

Australia's Strategic Role In The Asia-Pacific Super Energy Highway



*Legal, Regulatory and Market Governance
Imperatives for a Renewable Export Pivot*



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Foreword



The Asia-Pacific energy transition is entering a decisive phase. Across the region, governments, industry and research institutions are exploring how stronger cross-border energy connections can support decarbonisation, energy security and economic development. Critically important work is already underway, including through ASEAN and the development of the ASEAN Power Grid. The Asia-Pacific Super Energy Highway (APSEH) builds on this momentum and asks what a more deeply connected regional energy system might ultimately look like.

This report reflects the Net Zero Institute's commitment to helping shape that conversation. The project grew from our close relationship with the Korea Institute of Energy Research (KIER), an NZI Scientific Advisory Board member, and was designed to support Korea's focus on the APSEH during its 2025 APEC Presidency. In November 2025, the University of Sydney and KIER strengthened that partnership through a Memorandum of Understanding to advance collaborative research in this important field.

The report was launched in partnership with the Australia-Korea Business Council (AKBC), reflecting the growing importance of Australia-Korea collaboration in shaping regional clean energy trade, infrastructure development and the future of the Asia-Pacific Super Energy Highway.

Japan is also central to this regional conversation. Its longstanding energy and economic relationships across the Asia-Pacific, including with Australia, make it a critical

partner in considering the future of regional energy connectivity. Engagement with the Australia-Japan Business Co-operation Committee has helped ensure that this work is informed not only by policy and research perspectives, but also by the commercial and investment realities that will shape implementation.

This report builds on initial APSEH research undertaken for the Net Zero Institute by Dr Gordon Weiss. It extends that research program by examining the regulatory, institutional, financial and geopolitical conditions needed to translate regional ambition into practical cooperation.

No single initiative or country can deliver regional energy integration alone. The opportunity lies in connecting and building upon the important work already occurring across ASEAN, APEC and the wider Asia-Pacific. Australia, Korea and Japan have significant contributions to make to that endeavour.

The Net Zero Institute is pleased to contribute this report to that important and rapidly evolving regional discussion.

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We acknowledge the tradition of custodianship and law of the Country on which the University of Sydney campuses stand. We pay our respects to those who have cared and continue to care for Country.

Abbreviations

ACE	ASEAN Centre for Energy
ACER	EU Agency for the Cooperation of Energy Regulators (ACER)
ADB	Asian Development Bank
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AERN	ASEAN Energy Regulators Network
AIMS	ASEAN Interconnection Masterplan Study
AMEM	ASEAN Ministers on Energy Meeting
ANAO	Australian National Audit Office
APAEC	ASEAN Energy Cooperation Architecture
APEC	Asia-Pacific Economic Cooperation
APG	ASEAN Power Grid
APGF	ASEAN Power Grid Financing Initiative
APGCC	ASEAN Power Grid Consultative Committee
APSEH	Asia-Pacific Super Energy Highway
ATSE	Australian Academy of Technological Sciences and Engineering
\$AUD	Australian Dollar
CBCA	Cross-Border Cost Allocation
CBET	Cross-Border Electricity Trade
CER	Clean Energy Regulator
CIGRE	International Council on Large Electric Systems
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth, Australia)
DFAT	Department of Foreign Affairs & Trade (Australia)
DOE	Department of Energy (Philippines)
EA	Electricity Authority (New Zealand)
ECMC	Energy and Climate Change Ministerial Council (Australia)
EDC	Electricité du Cambodge
EEZ	Exclusive Economic Zone
EGAT	Electricity Generating Authority of Thailand

EIA	Energy Information Administration (US)
EMA	The Singaporean Energy Market Authority
EMC	Energy Market Company (Singapore)
EMS	Energy Management System
ENTSO-E	European Network of Transmission System Operators for Electricity
EPBC	Environment Protection and Biodiversity Conservation Act 1999 (Cth)
EPC	Engineering Procurement Contract
EPWA	Energy Purchase and Wheeling Agreement
ERAV	Electricity Regulatory Authority of Vietnam
ERC	Energy Regulatory Commission (Mongolia)
ERC	Energy Regulatory Commission (Philippines)
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
EVN	Vietnam Electricity
FID	Final Investment Decision
GO	Guarantee of Origin (Australia)
HAPUA	Heads of ASEAN Power Utilities and Authorities
HPTI	Hydrogen Production Tax Incentive (Australia)
ISP	Integrated System Plan (Australia)
JEPX	Japan Electric Power Exchange
JICA	Japan International Cooperation Agency
ICPC	International Cable Protection Committee
IEA	International Energy Agency
IEEJ	Institute of Energy Economics Japan
IEM	EU's Internal Energy Market
IEMOP	Independent Electricity Market Operator of the Philippines
IGA	Intergovernmental agreements

IMO	International Maritime Organization
IPP	Independent Power Producer (Indonesia)
IT	Information Technology
KIER	Korea Institute for Energy Research
KEEI	Korean Energy Economics Institute
LNG	Liquefied Natural Gas
LTM-PIP	The Lao PDR–Thailand–Malaysia Power Integration Project
LTMS-PIP	Lao PDR–Thailand–Malaysia–Singapore Power Integration Project
MBIE	Ministry of Business, Innovation and Employment (New Zealand)
MDB	Multilateral Development Bank
MEA	Metropolitan Electricity Authority (Thailand)
MEMR	Ministry of Energy and Mineral Resources of Indonesia
METI	Ministry of Economy, Trade and Industry (Japan)
MLT	Medium-to-long-term contracts
MOEA	Ministry of Economic Affairs (Chinese Taipei)
MOIT	Ministry of Industry and Trade (Vietnam)
MOTIE	Ministry of Trade, Industry and Energy (Republic of Korea)
MoU	Memorandum of Understanding
NDRC	National Development and Reform Commission (China)
NEA	National Energy Administration (China)
NEM	National Electricity Market (Australia)
NRA	National Regulatory Authorities
OCCTO	Organization for Cross-regional Coordination of Transmission Operators (Japan)
OECD	Organisation for Economic Co-operation and Development
OT	Operational Technology
PCIs	Projects of Common Interest

PEA	Provincial Electricity Authority (Thailand)
PGO	Product Guarantee of Origin (Australia)
PJ	Petajoules
PLN	Perusahaan Listrik Negara (Indonesia)
REGO	Renewable Electricity Guarantee of Origin (Australia)
REMIT	Regulation on Wholesale Energy Market Integrity and Transparency (EU)
REZ	Renewable energy zone
SCADA	Supervisory Control and Data Acquisition
SDAC	Single Day-Ahead Coupling
SGEI	Singapore Energy Interconnections Pte Ltd
SIDC	Single Intraday Coupling
SoC	Scheme of Control
SOCI	Security of Critical Infrastructure
TEN-E	Trans-European Networks for Energy
TNB	Tenaga Nasional Berhad (Malaysia)
TWh	Terawatt-hour
TYNDP	Ten-Year Network Development Plan (EU)
UNCLOS	United Nations Convention on the Law of the Sea
\$USD	United States Dollar
VRE	Variable renewable energy
WESM	Wholesale Electricity Spot Market (Philippines)

Executive Summary

Building the APSEH Architecture

A governance framework for making regional clean energy trade investable, credible and deliverable.

Overview

- This White Paper critically analyses Australia's potential engagement in the proposed Asia-Pacific Super Energy Highway (APSEH).
- APSEH is best conceptualised as a corridor architecture rather than a single asset, comprised of coordinated pathways that move clean energy in multiple forms across Australia, Southeast Asia and Northeast Asia using ships, pipelines and cables. This reduces single-project risk and supports the sequenced delivery consistent with an incremental integration approach.

Why now

The APSEH proposal comes at a time when:

- The Asia-Pacific region remains structurally fossil fuel dependent, accounts for a majority share of global fuel-combustion CO₂ emissions and will therefore determine global emissions outcomes in absolute terms.
- Regional connectivity has moved from conception to execution, with ASEAN progressing interconnection for the ASEAN Power Grid through operational projects and multilateral pilots and, critically, beginning to institutionalise the governance and financing architecture required for deeper integration.
- Import demand for clean energy is increasingly explicit and policy-backed, with Singapore's electricity import policy providing a concrete demand anchor and regulatory steps that support potential imports from Australia.
- Technology cost curves are altering the composition of export opportunity rather than eliminating it. Declining energy storage costs may reduce demand for imported electrons in some jurisdictions, while intensifying demand for the critical minerals, equipment and low-emissions industrial products required for large-scale electrification and clean industrialisation.

Australia's opportunity

- Australia's comparative advantage lies in governance credibility and market-design capability. It has mature institutions and deep operational experience with complex inter-jurisdictional electricity market governance, directly relevant to developing cross-border rules on access, dispatch, congestion, settlement and system security.
- Australia can also offer a portfolio of export vectors, including (i) renewable electricity, (ii) low-carbon hydrogen and its derivatives for hard-to-abate sectors and (iii) processed critical minerals and green industrial outputs aligned with regional critical minerals strategies and clean supply chain objectives.

Commercial reality

- However, not all three export vectors are currently commercial and all face barriers under present market, technical and regulatory conditions. Bulk electricity export via long-distance HVDC cable requires solving unprecedented engineering and financing challenges at distances five times longer than any operational benchmark. Large-scale green hydrogen exports are dependent on either importing countries imposing domestic carbon prices or procurement mandates substantially above those currently in place. Green processed critical minerals and green industrial outputs will also require the development of significant sovereign processing and manufacturing capability.

The export pivot

- The case for Australian engagement with APSEH does not rest on the assumption that all pathways will be simultaneously viable in the near term. It rests on a more urgent proposition that Australia's fossil fuel export earnings, currently worth approximately \$AUD 239 billion per year and representing approximately

“Australia’s comparative advantage lies not only in its natural resources, but in the governance capability needed to make regional clean energy corridors investable, legitimate and deliverable.”

80% of total energy production are forecast to decline materially over the second half of the 2020s. Thermal coal and LNG earnings alone are projected to fall by more than \$AUD 39 billion by 2029–30.

- APSEH-aligned vectors are therefore not optional additions to a stable export base. Rather, they are, over the medium term, the principal candidates for partially replacing it. This structural imperative justifies investing now in the governance, certification and institutional architecture that will determine which export pathways become commercially viable and on what terms, over the decades ahead.

Regional alignment

- Thus, regional alignment should be treated as an ex-ante design constraint for APSEH, not an ex-post coordination problem. This requires deliberate interface with the ASEAN Power Grid (APG), given its rapid build-out and institutional consolidation and early alignment of APSEH delivery settings with regional financing architectures capable of mobilising capital at scale.
- The ASEAN Power Grid Financing Initiative (APGF), established in 2025 by ASEAN, the Asian Development Bank and the World Bank, was developed to support financing the approximately \$USD 800 billion investment required to achieve the APG vision by 2045. It signals an emerging regional template for the bankability, risk allocation and governance of large-scale cross-border energy infrastructure.
- Australia’s positioning can be anchored in existing cooperation frameworks, including the Australia–Singapore Cross-Border Electricity Trade Framework, which explicitly supports ASEAN’s APG objective and records Australia’s engagement with ASEAN institutions to advance regional grid integration.

Principal risks

- The principal risks associated with the APSEH project are:
- Bankability and risk allocation across cost recovery, curtailment and dispatch rights, change-in-law risk, settlement and credit support, force majeure and dispute resolution.
- Critical infrastructure security is a decisive constraint, as cyber-physical and subsea vulnerabilities necessitate baseline standards, operational resilience requirements and coordinated incident response protocols.
- Social licence and environmental permitting must



be treated as core project architecture, because large-scale export-linked infrastructure requires robust domestic safeguards, credible benefit-sharing and durable approvals pathways.

- Technology uncertainty remains material. Energy storage cost declines may further compress the role of bulk renewable electricity imports in some jurisdictions, reinforcing the prudence of a multi-vector strategy rather than a single-product export model.

Priority actions for Australia

- Australia should prioritise the legal and institutional conditions required to make APSEH investable, including designing and implementing interoperable standards, credible certification frameworks and bankable cross-border regulatory and contractual rules.
- Over the next 12 to 24 months, Australia should lead a targeted minilateral governance pilot with willing



partners, such as Singapore and selected ASEAN counterparts, to develop model provisions on access, curtailment and compensation, operational coordination, data sharing and dispute avoidance and to align these provisions explicitly with APG pathways.

- Australia should prioritise certification interoperability using Guarantees of Origin as the platform, as well as mutual recognition and technical alignment of measurement, verification and reporting for renewable electricity attributes and hydrogen and product emissions intensity.
- Australia should embed APSEH within ASEAN investment mobilisation by linking Australian de-risking instruments, including export credit, political risk cover and project preparation capacity, into APGF-aligned pipelines where they are consistent with ASEAN priorities.
- Australia should develop an APSEH critical

infrastructure and cybersecurity baseline that sets minimum standards for subsea cable protection, operational resilience and incident response coordination and require adoption of these standards in pilot projects.

Measure of success

- Success for Australia should be defined as a staged APSEH corridor that is demand-anchored through Singapore and ASEAN, financeable through APGF-aligned initiatives and compliance-ready through interoperable certification, positioning Australia as a trusted supplier and rule-shaper in the region's transition architecture.

1. Introduction

This White Paper provides a high-level legal, regulatory and governance analysis of what the Asia-Pacific Super Energy Highway (APSEH) would require to be bankable, legitimate and deliverable at scale. It analyses Australia's domestic regulatory readiness (export approvals, certification, offshore cable permitting, market governance and social licence), the regional governance architecture in the Asia-Pacific region needed to support interconnection (rules, cost allocation, dispute resolution, cybersecurity and critical infrastructure protection and alignment with ASEAN-led frameworks) and the key trade and investment law interfaces (contracting, risk allocation, government support and investment protections). This White Paper also examines how shifting technology cost curves for batteries, HVDC and hydrogen are likely to reshape the most viable export pathways over time.

The central proposition tested in this White Paper is that:

Australia's comparative advantage increasingly lies not only in its natural resources, but also in its governance capability. Australia brings deep expertise in market design, strong regulatory institutions and practical experience operating complex power systems with high penetrations of variable renewable energy. Within the Asia-Pacific region, much of APSEH's value will be realised through the institutional architecture built around it, including investment rules, standards and certification, cost allocation, dispute management, cyber-physical resilience, social licence and mechanisms capable of accommodating diverse domestic electricity market models across the region.

The White Paper is designed to support decision-making and stakeholder alignment around Australia's prospective role in the APSEH. Its purpose is to serve as:

1. A robust, evidence-based piece of research that provides the background for APSEH and a strategic analysis of some of the key legal, governance, financial and geopolitical considerations for Australia's future engagement with APSEH.
2. A policy briefing for regional leadership and agenda-setting, providing tailored analysis for senior officials and advisers working across the APEC policy ecosystem (including energy, trade, investment and economic security portfolios).
3. Operationally grounded guidance for Australian government agencies. The legal and governance emphasis is intended to be practical when considering: (i) whether and how to engage APSEH as an outward-facing strategic platform; and (ii) what domestic regulatory preparations would be required to make Australian participation credible, bankable and socially legitimate.

Given the breadth of the APSEH proposal and the constraints of paper length, this White Paper focuses on the core "enabling conditions" rather than project-level technical design. It does not model project-specific engineering optimisation, such as route selection, converter placement, or detailed dispatch modelling. Those matters are critical, but the purpose here is to frame the regulatory and institutional foundations that must be in place before any such project can proceed.

1.1 Defining the Asia-Pacific Super Energy Highway

There is currently no formal definition of the Asia-Pacific Super Energy Highway. Rather, APSEH is best understood as an umbrella strategic initiative that bundles multiple vectors of cross-border energy exchange across a range of potential corridors. The lead proponent of APSEH, the Korea Institute of Energy Research (KIER), frames APSEH as ‘...a highly interconnected energy network spanning across Australia, Thailand, Mongolia, China and Japan, utilising ships, pipelines and cables.’¹

For the purposes of this White Paper, APSEH is treated as a high-level regional energy policy and infrastructure strategy rather than as a single project. It includes, in varying combinations and timelines:

1. Electricity interconnection (particularly HVDC subsea cables and converter infrastructure);
2. Trade in green hydrogen and hydrogen carriers (including ammonia and hydrogen-based synthetic fuels (e-fuels) moved through

shipping corridors and port infrastructure and in some scenarios via pipeline segments;

3. Embodied clean energy exports (green metals, processed critical minerals, low-emissions industrial products), which function economically like energy exports because they monetise low-cost renewable electricity and/or hydrogen inside Australia and export the value-added product.

This definition is deliberately multi-vector for two reasons. First, importing economies face very different constraints, including their domestic energy resources, land availability, existing infrastructure, network configuration, market structure, public acceptance, available capital, geopolitical conditions and exposure to strategic dependencies. Second, technology cost curves and certification regimes are evolving rapidly, meaning that any single-vector framing risks becoming outdated by the mid-2030s.



Figure 1: The Asia-Pacific Super Energy Highway²

1.2 The rationale for APSEH

The Asia-Pacific region represents a central challenge for achieving global decarbonisation because it combines: (i) rapid demand growth for energy; (ii) large existing fossil fuel infrastructure; and (iii) major industrial energy use.³ IRENA reports that the region accounts for more than half of global energy consumption and that 85% of the region's energy consumption is sourced from fossil fuels.⁴ At its core, the energy transition imperative in the region is inseparable from the need to address climate change, as well as structural questions of energy security and industrial competitiveness. As policy settings tighten around the decarbonisation of the economy globally and clean technology costs continue to decline, governments within the region will face concurrent pressures to rapidly decarbonise, improve energy and supply chain security and address affordability concerns.⁵

Connectivity proposals, whether labelled as “supergrids”, “energy highways”, or “regional power grids”, are recurring within the Asia-Pacific region because they promise to improve the system economics of deep decarbonisation. Indeed, the United Nations Economic and Social Commission for Asia and the Pacific's (ESCAP) regional roadmap identifies power system connectivity as a pathway to a more reliable, affordable and sustainable regional grid, highlighting the need for planning, coordination and governance mechanisms.⁶

The underlying logic for regional connectivity is well-established in power system planning. Larger balancing areas and stronger transmission can reduce the total cost of integrating variable renewable energy (VRE) by smoothing weather-driven variability, reducing curtailment and enabling reserve sharing.⁷ The governance reality, however, is that cross-border interconnection converts energy infrastructure into a form of shared critical infrastructure. That increases the value of connectivity when it works by diversifying the geographic and weather-contingent supply risk, but it also increases the consequences when it fails.⁸

APSEH can be seen as a “next step” in regional ambition by expanding connectivity beyond electricity into multi-vector trade and critical infrastructure system-of-systems. At the same time, APSEH is likely to face an amplified version of the governance constraints identified by ESCAP,⁹ all while developing a series of projects in one of the most geopolitically contested regions of the world. APSEH's success therefore will rely on the development and interplay of three key workstreams:

1. **Physical infrastructure:** Subsea and terrestrial transmission infrastructure (including long-distance HVDC links and converter stations), pipelines, ports and port-side logistics, shipping routes and maritime corridors, terminals (import/export and regasification where relevant), grid interconnection and co-located industrial hubs such as REZ interfaces, hydrogen/ammonia export precincts and green metals/manufacturing clusters.
2. **Digital infrastructure:** Fibre communications embedded within cable systems; telemetry and monitoring networks; Supervisory Control and Data Acquisition (SCADA)/Energy Management System (EMS) and other operational control systems; real-time market operations platforms (dispatch, scheduling, metering and settlement); data centres and cloud services supporting forecasting, optimisation and trading; identity and access management; and cybersecurity across Information Technology (IT)/Operational Technology (OT) interfaces, including incident response and recovery arrangements.
3. **Commercial, regulatory and governance infrastructure:** Bankable contracting architecture (wheeling, transmission access and offtake arrangements); credit support and settlement governance; investment screening and foreign ownership controls; sanctions compliance and export controls; standards and certification frameworks (including emissions attributes/Guarantee of Origin (GO) scheme where applicable); dispute resolution

and governing law choices; and financing, insurance and risk-allocation instruments (including political risk cover, force majeure and change-in-law protections).

These developments within the APSEH proposal must also be situated within the Asia-Pacific region's existing energy connectivity agenda. Existing projects include those associated with the ASEAN Power Grid (APG), which ASEAN Member States have repeatedly reaffirmed their commitment to build by 2045. The APG is now supported by an increasingly concrete financing and institutional push. Further, Australia has explicitly aligned itself with this ASEAN objective in formal bilateral frameworks, commitments to provide technical assistance and capacity building for regional power integration and

public diplomacy. This was most recently evidenced within the Australia/Singapore Cross-Border Electricity Trade (CBET) Framework signed in October 2025.¹⁰ Thus, APSEH should be treated less as a single interconnector project and more as a regional critical infrastructure regime, in which technical integration and legal-operational interoperability must be designed in tandem. The strategic prize is lower-cost decarbonisation and improved security of supply, but this will occur only where the physical build is matched by bankable rules, robust digital resilience and credible governance that can withstand shocks, disputes and geopolitical volatility.

1.3 Structure of this White Paper

The remainder of this White Paper is structured as follows. Section 2 evaluates the regional decarbonisation and connectivity imperatives, substantiating the “why now” rationale and the core demand drivers. It then situates APSEH within the ASEAN Power Grid, Northeast Asia interconnection agendas and related regional proposals and critically analyses the connectivity being implemented in practice and where political economy constraints continue to bind. Section 3 investigates Australia's export pivot from coal and LNG export dependence towards low-carbon hydrogen and its derivatives, renewable electricity, green metals and embodied-energy exports, with particular attention to certification architectures and

the legal boundaries of industrial policy. Sections 4 to 6 develop the central opportunity case for APSEH across economic, market, geopolitical and normative dimensions and then rigorously assess the risk case, including regulatory barriers, market-viability risk, cybersecurity and social licence. The White Paper concludes in Section 7 with strategic recommendations for domestic reform, regional institution-building options and market design principles capable of converting APSEH from a concept into investable pathways aligned with regional development objectives and high-integrity standards.

2. Regional decarbonisation and connectivity imperatives

The Asia-Pacific region combines the world's largest energy demand centre with persistent fossil fuel dependence (85% of energy consumption) and a majority share of global fuel-combustion CO₂ emissions (52.4% in 2023).¹¹ Electricity demand growth, particularly in Southeast Asia, is rapid (over 1,300 TWh today to above 2,000 TWh by 2035) and has historically been met mainly by fossil fuels, raising carbon lock-in and energy security

risks.¹² In response, net-zero pledges have proliferated, but many economies increasingly rely on trade-enabled solutions, as reflected in ASEAN's accelerating interconnection agenda and investment mobilisation.¹³ Falling storage costs may change the composition of imports, but they do not remove the strategic value of regional connectivity as an option-preserving platform for decarbonisation, resilience and industrial transformation.

2.1 The Asia-Pacific energy transition is the global transition

The strategic case for the APSEH is that the Asia-Pacific region is now at the apex of global energy demand, energy investment and energy-related emissions.

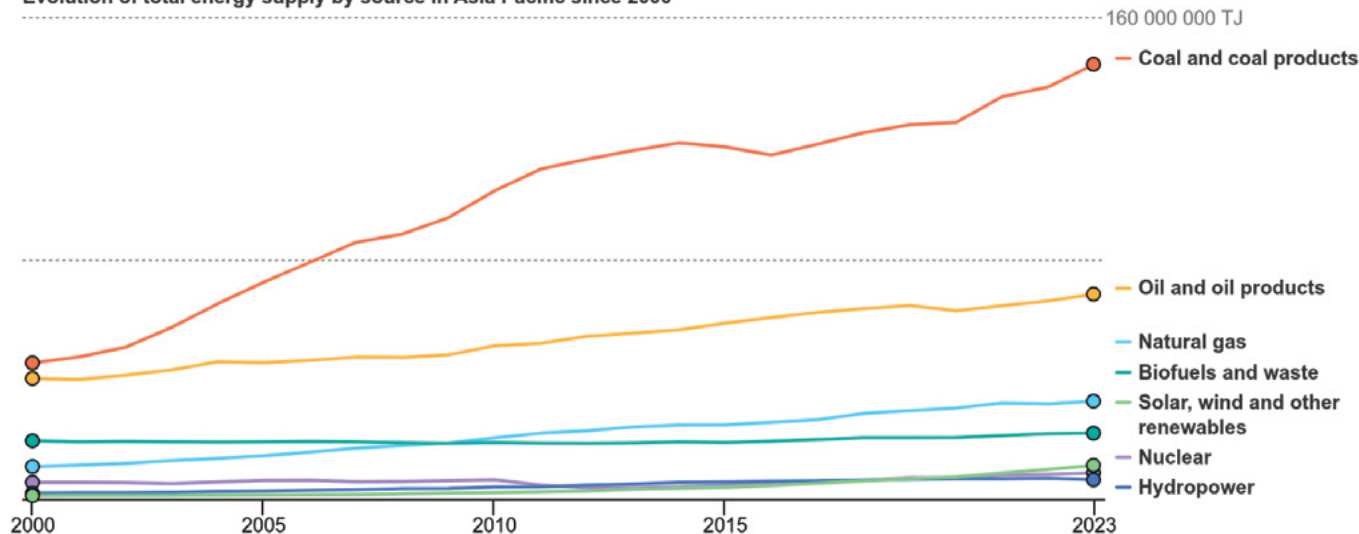
The implications of the Asia-Pacific's historic fossil fuel dependence and the scale of the resulting carbon emissions, as highlighted in Figures 2 and 3, are that:

1. Absolute greenhouse gas emissions outcomes globally will be determined in this region, even where individual economies have ambitious targets or strong policy frameworks.

2. The least-cost pathway to decarbonisation will be system-wide, involving domestic deployment combined with cross-border optimisation through trade, interconnection and shared flexibility resources.

This means that the Asia-Pacific's energy transition cannot be delivered solely through isolated national strategies, especially where demand growth, urbanisation, industrial policy and energy security pressures remain acute.

Evolution of total energy supply by source in Asia Pacific since 2000

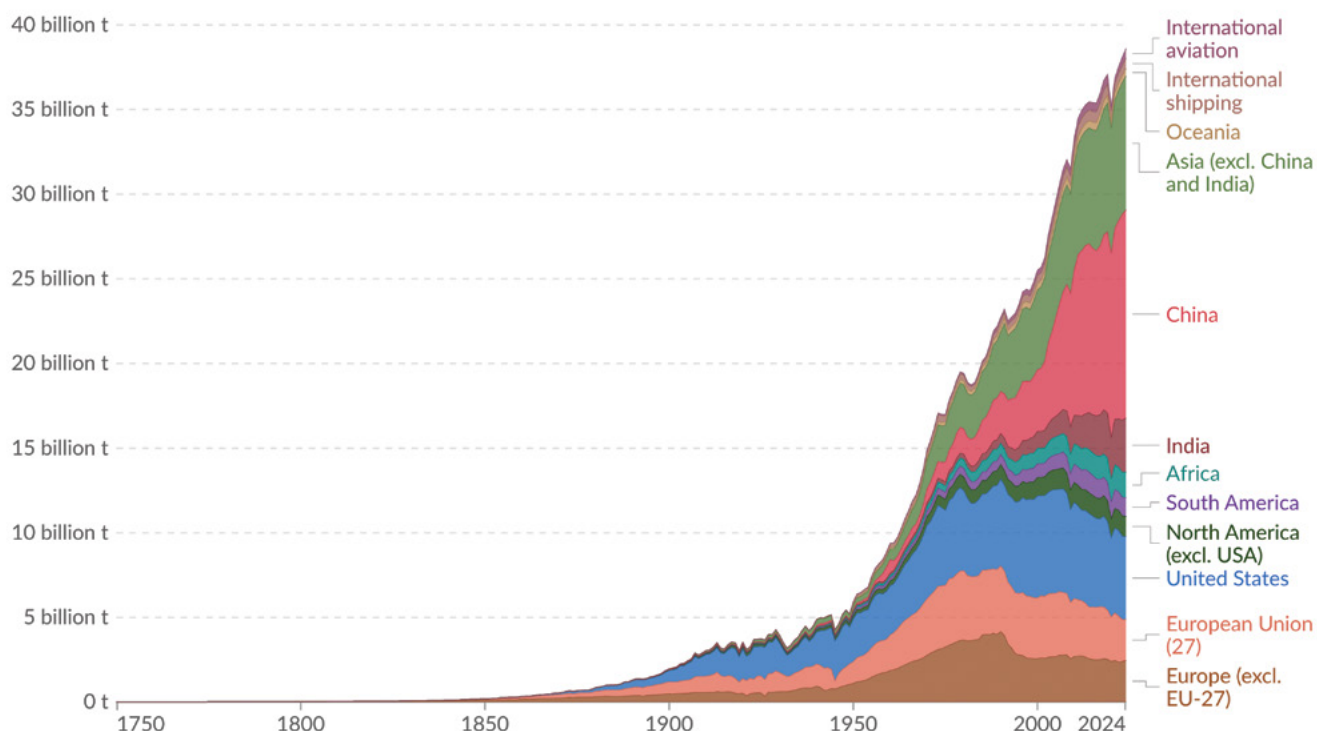


Source: International Energy Agency. Licence: CC BY 4.0

Figure 2: Total primary energy supply by product in Asia and the Pacific¹⁴

Annual CO₂ emissions by world region

Emissions from fossil fuels and industry are included, but not land-use change emissions. International aviation and shipping are included as separate entities, as they are not included in any country's emissions.



Data source: Global Carbon Budget (2025)

OurWorldinData.org/co2-and-greenhouse-gas-emissions | CC BY

Figure 3: Annual CO₂ emissions by region (1990–2024) (Billion tonnes of CO₂)¹⁵

2.2 Demand growth, electrification and the “carbon lock-in” risk

Against that backdrop, the Asia-Pacific’s economies span the full development spectrum, from highly industrialised, high-income states to countries still working to close basic energy access gaps, including access to electricity and clean cooking.¹⁶ Across this diversity, the region is simultaneously expanding energy services and building the long-lived infrastructure that will shape its emissions trajectory for decades. The resulting demand growth and late-stage infrastructure build-out, driven in part by the imperative to extend modern energy access, can therefore either accelerate decarbonisation or entrench a high-emissions pathway through long-horizon investment choices.

While electrification within the Asia-Pacific region has significantly improved since 2010, 157 million people within the region still lack access to electricity,¹⁷ and only 65% of the population has access to clean cooking fuels and technologies.¹⁸ These development dynamics sit alongside rapid growth in electricity demand, especially in Southeast Asia. The IEA has projected that electricity demand in Southeast Asia will increase by approximately 4% compounded annually from over 1,300 TWh in 2025 to above 2,000 TWh by 2035 under stated policies.¹⁹ The drivers for this rapid rise in electricity demand include manufacturing growth,²⁰ the electrification of transport,²¹ and sharply rising cooling demand, including

air-conditioning uptake in Indonesia.²² Data centres will also contribute to rising demand for power and cooling. In 2026, the region hosted only 3% of global data centre demand, however, both the number and scale of data centres within the region is predicted to increase sharply over the next decade. This has led the IEA to project electricity consumption from data centres in Southeast Asia will nearly double by 2030.²³

This growth in demand matters because it magnifies the risk of carbon lock-in. In Southeast Asia, the IEA reported

that fossil fuels have met nearly 80% of rising energy demand since 2010.²⁴ Further, in 2023, coal generated half of the region's electricity, accounting for 80% of power sector emissions.²⁵ This means that without an accelerated transition and new flexibility options (including trade-enabled flexibility) such as those that will be provided by the APG and could be provided across a broader area and more energy vectors by APSEH, the region's expanding grids risk entrenching coal and gas as "default" reliability tools.

2.3 Net zero commitments

Economy-wide net-zero emissions pledges are now common within the Asia-Pacific region. The IEA has identified that eight of the ten Southeast Asian economies have net-zero emissions goals, with target dates including 2050 for Brunei Darussalam, Cambodia, Lao PDR, Malaysia, Singapore and Viet Nam; 2060 for Indonesia; and 2065 for Thailand.²⁶ In Northeast Asia, Japan's national policy framework embeds a 2050 carbon neutrality goal.²⁷ The Republic of Korea has a 2050 carbon neutrality target in its long-term strategy framework.²⁸ China's leadership has stated the intention to reach carbon neutrality before 2060 and China has submitted long-term strategies through UNFCCC channels.²⁹ Singapore's national climate framework targets net-zero emissions by 2050.³⁰ However, to date the implementation of these pledges has been uneven across the region.³¹

Many APSEH partner economies face one or more of the following constraints:

- limited land availability for utility-scale renewables;
- constrained domestic resource diversity (for example, seasonal hydro variability or limited wind regimes);
- high reliance on imported fuels and exposure to price shocks; and
- accelerating demand growth that outpaces domestic clean supply build-out.

A recent report from the IEA identified energy security and affordability as top priorities in Southeast Asia. The IEA highlighted that the recent global energy crisis drove fossil fuel consumption subsidies to a record \$USD 105 billion in 2022 and that Southeast Asia was reliant on the Middle East for 60% of its oil imports.³² This represents a critical driver for interconnection, with cross-border clean energy trade not only a decarbonisation lever, but also increasingly a risk-management strategy against fuel volatility, supply disruptions and extreme weather shocks.

Singapore illustrates how a national net-zero strategy, the 'Long-Term Low Emissions Development Strategy', can be translated into an explicit connectivity agenda.³³ The Singaporean Energy Market Authority (EMA) describes the Lao PDR–Thailand–Malaysia–Singapore Power Integration Project (LTMS-PIP) as the first multilateral cross-border electricity trade involving four ASEAN countries.³⁴ Phase 1, which launched in June 2022, enabled imports of up to 100 MW of renewable hydropower into Singapore via Thailand and Malaysia and Phase 2 will increase trading to a maximum of 200 MW, including additional supply from Malaysia through multidirectional trade.³⁵ These projects are small-scale relative to Singapore's national energy demand but they serve as important legal and regulatory precedents, establishing templates for transit arrangements, scheduling and settlement, system-operation protocols and multi-party risk allocation.

2.4 Climate impacts and resilience pressures are accelerating the case for regional solutions

Beyond economic and geopolitical factors, the physical risks of climate change are reshaping how regions approach energy connectivity, creating both new imperatives and new opportunities for cross-border cooperation. The Asian Development Bank's 2024 Asia-Pacific Climate Report warned that climate impacts could reduce GDP in developing Asia and the Pacific by 17% by 2070 under a high-end emissions scenario, with substantially larger long-run impacts under more severe trajectories.³⁶ Indeed, the Report notes that, '[e]xtrapolation of patterns of loss relative to warming suggests that losses could reach 41% by 2100 under a high end emissions scenario.'³⁷ For energy infrastructure, these climate risks mean that future grids and energy supply chains must be designed for resilience, including using diversified supply sources, building in redundancy

to support grid stability and enabling coordinated emergency support.³⁸

The IEA similarly highlighted Southeast Asia's increasing exposure to extreme weather and environmental risks in their recent Southeast Asia Energy Outlook Report, including a "crippling heat wave" in 2024 and heightened flood risks, alongside acute air quality burdens.³⁹ The international interconnection of energy networks is not a substitute for domestic resilience investment. However, modelling by the IEA, IRENA and the World Bank has repeatedly established that it can materially reduce outage and adequacy risks by allowing countries to draw on diversified resources and renewable generation time zones and to share reserve and balancing services across the region, where operating frameworks permit.⁴⁰

2.5 The impact of falling technology costs on import dependence and the value of connectivity

A robust APSEH case must avoid the assumption that all decarbonising economies in the Asia-Pacific region will necessarily rely on imported energy vectors. One of the most material uncertainties in the APSEH proposal is the speed at which energy storage and flexibility technologies reduce the need for cross-border imports. The IEA observed that battery storage costs have continued to fall quickly, driven by manufacturing scale-up and technology learning.⁴¹ Indeed, in its Renewable Power Generation Costs Report, IRENA reported that between 2010 and 2023 battery storage project costs declined by 89%. This significant cost reduction reinforces the idea that some economies may be able to meet a larger share of their reliability needs domestically through greater deployment and use of energy storage, demand response and firmed renewables.⁴²

The implication of a greater use of domestic energy storage is not that APSEH becomes irrelevant but that its value proposition must be framed more precisely.

In this context, if energy storage costs continue to fall rapidly, APSEH may shift from being primarily about bulk renewable electricity imports to being about (i) strategic trade in industrial clean molecules (low-carbon intensity hydrogen and ammonia and green methanol); (ii) embodied clean energy in processed materials (green iron, alumina and critical minerals); and (iii) resilience, redundancy and system services across jurisdictions. Conversely, if energy storage cost declines slow or supply chains constrain the deployment of storage and flexibility technologies, the economic case for cross-border balancing, time-zone diversity and shared reserve margins strengthens, particularly for fast-growing systems where domestic flexibility build-out lags demand. Either way, connectivity remains institutionally relevant because it creates option value. The legal and governance task is to design frameworks that can accommodate these divergent pathways without locking countries into inflexible, high-stranded-risk infrastructure decisions.

2.6 The strategic role of grid interconnection in the decarbonisation of the Asia–Pacific

Across the Asia–Pacific, the transition from fossil-based electricity to high shares of variable renewable energy is creating a systems problem: how do we maintain reliability, affordability and resilience, as generation capacity becomes more weather-dependent and more geographically distributed? In this context, interconnection into a “supergrid” is strategic because it enables:

1. geographic diversification of weather and resource profiles;
2. access to lower-cost renewable zones irrespective of national boundaries;
3. reduced curtailment by sharing surplus generation; and
4. enhanced system security through mutual support during supply shocks and extreme weather events.⁴⁷

Within Southeast Asia, the ASEAN Centre for Energy (ACE) has framed the ASEAN Power Grid (APG) as the core enabling infrastructure for achieving higher renewable shares, explicitly linking interconnection to the region’s quantified renewable energy targets and to measurable economic and employment outcomes.⁴⁸ The 2025 ASEAN Power Grid Update highlighted ASEAN’s very large technical renewable resource potential (including 8,119

GW solar and 342 GW wind) and identified strengthened cross-border interconnections as a mechanism for unlocking that potential at scale.⁴⁹

The APSEH should be understood in this context as a second-generation connectivity proposition: it is not only an electricity-transmission concept (HVDC lines and subsea cables),⁵⁰ but a multi-vector “energy trade corridor” that can move energy in several forms (electricity, hydrogen and derivatives such as ammonia and other low-emissions fuels), using multiple transport modes (cables, pipelines, shipping).⁵¹

This multi-vector design matters legally and institutionally. It implies governance demands that are broader than those addressed by traditional power-pool arrangements: APSEH requires a coherent approach to (i) electricity market coupling and network access; (ii) cross-border certification and guarantees of origin; (iii) maritime regulation and port state controls for hydrogen/ammonia shipping; (iv) investment screening and critical-infrastructure protections; and (v) environmental and social safeguards across multiple supply chains.

2.6.1 The ASEAN Power Grid

ASEAN Power Grid snapshot (2024–2040)⁴⁶

- 18 identified interconnection projects; 8 operational as of 2024.
- 2.8 GW operational grid-to-grid interconnection capacity as of 2024; 13.7 GW planned by 2040.
- Six future submarine interconnections identified within APG planning materials.
- LTMS-PIP cumulative multilateral trade reported at 266 GWh as of 2024; Phase 2 increases traded capacity to 200 MW and extends the relevant importer licence to 2026.
- APG financing and build-out framing indicates an investment requirement of approximately \$USD 764–800 billion to achieve the APG vision by 2045, with APGF designed to mobilise finance and convert projects from concept to construction.

The ASEAN Power Grid (APG) developed as an institutional response to the rapid expansion of national electricity systems within Southeast Asia in the late 1990s.⁴³ At that time, load growth, fuel price volatility and the emergence of variable renewables increased the value of larger balancing areas, shared reserves and cross-border resource diversity, prompting ASEAN to develop

a long-horizon regional integration programme.⁴⁴ Rather than pursuing immediate region-wide market coupling, ASEAN has advanced the APG through an incremental interconnection and governance strategy designed to build feasibility, institutional confidence and replicable implementation pathways.⁴⁵

ASEAN Power Grid Map

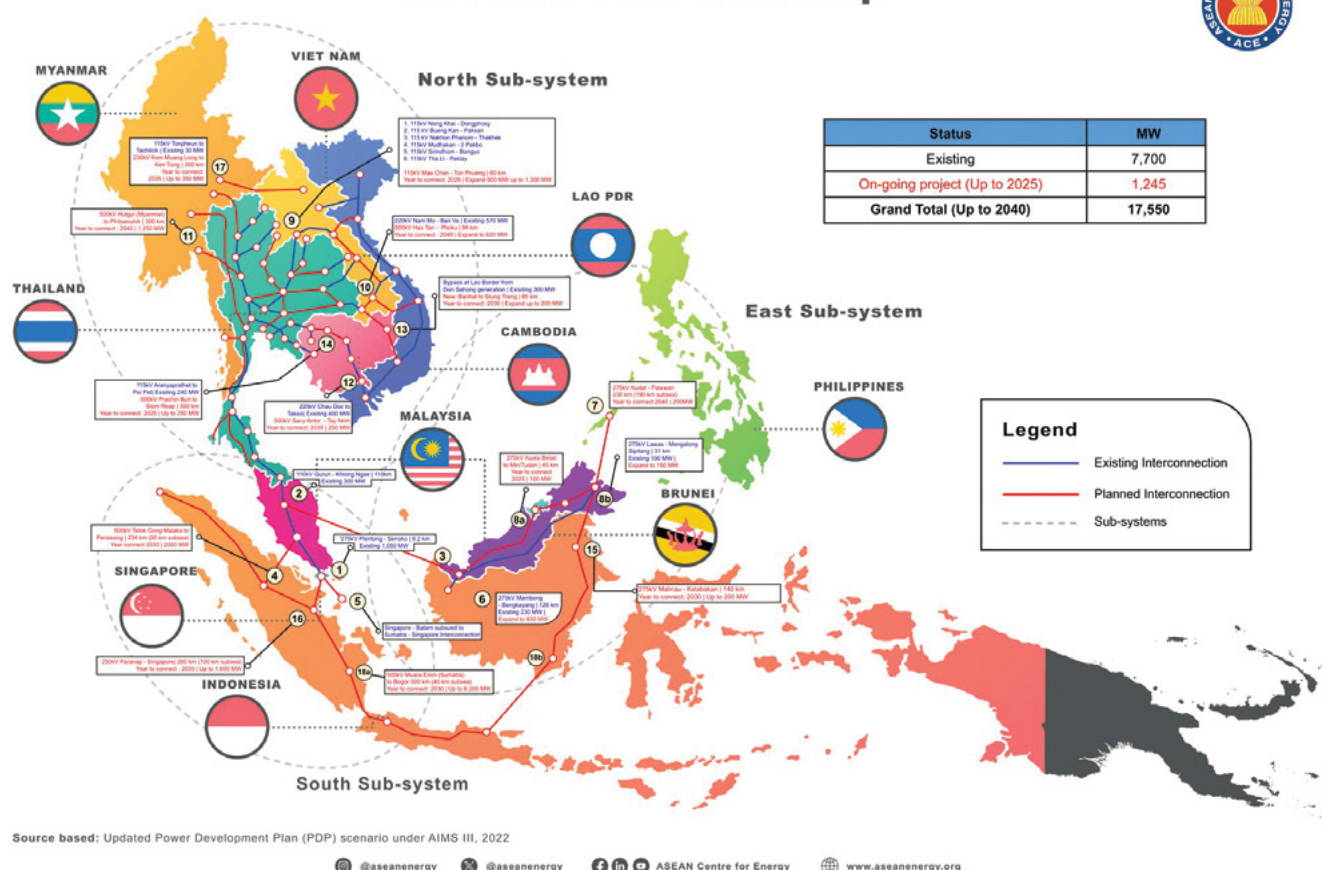


Figure 4: ASEAN Power Grid⁶³

Institutionally, the APG sits within ASEAN’s wider energy cooperation architecture and is implemented under the ASEAN Plan of Action for Energy Cooperation (APAEC).⁵² Governance of the APG is multi-layered and reflects ASEAN’s consensus-based approach and the continuing primacy of national sovereignty in energy policy.⁵³ Ministerial direction is provided through ASEAN energy ministerial processes. Technical and delivery work is led by the Heads of ASEAN Power Utilities and Authorities (HAPUA),⁵⁴ the specialised energy body responsible for APG implementation. Regulatory perspectives are channelled through the ASEAN Energy Regulators Network (AERN)⁵⁵ and the ASEAN Power Grid Consultative Committee (APGCC).⁵⁶ The ASEAN Centre for Energy (ACE) functions as the technical and coordination hub within the ASEAN system.⁵⁷

Against the APG’s original ambition, progress is being made, but in legal and market-design terms it remains a process of staged regionalisation rather than full integration. ASEAN differentiates between: (i) grid-to-grid interconnection capacity, which typically requires deeper coordination of technical standards, operational rules and regulatory oversight, including for congestion, losses and imbalance management; and (ii) project-linked, export-style connections, which can often proceed through

project approvals and bilateral contracting.⁵⁸ In the 2025 APG Update, operational grid-to-grid interconnection capacity was reported as 2.8 GW (2024), with 13.7 GW planned by 2040 and 8 operational interconnections out of 18 identified projects.⁵⁹ In parallel, ACE reported 7.5 GW of operational “generation-to-grid” capacity as of 2024.⁶⁰ These physical interconnections and delivered trade outcomes must not be conflated. Interconnection capacity is a necessary condition for trade but does not itself indicate the scale of active market exchange. The International Energy Agency (IEA) reported more than 38,000 GWh of cross-border electricity exchanged across Southeast Asia between 2016 and 2022.⁶¹ This demonstrates that APG projects are resulting in operational trade but that regional exchange remains modest relative to regional demand and projected growth.⁶² The most frequently cited multilateral proof of concept of the APG is the Lao PDR–Thailand–Malaysia–Singapore Power Integration Project (LTMS-PIP) (discussed in more detail at 2.6.2 below).

ASEAN’s current work programme increasingly treats governance as the binding constraint. This aligns with the IEA’s diagnosis that the principal barriers to faster APG delivery are political, regulatory and institutional, reflecting regulatory heterogeneity, limited resourcing

of coordinating bodies and sovereignty sensitivities with respect to control over critical infrastructure and operational decision-making.⁶⁴ ASEAN programme documents reinforce this diagnosis by identifying “minimum requirements” for multilateral power trade.⁶⁵ These include institutional and regulatory capacity building; harmonised grid codes; a harmonised wheeling charge methodology; third-party access guidelines; data-sharing practices; coordinated transmission capacity calculation; and dispute settlement mechanisms.⁶⁶ This represents the rules, processes and institutional capabilities needed to convert interconnection into dependable trade.

These governance constraints also interact directly with market structure and financeability. The IEA noted that many ASEAN Member States’ electricity systems remain vertically integrated or operate under single-buyer models, with state-owned utilities commonly owning and operating the grid.⁶⁷ Investment needs are substantial relative to the financial position of many utilities. This constrains domestic grid investment, limits capacity to underwrite capital-intensive cross-border assets and slows the emergence of private-led or merchant transmission models.⁶⁸ ASEAN’s approach has been pragmatic, relying on utility-to-utility and government-backed arrangements (where consistent with prevailing market structures), while elevating project preparation and de-risking as explicit bottlenecks requiring targeted intervention.⁶⁹

The ASEAN Power Grid Financing Initiative (APGF) was launched in October 2025 with ASEAN, the World Bank and the Asian Development Bank as coordinating partners.⁷⁰ The ASEAN Interconnection Masterplan Study (AIMS) III estimated that \$USD 764 billion in generation and transmission investment would be required to achieve the APG vision by 2045 under high variable renewables adoption scenarios.⁷¹ The ADB reported a shift in Ministerial emphasis towards domestic grid upgrades and the development of subsea cable frameworks, supported by governance measures including an APGF Working Group and the signing of an enhanced APG Memorandum of Understanding.⁷² The ADB has indicated a commitment of up to \$USD 10 billion over the next decade, supported by technical assistance.⁷³ The World Bank has indicated it would provide an initial \$USD 2.5 billion contribution under its programmatic support, including a seed grant to ACE to support its preparation of bankable projects and to define subsequent phases of support.⁷⁴ The World Bank’s APGF Brief framed the investment requirement at approximately \$USD 800 billion. It described the

APGF as designed to move projects “from concept to construction”, including pipeline development, capacity building, a centralised regional energy database and de-risking instruments such as guarantees, blended finance and credit enhancements, with an explicit connection to renewable energy certificates within the enabling ecosystem.⁷⁵

The institutional trajectory is therefore focused on more formalised regional functions and deeper rulemaking. A recent study on enabling agreements for multilateral power trade illustrates this shift. It argued that advancing the APG now requires the creation and institutionalisation of two regional functions: (i) a regional generation and transmission planning function (AGTP); and (ii) a regional transmission system operator function (ATSO).⁷⁶ It has been argued that these should be supported by a high-level intergovernmental agreement or protocols addressing governance arrangements, institutional responsibilities, a framework for cross-border trade and funding mechanisms.⁷⁷ Its proposed pathway is stepwise, beginning with consensus on an intergovernmental framework, followed by a decentralised Secretariat and Working Groups, then coordination and data-sharing with an initial “shadow” market approach and only later progressing towards an advanced operational stage with fully integrated regional market functions.⁷⁸

Thus, the APG reflects iterative institutional learning. ASEAN has treated regionalisation as an accumulated governance and infrastructure project, using pathfinder pilots such as LTMS-PIP to establish credibility for multilateral trade without requiring immediate EU-style market coupling. It has treated domestic grid readiness and system operation capability as prerequisites rather than ancillary issues, including explicit attention to subsea frameworks in an increasingly maritime connectivity agenda. It has also recognised that mobilisation of finance depends on standardised project preparation, credible risk allocation and institutional arrangements capable of withstanding political and regulatory change over multi-decade asset lives.

For APSEH, the APG does not provide a template to replicate. APSEH is broader in geography, more complex in technical and geopolitical terms and may require longer-distance subsea corridors. That said, a super-regional energy export corridor will only be investable and governable if it is designed for interoperability with regional integration programmes already underway, particularly the APG and its financing and governance platforms. ASEAN’s experience suggests that a build-first,

harmonise-later approach increases delivery risk. Minimum viable governance, including clear roles, operational protocols, wheeling and settlement principles, data-sharing rules and credible dispute-avoidance pathways, are the features that convert interconnection into dependable trade. On that basis, APSEH should be treated as a governance project as much as an

engineering project, with early pilots selected for their capacity to validate replicable legal and contractual architecture under real operating conditions, while aligning from inception with the regional institutions, standards and project-preparation pipelines that ASEAN is actively developing.

Lessons learnt from the ASEAN Power Grid and why they matter for APSEH

- 1. Progress is cumulative and sequenced, not a single market-coupling event.** ASEAN moved from bilateral links to sub-regional arrangements and then to multilateral pilots, preserving momentum while managing sovereignty constraints.
- 2. Pathfinders can be politically catalytic even at small scale.** LTMS-PIP's systemic value lies in proving wheeling, settlement and licensing mechanics that can be scaled as a template.
- 3. Governance is the binding constraint.** ASEAN's own work programme foregrounds harmonised grid codes, wheeling charges, third-party access, data sharing and dispute settlement as minimum requirements.
- 4. Market structure shapes bankability and delivery pathways.** In vertically integrated and single-buyer systems, utility-to-utility and government-backed arrangements often precede merchant models and financing must match that reality.
- 5. Finance platforms and project preparation are decisive.** APGF implements a pipeline-and-de-risking approach that is directly relevant to APSEH's multi-jurisdictional risk envelope.
- 6. Domestic grid readiness is a precondition for cross-border trade.** ASEAN's Ministerial Direction now explicitly couples cross-border connectors with domestic network upgrades and subsea governance frameworks.
- 7. Institutional capability must be built, not assumed.** The focus on AGTP and ATSO functions reflects the need for durable planning, operational coordination and market administration capacity.

2.6.2 Multilateral power trading: LTMS-PIP as “proof of concept”

A defining institutional milestone within ASEAN was the emergence of multilateral (rather than purely bilateral) trading through the Lao PDR–Thailand–Malaysia–Singapore Power Interconnection Project (LTMS-PIP).⁷⁹ The LTMS-PIP is best understood as an institutional experiment that emerged from and now actively shapes ASEAN's larger programme to make cross-border electricity trading routine.⁸⁰



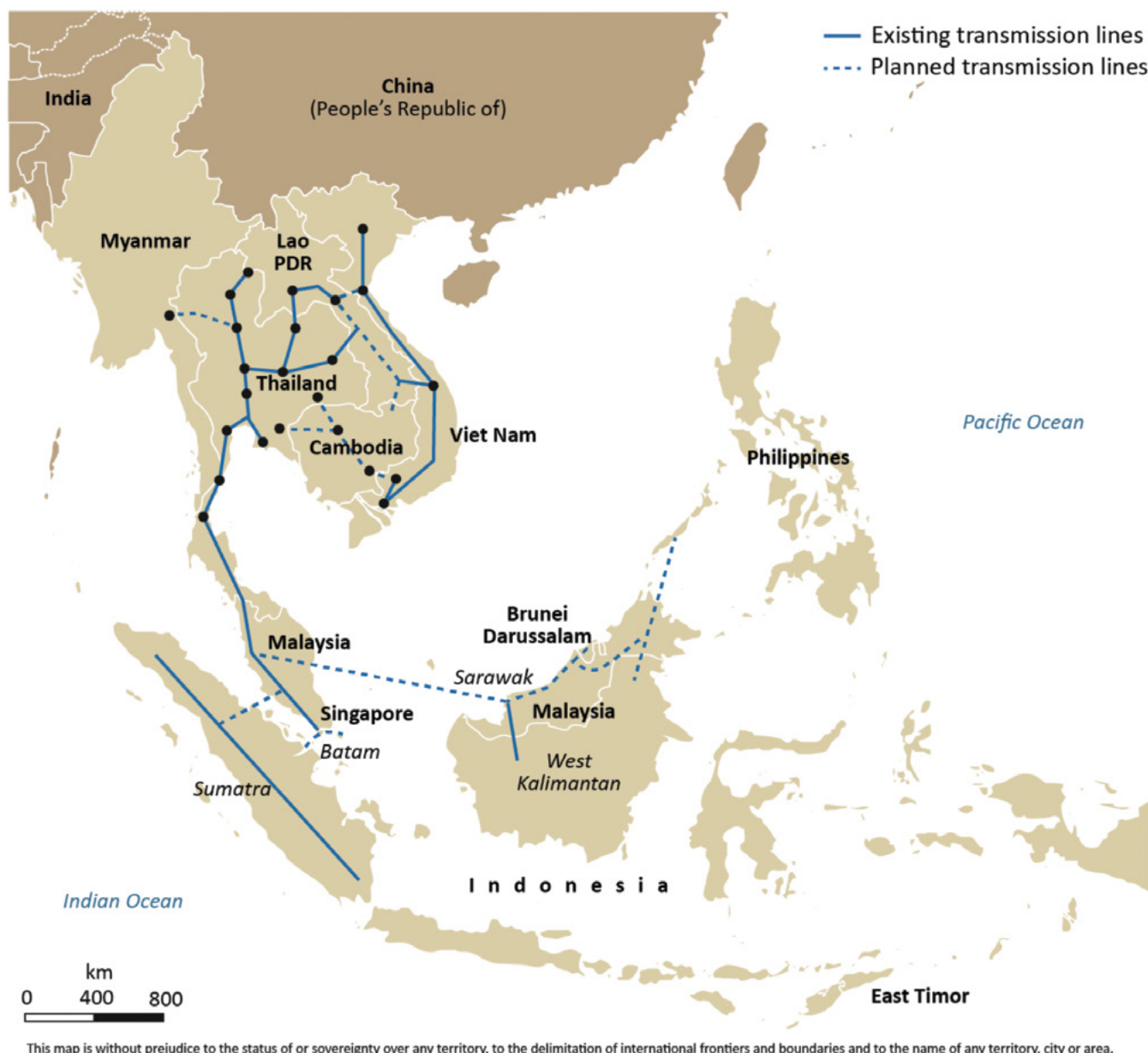


Figure 5: Map of the Existing and Planned Transmission Lines in the LTMS-PIP Project⁸⁶

The LTMS-PIP did not begin as a fully-fledged four-country market. Rather, it evolved from a tripartite precursor, the Lao PDR–Thailand–Malaysia Power Integration Project (LTM-PIP), initiated in 2016 to test whether electricity could be sold across borders using existing national grids, with Thailand acting as the transit country for delivery into Malaysia.⁸¹ In September 2017, the three countries concluded a two-year Energy Purchase and Wheeling Agreement at the 35th ASEAN Ministers on Energy Meeting, initially enabling trade of up to 100 MW under a power purchase agreement model.⁸² In December 2019, that arrangement was extended for a further two years to December 2021 and the maximum trading capacity was increased to up to 300 MW.⁸³

LTMS-PIP, as the four-country pilot, was formally put on the ministerial track through ASEAN’s energy governance

cycle. At the 38th ASEAN Ministers on Energy Meeting (AMEM) in 2020, Lao PDR, Thailand, Malaysia and Singapore issued a Joint Statement committing to explore the technical and commercial feasibility of multilateral electricity trading into Singapore, again using existing interconnections, with an initial ambition of trading up to 100 MW for a two-year period.⁸⁴ At the 39th AMEM in 2021, the four countries reaffirmed the initiative through a second Joint Statement, noting progress via an LTMS-PIP Working Group and signalling early finalisation of the agreements required for operations to commence in 2022.⁸⁵

The project moved from diplomacy to operation on 23 June 2022, when Singapore’s Energy Market Authority announced the commencement of renewable electricity imports of up to 100 MW of hydropower from Lao PDR to

Singapore via Thailand and Malaysia.⁸⁷ The Singaporean EMA characterised this as the first multilateral cross-border electricity trade involving four ASEAN countries and, for Singapore, the first renewable energy import.⁸⁸ Importantly for bankability, the announcement also situated LTMS-PIP within Singapore's wider pathway for scaling electricity imports, noting that such trials were intended to pave the way for larger-scale imports of up to 4 GW into Singapore by 2035.⁸⁹

In governance terms, LTMS-PIP is neither an ASEAN-level market operator nor a supranational transmission system. It is an interlocking set of state and utility actions, overseen politically through ASEAN Energy Ministerials and operationalised through national regulators, system operators and contractually specified roles. Singapore's model saw Keppel Electric as the initial licensed importer and counterpart to Electricité du Laos under a two-year power purchase arrangement, with Electricity Generating Authority of Thailand (EGAT) and Tenaga Nasional Berhad (TNB), Malaysia's principal electricity utility in Peninsular Malaysia, positioned as critical counterparts for transmission and delivery through their networks.⁹⁰ A central "proof" of LTMS-PIP is therefore institutional, not physical. It demonstrates that multilateral trade can be made operational through regulatory licensing and tightly drafted inter-utility instruments, even where the participating jurisdictions retain divergent domestic market structures.

The legal architecture required to do this is documented explicitly in regional technical work. The LTMS-PIP required multiple agreements to transfer electricity, including an LTMS Energy Wheeling Agreement, a fifth Supplemental Agreement linked to interconnection arrangements involving the relevant Malaysian utility and a Supplemental Letter relating to the HVDC system interconnection arrangements between EGAT and TNB.⁹¹ The regulatory and commercial challenges flow from differences in power market structures and from aligning multilateral power trade with pre-existing bilateral arrangements.⁹² The design lesson for APSEH is straightforward. The "bankable unit" is not a political declaration of cooperation, but a repeatable suite of operational contracts, licensing decisions and settlement rules that allocate cost, performance risk and non-delivery consequences.

The ASEAN Centre for Energy's ASEAN Power Grid Updates 2025 reports that Phase 1 of LTMS-PIP completed in 2024 with total traded energy of 266 GWh through capacity of up to 100 MW.⁹³ It further reported the planned move to Phase 2, including an increase in import capacity to 200 MW, a transition to two power flows (Lao

PDR to Singapore via Thailand and Malaysia and Malaysia to Singapore) and a reported 14.99 GWh cumulative total of purchased power from Malaysia to Singapore alone in the Phase 2 snapshot.⁹⁴ ACE also links Phase 2 scaling to regulatory authorisation in Singapore, stating that the Singaporean EMA extended Keppel's importer licence until 2026 and doubled the power import capacity to 200 MW.⁹⁵

Subsequent reports confirm both the ambition and the fragility of scaling. It was reported in July 2024 that the renewal after the initial two-year period was at risk due to unresolved disputes over transmission agreements with Thailand and Malaysia. This was because transit states were seeking a guaranteed fixed purchase quantity to cover transmission costs and Singapore resisting.⁹⁶ This was compounded by strategic competition for renewable electricity, including Thai authorities indicating a preference to retain electricity for domestic use.⁹⁷ By October 2024, Thailand had not finalised the extension terms, with wheeling charges a decisive outstanding issue.⁹⁸ These developments identify the bankability constraint in practice, namely the difficulty of sustaining corridor economics when transit states require credible cost recovery while importers and offtakers resist paying for undelivered volumes.

A second, equally practical constraint is utilisation risk, which exposes multilateral clean power trade to fuel-price cycles unless procurement frameworks lock-in demand. During the first phase, Singapore used only 40% of its contracted capacity and imports dropped as global natural gas prices fell.⁹⁹ More recent media reports situate cross-border renewable imports within a context of rising electricity demand and an expanding import agenda.¹⁰⁰ This also underscores that imports and domestic renewable outputs remain sensitive to market and operational conditions. For APSEH, this points to a distinction that is often elided in connectivity narratives. Deliverability is necessary, but not sufficient. Bankability requires credible and durable revenue stabilisation mechanisms, whether through capacity reservation, mandated procurement, contracts for difference, regulated network charges, or other policy instruments that sustain investment through commodity cycles and political change.¹⁰¹

Notwithstanding these constraints, LTMS-PIP highlights what ASEAN has done well. First, it validated incrementalism as a governance strategy, rather than waiting for EU-style market coupling.¹⁰² It built a multilateral trading pathway by stacking discrete contracts and regulatory permissions around existing interconnectors, then tested the model under real

operating conditions.¹⁰³ Second, it created an institutional learning loop.¹⁰⁴ The 2025 ACE Update frames Phase 2 as an enhancement that includes multi-directional trade and expanded supplier configurations, precisely the kind of iterative adaptation that large corridor concepts require.¹⁰⁵ Third, the project's recent revival steps indicate that the region is continuing to refine wheeling and transit arrangements rather than abandoning the model. In January 2026, TNB, Electricité du Laos and EGAT signed a tripartite Energy Wheeling Agreement Phase 2 under LTMS-PIP 2.0 to facilitate renewable supply of up to 100 MW from Lao PDR to Singapore, with Thailand and Malaysia as wheelers. This completed the implementation of LTMS-PIP 2.0 by increasing total traded capacity from 100 MW to up to 200 MW with additional energy supplied from Malaysia to Singapore.¹⁰⁶ This agreement is reported to have revived the deal that had stalled since 2024.¹⁰⁷

The lessons for APSEH from the LTMS-PIP are that the decisive bankability questions are likely to be: wheeling cost recovery, settlement design, licensing and authorisation pathways and pre-agreed rules for non-delivery and curtailment under stress. The LTMS-PIP's renewal difficulties show that the transit-state incentive is structurally fragile unless corridor tariffs reconcile fixed cost recovery with importing-state demands for value-linked payment. Its utilisation fluctuations indicate that corridor economics cannot be left entirely to short-run fuel price comparisons if the objective is strategic decarbonisation and resilience. Finally, the project's periodic stalling due to political change and sovereign preferences demonstrates that corridor design must internalise "retention risk" and political contingency as normal features of cross-border power trade, rather than exceptional failures.

2.6.3 Beyond ASEAN: Northeast Asia supergrid proposals

Northeast Asia has long been the focus of ambitious "supergrid" proposals within the Asia-Pacific region including the Northeast Asia Super Grid,¹⁰⁸ Gobitec¹⁰⁹ and Asian Super Grid,¹¹⁰ or broader Asian/Global supergrid concepts. These proposals generally rely on very long-distance HVDC transmission to move renewable electricity from resource-rich regions, notably the Gobi Desert and Mongolia, to demand centres in China, Korea and Japan, sometimes with onward links.

A key feature of the Northeast Asia context is that, unlike Southeast Asia where cross-border trade already occurs at meaningful scale via the LTMS-PIP, Northeast Asia's most valuable prospective interconnections would cross major geopolitical fault lines.¹¹¹ This does not negate their economic logic but it does fundamentally change the institutional design problem from "legal frameworks, finance, construction, trade and govern" to "build serious trust first, legal frameworks, finance, construction, trade and govern".

The International Renewable Energy Agency (IRENA) has identified the Northeast Asia Gobitec and Asian Super Grid concept as one of the prominent cross-border interconnection proposals.¹¹² In their *Renewable Energy and Electricity Interconnections for a Sustainable Northeast Asia* report, IRENA and the Korean Energy Economics Institute (KEEI) surveyed the broader case for interconnections as a means of enabling high renewable penetrations and balancing across large geographic regions.¹¹³ The 'Gobitec and Asian Super Grid' initiative, prepared by five partner organisations from Japan, the Republic of Korea, Mongolia and the Russian Federation in collaboration with the Energy Charter Secretariat, likewise set out the foundational vision of linking Gobi renewables into an integrated Northeast Asian market framework.¹¹⁴

Peer-reviewed literature continues to explore technically feasible routing options that avoid certain geopolitical and bathymetric constraints. For example, Itiki et al's study assessed the technical feasibility of a Japan–Taiwan–Philippines HVDC interconnector as part of an Asia-Pacific supergrid pathway.¹¹⁵ This research highlighted that engineering challenges can often be managed with sufficient capital and innovation.¹¹⁶ However, as Goldthau and Witte's work has shown, for financing to be successful, cross-border institutional durability, including the market rules, security of supply commitments and dispute resolution, become decisive factors for both public and private investors when critical infrastructure projects span sensitive strategic relationships.¹¹⁷

Research by Itiki et al and Hughes and Lipsky found that the energy-security and foreign-policy dimensions of interconnection can be as material to decision-makers as the economic case.¹¹⁸ For example, both Tanaka (a former Executive Director of the IEA) and the Atlantic Council have framed Japan's engagement with an Asian Super Grid as a policy pathway deeply intertwined with broader energy diplomacy and regional strategic considerations.¹¹⁹

For Australia, the Northeast Asia experience supplies two cautionary lessons that ought to be built into APSEH design. First, without credible governance institutions and security arrangements, economically efficient interconnection can remain stranded as a political

proposition. Second, multi-vector corridors may be more resilient than single-asset links. Where electricity interconnection is politically sensitive, hydrogen/ammonia shipping or hybrid models can provide partial connectivity benefits while reducing perceived strategic dependence.

2.7 Australia's existing engagement with regional grid interconnection initiatives

Australia's engagement with regional power interconnection is advancing through both high-level policy frameworks and project-level regulatory processes that test whether ultra-long-distance electricity exports can be permitted, financed and governed at corridor scale. Singapore has become the principal gateway for any APSEH-aligned interconnection corridor for two reinforcing reasons. First, it has a clear strategic policy of diversifying energy supply through low-carbon imports. Second, it possesses the institutional capacity to administer credible import licensing and system-integration rules. Singapore's objective of importing up to 6 GW of low-carbon electricity by 2035 reflects a structural reliance on cross-border supply as a core element of its decarbonisation pathway,¹²⁰ a position confirmed by analysis from the Japan International Cooperation Agency (JICA) and the Institute of Energy Economics Japan (IEEJ).¹²¹

Within this framework, Singapore's Energy Market Authority (EMA) granted conditional approval in October 2024 to Sun Cable (Singapore) Assets Pte Ltd to import 1.75 GW of low-carbon electricity from Australia via approximately 4,300 kilometres of subsea cable.¹²² This approval was explicitly linked to Singapore's decarbonisation strategy and recognising the project as technically and commercially viable pending development toward operation after 2035.¹²³ This decision carries distinct implications for APSEH. It established a regulatory precedent demonstrating that a sophisticated importing jurisdiction can design a licensing and review process for ultra-long-distance electricity imports, even where the generation is offshore and transmission crosses multiple maritime zones. Further, it signified Singapore's emerging role as both an importer and a trading hub. This places Singapore at the intersection of the ASEAN Power Grid's multilateral trading evolution and any APSEH corridor that routes Australian renewable exports into Southeast Asia.

At the project level, Sun Cable's Australia-Asia PowerLink (AAPowerLink) operates as a pathfinder for APSEH by

illustrating, in concrete regulatory terms, the governance, permitting and cross-jurisdictional coordination challenges that any corridor-scale proposal must resolve. The project combines large-scale solar generation at Powell Creek in the Northern Territory's Barkly region,¹²⁴ high-voltage direct current transmission to the Gunn Point Peninsula near Darwin,¹²⁵ and a subsea export link through Australian and international waters to Singapore.¹²⁶

Infrastructure Australia describes the AAPowerLink as a private proposal designed to supply electricity to the Darwin region and Singapore, positioning it as a potential foundation for a renewable electricity export industry from northern Australia.¹²⁷ The project received environmental approvals from both the Commonwealth and Northern Territory governments in 2024,¹²⁸ and renewed Australian Major Project Status in 2025.¹²⁹ These developments signalled continued government confidence despite capital-raising pressures and corporate changes following its 2023 administration.¹³⁰ The revised project now targets approximately 6 GW for both domestic industry and eventual export, supported by Commonwealth approvals under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) and ongoing engagement with Indonesia on subsea permitting.¹³¹ A Final Investment Decision is being prepared for 2027, with a pragmatic near-term focus on supplying Northern Territory customers, including large data centres, before pursuing exports.¹³² Early generation and storage capacity from the project is expected to be operational before 2030.¹³³ On the import side, EMA's conditional approval anchors the project within a formal regulatory pathway. On the export side, these processes foreground precisely the APSEH-type issues that regional stakeholders must resolve at corridor scale: permitting, environmental and social licence, grid access, export contracting, investment protection and cross-jurisdictional risk allocation.

A separate but related design implication follows from examining the existing state of cross-border power trade

in Southeast Asia. A frequent misconception is that the region lacks material power trade. In reality, trade is already substantial in parts of the region and is expanding as an energy-security instrument. Cambodia, for example, currently imports approximately 1,030 MW of electricity from Laos, Vietnam and Thailand, around 25% of its supply,¹³⁴ and plans to increase import capacity by more than 600 MW, including 300 MW expected to begin flowing from Laos from 2026.¹³⁵

This existing trade reality carries a critical design implication for APSEH: any corridor seeking to connect Australian exports into Southeast Asia should be structured to complement and scale existing multilateral and bilateral practices. These include Greater Mekong Subregion trading, ASEAN Power Grid pilots and Singapore's import licensing framework rather than attempting to impose an entirely novel governance architecture on a region where incremental, institution-building approaches have already demonstrated viability.

2.8 Conclusion

Section 2's regional survey supports a decisive proposition for Australia's APSEH strategy. The ASEAN case study demonstrates that incremental integration is possible, if institutions are built in parallel with assets. APG's move from bilateral lines to multilateral trading pilots and the parallel development of intergovernmental agreement concepts and regional institutions, provides the most practical blueprint for APSEH governance staging. Meanwhile, Northeast Asia demonstrates that technical feasibility is insufficient where political-security risk is not institutionally managed. The persistence of Northeast Asian supergrid studies alongside limited real-world execution underscores the premium on durable rules, security of supply commitments and credible dispute-avoidance mechanisms.¹³⁶

Australia's most credible near-term pathway is to position itself as a rules-based "connector" into systems that are already building connectivity, particularly via Singapore and APG-aligned mechanisms, while shaping APSEH as a multi-vector corridor rather than trying to pick a single-asset "winner". Conceptually, APSEH can be read as an attempt to connect the connectivity projects: linking the Southeast Asian trajectory (APG and GMS-based trade) with Northeast Asian demand and decarbonisation needs, while adding Australia's export-scale renewables potential and clean-industry ambitions. Three design features distinguish APSEH from earlier "supergrid" narratives:

- *Multi-vector energy trade*: APSEH is not confined to "electrons", broadening feasible trade pathways. Where grid interconnection is constrained by sovereignty concerns or financing barriers, hydrogen/ammonia shipping can function as a substitute or complement, particularly for decarbonising industrial end-uses and shipping fuels.
- *Corridor governance rather than single-market integration*: APSEH does not require immediate full market coupling across all participating economies. It can be advanced through corridor-style governance (common standards, certification, investment safeguards and interoperable trading rules) that permits staged expansion.
- *A regulatory competition dynamic*: APSEH would operate across jurisdictions with markedly different electricity sector structures (state-owned single-buyer systems, vertically integrated utilities and liberalised wholesale markets). This increases the premium on governance interoperability, i.e., clear rules for third-party access, settlement, congestion allocation and regulatory oversight, rather than forcing uniform domestic market reform as a precondition to participation.

3. Australia's current energy export profile and the case for a renewable export pivot

Australia approaches APSEH from a different starting point compared to many nations within the region: it is already a super-exporter of energy.¹³⁷ That legacy matters because Australia's potential involvement in APSEH principally represents, in legal and commercial terms, not a "new" task of exporting energy, but rather the deliberate re-engineering of Australia's export model away from fossil-dominant trade (largely coal and liquefied natural gas (LNG)). This means that over time, Australia's energy

exports must shift towards a portfolio of low-emissions export vectors, including electricity, hydrogen/ammonia and "embodied" clean energy in the form of processed critical minerals and green manufactured products, all while maintaining social licence, system security and investor confidence.

3.1 Australia is an energy-export economy by design

Australia's energy system is structurally export oriented. In 2023–24, Australia produced 19,230 petajoules (PJ) of energy,¹³⁸ and exported 15,292.5 PJ, or about 80% of production.¹³⁹ When Australia's petroleum imports are factored into the trade balance, energy exports were 12,824 PJ, i.e., they still represent 67% of net energy production.¹⁴⁰

This export profile is highly concentrated in two commodities, coal and LNG. In 2023–24, black coal

exports were 10,056.9 PJ, representing 65.8% of Australia's total energy exports, while LNG exports were 4,508.5 PJ, representing 29.5% of total energy exports.¹⁴¹ The remaining export basket made up of crude oil and feedstocks, as well as some refined products, is comparatively small, but can be strategically significant for supply chains and shipping infrastructure.¹⁴² These exports were worth approximately \$AUD 239 billion to the Australian economy and represent 8.5–9% of Australia's GDP/terms of trade.¹⁴³

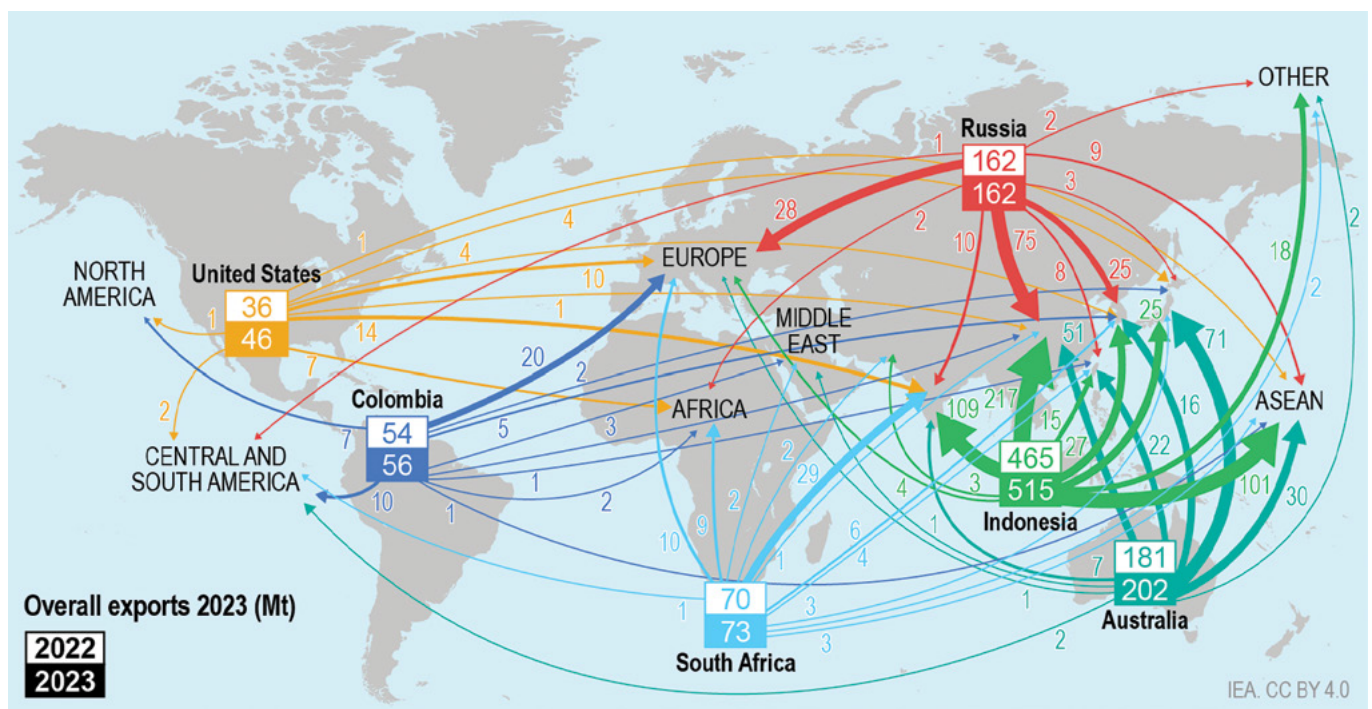


Figure 6: Main Trade Flows in the Thermal Coal Market, 2023 (Mt)¹⁴⁴

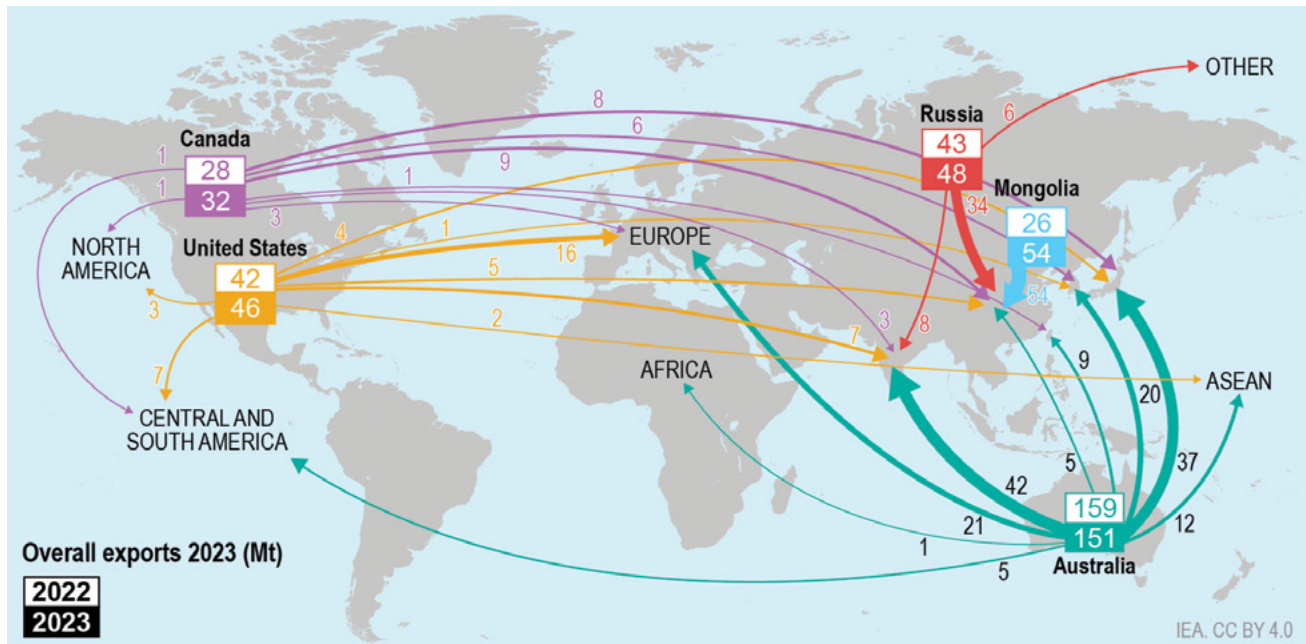


Figure 7: Main Trade Flows in the Metallurgical Coal Market, 2023 (Mt)¹⁴⁵

Australia's energy-export-driven economy means that the pivot away from fossil fuel to clean energy exports does not represent a marginal adjustment. Rather, it is an economic transition on the scale of the existing \$AUD 239 billion energy export economy.¹⁴⁶ As such, APSEH-aligned strategies must be evaluated against the magnitude of maintaining business as usual and what this means both for the region and for Australia's position within it, over the long-term. In this sense, Australia is not deciding whether to begin exporting energy; it is deciding whether it can remain competitive as an energy exporter in a decarbonising Asia-Pacific and, if so, in which forms.

This question carries an urgency that goes beyond opportunity-seeking. It is a question about economic survival at export scale. Australia's energy export base, which is currently worth approximately \$AUD 239 billion per year, is heavily concentrated in two commodities whose long-term demand trajectory is structurally downward in a decarbonising world. The same regional net-zero commitments that create the market for APSEH-aligned exports are also and more immediately, eroding the market

for existing exports. Sections 3.2 and beyond document this trajectory in detail; the point to underscore here is that APSEH is not an optional strategic enhancement to a stable incumbent business. It is the primary candidate for partially replacing an export base that the global energy transition and decarbonisation efforts will otherwise shrink. This provides the correct frame within which to evaluate the economic case for early governance investment, even where specific export pathways are not yet fully commercial.

Australia's comparative advantage is not merely its resource endowment. It is also Australia's institutional capability in scaling, financing, permitting, regulating and operating fossil fuel export infrastructure over decades, including in deep water ports, pipelines, gasification and shipping and long-term offtake contracting.¹⁴⁷ This experience can be repurposed for renewable export corridors, provided the regulatory architecture is modernised and social licence is sustained.

3.2 Australia's fossil fuel export dependence is regionally anchored and increasingly exposed

Australia's fossil exports are overwhelmingly linked to Asian demand. For example, for the past three decades the vast majority of Australia's LNG exports have been sent to Asia, with major destinations including Japan (36%), China (28%), the Republic of Korea (14%) and Taiwan

(11%) (as reported for 2022–23).¹⁴⁸ This concentration has historically been a strength, benefiting from long-term contracts, deep trade relationships and mutually reinforcing investment ties.¹⁴⁹

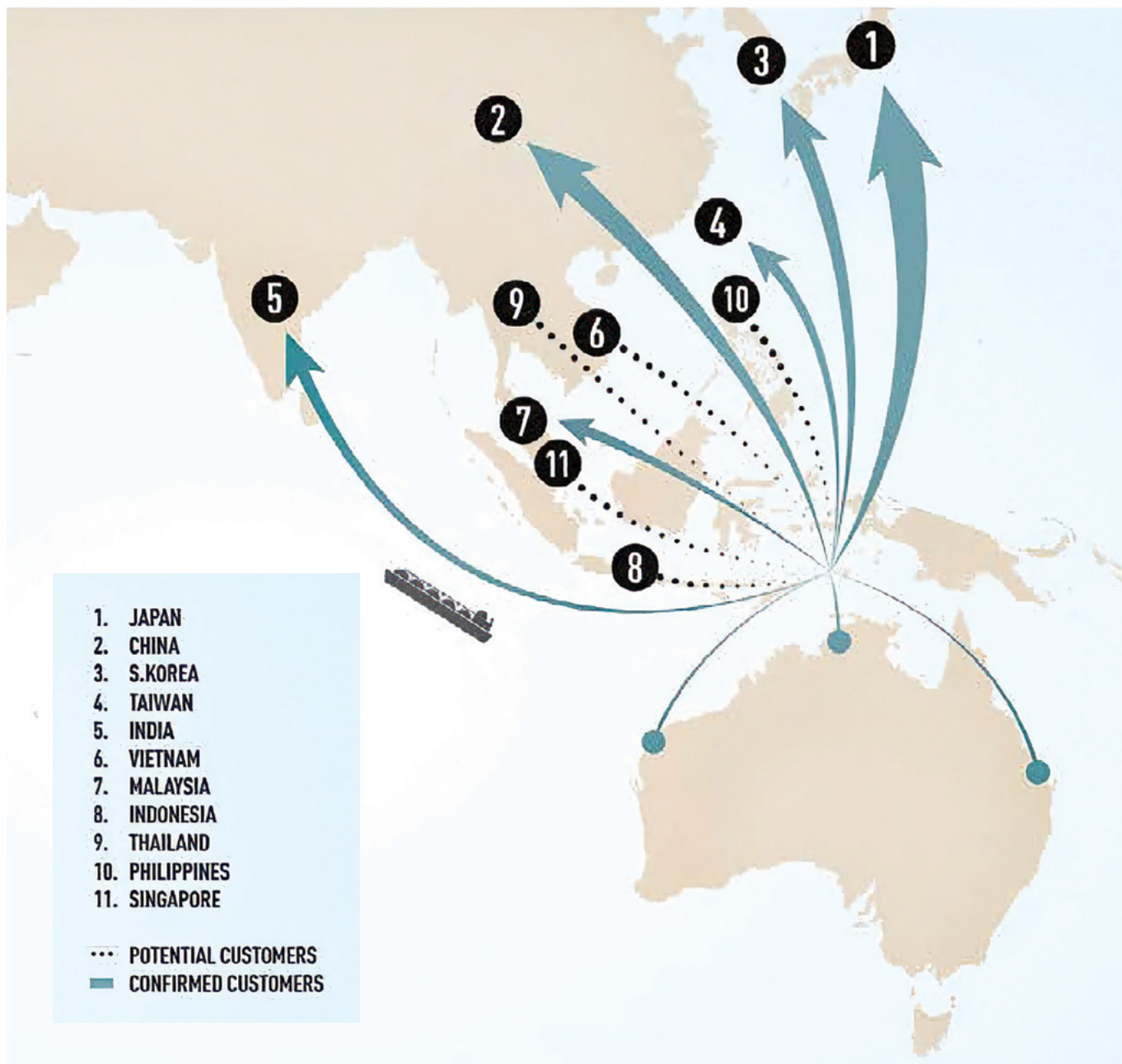


Figure 8: Australia's LNG Export Markets¹⁵⁰

For APSEH, however, this concentration creates exposure to three interacting dynamics:

1. *Accelerating net-zero policy commitments across importers.* Korea, Japan and a growing number of ASEAN economies have net-zero or carbon-neutrality pledges that increasingly translate into procurement standards, industrial decarbonisation mandates and green public finance conditions.¹⁵¹ Even where fossil fuel imports persist, buyers are shifting towards lower-emissions supply (e.g. requiring evidence of methane performance, lifecycle accounting, certification requirements).
2. *Energy security diversification.* APSEH discussions

sit alongside a wider regional push to diversify supply sources, routes and technologies. Electricity interconnection, hydrogen/ammonia trade and critical minerals supply chain agreements are increasingly treated as strategic geopolitical negotiations, in addition to the commercial negotiations.

3. *Technology-driven demand uncertainty.* The export outlook is increasingly shaped by technology cost curves (for renewable technologies, batteries, electrolyzers) and the speed at which importing countries can onshore their clean energy supply.

The onset of energy transition-related risk is already evident in Australia's Department of Industry's Resources

and Energy Quarterly (March 2025), which forecasted a structural decline in Australia’s overall resources and energy export earnings from \$AUD 385 billion (2024–25) to \$AUD 241 billion (2029–30).¹⁵² This is not a short-term commodity cycle forecast. Rather, it is an economy-level signal that demand, prices and trade patterns are anticipated to shift materially over the second half of the 2020s. Within that trend, the two biggest APSEH-relevant incumbent energy sources, thermal coal and LNG, are projected to face pronounced earnings declines over the forecast period:

- Thermal coal export earnings were projected to fall from \$AUD 34 billion (2024–25) to \$AUD 22 billion (2029–30).¹⁵³
- LNG export earnings were projected to fall from \$AUD 72 billion (2024–25) to \$AUD 45 billion (2029–30).¹⁵⁴

For APSEH, the central point is not that coal or LNG “disappear” quickly. It is that Australia’s fiscal and industrial reliance on these exports becomes a strategic vulnerability unless Australia develops credible, bankable alternative export sectors at scale.

3.3 Australia’s renewable energy resources

Australia has abundant renewable energy resources that have been described as “the envy of the world”.¹⁵⁵ In 2025, Australia had over 42 GW of installed solar PV, giving Australia the highest solar PV capacity per capita globally.¹⁵⁶ Additionally, Australia passed 4 million installations in rooftop solar, generating over 12% of Australia’s electricity and total new clean energy investment reached \$AUD 12.7 billion, including \$AUD 9 billion in large-scale generation.¹⁵⁷ Australia also possesses

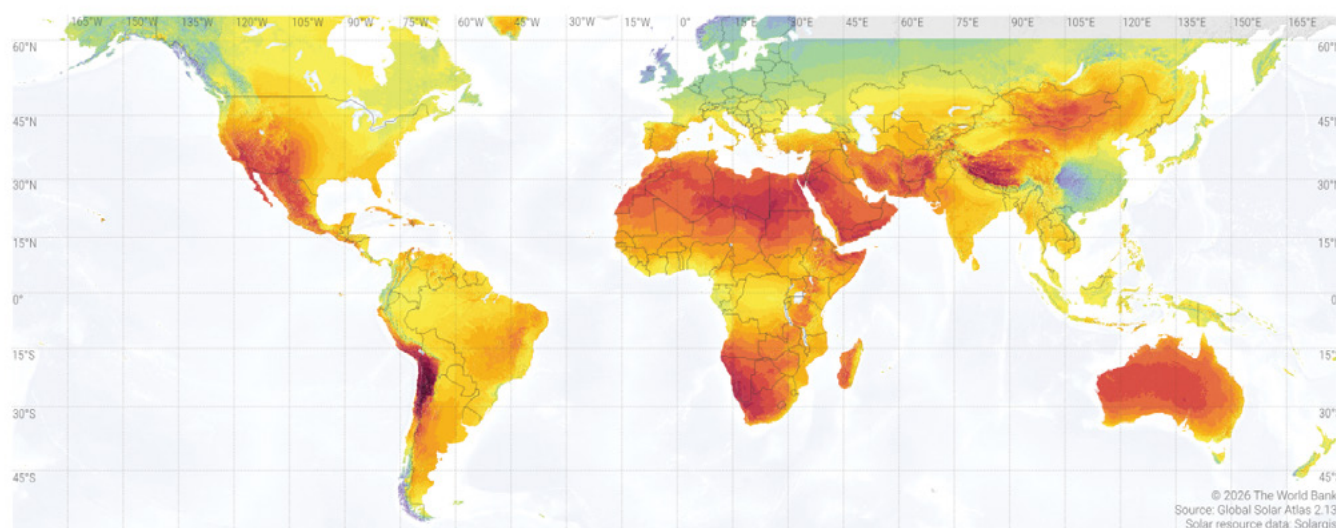
extensive wind resources, with onshore wind generating approximately 32.5 GWh of energy in 2024.¹⁵⁸ The country has still not tapped into its full renewable energy potential, particularly in offshore wind, where the domestic industry remains in its infancy. Estimates suggest that Australia’s offshore wind resource could theoretically generate up to 5,000 GW of electricity, a scale equivalent to roughly one hundred times the installed capacity of the country’s two largest electricity networks combined.¹⁵⁹

SOLAR RESOURCE MAP

PHOTOVOLTAIC POWER POTENTIAL



WORLD BANK GROUP



Long-term average of photovoltaic power potential (PVOUT)													
Daily totals:	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	kWh/kWp
Yearly totals:	730	876	1022	1168	1314	1461	1607	1753	1899	2045	2191	2337	

This map is published by the World Bank Group, funded by ESMAP, and prepared by Solargis. For more information and terms of use, please visit <http://globalsolaratlas.info>.

Figure 9: Map of World Solar Potential: Photovoltaic Power Potential¹⁶⁰

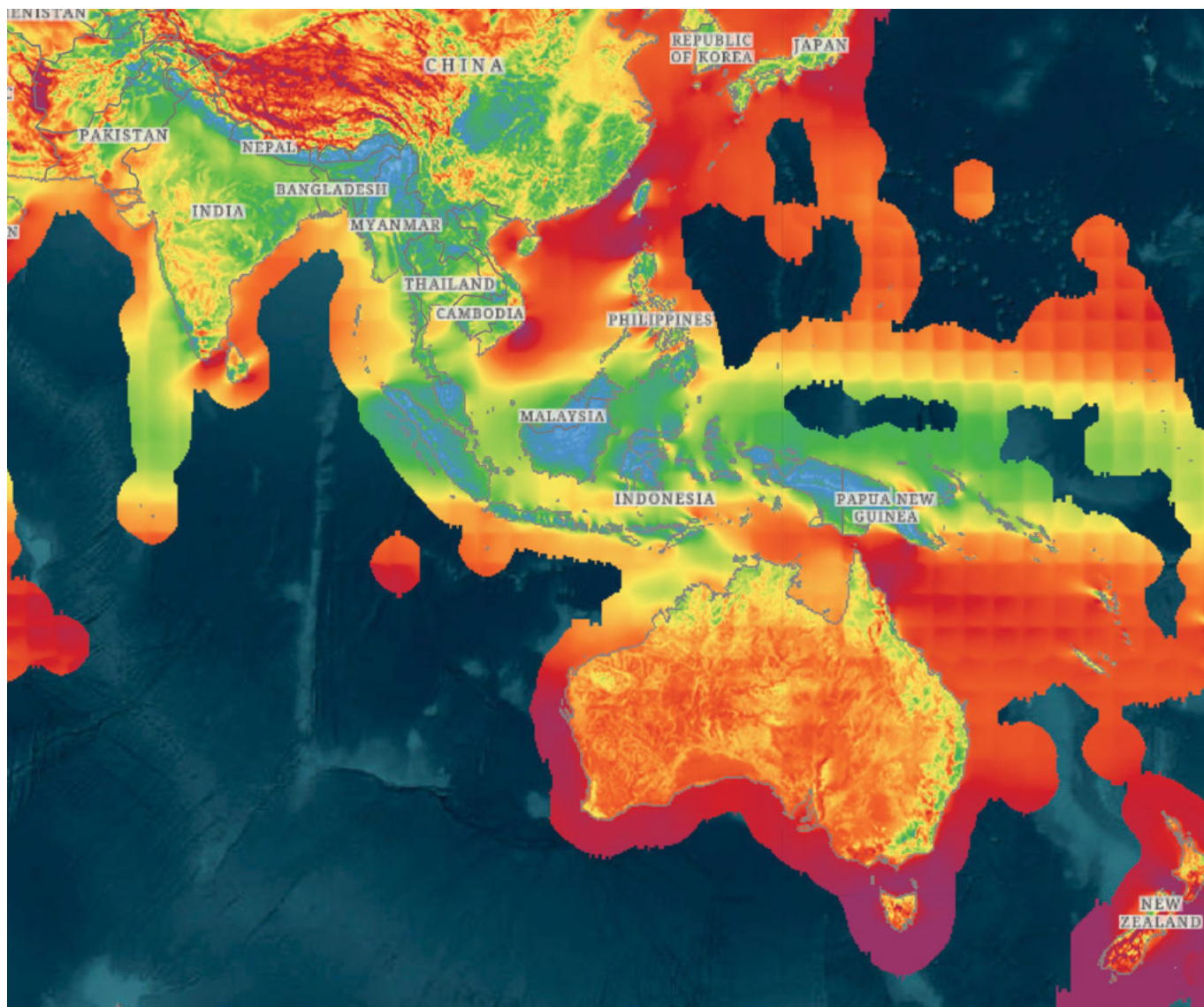


Figure 10: Map of World Wind Potential: Mean Wind Speed¹⁶¹

Taken together, this potential solar and wind renewable generation capacity represents an opportunity for Australia to develop globally significant clean-energy industries and export markets. This was recognised by the Australian Government in their 2023 Intergenerational Report¹⁶² and the Australian Treasury's 2025 modelling,¹⁶³ which have both highlighted that Australia's low-cost renewables, combined with its critical mineral endowments, could support scenarios in which clean exports progressively replace declining fossil-fuel revenues. If Australia successfully shifts toward a renewable-export-led growth model, the economic gains could be substantial. Under the Australian Treasury's Renewable Exports Upside Scenario, if Australia captures a large share of global demand for clean energy-embedded products by exporting hydrogen, green ammonia and green metals, then economic growth is projected to exceed the Baseline Scenario from 2030

onward.¹⁶⁴ Australian Treasury modelling indicated that by 2050 the economy would be \$AUD 85 billion larger than under the baseline pathway, with real GDP per capita rising by about \$AUD 38,000 over the 25 years to 2050.¹⁶⁵ These projections represent the Australian Treasury's optimistic scenario, which was one of several modelled futures and not the central forecast. They should be read as illustrating the ceiling of economic possibility if Australia captures a large share of clean export demand under conditions of strong global climate action, not as a probable baseline outcome. The more conservative scenarios in the same modelling exercise are substantially less favourable and the IEA and Treasury both note that realising the upside requires not only resource endowment but also credible certification, regulatory settings and the development of new export pathways that do not yet have proven markets at the required scale.¹⁶⁶

3.3.1 The technical challenges associated with exporting renewable electricity from Australia

Exporting electricity (as distinct from hydrogen, ammonia, or green metals) is technically feasible but requires solving a set of interlocking engineering problems.

1. *Extreme distance drives losses, cost and design complexity*

A subsea link from Australia to Singapore would need to cover approximately 4,300 km, which is unprecedented relative to operational benchmarks. The Singaporean EMA's conditional approval references this approximate distance.¹⁶⁷ By comparison, the Viking Link interconnector which operates between the UK and Denmark is about 765 km.¹⁶⁸ Distance matters technically because it compounds electrical losses and constrains operating margins. The US Energy Information Administration (EIA) notes typical HVDC line losses of ~3.5% per 1,000 km, plus converter station losses of roughly 0.6–1%.¹⁶⁹ On a 4,300 km route, that implies a ballpark order of magnitude of ~15% line losses, plus ~1–2% conversion losses at the ends, before considering additional system and availability constraints.¹⁷⁰ The economic implication of this technical challenge is that the exported electricity must be produced at sufficiently low cost, at sufficiently high utilisation, to absorb these losses and still clear the delivered price hurdle.

2. *Reliability engineering and repair logistics for long subsea assets*

Subsea HVDC faults may be infrequent, but when they occur, they can be slow to locate and repair. This is particularly an issue across long routes with varied seabed conditions and multiple jurisdictions. A joint ENTSO-E/Europacable Report drawing on the International Council on Large Electric Systems (CIGRE) statistics found that the average repair duration for submarine cable faults was around 60 days.¹⁷¹ For an Australia–Singapore scale project, this elevates the technical requirement for redundancy (for example, multiple circuits, sectionalisation strategies, spare cable management, repair vessel access and well-rehearsed fault-location procedures), because extended outages are not simply a commercial inconvenience but a system adequacy issue for the importing grid.

3. *Firming variable renewables to meet importing-system expectations*

Singapore's demand profile is not aligned to daylight hours and its import programme is aimed at dependable decarbonisation rather than intermittent supply. Technically, this means that

exporting “renewable electricity” is, in practice, exporting a portfolio: large-scale generation plus storage, plus operational controls that can shape output. The Singaporean EMA's conditional approval pathway explicitly requires compliance with technical requirements and credible delivery planning. The main engineering challenge is not daily shifting alone, but also resilience through multi-day weather events and seasonal variability. Depending on the generation mix and location, meeting firm delivery obligations can require a significant overbuild, large battery energy storage, a complementary wind resource and possibly other flexibility assets to avoid extended low-output periods.

4. *Grid strength, stability and interactions at both ends*

Large HVDC links are controllable, but they are also complex power-electronics systems that must operate within the grid codes of both systems and remain stable under faults, voltage disturbances and frequency events. Key technical issues typically include:

- i. voltage support and reactive power management at converter stations;
- ii. harmonic filtering and electromagnetic compatibility;
- iii. fault ride-through performance and protection coordination; and
- iv. “weak grid” interactions if the receiving or sending AC system has low system strength.

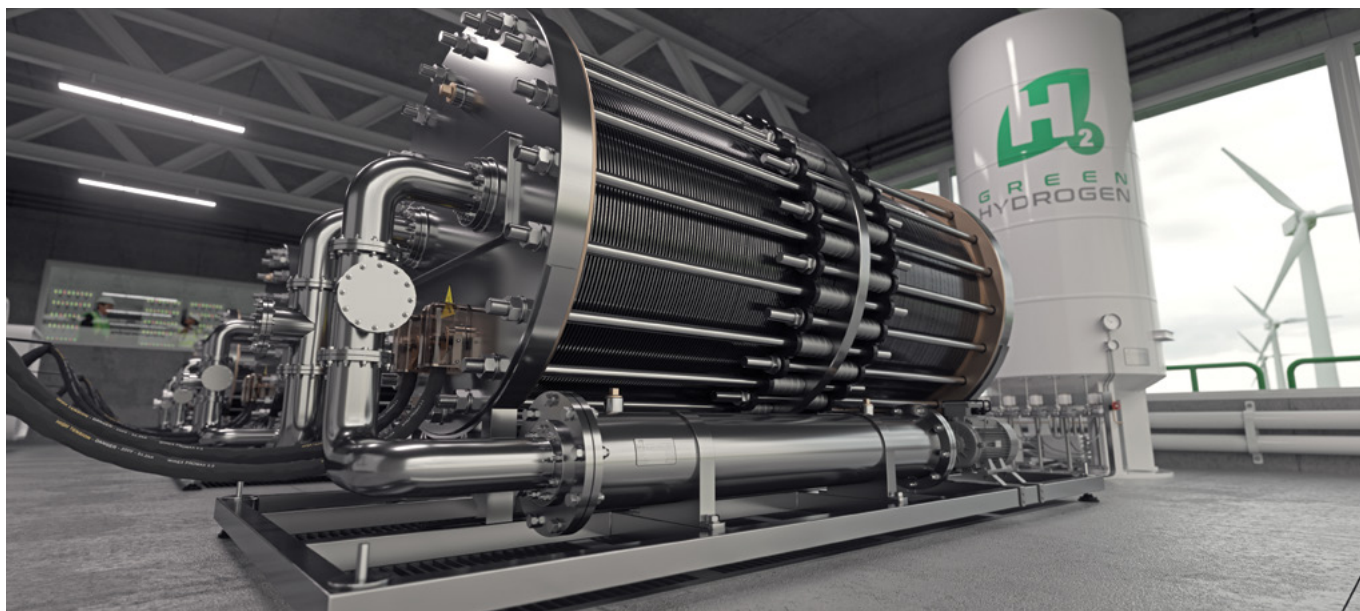
These issues are particularly relevant when injecting or extracting power at gigawatt scale into comparatively smaller nodes. They become binding design constraints when the export link is a large share of the importing system's supply or when the sending region is remote and requires substantial new transmission to reach the cable landing point.

5. *Onshore transmission build and operational integration in Australia*

Export projects of this kind are not only reliant on infrastructure. They require very large onshore transmission, grid augmentation and system services capability to move power from renewable zones to the export converter station while maintaining stability. Where export generation is located in remote regions, the technical challenge is amplified by the need to construct new high-capacity corridors, manage congestion and maintain reliability standards during both steady-state and contingency conditions.

6. *Cybersecurity and operational technology assurance*

Modern HVDC schemes rely on sophisticated digital control and communications. In cross-border operation, cybersecurity assurance becomes



a technical requirement for system integrity because control compromise can create rapid, system-wide operational consequences. For an export proposition premised on reliability, cyber hardening, segmentation, monitoring and incident response capability form part of the engineering envelope, not merely an organisational add-on.

Singapore's import trajectory creates a real opportunity for Australia to export renewable electricity as a premium,

firmed product, backed by a policy programme targeting gigawatt-scale imports. The central technical challenge is that this is not just "selling electrons". It is building an integrated, high-availability HVDC supply chain across an unprecedented distance, with load losses, outage management, firming, grid stability and control assurance all needing to be solved simultaneously at bankable standards.

3.4 Low carbon intensity hydrogen and ammonia

Australia's hydrogen narrative has moved from strategy to institutional build-out. The key point for APSEH is that low carbon intensity hydrogen/ammonia can only become bankable export commodities, if there are credible and interoperable certification and measurement, reporting and verification, predictable fiscal settings and safety-aligned shipping and handling rules.

Australia's 2024 National Hydrogen Strategy set a base export target of at least 0.2 Mt/year of renewable hydrogen by 2030, with a stretch target of 1.2 Mt/year.¹⁷² Australian Treasury modelling, conducted in 2025, showed that under a strong global climate action scenario, green exports (hydrogen, green ammonia, green iron, green alumina and associated critical minerals) could reach \$AUD 80–93 billion per year by 2035 and \$AUD 109–178 billion per year by 2050, significantly exceeding fossil fuel export revenues in net-zero aligned pathways.¹⁷³ International demand signals reinforce this outlook. A 2025 Report by the Australian Academy of Technological Sciences and Engineering on the Australia–Japan

renewable hydrogen value chain highlighted opportunities in renewable hydrogen/ammonia for chemicals, iron and steel and shipping fuels, emphasising long-term complementarities between Australian resources and Japanese demand.¹⁷⁴ However, these projections could be unduly optimistic given present market and regulatory uncertainties. The IEA's 2024 Global Hydrogen Review noted that while announced low-emissions hydrogen projects could reach ~520 GW of electrolysis capacity by 2030, only about 4% of that capacity has reached final investment decision or construction, reflecting significant demand and policy uncertainty.¹⁷⁵ In 2025, the Clean Energy Council observed that Australia's hydrogen project pipeline amounts to almost ten times current domestic hydrogen demand, underscoring the need for credible export offtake to unlock investment.¹⁷⁶ Further, the certification, measurement, reporting and verification of renewable electricity for low carbon intensity hydrogen and its derivatives, remains incomplete and contested across jurisdictions.

3.4.1 The emerging fiscal and policy toolkit

APSEH trade will increasingly depend on “green claims” that are legally enforceable. Importers’ subsidies, procurement rules and carbon-accounting regimes will require proof of emissions intensity and renewable provenance. This has led Australia to legislate to support the creation of a “green hydrogen export state”:

- A Hydrogen Production Tax Incentive (HPTI) that provides \$AUD 2 per kilogram of eligible renewable hydrogen produced, with production supported between 1 July 2027 and 30 June 2040 (subject to the scheme’s eligibility and duration rules).¹⁷⁷
- A policy linkage between hydrogen support and the broader Future Made in Australia agenda, explicitly framing hydrogen as a cornerstone of domestic value-adding and export positioning.¹⁷⁸

This is important for APSEH because importing jurisdictions will increasingly evaluate supply not simply on price, but on credibility and compliance: emissions intensity, additionality claims, chain-of-custody and alignment with domestic subsidy and procurement rules.

3.4.2 Certification: the “passport” for APSEH trade in low-emissions products

The most consequential institutional development is Australia’s Guarantee of Origin (GO) Scheme, which went live on 3 November 2025.¹⁷⁹ The Clean Energy Regulator (CER) describes the GO Scheme as a voluntary certification framework that (i) tracks the emissions intensity of products such as hydrogen and (ii) verifies renewable electricity generation and consumption.¹⁸⁰ It has two parts: the Product Guarantee of Origin (PGO) and the Renewable Electricity Guarantee of Origin (REGO).¹⁸¹ Critically for APSEH:

- The PGO initially certifies hydrogen from electrolysis and is intended to expand to products including low-carbon liquid fuels, green metals and biomethane.¹⁸²
- The REGO is positioned as an “enduring mechanism” beyond the Renewable Energy Target framework, which is set to expire in 2030 and is designed to certify renewable electricity characteristics with broader eligibility than existing certificate regimes.¹⁸³

In governance terms, the GO scheme is an export-enabling institution. It can function as a regional compliance bridge by supporting interoperability and mutual recognition across partner certification regimes, reducing transaction costs and underpinning the contractual structures (warranties, representations, change-in-law clauses and audit rights) necessary for long-term offtake and project finance.

3.5 Critical minerals and green manufacturing: exporting “embodied clean energy”, not only electrons or molecules

A core limitation of many supergrid narratives is that they assume the export product is electricity (by cable) or hydrogen (by ship).¹⁸⁴ Australia’s most durable APSEH-aligned opportunity may instead be embodied clean energy exports in the form of processed green critical minerals, refined green materials and energy-intensive

products manufactured using renewable electricity and renewable hydrogen.

3.5.1 Australia’s current position in the critical mineral economy

Australia has large critical minerals endowments¹⁸⁵ and is the world’s largest producer of lithium and one of the top five producers of cobalt and rare earths.¹⁸⁶ However, much of Australia’s mined critical minerals are processed

offshore in key export markets and critical minerals exports remain a relatively small share of total resource export value compared to iron ore, LNG and coal.¹⁸⁷ This means that Australia’s opportunity in critical minerals is

not simply “more mining.” Rather, the opportunity is more value capture through processing and manufacturing, especially where clean electricity and hydrogen can be integrated into production to deliver the lower-emissions outputs demanded by APSEH partner industries.

3.5.2 The policy pivot: processing capability, ESG leadership and supply chain resilience

Australia’s engagement with Southeast Asia is increasingly framed in supply-chain terms. DFAT’s Southeast Asia Economic Strategy to 2040 identified opportunities associated with regional clean energy supply chain initiatives to support projects involving Australian and Southeast Asian partners in batteries, EVs and solar.¹⁸⁸ The Strategy specifically identified Malaysia and Vietnam as major solar manufacturing bases outside of China and linked partnerships to Australian silica exports and solar supply security.¹⁸⁹ This points to a realistic, near-term mode of integration. APSEH could build interdependent clean energy supply chains that combine Australia’s resource strengths and financing tools with Southeast

Asia’s manufacturing capability and market growth, whether or not large subsea interconnectors proceed at pace. To that end, Australia’s Critical Minerals Strategy 2023–2030 has explicitly set objectives to build sovereign capability in critical minerals processing, create resilient supply chains through partnerships and extract more value onshore. It aims to do this while sharing the benefits including for regional and First Nations communities and promoting Australia as a leader in ESG performance.¹⁹⁰

Fiscal policy now reinforces this direction. Australia’s Future Made in Australia production tax settings include a Critical Minerals Production Tax Incentive worth 10% of relevant processing and refining costs for 31 critical minerals, for processing/refining between 2027–28 and 2039–40, for up to ten years per project.¹⁹¹ In 2026, Australia also announced a \$AUD 1.2 billion critical minerals strategic reserve, prioritising minerals including antimony, gallium and rare earths, with an explicit framing around strengthening supply chains and reducing dependency risk.¹⁹² Thus, Australia is positioning not only as a supplier of raw inputs, but as a supplier of strategic, processed materials that are indispensable to the physical build-out of regional energy interconnection (HVDC cables, grid equipment, batteries) and the electrification of industry.

3.6 Uranium: Australia’s “silent” strategic energy export

Australia’s export profile includes a major energy transition-relevant commodity that is often treated as separate from the supergrid narrative: uranium. Australia exported 5,742 tonnes of uranium in 2023–24, up 5% on the prior year (reflecting both volume and market conditions).¹⁹³ Uranium export earnings were \$AUD 1.2 billion in 2023–24 and are forecast to rise to \$AUD 1.4 billion by 2026–27.¹⁹⁴

The uranium market matters for APSEH for three reasons:

1. Partner system realities. Several APSEH-adjacent economies (notably Japan and Korea) operate within energy strategies in which nuclear remains material to system adequacy and decarbonisation trajectories.
2. High-integrity safeguards as export governance capability. Australia’s uranium trade is managed through stringent safeguards and bilateral arrangements, reflecting long-standing experience in

compliance, traceability and international assurance frameworks. Those assurance processes of traceability, auditing and verification are directly relevant to the emerging governance requirements of hydrogen, green metals and renewable electricity certification.

3. Normative positioning. Australia’s ability to supply energy commodities under robust governance (e.g. rule of law, transparency and compliance culture) supports its broader APSEH positioning as a trusted supplier in a region where energy trade is increasingly securitised.

Uranium is therefore best understood as part of Australia’s broader APSEH proposition, i.e. supplying energy under high-integrity governance, which becomes more valuable as cross-border clean energy markets expand and green claims are scrutinised.

3.7 Technology uncertainty and the export modality question: electrons, molecules, or materials?

APSEH strategy must be robust in the face of a central uncertainty: what impact will the rapid cost declines in batteries and storage have on the economics of cross-border energy trade? The export pathway that looks inevitable under one technology trajectory may be marginal under another. What is known is that lithium-ion battery prices have fallen dramatically. The IEA reported a decline from about \$USD 1,400/kWh (2010) to below \$USD 140/kWh (2023) or around a 90% reduction, making it one of the fastest cost declines in energy technologies.

¹⁹⁵ Further, IRENA reported that utility-scale battery storage costs declined 93% from 2010 to 2024, falling from \$USD 2,571/kWh to \$USD 192/kWh.¹⁹⁶ BloombergNEF's December 2025 survey similarly reported continued price declines, with average battery pack prices at \$USD 108/kWh (2025) and stationary storage pack prices reported at \$USD 70/kWh (with very low outliers).¹⁹⁷ Against that evidence, APSEH-aligned export strategy should be framed through scenario-contingent pathways rather than a single "export by cable" vision.

Scenario A: "Storage-accelerated Asia" (reduced need for imported electricity; higher value of embodied and molecular exports)

If battery and long-duration storage cost curves continue to improve quickly and if partner countries can scale domestic renewables with storage and flexible demand, then incremental electricity imports may become less valuable for many countries, particularly those with high-quality domestic solar and wind resources and adequate land and grid build-out capacity.

Under this scenario, Australia's comparative advantage shifts towards:

- Molecules (hydrogen/ammonia) for hard-to-abate sectors and seasonal balancing, supported by certification credibility and shipping-ready supply chains; and
- Materials/industrial products ("embodied energy"), where Australia uses cheap renewables to produce lower-emissions processed minerals and green metals that are difficult for land-constrained importers to produce domestically at scale.

Australia's GO Scheme and production tax incentives become the pivotal instruments: supporting compliance-ready and finance-ready trade, even as the marginal value of cross-border electrons declines.

Scenario B: "Constraint-bound Asia" (imports remain valuable; interconnection provides system security and resilience)

Alternatively, even with falling storage costs, many APSEH partner economies may face binding constraints, such as land scarcity, permitting bottlenecks, grid congestion, limited domestic resources and the need for firm capacity during prolonged low-renewable periods.¹⁹⁸

Under this scenario, diversified imports remain valuable and large-scale interconnection can provide:

- geographic diversity and resilience against weather correlation;
- reduced curtailment through regional balancing; and
- additional optionality in crisis conditions (fuel shocks, drought impacts on hydro, extreme weather events).¹⁹⁹

Australia's export proposition in this scenario is broader. Electricity exports (where feasible), with hydrogen/ammonia and processed materials all playing complementary roles. The policy challenge becomes governance coordination: how to align certification, emergency support arrangements, cyber and infrastructure security and investment protections across jurisdictions.

3.8 Conclusion

Section 3 establishes three propositions that should anchor APSEH policy design. First, Australia's starting point is scale. Australia exports ~80% of its energy production and remains heavily concentrated in black coal and LNG exports.²⁰⁰ Second, the fiscal and market signal is clear. Official outlooks project substantial declines in resources and energy export earnings through to 2029–30, with thermal coal and LNG earnings projected to fall markedly.²⁰¹ Third, the export pivot architecture is being built now. Australia implemented a GO certification scheme in November 2025²⁰² and legislated major

production tax incentives for hydrogen and critical minerals processing commencing in 2027–28.²⁰³ This has positioned Australia to compete internationally for clean energy trade provided that project delivery, permitting, transmission build-out and social licence can be sustained. Thus, Australia's participation in APSEH is best understood as a renewable export pivot leveraging existing export competence but requiring deliberate governance choices to be credible under both "storage-accelerated" and "constraint-bound" regional futures.



4. Opportunities and Benefits of Australian Participation in the Asia-Pacific Super Energy Highway

Australia's optimal contribution to APSEH is best conceptualised as a renewable export pivot. Australia should leverage its comparative advantages in renewable resource quality, land availability, stable market

governance and high-integrity regulatory institutions to supply a regional decarbonisation corridor, while also supporting the rulesets and safeguards necessary to scale regional infrastructure and trade.

4.1 Economic and industrial opportunities for Australia

4.1.1 From commodity exporter to “renewable export platform”

Australia already has the commercial and infrastructure experience of an energy export state. The strategic economic question for APSEH is whether Australia can repurpose its existing export capability in the form of ports, shipping, contracting sophistication and risk allocation to sell low-emissions energy and energy-enabled products at scale, rather than remaining locked into declining fossil fuel export trajectories. This pivot is economically compelling because of structural demand signals in regional partner economies, with some import-dependent jurisdictions moving from “exploration” to “implementation” of large-scale low-carbon imports. Singapore, for example, has set a target to import ~6 GW of low-carbon electricity by 2035 (around one-third of its projected demand), increasing its earlier 4 GW ambition.²⁰⁴ It has also issued Conditional Approvals to 11 projects to import low-carbon electricity (including from Australia) with six projects now progressed to Conditional Licences.²⁰⁵ Furthermore, Australian industrial policy settings are increasingly aimed at capturing more domestic value from the energy transition supply chain (processing, refining, clean manufacturing), rather than exporting raw inputs.²⁰⁶ The combination supports a credible investment narrative. Australia is not merely proposing an export vision but can anchor that vision in the partner-side procurement programmes already being implemented.

4.1.2 “Embodied clean energy” exports: green metals, processed minerals and energy-intensive manufacturing

A central APSEH opportunity is the export of energy-intensive products manufactured with low-emissions electricity and hydrogen, effectively exporting renewable value even where electrons are not traded directly. This pathway is strengthened by two intersecting trends. First, the IEA reported growing demand across key energy-transition minerals in 2023. Lithium demand rose 30%, while demand for nickel, cobalt, graphite and rare earth elements each increased between 8–15%.²⁰⁷ The IEA has estimated the aggregate market value of key energy-transition minerals at around \$USD 325 billion (comparable to iron ore) and projects the combined value more than doubling to \$USD 770 billion by 2040 in its Net Zero Scenario.²⁰⁸ Second, the technology learning curves for renewable technologies and energy storage also support this development. The same cost declines that make domestic renewables more feasible in importing countries also drive build-out of grids, batteries, EVs and electrified industry, intensifying demand for copper, aluminium, lithium, nickel and other inputs and increasing the strategic value of secure, responsibly produced supply chains.²⁰⁹

4.1.3 Clean molecule exports as a complement, not a substitute

Hydrogen and derivatives (ammonia, e-fuels) remain a strategically valuable component of APSEH because they address “hard-to-electrify” end uses and provide seasonal/industrial flexibility.²¹⁰ However, credible opportunity assessment must also reflect updated economics and realism about whether hydrogen will be competitive. Australian Treasury modelling has emphasised that earlier assumptions of very steep hydrogen cost declines have been revised and that

hydrogen is now viewed as a viable option primarily where direct electrification is not feasible (for example, certain chemical feedstocks and industrial processes).²¹¹ This clarification of green hydrogen's highest-value use cases supports a more defensible APSEH strategy. Australia should target hydrogen exports to industrial decarbonisation and flexibility services, rather than assuming hydrogen will substitute for electricity across the board.

4.1.4 Converting fossil fuel infrastructure for use by a renewables pivot

Australia's fossil-fuel export system is among the most intensively developed in the Asia-Pacific, with extraction sites and an integrated logistics and industrial platform. In 2023–24, Australia exported 356 million tonnes of black coal alone, illustrating the scale of bulk-export capability embedded in ports, deepwater channels, railways, supply chains, industrial precincts and a workforce skilled in continuous operations and hazardous environments.²¹² As regional demand shifts away from coal and LNG towards low-emissions electricity, hydrogen carriers such as ammonia, processed critical minerals and clean manufactured products, Australia can, in principle, re-deploy parts of its existing export infrastructure to lower delivery risk, shorten development timelines and accelerate market entry.

Converting fossil fuel export assets will require an infrastructure-and-governance strategy to reuse what is already built, permitted, serviced and commercially embedded, while replacing or redesigning the infrastructure that is tightly locked to coal, oil, or gas.²¹³ The economic logic is straightforward. Brownfield export precincts can reduce time to market because they often already have industrial zoning, established access arrangements, utility connections and an existing social licence for heavy industry.²¹⁴ They can reduce cost and construction risk because high-capital "platform" assets such as channels, breakwaters, berths and port services are expensive and physically difficult to replicate.²¹⁵ They can also improve bankability because functioning trade hubs tend to have established counterparties, shipping lanes and operating disciplines that are legible to financiers and insurers.²¹⁶ Conversion, in this sense, is a disciplined approach to capturing residual value from fossil fuel-era infrastructure and re-deploying it to support new energy trade vectors.²¹⁷

At the same time, conversion should not be treated as a simple substitution. In practice, it involves the

selective repurposing and staged diversification rather than one-for-one asset replacement, because different export commodities require fundamentally different handling systems, safety cases and logistics.²¹⁸ Some assets translate well across commodity shifts, including deepwater channels, marine access, berths, industrial land, utilities, communications and rail corridors.²¹⁹ Other assets are highly commodity-specific and may have limited reuse potential beyond coal operations, including stackers, reclaimers, conveyors, stockyard systems and coal-specific dust controls. Certain clean-energy exports will also require specialised infrastructure newly built rather than refurbished. Liquid hydrogen is the clearest example, given its extreme cryogenic requirements and the associated demands for specialised materials, insulation and boil-off management.²²⁰ The core techno-economic question for APSEH is therefore which components of the existing export platform can be reused at meaningful scale and at what cost, regulatory burden and operational risk.

Ports sit at the centre of this conversion logic because they concentrate precisely the platform assets that are most expensive and time-consuming to build from scratch.²²¹ Across Australia's coal and LNG export regions, ports commonly offer four reusable foundations. First, they provide deepwater channels and marine access already engineered for large vessels. Second, they provide established berths and port services such as towage, pilotage, dredging regimes and marine safety systems. Third, they provide industrial zoning and brownfield land within port precincts, frequently with an established social licence for heavy industry.²²² Finally, they also provide utility connections, including power, communications and water, alongside an experienced maritime workforce.²²³ These foundations are particularly valuable where APSEH pathways point towards new export hubs in Northern Australia and the re-purposing of the major east-coast industrial ports.

The principal physical constraint is that the systems that move, store and condition export commodities are typically commodity-specific and often cannot be reused without major reinvestment.²²⁴ Coal terminals are optimised for continuous dry bulk solids through conveyors, stockyards and shiploaders. Ammonia and other hydrogen derivatives require pressurised or refrigerated storage, hazardous-area design, vapour management, enhanced emergency response capability and dedicated loading arms and pipelines.²²⁵ Containerised critical minerals and clean manufactured products rely on container terminal capacity, inter-modal yards and fundamentally different port logistics.²²⁶ A practical proxy for "conversion readiness" is therefore

whether a port already manages diverse trade types and, in particular, whether it has bulk-liquid capability that is compatible, or readily upgradable, for hydrogen-derivative exports.

The Port of Newcastle illustrates the opportunity and the constraint in a single trade profile. Its 2024 Trade Report noted that coal remained 95% of total port trade in 2024, at 149,950,823 revenue tonnes, while also recording 8,509,266 revenue tonnes of diversified trade.²²⁷ Of particular relevance to conversion is the presence of commodities aligned with APSEH pathways, including mineral concentrates at 491,758 revenue tonnes and ammonia at 104,406 revenue tonnes.²²⁸ Newcastle's coal export markets in 2024 were overwhelmingly APSEH-relevant, with Japan receiving 44.3% and China 29.5%, alongside Taiwan, Korea and other Southeast Asian nations.²²⁹ Thus, commercial relationships and shipping lanes to Northeast Asia already exist at scale. The ports servicing these markets are arguably already conversion-capable where they handle even modest volumes of bulk liquids and mineral products. Conversion is typically most credible and fastest when framed as incremental diversification of a functioning port, rather than as an immediate cessation of coal exports.

Gladstone provides a second concrete example of conversion logic being implemented through co-location and the leveraging of existing hazardous-liquid logistics. Queensland's project plans for the H2-Hub Gladstone described a proposed development of up to 3 GW of electrolysis and up to 5,000 tonnes per day of green ammonia on a staged basis, reporting investment of \$4.7 billion and employment of 550 construction jobs and 140 operational jobs.²³⁰ The proposed export precinct is co-located with existing ammonia storage and import facilities at Fisherman's Landing Wharf at the Port of Gladstone.²³¹ Co-location materially reduces development risk relative to fully greenfield ammonia export systems because it builds on existing industrial land, established hazardous-liquid interfaces and an operating environment already accustomed to chemical handling.

Railways and export corridors present a different conversion profile. Australia's coal export system is built around heavy-haul rail corridors feeding dedicated terminals and the scale of these chains is considerable. Port Waratah Coal Services reported 100.8 million tonnes shipped from its terminals in 2024, with 182.2 million

tonnes delivered to its terminals by rail.²³² Queensland reporting indicated coal exports exceeding 200 million tonnes with a value above \$74 billion in the cited financial year,²³³ while BHP states that its Hay Point terminal can handle more than 55 million tonnes of coal for export annually.²³⁴ These corridors are significant national assets, but their conversion value varies across APSEH export vectors. Rail is highly reusable for the inbound movement of the equipment and consumables required to build and operate new export precincts and for the outbound movements of dry bulk clean-industry products such as mineral concentrates and green metals, as well as for intermodal hubs supporting containerised critical minerals. Its suitability for these movements is reflected in its existing freight base, as bulk commodities, principally iron ore, coal and grain, accounted for over 70% of Australia's rail freight by volume in 2024-25.²³⁵ Rail is generally less important for hydrogen as a molecule at export scale because pipelines and on-site conversion to ammonia typically dominate.²³⁶ Rail becomes more relevant where ammonia is moved via tank-car logistics and where upstream and downstream inputs and outputs are containerised.²³⁷ A further governance constraint is decisive. Capacity reallocation as coal volumes decline is likely to be constrained by existing long-term contracts and access arrangements. In many cases, conversion will require deliberate policy and commercial restructuring rather than merely physical retrofitting.

These infrastructure realities are sharpened by the technical differences between ammonia and liquid hydrogen. From a techno-economic perspective, ammonia is widely regarded as the near-term conversion-friendly export vector because it aligns better with existing port precinct capabilities and mature global handling practices.²³⁸ Ammonia can be stored at atmospheric pressure at -33°C or at elevated pressure at ambient temperature and approximately 18 to 20 million tonnes are shipped internationally each year, supporting established maritime safety and operational systems.²³⁹ Liquid hydrogen, by contrast, typically requires temperatures around -253°C, imposing far more stringent requirements for materials, insulation and boil-off management than most existing Australian liquid-bulk assets are designed to meet.²⁴⁰ Even where parts of an LNG precinct are relevant, extensive redesign is often required because LNG operates at materially warmer temperatures, around -162°C, and presents different compatibility and hazard profiles.²⁴¹ Thus, early, conversion-enabled exports from

established port precincts are more plausibly anchored in green ammonia and in some settings, potentially also methanol, while liquid hydrogen export remains technically difficult, requiring a greenfield build or a deep redesign rather than straightforward adaptation.

APSEH also depends on critical minerals, processed materials and clean manufactured products traded across the region, including batteries, precursors, components and green metals. Here, existing fossil export precincts can often be repurposed effectively because the required foundations are industrial-port fundamentals such as secure laydown areas, container handling, reliable utilities and strong road and rail interfaces.²⁴² Newcastle's trade profile again signals overlap through mineral concentrates and project cargo. The technical pivot is that critical minerals and higher-value clean products often require containerisation, stronger traceability and chain-of-custody systems and upgraded environmental controls for dust, runoff and hazardous classification (where relevant).²⁴³ These are generally feasible upgrades within port precincts, but they require different operational capabilities and governance systems than those typical of coal operations.

Overall, Australia's strongest infrastructure and systems conversion proposition for APSEH lies in precinct repurposing coupled with incremental diversification, rather than one-for-one asset substitution. The higher-feasibility pathways in the near to mid-term are those that reuse deepwater access, port services, industrial

land, utilities and workforce capability to host ammonia export hubs, critical mineral processing exports and clean-industry shipping corridors. This is exemplified by Gladstone's co-location approach and those that reorient logistics corridors to support bulk and containerised exports at ports that already handle diversified trade, such as the Port of Newcastle. More conditional pathways include repurposing coal-chain rail assets where contractual regimes can be renegotiated and where new commodities align with heavy-haul strengths. Port conversions that require substantial hazardous-liquid investment but benefit from proximity to existing chemical handling and industrial services may also be suitable for conversion. The lowest-feasibility and highest-risk approach is attempting to retrofit coal terminal equipment directly for fundamentally different export commodities, such as liquid hydrogen.

Australia can credibly position itself as a reliable export node by treating conversion as an integrated infrastructure-and-governance strategy. The practical priority is to reuse what is universal and high-value, including port access, industrial land, corridors, utilities and workforce capability and to new build infrastructure where physics, safety and certification requirements compel it, including hazardous-liquid systems, specialised storage, new pipelines and robust certification and tracking architectures that make clean exports commercially credible in regional markets.

4.2 System-level benefits: why APSEH can reduce costs and improve resilience

4.2.1 Resource complementarity, time zones and reduced system costs

Interconnection creates value by pooling diverse renewable resources across geography and time zones, thereby reducing the need for "overbuild" and curtailment and lowering system balancing costs.²⁴⁴ Australia's relevance to APSEH is particularly strong where: (i) solar and wind production profiles are complementary across

regions; and (ii) large-scale, controllable loads (e.g., hydrogen electrolysis; mineral processing) can operate as flexible demand in response to regional price signals. Even if battery costs continue to fall, geographic diversity and interconnection can still provide system value. Storage can be used to manage intra-day variability, while interconnections can address correlated weather risk, support emergency reserves and reduce the need for every jurisdiction to maintain expensive redundancy.

4.2.2 Cross-border trade as a catalyst for ASEAN grid modernisation

Australia's APSEH participation can also indirectly benefit the APG trajectory by helping to enlarge the pool of bankable projects within the region and by strengthening institutional models for power trade.

The World Bank described the APGF Initiative as a flagship regional effort to create an integrated transmission network and accelerate renewables in Southeast Asia. It has estimated that achieving the APG vision by 2045 will require ~USD 800 billion in generation and transmission investment.²⁴⁵ APGF's objectives include facilitating regional power trade, mobilising finance and harmonising policies and technical standards. Australia's participation in APSEH can reinforce these efforts in two ways:

1. Finance and de-risking spillovers: Australia's participation (including through export credit, project structuring expertise and stable regulatory institutions) can support "concept to construction" pathways that APGF is explicitly designed to enable.
2. Standards spillovers: APGF identifies policy harmonisation and standards as core to regional integration.²⁴⁶ Australia can help shape emerging norms for interconnector access, congestion management and reliability obligations.

4.3 Strategic and geopolitical benefits for Australia and partner economies

In a region where infrastructure projects can become entangled in geopolitical competition, Australia's relative strengths, stable institutions, transparent market governance and established relationships with Northeast Asian and Southeast Asian partners, create a trusted supplier proposition. The value is not only in physical supply. It is also in governance credibility, contract enforceability and predictable regulation, the same attributes that reduce risk premia and lower financing costs for long-lived infrastructure.

4.3.1 Deepening regional partnerships through practical energy cooperation

APSEH-aligned cooperation can deepen ties beyond conventional trade and defence settings by building durable, technical interdependence. Singapore's import framework is already creating a multi-country ecosystem of developers, offtakers and transmission planners.²⁴⁷ Singapore has established Singapore Energy Interconnections Pte Ltd (SGEI) (April 2025) to develop and operate cross-border interconnections enabling

imports.²⁴⁸ For ASEAN, the value proposition includes access to investment, project preparation and the prospect of monetising high-quality renewable resources for export and domestic system support. For example, for Northeast Asia, the value proposition includes diversified clean supply chains for fuels, minerals and equipment essential to the net-zero transition.

4.3.2 Shaping the "rules of the road" for emerging regional energy trade

Early participation in this emerging regional energy trade matters because it shapes technical standards and interoperability requirements, emissions accounting and certification frameworks (including the credibility of "low-carbon" claims), ESG safeguards and benefit-sharing expectations and dispute-avoidance norms for cross-border infrastructure. The opportunity for Australia is to ensure that APSEH's governance embeds high-integrity rules early. Thereby reducing the risk that regional energy trade develops through fragmented bilateral arrangements with inconsistent safeguards.

4.4 Regulatory and market-design leadership as an exportable capability

4.4.1 Australia has a comparative advantage: operating a complex, liberalised market across multiple jurisdictions

Australia's experience is unusually relevant to APSEH because the National Electricity Market (NEM) combines a large physical grid with a sophisticated market design spanning multiple sub-national jurisdictions. The NEM which operates across NSW, ACT, Queensland, South Australia, Victoria and Tasmania and is one of the world's longest interconnected energy grids.²⁴⁹

Many of the cross-border trade challenges that APSEH is likely to face mirror the issues Australia has been solving domestically for decades. These include jurisdictional coordination and rule harmonisation, system security obligations and real-time operational coordination,

long-run investment signals with access regulation and participant registration, pricing and congestion and dispatch arrangements and the integration of high penetrations of variable renewables and distributed energy resources.

Australia's experience proves that physical engineering feasibility for multi-jurisdictional energy trade is necessary but not sufficient. Bankability depends on the clear allocation of risk across connection and access rights, curtailment rules and compensation, credit support and settlement architecture, change-in-law exposure and emergency and force majeure protocols. The ability to design and administer these rules is a competitive advantage. Australia's experience with market governance and reform creates a pathway to shape regional trade rules in ways that increase investor confidence and reduce transaction costs for partner economies.

4.5 Benefits for other market participants: a differentiated value proposition

APSEH's legitimacy will ultimately depend on benefits for partner economies. Australia's participation can be positioned as complementary to regional initiatives such as the ASEAN Power Grid.

For Singapore, involvement can offer access decarbonisation under land/resource constraint and a credible import pipeline. Singapore has explicitly linked regional power grids to accessing abundant low-carbon electricity in the region and paving the way for the ASEAN Power Grid vision.²⁵⁰ Its target to import ~6 GW by 2035 and its issuance of Conditional Approvals and Conditional Licences demonstrates a concrete demand-side pathway for imports, including an Australian project proponent (Sun Cable (Singapore) Assets Pte Ltd) listed among recipients of Conditional Approval.²⁵¹ For Australia, Singapore's approach offers a particularly important "proof-of-market" channel. It reduces the risk that APSEH is perceived as purely supply-driven.

For ASEAN, APSEH can create additional demand for

renewable development and strengthen the commercial case for cross-border transmission. The APGF Initiative is explicitly aimed at bridging the financing gap and moving interconnection projects "from concept to construction", including through technical support, bankable project pipelines and environmental/social risk management.²⁵² Australia's participation can support these objectives through co-investment partnerships, project preparation expertise and by aligning APSEH development with ASEAN's grid modernisation agenda rather than bypassing it.

For Northeast Asian partners pursuing net-zero pathways, APSEH provides a platform for diversification away from single-source dependencies, spanning low-carbon fuels for industry and shipping, critical minerals and processed materials and certified low-carbon industrial products such as green metals. The strategic value of diversification rises, as critical minerals become more central to the energy systems and as new vulnerabilities emerge in supply chains.

4.6 Managing uncertainty: two plausible technology pathways and the “no-regrets” strategy

A robust strategy across both futures requires a multi-vector export posture that (i) develops APSEH-enabling infrastructure and governance in ways that preserve optionality (electricity, molecules, embodied exports); (ii) invests in certification, traceability and high-integrity standards to make Australian exports financeable and politically acceptable; and (iii) uses Australia’s regulatory capability to help reduce transaction costs and de-risk regional trade.

Pathway A: “High-interconnection value” future

If long-duration storage remains costly, permitting bottlenecks constrain domestic renewable build-out in importing countries and electrification demand grows rapidly, then cross-border electricity and clean molecule imports become increasingly valuable for energy security and decarbonisation. In this scenario, Australia’s comparative advantages in land, renewable resources and export experience support large-scale trade and

Australia’s market governance capabilities become a cornerstone of regional rulemaking.

Pathway B: “Cheap storage and domestic sufficiency” future

If storage costs continue declining sharply (consistent with the dramatic declines already observed in battery storage project costs), some importing countries may find it economic to meet more electricity demand domestically.²⁵³ This could reduce the marginal need for long-distance electricity imports for bulk energy.

But this pathway does not eliminate Australia’s APSEH opportunity. Instead, it re-weights the opportunities towards critical minerals and components, green manufacturing and processed materials, and hydrogen/e-fuels targeted to hard-to-abate segments, consistent with the Treasury’s more constrained view of hydrogen’s comparative role.

4.7 Conclusion

Australia’s participation in the APSEH should be understood as an opportunity to reposition the national energy export model for a net zero regional economy while strengthening Australia’s strategic and economic relevance in the Indo Pacific. The principal benefit is the creation of a multi-modal regional trade corridor that enables Australia to supply and to help govern, multiple decarbonisation vectors, including clean electricity, clean molecules such as hydrogen and ammonia and embodied clean energy embedded in green metals, processed critical minerals and low-emissions manufacturing supply chains. This corridor framing materially increases resilience to uncertainty in technology trajectories and geopolitical conditions, since the optimal trade vector will vary across jurisdictions and over time. It also expands the set of potential partner economies, including those that may progressively increase domestic electricity self-sufficiency through storage, demand response and accelerated deployment of firmed renewables.

A second and often underestimated, opportunity lies in Australia’s capacity to contribute governance credibility as a traded public good. Long-lived cross-border energy

infrastructure and associated commodity trade depend on enforceable rules, predictable regulatory decision-making and a contracting culture that can allocate and manage risks relating to access, curtailment, settlement, system security and change in law. Australia can credibly position itself as both a supplier and rule maker by drawing on its institutional experience of operating a multi-jurisdictional wholesale electricity market at scale. For regional partners and capital providers, this governance capability is not merely reputational. It is a bankability asset that can reduce transaction costs, strengthen investor confidence and improve the investability of interconnected projects whose commercial viability depends on stable and interoperable arrangements across borders.

The most immediate pathway for realising these benefits is likely to run through Southeast Asia. Aligning APSEH with ASEAN’s grid integration and with Singapore’s low-carbon import programme, provides a demand-led entry point that is compatible with the staged and diverse nature of ASEAN power sector development. In parallel, finance must be treated as the decisive constraint and therefore

as a central opportunity for Australian contribution. By prioritising de-risking and mobilisation instruments, including blended finance, export credit, political risk cover, standardised contracting and credible certification, Australia can help convert regional strategic alignment into deployable capital and implementable projects. This emphasis is reinforced by the durable value of embodied clean energy exports, particularly as demand for critical minerals, grid materials, batteries and clean industrial products intensifies under most credible transition scenarios.

Finally, Australia's participation in APSEH offers a significant compliance and integrity dividend for the region. Trade in energy vectors and clean industrial products is increasingly conditioned by auditable emissions accounting, provenance and renewable electricity verification. A credible certification and traceability architecture can therefore operate as enabling infrastructure that supports procurement, subsidy eligibility, carbon border adjustment compliance and corporate claims, while also underpinning project finance through warranties, covenants and audit rights. APSEH represents an integrated platform through which Australia can advance a rules-based renewable export pivot that delivers economic opportunity, regional

decarbonisation value and investable connectivity at scale. These opportunities are not equally mature. Of the three export vectors, embodied clean energy i.e. processed critical minerals, green metals and low-emissions manufactured products, is the commercially closest to viability under current market conditions, because it relies on existing trade relationships, developing processing infrastructure and strengthening demand signals from regional clean supply chain strategies. Clean molecule exports (hydrogen and ammonia) remain contingent on importing-country procurement mechanisms and carbon pricing settings that do not yet exist at the scale required for large project finance. Bulk electricity export via long-distance HVDC interconnection faces the highest capital and technical barriers and the longest lead times and is most sensitive to storage technology trajectories. Thus, while the strategic case for multi-vector engagement is strong, the expected sequence of commercial realisation runs from embodied energy first, molecules contingently and electrons on a longer horizon and under specific conditions.



5. Challenges, Risks and Regulatory Hurdles for Australia's Involvement in APSEH

The factors that make APSEH strategically attractive, its scale, interconnections and multi-jurisdictional reach, also create a distinctive risk profile that cannot be managed through the usual project finance and permitting

processes. This section identifies the most material hurdles and, critically, explains why they are governance problems as much as engineering problems.

5.1 Scale risk and domestic delivery constraints

A persistent misconception in regional interconnection debates is that export corridors can be built “on top of” existing domestic systems. In practice, export capability is downstream of domestic transmission and system-security capability, particularly in a grid like Australia's, where renewable energy zones (REZs) and new firming assets require substantial new network capacity. The Australian Energy Market Operator's (AEMO) 2024 Integrated System Plan (ISP) identified that Australia's near-term transition requires very large transmission expansion, estimating ~4,581 km of new transmission by 2030 and ~10,000 km by 2050 (NEM-wide), in addition to major investments in system strength, storage and dispatchable capacity.²⁵⁴ This has implications for Australia's involvement in APSEH, as without this build-out, Australia cannot credibly offer firm, contractable export volumes (whether as electrons via cable, or as hydrogen/ammonia produced at scale).

The ISP also highlighted another barrier at the domestic level, tightly constrained delivery capacity for this

buildout, across the skilled workforce, the supply chain and construction throughput. AEMO stated that transmission cost estimates have increased ~30% in real terms between 2022 and 2024.²⁵⁵ Further, it is predicted that industry workforce demand would increase from ~36,000 to over 60,000 over the ISP horizon to 2050.

²⁵⁶ These conditions materially affect timelines and the cost of capital. In a “constrained build” scenario, AEMO warned that Australia would fall short of its intended renewables trajectory, reaching ~68% renewables by 2030 rather than ~82% and generating an additional ~109 Mt of carbon emissions between 2024–2030.²⁵⁷ These figures bear directly on APSEH export credibility, because partner economies are unlikely to underwrite long-term offtake unless Australia can demonstrate domestic delivery capability on credible timelines. Accordingly, Australia's APSEH proposition must be anchored in and disciplined by, an evidence-based domestic delivery plan; otherwise, regional counterparts will treat export ambition as speculative.

5.2 Capital expenditure inflation and construction risk

The build-out of the infrastructure needed to support APSEH will be exposed to compounding cost drivers: converter stations, HVDC cable manufacturing capacity, specialised vessels, subsea route surveys, geotechnical uncertainty and constrained global engineering and construction labour. Importantly, these are sectors experiencing global demand surges, so this procurement risk is increasingly structural. Australia's own transmission experience illustrates the point. Transgrid reported that the overall cost of the new 500kV HumeLink transmission

line increased from \$AUD 3.27 billion (2021) to \$AUD 4.88 billion (2024), citing global demand, supply chain disruption and increased raw material prices.²⁵⁸ The Australian Energy Regulator's (AER) contingent project decision-making for HumeLink similarly reflects the need to interrogate and refine capital expenditure assumptions as market conditions change.²⁵⁹ At the technology layer most relevant to APSEH, HVDC and subsea cables, AEMO's Transmission Cost Database Update (2025) reported that HVDC subsea cables experienced ~40–50% cost increases

between 2023 and 2025 and converter stations increased ~140–180% over the same period.²⁶⁰

This means that APSEH will require (i) staged commitments with defined decision gates; (ii) shared-cost underwriting

mechanisms (export credit, multilateral development bank (MDB) co-finance, political-risk insurance); and (iii) rules for reallocating risk when exogenous cost shocks occur (force majeure, change-in-law, supply-chain constraints).

5.3 Demand-side and market-viability risk

A major APSEH pathway is the export of low-emissions hydrogen and hydrogen derivatives (ammonia, e-fuels). However, the global hydrogen economy remains in a transitional stage where regulatory policy, certification and procurement architecture determine bankability. The IEA's Global Hydrogen Review 2024 identified that global hydrogen demand was dominated by conventional (unabated) supply, with low-emissions hydrogen production still below 1 Mt in 2023.²⁶¹ It also recorded a persistent "announcement-to-delivery" gap, with only ~4% of announced low-emissions hydrogen projects globally having reached final investment decision at the time of report.²⁶² For low-emissions hydrogen to compete with fossil-based hydrogen, the cost gap must narrow substantially. International analyses consistently show that producing low-carbon hydrogen carries a significant cost premium over fossil-fuel based hydrogen. In 2024, the IEA's Global Hydrogen Review 2024 estimated the gap at \$USD 1.5–8/kg.²⁶³ This typically requires an effective carbon price in the \$US120–200 per tonne range to enable it to compete with fossil based hydrogen.²⁶⁴ At the date of this report, the effective carbon price globally was far lower than this amount.²⁶⁵ This means that without significant regulatory intervention in global

carbon markets to price carbon effectively and address the unpriced negative externalities of fossil-based hydrogen, possibly through a carbon border adjustment mechanism, this represents a core demand-side risk for Australia. Within the low-carbon hydrogen sector, large export projects can be technically feasible yet will be commercially stranded if importing jurisdictions do not or cannot implement durable low-carbon procurement frameworks such as contracts-for-difference, quotas, guaranteed offtake, or regulated cost recovery. This risk is not theoretical. Even in markets with strong decarbonisation intent, offtake uncertainty and price formation remain unsettled, particularly for ammonia co-firing, hydrogen-to-power and industrial switching where end-users face competitiveness constraints. Thus, Australia should treat hydrogen export as a portfolio option contingent on (i) credible guarantees of origin and emissions accounting; and (ii) importing-country procurement mechanisms capable of delivering bankable revenue. The legal architecture must anticipate "policy rollback" and "policy redesign" risk, including stabilisation tools, step-in rights and clearly defined allocation of certification failure risk.

5.4 Transboundary permitting, maritime routing and jurisdictional complexity

APSEH is necessarily transboundary. For electricity interconnection in particular, the project is as much about rights to place, operate, protect, repair and decommission infrastructure as it is about transmitting electricity. Under United Nations Convention on the Law of the Sea (UNCLOS) States enjoy key freedoms in their EEZ (exclusive economic zone), including the laying of submarine cables (subject to "due regard" and other provisions).²⁶⁶ On the continental shelf, UNCLOS also recognises the entitlement to lay submarine cables and pipelines, while allowing coastal States to take reasonable measures connected to exploration/exploitation and to prevent pollution and to

regulate the delineation of pipeline courses in accordance with marine spatial planning.²⁶⁷

The most acute legal chokepoints occur not in the EEZ/high seas, but in territorial seas and archipelagic waters, where coastal/archipelagic States have materially stronger control over routing and authorisations.²⁶⁸ UNCLOS Part IV (archipelagic States) expressly addresses passage and includes provisions relevant to cables' maintenance and replacement, reflecting a higher-control environment than the EEZ.²⁶⁹

Within Australia's Commonwealth offshore area, the Offshore Electricity Infrastructure Act 2021 (Cth) and associated regulations establish a licensing and regulatory framework covering offshore renewable generation and subsea electricity interconnectors.²⁷⁰ Administration guidance issued by DCCEEW illustrates the breadth of compliance and control-change obligations that attach to feasibility and transmission licences.²⁷¹ This framework is relevant to APSEH because it highlights that Australia already recognises offshore transmission as a regulated activity with lifecycle obligations (including decommissioning).

Like Australia, every coastal state on the APSEH route will assert its regulatory authority over permitting and conditions, especially where cables traverse territorial seas, exclusive economic zones, archipelagic waters, protected areas and high-traffic shipping lanes. The practical reality is that APSEH's route will become a negotiation across sovereign priorities (security, marine conservation, fisheries, seabed resources and industrial policy) and approval processes can become an important strategic lever. An example of this is the Australia–Singapore electricity import proposal, which is currently seeking approvals prior to an anticipated final investment decision in 2027. Singapore's Energy Market Authority granted conditional approval to import 1.75 GW of low-carbon electricity from Australia, transmitted via subsea cables over ~4,300 km.²⁷² For this project to be successfully developed, approvals will be required across multiple jurisdictions, including third party transit jurisdictions such as Indonesia through whose waters the cable must pass.²⁷³ Indonesia's archipelagic geography is a structural legal factor, because routing options, corridor security and permitting complexity will depend on Indonesian domestic law and administrative coordination. This is typically where delays and redesign costs arise.

Indonesia's permitting environment is therefore integral to any Australia–Singapore subsea cable route and, by extension, to broader ASEAN and APSEH connectivity.

Indonesia has adopted policy instruments addressing submarine pipeline and cable governance, including Ministerial Decrees such as the Minister of Marine Affairs and Fisheries Decree No. 14/2021,²⁷⁴ which form part of the formal regulatory landscape. The legal critical path will run through several interconnected regulatory layers: securing multi-ministry permits across marine affairs, transport, defence and security and environment; navigating marine protected areas and fishing zone designations; and establishing clear repair rights, access windows and emergency authorisations. These latter elements are not merely procedural, rather they directly affect reliability guarantees and insurance underwriting, making them material to project financing and operational viability.

Where subsea routes approach disputed maritime areas, APSEH proponents face heightened risks including permit contestation, insurance premia, security constraints and the need for redundancy. In addition, UNCLOS obliges States to adopt laws and regulations to provide for cable protection in certain contexts, but operational protection still depends on national enforcement capacity and coordination.²⁷⁵

Cross-border electricity trade is frequently constrained by multi-sovereign legal and political sequencing. This means that APSEH participants need to plan for (i) long permitting lead-times; (ii) route contingency; (iii) clear repair-access rights; and (iv) a dispute avoidance and resolution framework that can operate across different jurisdictions with administrative-law systems with very different transparency and review norms.

5.5 Cross-border pricing, wheeling charges and market design

The largest governance lesson from ASEAN connectivity initiatives is that tariff allocation and commercial settlement are among the hardest problems to resolve. The project stalled when parties could not agree who would bear the transmission costs and the purchase guarantees required.²⁷⁶ The significance for APSEH is direct: if cost recovery and risk allocation can delay ~100 MW of cross-border trade, the governance demands

for multi-gigawatt APSEH corridors will be qualitatively greater. International organisations emphasise the same point. The IEA's work on multilateral power trade in ASEAN examined the importance of intergovernmental agreements, harmonised operational protocols and settlement systems to move from bilateral trading to scalable multilateral trade.²⁷⁷ OECD analysis similarly stressed that regional electricity trade was impeded by divergent market structures, regulatory mandates

and the absence of robust cross-border institutions capable of managing congestion, settlement and dispute resolution.²⁷⁸

Australia's comparative advantage is not simply "resources," rather it is the ability to help design bankable cross-border market architecture. APSEH governance architecture must embed hard-wired provisions addressing four fundamental operational and commercial pillars. First, tariff methodologies for transit and wheeling must be established at the outset, ensuring transparent and predictable cost allocation across jurisdictions and market participants. Second, congestion and curtailment allocation mechanisms must be defined in advance, specifying how capacity constraints will be managed and which parties bear the costs of scarcity or system limitations. Third, operational authority and emergency

support arrangements must be clearly delineated, establishing a hierarchy of decision-making during normal operations and crisis scenarios, including protocols for mutual aid and cross-border technical coordination. Fourth, transparent dispute resolution frameworks must be instituted for system events, encompassing routine technical disagreements, force majeure events and geopolitical interruptions, with clearly specified procedures, timelines and escalation paths. Without these hard-wired governance provisions embedded in founding agreements and operational protocols, APSEH will face endemic uncertainty regarding cost recovery, system reliability, emergency response and interstate conflict resolution. For APSEH to be successful, these foundational legal and commercial terms must be negotiated and locked in place before system development proceeds.

5.6 Cyber-physical and subsea security risk: interconnected systems create new vulnerabilities

A super-connected regional energy architecture increases the consequences of failure, with serious single-point disruptions capable of propagating across borders and markets. Risks include both physical subsea vulnerabilities (damage, sabotage, repair access)²⁷⁹ and cyber vulnerabilities (operational technology compromise, ransomware, market manipulation).²⁸⁰ In 2025, the International Cable Protection Committee reported that dragged anchors account for around 30% of cable incidents annually, representing roughly 60 faults per year.²⁸¹ Repair costs for power cables can range from £10 million to £100 million.²⁸² The recent EstLink 2 subsea power connection (Finland–Estonia) outage illustrates the operational reality of repair complexity and extended outage periods following seabed damage.²⁸³

In terms of cyber risks, Australia's critical infrastructure incident notifications in recent years have included the electricity and gas sector, with the sector constituting a material share of reported incidents.²⁸⁴ Internationally, attacks targeting utilities have also been growing in number and scale, reflecting the broader trend of escalating cyber pressure on energy systems.²⁸⁵

As a result of the risks posed, this area is highly regulated.

Australia's Security of Critical Infrastructure Act 2018 (Cth) (SOCI) regulates critical infrastructure assets and creates obligations for responsible entities (including risk management programme requirements in the Act).²⁸⁶ Official guidance recognises that critical electricity assets include certain generation assets and the systems/networks/interconnectors involved in transmission and distribution.²⁸⁷ This means that export cables, large HVDC assets, major ports and control systems may trigger SOCI-related governance measures, reporting and risk-management obligations, affecting ownership and control structures; cyber standards and auditability; and supply chain/vendor decisions (which can become geopolitically sensitive). There are similar legal regimes in the other ASEAN and potential APSEH jurisdictions.

In addition to complying with the domestic legal regimes in each jurisdiction, APSEH will require alignment between neighbouring nations to function efficiently. Furthermore, APSEH will also require (i) cyber requirements embedded in technical standards and licence conditions; (ii) physical protection, monitoring and rapid-repair logistics; (iii) redundancy (multiple routes, storage buffering, alternative supply modes); and (iv) clear cross-border incident response protocols.

5.7 Domestic environmental approvals, social licence and litigation risk

Within the Australian context, APSEH-aligned build-out (generation, transmission, ports, hydrogen hubs) will intensify land-use and community impacts, particularly in Northern Australia and regional corridors. The binding constraint often is the intersection of social licence and administrative law. Approvals must be legally robust, consultative and capable of withstanding review.

A complicating factor is that Australia's environmental approvals landscape is undergoing substantial transformation. The Australian Government's Environment Protection Reform Bills were passed by the Australian Parliament on 28 November 2025, with some parts of the new laws commencing immediately, while others will take effect in staged tranches.²⁸⁸ Tranche 1 of the reforms commenced on 20 February 2026, the National Environmental Protection Agency will commence on 1 July 2026 and remaining reforms will commence on or before 1 December 2026.²⁸⁹ This staggered implementation timeline creates a layered period of regulatory uncertainty that will persist throughout 2026. The reforms, which include the Environment Protection Reform Act 2025 (Cth), National Environmental Protection Agency Act 2025 (Cth) and Environment Information Australia Act 2025 (Cth), will substantially change the operation of the Environment Protection and Biodiversity Conservation Act 1999 and have significant implications for the environmental assessment and approval of projects in Australia.

Large-scale export-oriented APSEH-relevant developments including mega solar facilities, hydrogen production hubs, transmission infrastructure and port expansions, will face compounded approval challenges. The new laws introduce National Environmental Standards that provide guidance on how to meet EPBC Act requirements and the Minister must be satisfied that a proposal is consistent with these standards for it to be approved unless it is in the national interest. More significantly, the reversal of onus means that actions must now be consistent with national environmental standards, with a positive onus on the decision-maker to be satisfied of an action's consistency with all prescribed standards, representing a material shift from the previous test.²⁹⁰ Additionally, projects will face heightened scrutiny for cumulative environmental impacts, land clearing

obligations, biodiversity offset requirements under a new net-gain test and strategic assessment determinations. Critical uncertainty persists regarding the sequencing of assessments, the precise scope of agency roles under the new National Environmental Protection Agency architecture and the substantive content of yet-to-be-finalised National Environmental Standards.

This regulatory flux is not merely procedural; approval risk directly translates into financing cost and bankability. Lenders, insurers and development financiers will price approval uncertainty into capital cost, extend timelines, or demand enhanced mitigation guarantees. For APSEH, this environment demands early consultation with DCCEEW, detailed mapping of project alignment with emerging standards and explicit strategies for avoiding unacceptable impacts and achieving net environmental gain, all before financial close negotiations commence.

Australia's national environmental approvals system has historically faced timeliness and quality challenges. The Australian National Audit Office (ANAO) found that for key EPBC Act decisions (referral, assessment method and approval), the Department of Agriculture, Water and the Environment (now administered under the Department of Climate Change, Energy, the Environment and Water) made only ~5% within statutory timeframes in 2018–19, down from ~60% in 2014–15; it also recorded an average approval overrun of 116 days in 2018–19.²⁹¹ The ANAO further found that 79% of sampled approvals contained conditions that were non-compliant with guidance or contained clerical/administrative errors. These errors create integrity and litigation exposure.²⁹² Large export projects cannot tolerate compounding delay, rework and legal fragility across multiple approvals. The Commonwealth has acknowledged the need to improve efficiency and effectiveness as an environmental regulator, including in response to the ANAO's recommendations.²⁹³

Australia must treat social licence and approval integrity as a strategic asset. This requires front-loaded community engagement, credible benefit-sharing, high-integrity biodiversity and cultural heritage management and co-design with First Nations communities to reduce downstream contestation risk.

5.8 The regulatory regime for shipping, ports and safety for hydrogen/ammonia

The legal feasibility of exporting liquid or gaseous fuels for APSEH also turns on shipping safety codes and port acceptance, with the relevant regulatory settings still in flux. While progress is underway, the regulatory landscape has not yet crystallised into a stable framework. The IMO has issued MSC.1/Circ.1687 (26 February 2025) interim guidelines for ships using ammonia as fuel.²⁹⁴ For hydrogen/fuel cells, IMO interim guidelines (e.g., MSC.1/Circ.1647, 2022) provide criteria for fuel cell power installations.²⁹⁵ Further, IMO amendments to the IGC Code were adopted by MSC.566(109) in December 2024, with entry into force indicated as 1 July 2026, enabling certain cargo gases (including ammonia on ammonia carriers) to be used as fuel subject to safety equivalence.²⁹⁶ This

rapidly evolving regulatory landscape means that APSEH planning cannot defer shipping and port regulatory compliance to a later project phase or treat it as a secondary concern. Instead, planners must integrate International Maritime Organisation (IMO) timelines, flag-state implementation schedules and port state control mechanisms directly into project bankability assessments. These regulatory elements should be treated as core due diligence and financing determinants, not as compliance matters to be resolved after financial close. The regulatory uncertainty itself represents a material risk that lenders, insurers and other financial stakeholders will scrutinise during capital mobilisation.

5.9 What these hurdles mean for Australia's APSEH posture

Taken together, the risks in this section point to a clear conclusion: APSEH will not be delivered by technology readiness alone. It will be delivered (or not delivered) by whether Australia and partner economies can construct a credible governance stack of domestic delivery

capability, bankable risk allocation, cross-border market rules, security architecture and high-integrity approvals processes that transform ambition into investable, insurable and contractable projects.

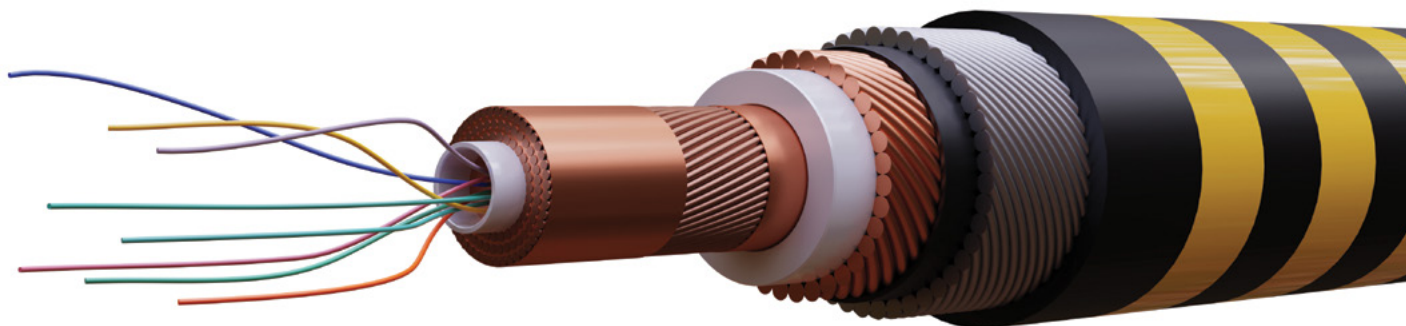


Table 1: Register of risks for Australia’s participation in APSEH and regional interconnection corridors

This register identifies the principal legal, regulatory, governance and market-design risks that could materially affect Australia’s capacity to participate credibly and at scale in the Asia-Pacific Super Energy Highway. It addresses risks across three participation pathways: cross-border electricity trade (including HVDC and subsea cable interconnection), low-emissions molecules and derivatives (including hydrogen, ammonia and related fuels) and “embodied” clean-energy exports (including green metals and processed critical minerals). It also captures key interface risks arising from overlap with other regional interconnection proposals, particularly

the ASEAN Power Grid / ASEAN Super Grid agenda and with specific demand-side initiatives, such as Singapore’s electricity import strategy.

The register is framed across two-time horizons: a development and financial close period from 2026 to 2035 and an operations and expansion period from 2035 to 2055. Likelihood and Consequence are each assessed on a Low/Medium/High scale, by reference to (i) the probability of the risk materialising within the relevant horizon and (ii) the expected consequences for schedule, cost, bankability, insurability and overall strategic viability.

Risk	Potential Impacts	Mitigation Strategies
Domestic transmission delivery gap (enabling export scale) Likelihood: High Consequence: High	Failure or delay in domestic transmission and grid augmentation (including REZ connections and backbone corridors) constrains generation firming, industrial hubs and any export-oriented supply chain.	Nationally significant project pathways (streamlined but defensible approvals), corridor protection and early land access frameworks.
	AEMO forecasts ~5,000 km of transmission build in the next decade and close to 10,000 km by 2050; under-delivery elevates cost and reliability risks and undermines export credibility. ²⁹⁷	Bankable regulated-asset governance (transparent RAB/allowances; clear contingent project triggers; robust consultation)
		Structured community benefit schemes; enforceable construction-phase obligations; consistent compensation approaches across jurisdictions.
Cost escalation and procurement constraints for HVDC and major network assets Likelihood: High Consequence: High	Material cost escalation for HVDC and related assets undermines business cases, requires renegotiation of offtakes and increases the risk of stranded development spend.	Procurement risk-allocation frameworks (indexed Engineering, Procurement and Construction (EPC) components; capacity reservation; dual-sourcing where feasible).
	AEMO’s 2025 Transmission Cost Database update indicates very large uplifts between 2023 and 2025 outputs for representative projects, including ~140–180% increases for HVDC converter station projects and ~40–50% increases for HVDC subsea cable projects (depending on conditions). ²⁹⁸	MDB co-finance/blended finance and political-risk cover to preserve debt sizing.
		Phased modular design (staged converters/cable strings) with pre-agreed expansion options.

Risk	Potential Impacts	Mitigation Strategies
Environmental approval timings litigation exposure and “social licence” constraints Likelihood: High Consequence: High	Major renewables, transmission and port upgrades face high exposure to planning appeals, judicial review, biodiversity offsets and First Nations engagement challenges. ²⁹⁹	Front-loaded cumulative-impact assessment; enforceable biodiversity and offset delivery plans; transparent benefit-sharing.
	Where approvals processes run materially beyond expected timeframes, carrying costs rise and project sequencing breaks. Australian audit evidence shows systemic schedule pressure in Commonwealth environmental approvals administration (a useful cautionary indicator for large-scale build-out). ³⁰⁰	Best-practice Indigenous engagement and consent-seeking models; cultural heritage management; grievance mechanisms aligned with the International Finance Corporation’s Performance Standards/UN’s Guiding Principles on Business and Human Rights (where MDB finance involved).
		“Permits-to-proceed” gated development (Final Investment Decision (FID) only once critical approvals are secured).
Market-design mismatch and settlement complexity (regulated vs non-regulated systems) Likelihood: High Consequence: High	APSEH participation traverses power systems with divergent market structures (liberalised wholesale markets versus vertically integrated state-owned utility models).	A dedicated APSEH “market integration protocol” (tariff principles, wheeling methodologies, congestion allocation, curtailment rules, credit support).
	Without explicit governance, misalignment in dispatch rules, congestion management, wheeling charges and settlement creates chronic dispute risk and undermines investor confidence.	Independent settlement/clearing arrangements (or escrow-based settlement) for cross-border trades.
		Regulatory cooperation MoUs and dispute-avoidance committees.
Demand uncertainty for clean hydrogen/ammonia exports and certification immaturity Likelihood: High Consequence: High	Hydrogen markets remain nascent; policy-driven demand may lag supply announcements.	Sequenced scale-up linked to contracted offtake; CCfDs or hydrogen production credits (where available) to bridge early-market cost gaps.
	The IEA reports that only a small share of announced low-emissions hydrogen projects have reached FID or begun construction (a key signal of execution risk). ³⁰¹	Mutual recognition pathways for certification schemes and guarantees of origin. Portfolio diversification: hydrogen + ammonia + green metals to reduce single-commodity exposure.
Offtake bankability and the “who pays” problem for transmission/wheeling Likelihood: Medium Consequence: High	Cross-border deals can stall over allocation of transmission and wheeling charges.	“Take-or-pay plus wheeling” templates with transparent tariff pass-through; capacity reservation fees; step-in rights for lenders.
	The Laos–Thailand–Malaysia–Singapore (LTMS) arrangement was reported as becoming stuck due to disagreements on guaranteeing fixed purchases to cover transmission costs and differing views on transmission charge arrangements. ³⁰²	Regional transmission service agreements (standard form) with arbitration clauses and interim relief mechanisms.
Route-state approvals for subsea cables and cross-border permitting complexity Likelihood: Medium Consequence: High	Subsea cable projects require multiple route-state permissions, marine spatial planning alignment and ongoing access for maintenance.	Corridor-specific intergovernmental agreements (IGAs) covering permitting, landing points, marine access, repair rights, emergency response and data/cyber requirements.
	Singapore’s conditional approval for importing 1.75 GW from Australia explicitly notes the need to secure “all requisite approvals” in jurisdictions the cables pass through, over ~4,300 km. ³⁰³	Harmonised consenting timetable (critical path mapped across jurisdictions).

Risk	Potential Impacts	Mitigation Strategies
		Standardised marine survey, cable protection and fisheries engagement plans.
Subsea cable damage, repair rights and outage liability allocation Likelihood: Medium Consequence: High	Subsea cables face material risks from “external aggression” (anchors/ fishing/third-party activity).	Cable protection zones; route selection avoiding high-traffic anchorage where possible; burial and armour standards.
	The International Cable Protection Committee (ICPC) reports a high proportion of faults attributable to such causes and notes repairs can cost millions (and up to tens of millions) depending on depth and location. ³⁰⁴	Contractual outage regimes: availability-based payments; liquidated damages calibrated to insurability; force majeure drafting aligned to marine realities.
		Pre-positioned spares; standing repair vessel arrangements; cross-border repair permitting protocols.
Misalignment (or non-recognition) of guarantees of origin and “green” certification Likelihood: Medium Consequence: High	Export value depends on recognition of emissions attributes. Australia’s Guarantee of Origin framework is designed to track emissions intensity of products (like hydrogen) and verify renewable electricity via certificates (PGO/REGO). ³⁰⁵	Bilateral and plurilateral mutual-recognition arrangements; alignment with ISO/IEC and emerging hydrogen accounting standards.
	If partner jurisdictions do not recognise the scheme (or impose additional criteria), transaction costs rise and eligibility for incentives may be lost.	Contractual “change in law / change in scheme” clauses; attribute replacement mechanisms.
Singapore import strategy dependence and corridor concentration risk Likelihood: Medium Consequence: High	Singapore is seeking to import around 6 GW of low-carbon electricity by 2035 and has granted conditional approvals/licences across multiple sources, including the Australia proposal. ³⁰⁶	Bilateral and plurilateral mutual-recognition arrangements; alignment with ISO/IEC and emerging hydrogen accounting standards.
	Concentration on one corridor increases exposure to single-point failures (route-state permissions, cable outages, political constraints).	Diversify routes, technologies and counterparties through a portfolio-based corridor strategy, supported by redundant interconnection capacity, alternative transit arrangements, contingency contracting and staged investment across multiple pathways.
ASEAN Power Grid interface risk: institutional and financing execution Likelihood: Medium Consequence: High	APSEH overlays an evolving ASEAN connectivity agenda. The World Bank’s ASEAN Power Grid Financing initiative indicates that achieving the ASEAN Power Grid vision by 2045 is estimated to require \$USD 800 billion in generation and transmission investments, coordinated across governments, utilities and partners. ³⁰⁷	Align APSEH governance with ASEAN/APGF pipelines; co-design bankability and ES risk management to MDB standards.
	Under-coordination or financing shortfalls can delay regional readiness for APSEH-linked trade.	“Ready-to-connect” milestones (grid codes, interconnection standards, settlement rules) prior to major export FIDs.

Risk	Potential Impacts	Mitigation Strategies
Trade and investment policy shocks (export controls, industrial policy, sanctions spillovers) Likelihood: Medium Consequence: High	Export-oriented clean-energy supply chains (critical minerals, green metals, low-emissions fuels) are exposed to changing export controls, inbound investment screening, sanctions and counter sanctions dynamics. ³⁰⁸	Stabilisation and change-in-law regimes in project documents; diversified procurement; strategic stockpiles for critical components.
	These can disrupt equipment procurement, finance flows and offtake eligibility.	Political-risk insurance; MDB involvement to reduce arbitrary interference risk.
Cyber-physical security obligations and critical infrastructure compliance Likelihood: Medium Consequence: High	Interconnected energy networks widen attack surfaces (SCADA/EMS compromise; data integrity attacks; coordinated disruption).	Mandatory cyber baselines in concession/licence conditions; incident reporting protocols; “secure by design” procurement.
	Compliance burdens and liability exposure increase when assets are designated critical infrastructure, especially where cross-border operational data is exchanged.	Segmentation between domestic grid control and export interconnector control; redundancy and manual fallbacks.
State subsidy and procurement compliance risks (including “green premium” support) Likelihood: Medium Consequence: High	Where government support is used (contracts for difference, export credits, grants), legal challenges can arise under domestic procurement law, competition rules and, in some settings, subsidy disciplines in trade agreements.	Transparent competitive allocation; published eligibility criteria; robust probity and audit trails.
		Treaty-consistent design (non-discrimination, objective environmental rationale).
Maritime safety, navigation and coexistence (fisheries, shipping lanes, defence use) Likelihood: Medium Consequence: High	Cable corridors, port expansions and hydrogen/ammonia shipping increase marine spatial conflicts (fisheries displacement, anchorage restrictions, navigational hazards).	Marine spatial planning and stakeholder agreements; AIS/traffic separation measures; cable protection enforcement.
	Inadequate coexistence planning elevates injunction risk and future operational constraints.	Compensation mechanisms for verified economic displacement.
Dispute resolution fragmentation and enforcement risk Likelihood: Medium Consequence: High	APSEH involves multiple contract types and public-law permissions (licences, concessions, treaties, procurement).	Tiered dispute clauses (technical expert → mediation → arbitration); seat selection with strong enforcement track record; sovereign immunity waivers for commercial acts where appropriate.
	Without a coherent dispute architecture, parties forum-shop; interim relief becomes inconsistent; enforcement may be uncertain against state-owned counterparties.	Establish an APSEH disputes “protocol” (standing panel for technical disputes; emergency arbitration).
Carbon accounting integrity and “greenwashing” liability Likelihood: Medium Consequence: High	Misstated emissions attributes (electricity provenance, hydrogen lifecycle intensity, green metals boundaries) expose proponents and offtakers to regulatory enforcement, investor claims and loss of eligibility under importing country rules.	Independent MRV; conservative boundary setting; audit rights in offtake contracts; alignment of GO certificates with counterpart scheme requirements.
Over-reliance on a single “technology pathway” (batteries/storage cost curve vs export economics) Likelihood: Medium Consequence: Medium-High	If battery and storage costs continue to fall rapidly, some importing economies may reduce reliance on imported electricity and shift to domestic firm renewables, reducing the bankability of long-distance export links; alternatively, slower storage cost improvements can strengthen import dependence. ³⁰⁹	Real options in project architecture (ability to re-optimize between electricity export, hydrogen conversion and domestic industrial use).

Risk	Potential Impacts	Mitigation Strategies
	This creates “scenario volatility” for export-linked assets with long amortisation lives.	Diversified offtaker portfolios and contract tenors; step-down exposure through staged capacity additions.
Corridor governance legitimacy and standards-setting competition Likelihood: Medium Consequence: Medium-High	Competing regional initiatives (APSEH framing vs ASEAN Power Grid implementation priorities) may generate overlapping standards and political contestation about governance “ownership.” Without legitimacy and transparency, APSEH may be perceived as a geopolitical instrument rather than a development and decarbonisation mechanism.	Embed APSEH governance within credible regional platforms; transparency of safeguards and procurement; alignment with ASEAN/APGF objectives.
Construction labour, capability and local content disputes Likelihood: Medium Consequence: Medium-High	Large simultaneous builds (renewables, transmission, ports, electrolyzers, conversion facilities) strain labour markets and contracting capability, provoking delivery delays and local-content disputes across jurisdictions.	Workforce strategies; training partnerships; targeted skilled-migration pathways; transparent local-content policies compatible with trade commitments.

To control the identified risks at programme level, Australia’s APSEH participation package should, at minimum, assemble a practical suite of interoperable legal instruments. It should include corridor-level IGAs or MoUs to secure route approvals and to govern repair rights, emergency response arrangements and shared data and cyber protocols. It should also include standard-form cross-border transmission and wheeling agreements that establish tariff principles, settlement mechanics and credit support, informed by ASEAN experience, including LTMS. A mutual recognition architecture for guarantees of origin and emissions attributes should be developed,

anchored in Australia’s GO scheme (PGO/REGO) and designed to remain compatible with importing-country rules. The package should further include a bankability framework aligned with multilateral development bank expectations covering environmental and social safeguards, procurement integrity and coherent dispute resolution and it should be dovetailed with ASEAN’s APGF financing pipeline. Finally, it should adopt a disciplined staging strategy that can pivot between electricity export and molecules or embodied clean-energy exports as storage economics and demand trajectories evolve.

6. Strategic Policy Recommendations: Building an APSEH-ready Australian policy and governance package

6.1 Strategic objective and “no-regrets” framing

Australia’s credible contribution to the Asia-Pacific Super Energy Highway depends on establishing an investable, interoperable governance ecosystem that can support multiple export vectors and multiple counterparties (ASEAN states, Japan, Korea and emerging Northeast Asian demand centres).

A robust strategy should therefore be built around optionality and sequencing:

Option 1 (electrons): where a bankable offtake and an acceptable route exist (for example, via regional hubs that connect into ASEAN grids), subsea transmission exports can be developed incrementally and integrated with ASEAN Power Grid pathways rather than treated as a standalone “Australia-to-X” leap.

Option 2 (molecules): where direct electricity export is constrained, hydrogen/ammonia exports can deliver decarbonisation services into partner

markets while also providing system flexibility domestically (hydrogen as a controllable load) and regionally (firming and storage-by-conversion).

Option 3 (embodied energy): where storage and battery cost declines reduce the relative value of long-distance energy imports for some markets, Australia can still export “clean energy in product form” by scaling green manufacturing (green iron, alumina, fertiliser feedstocks) co-located with renewable zones and port infrastructure, leveraging Australia’s institutional strengths in market governance and certification. The core policy recommendation is therefore to treat APSEH as a governance and market-design project as much as an infrastructure project and to adopt a staged approach that can accommodate different technology and demand outcomes over time.

6.2 Domestic policy recommendations (Commonwealth–State coordination)

6.2.1 Accelerate transmission and renewable-industrial enabling infrastructure

Australia cannot credibly underwrite regional export corridors without first delivering its own transition-critical network and firming assets at scale. AEMO’s 2024 ISP indicated that around 10,000 km of new transmission and upgrades will be required by 2050 to connect new generation across the NEM.³¹⁰ This will serve as the foundational platform for export-oriented renewable hubs (particularly in northern and western regions) and for the “industrial precinct” model required for hydrogen and green manufacturing.

Three governance implications follow:

1. Treat transmission as both strategic energy and economic infrastructure. In 2025 AEMO estimated the transmission component of the National Electricity Market’s optimal development path at \$16 billion (net present value of capital costs for transmission augmentation to 2049–50), within a broader annualised capital cost of \$122 billion (Step Change scenario to 2050).³¹¹ AEMO also noted that transmission investment costs are expected to be recouped and accompanied by the \$18.5 billion in avoided costs and \$3.3 billion in valued emissions reductions (using ministers’ value of emissions reduction).³¹² These figures can be deployed to justify an explicit “national

strategic infrastructure” framing for priority corridors that also enable export-aligned industrial hubs.

2. Build an approvals and delivery “fast lane” for projects that unlock renewable export precincts. Recent cost evidence indicates that delays and delivery risk are materially contributing to capital inflation. AEMO’s 2025 Transmission Cost Database update reported that between the 2023 and 2025 cost outputs, a representative HVDC converter station estimate increased by approximately 140–180% and a representative HVDC subsea cable estimate increased by around 40–50% (real dollars), depending on project conditions.³¹³ It also reported that environmental offset cost components increased by around 4.5 times compared to 2023 and that the cost and time required for community and stakeholder engagement, especially for overhead corridors, was increasing. These data points support a policy shift. The Commonwealth and States should establish an APSEH-relevant “corridor delivery framework” similar to the existing Renewable Energy Zones that bundles (i) spatial planning, (ii) corridor-level environmental assessment, (iii) community benefit-sharing arrangements and (iv) coordinated land access protocols so that projects progress with fewer stop-start cycles and less “serial re-litigation” of route selection.
3. Treat workforce and supply chain as a binding constraint and plan accordingly. AEMO forecasts electricity sector workforce demand rising from around 32,000 workers in 2024 to a peak of over 60,000 to 2050 under the Step Change scenario, across disciplines beyond engineering.³¹⁴ Commonwealth skills, migration and procurement policy should be aligned to prioritise (i) transmission and port-hub skills and (ii) HVDC and electrolyser supply chains, including framework contracts and joint procurement models where feasible.

Recommended domestic actions (12–24 months):

- Create an APSEH-Readiness Infrastructure List (Commonwealth–State) that designates priority transmission corridors and port-industrial upgrades as “export-enabling” and eligible for accelerated coordination.
- Implement corridor-level planning to reduce rework and delay costs (including up-front community benefit mechanisms and structured First Nations engagement protocols).
- Coordinate HVDC and converter procurement strategy to mitigate exposure to global bottlenecks reflected in recent cost escalations.

6.2.2 Establish export-grade certification and “proof of green” infrastructure

Export pathways for renewable electricity, hydrogen/ ammonia and green products will increasingly depend on the importing economy’s ability to verify emissions intensity and renewable provenance. Australia has recently taken a significant step by launching the Guarantee of Origin (GO) Scheme, under the Future Made in Australia (Guarantee of Origin) Act 2024. This was designed as a voluntary certification framework to track emissions intensity of products (such as hydrogen) and verify renewable electricity generation and consumption. The Clean Energy Regulator has also described Renewable Electricity GO certificates (REGO) as digital instruments that can be traded or retired as evidence of renewable electricity use.³¹⁵

A credible Australian certification system is a market access instrument and a de-risking tool for cross-border contracting. Without interoperable certification, counterparties will price in reputational, regulatory and compliance risk. Conversely, with credible certification, Australia can position itself as a rules-based supplier with a verifiable low-emissions attribute.

Recommended domestic actions (12–24 months):

- Publish technical mapping for interoperability to likely counterpart schemes (Japan, Korea, Singapore import regimes and any ASEAN regional approaches) and crosswalk guidance for offtakers and financiers.
- Create a statutory “mutual recognition pathway” (or at minimum a regulatory mechanism) enabling bilateral or plurilateral recognition arrangements for GO-verified attributes, subject to equivalence tests.
- Where possible under competition law, integrate GO into procurement and export finance so that GO-verified projects receive faster diligence and preferential risk treatment by public financing bodies.

6.2.3 Align fiscal incentives and industrial strategy with APSEH corridors

Australia’s “renewable export pivot” requires an investable bridge from project concept to financial close, especially for early hydrogen/ammonia and critical minerals processing projects facing first-mover costs and demand uncertainty. The Commonwealth has legislated a series of APSEH-relevant production-linked incentives:

- Hydrogen Production Tax Incentive: provides \$2 per kilogram of renewable hydrogen produced, available between 1 July 2027 and 30 June 2040, for up to 10 years per project.³¹⁶
- Critical Minerals Production Tax Incentive: provides a 10% refundable tax offset on eligible Australian processing expenditure for 31 critical minerals if they are processed/refined during the period 1 July 2027 to 30 June 2040, also up to 10 years per project.³¹⁷
- These incentives can materially strengthen the bankability of export-aligned precincts if they are aligned with enabling infrastructure (renewable zones, transmission, ports, water supply and shipping corridors) and if they are paired with credible certification (GO) and offtake frameworks.

Recommended domestic actions (12–36 months):

- Precinct-based implementation: prioritise incentives for projects that are demonstrably linked to export-ready precincts (port access, grid capacity and verified renewable supply), reducing stranded-asset risk.
- Offtake “stapling”: permit and encourage bundling of (i) tax incentives, (ii) GO certification and (iii) long-term offtake support instruments (such as contracts for difference or government-backed offtake aggregation) for first-wave projects with high strategic value.
- Critical minerals-to-infrastructure linkage: identify which processed outputs are most directly APSEH-enabling (batteries, power electronics, HVDC cable inputs and energy storage supply chains) and tie project selection to demonstrable contribution to regional grid integration and export resilience.

6.3 Regional policy recommendations

6.3.1 Establish an APSEH governance “framework” anchored in existing regional institutions (APEC, ASEAN mechanisms, UNESCAP connectivity work)

APSEH governance should be framed as an energy security and economic integration initiative in a manner consistent with APEC’s convening role, while also interfacing pragmatically with ASEAN’s implementation machinery. The APEC context matters: Korea hosted APEC in 2025, including the Ministerial Meeting in Gyeongju.³¹⁸ China is the host of APEC 2026 in Shenzhen and this provides an immediate diplomatic window.³¹⁹ Australia can position APSEH as a practical “connectivity” and “standards” agenda item that complements (rather than competes with) ASEAN Power Grid delivery and Northeast Asian decarbonisation needs.

Recommended regional actions (0–24 months):

- Propose an APSEH Track under the APEC Energy Working Group focused on (i) certification interoperability, (ii) bankable cross-border contracting templates and (iii) cyber-physical resilience standards for interconnection infrastructure.
- Create an APSEH–ASEAN interface working arrangement, explicitly linked to the ASEAN Power Grid Financing (APGF) Initiative (see below), to avoid duplication and to embed APSEH within ASEAN’s priorities.

6.3.2 Integrate Australia’s APSEH agenda with the ASEAN Power Grid Financing Initiative (APGF) and real import demand signals

The ASEAN Power Grid is being implemented through its new APGF financing architecture. Australia’s APSEH positioning becomes stronger where it can be aligned to existing ASEAN grid integration and credible import programmes already under way. Rather than treating APSEH as a single corridor to a single market, Australia should treat it as participation in a regional “electricity imports ecosystem” that is building modularly through ASEAN.

Recommended regional actions (12–36 months):

- Negotiate interoperability of certification and dispatch attributes (GO equivalence, renewable provenance and emissions intensity baselines) with import regimes in ASEAN hubs.
- Support APGF pipelines with Australian regulatory expertise, particularly in open access principles, congestion management, reliability frameworks and independent regulatory practice, while recognising the political economy of regulated versus vertically integrated ASEAN power sectors.
- Develop “hub-and-spoke” corridor governance (Australia ↔ ASEAN hubs ↔ Northeast Asia) as a risk-reduction approach compared with single, ultra-long routes.

6.4 Market design and contracting recommendations

6.4.1 Standardise cross-border contracting for APSEH-type transactions

The principal legal barrier to regional energy trade is the absence of credible, repeatable risk allocation. Australia should lead a project to create model contracting architecture suitable for APSEH-aligned trades, including:

- Long-term offtake templates for renewable electricity imports (including curtailment risk, change-in-law, force majeure, transmission availability and regulatory pass-through).
- Hydrogen/ammonia offtake templates aligned to certification and emissions intensity thresholds (using GO as the Australian anchor).
- Interconnector use and access agreements appropriate to whether the relevant market is liberalised (merchant) or regulated (single buyer/utility), with clear dispute resolution provisions.

6.4.2 Create bankable risk-reduction instruments matched to real cost drivers

The recent HVDC and transmission cost inflation evidence suggests that schedule risk, procurement bottlenecks, insurance overheads and community engagement costs are now central project risks.³²⁰ Australia should therefore develop instruments that specifically target these drivers rather than relying only on generic concessional finance. Recommended market-design actions (12–36 months):

- Public co-financing tied to delivery milestones for early interconnector components (converter stations, port upgrades, grid connection assets) where cost inflation is most acute.
- Political risk and regulatory change coverage for cross-border segments, structured to complement multilateral instruments and ASEAN financing pipelines.
- Certification-backed offtake de-risking: integrate GO-verified attributes into contract price adjustments, creating a direct “value line” from verified low-emissions status to revenue certainty.

6.5 Environmental and social licence recommendations

Domestic and regional legitimacy will determine delivery speed. Two factors are material:

First, project cost evidence indicates that environmental and engagement dimensions are no longer marginal. Environmental offset cost components in the 2025 transmission cost database baseline increased by around 4.5 times compared with the 2023 version. Further, increasing cost/time for stakeholder engagement is explicitly identified as a driver of rising estimates. This means that strong environmental and social governance is not only normatively desirable; it is economically material. Second, APSEH depends on demonstrating that Australia is exporting not only energy but also high-standard governance, including meaningful First Nations engagement, transparent benefit sharing, strong labour protections and credible biodiversity management.

Recommended environmental/social actions (0–24 months):

- Adopt a “high-standard corridor” framework: establish corridor-level principles for First Nations engagement, land access, benefit sharing and biodiversity management that can be applied consistently across export-enabling infrastructure.
- Embed ESG and human rights requirements into export financing so that public support is conditioned on demonstrable compliance and monitoring, strengthening Australia’s reputational differentiation as a supplier.
- Regional safeguards alignment: ensure APSEH engagement with ASEAN financing (including APGF) is aligned with strong safeguards expectations, supporting social acceptability and investor confidence.

6.6 Implementation roadmap of deliverables for government and stakeholders

Immediate (0–12 months): “Enable and align”

- Establish an interdepartmental APSEH taskforce linking energy, trade, infrastructure and foreign policy.
- Publish an APSEH-Readiness Infrastructure List (corridors, ports, precincts).
- Operationalise GO interoperability workstreams and issue market guidance.

Near term (12–36 months): “Standardise and de-risk”

- Release model contract suites for electricity imports, hydrogen/ammonia and interconnector access.
- Deploy targeted risk instruments addressing HVDC and transmission cost escalation and schedule risk.
- Conclude at least one mutual recognition arrangement or equivalence pathway for certification attributes.

Medium term (3–7 years): “Demonstrate”

- Deliver at least one export-aligned precinct (renewables + firming + port/logistics + certification + offtake) supported by tax incentives where eligible from 2027.
- Integrate Australia’s APSEH agenda into ASEAN implementation pipelines via APGF-aligned project preparation and regulatory cooperation.

7. Conclusion and Path Forward: A governance-led, scenario-resilient Australian contribution to APSEH

The Asia-Pacific Super Energy Highway should be treated as a governance project as much as an infrastructure project. Properly understood, it is not a single “one-shot” interconnector, but a multi-vector regional energy trade architecture that can connect Australia with key Asian partners through a combination of cables, ships and pipelines.³²¹ Australia’s most valuable contributions will be its renewable resource endowment and its capacity to help make cross-border energy trade investable and governable. Three foundational pillars are critical for this to become a reality. The first is credible domestic delivery capability, particularly in transmission build-out and industrial enablement, because export credibility cannot be decoupled from domestic system performance. The second is export-grade certification and integrity systems capable of supporting high-trust, cross-border trade in emissions attributes. The third is a bankable set of cross-border rules covering cost recovery, settlement, resilience and dispute avoidance. A governance-led strategy of this kind is the most resilient across plausible technology futures, especially as battery and storage costs continue to fall and thereby reshape the comparative economics of importing “electrons” versus importing “molecules” and “embodied clean energy”.

Crucially, the regional “pull” is already concrete rather than hypothetical. Two developments illustrate why APSEH is no longer only a concept. First, credible import programmes are emerging. Singapore’s EMA has stated a target to import around 6 GW of low-carbon electricity by 2035, or roughly one-third of its projected demand at that time.³²² Singapore has also reported conditional approvals or authorisations totalling 7.35 GW across multiple projects (including proposals involving Australia), with some projects progressing into more advanced licensing stages.³²³ Thus, import demand is being translated into a regulated pipeline rather than remaining at the level of general policy aspiration. Second, ASEAN interconnection is being institutionalised alongside explicit finance mobilisation in the form of the World Bank’s ASEAN Power Grid Financing Initiative³²⁴ These signals demonstrate, first, that import demand is being articulated through policy and regulatory processes and second, that ASEAN’s grid integration pathway is increasingly being treated as a bankable programme supported by multilateral development banks. APSEH design should therefore be aligned to and built to complement, these existing

structures rather than framed as a parallel “Australia-to-Asia” project detached from ASEAN’s institutional reality.

At the same time, APSEH strategy must remain robust to rapid technology change. The most consequential near-term cost curve is storage. The IEA reported that lithium-ion battery prices fell from about \$USD 1,400/kWh in 2010 to less than \$USD 140/kWh in 2023, representing an approximately 90% decline.³²⁵ This has two strategic implications. Some economies may reduce their reliance on imported bulk electricity as domestic renewables paired with cheap storage become increasingly competitive, particularly where land availability, permitting settings and grid constraints are manageable. In parallel, demand is likely to intensify for the enabling supply chains such as critical minerals, batteries, grid equipment, power electronics and low-emissions industrial inputs required to electrify transport, industry and buildings at scale. That shift aligns with the IEA’s assessment that the combined market value of key energy transition minerals (including copper, lithium, nickel, cobalt, graphite and rare earth elements) is around \$USD 325 billion today and, in its Net Zero Emissions scenario, more than doubles to \$USD 770 billion by 2040.³²⁶ This directly reinforces the case for Australia to treat value-added processing and “embodied clean energy” exports including green metals and processed minerals as a core APSEH-relevant proposition, alongside any electricity or hydrogen pathway.

Hydrogen and ammonia nevertheless remain central to decarbonising hard-to-abate sectors and therefore central to APSEH’s multi-vector logic. However, the near-term commercial risk must be stated plainly. Hydrogen remains a policy-made market and is unevenly bankable.³²⁷ The IEA reported that global hydrogen production reached 97 Mt in 2023, with less than 1% being low-emissions hydrogen.³²⁸ For Australia, early hydrogen export projects should be built on contracted, verifiable demand and certification interoperability, rather than on assumed market take-off. In practical terms, APSEH-aligned hydrogen development is best treated as a sequenced portfolio option. It should be scaled in line with importing-country procurement regimes, industrial switching timetables and the maturation of certification rules, rather than proceeding as an all-at-once export build predicated on optimistic demand trajectories.

Australia's differentiators, in this context, are institutional credibility, market governance capability and certification infrastructure. Export credibility ultimately depends on delivery discipline at home. AEMO's 2024 Integrated System Plan stated that 4,581 km of new transmission lines are needed to meet 2030 targets, with forecasts showing that close to 10,000 km of transmission will be needed by 2050.³²⁹ These benchmarks serve as domestic planning indicators and as the observable platform on which counterparties and financiers will judge whether Australia can credibly underwrite large-scale export commitments. Australia can also offer regional alignment capability as a rules-based partner able to support governance architecture where market structures differ (including liberalised systems and vertically integrated models). The practical payoff of that capability is bankability, through consistent rules for access, cost recovery, settlement, emergency support and dispute avoidance.

Taken together, these realities support a scenario-resilient Australian APSEH strategy structured around three export vectors, underpinned by a single governance framework. Electricity exports should be developed where demand anchors and route-state permissions are credible, including through ASEAN hubs and Singapore's import ecosystem. Clean molecules should be scaled only against bankable procurement and verifiable certification, treating hydrogen as both an export product and a domestic flexibility mechanism rather than as a single-track export bet. Embodied clean energy in the form of processed minerals, green metals and green industrial products, should be treated as a durable export pillar in a world where electrification accelerates and mineral supply chains tighten. Battery cost declines and domestic storage build-out will not remove the strategic logic of trade and connectivity. They will, however, reshape what is traded and how value is captured. A governance framework is therefore the critical continuity mechanism across scenarios.

APSEH can be anchored in a purposefully layered legal architecture that aligns different governance levels. First, an intergovernmental framework instrument that establishes foundational principles, defines the structure and mandate of corridor governance bodies, articulates security and defence cooperation protocols, enshrines environmental and social safeguards and creates mechanisms for dispute avoidance and early resolution of disagreements between participating states. This

intergovernmental framework provides the constitutional foundation and political commitment while preserving flexibility in operational and commercial implementation. Second, a suite of implementing instruments addressing the technical and regulatory mechanics of corridor operation. These include licensing and permitting coordination mechanisms across jurisdictions, mutual recognition arrangements for technical certification and standards compliance, emergency repair and maintenance protocols with predetermined notification and authorisation timelines and baseline standards for data security and cyber resilience. These instruments will translate the high-level principles from the intergovernmental framework instrument into workable coordination procedures that respect jurisdictional autonomy while building transparent, reciprocal recognition of each jurisdiction's authorisation outcomes. Third, a series of investable contracts which will serve as the commercial and operational agreements that enable actual capital deployment. These include power offtake agreements, availability guarantees and curtailment compensation mechanisms. These agreements will explicitly allocate change-in-law risk, clearly specify arbitration and dispute resolution venues and provide step-in rights that permit financiers or sponsors to assume control and protect their interests.

This layered architecture has proven efficacy. Singapore's electricity import pipeline's regulatory framework, Australia's Offshore Electricity Infrastructure Act (OEI Act) and Australia's Guarantee of Origin scheme for renewable energy demonstrate that functional legal instruments, certification protocols, emergency procedures and cross-border coordination mechanisms already exist across the region and can be adapted for corridor application. By mapping these three layers explicitly, identifying potential alignment opportunities and negotiating harmonisation and mutual recognition arrangements before corridor operations commence, APSEH can leverage existing regulatory infrastructure and establish a governance model that is simultaneously robust, flexible and investable.

“Proof of progress”: milestones for 2026–2030

Progress should be demonstrated through a small number of observable, credibility-building milestones.

1. Australia should publish an interoperability pathway for guarantees of origin and emissions-attribute certification, including formal equivalence criteria and at least one bilateral or plurilateral recognition pathway (or a concrete technical alignment process) capable of scaling beyond a single pilot.
2. Australia should develop a model cross-border contracting suite, with standard templates covering wheeling and settlement, curtailment and availability regimes and a staged dispute-avoidance pathway (for example, expert determination followed by mediation and then arbitration) that is recognisable to infrastructure and project finance markets.
3. Australia should conclude at least one corridor-level intergovernmental instrument (Memorandum of Understanding or Intergovernmental Agreement) with a partner or hub jurisdiction, covering route-state permissions, repair access, operational coordination and incident response, thereby converting conceptual corridors into de-risked legal pathways.
4. Australia should demonstrate transmission delivery progress consistent with ISP benchmarks, particularly the 4,581 km new transmission requirement associated with 2030 targets, as a measurable

proxy for domestic platform credibility.³³⁰

5. Australia should bring at least one export-aligned industrial precinct to “bankable readiness”, evidenced by approvals, a grid connection pathway, a port and logistics plan, certification arrangements and an offtake pathway aligned to the importing market’s regulatory framework.
6. Australia should establish formal linkage to the ASEAN Power Grid Financing pipeline, for example through joint project preparation support or technical workstreams that directly support APGF priorities and are consistent with the \$USD 800 billion investment mobilisation objective for ASEAN Power Grid integration by 2045.³³¹

APSEH presents Australia with a strategic opportunity to evolve from a legacy fossil-export profile to a renewables-enabled regional partnership that exports energy in multiple forms while helping to shape the governance foundations of Asia-Pacific decarbonisation. The central proposition is that Australia’s highest-value contribution is to combine credible domestic delivery, high-integrity certification and bankable cross-border rules, aligned with ASEAN’s integration trajectory and anchored in real import demand signals such as Singapore’s regulated import programme. Australia can be a supplier, a rule-setter and a de-risking partner. It will only be treated as such, however, if it builds the governance framework that turns interconnection ambition into investable reality.

Appendix 1: Electricity-market structures across the region

Asia-Pacific electricity systems are not designed for and do not operate within, a single market model. They span a spectrum from fully liberalised wholesale markets with retail contestability, to single-buyer procurement structures, to vertically integrated or administratively dispatched state-led systems, with many jurisdictions occupying hybrid pathways that combine staged unbundling with targeted competition. Thus, developing APSEH's cross-border energy trade is not merely an infrastructure play. It is a governance exercise that must bridge different national market designs, institutional mandates, tariff regimes and accountability frameworks. The market structure in each jurisdiction determines:

- who can legally buy and sell electricity (or attributes such as renewable certificates);
- how prices are formed;
- whether cross-border costs can be recovered from consumers;
- how dispatch, system security, reliability and congestion are managed;
- which public bodies can authorise and supervise cross-border transactions; and
- ultimately, where legal risk concentrates in cross-border trade and investment.

This means that the early phases of APSEH's development are far more likely to rely on government-to-government agreements and long-term utility/offtake contracts (which can sit more comfortably within single-buyer and monopoly systems) than on an integrated multi-country spot market. This is consistent with the experience of ASEAN interconnection to date, which has largely progressed through bilateral and "project-by-project" arrangements rather than full market coupling.

As shown in Table 2 below, there are four common market structures used within the region:

1. Liberalised wholesale markets with meaningful retail contestability

Liberalised electricity markets are characterised by competitive bidding and market-based wholesale prices, run by an independent or quasi-independent market/system operator, with retail competition for at least some customer classes.³³² For APSEH, these systems can accommodate multiple procurement routes (Power Purchase Agreements, exchange trading, hedging) and can support cross-border financial products, but they depend on sophisticated settlement, congestion management and aligned system security rules. Regional examples include:

- Australia (NEM; also, WA's separate arrangements): rulemaking, compliance and operation are institutionally separated among the AEMC (rules),³³³ AER (regulation/enforcement),³³⁴ and AEMO (operation).³³⁵
- New Zealand: the Electricity Authority regulates the market and contracts Transpower (System Operator) to run real-time system operations/wholesale arrangements.³³⁶
- Singapore: a competitive wholesale market with extensive contestability, overseen by the Energy Market Authority;³³⁷ the market operator reports substantial traded volumes and transparent spot pricing (e.g., 2024 demand about 57.3 TWh and reported market indicators including average USEP).³³⁸
- Philippines: competitive wholesale trading via the Wholesale Electricity Spot Market (WESM),³³⁹ with the Independent Electricity Market Operator of the Philippines (IEMOP) established to operate the WESM and act as the central registration body for retail competition.³⁴⁰

A useful regional benchmark is that OECD/IEA analysis characterises competitive wholesale markets in ASEAN as essentially confined to Singapore and the Philippines, with most other ASEAN systems operating single-buyer structures.³⁴¹

2. Single-buyer model (often with IPPs and partial unbundling)

Single-buyer markets are characterised by a designated buyer, typically a state utility or mandated procurement entity, that purchases power from generators (including IPPs) and sells onward, usually under regulated tariffs.³⁴² System operation may sit with the buyer or a related grid entity. For APSEH, the single counterparty can simplify cross-border trade, but tariff pass-through and competitive neutrality often become politicised and legally contested. Regional examples include:

- Malaysia (Peninsular): explicitly adopts a Single Buyer Market model, with the Energy Commission (Suruhanjaya Tenaga) issuing Single Buyer rules/guidelines and ring-fencing requirements.³⁴³
- Thailand: commonly described as an "enhanced single-buyer" arrangement centred on the Electricity Generating Authority of Thailand (EGAT), alongside the Metropolitan Electricity Authority (MEA)/Provincial Electricity Authority (PEA) distribution; overseen by the Energy Regulatory Commission.³⁴⁴
- Vietnam: sector oversight sits with the Ministry of Industry and Trade (MOIT)³⁴⁵ and the Electricity Regulatory Authority of Vietnam (ERAV),³⁴⁶ while EVN (Vietnam Electricity) remains central to purchasing/system coordination under phased reforms.

- Mongolia: international institution reporting describes an Energy Regulatory Commission (ERC)–supervised single-buyer model with a national dispatching function managing buying/selling and settlement mechanics.³⁴⁷

3. Vertically integrated monopoly/administratively dispatched systems (often state-owned)

In vertically integrated markets, a dominant utility controls networks and much generation, with centrally planned procurement and regulated, sometimes subsidised, tariffs.³⁴⁸ APSEH projects could be possible, but typically require state-to-state negotiation and robust treaty or intergovernmental arrangements on cost recovery, security standards and dispute settlement. Regional examples include:

- Indonesia: electricity law and multilateral analysis emphasise the vertically integrated role of the state electricity company Perusahaan Listrik Negara (PLN) and its control of networks, with the Ministry of Energy and Mineral Resources of Indonesia (MEMR) acting as regulator and policy-setter.³⁴⁹
- Cambodia: ADB analysis characterises Cambodia’s market as a hybrid with vertical integration plus elements of a single-buyer and semi-privatised rural supply.³⁵⁰
- Brunei: electricity is commonly administered through government departments/ministries rather than a liberalised market framework.

4. Hybrid liberalisation pathways (incremental unbundling + targeted competition)

These markets are characterised by incremental legal or functional unbundling, phased retail contestability and strengthening regulators and system institutions to oversee access and competitive conduct. For APSEH, these systems can become highly compatible if governance reforms keep pace, particularly on third-party access, transparent congestion rules and enforceable network codes. Regional examples include:

- Japan: reform steps include full retail liberalisation from 1 April 2016 and legal unbundling of transmission/distribution from April 2020, alongside dedicated institutions such as Organization for Cross-regional Coordination of Transmission Operators (OCCTO) and an enhanced surveillance commission.³⁵¹
- Taiwan: government statements identify the 2017 Electricity Act amendments as initiating liberalisation (particularly around green power market access), with ongoing staged reform.³⁵²

- Hong Kong: the market is not liberalised; it is regulated through Scheme of Control Agreements with two power companies, representing a distinct “regulated franchise” model.³⁵³

Implications of market structures for APSEH

These market realities have direct implications for APSEH’s design and governance. First, APSEH should plan for asymmetric integration rather than uniform market coupling. As most ASEAN electricity markets remain single-buyer, while others remain vertically integrated, interconnection is more likely to scale through bilateral or triangular contracted trade, such as through utility-to-utility arrangements or state-backed offtake, rather than through a single regional electricity spot market in the medium term. This constraint is reinforced by OECD and IEA-style characterisations of ASEAN market structures, which treat competitive wholesale markets as largely confined to Singapore and the Philippines.³⁵⁴

Second, regulator capacity and independence vary sharply across the region, which in turn affects the bankability of projects. In liberalised markets such as Australia, New Zealand, Singapore and the Philippines, the investor proposition typically depends on predictable rulemaking, open access and enforceable market conduct obligations. In single-buyer or monopoly systems, bankability more often turns on sovereign-backed payment certainty and credible tariff pass-through, which increases the importance of public finance settings and political risk mitigation.

Third, system operation is likely to pose a choke point. Even where wholesale competition exists, cross-border power flows require aligned operational protocols, including frequency standards, contingency reserves, curtailment rules and congestion management. This coordination is institutionally easier where a credible system operator has a clear legal mandate, as in the AEMO and Transpower models, than where operational authority is embedded within a dominant utility.

Finally, APSEH governance will need an explicit regulatory bridging mechanism. Given the diversity of market structures, a realistic pathway is to build, first, a cross-border contracting framework using standardised PPAs and availability and firming products; second, a technical and system-security code of practice to support system operator coordination; and third, a regulator-to-regulator forum to manage disputes, compliance expectations and tariff and cost allocation.

Table 2: Electricity Market Structures in Selected Asian Jurisdictions

Jurisdiction	Predominant Market Structure	Policy Ministry/ Department	Regulator	Market/System Operator
Australia (NEM)	Liberalised wholesale market (gross pool) with competitive retail (in participating jurisdictions) ³⁵⁵	Energy and Climate Change Ministerial Council (ECMC) (federal/state coordination) ³⁵⁶	AER; ³⁵⁷ rules by AEMC ³⁵⁸	AEMO operates markets/ system ³⁵⁹
New Zealand	Liberalised wholesale market; retail competition ³⁶⁰	Ministry of Business, Innovation and Employment (MBIE) (policy), with sector-specific institutions ³⁶¹	Electricity Authority (EA); ³⁶² Commerce Commission regulates lines economics ³⁶³	Transpower as system operator (contracted to EA) ³⁶⁴
Singapore	Competitive wholesale market + high contestability ³⁶⁵	Government of Singapore (sector policy via EMA) ³⁶⁶	Energy Market Authority (EMA) ³⁶⁷	Energy Market Company (EMC) as market operator; reported 2024 demand ~57.3 TWh ³⁶⁸
Philippines	Competitive wholesale market (WESM) + retail competition for contestable customers ³⁶⁹	Department of Energy (DOE) ³⁷⁰	Energy Regulatory Commission (ERC) ³⁷¹	IEMOP operates WESM/CRB; ³⁷² NGCP dispatch role noted in DOE materials ³⁷³
Malaysia (Peninsular)	Single Buyer Market model ³⁷⁴	Minister / energy portfolio (federal) ³⁷⁵	Energy Commission (Suruhanjaya Tenaga) ³⁷⁶	Single Buyer authorised under the Electricity Supply Act 1990; ring-fenced procurement rules ³⁷⁷
Thailand	Enhanced single buyer (EGAT-centred) ³⁷⁸	Ministry of Energy ³⁷⁹	Energy Regulatory Commission (ERC) ³⁸⁰	EGAT (generation/ transmission role); MEA/PEA distribution ³⁸¹
Indonesia	Vertically integrated utility dominance with Independent Power Producer (IPP) participation ³⁸²	MEMR (incl. Directorate General of Electricity) ³⁸³	MEMR as regulator (sector oversight) ³⁸⁴	PLN controls transmission/ distribution and remains principal provider ³⁸⁵
Vietnam	Single-buyer model with staged competitive reforms ³⁸⁶	MOIT ³⁸⁷	ERAV (within MOIT framework) ³⁸⁸	EVN central actor; reform pathway described in sector analyses ³⁸⁹
Cambodia	Hybrid: vertical integration + single-buyer elements ³⁹⁰	Ministry of Mines and Energy ³⁹¹	Electricity Authority of Cambodia ³⁹²	Electricity Authority of Cambodia (EDC) and mixed supply arrangements (ADB characterisation) ³⁹³
Mongolia	Single Buyer Model (internationally described) ³⁹⁴	Ministry of Energy ³⁹⁵	Energy Regulatory Commission ³⁹⁶	National dispatching/single-buyer settlement function described by IFIs ³⁹⁷
Japan	Liberalised retail + unbundled T&D (staged reform) ³⁹⁸	METI (Agency for Natural Resources and Energy) ³⁹⁹	Electricity and Gas Market Surveillance Commission within reform architecture ⁴⁰⁰	OCCTO grid coordination; ⁴⁰¹ exchange trading via Japan Electric Power Exchange (JEPX) etc. ⁴⁰²
Republic of Korea	“Single buyer + pool” hybrid (KEPCO buyer; KPX pool) ⁴⁰³	MOTIE (institutional affiliation noted in KOREC materials) ⁴⁰⁴	KOREC (regulatory commission) ⁴⁰⁵	KPX operates cost-based pool; ⁴⁰⁶ KEPCO as single buyer ⁴⁰⁷
People’s Republic of China	Rapidly evolving: provincial/ sectoral trading + push for unified national market by 2030 ⁴⁰⁸	State planner/energy regulators – National Development and Reform Commission (NDRC)/ National Energy Administration (NEA) referenced in reform guidance ⁴⁰⁹	Multi-agency oversight ⁴¹⁰	Foundations in interprovincial medium-to-long-term (MLT) contracts/spot pilots; national “unified market” goal by 2030 ⁴¹¹
Hong Kong (SAR)	Regulated franchise under Scheme of Control (SoC) ⁴¹²	Government policy bureaux ⁴¹³	Government oversight under SoC framework ⁴¹⁴	Two power companies regulated via SoC agreements ⁴¹⁵
Chinese Taipei (Taiwan)	Hybrid liberalisation (notably green power access) ⁴¹⁶	Ministry of Economic Affairs (MOEA) ⁴¹⁷	Sector oversight via MOEA institutions ⁴¹⁸	2017 Act amendments initiated liberalisation pathway ⁴¹⁹

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