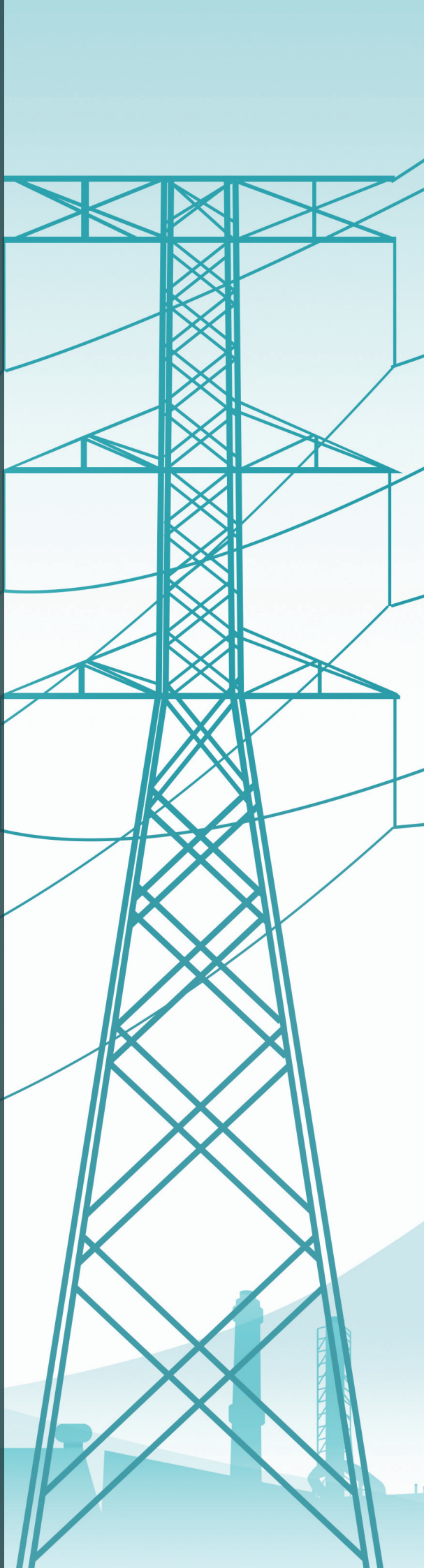
ACCELERATING THE ASEAN POWER GRID 2.0

Lessons from the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP)

Policy Report

Mirza Sadaqat Huda
Sharon Seah
Qiu Jiahui



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Accelerating the ASEAN Power Grid 2.0: Lessons from the
Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP)
is published by the Climate Change in Southeast Asia Programme at
ISEAS - Yusof Ishak Institute and available electronically at www.iseas.edu.sg
If you have any comments or enquiries about the report, please email us at
climatechange@iseas.edu.sg

Published on 12 December 2023
Print ISBN: 978-981-5104-98-1
Online ISBN: 978-981-5104-99-8

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ISEAS - Yusof Ishak Institute (formerly Institute of Southeast Asian Studies) is an autonomous organisation established in 1968. It is a regional centre dedicated to the study of socio-political, security, and economic trends and developments in Southeast Asia and its wider geostrategic and economic environment. The Institute's research programmes are grouped under Regional Economic Studies (RES), Regional Social and Cultural Studies (RSCS) and Regional Strategic and Political Studies (RSPS). The Institute is also home to the ASEAN Studies Centre (ASC), the Temasek History Research Centre (THRC) and the Singapore APEC Study Centre. The Climate Change in Southeast Asia Programme (CCSEAP) was established in 2020 to examine the phenomenon of climate change, its impact, and policy responses across the regions. The Programme hopes to cultivate a network of scholars at the forefront of climate change research and build on ISEAS' thought leadership to advance climate discourse and knowledge in Southeast Asia through a series of publications and seminars.

The report can be cited as: Huda, M.S., Seah, S., Qiu, J. Accelerating the ASEAN Power Grid 2.0: Lessons from the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP) (Singapore: ISEAS - Yusof Ishak Institute, 2023)

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Abbreviations

ACE	ASEAN Centre for Energy
ACCEPT	ASEAN Climate Change and Energy Project
ADB	Asian Development Bank
AMEM	ASEAN Ministers on Energy Meeting
APAEC	ASEAN Plan of Action for Energy Cooperation
APCI	ASEAN Projects of Common Interest
APG	ASEAN Power Grid
APGCC	ASEAN Power Grid Consultative Committee
ASEAN	Association of Southeast Asian Nations
BIMP	Brunei Darussalam-Indonesia-Malaysia-Philippines
BIMP-PIP	Brunei Darussalam-Indonesia-Malaysia-Philippines Power Integration Project
CASE	Clean, Affordable and Secure Energy for Southeast Asia
CO_2	carbon dioxide
EDL	Électricité du Laos
EGAT	Electricity Generating Authority of Thailand
ERIA	Economic Research Institute for ASEAN and East Asia
ETP	Southeast Asia Energy Transition Partnership
GDP	gross domestic product
GIS	Geographic Information System
GMS	Greater Mekong Subregion
GW	gigawatt
GWh	gigawatt-hour
HAPUA	Heads of ASEAN Power Utilities/Authorities
HVDC	High-Voltage Direct Current
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
kV	kilovolt
LTMS	Lao PDR-Thailand-Malaysia-Singapore
LTMS-PIP	Lao PDR-Thailand-Malaysia-Singapore Power Integration Project
Mt	metric tonne
$MtCO_2e$	metric tonne of carbon dioxide equivalent
MW	megawatt
TWh	terawatt-hour
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
USAID	US Agency for International Development
USTAD	United States Trade and Development Agency

Foreword

The majority of Southeast Asian countries aim to transition to a low-carbon energy future between 2050 and 2065. Regional electricity interconnections can play a vital role in this transition by enabling the sharing of renewable energy resources and reducing reliance on fossil fuels. While regional electricity markets have emerged across the world, newer regional initiatives in Southeast Asia are up against time to overcome political, technical and economic challenges to meet climate and sustainability goals.

The ASEAN Power Grid (APG) initiative, first identified as an area of cooperation for ASEAN in 1999, aims to expand cross-border electricity interconnections to create an integrated regional electricity grid system. The Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP), which came into operation in 2022, is the first multilateral cross-border electricity trading initiative in the region. It is seen as a pathfinder project that moves the region one step closer to the APG.

Future projects will need to replicate the successful launch of the LTMS-PIP and make even greater strides in energy cooperation, technical and infrastructural capacities, and market solutions. The research underpinning this report, carried out by the Climate Change in Southeast Asia Programme at the ISEAS – Yusof Ishak Institute, aims to identify region-specific lessons from the LTMS-PIP that can be applied to future multilateral interconnection projects, such as the Brunei Darussalam-Indonesia-Malaysia-Philippines Power Integration Project.

ISEAS researchers undertook a detailed analysis of the LTMS-PIP, including a literature review of country- and region-specific political, technical and economic contexts, and conversations with key stakeholders. In this report, their findings are synthesised in an assessment of best practices, limitations and recommendations for the further expansion of the APG.

To ensure the accuracy of the report, ISEAS organised a closed-door workshop in September 2023 in partnership with the United Nations Economic and Social Commission for Asia and the Pacific, where researchers presented their preliminary findings to expert government officials from Laos, Thailand, Malaysia and Singapore.

To our knowledge, this is the most extensive and holistic study to be carried out on the LTMS-PIP, and we believe it will be a valuable resource for researchers and practitioners working in the field of energy transition in Southeast Asia.

Choi Shing Kwok
Director & CEO
ISEAS – Yusof Ishak Institute

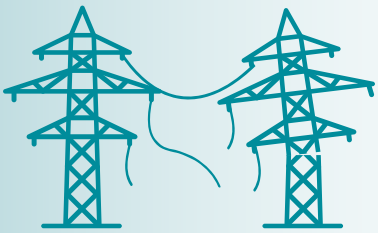
Key Findings

The ASEAN Power Grid (APG) initiative stands at a critical juncture. The implementation of the region's first multilateral pathfinder project, the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP) in 2022, has led to a growing momentum towards regional energy cooperation. The key findings including best practices and recommendations from the LTMS-PIP are as follow:

Develop a **targeted communication strategy** highlighting the positive benefits of regional interconnections for local communities, economic development and the environment. A collective **ASEAN net-zero target** in the power generation sector can motivate collective action and help resolve issues of resource nationalism.

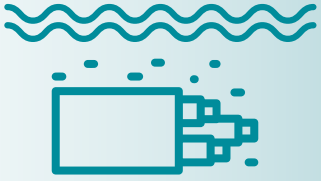
Ensure **continuity of regional energy interconnection plans** by facilitating long-term contracts and developing consistent domestic policies. Develop broad-based support for energy interconnections through **inclusive governance mechanisms** that incorporate the views of multiple stakeholders in the routing of energy grids as well as their social and environmental impacts.

Identify and prioritise **ASEAN Projects of Common Interest (APCI)** to ensure that regional efforts are concentrated towards initiatives that are critical to the APG initiative. APCI can be developed through consultations with energy stakeholders and through collaborative research on the benefits and costs of particular interconnections.



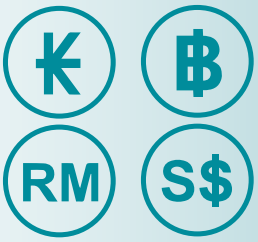
Facilitate the development of **resilient regional interconnection infrastructure** that can withstand the impacts of climate change. Invest in climate modelling of existing and proposed interconnections to identify potential vulnerabilities from extreme weather events. Implement policies to enhance resilience, such as laying grids underground, designing better cooling systems and retrofitting existing infrastructure.

Undertake feasibility studies to examine **the technical, infrastructural, legal, environmental and financial implications of subsea cables.** Conduct cost-benefit analysis of subsea cables compared to overland grids, taking into consideration the impacts on **communities, the environment and geopolitics.**



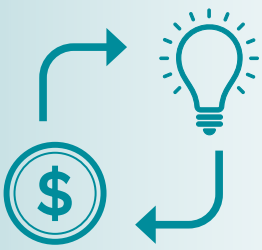
Develop a **common wheeling charge methodology** based on four internationally recognised principles: promoting efficiency; recovering costs; ensuring transparency, fairness and predictability; and promoting non-discriminatory behaviour. Undertake consultations and training on best practices from developed economies, such as the Nord Pool, and emerging economies, such as the Southern African Power Pool.

Include financial institutions and other commercial actors in the Working Groups of interconnection projects. Multilateral Development Banks can play an important role by providing advice on financial inclusivity and assessing the bankability of projects. In some instances, financial institutions may facilitate negotiations between public sector officials and guide the implementation of social and environmental safeguards.



Establish a **regional institution** that can **drive energy integration processes** by sharing real-time data, implementing long-term energy plans, enforcing market regulations, administering payments and coordinating a dispute resolution mechanism. The study on the establishment of the ASEAN Power Grid Generation and Transmission System Planning Institution highlights some key pathways towards regional institution-building.

Upskill the energy workforce in Southeast Asian countries to facilitate the integration of variable renewable energy and enhance resilience and stability of domestic grids. Training and education in collaboration with international partners should focus on the harmonisation of grid and market codes, flexibility, grid congestion, digitalization and enhanced cybersecurity measures.



Utilise coordination and communication to bridge differences in energy markets in the short to medium term, while undertaking **research on the impacts of market reforms on regional energy trade.** In the long-term, apply market reforms that are politically and economically feasible. Protracted efforts to liberalise markets are important, as they send positive market signals to the private sector and play a crucial role in facilitating regional energy integration by providing a framework for efficient and transparent electricity trade, enabling cross-border investments and promoting competition.

Executive Summary

Southeast Asia's first multilateral power trading project, the Lao PDR-Thailand-Malaysia-Singapore power Integration Project (LTMS-PIP), started operations in 2022, more than 20 years after the ASEAN Power Grid (APG) was first proposed as an integrated regional electricity grid system. The success of the LTMS-PIP has led to a renewed momentum in regional energy integration. The project is a potential blueprint for new multilateral initiatives such as the Brunei Darussalam-Indonesia-Malaysia-Philippines Power Integration Project. At the bilateral level, multiple projects are at various stages of negotiation or implementation, including subsea and overland interconnectors between Singapore and Cambodia, Laos and Vietnam, Indonesia and Malaysia, and Singapore and Vietnam.

The region's rising energy demands and the climate imperative have driven contemporary progress in interconnection projects. Demographic and economic pressures will triple electricity demand in Southeast Asia by 2040. Growing economically without paying heed to the environment is no longer tenable as the region is extremely vulnerable to the impacts of climate change. Transitioning to renewable energy is thus of primary importance to regional countries' ability to meet their mitigation targets. One of the key drivers of a successful transition from fossil fuels to wind, solar and other forms of renewable energy in Southeast Asia is multilateral power trade.

The APG is the region's primary blueprint for facilitating energy trade. It aims to integrate the power systems of Southeast Asian countries through cross-border energy interconnections, the harmonisation of rules and procedures, and the development of a regional energy market. Despite being technically feasible and offering multiple benefits towards energy security, economic efficiency and mitigation, the implementation of the APG has been delayed by a number of critical challenges. Given that the APG is critical for the region to develop sustainably, there is a need to systematically identify these challenges and evaluate policy responses.

The success of the LTMS-PIP provides an opportunity for the identification of best practices that can drive the APG as well as the challenges that constrain it. To this end, this report aims to examine lessons from the LTMS-PIP for the development of the APG. Using a mixed-methods research approach including the review of existing literature on power grids, analyses of official documents and published sources, media reports, extrapolation of statistical sources, geographic information system representation, conversations with stakeholders, and feedback from a closed-door stakeholder workshop, the final analysis assesses the contribution of the LTMS-PIP to the regional ambition of expanding existing bilateral arrangements to multilateral and bidirectional energy trade facilitated by reliable, efficient and integrated grids.

This report unpacks the best practices of the LTMS-PIP including the extent of political endorsement received, the coordination and governance structures in place, the level of political and technical maturity in the region, as well as attendant challenges such as technical limitations of aging grid infrastructures, the impacts of climate change and anthropogenic activities on hydropower generation, and the environmental and social impacts of hydropower dams. To derive lessons for the broader APG initiative, the analysis uses lessons from the LTMS-PIP to propose policy pathways that can meet the minimum requirements for multilateral power trade. These are grouped into three categories: political, technical and institutional.

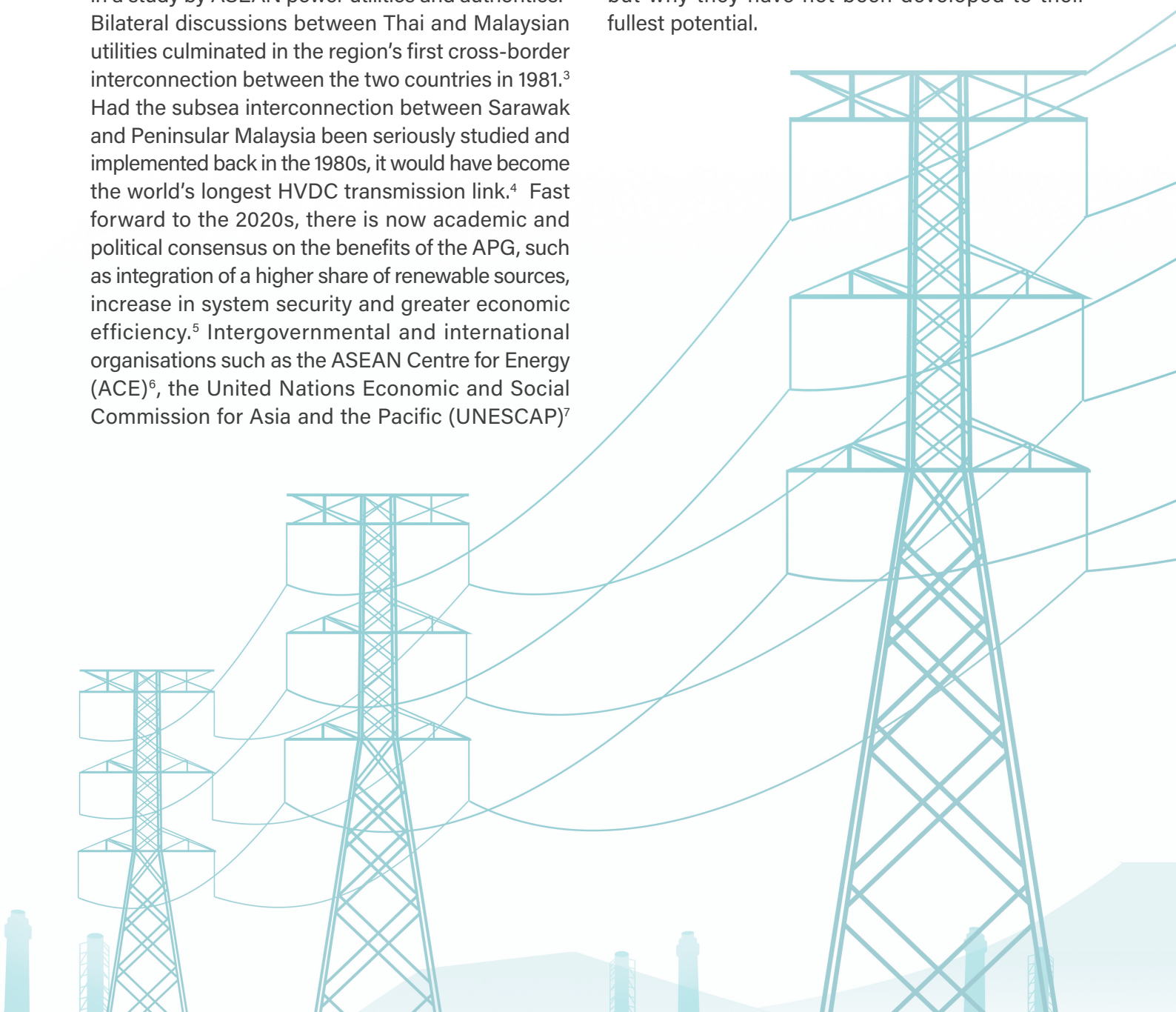
Besides providing recommendations that are contextually relevant for Southeast Asia, this report also studies projects in other regions that successfully met the minimum requirements for multilateral power trade. The findings aim to support the realisation of multiple cross-border projects that are currently being developed. In light of the dynamic and rapidly evolving landscape of interconnections in Southeast Asia, the authors of this report hope to contribute to the development of an 'APG 2.0', where clean-energy trade is facilitated by bidirectional and multilateral grids, sound regional institutions and cross-border trading frameworks.

1 Introduction

Regional interconnections are at the very heart of Southeast Asia's ambition to address increasing energy demand while implementing rapid decarbonisation of the power sector. The ASEAN Power Grid (APG) is an initiative to integrate the power systems of Southeast Asian countries through cross-border energy interconnections, harmonisation of rules and procedures, and the development of a regional energy market.

The technical and economic feasibility of the APG has been established by numerous studies since the initiative was mooted in 1999.[1] The economic rationale of interconnections was elucidated as early as 1979 in a study by ASEAN power utilities and authorities.[2] Bilateral discussions between Thai and Malaysian utilities culminated in the region's first cross-border interconnection between the two countries in 1981.[3] Had the subsea interconnection between Sarawak and Peninsular Malaysia been seriously studied and implemented back in the 1980s, it would have become the world's longest HVDC transmission link.[4] Fast forward to the 2020s, there is now academic and political consensus on the benefits of the APG, such as integration of a higher share of renewable sources, increase in system security and greater economic efficiency.[5] Intergovernmental and international organisations such as the ASEAN Centre for Energy (ACE)[6], the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)[7] and the International Energy Agency (IEA)[8] have identified pathways, trading models and minimum requirements for the realisation of the APG. Yet, thirty years since its conception, the APG and energy integration in Southeast Asia remain at a nascent stage.

Currently, the APG is dominated by bilateral arrangements and less than half of the proposed interconnections have been completed. Given that the feasibility, benefits and prerequisites to the APG have been established, the main puzzle that energy researchers in the region are grappling with is not so much why interconnections should be developed but why they have not been developed to their fullest potential.



This report aims to assess the root causes for the slow progression of the APG and suggests policy responses to address them. It does this by identifying the best practices and challenges of the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP), the region's first multilateral energy trading initiative.

The rationale for undertaking a case study on the LTMS-PIP is to understand the impact of this pathfinder project[a] on the broader APG plan. While the energy trade facilitated through the LTMS-PIP is relatively modest, the project has had an enormous impact on the milieu of energy cooperation in Southeast Asia. The success of the LTMS-PIP has led to a growing momentum in regional energy cooperation.

The Brunei Darussalam-Indonesia-Malaysia-Philippines Power Integration Project (BIMP-PIP)[9] announced at the 41st ASEAN Ministers on Energy Meeting (AMEM) in August 2023 aims to follow the LTMS-PIP's example. In addition, several bilateral interconnections that were not part of the original APG plan are now at various stages of development (Figure 7). Statements by the AMEM and the ASEAN Power Grid Consultative Committee (APGCC) have attributed the contemporary progress in energy integration to the success of the LTMS-PIP.[10]

The contemporary drive towards integration—buoyed by strong political will, increased commercial interest, the need to meet the countries' Nationally Determined Contributions[11] as public demand for climate ambition grows,[12] and the promise of technological innovation—may lead to a new era of energy interconnections that can be envisioned as an 'APG 2.0' where reliable, efficient grids facilitate multilateral, multidirectional and real-time trade in renewable energy. In addition to physical infrastructure, the APG 2.0 will require sound regional institutions, innovative financial tools, integrated markets and highly skilled labour forces.

Yet, the path to better and more robust interconnections is impeded by a number of critical challenges. The experience of the LTMS-PIP offers an opportunity to understand how challenges to integration can be overcome and what more can be done to facilitate bidirectional, multilateral energy trade.

This report aims to contribute to the contemporary momentum in regional energy interconnection projects by identifying key policy considerations in the LTMS-PIP that can accelerate multilateral power trade through the APG. The research aims to identify the technocratic, political and economic processes that facilitated the successful implementation of the initiative, which can inform the development of similar projects in other parts of Southeast Asia. It also aspires to contribute to the regional goal of re-envisioning the succeeding APG agreement, following the anticipated expiration of the current memorandum of understanding in 2025.

The report is divided into eight sections. The first is the introduction, followed by a description of the methodology. The third section provides an overview of the importance of regional interconnections to energy transition. The fourth describes the LTMS-PIP, while the fifth and sixth sections delve into the best practices and challenges gleaned from the LTMS-PIP. The seventh section describes the implications of the LTMS-PIP for meeting the minimum political, technical and institutional requirements of the BIMP-PIP and the broader APG initiative, followed by a conclusion.

[a] The LTMS-PIP has been called a 'pathfinder' as it demonstrates the feasibility of multilateral power trade beyond immediate neighbouring countries in Southeast Asia.

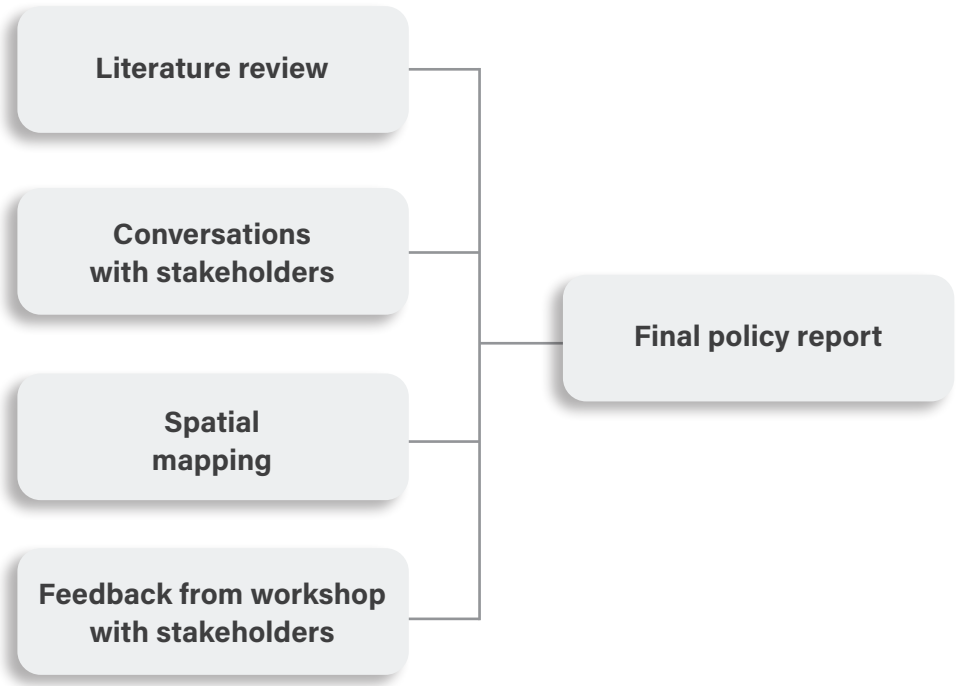
2 Methodology

This report uses a mixed-methods research approach. As seen in Figure 1, the methodology has four components. First, we undertook a review of existing literature on the LTMS-PIP and the APG. The literature review covered reports, media releases and journal articles. While substantial research exists on the APG, there is less literature on the LTMS-PIP due to it being a relatively new project. Data was also collected through conversations with public and private stakeholders in the energy sector in ASEAN on a non-attributable basis. Between April and August 2023, the authors of this report held more than 30 meetings with energy stakeholders in Laos, Thailand, Malaysia and Singapore (Annex A). A majority of these meetings included government officials employed at utility companies, regulatory bodies and policy ministries in the four LTMS-PIP countries. The researchers also interacted with civil society organisations, academia and other private sector stakeholders. The conversations were useful for understanding stakeholder perceptions regarding the drivers and challenges of the LTMS-PIP.

The methodology also included the use of geographic information system (GIS) software to develop spatial representations of grid infrastructures. Figures 2, 4 and 7 were developed through ArcGIS Pro 2.9.5, using a series of open-sourced datasets. Administrative boundaries of all ten Southeast Asian countries were first visualised on ArcGIS Pro. Electricity grid lines were extracted from Overpass Turbo, a web-based data-mining tool for OpenStreetMap. To ensure that the plotting of the interconnections was accurate and reflective of the real world, cross-checking of the names of the interconnection projects with their locations on Google Maps was conducted before they were mirrored over to ArcGIS Pro. Manual drawing and labelling were used to illustrate upcoming projects under the APG.

The final step was soliciting feedback on initial research findings from a hybrid closed-door workshop held in Bangkok on 14 September 2023. More than twenty participants attended the workshop, which included stakeholders from LTMS. At the workshop, the authors of the report delivered a presentation on the preliminary findings of the literature review, fieldwork and GIS mapping. Feedback on the research findings from the stakeholders of LTMS were then incorporated into the study.

Figure 1. Summary of Methodology for the Policy Report



3 The ASEAN Power Grid and Energy Transition in Southeast Asia

Southeast Asia is expected to become the fourth-largest economy in the world with a population of 770 million by 2040.[13] ASEAN's gross domestic product (GDP) is projected to grow 4.4 per cent annually in the next five years, making it the second-fastest-growing economy after India.[14]

Demographic and economic pressures will triple electricity demand from 1,002 terawatt-hours (TWh) in 2017 to 3,123 TWh in 2040.[15] In 2020, more than 76 per cent of electricity generation in the region was dependent on fossil fuels.[16] In a business-as-usual scenario, coal accounts for the largest share of electricity generation in the region—as much as 25 per cent, causing ASEAN's CO_2 emissions to increase by nearly 2.5 times, from 1,686 metric tonnes (Mt) in 2017 to 4,171 Mt by 2040, which will undermine the region's ability to meet its climate targets as well as environment and energy security.[17]

In the last decade, momentum in energy transition in Southeast Asia has been increasing (Annex B). In 2020, more than 80 per cent of new power generation capacity in the region was from renewable sources.[18] The collective regional ambition of achieving 23 per cent renewable energy in total primary energy supply, along with a 35 per cent share of renewable energy in installed capacity by 2025,[19] has led to increased investments in wind, solar and hydropower in several Southeast Asian countries (Table 1). Despite the positive momentum, renewable energy makes up only 33 per cent of the region's total installed capacity and 14.2 per cent of the total primary energy supply as of 2020.[20]

Table 1. Selected Major Renewable Energy Projects Completed in 2020-2021

Project	Country	Capacity	Year completed
Solar Power Farm, Thuan Nam	Vietnam	450 MW	2020
Floating Solar, Dengkil Selangor	Malaysia	13 MW	
Floating Solar, Ubon, Ratchathani	Thailand	12.5 MW	
Hydro-Floating-Solar Hybrid, Sirindhorn Dam		45 MW	2021
Sembcorp Tengeh **Floating Solar Farm**	Singapore	60 MW	

Source: Compiled by authors

A number of challenges have impeded the rapid deployment of renewables, including the lack of finance, provision of fossil fuel subsidies, entrenched corporate and political interests in coal, and poor government policies. One challenge to energy transition that is frequently mentioned is the gap in finance.[21] While the region needs investments of around US$230 billion annually up to 2050 to meet the 1.5°C target, the annual average energy investment in Southeast Asia is approximately US$70 billion; out of these, less than US$30 billion are funds allocated to renewables.[22] In terms of international public development finance, only around US$12.8 billion flowed to the region's energy sector

Table 2. Regional Grids Around the World

Regional Market	Level of Integration	Year of Establishment	Total Capacity
Eastern Africa Power Pool	Early stage of market integration	2005	60.7 GW (2015)
Greater Mekong Subregion		1995	118.9 GW (2012)
Central America Power Market	Shallow market integration	2013	16.5 GW (2016)
South African Power Pool		1995	62 GW
European Union	Deep market integration	1990s (creation of Nordpool) 2018 (intraday market involving 14 countries)	995 GW (2017)
Western Energy Imbalance Market		2014	No data

Source: IRENA (2019), Innovation Landscape Brief: Regional Markets, International Renewable Energy Agency, Abu Dhabi

from 2000–2019.[23] Another impediment to energy transition that is often overlooked is the low number of regional interconnections relative to potential.

At the global level, regional interconnections play an increasingly important role in energy transition. Interconnections have a number of advantages. First, they facilitate the utilisation of multiple types of clean and renewable sources, which can be used to overcome the intermittent nature of solar and wind power. Second, interconnections can provide economies of scale, thereby offering wider energy access and greater investment in renewable energy projects. Third, interconnections increase system reliability and flexibility, while also enhancing energy security and regional integration.[24] As seen in Table 2, multiple regions, from Europe to Central America and Africa, have developed multilateral grids and related market systems and policies to exploit the benefits of interdependence. The level of cooperation varies from region to region, ranging from early stage to deep market integration (Table 3).

In Southeast Asia, the APG was included in the ASEAN Plan of Action for Energy Cooperation (APAEC) as early as 1999. The goal of the APG is to increase physical interconnections and facilitate the harmonisation of markets and procedures. Improved integration through the APG could save US$1.87 billion by 2025, while increasing the utilisation of the region's abundant renewable energy resources.[25] As shown in Annex C, several important studies and agreements have been signed for the APG under the auspices of organisations such as the Heads of ASEAN Power Utilities/Authorities (HAPUA)[b] and the ASEAN Power Grid Consultative Committee (APGCC)[c] in the last decade.

[b] HAPUA aims to promote cooperation among its members to strengthen regional energy security through interconnection development and enhancing private sector participation, and to improve the quality and reliability of electricity supply systems.

[c] The APGCC aims to strengthen and promote a broad framework for member countries to cooperate towards the development of a common ASEAN policy on power interconnection and trade, and ultimately towards the realisation of the APG.

Table 3. Stages in the Development of Regional Power Markets

Market Integration Level	Interconnectivity Level	Trading Arrangements	Harmonisation Rules
Early stage	Physical interconnection between two countries	Long-term, bilateral, over-the-country power purchase agreements (PPAs)	Simple rules agreed for the operation of the interconnection system
Shallow	Physical interconnection between several neighbouring countries	Long-term PPAs supplemented with short-term wholesale markets	Harmonisation of market rules, grid codes and transmission tariffs
Deep	Full synchronous operation of a multi-country interconnected system	Well-functioning markets with competition achieved through trading in different timeframes and various markets	Regional regulatory agencies, regional market operators, and harmonisation of market rules, grid codes and transmission tariffs

Source: IRENA (2019), Innovation Landscape Brief: Regional Markets, International Renewable Energy Agency, Abu Dhabi

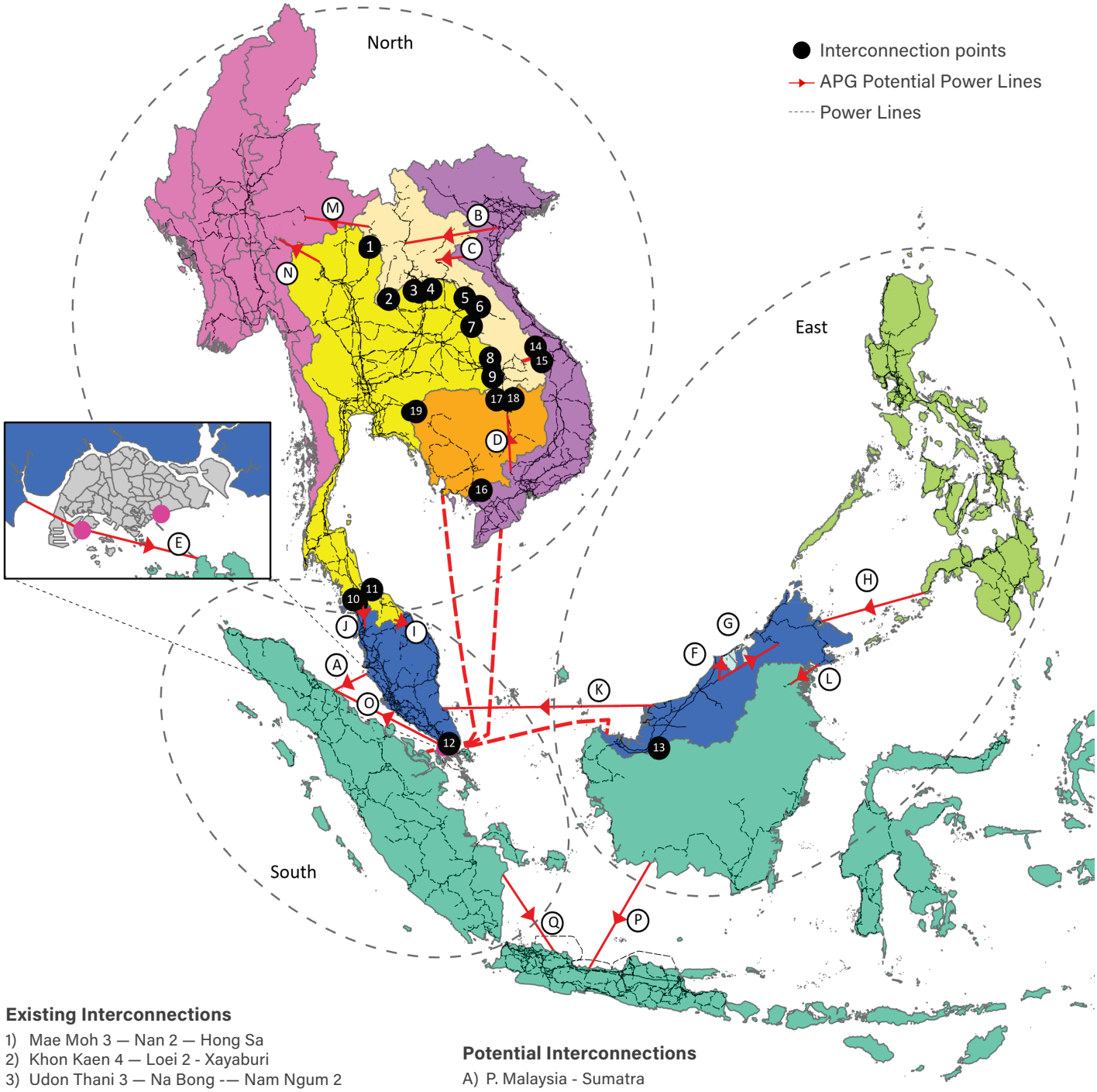
The APG is envisioned as progressing through three steps: starting with bilateral trade, followed by subregional trade and, finally, an integrated regional system. The initiative is divided into three subregions: North System (Cambodia, Lao PDR, Myanmar, Thailand and Vietnam), South System (Indonesia, Malaysia and Singapore) and East System (Brunei Darussalam, Indonesia, Malaysia and the Philippines).[26] Currently, energy trade is dominated by bilateral exchanges that are mostly undertaken through long-term power purchase agreements, particularly in the Greater Mekong Subregion (GMS).[d] While eight out of ten ASEAN countries have cross-border interconnections, many of these infrastructures are used for mitigating emergencies rather than for energy trade.

As shown in Figure 2, 19 out of 36 projects across 18 identified borders[27] have been completed, increasing regional cross-border transmission capacity to 7,720 MW. To meet the regional goal of 23 per cent renewable energy in its total primary energy supply by 2025, interconnection capacity needs to be increased to 19,918 MW.[28] If planned interconnections are completed, the future capacity of the APG can range from 18,369–21,769 MW.[29]

The success of the LTMS-PIP has raised prospects for the timely completion of the ten key interconnections planned under the APG and several others that are not covered in the original APG plan. Despite the positive momentum, completing these interconnections and moving towards the APG 2.0 vision as described above will require addressing critical challenges. In this context, the best practices and lessons learnt from the LTMS-PIP pathfinder may offer some valuable policy insights.

[d] The Greater Mekong Subregion (GMS) comprises five ASEAN countries—Cambodia, Laos, Myanmar, Thailand and Vietnam—as well as the Guangxi Zhuang Autonomous Region and Yunnan Province of China. Currently, cross-border grid-to-grid transmission interconnections are approximately 100- to 1,500-kilometre long and carry power transfers exceeding 1,000 MW. Of the five ASEAN members in the GMS, Thailand and Vietnam have the most extensive 500 kV and 220 kV networks that export electricity from Laos. For more information, please see https://www.adb.org/sites/default/files/publication/846471/power-trade-greater-mekong-subregion_0.pdf.

Figure 2. The ASEAN Power Grid



Existing Interconnections

1) Mae Moh 3 — Nan 2 — Hong Sa
2) Khon Kaen 4 — Loei 2 - Xayaburi
3) Udon Thani 3 — Na Bong -— Nam Ngum 2
4) Udon Thani 3 — Na Bong
5) Nakhon Phanom - Thakhek — Theun Hinboun
6) Nakhon Phanom 2 - Thakhek — Theun Hinboun
7) Roi Et 2 — Suvannakhet — Nam Theun 2
8) Ubon Ratchathani 2 - Houay Ho
9) Ubon Ratchathani 3 — Pakse -— Xe Plan Xe Namnoi
10) Sadao- Chuping
11) Khlong Ngae - Gurun
12) Plentong - Woodlands
13) West Kalimantan - Sarawak
14) Xekaman 1 — Pleiku 2
15) Xekaman 3 — Thanh My
16) Chau Doc — Takeo — Phnom Penh
17) Ban Hat- Kampong Sralao
18) Ban Hat- Stung Treng
19) Watthana Nakhon — Aranvaprathet — Industrial Estate

Potential Interconnections

A) P. Malaysia - Sumatra
B) Lao PDR-Vietnam (Nam Mo-Ban Ve)
C) Lao PDR-Vietnam (Luang Prabang-Nho Quan)
D) Vietnam-Cambodia (Tay Ninh-Stung Treng)
E) Singapore -Batam
F) Sarawak-Brunei
G) Sarawak-Sabah
H) Philippines-Sabah
I) Su Ngai Kolok — Rantau Panjang
J) Khlong Ngae — Gurun
K) Sarawak - P. Malaysia
L) East Sabah — North Kalimantan
M) Lao PDR — Myanmar
N) Thailand — Myanmar
O) Singapore - Sumatra
P) Kalimantan - Java
Q) Sumatra - Java

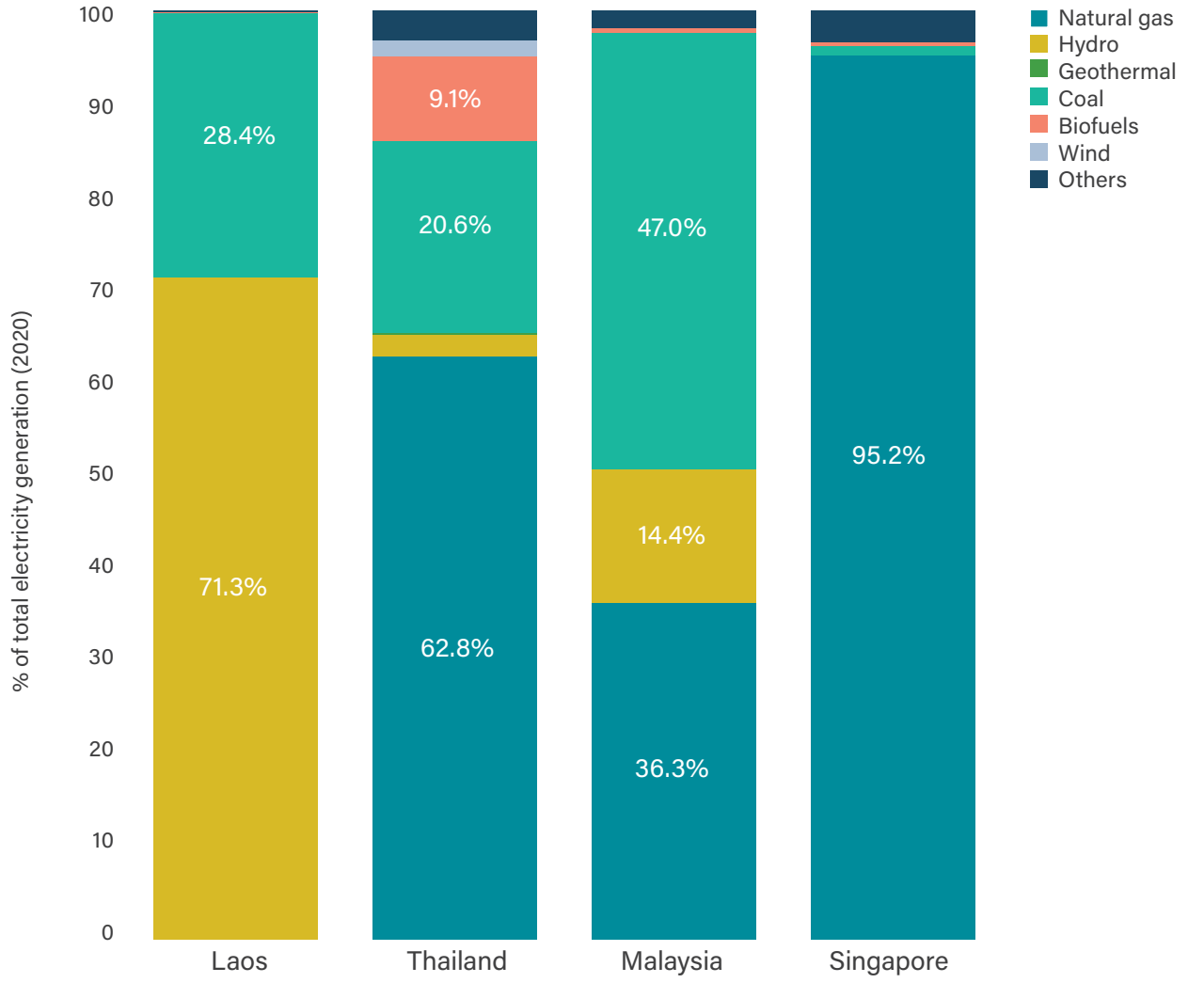
Map created by ISEAS-Yusof Ishak Institute © (2023) (Subject to scale)

4 The Pathfinder: An Overview of the LTMS-PIP

The LTMS-PIP was first proposed in 2013 at the ASEAN Senior Officials Meeting on Energy in Manado, Indonesia.[30] The LTMS-PIP was initially implemented as the LTM-PIP (without Singapore) in 2018, which involved the transfer of 100 MW of electricity from Laos to Malaysia. In 2022, Singapore joined the project, and currently the LTMS-PIP facilitates the import of up to 100 MW of electricity from Laos to Singapore via Thailand and Malaysia using existing interconnections (Figure 4). The current agreement lasts until 2024, after which the volume of import may be increased to 300 MW and the project length extended from two to five years. The motivation for the LTMS-PIP was the enormous hydroelectric potential of Laos and increasing energy demand in neighbouring countries. Currently, 78 dams are operational in Laos with a generation capacity of approximately 8,108 MW as of 2021.[31]

Meanwhile, Singapore plans to import as much as 4 GW of low-carbon electricity by 2035.[32] The LTMS-PIP pathfinder is believed to be an economically viable project because of the demand for clean energy in Singapore and the excess capacity in Laos. The project will also contribute towards reducing the use of fossil fuels, which dominates the electricity mix of all LTMS countries with the exception of Laos (Figure 3).

Figure 3. Electricity Generation by Source (2022)



Source: International Energy Agency (2022), World Energy Statistics and Balances, IEA

As shown in Tables 4 and 5, the LTMS-PIP navigated different domestic electricity market structures and also different peak loads and reserve margins. Singapore operates a liberalised electricity market, Thailand operates under an enhanced single-buyer model, while Malaysia and Laos have single-buyer markets. Laos and Malaysia have relatively high reserve margins, while electricity imports are set to become a key element of Singapore's energy security.

Table 4. Energy Sector Structures of LTMS Countries

Country	Type of Domestic Power Market	Generation	Transmission	Distribution
Laos	Single-buyer	▪ Électricité du Laos ▪ Independent power producers	Électricité du Laos	
Thailand	Enhanced single-buyer	▪ Electricity Generating Authority of Thailand ▪ Independent power producers	Electricity Generating Authority of Thailand	▪ Provincial Electricity Authority (PEA) ▪ Metropolitan Electricity Authority (MEA)
Malaysia	Single-buyer	Independent power producers	Tenaga Nasional Berhad	
Singapore	Liberalised	▪ SP Group ▪ Independent power producers	SP Group (SP PowerAssets, SP PowerGrid)	

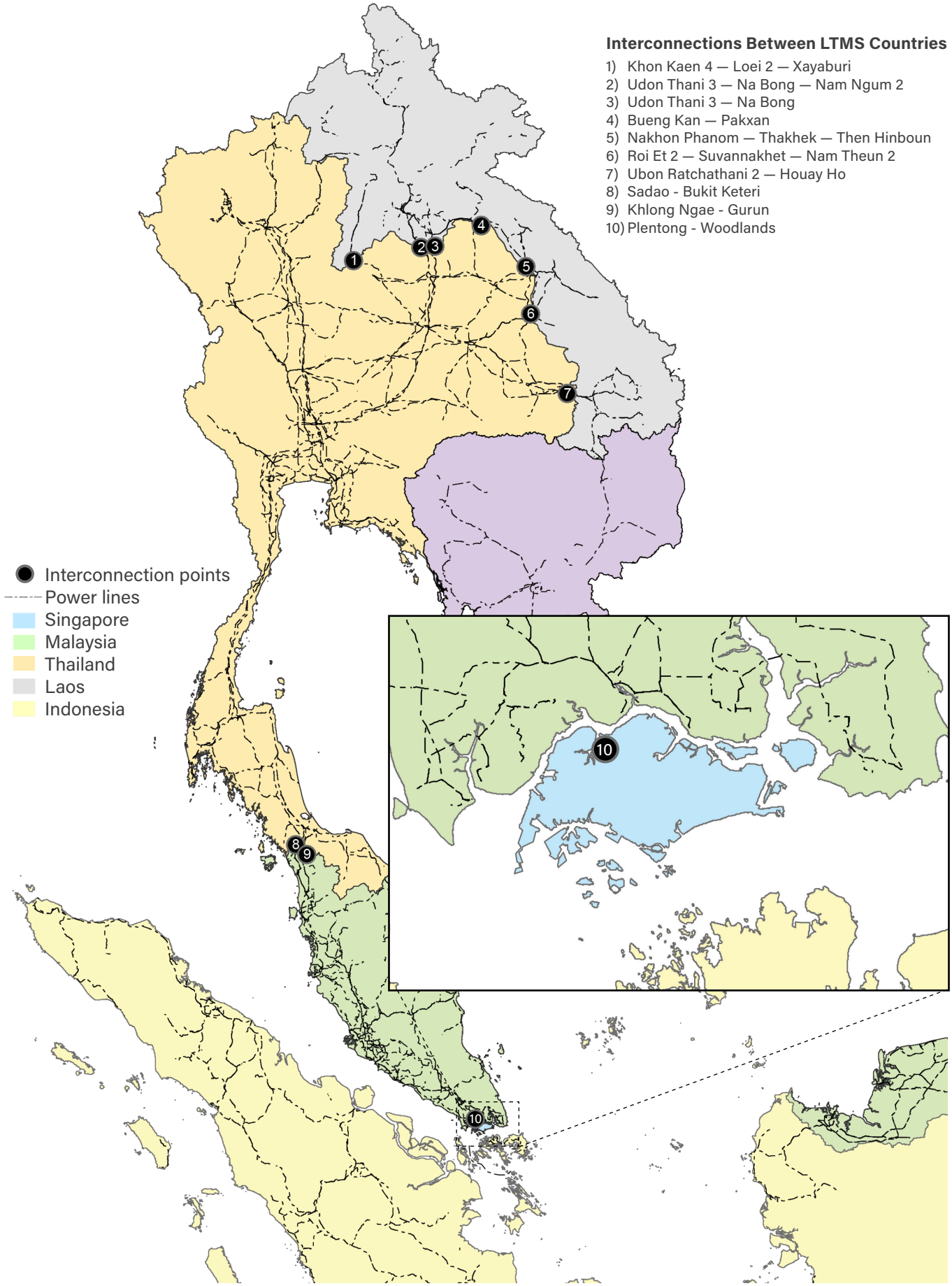
Source: Compiled by authors

Table 5. Electricity Industry Statistics of LTMS Countries

Country	Total Electricity Generated (Excluding Imports)	Peak Load	Total Imports	Total Exports	Reserve Margins
Laos	19,862 GWh (2022)	1,540 MW (2022)	872.57 GWh (2022)	5,547.85 GWh (2022)	52.6% (2023 forecast)
Thailand	215,838 GWh (2022)	33,177 MW (2022)	35,471.76 GWh (2022)	1,327 GWh (2022)	34% (2022)
Malaysia	17,479 GWh (2021)	18,808 MW (2020)	17.96 GWh (2020)	1,571 GWh (2020)	52% (2021 projected)
Singapore	55.8 TWh (2021)	7.8 GW (2022)	270 GWh (Jun 2022–Aug 2023 under LTMS-PIP)	NA	50% (2022)

Source: Compiled by authors

Figure 4. The Lao PDR-Thailand-Malaysia-Singapore Power Integration Project



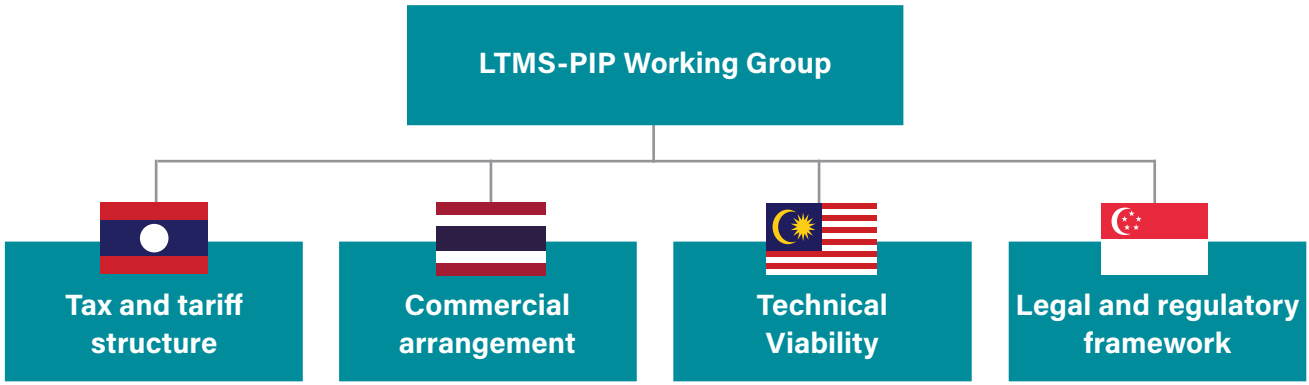
Map created by ISEAS-Yusof Ishak Institute © (2023) (Subject to scale)

Cooperation under the LTMS-PIP is framed by four main agreements. Keppel Electric Pte Ltd, a subsidiary of Keppel Infrastructure Holdings Pte Ltd, and Électricité du Laos signed an exclusive framework agreement in 2021 and a two-year power purchase agreement in 2022. To facilitate the transit of electricity through Thai and Malaysian grids, separate energy wheeling agreements were signed between Électricité du Laos and the Electricity Generating Authority of Thailand and Tenaga Nasional Berhad respectively.

The LTMS-PIP is governed by a working group and four taskforces focusing on technical viability; legal and regulatory framework; commercial arrangement; and tax and tariff structure. As seen in Figure 5, each country led a taskforce, which collectively contributed to the development of the project.

In the coming years, the outcomes of the LTMS-PIP are likely to determine how the broader goal of regional energy integration is conceived and implemented in ASEAN. The following sections share some of the best practices and challenges of the project.

Figure 5. Governance Structure of the LTMS-PIP



5 Best Practices of the LTMS-PIP

5.1 Political Endorsement

Political leadership is one of the key prerequisites to the development of multilateral grids.[33] Cross-border grids require large investments and face a number of security, environmental and political challenges.[34] In Central and South Asia, governments have played a key role in driving the momentum for energy integration by developing institutional frameworks and legislation that facilitate cooperation, providing incentives to investors and financing upfront costs.[35]

Research on energy integration points towards two mechanisms for the endorsement of energy integration by political leaders.[36] The first involves the championing of cross-border projects to domestic and international audiences, which builds broad support for energy integration.[37] The second mechanism is the alignment of national development plans, such as power development plans, with regional goals.[38] Both these mechanisms of political endorsement were used by governments to drive the LTMS-PIP.

Public stakeholders employed multiple channels to build support for the LTMS-PIP. The project has been mentioned in every Joint Ministerial Statement from the 32nd to the 41st AMEM over a span of nine years. The key messages in these statements prior to the implementation of the project had focused on the importance of developing feasibility studies and governance frameworks to facilitate energy trade. After the project commenced in 2022, the AMEM statements expressed the collective goal of examining opportunities to expand the generation capacity of the LTMS-PIP and to use the experience

to develop other multilateral grids in Southeast Asia.[39] In addition, the energy ministers of LTMS-PIP countries released four joint statements on the project between 2014–2023 on the sidelines of the AMEM, which further publicised political consensus on the project.[40]

The LTMS-PIP and the broader vision of the APG also received mention in discussions at the highest levels in countries involved in the project[41] and in statements by foreign ministry officials.[42] At the 43rd ASEAN Summit, the development of the APG was mentioned by regional leaders as a key pathway to economic prosperity and deeper regional integration.[43]

The second mechanism—aligning regional energy goals with domestic power development plans—was also effectively utilised by Southeast Asian governments (see Table 6). Malaysia's National Energy Transition Roadmap,[44] launched in August 2023, emphasises cross-border trade as a key pathway for enhancing energy security and reducing greenhouse gas emissions. Laos' Electricity Development Strategy aims to enhance trade with ASEAN countries,[45] while Singapore envisions the import of up to 4 GW of low-carbon electricity by 2035.[46] Political endorsement of the LTMS-PIP through statements and policy documents is one of the key factors that contributed to the success of the project, and this approach can be replicated for future cross-border grid projects.

Table 6. Selected Energy Policies/Planning Documents of LTMS Countries

Plan/Policy Document	Key Energy- and Climate-related Targets/Actions
Laos	
Electricity Development Strategy of Lao PDR (2021–2030)	▪ Develop an electricity mix of 75% hydropower, 14% coal thermal power and 11% renewable energy ▪ Develop transmission systems and stations domestically ▪ Develop connections for electricity trade in the Greater Mekong Subregion and ASEAN ▪ Back up power production to reach 15 per cent of total demand ▪ Electricity exports to reach over 9,000 MW to Thailand, 5,000 MW to Vietnam, 3,000 MW to Cambodia, 500 MW to Myanmar and 300 MW to Malaysia
Thailand	
National Energy Plan	▪ Focus on clean-energy transition to achieve carbon neutrality by 2050 ▪ Increase share of new renewable power plants to more than 50% ▪ Energy efficiency greater than 30% ▪ Implement 4D1E strategy: Decarbonisation, digitalisation, Decentralisation, Deregulation and Electrification
Power Development Plan 2018 Revision 1 (2018–2037)	▪ Increase share of renewable generation to more than 50% ▪ Transition away from imported coal ▪ CO2 emissions to reach below 63 MtCO2e
Malaysia	
Malaysia Renewable Energy Roadmap (2021)	▪ Increase share of renewable energy to 31% by 2025 and 40% in 2035
National Energy Transition Roadmap (2023)	▪ Installed renewable capacity of 70% by 2050 ▪ Allow cross-border renewable energy trade
Singapore	
Singapore Green Plan 2030 (2021)	▪ Increase solar energy deployment to at least 2 gigawatt-peak by 2030
Media release by Energy Market Authority (2021)	▪ Import up to 4 GW of electricity by 2035

Source: Compiled by authors

5.2 Coordination and Governance Structures

Cross-border energy projects require a high level of coordination across multiple types of stakeholders. Coordination is required to harmonise grid codes, exchange information, increase energy security and develop protocols for trade and emergencies. Studies show that technocratic cooperation facilitated by effective institutions and governance frameworks can play a key role in energy integration and natural resource management.[47]

As mentioned, coordination of the LTMS-PIP was facilitated by the Working Group and four Taskforces. This framework was seen as widely successful in bringing officials from utilities, regulatory bodies and ministries to coordinate energy trade. The structure of the Working Group allowed equal participation, without the need to cede control of national energy generation and transmission infrastructures. In addition, by allocating portfolios to each country, the Taskforces took ownership of the coordination process and the project itself.[48] The Working Group also provided a flexible mechanism for other countries to join the project, even if it was not involved from the beginning. This flexible arrangement facilitated Singapore's participation in the LTMS-PIP after the LTM project was already up and running.[49]

One key impediment to the LTMS-PIP was the difference between Singapore's open, liberalised electricity market and the single-buyer model in other countries. The energy sectors in the LTMS-PIP countries also differ in decision-making structures and communication protocols. To overcome these differences in energy markets, the LTMS-PIP Working Group prioritised coordination rather than consolidation, which has been suggested by researchers as a pragmatic pathway towards regional energy integration.[50] The Working Group meetings brought together high-level officials to identify priorities in cooperation, while the groundwork in coordinating the project was carried out through more than a hundred meetings between technocrats. These meetings were crucial in providing training and information that helped bridge differences in market structures and developing common protocols on trade, regulation, emergencies and information sharing. To account for differences in market structures, existing balancing mechanisms and interconnection operations were updated to prevent financial risks to wheeling countries (Thailand and Malaysia). A new web-based communication platform was also developed to facilitate coordination between system and market operators.

Overall, the Working Group facilitated a high level of coordination across different levels of seniority in ministries, utilities and other institutions. The Working Group structure provided an important and flexible approach to coordinating cross-border projects, which can be replicated with contextual adjustments for other cross-border grids in Southeast Asia.

5.3 Policy and Technical Maturity

Regional energy trade is contingent on a highly skilled workforce. Engineers, economists, financial experts, lawyers, negotiators and other stakeholders involved in energy trade need to be aware of the latest technological developments, innovative means of finance as well as technical and financial disparities within a regional market. One of the key factors for the success of the LTMS-PIP is the growing policy and technical maturity among stakeholders in ASEAN.

The level of professionalism of the energy workforce in ASEAN is partly an outcome of capacity-building exercises undertaken with international partners. In conversations with stakeholders, the cooperation between Germany and Vietnam was highlighted as having a particularly strong impact on the development of wind power generation in ASEAN. This type of collaboration has a spillover effect on the whole region and multiple countries can benefit from the exchange of knowledge and best practices. For example, a Thai company is currently leading the Monsoon Wind Power Project in southern Laos, which will export electricity to Central Vietnam. Other examples of capacity-building include the US Agency for International Development's (USAID) Regional Southeast Asia Smart Power Program that focuses on knowledge sharing on advancing power trade and grid integration.[51]

Capacity-building programmes such as those highlighted above were perceived by stakeholders as a key factor that enhanced the skills required to implement the LTMS-PIP.

6 Challenges of the LTMS-PIP

6.1 Technical Limitations

The LTMS-PIP is a multilateral project because it involves more than two countries. However, its trade and power flows are unidirectional and there is no framework allowing energy trade between multiple combinations of participating countries, e.g., Malaysia and Laos, Singapore and Thailand.[52] The LTMS-PIP is thus limited in scope, and its lack of multidirectional power flow and the absence of a framework that allows trade between all four countries have cast doubt on whether it truly is a multilateral project.[53]

One critical technical challenge to energy trade in ASEAN is the region's aging grid infrastructures. The use of variable renewable energy can pose challenges to grid stability, increase operational costs of grids and decrease effective utilisation hours.[54] The LTMS-PIP currently uses domestic infrastructures to transfer electricity. Several officials expressed concern regarding the reliability of existing infrastructures in conversations with the researchers. In addition, the current maximum capacity of the grids used for the LTMS-PIP is 300 MW, which will limit the expansion of the project in the future.

Some measures are being taken to upgrade the interconnections between LTMS-PIP countries. For example, Singapore and Malaysia have upgraded their interconnection between Plentong in Johor Bahru and Woodlands in Singapore to accommodate 1,000 MW in 2022.[55] Thailand and Malaysia are undertaking feasibility studies on the upgrading of the Sadao–Chuping and Khlong Ngae–Gurun interconnections. While these developments are encouraging, some stakeholders shared that the capacity of the hydropower dams in Laos that supply electricity to the LTMS is also limited, which indicates that an expansion of the LTMS-PIP may require importing electricity from other hydropower dams in Laos or energy plants in Thailand or Malaysia.

Another key challenge to energy cooperation highlighted by the LTMS-PIP is the diversity of views among stakeholders regarding the formulation of the wheeling charges. Some stakeholders opined that the wheeling charges were too high, while others felt that they were too low. Overall, most stakeholders indicated that the wheeling charges of the LTMS was not developed according to any strict formula, but rather with an attitude to greater cooperation with a view to start the project as soon as possible. The LTMS-PIP experience reveals that wheeling charges for proposed interconnections can be a complex issue that requires building consensus between stakeholders with different starting points for cooperation.

6.2 The Impact of Climate Change and Human Activities on Hydropower Generation

Currently hydropower accounts for around 20 per cent of Southeast Asia's energy mix.[56] Climate change is expected to have an adverse impact on the capacities of the region's hydropower dams. Inconsistent waterflows from intense rainfalls and prolonged droughts will reduce hydropower capacity in Cambodia, Lao PDR, Myanmar, Thailand and Vietnam. Hydropower capacity of Southeast Asia is expected to decrease by 5.9 per cent in the Below 2°C Scenario and by 8.2 per cent in the Above 4°C Scenario.[57]

Conversations with stakeholders revealed that the impacts of climate change on hydropower generation are already being felt today. Droughts have led to declines in the capacities of hydropower dams that supply electricity to the LTMS-PIP. This issue is not limited to Laos. In June 2023, the El Niño season reduced the availability of water for hydropower generation in Vietnam, resulting in blackouts.[58] Stakeholders expressed that El Niño can be an important factor in the development of hydropower as a renewable energy source in the future.

Hydropower capacity in Laos is also threatened by anthropogenic activities. Communities living around certain hydropower dams are economically marginalised and engage in the plantation of cash crops such as cassava through slash-and-burn agriculture. In addition to the climate impacts of deforestation, slash-and-burn activities also reduce hydropower generation by increasing sedimentation in the reservoir, thus slowing waterflow through the generation turbines. There have been some measures to provide alternative livelihoods to communities such as rice planting and fishing, as well as efforts to increase awareness about the impacts of slash-and-burn activities on the environment.

6.3 Environmental and Social Impacts of Hydropower Dams

The electricity traded through the LTMS-PIP comes from hydropower dams that existed prior to the commencement of the project in 2022. Laos implemented a domestic environmental impact assessment process starting in 2010,[59] with room for improvement. Conversations with stakeholders revealed some differences in perception regarding the environmental impacts of developing hydropower dams in Southeast Asia. Some stakeholders feel that environmental and social impacts of hydropower dams can be minimised, while others view that large dams have irreversible impacts on communities and biodiversity. To counter the externalities of large dams, stakeholders recommended a continuous process of measuring and responding to impacts on the environment and communities. Corporate social responsibility programmes can benefit the nearby communities through the provision of education and healthcare facilities.

7 From LTMS-PIP to BIMP-PIP and APG 2.0: Challenges and Recommendations

As mentioned earlier, the LTMS-PIP has provided much-needed momentum for regional interconnections in Southeast Asia. New subsea cable projects are being considered between Peninsular Malaysia and Sarawak, Peninsular Malaysia and Sumatra, Singapore and Sarawak, Cambodia and Singapore, Vietnam and Singapore, and Indonesia and Singapore, which would benefit from the lessons of the LTMS-PIP (please see Figure 7). Further afield, there are projects under discussion between Singapore and Australia as well as Singapore and India via the Andaman and Nicobar Islands.[60]

The LTMS-PIP has also provided a boost to multilateral projects such as the BIMP-PIP. The BIMP project is underpinned by the Brunei Darussalam-Indonesia-Malaysia-Philippines East ASEAN Growth Area,[61] a subregional cooperation initiative established in 1994 focusing on economic collaboration between these countries. Launched at the 41st AMEM in 2023, the BIMP-PIP envisions interconnections between the grids of the four countries by 2025. Currently a US$2 million feasibility study on the BIMP-PIP is being undertaken with support from the USAID.[62] The BIMP-PIP includes the Trans Borneo Power Grid,[e] which facilitates the export of hydropower from Sarawak to West Kalimantan via a 275-kilovolt grid-to-grid transmission line.[63] The BIMP-PIP is an ambitious project that envisions as many as 17 interconnections between the four countries (Annex D). A study by the Economic Research Institute for ASEAN and East Asia (ERIA) demonstrates that the BIMP-PIP will reduce the use of fossil fuels and result in lower electricity prices.[64]

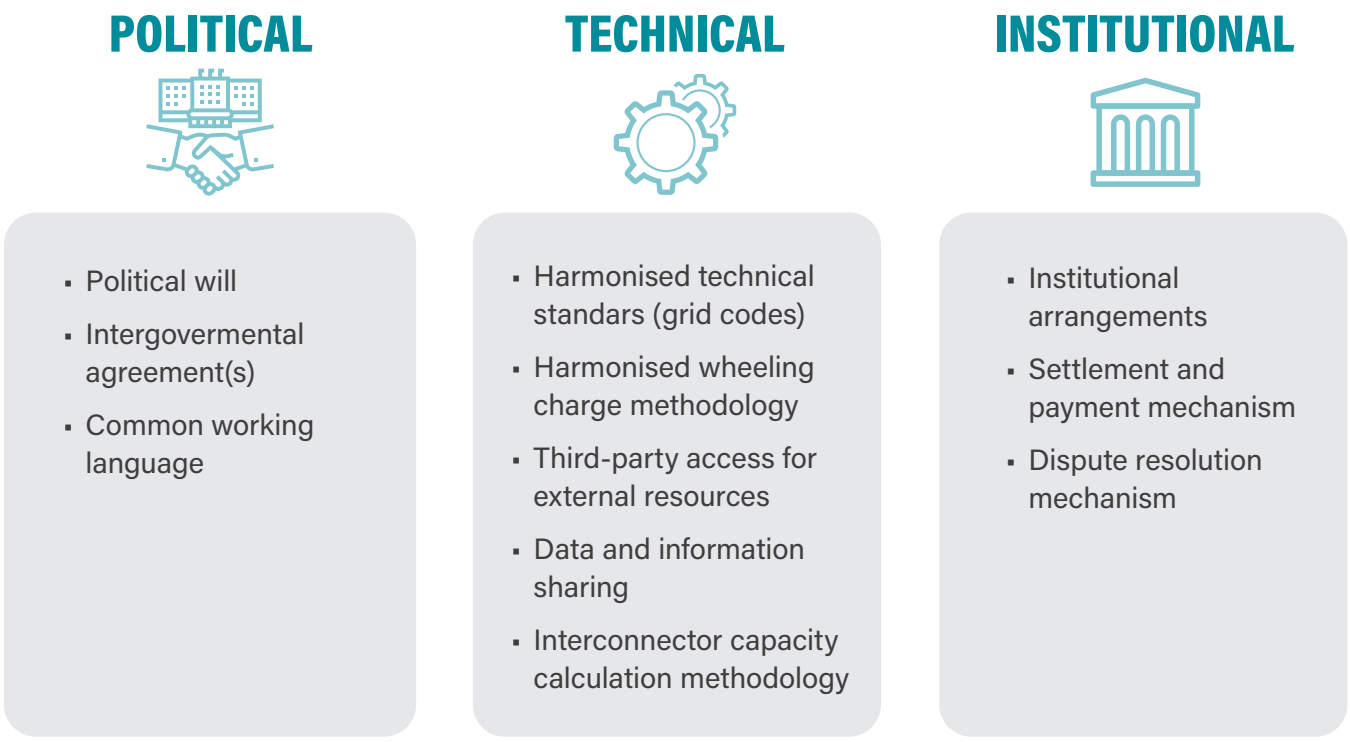
The LTMS-PIP experience has significance for the BIMP-PIP for two key reasons. First, Malaysia is a member of both the LTMS-PIP and the BIMP-PIP and is thus well positioned to utilise and share lessons. One of the issues that led to the timely implementation of the LTMS-PIP was that the LTM countries had already developed contracts and governance mechanisms that were then built into the LTMS-PIP processes. Similarly, Malaysia can utilise the mechanisms of the LTMS-PIP to accelerate the BIMP-PIP.

Second, the exchange of knowledge and best practices between the two projects can develop into regional norms and principles for the development of the APG, as collectively the two projects involve seven out of the ten ASEAN countries (excluding Cambodia, Myanmar and Vietnam).

The sections below will systematically examine the implications of the LTMS-PIP for the BIMP and the broader APG 2.0 initiative (Figure 7). We frame our analysis through the three minimum requirements for multilateral power trade as identified by IEA (2019), which are political, technical and institutional (Figure 6). We highlight the challenges to meeting the minimum requirements in ASEAN, while examples of international best practices for each category of requirement are provided in Boxes 1 to 3.

[e] The Trans Borneo Power Grid was commissioned in 2016. The project is estimated to benefit 8,000 households and cut power costs by US$0.18 per kilowatt-hour.

Figure 6. Minimum Requirements for Establishing Multilateral Power Trade



Source: IEA (2019), Establishing Multilateral Power Trade in ASEAN

7.1 Political Requirements

Political requirements of multilateral energy trade include relevant intergovernmental agreements and a common working language.[65]

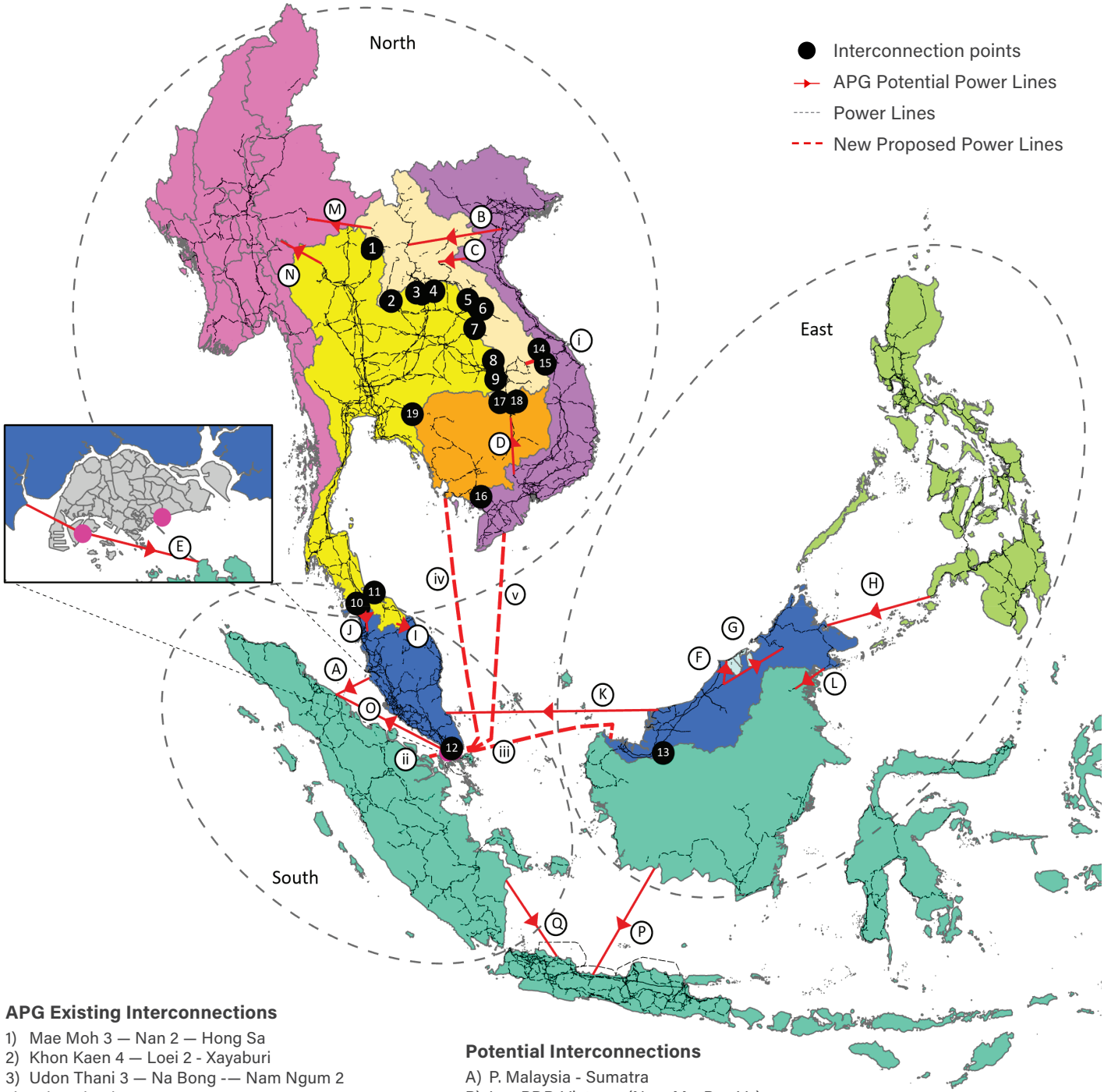
- **Challenge: Resource nationalism**

The LTMS-PIP successfully overcame one of the most critical impediments to energy interconnections: the lack of regional trust. While the success of this project has increased confidence in regional integration, the issue of resource nationalism continues to hamper political consensus in regional energy agreements. Resistance to energy cooperation sometimes results from the notion that renewable energy sources should be reserved to meet the needs of the country where the resources are located. In some cases, resource nationalism can intertwine with regional rivalries,[66] and this undermines the assertion of political will, which is crucial for energy integration. The critical issue in this context is that the presentation and framing of energy projects tend to isolate some stakeholders as well as amplify resource nationalism and regional rivalries.

- **Recommendation: Targeted communication strategies to promote regional cooperation**

Political endorsement of the LTMS-PIP was a key factor in its success. The BIMP-PIP can build upon this experience but also develop communication strategies to counter resource nationalism. One of the ways to promote energy cooperation is to develop a communication strategy that clearly identifies the positive impacts of regional interconnections on local communities such as jobs, schools, energy access and housing. Proposals for interconnections should highlight the collective benefits of interconnections to energy security and mitigation to counter regional rivalries and competitions. The prospects for regional energy cooperation need to be presented in a way that inspires stakeholders with differing views to collaborate. An ASEAN net-zero target in the power generation sector can provide a stronger motivation for collective action and to help resolve issues of sovereignty in terms of meeting climate targets.

Figure 7. ASEAN Power Grid 2.0



APG Existing Interconnections

1) Mae Moh 3 — Nan 2 — Hong Sa
2) Khon Kaen 4 — Loei 2 - Xayaburi
3) Udon Thani 3 — Na Bong -— Nam Ngum 2
4) Udon Thani 3 — Na Bong
5) Nakhon Phanom - Thakhek — Theun Hinboun
6) Nakhon Phanom 2 - Thakhek — Theun Hinboun
7) Roi Et 2 — Suvannakhet — Nam Theun 2
8) Ubon Ratchathani 2 - Houay Ho
9) Ubon Ratchathani 3 — Pakse -— Xe Plan Xe Namnoi
10) Sadao- Chuping
11) Khlong Ngae - Gurun
12) Plentong - Woodlands
13) West Kalimantan - Sarawak
14) Xekaman 1 — Pleiku 2
15) Xekaman 2 — Thanh My
16) Chau Doc — Takeo — Phnom Penh
17) Ban Hat- Kampong Sralao
18) Ban Hat- Stung Treng
19) Watthana Nakhon — Aranvaprathet — Industrial Estate

Potential Interconnections

A) P. Malaysia - Sumatra
B) Lao PDR-Vietnam (Nam Mo-Ban Ve)
C) Lao PDR-Vietnam (Luang Prabang-Nho Quan)
D) Vietnam-Cambodia (Tay Ninh-Stung Treng)
E) Singapore -Batam
F) Sarawak-Brunei
G) Sarawak-Sabah
H) Philippines-Sabah
I) Su Ngai Kolok — Rantau Panjang
J) Khlong Ngae — Gurun
K) Sarawak - P. Malaysia
L) East Sabah — North Kalimantan
M) Lao PDR — Myanmar
N) Thailand — Myanmar
O) Singapore - Sumatra
P) Kalimantan - Java
Q) Sumatra - Java

New Proposed Subsea & Overland Interconnections

i) Lao PDR-Vietnam (Monsoon Wind Power)
ii) SG-Riau
iii) SG-Sarawak
iv) SG-Cambodia
v) SG-Vietnam

Map created by ISEAS-Yusof Ishak Institute © (2023) (Subject to scale)

- **Challenge: Lack of continuity in energy trade policies**

One of the concerns regarding energy cooperation is the lack of continuity in government policies. Changes in government can lead to some projects being abandoned due to a shift in priorities or bans on energy exports. For instance, the Malaysian government decided to ban the export of renewable energy in 2021, though this did not extend to the passage of electricity through Malaysia to third countries.[67] The decision was reversed in 2023 to help build Malaysia's renewable power generation capacity, reflecting a change in government priorities.[68]

The current agreement of the LTMS-PIP lasts two years and will expire in 2024, by which time a longer contract of five years will be negotiated. The move towards longer contracts is encouraging as energy integration and the development of cross-border grids are protracted processes. For instance, the average timeline of developing a HVDC interconnection project is between six to ten years, depending on the level of complexity.[69] Sudden changes in energy trade policies therefore do not provide the long-term stability that is required to attract investors for interconnection projects.

- **Recommendation: Policy support for long-term energy agreements**

Developing energy interconnections requires consistent policy support. For example, the North Sea Link between the United Kingdom and Norway was proposed in 2003 and only became operational in 2021. The BIMP-PIP and other interconnection projects in the region will require enormous investments, which can only be supported through long-term energy contracts and consistent policies that are resilient to changes in domestic politics. Pathways to ensure the continuity of energy projects include building broad-based support for regional energy integration across political divides. This can be done through inclusive governance mechanisms that incorporate the views of multiple stakeholders in the routing of energy grids, as well as their social and environmental impacts.[70]

7.2 Technical Requirements

Technical requirements include the rules, procedures and assets that facilitate cross-border energy trade.[71]

- **Challenge: Differing perceptions on wheeling charge methodology**

A common wheeling charge methodology is necessary to facilitate multilateral energy trade. For the LTMS-PIP, there are differences in how stakeholders and studies perceive wheeling charges. For example, one study[72] states that the LTMS-PIP wheeling charges are based on the following: distance of the trade (megawatts per mile), loss charge (per megawatt hour), balancing charge (per megawatt hour) and fixed administrative charge. However, some stakeholders expressed the view that the wheeling charges for the LTMS-PIP was not calculated through a formula strictly rooted in financial or technical considerations but with the goal of piloting the project as soon as possible. More importantly, some stakeholders feel that the wheeling charge is too high compared to operational costs, while others feel that it is too low and discourages investment in cross-border projects. Given these diverse perceptions for existing infrastructures, negotiations for wheeling charges for new infrastructures are likely to be complex and protracted.

- **Recommendation: Utilise international best practices on wheeling charge methodology**

Some studies propose that wheeling charges for the LTMS-PIP can be replicated for the BIMP-PIP and even the APG.[73] However, conflicting perceptions on the wheeling charges for the LTMS-PIP can prevent it from becoming a blueprint for the region. The BIMP-PIP initiative may draw upon international best practices in developing a wheeling charge methodology, which is based on four principles: promoting efficiency; recovering costs; ensuring transparency, fairness and predictability; and promoting non-discriminatory behaviour.[74] A real-world example is the Southern African Power Pool, where the wheeling charge applicable through a third-party network has three components: (1) proportion of the country's network capacity used (based on thermal rating); (2) age of the assets and current replacement cost of the assets; and (3) allowance for the operational and maintenance costs of assets involved in wheeling.[75]

Box 1

Political Context in the Trans-Balkan Electricity Corridor

Trans-Balkan Electriciy Corridor is on the list of Projects of Energy Community Interest, being located in one of the Energy Community Treaty Contracting Parties and connecting to EU Member States.

Source: EU Za tebe, "The Trans-Balkan Electricity Corridor," EU Projects in Serbia, 2023, https://www.euzatebe.rs/en/projects/the-trans-balkan-electricity-corridor-

The Trans-Balkan Electricity Corridor can be seen as part of a bigger story of the regional integration of Western Balkan countries and the EU as individual states make their way towards accession into the EU. The Corridor will connect the energy systems of Bosnia and Herzegovina, Montenegro and Serbia with Croatia, Hungary, Romania and Italy, bringing them closer to neighbouring EU markets.[76]

The EU is committed to including the Western Balkan countries in its enlargement through the Berlin Process—a series of meetings aimed at developing and implementing agreements for economic cooperation between the EU and the region. The Western Balkan Investment Framework supports the region's countries towards EU membership through investments in energy as well as environmental, social, transport and digital infrastructure,[77] while the EU's Instrument for Pre-accession Assistance (IPA) sets aside funds for the co-financing of such investments together with international financial institutions and bilateral donors. The Serbian section of the Trans-Balkan Electricity Corridor, which links Montenegro, Bosnia and Herzegovina, Serbia and Romania as well as Montenegro and Italy via a submarine cable, is one of five priority interconnection projects under the IPA 2015[78] as agreed upon by the Western Balkan energy ministers in a joint statement.[79]

From the perspective of Western Balkan countries, dire infrastructure gaps that have long hindered economic development provide a strong driver for energy cooperation with their European neighbours. Furthermore, the Balkans is rich in renewable energy potential, which could transform the region into an energy exporter and advance its economies while reducing dependence on Russia, which currently supplies almost all of their natural gas.[80]

While the Berlin Process has had limitations such as slow or delayed implementation of projects, it has grown in priority since the Russia–Ukraine war. In this case, cooperative efforts and the availability of finance are directly linked to one of the EU's key geopolitical aspirations: the integration of Eastern Europe. These motivations are aligned with both the economic and security goals of Western Balkan countries (especially Serbia[81]), which not only need to meet domestic demand for more advanced energy infrastructure, but have also already begun laying the foundation for accession through other economic and infrastructure-related collaborations with the EU.

- **Challenge: Harmonisation of Grid Codes**

Harmonisation of grid codes in ASEAN is a fundamental requirement for facilitating smooth, optimal, secure and reliable power trade.[82] At the national level, grid codes ensure proper coordination between utilities, system operators, power producers and consumers and adherence to regulation and standards. While the LTMS-PIP successfully addressed differences in grid codes through coordination, upcoming projects such as the BIMP-PIP are more complex initiatives that will involve the integration of diverse energy systems and regional coordination between stakeholders in generation, transmission, distribution and other sectors. Harmonisation of grid codes are important for optimisation, and to reduce the risks associated with regional interconnections, such as cascading grid failures. Yet, ASEAN currently does not have a regional grid code and each country develops their own rules and procedures.

- **Recommendation: Undertake consultation and develop communication channels for grid harmonisation**

Harmonisation of grid codes will require inclusive but structured consultations. At the initial stages, consultation between national grid committees can identify priority areas, which can be studied by technical working groups and consultants. This can be done through the aegis of an ASEAN Grid Code Committee. Streamlining grid code documents at the national level can assist harmonisation efforts.[83] The ASEAN community can also seek inspiration from the Greater Mekong Subregion Regional Grid Code, which lays out detailed policies and requirements for regional electricity trade.[84] In addition, as regional grid codes are living documents that require constant updating, online communication platforms, such as the one used for the LTMS-PIP project, can be used to facilitate timely coordination between stakeholders. Grid codes will also need to adapt to accommodate the higher integration and intermittent nature of renewable energy and distributed generation which will make grid management increasingly complex.

- **Challenge: Outdated Infrastructure**

The LTMS-PIP is based on existing infrastructure, which has limited capacities. While steps are being taken to upgrade the infrastructure of the LTMS-PIP, the broader goal of regional interconnections is impeded by outdated grids that are susceptible to congestion, extreme weather events and transmission losses. Some countries such as Thailand and Vietnam have drafted policy frameworks on developing smart grids, with a view to increasing flexibility and reliability and reducing transmission losses. However, these plans are contingent on the availability of public finance. To accelerate interconnections and energy transition, Southeast Asia will need to invest as much as US$200 billion into upgrading both domestic and regional energy infrastructures by 2030.[85]

- **Recommendation: Identify and prioritise ASEAN Projects of Common Interest**

Critical regional interconnections can be classified as ASEAN Projects of Common Interest (APCI), which will ensure that regional efforts are directed towards initiatives that can form the backbone of the APG. This classification can draw from the Projects of Common Interest (PCI) initiative by the European Union (EU), which facilitates the accelerated implementation of projects that have a significant impact on the EU's energy security and climate goals.[86] To promote open sharing of information, an interactive map of all the PCI can be made available for stakeholders including investors and regulators to access details of interconnection projects such as location, implementation schedules, costs, contribution by the EU and project status.[87] The APCI can be developed through consultations with energy stakeholders in ASEAN member countries as well as collaborative research on the benefits and costs of particular interconnections. An open and transparent process of developing the APCI will increase its acceptance and impact, and garner interest from investors. In this context, the key projects identified by the ASEAN Interconnection Masterplan Study III can provide a guiding framework.

- **Recommendation: Examine the feasibility of subsea cables**

Subsea cables may be a game changer for the region as they allow energy cooperation to overcome the challenges posed by the archipelagic geography of

Southeast Asia. The world's longest 590-kilometre subsea power cable between the UK and Norway will soon be overtaken by a new 765-kilometre subsea cable—the Viking Link—between the UK and Denmark which is due to be operational at the end of 2023.[88] Subsea cables will play a key role in the ASEAN region by allowing energy exchange between the continental and maritime countries of Southeast Asia. However, for subsea cables, traversing territorial waters will be a new issue in terms of the legal, technical, environmental and financial challenges.[89] There are some concerns regarding the cost and technical complexity of subsea cables as well as their environmental and geopolitical implications. Despite their potential, the opportunities and challenges of subsea cables will need to be carefully examined. In this regard, a feasibility study covering all aspects of subsea cables including the technical, infrastructural, legal and financial aspects is needed.

- **Recommendation: Develop resilient energy infrastructures**

Energy infrastructures in Southeast Asia are becoming increasingly vulnerable to extreme weather events. Most countries in the region have not addressed the issue of climatic impacts on energy infrastructures. Climate change does not only impact hydropower generation as experienced in the LTMS-PIP project; higher temperatures decrease the amount of water required for cooling thermal plants and reduce the efficiency of electricity grids, while storms and typhoons routinely cause blackouts in some regional countries. There is an urgent need for the region to invest in modelling the impact of climate change on energy infrastructures and develop resilient grids. The region's policymakers can refer to best practices such as building grids underground and using legislation to facilitate a proactive rather than reactive approach to developing resilient infrastructure.[90] Such initiatives are ongoing in countries like Finland, which predicted increased storms and precipitation due to climate change that may lead to costly damages or power outages. To minimise risk and adhere to national outage requirements, distribution system operators should ensure that new distribution lines are weather-proof while exploring alternatives like underground cabling.[91]

7.3 Institutional and Capacity Requirements

Institutional requirements include governance structures and stakeholder coordination, while capacity requirements encompass human resource, training, and knowledge development.[92]

- **Challenge: Existing institutional limitations**

The LTMS-PIP Working Group has facilitated a high level of coordination between various stakeholders involved in the project and can be used as a blueprint for future initiatives. However, there is a dearth of representation by international financial institutions such as multilateral development banks in the Working Group, which may inhibit opportunities for expanding the project. Government-to-government collaboration has been very successful in driving energy trade in Southeast Asia but it should be noted that public finance alone may not be sufficient. Involving more financial institutions early in the process can enhance the viability and bankability of interconnection projects.

- **Recommendation: Include financial institutions and other commercial players in the working group**

The BIMP-PIP Working Group can include more private sector stakeholders to facilitate investment in energy infrastructures, such as multilateral and national development banks as well as international financial institutions. These stakeholders can play a key role in assessing bankability and providing expert advice on the financial risks of energy investments. Private sector stakeholders can also facilitate the utilisation of nontraditional financial tools such as green bonds and sustainability-linked loans and green asset-backed securities. Existing energy projects show that financial institutions can have a key role in facilitating negotiations between public sector officials and ensuring that the benefits of regional energy projects percolate to communities.[93]

- **Recommendation: Develop regional energy institutions**

On a broader level, ASEAN needs to establish a supranational institution[94] that can drive the energy integration process by sharing real-time data, implementing long-term energy plans, enforcing

Box 2

Drivers of Technical Cooperation in the Nord Pool

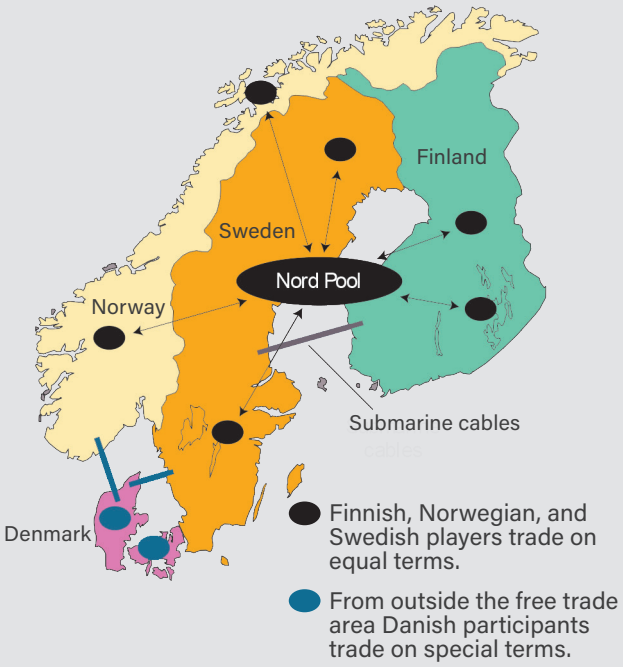
The Nord Pool is an electricity exchange and trading platform operating in Germany, Poland, France, the Netherlands, Belgium, Austria, Luxembourg and the UK. It was established as the world's first international power exchange in 1996 (involving Norway and Sweden before expanding to other countries), years before the first edition of the Nordic Grid Code in 2004. By then, three key drivers and enablers of technical cooperation on grid codes had been in place.

Firstly, many bilateral trade interconnections had been set up in the pan-European region since the 1910s, driven by the countries' varying electricity mixes. The main motivator of these interconnections was not necessarily export profits but savings from pooling electricity resources and optimising production—made possible by sharing information on their marginal costs of production.[95]

Secondly, Nordel, the cooperative body between member countries set up in 1963, had begun responding to shared technical concerns of control and stability in the region's power systems as cross-border interconnections grew. Its recommendations, while nonbinding, were unanimously accepted: besides enjoying a strong tradition of cooperation, all parties shared the desire for an 'effective common system' and its associated benefits.[96] As such, a basic level of operational grid coherence had already existed between countries.

Thirdly, electricity sector reforms beginning in Norway, Sweden, Finland and Denmark in the 1990s helped facilitate the development of a regional power exchange. As the Nordic power market developed, the need for coordinated operations across the region grew.[97]

Today, the Nord Pool has a variety of users including both buyers and sellers. Users pay an access tariff to the owner of the network in which the point of connection is located, allowing them to trade within the entire network system. Local network owners pay network fees to their respective regional network owners, which then pay fees to the national transmission network owners. These fees are determined by the regulatory offices of each respective country for recouping the costs of operating their transmission networks. Besides transmission access fees, each country also determines its own mechanism for calculating loss pricing and congestion pricing.[98] This gives each country and transmission operator some control over their own pricing rather than adhering to a fixed formula.



Source: Carlsson, Lennart. "International Power Trade — The Nordic Power Pool." Note. Public Policy for the Private Sector. World Bank, 1999. https://documents1.worldbank.org/curated/en/674141468746743919/pdf/19063-Replacement-file-171CARLS.pdf

While these factors contributed to the establishment of a common Nordic Grid Code, complete harmonisation of rules was not achieved from the outset. It was acknowledged at the time of publishing that electricity subsystems might not immediately be able to follow identical rules as they were still under different legislation and supervisory bodies. Nevertheless, the Grid Code was a starting point that put forth minimum technical requirements while still operating within the national rules of each Nordic country, with a view to further harmonisation.

market regulations, administering payments and coordinating a dispute resolution mechanism. The study on the establishment of the ASEAN Power Grid Generation and Transmission System Planning Institution highlights some key pathways for regional institution-building.[99] The main challenge to the establishment of a supranational institution is that most countries in the region are unwilling to cede control of national energy resources and institutions.

- **Challenge: Limited human resources**

Although the success of the LTMS-PIP is partly an outcome of the growing professionalism of the region's energy sectors, managing complex multilateral grid systems will require a greater level of expertise. Currently, there are skills and knowledge gaps in areas such as the formulation of wheeling charges, market deregulation, harmonisation of grid codes and construction of subsea cables which can impede the progress of the APG.

- **Recommendation: Targeted capacity-building**

Within the region, ACE is undertaking multiple projects to enhance capacities in the energy sector. The ASEAN Climate Change and Energy Project Phase 2 (ACCEPT II) programmes[f] aim to enhance the level of knowledge and policy implications of a low-carbon economy among the region's policymakers.[100] ACE has also collaborated with Energy Foundation China to develop specific policy approaches to enhance capacity-building in the energy investment sector, with a focus on increasing awareness of the private funding of mature and emerging technologies and acquiring knowledge and skills to engage effectively with financial providers.[101] However, much more needs to be done to enhance the technical skills of the energy workforce in Southeast Asia to enable the integration of more variable renewable energy and to boost the resilience and stability of domestic grids. To facilitate regional interconnections, there needs to be more training and education on the harmonisation of grid and market codes, flexibility, grid congestion, digitalisation and enhanced cybersecurity measures. ASEAN energy officials should continue to engage in training programmes on renewable energy certification, smart grids and virtual power purchase agreements.

Capacity-building in wheeling charge methodology and developing a common language on energy regulation will be key to supporting the BIMP-PIP and other proposed projects. While international collaboration in developing the region's capacity for energy transition is necessary, the challenges of interconnections are different in Southeast Asia compared with Europe and other places, which will require a contextual application of global best practices.

- **Challenge: Resistance to market reforms**

The LTMS-PIP has demonstrated that regional interconnections can be implemented despite differences in market structure. In the case of the BIMP-PIP, the competitive wholesale and retail electricity market in the Philippines can be a challenge but the case of the LTMS-PIP shows that these market differences can be overcome. Yet, research suggests that higher levels of energy integration will require that steps are taken to reform domestic electricity markets, including the revision of regulations on cross-border licencing, non-discriminatory access to networks, competition in generation, and import tariffs.[102] These measures are likely to face resistance from state-owned utilities, which would not want to change the status quo of enjoying government support and forego their current dominance for a more competitive environment.[103]

- **Recommendation: Country-based market sector reforms**

Electricity market reforms play a crucial role in facilitating regional energy integration by providing a framework for efficient and transparent electricity trade, enabling cross-border investments and promoting competition. The establishment of a regional market structure and regulatory frameworks can create a level playing field and thus ensure fair competition among market participants, including

[f] ACCEPT II is a collaborative project between ACE and the Norwegian Institute of International Affairs. It aims to support the implementation of the ASEAN Plan of Action for Energy Cooperation's programme area no. 6, 'Regional Energy Policy and Planning', Outcome-based strategy 6, 'Promote Information Sharing on the Energy-Climate Nexus', which was initiated by ACCEPT Phase 1

Box 3

Institutional Governance of the ENTSO-E

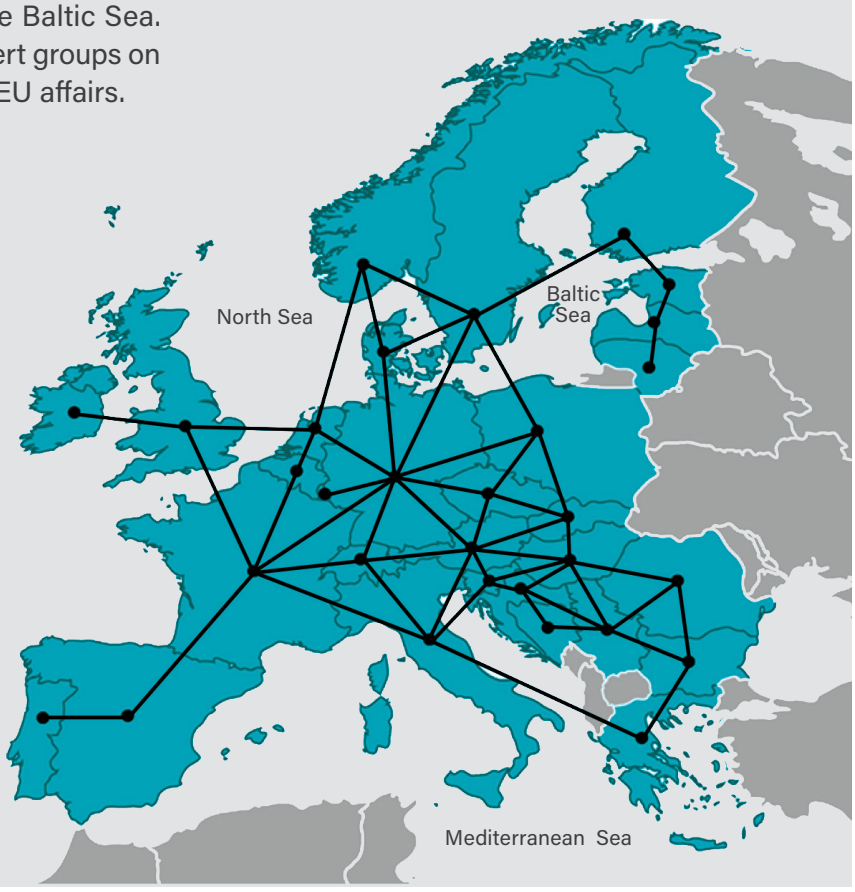
ENTSO-E (European Network of Transmission System Operators) is the platform for cooperation between the transmission system operators (TSOs) of 35 countries across Europe. It focuses on electricity operations, markets, systems development, information and communications technologies, and innovation. Its objectives are to maintain the security, optimal functioning and development of the region's electricity markets. It also aims to contribute to Europe's 2050 climate neutrality goals. TSOs are considered independent, regulated and neutral in pursuing their mandates.[104]

ENTSO-E is helmed by an assembly of all 39 TSOs, followed by a board, secretariat, legal and regulatory group, and four committees: System Development Committee; Systems Operations Committee; Market Committee; and Research, Development and Innovation Committee. Each committee consists of working groups overseeing multiple subtopics. The System Development and Market committees also contain regional groups pertaining to specific geographical subregions such as the Baltic Sea. Additionally, ENTSO-E has three expert groups on strategic data governance, data and EU affairs.

ENTSO-E is officially an international nonprofit association governed by Articles of Association[105] that determine its operation, membership, roles, ENTSO-E bodies and voting rights. They consist of the following:

- definitions;
- rules for membership;
- ENTSO-E bodies and their responsibilities;
- election processes;
- financial arrangements; and
- miscellaneous provisions.

For example, disputes relating to the Articles of Association are under the jurisdiction of courts of the registered office of the Association, which is currently the Brussels-Capital Region. In addition, Internal Regulations[106] provide more detailed practical rules and procedures for adhering to the Articles of Association.



Pan-European transmission network. A simplified pan-European transmission network, where countries are treated as ideal nodes and are linked by interconnectors.

Source: Rodriguez, R.A., Dahl, M., Becker, S. et al. Localized vs. synchronized exports across a highly renewable pan-European transmission network. Energ Sustain Soc 5, 21 (2015). https://doi.org/10.1186/s13705-015-0048-6

both domestic and international players. Reforms often involve aligning rules, regulations and technical standards to enable seamless electricity transfers. It can also provide an impetus for investment in interconnection infrastructures, allow for more efficient utilisation of energy resources, and promote the integration of diverse energy sources, including renewable energy.[107] Importantly, price stability based on supply and demand dynamics and the security of supply—e.g., by providing access to alternative sources during peak demand or in the event of supply disruption—can be assured. However, we note that the specific electricity market reforms required for regional energy integration may vary depending on the context and existing energy systems.

Discussions around the idea of establishing an ASEAN Power Pool have been gathering momentum since the initiation of the LTMS-PIP. Nord Pool Consulting's *ASEAN Power Pool: Guideline, Implementation Plan and Roadmap*, commissioned by the ASEAN Secretariat, was part of a Study on the Formation of the ASEAN Power Grid Transmission System Operator, aligned with the Tokyo Electric Power Company's study on transmission system planning.[108] The Asian Development Bank (ADB) has embarked on a pilot study of a regional power market (day-ahead market) using existing interconnections in the ASEAN/GMS grid from 2023–2026.[109] This study aims to establish a common methodology for the management of cross-border flows and prices. The completion of the ADB's pilot in 2026 would facilitate the region's understanding of a power trading mechanism that would work and hence a better understanding of the reforms needed. To complete the picture, in-depth and contextualised country-level studies would be useful for stakeholders to understand how market sector reforms can aid in regional energy integration.

8 Conclusion

The vision of an integrated, efficient and smart APG that is powered by renewable energy sources is ambitious, but it is an opportunity for ASEAN member states to significantly enhance their energy security through connectivity, foster economic growth and meet their climate obligations. Furthermore, the potential of the APG 2.0 in promoting renewable energy integration, maximising resource utilisation and reducing greenhouse gas emissions at a regional level cannot be understated. The key findings of this policy report underscore the importance of regional collaboration, political will and consensus, the need for robust governance structures, harmonisation of technical standards and enhanced institutional capacities to fulfil this vision.

This report has acknowledged the challenges and complexities associated with this vision, such as financing, market reforms, institutional limitations and lack of human resource, but these challenges can be addressed through regional cooperation. The recommendations put forth in this report include targeted communication strategies to counter resource nationalism; providing policy support for long-term energy agreements; utilisation of international best practices to standardise a common wheeling charge methodology; examining the feasibility of subsea cables; developing resilient energy infrastructures; early inclusion of financial institutions in the institutional governance; and initiating market reforms. The report also calls for targeted capacity-building initiatives and the sharing of best practices to facilitate knowledge transfer and expertise sharing among ASEAN member states.

The APG 2.0 has the potential to change the energy landscape of Southeast Asia, drive greater economic integration, improve energy security, and advance the region's sustainable development agenda. However, it requires collective efforts, long-term commitment, and coordination among stakeholders to unlock the potential for creating a climate-secure future for ASEAN.

Annexes

Annex A: List of Stakeholder Organisations in Conversation with Authors

- eCEOs
- Economic Planning Unit, Malaysia
- Électricité du Laos (EDL)
- Electricity Generating Authority of Thailand (EGAT)
- Embassy of the Republic of Singapore in Vientiane
- Energy Market Authority (EMA), Singapore
- Energy Commission, Malaysia
- Energynautics GmbH
- Energy Studies Institute (ESI), National University of Singapore
- Foundation for Local Development, Thailand
- German Embassy in Vientiane, Lao PDR
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
- Institute of Electrical and Electronics Engineers (IEEE), Thailand
- Impact Electrons Siam
- Institute of Foreign Affairs, Lao PDR
- Ministry of Energy, Thailand
- Nam Theun 2 Power Company, Lao PDR
- Faculty of Engineering, National University of Laos
- Office of Energy Regulatory Commission (OERC), Thailand
- OFFIS - Institute for Information Technology
- Parliament of Malaysia
- Reporting ASEAN
- Stimson Center, USA
- Tenaga Nasional Berhad (TNB), Malaysia
- Thammasat University, Thailand
- Universiti Malaya

Annex B: Renewable Potential for Electricity Generation in ASEAN

Renewable Energy Potential by Source (GW)						
Country	**Solar**	**Onshore Wind**	**Offshore Wind**	**Biomass**	**Hydro**	**Geothermal**
Brunei Darussalam	1.9	–	–	–	0.1	–
Indonesia	2,898	19.6	589	43.3	94.6	29.5
Cambodia	1,597	2.5	88.8	–	10	–
Lao PDR	983	11.9	–	1.2	26	0.1
Myanmar	5,310	2.4	–	1	40.4	–
Malaysia	337	–	53.3	4.2	28	–
Philippines	122.5	3.5	69.4	0.2	10.5	4
Singapore	0.3	0.3	–	–	–	–
Thailand	3,509	32.4	29.6	18	15	–
Vietnam	844	31.1	322.1	8.6	35	0.3

Source: IRENA (2022), Renewable Energy Outlook for ASEAN: Towards a Regional Energy Transition. 2nd Edition

Annex C: Selected agreements and studies on the ASEAN Power Grid

Agreements and Plans	
Joint Statement of the Lao PDR, Thailand, Malaysia and Singapore Power Integration Project (LTMS PIP) (2014)	
ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase I (2016-2020)	
ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase II (2021-2025)	
Bandar Seri Begawan Joint Declaration of the 39th ASEAN Ministers on Energy Meeting on Energy Security and Energy Transition (2021)	
Joint Declaration of the 41st ASEAN Ministers on Energy Meeting on Sustainable Energy Security Through Interconnectivity (2023)	
Studies and projects	**Institutions involved**
Study on the Formation of the ASEAN Power Grid Generation and Transmission System Planning Institution (2018)	ERIA
Study on the Formation of the ASEAN Power Grid Transmission System Operator Institution (2018)	
Feasibility Study for ASEAN Multilateral Power Trade (2019)	IEA
ASEAN Interconnection Masterplan Study III (ongoing)	ACE
Feasibility Study for ASEAN Regional Interconnector (ongoing)	ACE, HAPUA, USTDA
Intergovernmental Agreement Study (ongoing)	ACE, ERIA
ASEAN Power Grid Program (ongoing)	ACE, ETP, CASE, UNESCAP, USAID

Annex D: Proposed projects under the BIMP-PIP

Projects Identified in APAEC 2016–2025	**Projects Identified in the ADB study, 'An Evaluation of the Prospects for Interconnections among the Borneo and Mindanao Power Systems' (2014)**
Sarawak–Peninsular Malaysia, 1,600 MW (2025). Power Purchase.	Sarawak–Peninsular Malaysia, 500 kV HVDC, 2,000 MW (2020)
Sarawak–West Kalimantan, 230 MW (existing). Initially power purchase; later economic exchange.	Sarawak–West Kalimantan, 275 kV, 300 MW (existing)
Sarawak–Brunei, 30–100 MW (2019), 100 MW (post-2020). Economic exchange.	Sarawak–Brunei–Sabah, 275 kV, 300 MW (2016)
Sarawak–Sabah, 100 MW (2020). Power purchase.	Sarawak–Sabah, 250 HVDC, 300 MW (2025)
Philippines–Sabah, 500 MW (post-2020). Economic exchange.	Sarawak–Sabah–Luzon, 500 kV HVDC, 2,000 MW (2025) Sabah–West Mindanao, HVDC, 600 MW (2025)
East Sabah–East Kalimantan, TBC MW (post-2020). Power purchase.	East Sabah–East Kalimantan, 275 kV, 600 MW (2020)
	West Kalimantan–South Kalimantan, 250 kV HVDC, 300 MW (2018)
	South Kalimantan–East Kalimantan, 275 kV, 600 MW (2018)
	South Kalimantan–Java, HVDC, 2,000 MW (2025)
	South Kalimantan–Northern Sulawesi, HVDC, 300 MW (2025)

Source: ERIA (2016), Achieving an Integrated Electricity Market in Southeast Asia: Addressing the Economic, Technical, Institutional, and Geo-political Barriers

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Acknowledgements

The authors wish to express their deepest gratitude to the anonymous experts and stakeholders who generously shared their time, knowledge and insights on the LTMS-PIP and regional energy integration. We also wish to record our appreciation to Mr. Matthew Wittenstein and Ms. Randi Kristiansen of UNESCAP for their partnership in this project; Ms. Badariah Yosiyana and colleagues at IRENA for their support; Dr. Lee Poh Onn for his valuable feedback; and Mr. Thanawat Pumprakobsri, Mr. Santi Kondavong, Ms. Indira Zahra Aridati and Mr. Damon Chee for their crucial research and fieldwork assistance. Finally, our deepest appreciation to Ms Rebecca Neo for her expert work on the GIS maps that are created for this study.

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