestic auction (DA) mechanisms, in which electricity intended for export is procured through competitive domestic bidding processes, and the traded power may flow between either adjacent or non-adjacent countries.

3.2.1. Direct bilateral power exchange

DBPE has been the predominant form of regional electricity trade in ASEAN. However, these cross-border arrangements remain limited in scope and are largely uncoordinated.

Contracts under this model typically involve two adjacent countries or utilities operating under long-term PPAs, often between an IPP and a purchasing utility in a neighbouring country. The PPAs specify volumes, prices, delivery points, and contract durations. Many of these agreements are negotiated at the government or state-utility level, reflecting the differing regulatory, technical, and policy environments across member states.

Such trades often depend on dedicated interconnection lines constructed specifically for the exchange, rather than on integrated grid systems. Most existing arrangements are designed for one-way power transfers (generator to foreign grid) rather than bidirectional, grid-to-grid exchanges that would support broader market integration.

In this arrangement, electricity is typically traded between a resource-surplus country and a resource-deficit country. The generation capacity for export is often developed in the resource-surplus country through various public–private partnership models. Under this structure, an IPP develops the project, entering into a concession agreement with the host government that outlines the rights and obligations for project development, operation, and ownership. Simultaneously, the IPP signs a PPA with a purchasing utility in the neighbouring, resource-deficit country, which guarantees the off-take of electricity under agreed terms for price, volume, and duration. This dual-contract framework enables cross-border trade whilst balancing the investment interests of the private sector with the energy security needs of both countries.

3.2.2. Linked bilateral trade/multilateral power trade

The Lao PDR–Thailand–Malaysia–Singapore Power Integration Project (LTMS–PIP) is widely regarded as a pioneering and innovative model of grid integration within ASEAN. The initiative enables cross-border electricity trade in which Électricité du Laos (EDL) serves as the power exporter, whilst Keppel Infrastructure (Singapore) acts as the primary importer. Electricity generated in the Lao PDR is transmitted to Singapore through the interconnected networks of several regional utilities, namely, the Electricity Generating Authority of Thailand (EGAT), Tenaga Nasional Berhad (TNB) of Malaysia, and SP Power Assets (SPPA) of Singapore.

The traded power under the LTMS-PIP originated from the surplus capacity of Lao PDR's existing national power system, exported and marketed by EDL to Singapore, *a non-adjacent country*, through the transmission networks of Thailand and Malaysia. Looking ahead, it is conceivable that IPPs could also participate directly in similar linked bilateral power trades, selling electricity from one country to another non-adjacent market through established regional interconnections.

The success of this multilateral power trade rests upon a series of foundational agreements concluded amongst these key participants. The principal agreements are summarised in Table 3.2.

The International Energy Agency (IEA, 2019) characterises the LTMS-PIP as *multilateral* only insofar as it involves more than two countries through a tripartite Energy Purchase Wheeling Agreement (EPWA) amongst EDL, EGAT, and TNB. In reality, the trade and power flow remain unidirectional, lacking a framework that allows exchanges amongst all participants, a key feature of a genuinely multilateral and multidirectional trading system. The main commercial transaction is bilateral, between EDL and Keppel Infrastructure, whilst the supporting interconnection agreements are likewise bilateral between EDL–EGAT, EGAT–TNB, and TNB–SPPA. This arrangement reflects a *linked bilateral trade structure*, in which electricity is exchanged through a series of bilateral agreements between country pairs, rather than within a single, unified multilateral market or regulatory framework.

Table 3.2. LTMS-PIP Agreements

1) Energy Wheeling Agreement

   a. Energy Purchase Wheeling Agreement (EPWA/EWA). Tripartite cross-border agreement amongst EDL-EGAT-TNB.

   b. EDL-EGAT Power Purchase Agreement (PPA)

      The EDL-EGAT PPA is an agreement regulates the purchase and transmission of EDL to EGAT. It specifies the pricing, quantity, timing, and technical details of the power exchanges between EDL and EGAT.

   c. EGAT-TNB System Interconnection Agreement (SIA)

      The EGAT-TNB SIA is an agreement that outlines the technical and operational characteristics required for delivering power from EGAT in Thailand to TNB in Malaysia. This applies to physical points of interconnection, operational infrastructures, and restorative actions between Thailand and Malaysia.

2) TNB-SPPA Interconnection Agreement (IA)

   The TNB-SPPA IA is an agreement that provides for the connection of TNB's transmission network with SPPA. The agreement allows for defining the capacity of energy transfer, technology standards, and coordination systems, and for managing power flow between Malaysia and Singapore more efficiently. This

agreement allows integrating both electricity markets and making them more competitive, as well as providing access to new types of energy.

3) SPPA-Keppel Importer Connection Agreement (ICA)

The SPPA-Keppel ICA is an agreement that lays out the framework for linking the SPPA to Keppel Infrastructure, including access, operating standards, and responsibilities for importing power into Singapore. It permits diverse energy sources, improving Singapore's energy security and market competitiveness.

4) EDL-Keppel Supply Agreement

The EDL-Keppel Supply Agreement describes the regulations under which the EDL will supply power to Keppel Infrastructure for distribution to Singapore. It covers price, delivery schedules, quality standards, and dispute resolution, assuring consistent supply whilst also complementing Singapore's energy mix and sustainability objectives.

Source: ACE (2025b).

3.2.3. Domestic auction mechanism

The domestic auction mechanism referred to in this study is illustrated by Malaysia's CBES-RE Scheme, which facilitates the competitive allocation of renewable energy exports through a structured national auction platform.

Under the CBES-RE Scheme, renewable energy generated in Peninsular Malaysia can be exported to neighbouring countries, beginning with Singapore and potentially extending to Thailand and other ASEAN partners. The scheme is regulated by the Energy Commission (EC) and administered through Energy Exchange Malaysia (ENEGEM), operated by the Single Buyer.

Trading is conducted via competitive auctions on the ENEGEM platform. Registered RE producers submit bids to export electricity, specifying capacity and price offers. Successful bidders enter into a Renewable Energy Supply Agreement with the Single Buyer, which governs the generation, export, and transfer of the associated Renewable Energy Certificates (RECs).

On the cross-border side, the Single Buyer (representing Malaysia) signs a PPA with the importing entity defining the commercial terms for delivery, metering, scheduling, and settlement across the interconnection. These agreements ensure that all electricity exported is physically delivered through the interconnector and accompanied by verifiable RECs certifying its renewable origin.

The TNB Grid System Operator coordinates the cross-border scheduling and dispatch, whilst the EC provides regulatory oversight to ensure compliance with technical and environmental standards.

Overall, the CBES-RE Scheme establishes a structured and transparent market

framework that enables Malaysia to export renewable electricity under well-defined commercial contracts whilst allowing neighbouring countries to procure certified green power.

3.3. Short-term Bilateral Electricity Trade

At present, short-term bilateral power trading is not yet practised within the APG. AMS continue to rely predominantly on long-term bilateral PPAs as the principal mechanism for cross-border electricity exchange. To date, no ASEAN country has implemented or operationalised a dedicated short-term power trading arrangement under the APG framework.

Short-term bilateral power trade refers to the exchange of electricity between two parties, typically across national borders, under contracts or transactions with a limited duration, usually ranging from hourly, daily, weekly, or up to one year. Unlike long-term PPAs, which span a period of years, short-term bilateral trades are designed to optimise operational flexibility, manage variable renewable generation, and respond to short-term supply–demand fluctuations.

These transactions can occur between utilities, IPPs, or market operators, and are typically settled through commercially negotiated terms or regulated market mechanisms. They may use existing interconnections or shared grid infrastructure, with prices reflecting near-real-time market conditions or agreed bilateral tariffs.

3.3.1. Key Drivers

The need for short-term electricity trade in ASEAN will be shaped by a convergence of technical, economic, and policy drivers, notably the integration of renewables, grid optimisation, market liberalisation, and deepening regional cooperation. These evolving trading arrangements represent a transitional phase towards the establishment of a fully integrated ASEAN power market, underpinned by transparent, competitive, and flexible cross-border electricity exchange.

- The increasing share of intermittent solar and wind generation across ASEAN, particularly in countries such as Viet Nam, Thailand and Malaysia, is creating heightened needs for operational flexibility and reliability. As a result, regional interconnections and more active cross-border trading frameworks (including short-term bilateral contracts) are gaining attention as tools to balance real-time supply and demand and reduce risks of curtailment.
- Grid reliability and system optimisation. Cross-border electricity exchange improves system reliability in the ASEAN region by enabling neighbouring systems to share reserves, optimise dispatch, and address short-term supply/demand imbalances. In hydropower-dominated areas such as the Mekong

subregion, interconnections provide essential flexibility to manage seasonal and variable output.

- Private sector participation. The growing participation of IPPs and international renewable developers in ASEAN cross-border power trade is a key trend. These actors are pushing for and negotiating more commercially flexible contractual frameworks, moving beyond traditional long-term PPAs towards shorter-term pilot arrangements and market-based structures. Such evolution helps reduce regulatory and business-model risk and opens pathways for monetising renewable generation in the regional context.
- Pilot projects and regional market learning. Pilot initiatives such as LTMS-PIP Phase 2 and emerging bilateral pilot agreements (e.g., Viet Nam–Malaysia–Singapore, Cambodia–Singapore) are serving as testbeds for cross-border electricity trade. They help establish governance, pricing transparency and grid coordination frameworks. Whilst full-scale regional short-term power markets have yet to be developed, the lessons from these pilots are laying the groundwork for future progression beyond physical bilateral contracts.

3.3.2. Barriers to developing short-term power trade

ASEAN's current lack of short-term electricity trading stems from a combination of institutional underdevelopment, infrastructural limitations, and cautious policy approaches to market liberalisation (Weno et al., 2025). The region's power systems remain largely state-controlled and governed by long-term contractual exchanges, with minimal real-time market activity.

- Structural model: predominance of the single-buyer system. Most ASEAN member states continue to operate under a single-buyer or vertically integrated electricity market structure, in which state-owned utilities control generation procurement, transmission, and system operations. Under this model, nearly all electricity generation is contracted through long-term PPAs with limited or no space for short-term, competitive, or market-based trading. These utilities primarily procure power to meet domestic demand and ensure supply reliability, rather than to engage in regional electricity exchanges driven by price signals or market dynamics. As a result, the centralised and non-market structure of most ASEAN power systems constrains the development of short-term bilateral or spot electricity trading mechanisms.
- Regulatory and institutional readiness gap. Effective short-term electricity trading, including day-ahead, intraday, or balancing markets, depends on a degree of coordination being in place. Independent market and system operator functions need to be defined to give trading and regional system security oversight. A regional regulatory body can assist national regulators and ministries to develop

clear transmission access, wheeling, and pricing systems to enable non-discriminatory cross-border transactions. These institutional and regulatory components are not yet fully established at a regional level, and varying approaches are taking nationally within the AMS. Whilst several countries have created national energy regulators, their mandates often remain limited to tariff regulation and licensing within vertically integrated systems, rather than the oversight of competitive wholesale or cross-border electricity markets. As a result, ASEAN's regulatory architecture is still oriented towards long-term bilateral contracting and utility cost recovery, rather than the real-time market coordination required for short-term or spot trading.

- Long-term contracts dominate regional power flows. Most existing cross-border electricity exchanges in ASEAN are governed by long-term bilateral PPAs that are typically tied to specific generation projects, particularly large hydropower or IPP developments. These contracts provide financial certainty and investment security, supporting capital-intensive infrastructure and long-term energy supply planning. However, the prevalence of such long-term contractual arrangements also locks in generation capacity and transmission allocation, leaving little flexibility for short-term or market-based electricity trading.
- Technical and infrastructure constraints. Although regional interconnections are steadily expanding under the APG initiative, they remain too limited in capacity, redundancy, and operational reliability to support dynamic, short-term electricity trading. Many existing cross-border links were designed primarily for dedicated long-term power transfers rather than flexible, bidirectional exchanges. Moreover, technical standards, grid codes, and operational protocols vary significantly amongst AMS, complicating real-time coordination and synchronised dispatch.
- Policy priorities: energy security and sovereignty concerns. Across ASEAN, electricity remains a strategic and politically sensitive sector, closely tied to national energy security, affordability, and industrial policy. Most governments continue to prioritise domestic supply reliability and tariff stability over market-driven cross-border imports. As a result, cross-border electricity trade is often restricted, heavily regulated, or subject to ministerial approval, reflecting concerns about overreliance on neighbouring systems and the potential vulnerability of critical infrastructure.

3.3.3. Misconceptions

The ASEAN Centre for Energy (ACE, 2024), based on its consultations with AMS and relevant stakeholders, has identified several common misconceptions that have contributed to the perception that short-term energy markets are either too complex to implement or unsuitable for the ASEAN context. These misconceptions include the following:

- It is sometimes perceived that establishing a short-term energy market could conflict with the LTMS-PIP contract-based market structure and the potential expansion of contract markets. In reality, contract and short-term markets are complementary, not competing. They serve distinct functions and are designed to coexist within all multilateral and regional power trading frameworks, where long-term contracts provide stability and investment certainty, whilst short-term markets enhance flexibility and operational efficiency.
- It is sometimes assumed that establishing a subregional short-term energy market would require each participating country to first develop its own national short-term energy market. This is not the case. Experiences from the Southern African Power Pool (SAPP) and the Central American Electrical Interconnection System demonstrate that regional short-term energy markets can operate effectively even in the absence of national short-term markets, provided that appropriate coordination, governance, and market rules are in place.
- It is also a misconception that short-term energy markets require countries to relinquish control over national system operations. The experiences of SAPP and the Central American Electrical Interconnection System clearly demonstrate that this is not the case. In both markets, short-term trading focuses on the exchange of surplus generation and system imbalances, allowing national system operators to retain full operational control whilst facilitating regional efficiency. This approach is consistent with one of the guiding principles for developing multilateral power trade in ASEAN, to promote cross-border trade without compromising national sovereignty over system operations.
- Another misconception is that short-term energy markets are too complex to establish. Whilst their design and implementation do involve a degree of complexity, there is extensive international experience and proven models that can guide their development. In fact, establishing fully functional multilateral power trade contract markets can be equally or even more complex, particularly in regions with an 'in-line' grid topology, such as the West Subregion of the APG, where available transfer capacity allocation presents significant technical and coordination challenges. The 'in-line' grid typology within the APG refers to a sequential or linear interconnection structure, where transmission lines connect countries in a chain-like configuration rather than through a meshed or looped network.

Chapter 4

Regional Power Market Evolution

The ASEAN Power Market, in its present state, consists of three distinct yet largely uncoordinated trading arrangements: direct bilateral power exchange, linked bilateral trade, and domestic auction mechanisms. These arrangements are primarily governed by long-term bilateral contracts, typically between utilities or IPPs in one country and purchasing entities in another.

To advance towards a more flexible, efficient, and integrated multilateral power market, ASEAN must progressively introduce short-term electricity trading mechanisms. Short-term markets would allow the exchange of surplus and deficit electricity capacity on shorter timescales, enhancing system optimisation, market liquidity, and regional reliability.

The development of a short-term market should adopt a phased or stepwise approach, in line with international best practices. The recommended pathway begins with the establishment of a short-term bilateral electricity market under the Harmonised Bilateral Trade Model, serving as a transitional framework. This can then evolve into more advanced short-term trading mechanisms under the Secondary Trading Model. In the ASEAN context, such short-term bilateral markets can naturally build upon the existing but uncoordinated trading arrangements, offering a practical platform for harmonisation, capacity building, and market testing.

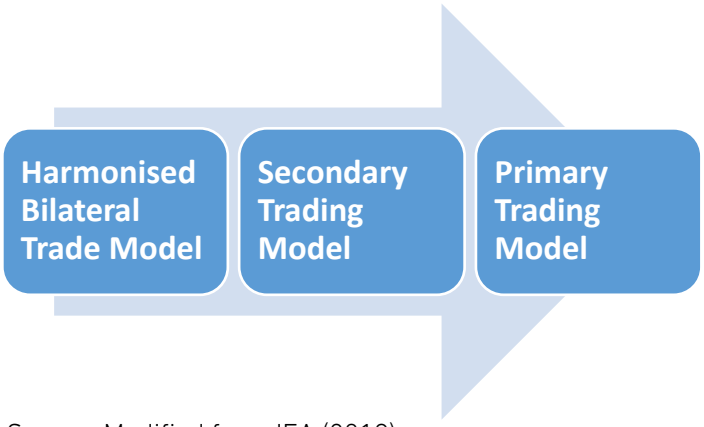
The Layered Market Concept supports the coexistence and coordination of different trading arrangements operating at various temporal levels, ranging from long-term contractual exchanges to emerging short-term and spot market mechanisms. This layered approach enables ASEAN Member States to integrate their power systems gradually, maintaining the flexibility to operate within their current national and bilateral frameworks whilst advancing regional market development.

4.1. Pathways to Multilateral Power Trade

The Layered Market Approach aligns closely with the three multilateral power trade models proposed by the IEA (2019), which outline a progressive and voluntary pathway for advancing regional electricity market integration within ASEAN. These models emphasise a stepwise approach that allows member states to participate according to their institutional readiness, regulatory maturity, and technical capability. The models are shown in Figure 4.1.

- Establishment of a harmonised bilateral trading framework as the initial step towards regional power market integration. This framework would comprise three key components: the development of standardised bilateral contract templates, the adoption of a common wheeling charge methodology, and the creation of a regional coordinating arrangements to facilitate and oversee cross-border transactions. Collectively, these measures would enable any AMS to engage in bilateral electricity trade with any other member state, even in the absence of a shared physical border. Although this approach would not yet achieve the full vision of a multilateral power market, it would significantly enhance the efficiency, transparency, and interoperability of bilateral trading arrangements whilst laying the institutional and regulatory foundation for future multilateral market development.
- Once harmonised bilateral trading becomes operational, ASEAN should advance towards the development of a secondary trading model, which entails establishing a regional electricity market that operates independently of national markets and system operators. This model would build upon the foundations established under the harmonised bilateral framework, such as the adoption of standardised wheeling charge methodologies, whilst introducing new institutional features, including a regional market operator function to oversee trading activities and a central clearing entity to manage settlement and risk. Collectively, these elements would form a more structured platform for regional power exchange, thereby enhancing transparency, liquidity, and coordination amongst participating AMS.
- A long-term objective of establishing a primary trading model. Under this model, AMS may opt to integrate their national electricity markets into a single regional market framework. Such an arrangement would offer substantial benefits through enhanced market efficiency, resource optimisation, and system reliability across the region. However, achieving this level of integration would necessitate significant national-level reforms, including market restructuring, regulatory alignment, and institutional harmonisation to ensure seamless participation in a unified ASEAN power market.

Figure 4.1. Multilateral Power Trade Models

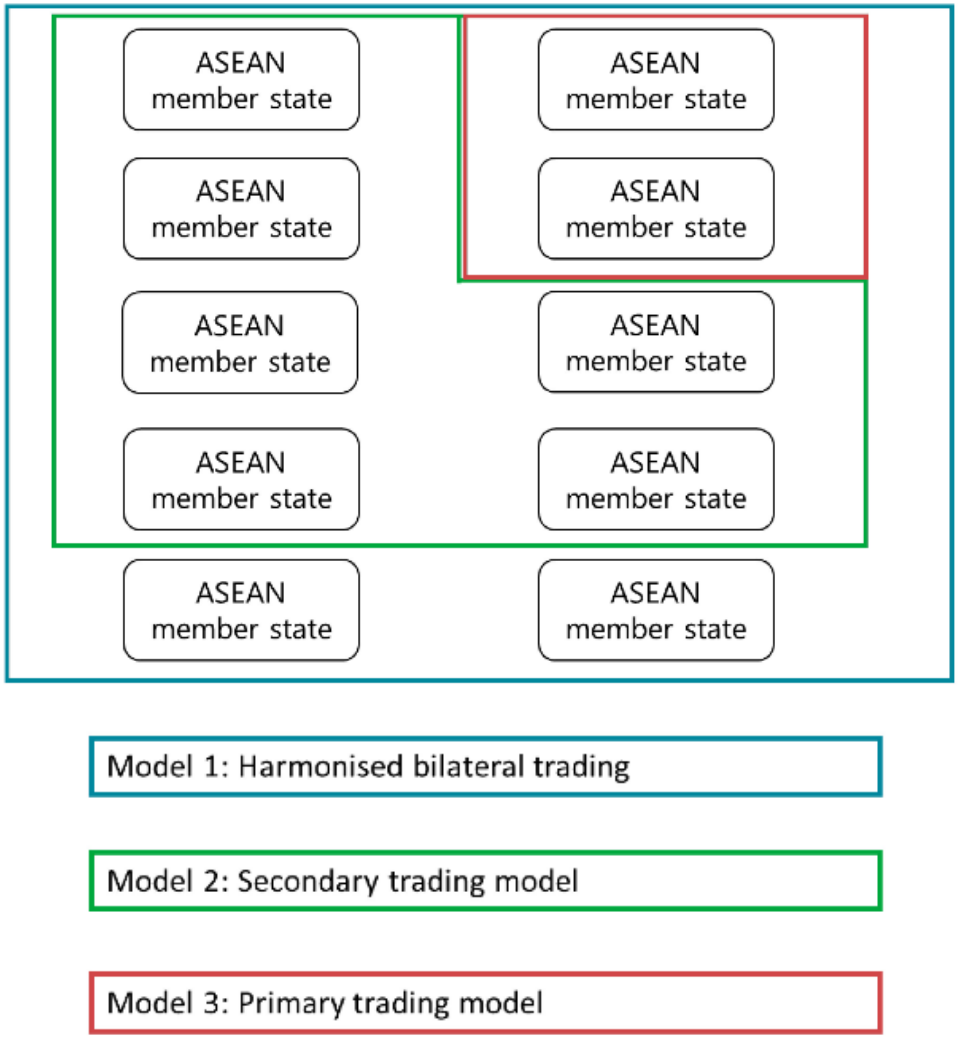


Source: Modified from IEA (2019).

The IEA (2019) suggests that the development of multilateral electricity trading in ASEAN should proceed in a **gradual, stepwise, and voluntary manner**, allowing each AMS to engage according to its own readiness and national priorities. Different countries may opt for varying levels of participation, reflecting the region's diverse market structures and policy contexts (Figure 4.2). The proposed trading models are intentionally designed to accommodate such flexibility, enabling some AMS to focus on harmonised bilateral trading, whilst others advance towards secondary or multilateral frameworks.

Harmonised bilateral trading can deliver mutual benefits to all interconnected AMS by providing a structured framework and institutional foundation that improves trading efficiency and transparency. Some countries may prefer to remain within bilateral arrangements, whereas others may choose to form or join regional trading clusters as readiness grows. Regardless of the specific pathways taken, the collective progress towards multilateral power trade will yield clear benefits for ASEAN as a whole, enhancing regional energy security, system efficiency, and renewable integration under the broader APG vision.

Figure 4.2. Possible Future Trade in ASEAN



Source: IEA (2019).

4.2. Transition Experience in the Southern African Power Pool

A similar transitional approach was adopted by the Southern African Power Pool (SAPP) before launching its Secondary Trading Model, the Day-ahead Market (DAM) (Table 4.1) (ECB Namibia, 2023; NARUC, 2009; NREL, 2024; World Bank, 2014). During its transition, SAPP implemented a bilateral short-term electricity market (STEM), which effectively served as a harmonised bilateral trading model. This phased development allowed participating countries to gradually build the technical, regulatory, and market capabilities required for successful multilateral trading.

The STEM was designed as a relatively simple mechanism to operate, allowing participating utilities to engage in short-term bilateral electricity trading with minimal institutional and technical requirements. Its processes were largely manual, relying on basic bid and offer submissions coordinated by the SAPP Coordination Centre, and settlements were based on scheduled rather than real-time deliveries. This simplicity

made the STEM an effective transitional platform for building initial trading experience and trust amongst participants.

In contrast, the DAM is a more complex and structured system that requires the establishment of comprehensive market rules, governance frameworks, and advanced market management systems. The DAM operates through a centralised auction-based mechanism, integrating transmission constraints, automated bid matching, and financial settlement processes. It also demands higher levels of institutional capacity, regulatory oversight, IT infrastructure, and system operation coordination.

The STEM in the SAPP was introduced in 2001 as a transitional platform for short-term cross-border electricity trading and was phased out in 2007. Meanwhile, preparatory studies for the Secondary Market, which evolved into the DAM, commenced in 2003, leading to its official launch in 2009. This overlapping approach allowed SAPP to build experience and institutional capacity whilst preparing for a more advanced market framework.

Similarly, in ASEAN, it is proposed that whilst the short-term bilateral trading model is being introduced, parallel preparations for the Secondary Trading Model should begin. This would enable a smoother and more efficient transition towards a fully integrated regional power market once the necessary readiness is achieved.

Table 4.1. SAPP Operational Requirements: Harmonised Bilateral Model vs. Secondary Model

Aspect	Short-term Energy Market (STEM)	Day-Ahead Market (DAM)
Launch/period of operation	Introduced in 2001, became inactive by around 2007.	Launched in 2009, currently operational.
Market structure	Semi-centralised platform (trades negotiated daily between participants), coordinated through the SAPP Coordination Centre.	Fully centralised auction-based market operated by the SAPP Market Operator.
Trading mechanism	Participants submitted bids and offers daily (typically one day ahead); matching done manually by SAPP Coordination Centre.	Participants submit hourly bids and offers for the following day; matching done automatically through a market-clearing algorithm.
Price formation	Prices determined through bilateral negotiation or matching of bids/offers; not a single regional price.	Market-clearing price determined through system-wide optimisation of bids and offers.

Aspect	Short-term Energy Market (STEM)	Day-Ahead Market (DAM)
Transmission coordination	Transmission capacity allocated manually; bilateral contracts had priority over STEM trades.	Transmission constraints integrated into market clearing; network model ensures feasible dispatch.
Settlement and billing	Daily accounting, monthly billing based on scheduled volumes (not actual delivery).	Automated settlement based on cleared prices and delivered energy; includes imbalance management.
Credit and risk management	Limited (counterparty risk managed bilaterally); no central credit cover.	Requires credit cover, centralised settlement, and clearing mechanisms to mitigate default risk.
System operation requirements	Relied on national utilities' coordination; limited real-time balancing or scheduling requirements.	Requires advanced system operation coordination, forecasting, and balancing mechanisms to ensure real-time reliability.
Regulatory and institutional requirements	Moderate (required a 'STEM Book of Rules' and voluntary participation).	High (governed by a Market Participation Agreement, Market Rules, and Market Operator License).
IT and data systems	Minimal; bids and offers submitted via email or spreadsheets.	Requires dedicated market management software, automated submission portals, and settlement databases.
Transparency and reporting	Limited visibility on prices and traded volumes.	High transparency (daily market results and prices published to all participants).
Market share/uptake	Represented less than 10% of total SAPP trade; activity declined due to limited surplus generation and transmission constraints.	Still smaller than bilateral trade but provides benchmark prices and serves as the foundation for future competitive markets.

Source: Authors' compilation from various references.

4.3. Transition in Layered Markets

Under the Layered Market Approach, the Harmonised Bilateral Trade Model serves as a critical transitional framework towards the eventual establishment of Multilateral Power

Trading (the Secondary Trading Model) within the APG.

This model provides a structured mechanism for AMS to engage in both long-term contractual trades and short-term transactions, thereby supporting a gradual expansion of cross-border electricity exchanges.

Harmonisation is designed to create a functioning environment for short-term bilateral trades, serving as the bridge to a future secondary market. Harmonised bilateral trading is focused on enabling short-term bilateral electricity trade, whilst long-term bilateral PPAs continue unchanged in parallel. The distinction between current long-term bilateral trading, harmonised bilateral trading and secondary trading model is shown in Table 4.2.

The framework is intentionally flexible and inclusive, allowing participation by any combination of AMS, provided the necessary cross-border interconnections, regulatory compatibility, and operational infrastructure are in place. Through the harmonisation of trading rules, procedures, and technical standards, the model promotes greater consistency in market operations, improves transparency, and strengthens coordination amongst system operators and regulators.

In this model, greater emphasis should be placed on promoting and enabling short-term bilateral trading initiatives to further enhance market flexibility, liquidity, and regional integration. These short-term transactions can help participating countries respond more effectively to fluctuating demand, optimise the use of available generation resources, and strengthen cross-border grid utilisation.

Such short-term bilateral trades are expected to evolve within the existing frameworks of direct bilateral power exchange (DBPE), linked bilateral trade (LBT), and domestic auction (DA) mechanisms, leveraging established institutional arrangements and interconnection infrastructure. Over time, these initiatives will serve as practical platforms for testing harmonised trading procedures and operational coordination, providing valuable experience that will inform the eventual transition towards multilateral power trading.

Table 4.2. Distinctions between Current Bilateral Trade, Harmonised Bilateral Trading, and Secondary Trading Model

Feature	Current Bilateral Trade (Status Quo)	Harmonised Bilateral Trading (Near-Term Evolution)	Secondary Trading Model (Medium- To Long-term Market)
Type of trade products	Long-term PPAs (5–30 years)	Short-term bilateral trades (hourly, blocks, day-ahead) + long-term PPAs continue	Day-ahead market and future intraday and balancing market products;
Contract structure	Country-specific, customised PPAs	Standardised short-term contract templates across AMS	Unified market rules and regional trading code
Market integration level	Minimal; fully bilateral	Partial integration; aligned procedures and rules	High; regional market platform with market clearing
Transmission access	Negotiated case-by-case	Harmonised wheeling methodologies and ATC reporting	Market-based ATC allocation; implicit/explicit auctions
System operation coordination	Basic, bilateral coordination	Regional coordinator facilitates information exchange	Regional market operation function + coordinated dispatch
Technical harmonisation	Low; national grid codes differ	Standardised procedures for metering, scheduling, settlement	Harmonised grid codes; common operational standards
Market participants	Mainly national utilities	Utilities + IPPs (where allowed)	Multi-seller/multi-buyer participation (utilities, IPPs, retailers)
Role of regional institutions	Limited (HAPUA/ACE facilitation only)	Regional Coordinator supports data exchange and transparency	Regional Market Operation function and platform with formal mandate
Complexity level	Low	Moderate	Moderate
Sovereignty requirements	Full national sovereignty retained	Still full sovereignty; no central dispatch required	Still full sovereignty, with higher coordination; partial alignment of market oversight

Feature	Current Bilateral Trade (Status Quo)	Harmonised Bilateral Trading (Near-Term Evolution)	Secondary Trading Model (Medium- To Long-term Market)
Primary benefits	Energy security; long-term investment certainty	Flexibility, renewable integration, operational experience	Efficiency, market liquidity, large-scale RE trade
Primary limitations	Inflexible; unsuitable for variable renewables; small trade volumes	Requires procedural/technical harmonisation; moderate reforms	Requires regional institutional capacity, regional political consensus

Source: Authors' elaboration.

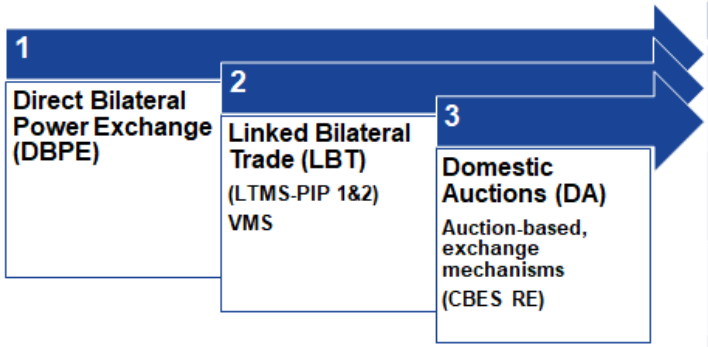
As illustrated in Figure 4.3 and Table 4.3, AMS that currently engage in long-term bilateral trading can gradually introduce short-term bilateral trading arrangements within their existing market frameworks. This approach allows AMS to leverage established institutional structures, contractual practices, and operational systems, thereby facilitating a smoother transition towards more dynamic cross-border electricity trading.

The rationale for this approach is that AMS currently have no experience in short-term bilateral electricity trading. Introducing this trading model will therefore help build operational experience, strengthen market confidence, and enhance institutional readiness, all of which are essential steps towards establishing a fully integrated multilateral trading framework in the region.

These short-term bilateral trading arrangements can be designed and executed using the frameworks and processes that are already in place. By doing so, they maintain alignment with existing regulatory structures and reduce the need for developing extensive new systems or infrastructure. In practice, this means that short-term bilateral trades can be established through three main existing mechanisms: the DBPE, the LBT, and the DA mechanisms, as further outlined in Table 4.3. Each of these mechanisms provides a structured platform for market participants to negotiate and settle trades efficiently, ensuring that transactions remain transparent, compliant, and operationally feasible within the current market environment.

Depending on their national circumstances and readiness, some countries may however choose not to participate immediately in this new arrangement and instead continue operating under existing long-term bilateral trading frameworks.

Figure 4.3. Layered Market Transition



Layered Market Transition	
	Bilateral Harmonisation
Long-Term Bilateral Trade	**Short-Term Bilateral Trade**
Direct Bilateral Power Exchange	Short-term bilateral trade between adjacent countries
Linked Bilateral Trade	Short-term bilateral trade between non-adjacent countries
Domestic Auctions	Short-term bilateral trade through domestic auction mechanisms

Layered Market with Secondary Trading		
	Bilateral Harmonisation	Secondary Trading
Long-Term Bilateral Trade	**Short-Term Bilateral Trade**	As proposed by the IEA (2019), start with a **Day-Ahead Market** (DAM), then introduction of an **Intra-Day Market**, a **Real-Time Market**, and a Market for **Ancillary Services**.
Direct Bilateral Power Exchange	Between adjacent countries	
Linked Bilateral Trade	Between non-adjacent countries	
Domestic Auctions	Through domestic auction mechanisms	

Existing Decentralised Structure (long-term bilateral trade using various mechanisms)	Transitional Phase	Centralised Market System for Secondary Trading

Source: Authors' elaboration.

Table 4.3. ASEAN Member States with Potential for Short-term Bilateral Trading Implementation

	Long-term Bilateral Trade (Existing)				Countries with the Potential for Short-term Bilateral Trade Implementation (Subject to Available Transmission Capacity or ATC)			
	Trade Arrangements with Existing Interconnectors				Countries that are Involved in the Following Trade Arrangements with Existing Interconnectors			
	Direct Bilateral Power Exchange	Linked Bilateral Trade	Domestic Auctions	Others	Direct Bilateral Power Exchange	Linked Bilateral Trade	Domestic Auctions	Others
Brunei Darussalam								
Cambodia	√				√			
Indonesia	√				√			
Lao PDR	√	√			√	√		
Malaysia	√	√	√		√	√	√	
Myanmar								
Philippines								
Singapore	√	√			√	√		
Thailand	√	√			√	√		
Viet Nam	√				√			

Source: Authors' elaboration.

4.4. Trading Arrangement

The trading arrangement under the Harmonised Bilateral Trade Model as envisaged by the IEA (2019) for ASEAN is shown in Figure 4.4.

Under this model, cross-border power trading continues to take place through bilateral contracts between buyers and sellers, typically utilities, generators, or large consumers, from different AMS. However, these transactions are carried out within a common regional framework that defines standardised contractual terms, harmonised grid codes, wheeling and transmission charge methodologies, and data-exchange protocols.

Trading can occur on both a long-term and short-term basis:

- Long-term bilateral contracts (e.g. PPAs) ensure predictable supply and investment security.
- Short-term bilateral trades (day-ahead, week-ahead, or month-ahead) provide flexibility for participants to manage demand fluctuations or optimise generation portfolios.

A regional coordinating body, often a Market Coordination Committee or Regional Market Coordinator, plays a limited but essential role. It does not operate the market or clear trades, but instead:

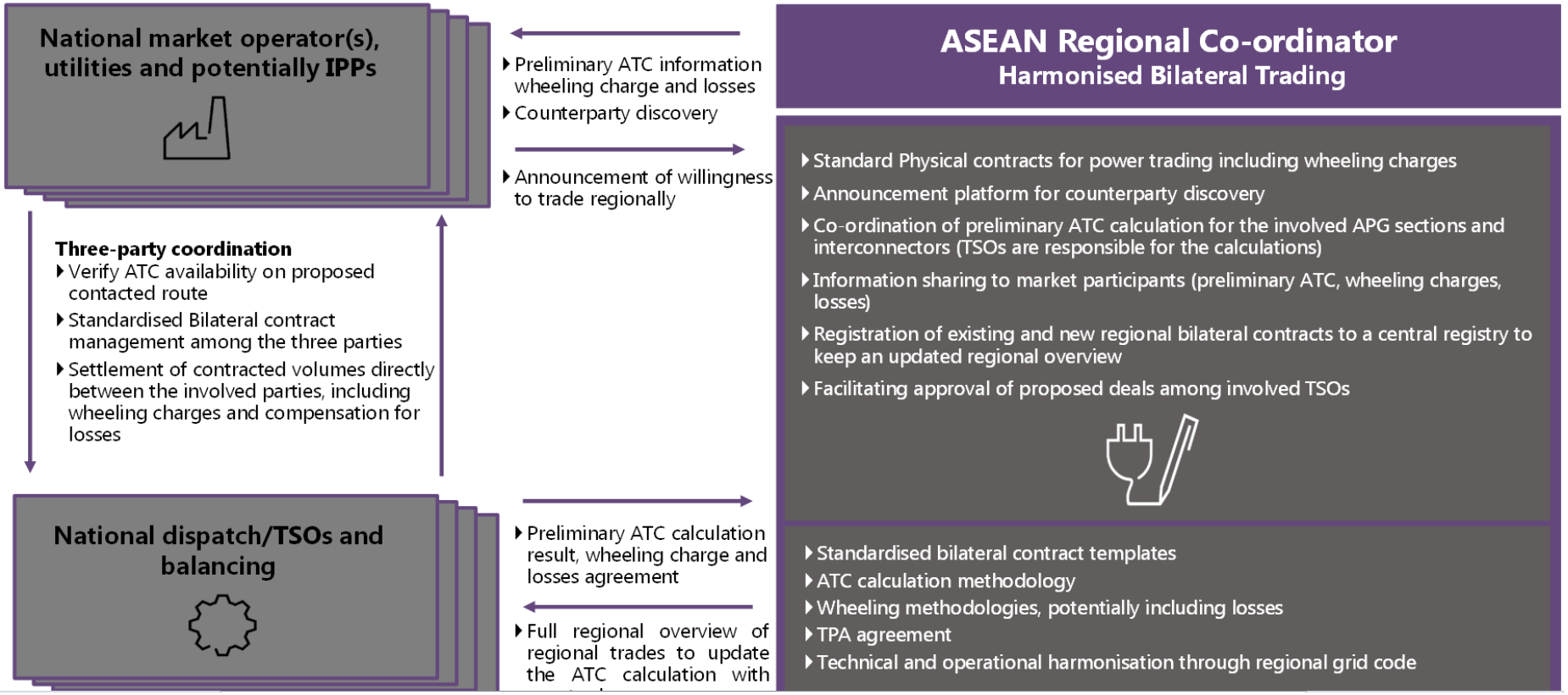
- Registers bilateral contracts between participants for transparency and grid security;
- Coordinates transmission scheduling and verifies available transfer capacity to ensure secure cross-border flows;
- Facilitates information exchange between national system operators;
- Monitors compliance with regional trading and technical standards.

Financial settlement remains bilateral, handled directly between the contracting parties, whilst the system operation and balancing responsibilities rest with the respective national system operators.

By harmonising these operational and contractual aspects, the Harmonised Bilateral Trade Model enhances market compatibility across AMS without requiring the full institutional and technical infrastructure of a centralised power exchange. It enables progressive market opening whilst allowing countries to maintain sovereignty over domestic systems and regulatory frameworks.

Ultimately, the harmonised bilateral model serves as a transitional phase towards the Secondary Trading Model, where trades are centrally cleared and prices are determined through regional market mechanisms. The experience gained in bilateral short-term trading, particularly in scheduling, coordination, and settlement, helps build the technical capacity, institutional confidence, and market culture needed for eventual multilateral integration.

Figure 4.4. Harmonised Bilateral Trading Arrangement



Source: NordPool, as cited in IEA (2019).

Chapter 5

AMS Readiness for Short-term Bilateral Power Trade

The implementation of the first short-term bilateral trading is expected to be initiated by a pair or cluster of trading countries, rather than by a region-wide mechanism. In other words, it will be AMS-driven, reflecting national readiness and mutual interest, rather than regionally imposed. This section therefore assesses which pairs or clusters of AMS are most likely to pioneer short-term bilateral trade, particularly amongst those already engaged in long-term bilateral power trading under various existing trading arrangements. The analysis evaluates AMS readiness using five key criteria: physical interconnection infrastructure; regulatory and policy framework; market and system operations; institutional and political commitment; and project pipeline and innovation readiness.

5.1. Strengths of ASEAN in Establishing Short-term Bilateral Power Trade

ASEAN's strengths in developing short-term bilateral power trade lie in its strong political commitment, successful pilot initiatives, and expanding cooperation in renewable energy integration. The APG has established a clear and shared regional vision for power system interconnection and market integration, serving as the backbone for future short-term trading mechanisms. Proven projects such as the Lao PDR–Thailand–Malaysia–Singapore Power Integration Project (LTMS-PIP) have demonstrated both the technical feasibility and commercial viability of cross-border electricity exchanges, including those involving non-adjacent countries.

Several AMS, particularly Malaysia, Singapore, Thailand, and the Lao PDR have already developed advanced interconnections, regulatory frameworks, and market mechanisms that can support the evolution of short-term bilateral trading. Examples include Malaysia's Cross-Border Electricity Sales of Renewable Energy (CBES-RE) scheme and Singapore's electricity import approval framework, both of which provide structured pathways for regional electricity flows.

Emerging large-scale initiatives such as the Cambodia–Singapore renewable export project, the Sarawak–Singapore interconnection, the Lao PDR–Viet Nam Monsoon Wind project, and the proposed Viet Nam–Malaysia–Singapore (VMS) Clean Energy Trade Corridor further strengthen ASEAN's position as a potential renewable power trading hub. These projects illustrate the region's abundant renewable resource base, particularly hydropower and wind, as well as its growing technical capacity and institutional readiness to manage cross-border energy exchanges.

Collectively, these developments reflect ASEAN's maturing regional cooperation

framework, supported by institutions such as the ASEAN Centre for Energy (ACE) and the Heads of ASEAN Power Utilities/Authorities (HAPUA), which play pivotal roles in facilitating coordination, harmonising regulations, and building capacity for market-based regional power integration. Together, these strengths position ASEAN well to diversify from long-term bilateral contracts to short-term, flexible, and harmonised electricity trading arrangements that will underpin the region's transition towards a more integrated multilateral power market.

5.2. Assessing Readiness

5.2.1. Quantifying Readiness

The study employed five key dimensions to assess the readiness of AMS in establishing short-term bilateral power trade. The description of each dimension and their corresponding weights are presented in Table 5.1. For each dimension, a scoring scale ranging from a minimum of 1 to a maximum of 5 was applied to evaluate the level of readiness. The detailed scoring scale and its definitions are provided in Table 5.2, whilst the dimension-by-dimension scoring explanations are presented in Appendix 1. This multi-dimensional approach allows for a more comprehensive and comparative assessment of the varying levels of preparedness amongst AMS in advancing short-term bilateral power trade initiatives.

Table 5.1. Dimensions Used in Assessing Readiness

Dimension	Description	Weight
1. Physical interconnection infrastructure	Existence, capacity, and reliability of cross-border power links	25%
2. Regulatory and policy framework	Legal/regulatory mechanisms enabling cross-border and short-term trades (e.g. CBES, PPAs, market rules)	25%
3. Market and system operations	Ability to support flexible dispatch, scheduling, metering, and settlement	20%
4. Institutional and political commitment	National participation in ASEAN Power Grid initiatives, bilateral agreements, policy alignment	15%
5. Project pipeline and innovation readiness	Ongoing or planned cross-border RE trade projects, pilot schemes, or digitalisation readiness	15%

Source: Authors' elaboration.

Table 5.2. Score Scale Overview

Score	Qualitative Level	General Definition
5	Fully ready	Strong physical, regulatory, and operational systems already enabling active short-term bilateral trade. Fully harmonised with regional standards.
4	Advanced readiness	Major systems and frameworks in place; bilateral trades ongoing or technically feasible. Some refinements still needed for full short-term market operation.
3	Moderate readiness	Foundational infrastructure and policy commitments exist, but gaps in real-time trading capability, regulation harmonisation, or data coordination.
2	Limited readiness	Early-stage interconnection or regulatory planning; no operational short-term trade possible yet. Requires significant technical or policy development.
1	Minimal readiness	No physical or regulatory basis for cross-border trade. Only conceptual or policy discussions underway.

Source: Authors' elaboration.

5.2.2. Assessment results

The ASEAN Short-Term Bilateral Power Trading Readiness Index reveals that the region is at a moderate stage of readiness, with an average composite score of 3.2 out of 5. This finding reflects the coexistence of significant progress amongst a few leading countries and continuing structural limitations amongst others. The country-level scoring results are presented in Appendix 2, whilst the regional summary and country-by-country readiness analysis are provided in Table 5.3 and Table 5.4, respectively.

The readiness assessment shows that Singapore, Malaysia, the Lao PDR, and Thailand form a high-readiness cluster, demonstrating strong physical interconnections, mature regulatory frameworks, and active cross-border electricity exchanges. These frontrunners have already established the physical and institutional foundations required for short-term bilateral power trade. For instance, the LTMS-PIP (linked bilateral trade) is a fully operational pilot demonstrating the technical and commercial viability of multi-country electricity flows. Malaysia's CBES-RE scheme (domestic auction mechanism) and Singapore's structured import approval process further strengthen the region's regulatory readiness. These countries also benefit from advanced grid operation systems, transparent market mechanisms, and growing private-sector participation in renewable power trading.

Table 5.3. Regional Summary of AMS' Short-term Bilateral Trade Readiness

Readiness Tier	Countries	Typical Trade Form	Short-term Bilateral Potential
High (4.5–5.0)	Singapore, Malaysia, Lao PDR, Thailand	**Direct bilateral power exchange**, **linked bilateral trade**, **domestic auction**, hourly scheduling possible	Highly ready (within 1–2 years)
Moderate (3.0–4.4)	Viet Nam, Cambodia	**Direct bilateral power exchange** (DBPE, long-term PPAs)	Moderately ready (between 2–5 years)
Low (<3.0)	Indonesia, Philippines, Myanmar, Brunei Darussalam	Minimal; focus on feasibility and grid studies	Less ready (more than 5 years)

Source: Authors' elaboration.

In contrast, Viet Nam and Cambodia represent the region's moderate readiness group, with readiness scores between 3.0 and 3.4. Both countries have growing renewable energy capacity and increasing cross-border trade potential but still face regulatory and technical constraints. The Lao PDR–Viet Nam Monsoon Wind project (600 MW) and the Cambodia–Singapore 1 GW renewable energy export are important milestones that demonstrate the region's expanding clean energy trade capacity. The planned Viet Nam–Malaysia–Singapore (VMS) Clean Energy Trade corridor, centred on Viet Nam's future offshore wind projects, is expected to further elevate regional interconnection and enable new pathways for renewable-based short-term trades by the early 2030s. These developments indicate that, whilst institutional frameworks are still evolving, both Viet Nam and Cambodia are steadily moving towards greater participation in short-term cross-border markets.

At the lower end of the readiness spectrum, Indonesia, the Philippines, Myanmar, and Brunei continue to face major barriers, reflected in scores below 2.5. These limitations stem primarily from geographic isolation, weak interconnection infrastructure, fragmented regulatory environments, and limited market mechanisms. The archipelagic nature of Indonesia and the Philippines poses unique challenges for grid integration, making physical cross-border trade technically and economically complex. Myanmar and Brunei, whilst possessing significant conventional and non-conventional energy resource potential, lack the institutional and policy frameworks necessary to support regular power exchange.

Overall, the readiness results highlight a clear geographic and developmental divide between continental and archipelagic AMS. Continental ASEAN, particularly the Greater

Mekong and Peninsular regions, has established the key conditions for short-term bilateral trade, including interconnectivity, political coordination, and pilot trading experience. Archipelagic ASEAN, on the other hand, remains at the planning or feasibility stage. The analysis also underscores that ASEAN's readiness is strongest in political commitment and project innovation, but weakest in market operations and regulatory harmonisation. Few countries currently possess the technical capability for real-time or day-ahead electricity trading, and regional market rules for wheeling, settlement, and tariff harmonisation are still under development.

In summary, the readiness results confirm that ASEAN is transitioning from vision to implementation in cross-border electricity trading. The combination of proven pilot projects (such as LTMS-PIP), emerging large-scale renewable exchanges (like VMS and Monsoon Wind), and expanding policy frameworks (such as CBES-RE) demonstrates that the region has entered a formative phase of clean energy trade integration. However, to move from limited bilateral transactions to true short-term, flexible trading, ASEAN must address persistent infrastructure gaps, strengthen market interoperability, and harmonise regulatory frameworks. With sustained collaboration and investment, the region could achieve operational short-term bilateral power trading on a broader scale within the next five years, advancing both energy security and renewable integration goals under the ASEAN Power Grid vision.

Table 5.4. Country-by-Country Short-term Bilateral Market Readiness Results

Country	Readiness Index (Score/Tier)	Key Strengths	Key Constraints/Gaps
Singapore	4.8/High	• Mature electricity market (NEMS) with hourly trading • Clear EMA framework for RE imports and conditional approvals • Strong digital and REC tracking systems	• Dependent on external physical links • Limited domestic flexibility; relies on partner readiness
Malaysia	4.6/High	• CBES-RE scheme enables regulated cross-border RE trade • Strong links with Thailand and Singapore • Active in APG; projects like Sarawak–Singapore and VMS corridor	• Needs real-time trading/balancing systems • Coordination gap between Peninsular and East Malaysia grids
Lao PDR	4.6/High	• Major regional exporter (hydro, wind) • Proven	• Limited domestic market sophistication •

Country	Readiness Index (Score/Tier)	Key Strengths	Key Constraints/Gaps
		LTMS-PIP and Monsoon Wind exports to Viet Nam • Strong political backing for trade	Reliant on few bilateral buyers for pricing/scheduling
Thailand	4.5/High	• Regional hub with multiple interconnections • Strong grid operation via EGAT • Long-standing bilateral import/export experience	• Lacks formal short-term market platform • Needs regulatory reform for hourly transactions
Viet Nam	3.4/Moderate–high	• Rapid RE expansion (wind, solar) • Cross-border projects (Monsoon Wind, planned VMS) • Integration goals under PDP VIII	• Centralised single-buyer model limits private trade • Grid congestion; weak real-time scheduling
Cambodia	3.1/Moderate	• 1 GW RE export from Cambodia to Singapore • Expanding RE generation • Supportive policy stance	• No physical Singapore link yet • Weak transmission and market systems
Indonesia	2.3/Low–moderate	• Large domestic power base; Batam and Sumatra export potential • Feasibility studies with Malaysia and Singapore	• Archipelagic geography limits connectivity • Fragmented grid; incomplete export regulation
Philippines	1.9/Low	• Liberalised domestic market (WESM) • Expanding RE and digital systems	• No interconnections to ASEAN grid • Lacks legal basis for power exports/imports
Myanmar	1.6/Low	• Some interties with Thailand • Strong hydropower potential	• Political and grid instability • No cross-border trade framework
Brunei Darussalam	1.5/Low	• Fiscal strength; potential to join Borneo Grid	• No interconnection or enabling regulation • Small isolated system

Source: Authors' elaboration.

The readiness results can also be grouped by subregional or geographic classifications, allowing for a clearer comparison of progress amongst neighbouring countries and regional clusters. A summary of these groupings is presented in Table 5.5.

The Peninsular subregion leads ASEAN's readiness for short-term bilateral electricity trading with a score of 4.5 (high), supported by strong interconnections, regulatory alignment, and operational experience under the LTMS-PIP (linked bilateral trade) and CBES-RE (domestic auction) frameworks. The Mekong subregion follows with 3.8 (moderate–high) readiness, reflecting growing trade potential through projects like Monsoon Wind and the VMS Clean Energy Corridor, which link continental and peninsular markets. Borneo, at 2.8 (low–moderate), shows emerging promise as a future green export hub, pending infrastructure completion such as for the Sarawak–Singapore interconnection. Meanwhile, the Archipelagic subregion, with 2.0 (low) readiness, faces the steepest challenges due to physical isolation and limited regulatory support for cross-border trading.

The overall pattern reveals a tiered regional readiness, with the Mekong–Peninsular corridor acting as ASEAN's operational core and Borneo–Archipelagic ASEAN as the next phase of integration. Sustained investment in interconnection, market harmonisation, and grid digitalisation will be critical to transform these subregional hubs into a cohesive, flexible ASEAN electricity trading network by the early 2030s.

Table 5.5. Readiness by Subregional or Geographic Grouping

Subregion	Readiness Index (Score/Tier)	Leading Countries	Key Active or Planned Initiatives	Short-term Trading Outlook (2025–2035)
Peninsular (Thailand, Malaysia, Singapore)	4.5/High	Malaysia, Singapore, Thailand	• CBES-RE (Malaysia cross-border RE exports) • LTMS-PIP (multilateral power integration pilot) • VMS Corridor (future expansion northward)	Most advanced subregion; strong interconnections and harmonised frameworks; ready for structured short-term bilateral trading by early 2030s
Mekong (Lao PDR, Thailand, Viet Nam, Cambodia,	3.8/Moderate–high	Lao PDR, Thailand, Viet Nam	• LTMS-PIP (Lao PDR–Thailand–Malaysia–Singapore) • Monsoon Wind	Strong foundation for regional renewable power exchange; bilateral scheduling

Subregion	Readiness Index (Score/Tier)	Leading Countries	Key Active or Planned Initiatives	Short-term Trading Outlook (2025–2035)
Myanmar)			(Lao PDR–Viet Nam, operational 2025) • VMS Clean Energy Trade Corridor (Viet Nam–Malaysia–Singapore)	feasible within 2020s; evolving towards day-ahead trading post-2030
Borneo (Sarawak–Sabah–Brunei Darussalam–Kalimantan)	2.8/Low–moderate	Malaysia (Sarawak), Brunei Darussalam	• Sarawak–Singapore Interconnection (planned HVDC subsea link) • Borneo Grid Initiative (Sarawak–Sabah–Brunei Darussalam–Kalimantan integration)	In preparatory phase; high export potential once connectivity is established; pilot trades likely after 2030
Archipelagic (Indonesia, Philippines)	2.0/Low	Indonesia, Philippines	• Batam–Singapore Interconnection (feasibility stage) • Sumatra–Peninsular Malaysia Intertie (study stage) • WESM (Philippines' wholesale electricity market)	Physical isolation limits near-term trade; focus on RE certificate and virtual exchanges; physical short-term trading unlikely before 2035

Source: Authors' elaboration.

Chapter 6

Layered Market Roadmap

The primary objective of the transition period is to enable frontrunner AMS to pilot short-term bilateral electricity trading as a precursor to broader regional market development. These early trades are expected to build on existing arrangements, evolving naturally from direct bilateral exchanges between adjacent systems, linked bilateral flows across non-adjacent countries, and domestic auction-based procurement frameworks. This approach leverages mechanisms already familiar to utilities and regulators, allowing pilots to proceed with limited disruption and minimal new infrastructure.

The transition is expected to span around 5 years, reflecting varied levels of regulatory development, and system-operation capability across ASEAN. Progress will remain voluntary and readiness-based, with ASEAN moving forward as member countries demonstrate preparedness and confidence. This phased approach safeguards national sovereignty and ensures that market evolution remains pragmatic, flexible, and aligned with domestic priorities whilst building shared operational experience and institutional maturity.

Based on current system readiness, the frontrunner countries for piloting short-term bilateral trading are the Lao PDR, Thailand, Malaysia, and Singapore, building on their proven collaboration under the LTMS-PIP. These countries have demonstrated effective cross-border power-trading operations supported by robust transmission interconnections, coordinated scheduling and dispatch procedures, and established commercial and settlement arrangements. Malaysia has further strengthened its leadership by launching a competitive domestic auction mechanism for export-oriented renewable energy, signalling strong regulatory and policy commitment to market-based trading. Collectively, these pioneers possess the most advanced combination of physical grid readiness, institutional frameworks, regulatory sophistication, and operator capability, positioning them to lead ASEAN's transition towards short-term bilateral trading and ultimately catalyse broader regional participation.

6.1. Roadmap

The Layered Market Approach Roadmap is structured into four progressive phases, as illustrated in Figure 6.1. Each phase builds on the previous one, enabling a gradual, capability-based transition towards a regional power market. The phases are:

- Phase 0: Pioneer Short-term Bilateral Trading

  Initiate voluntary pilot trades amongst frontrunner countries to test operational readiness and establish proof-of-concept.

- Phase 1: Preparation of Harmonised Bilateral Framework & Capacity Building

  Develop standardised rules, technical protocols, and institutional arrangements, whilst strengthening regulatory and operator capabilities.

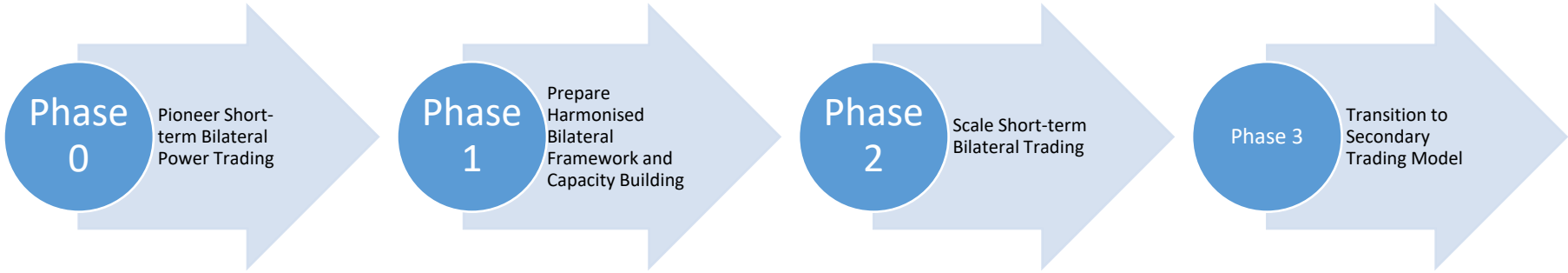
- Phase 2: Regional Scaling of Short-term Bilateral Trading

  Expand participation, increase trade volumes, and enhance operational coordination across additional AMS.

- Phase 3: Transition to a Secondary Trading Model

  Prepare the foundation for a regional market platform, evolving towards day-ahead and intraday trading for willing and ready participants.

Figure 6.1. Layered Market Approach Roadmap



Source: Authors' elaboration.

6.2. Phase 0: Pioneer Short-term Bilateral Trading

Phase 0 represents the launchpad for ASEAN's transition from long-term contractual exchanges to more dynamic regional electricity markets. This phase focuses on voluntary, small-scale pilot bilateral trades amongst a select group of frontrunner AMS that have already demonstrated a strong degree of technical readiness, transmission connectivity, regulatory maturity, and institutional cooperation. These early movers act as the proof-of-concept cluster, validating operational processes and market coordination approaches that can later be scaled across the region.

Pilot trading in this phase will build on existing bilateral relationships and utilise current physical interconnections. Trading will expand beyond long-term PPAs to include structured short-term transactions, such as day-ahead blocks, hourly exchanges, or renewable-based spot deliveries, depending on system capabilities. These transactions may occur between adjacent systems (e.g. Malaysia–Singapore, Lao PDR–Thailand) and linked non-adjacent systems (e.g. Lao PDR–Thailand–Malaysia–Singapore), as well as through auction-based export mechanisms where applicable (e.g. Malaysia's CBES-RE platform). This flexible entry approach enables participating countries to test different trading modalities in a controlled and operationally secure environment.

During Phase 0, utilities, system operators, and regulators will trial essential cross-border coordination processes, including scheduling, nominations, metering, settlement, and operational data exchange. Pilot activities will also test grid security, reserve sharing, congestion management, and emergency protocols, ensuring reliability is maintained under real-time market-driven flows. Importantly, this phase encourages learning-by-doing, with systematic documentation of lessons, challenges, and opportunities feeding directly into the design of later harmonised frameworks.

Participation remains voluntary and progress-based, allowing frontrunners to lead without imposing obligations on other AMS. However, transparent reporting, shared learning, and structured knowledge-transfer mechanisms ensure that non-participating states benefit from the pilots and can prepare their systems for future involvement. This phase therefore serves not only as a technical and commercial trial but also as a confidence-building exercise, strengthening trust amongst AMS and demonstrating that short-term cross-border trading is feasible within ASEAN's sovereignty-respecting regional architecture.

6.3. Phase 1: Prepare Harmonised Bilateral Framework and Capacity Building

Phase 1 serves as the critical institutional and technical foundation for ASEAN's transition towards structured short-term bilateral electricity trading. The core aim in this phase is to move from project-specific bilateral agreements to transparent, standardised, and interoperable bilateral trading frameworks that can be consistently applied across participating AMS. This creates a predictable investment environment,

enhances system reliability, and builds confidence amongst market participants before more advanced regional market structures are introduced.

At the regulatory level, this phase prioritises the harmonisation of bilateral contracting frameworks, including standardised terms for power purchase agreements, wheeling and access arrangements, delivery obligations, curtailment protocols, and dispute resolution. A consistent wheeling-charge methodology will be developed to ensure fair, transparent, and predictable transmission pricing across borders. In parallel, participating countries will align or mutually recognise grid codes, operational standards, and cybersecurity protocols, including scheduling rules, energy-metering and verification systems, cross-border contingency procedures, and communication and data-exchange standards. The goal is not full market convergence but a minimum common rule set that lowers transaction complexity and ensures safe and reliable cross-border operations.

Institutionally, this phase establishes a regional coordination function, potentially within an enhanced coordination platform involving ACE, HAPUA, energy regulators, and transmission system operators (TSOs). This body will not operate the market, but will:

- Coordinate information-sharing amongst TSOs;
- Support calculation and publication of available transfer capacity for cross-border lines;
- Develop operational guidelines and compliance expectations;
- Facilitate dispute resolution and cooperation protocols;
- Maintain a registry of bilateral trading arrangements and participants;
- Act as a knowledge and technical assistance hub.

Capacity building is a central pillar of this phase, targeting regulators, utilities, market operators, system operators, and policymakers. Structured programmes will include training on market design and power-system economics, cross-border dispatch and balancing, grid stability and congestion management, digital grid technology and cybersecurity, transparency and data governance, and renewable-integration strategies. Table-top exercises, simulations, and pilot-operation rehearsals will be conducted to familiarise operators with short-term trading mechanics.

6.4. Phase 2: Scale Short-term Bilateral Trading

In Phase 2, ASEAN transitions from isolated pilot transactions to broader regional participation in short-term bilateral electricity trade. Building on the lessons learned and operational confidence gained from Phase 0 and Phase 1, this phase focuses on expanding the number of participating countries, increasing trade volumes and frequency. This period serves as the bridge between pioneer trading and the

establishment of a more formalised regional short-term market platform.

Key objectives include deepening cross-border operational coordination, enhancing transparency in pricing and scheduling practices, and strengthening the reliability and flexibility of interconnection points. Regulatory agencies and system operators are expected to increasingly harmonise operational protocols and adopt aligned dispatch, metering, and settlement procedures, allowing cross-border trades to occur with greater efficiency and predictability.

During this stage, countries beyond the initial frontrunner group may elect to join based on readiness and national policy priorities. Participation remains voluntary and sovereign-aligned.

6.5. Phase 3: Transition to a Secondary Trading Model

Phase 3, which concerns the transition towards a Secondary Trading Model and the establishment of a regional short-term market platform (e.g. day-ahead and intraday trading), lies beyond the scope of this study. The design and implementation pathway for this advanced stage of market development is currently being undertaken under the ASEAN Interconnection Masterplan Study (AIMS) III Phase 3 initiative, which is specifically mandated to explore market-coupling options, define regional market rules, develop institutional arrangements, and assess operational requirements for a future ASEAN secondary trading mechanism.

Whilst this study recognises the importance of a regional power exchange in ASEAN's long-term integration vision, its focus is on the necessary preparatory and transitional steps leading up to, but not including, the establishment of a full secondary trading platform. Accordingly, Phase 3 is acknowledged only as the ultimate market evolution pathway for willing and ready AMS and is not elaborated further here to avoid duplication with the ongoing work under the AIMS III programme.

Chapter 7

Conclusion and Recommendations

The analysis of ASEAN's current trading arrangements, readiness levels, and transitional pathways reveals three overarching conclusions that shape the region's market-integration trajectory.

1. ASEAN's regional power market is structurally ready to introduce a new 'short-term trading layer'.

ASEAN has accumulated sufficient physical interconnection capacity, proven operational experience, and political direction to move beyond exclusive reliance on long-term PPAs. The APG now connects most continental systems, and pilot initiatives, such as the LTMS-PIP, Malaysia's CBES-RE auctions, and the emerging VMS and Cambodia–Singapore renewable corridors, demonstrate that cross-border power flows can be coordinated reliably across different regulatory and technical environments.

These developments indicate that ASEAN has entered a new phase where short-term bilateral trading is not only technically feasible but increasingly necessary to support renewable integration, reduce curtailment, and improve system-wide efficiency. Whilst gaps remain in market operations, regulatory harmonisation, and grid digitalisation, the region's current structural readiness provides a solid platform for introducing short-term trading on a limited, voluntary basis amongst willing participants.

2. A harmonised bilateral short-term market offers a practical and politically acceptable next step.

A harmonised bilateral short-term trading framework presents a realistic and sovereignty-respecting next step for the expansion of bilateral trade. It allows participating AMS to:

- Use familiar bilateral contracting models, adapted for short-term products;
- Apply harmonised templates, wheeling methodologies, and operational procedures;
- Conduct trades without relinquishing national dispatch control;
- Gradually build institutional capacity and technical competence;
- Strengthen transparency and predictability for utilities and private investors.

This incremental approach reduces implementation risks and enables ASEAN to expand cross-border trading activity without requiring immediate, large-scale institutional

restructuring. It also creates the foundational building blocks, standardised contracts, aligned procedures, trusted coordination channels, for a future Secondary Trading Model when readiness improves.

3. Market evolution will be corridor-based, AMS-driven, and layered on top of existing long-term PPAs.

ASEAN's diversity means that market integration will unfold unevenly. The most advanced readiness exists in a defined geographic corridor spanning the Lao PDR, Thailand, Malaysia, and Singapore, with Viet Nam and Cambodia emerging as the next wave of participants. These countries already share strong interconnections, established trading relationships, and active renewable-export projects. As such, they form the natural nucleus for the first short-term bilateral trades.

Progress will remain voluntary and readiness-based, allowing willing AMS to move ahead without requiring uniform participation. Other subregions, such as Borneo and the archipelagic systems of Indonesia and the Philippines, will integrate later as physical links and regulatory frameworks mature.

Importantly, short-term trading will not replace long-term PPAs. Instead, it will be added as a flexible operational layer that enhances the utilisation of interconnections, enables renewable balancing, and supports real-time system optimisation. Long-term PPAs will continue to underpin investment security, financing confidence, and national energy planning, ensuring that ASEAN's transition is stable and non-disruptive.

Based on the Layered Market Roadmap and readiness assessment, the study recommends the following:

1) Adopt the Harmonised Bilateral Trade Model as the transitional framework

- Standardise short-term contract templates, wheeling methodologies, and scheduling, metering, and settlement procedures.
- Create a light-touch regional coordination function to publish ATC, register bilateral trades, support information exchange, and monitor compliance without operating a centralised exchange.

2) Launch Phase 0 pilots amongst frontrunners

- Initiate voluntary, small-scale short-term bilateral trades amongst the Lao PDR, Thailand, Malaysia, and Singapore, expanding to Viet Nam and Cambodia as readiness grows.
- Use DBPE, LBT and DA mechanisms as testbeds for hourly/block trades and renewable-based transactions.
- Document and share lessons to guide framework refinement and capacity-building.

3) Implement Phase 1: Harmonisation and Capacity Building

- Align bilateral PPAs and short-term contracts through standard terms and common wheeling and access principles.
- Harmonise or mutually recognise key technical rules (grid codes, scheduling protocols, data standards).
- Establish a regional coordination platform (e.g. through ACE/HAPUA/APGCC) to support ATC calculation, guidelines, and dispute facilitation.
- Roll out targeted training and simulations for regulators, utilities, TSOs, and market operators.

4) Prepare for Phase 2 and Phase 3: Scaling and Secondary Trading

- Gradually expand participation and trading volumes as more AMS meet minimum readiness benchmarks.
- In parallel, building on AIMS III, continue work on Secondary Trading Model design, including market rules, governance structures, clearing and settlement systems, and IT platforms.

5) Support lower-readiness AMS and subregions

- Develop subregional transition plans for Borneo and Archipelagic ASEAN, linking interconnection projects to regulatory and market-readiness milestones.
- Mobilise technical assistance and concessional finance to address interconnection gaps, regulatory reforms, and market-operation capabilities.

In sum, ASEAN has moved beyond vision-setting and is ready to pilot short-term bilateral electricity trading as the next practical step towards a more flexible and integrated regional power market. By following a layered, phased, and voluntary pathway, leveraging existing mechanisms and institutions, the region can build a robust foundation for future multilateral markets whilst respecting national sovereignty and diverse market structures.

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Appendices

Appendix 1. Explanation of Weight Allocation

The weights are designed to reflect the relative importance of each dimension in determining a country's or subregion's ability to participate effectively in short-term cross-border power trade. The allocation balances technical, institutional, and market readiness factors in line with the ASEAN Power Grid (APG) roadmap and international power market best practices.

The weight allocation ensures that:

- 50% of the index focuses on *core enablers* (infrastructure + regulation), essential for basic participation.
- 35% focuses on *operational and institutional maturity*, critical for moving from bilateral to short-term trade.
- 15% captures *forward-looking innovation and project momentum*, ensuring sustainability and long-term scalability.

Table 1. Summary of Weight Logic

Dimension	Role in Short-term Trade	Weight (%)	Reason for Weight
Physical interconnection infrastructure	Enables physical power flow	25%	Foundational prerequisite
Regulatory and policy framework	Enables commercial and legal power flow	25%	Critical for market functioning
Market and system operations	Enables real-time and short-term transactions	20%	Operational backbone
Institutional and political commitment	Provides stability, coordination, and governance	15%	Ensures continuity and cooperation
Project pipeline and innovation readiness	Indicates future readiness and system evolution	15%	Captures momentum and scalability

Source: Authors' elaboration.

A.1.1. Physical interconnection structure: 25%

This is the *foundation* of cross-border electricity trade. Without physical interconnections (transmission lines, substations, and reliable grid links) no amount of policy or market readiness can enable real power flows. The 25% weight recognises that connectivity and transmission reliability are the most critical enablers of actual electricity exchange.

A.1.2. Regulatory and policy framework: 25%

A well-defined legal and policy environment is equally vital. Even with physical links, electricity cannot flow commercially without rules governing cross-border sales, tariffs, licensing, and market access. The 25% weight reflects parity with infrastructure, as regulatory readiness directly determines how efficiently and transparently power can be traded.

A.1.3. Market and system operation: 20%

Short-term trade requires operational flexibility (real-time dispatching, metering, balancing, and settlement systems). Whilst slightly less weighted than the first two, this dimension captures a country's technical capacity to handle hourly or day-ahead transactions. The 20% weight highlights its critical but dependent role (operational readiness builds on existing infrastructure and regulatory systems).

A.1.4 Institutional and political commitment: 15%

Political will and institutional alignment drive cooperation. ASEAN's cross-border power trade depends on trust, coordination, and sustained government support. While not directly technical, this factor underpins all others (projects and reforms rarely move without strong institutional leadership). It is given 15% to recognise its enabling, long-term influence.

A.1.5. Project pipeline and innovation readiness: 15%

Future-oriented readiness, the extent to which countries are expanding or modernising through ongoing projects, renewable trade pilots, and digital integration. This dimension recognises progress and forward momentum. The 15% weight captures its role as a growth catalyst rather than a current enabler.

Appendix 2. Dimension to Assess the Readiness of AMS In Establishing Short-term Bilateral Power Trade

A.2.1. Physical Interconnection Infrastructure: 25%

Definition: Assesses the extent, reliability, and flexibility of cross-border electricity transmission infrastructure.

Table 2Physical Interconnection Infrastructure Dimension

Score	Description	Example Indicators
5	Multiple high-capacity cross-border lines; able to handle flexible, two-way short-term trade	Lao PDR–Thailand–Malaysia–Singapore (LTMS-PIP)
4	Strong interconnections with at least one neighbour; dispatch flexibility proven	Thailand–Cambodia, Sarawak–Sabah link
3	Some bilateral interties exist but limited capacity or one-way flow	Viet Nam–Cambodia, Thailand–Myanmar
2	Planned or under construction interconnection only	Sarawak–Singapore (not yet operational)
1	No physical interconnection	Philippines, Brunei Darussalam

Source: Authors' elaboration.

A.2.2. Regulatory and policy framework: 25%

Definition: Measures the existence of legal and policy mechanisms that explicitly permit and regulate cross-border power trading, including short-term or renewable-specific schemes.

Table 3. Regulatory and Policy Framework Dimension

Score	Description	Example Indicators
5	Comprehensive regulatory framework in force for cross-border and short-term trade (e.g. market access, REC systems)	Malaysia CBES-RE Scheme; Singapore EMA import regulation
4	Partial framework enabling long-term bilateral PPAs or pilot schemes	Thailand EGAT bilateral MOUs
3	Policy intent exists but no operational regulation yet	Viet Nam's Power Development Plan VIII

Score	Description	Example Indicators
		(PDP8) export ambitions
2	Draft policies or early-stage studies	Indonesia's PLN exploring Batam–Singapore RE export
1	No regulatory framework or enabling law	Myanmar, Brunei Darussalam

Source: Authors' elaboration.

A.2.3. Market and system operation: 20%

Definition: Assesses operational readiness for short-term or real-time trading including scheduling, balancing, metering, and settlement systems.

Table 4. Market and System Operations Dimension

Score	Description	Example indicators
5	Mature power market with hourly/day-ahead trading, imbalance management, transparent settlement	Singapore's NEMS (wholesale market)
4	System operations allow limited short-term bilateral scheduling	Lao PDR–Thailand EGAT–EDL arrangements
3	Central dispatch but no flexible bilateral trading	Viet Nam's single-buyer model
2	Manual or ad hoc coordination; not ready for short-term trades	Indonesia, Cambodia (current stage)
1	Fragmented or non-existent market operations	Myanmar, Brunei Darussalam

Source: Authors' elaboration.

A.2.4. Institutional and political commitment: 15%

Definition: Reflects engagement in regional cooperation, policy alignment, and long-term political will towards cross-border power trading.

Table 5. Institutional and Political Commitment

Score	Description	Example Indicators
5	Active member in ASEAN Power Grid projects; multiple signed bilateral MOUs; stable political support	Singapore, Thailand, Malaysia
4	Consistent participation with domestic backing	Lao PDR, Viet Nam
3	Expressed support but inconsistent follow-through	Cambodia, Indonesia
2	Limited participation due to policy instability	Myanmar
1	No active engagement	Brunei Darussalam (current stage)

Source: Authors' elaboration.

A.2.5. Project pipeline and innovation readiness: 15%

Definition: Evaluates the presence of new, credible cross-border or renewable trading projects and adoption of digital/market innovations.

Table 6. Project Pipeline and Innovation Readiness

Score	Description	Example indicators
5	Multiple large-scale, approved or operating projects; innovation schemes in progress	LTMS-PIP, Monsoon Wind, CBES-RE, Cambodia–Singapore
4	Ongoing or funded projects under construction	Sarawak–Singapore link, VMS corridor
3	Announced projects pending investment decision	Indonesia–Malaysia–Singapore feasibility
2	Conceptual proposals or early feasibility only	Brunei Darussalam, Philippines
1	No active projects	Myanmar

Source: Authors' elaboration.

Appendix 3. Country Scoring Matrix

Table 7. Country Scoring Matrix

Country	Interconnection (25%)	Regulation (25%)	Market Operation (20%)	Political Commitment (15%)	Project Pipeline (15%)	Weighted Score (Out of 5)	Readiness Tier
Lao PDR	5	4	4	5	5	4.6	High
Thailand	5	4	4	5	4	4.5	High
Malaysia	4	5	4	5	5	4.6	High
Singapore	4	5	5	5	5	4.8	High
Viet Nam	3	3	3	4	4	3.4	Moderate–high
Cambodia	3	3	2	4	4	3.1	Moderate
Indonesia	2	2	2	3	3	2.3	Low–moderate
Myanmar	2	1	1	2	2	1.6	Low
Brunei Darussalam	1	1	1	2	2	1.5	Low
Philippines	1	2	2	3	2	1.9	Low

Source: Authors' elaboration.