NET ZERO WORLD INITIATIVE

Accelerating Global Energy System Decarbonization

High-Level Assessment of Grid Infrastructure in Southeast Asia to Support Regional Interconnections

Prateek Joshi, Howard Marano, and Travis Douville

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U.S. DEPARTMENT OF ENERGY
USTDA U.S. TRADE AND DEVELOPMENT AGENCY
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EXIM EXPORT-IMPORT BANK OF THE UNITED STATES
MILLENNIUM CHALLENGE CORPORATION UNITED STATES OF AMERICA

Contents

1. Introduction

- Background on Net Zero World (NZW)
- Relevant Prior Work
- Purpose of Assessment

Net Zero World

A cross-lab team that partners with countries to provide demand-driven support:

1 Rigorous country-driven net-zero **pathways** and **technical and investment plans**

2 World-class technical support for **transformative implementation and just transition actions**

3 **Investment mobilization** assistance at all stages.

Key Energy Sectors, Partners, and Cross-Lab Team

- Buildings
- Industry
- Transport
- Power and Energy Storage
- Carbon Capture, Use, and Storage
- Investment Services
- Energy Systems
- Nuclear

NREL Transforming ENERGY

Pacific Northwest National Laboratory

Berkeley Lab

Argonne National Laboratory

Oak Ridge National Laboratory

Brookhaven National Laboratory

Lawrence Livermore National Laboratory

Sandia National Laboratories

INL Idaho National Laboratory

National Energy Technology Laboratory

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U.S. Department of Energy

USTDA U.S. Trade and Development Agency

DFC U.S. International Development Finance Corporation

EXIM Export-Import Bank of the United States

Millennium Challenge Corporation United States of America

Purpose of Assessment

The purpose of this assessment is to provide an overview of the benefits of interregional transmission and to assess the specific transmission landscape of Southeast Asia, with respect to potential interconnections between countries. This analysis also explores the distribution of renewable resources and electricity demand in ASEAN (Association of Southeast Asian Nations) as well as current and anticipated interregional transmission, in order to inform future interconnection plans.

2. Interregional Transmission

- Interregional Transmission Benefits
- Select Case Studies

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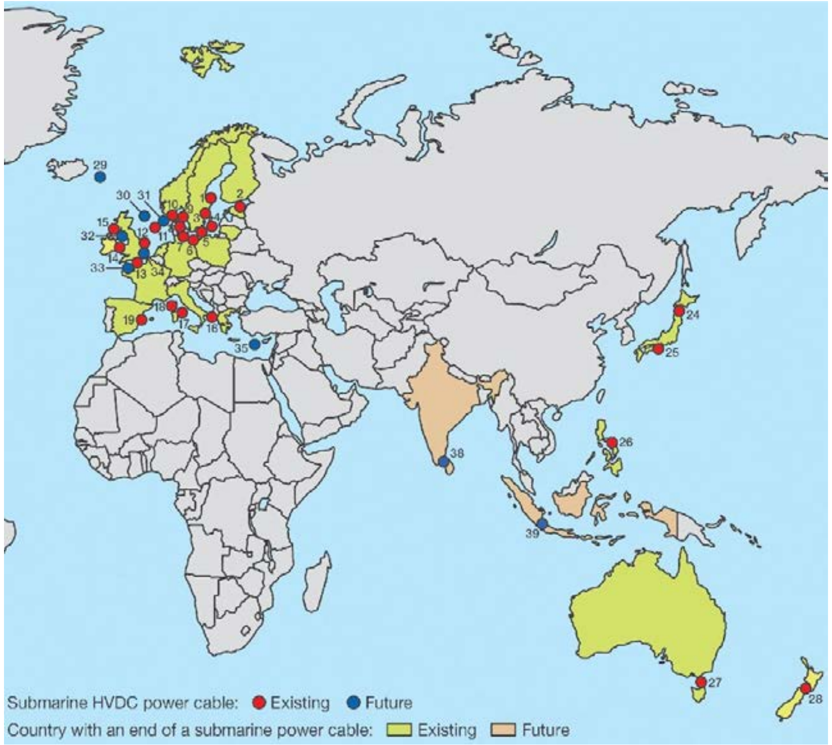
Interregional Transmission Offers Many Benefits

Grid connectivity secured through regional interconnectors enables a host of benefits:

- Generation capital cost savings
- Production cost savings
- Resource adequacy and resilient power supply
- Risk mitigation and energy security
- Emissions reductions
- Renewable energy integration
- Jobs and economic development

Sources: Deyoe, Stenclik, and Lasher (2024), Stenclik and Deyoe (2022)

Figure. Submarine HVDC Interconnectors in Europe and Asia Pacific



Source: Ardelean and Minnebo (2015)

Interregional Transmission Challenges

Policy, **regulatory**, **financial**, **economic**, and **technical** challenges often present obstacles to successful interregional transmission development.

These challenges can include:

- Diverse policies, regulations, and standards across domestic power grids
- Varied priorities and political uncertainty, which may delay needed decision-making
- Lengthy regulatory and permitting processes for new or upgraded grid infrastructure
- Uncoordinated interregional grid planning and grid stability concerns from variable renewable energy
- Uncertain funding sources, ownership structures, and remuneration mechanisms
- Limited technical capacity to operate cross-border, long-distance interconnections
- Transmission equipment supply-chain constraints

Source: DNV (2024); Simeone and Rose (2024)

Generation Capital and Production Cost Savings

Interregional transmission can provide significant capital and production costs savings.

Generation Capital Cost Savings	• Avoided/deferred generation capacity investments • Access to lower-cost/higher-resource potential generation sites • Access to policy incentives for renewable energy capital investments
Production Cost Savings	• Avoided costs for fuel, cycling, and other variable costs of power generation • Displacement of higher-cost suppliers with those with lower incremental production costs • Reduced transmission energy losses • Reduced congestion due to transmission outages • Reduced costs for operating reserves and other ancillary services

Sources: Pfeifenberger et al. (2021), Stenclik and Deyoe (2022), U.S. Department of Energy (2024)

Resource Adequacy and Resilient Power Supply

Interregional transmission can support a more reliable and resilient energy system.

Resource Adequacy	The ability of the supply-side, demand-side, and transmission resources to meet demand. • Avoided/deferred costs of reliability projects for new or aging infrastructure • Reduced risk of load loss • Reduced margin for planning reserves
Grid Resilience	The system's capability to limit extreme events' impacts through efforts to prepare for, anticipate, absorb, adapt to, and recover from them. • Reduced customer impacts due to adverse conditions (e.g., extreme weather events) • Reduced severity of events requiring load shedding to maintain grid operations

Source: Deyoe, Stenclik, and Lasher (2024)

Risk Mitigation and Energy Security

- Interregional transmission can help planners prepare for **macroeconomic volatility**, **extreme weather**, and **other unexpected events**, while minimizing costs.
- Interregional transmission can also help planners respond to different scenarios in an evolving energy sector:
  - **Fuel Price:** Transmission can reduce reliance on fossil generation and the associated financial costs to hedge against fuel price volatility.
  - **Load Growth:** Electrification of building and transportation sectors will likely increase loads and without transmission to supply renewable energy to meet these loads, more costly generation units are likely to be run.
  - **Plant Retirements:** Transmission that brings cheaper electricity generation online reduces the potential for uneconomic generation to remain online.
  - **Local Capacity:** Transmission brings lower cost resources into a region and thus does not require the development of suboptimal resources to serve local electricity demand.

Sources: Pfeifenberger et al. (2021) , Stenclik and Deyoe (2022)

Emissions Reductions

Interregional transmission can be a key enabler to achieve a low-emissions grid while maintaining reliability at least cost. Benefits may include:

- Reduced **localized emissions** (e.g., SO_2, NO_x, particulates, mercury), improving air quality and public health outcomes.
- Reduced **greenhouse gas emissions** from better integrated renewable energy and the avoided dispatch of high-emission generation resources.

Source: Clack, Goggin, and Choukulkar (2020); Pfeifenberger et al. (2021)

Figure. Avoided Emissions in 2040 for the ASEAN RE Target Scenario, Including Interregional Transmission Expansion

AVOIDED EMISSIONS - ASEAN RE TARGET SCENARIO		
	CO_2	N_2O (in CO_2 eq)
	Million Tons	Thousand Tons
Coal	70,216	55
Oil	3,734	1
Natural Gas	16,902	1

Source: ASEAN and HAPUA (2021)

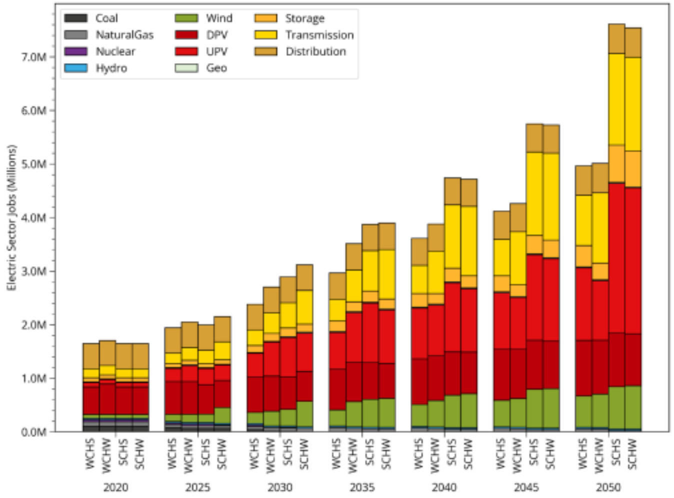
Jobs and Economic Development

- Investments in interregional transmission can provide direct employment opportunities and support additional investments in renewable energy projects.

- Reduced electricity costs for homes and businesses can also drive additional economic activity and job creation due to increased consumption and productivity.

Source: Clack, Goggin, and Choukulkar (2020)

Figure. Employment Scenarios for Regional Transmission Expansion in the Eastern United States



Source: Clack, Goggin, and Choukulkar (2020)

Select Case Studies of Interregional Transmission

United Kingdom ←→ Norway

India ←→ Nepal

France ←→ Spain

Australia ←→ Singapore

Morocco ←→ United Kingdom

UK-Norway North Sea Interconnector

- 700 km HVDC interconnector developed by National Grid and Statnett.
- Developed under the UK Ofgem cap and floor regime, which sets a yearly maximum and minimum level revenue that the interconnector can earn over a 25-year period to reduce risks and encourage investments.
- Participates in implicit day-ahead capacity allocation, coupling the day-ahead markets of the UK and the NO_2 bidding zone in Norway.

Sources: Ofgem (2021a), Ofgem (2021b)

Figure. UK-Norway North Sea Interconnector Schematic

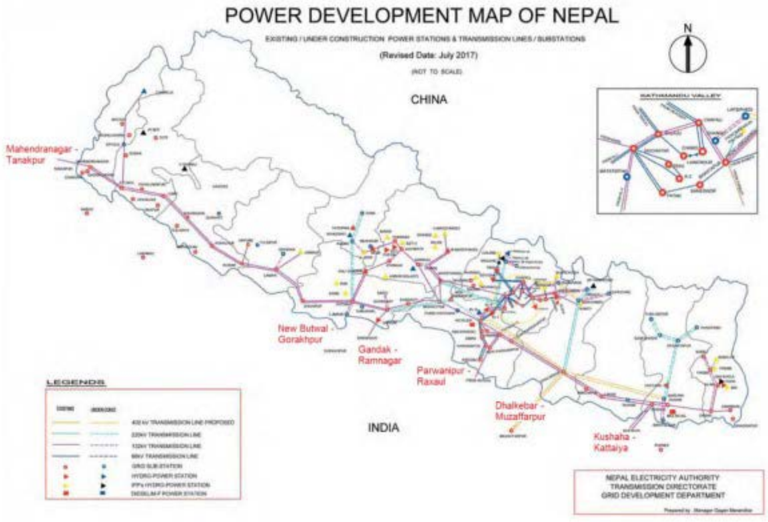
Source: Stattnet and National Grid (n.d.)

India-Nepal Interconnector

- Dhalkebar-Muzaffarpur 400 kV HVDC transmission line.
- Electricity is traded on India's Day-Ahead Market of the Indian Exchange Market (IEX).
- Imports/exports governed by India’s Guidelines for Import/Export (Cross Border) of Electricity – 2018.
- India also shares existing high-capacity transmission lines with Bangladesh, supporting additional resource sharing.

Sources: Adhikari and Pandey (2023), Ministry of Power (n.d.)

Figure. India-Nepal Grid Interface Schematic



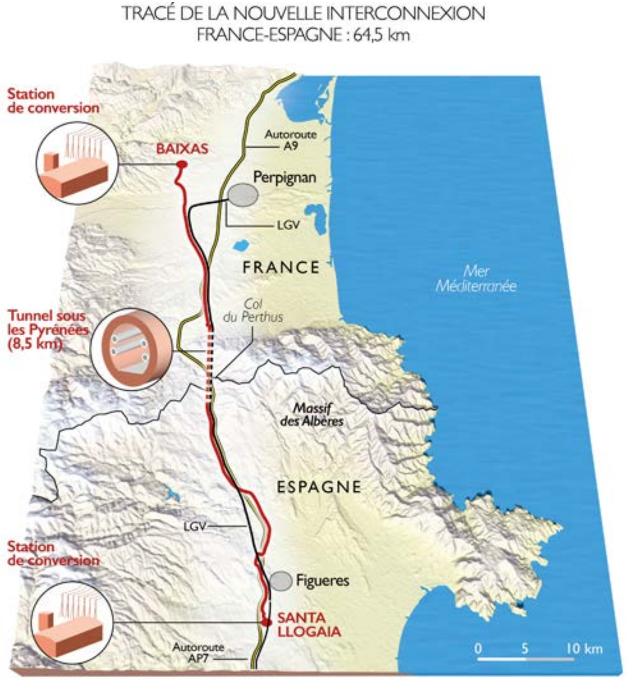
Source: McBennett et al. (2019)

France-Spain Pyrenees Interconnector

- 65 km underground HVDC interconnector developed by RTE (French Utility) and REE (Spanish Utility).
- Developed with support from the EU European Energy Programme for Recovery and the European Investment Bank.
- System operators participate in annual auctions for cross-border transmission capacity rights.
- Bidders can establish physical energy exchanges throughout the year or benefit from positive price differences for day-ahead markets.

Source: Red Eléctrica (2023)

Figure. France-Spain Pyrenees Interconnection Schematic



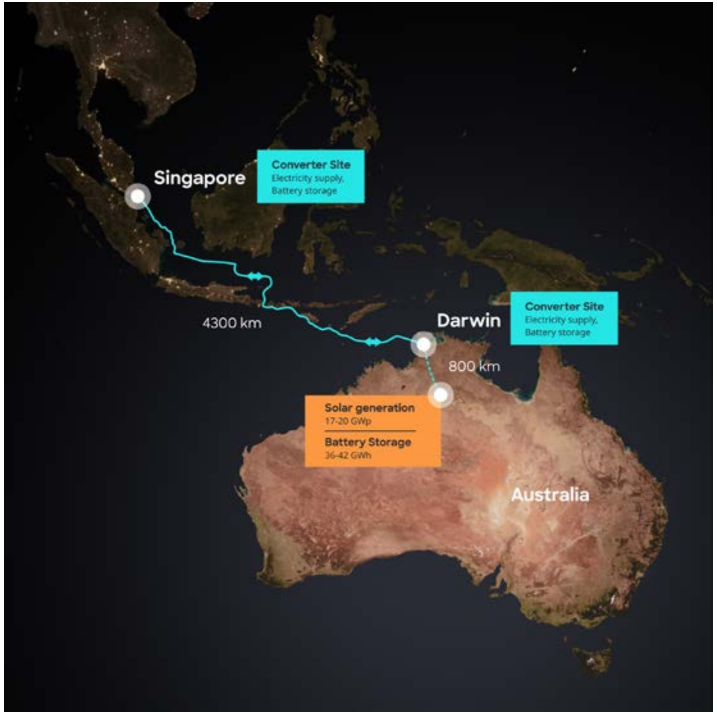
Source: European Investment Bank (2015)

Australia-Asia PowerLink Interconnector

- Proposed 4,300 km HVDC interconnector between Australia and Singapore, coupled with solar and battery storage.
- Estimated capacity of 1.75 GW, or up to 15% of Singapore's electricity demand (supporting energy security for Singapore).
- Additional planning is underway before final investment and funding arrangements, including securing environmental approval and commercial agreements to underpin demand.
- Australia's Northern Territory Environment Protection Agency is reviewing the proposal's environmental impact.

Source: Infrastructure Australia (2024)

Figure. Australia-Asia Interconnection Schematic



Source: SunCable (n.d.)

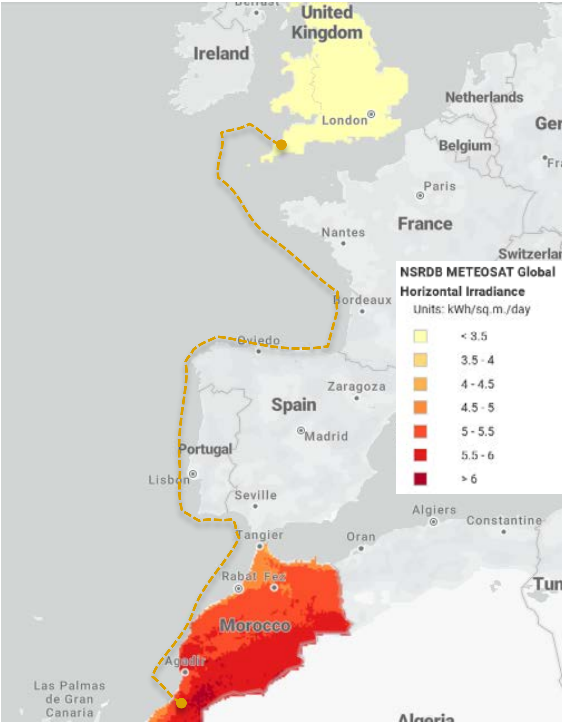
Morocco-UK Xlinks Interconnector

Select Case Studies

- Proposed 4,000 km HVDC subsea project to connect Morocco's solar resources and the UK's wind resources.
- Agreement secured with National Grid for two 1.8 GW connections.
- Identified as a UK National Infrastructure Project due to its size and potential benefits.
- Developers are conducting pre-application consultations and environmental assessments with stakeholders.

Sources: Xlinks (n.d.), Planning Inspectorate (n.d.)

Figure. Morocco-UK Interconnection Schematic



Source: Data from RE Data Explorer

Transmission Cost Comparison

- HVDC (high-voltage, direct current) transmission lines are the economical solution for long-distance asynchronous interconnections and long-distance submarine cables, compared to HVAC (high-voltage, alternating current) lines.

- HVDC technology has higher terminal costs (and thus higher initial costs) compared to HVAC technology.

- However, HVDC lines are more efficient and less expensive per unit of length.

- Thus, for longer distances, HVDC lines are generally lower cost compared to HVAC lines (though costs can be highly route-specific).

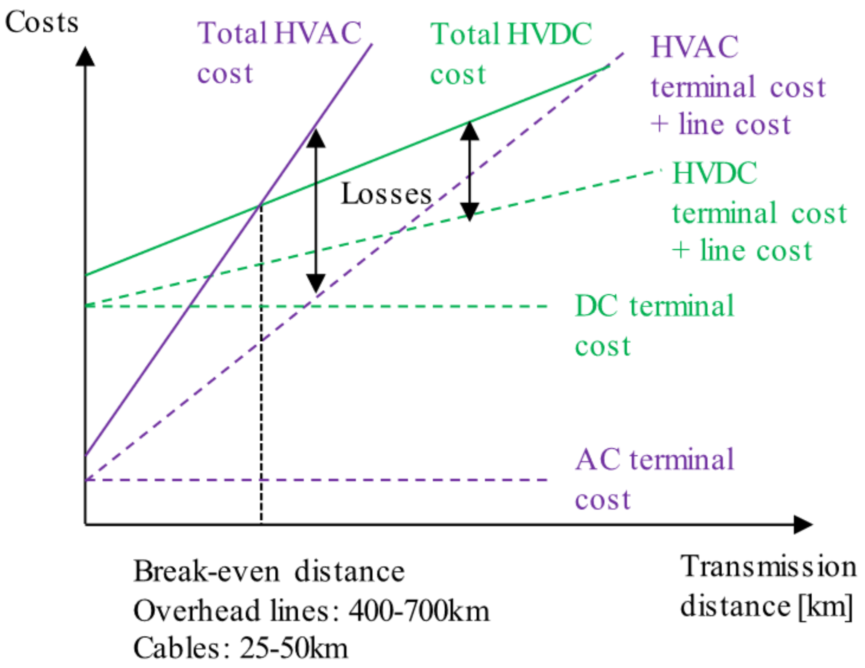


Figure. Comparative cost of HVDC and HVAC transmission lines (overhead lines and submarine cables) as a function of line length

Source: Czernorucki et al. (2022)

3. ASEAN Energy and Transmission Landscape

- Renewable Energy and Electricity Demand in ASEAN
- Transmission Interconnections in ASEAN

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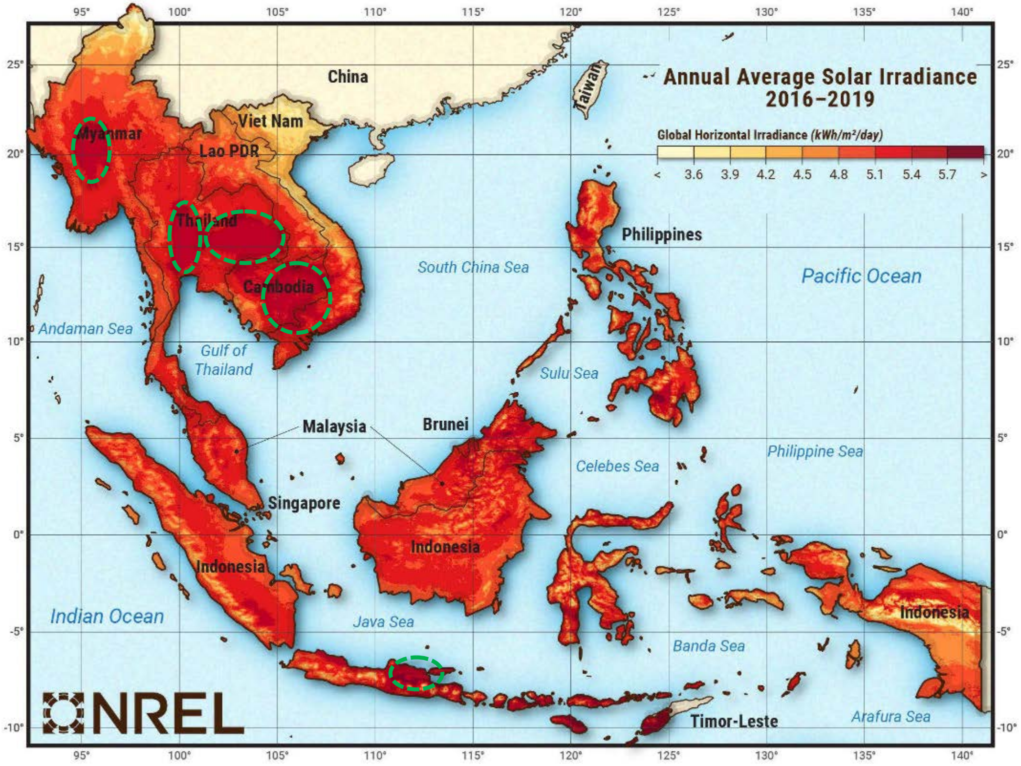
Solar Resource in ASEAN

Figure. Southeast Asia solar resource data



The solar resource (i.e., global horizontal irradiance, direct normal irradiance, and direct horizontal irradiance) is strong throughout all of ASEAN, and particularly in regions such as central Myanmar, central Thailand, eastern Cambodia, southern Vietnam, and Java Indonesia.

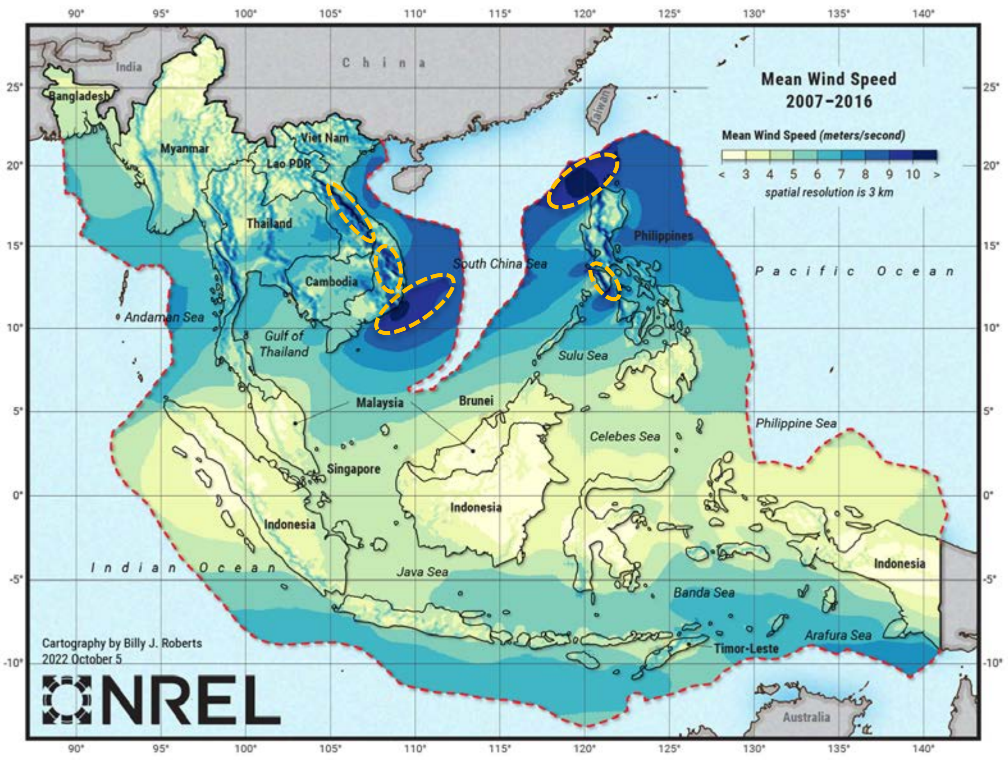
Spatial Resolution: 2-km x 2-km
Temporal Resolution: 10 minutes

Source: Maclaurin et al. (2022)

Strongest Resources

Wind Resource in ASEAN

Figure. Southeast Asia wind resource data



The wind resource (i.e., wind speed) is strong in certain regions of ASEAN, particularly in southern Laos, southern Vietnam, off the coast of southern Vietnam, off the coast of northern Philippines, and Mindoro Philippines.

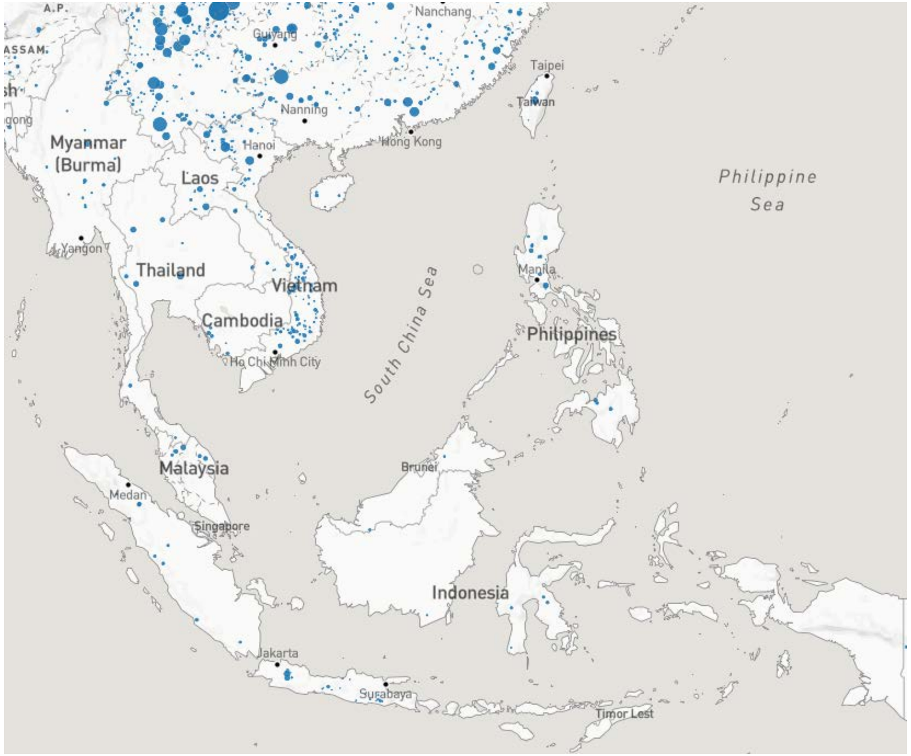
Spatial Resolution: 3-km x 3-km
Temporal Resolution: 15 minutes

Source: NREL (2023)

Strongest Resources

Hydropower Plants in ASEAN

Figure. Southeast Asia hydropower plant data



According to the Global Power Plant Database version 1.3.0 (June 2021), Vietnam has the largest capacity of hydropower in ASEAN (approximately 17 GW), followed by Indonesia (approximately 5 GW) and Thailand (approximately 4 GW).

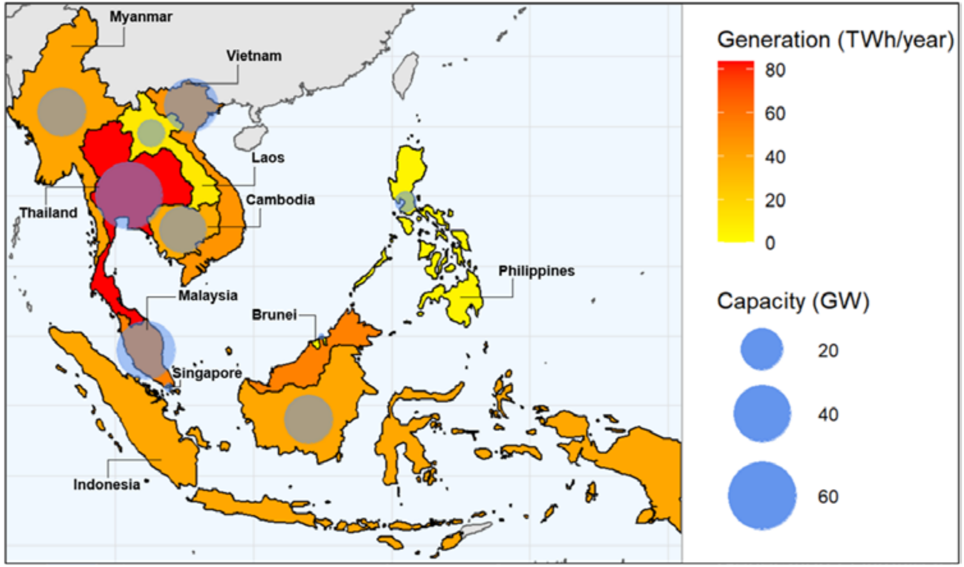
Hydro Power Plants by Capacity (MW)

Capacity (1MW-22.5GW)

Source: World Resources Institute (2019)

Floating Solar PV Potential in ASEAN

Figure. Southeast Asia floating solar PV technical potential on reservoirs



There is a large technical potential for floating solar PV sited on reservoirs (including hydropower and non-hydropower reservoirs) in ASEAN, led by Thailand (33 – 65 GW), Malaysia (23 – 54 GW), and Vietnam (21 – 54 GW).

Source: Joshi et al. (2023)

ASEAN Electricity Demand

ASEAN Energy and Transmission Landscape

Data from the ASEAN Interconnection Masterplan Study (AIMS) III Phase 1 & 2 Update

Source: ASEAN Centre for Energy (2023)

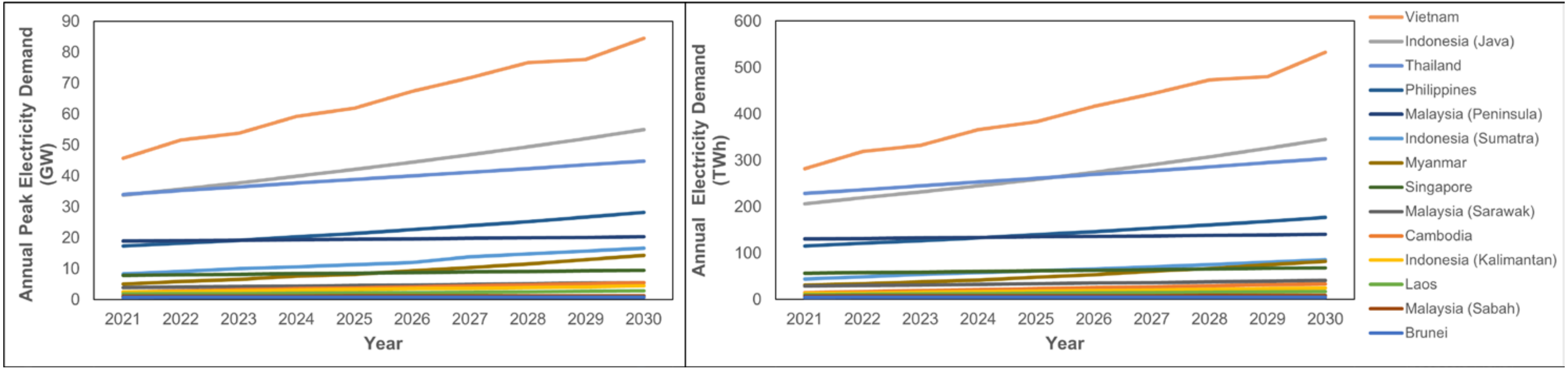


Figure. Annual peak electricity demand (GW) and electricity demand (TWh) in ASEAN

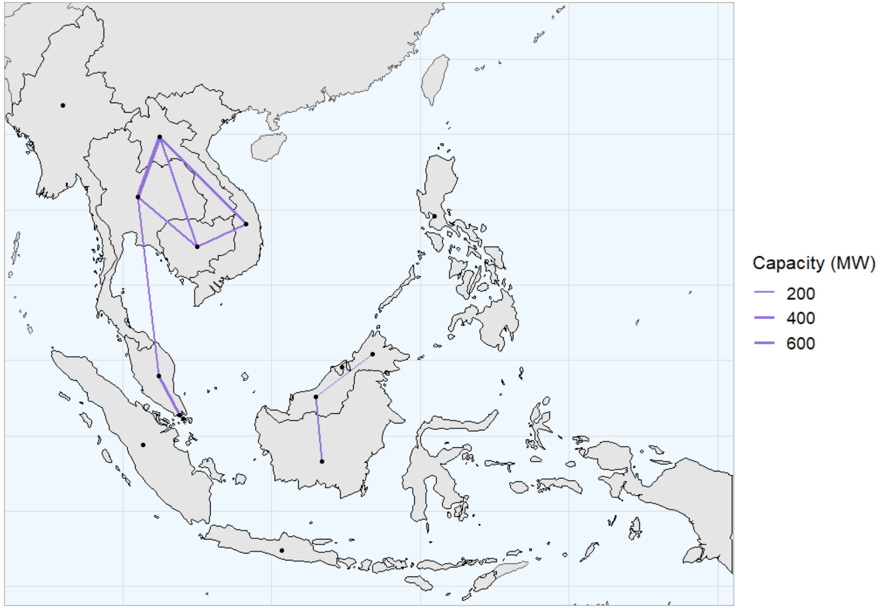
ASEAN Interconnections:
Current Status (2022)

ASEAN Energy and Transmission Landscape

Data from the ASEAN Interconnection Masterplan Study (AIMS) III Phase 1 & 2 Update

Source: ASEAN Centre for Energy (2023)

Figure. Interregional Transmission in Southeast Asia – Current Status (2022)



Note: the transmission routes shown in the figure are representative lines connecting regions in Southeast Asia and are not exact routes.

As of 2022, the largest total cross-regional interconnection in ASEAN is *Thailand-Laos* [700 MW], followed by *Laos-Vietnam* [570 MW] and *Malaysia (Peninsula)-Singapore* [525 MW].

Other interconnections exist between *Thailand-Malaysia (Peninsula)* [300 MW], *Malaysia (Sarawak)-Indonesia (Kalimantan)* [230 MW], *Malaysia (Sabah)-Malaysia (Sarawak)* [50 MW], *Vietnam-Cambodia* [200 MW], *Laos-Cambodia* [200 MW], and *Thailand-Cambodia* [230 MW].

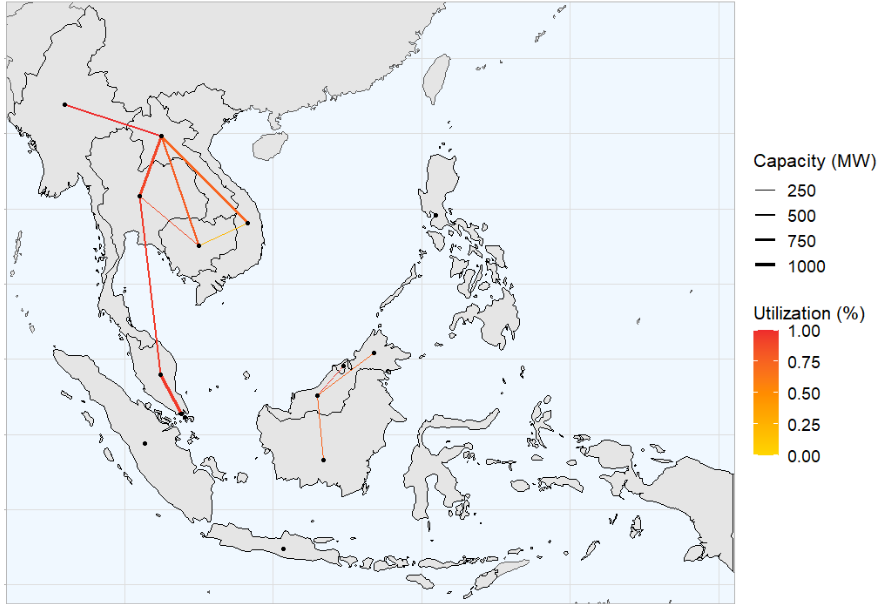
ASEAN Interconnections: Updated Power Plans (2025)

ASEAN Energy and Transmission Landscape

Data from the ASEAN Interconnection Masterplan Study (AIMS) III Phase 1 & 2 Update

Source: ASEAN Centre for Energy (2023)

Figure. Interregional Transmission in Southeast Asia – Updated Power Plans (2025)



Note: the transmission routes shown in the figure are representative lines connecting regions in Southeast Asia and are not exact routes.

Transmission Corridors with Changes Between Scenarios	Current Status (2022)	Updated Power Plans (2025)
Malaysia (Peninsula) – Singapore	525 MW	1050 MW
Malaysia (Sabah) – Malaysia (Sarawak)	50 MW	100 MW
Thailand – Laos	700 MW	900 MW
Laos – Cambodia	200 MW	300 MW
Malaysia (Sarawak) – Brunei	0 MW	100 MW
Laos – Myanmar	0 MW	300 MW

Transmission Utilization:

- **Utilization at or above 90%**: *Malaysia (Peninsula)-Singapore, Thailand-Malaysia (Peninsula), Malaysia (Sarawak)-Brunei, Thailand-Laos,* and *Laos-Myanmar.*
- **Utilization at or below 50%**: *Vietnam-Cambodia*.

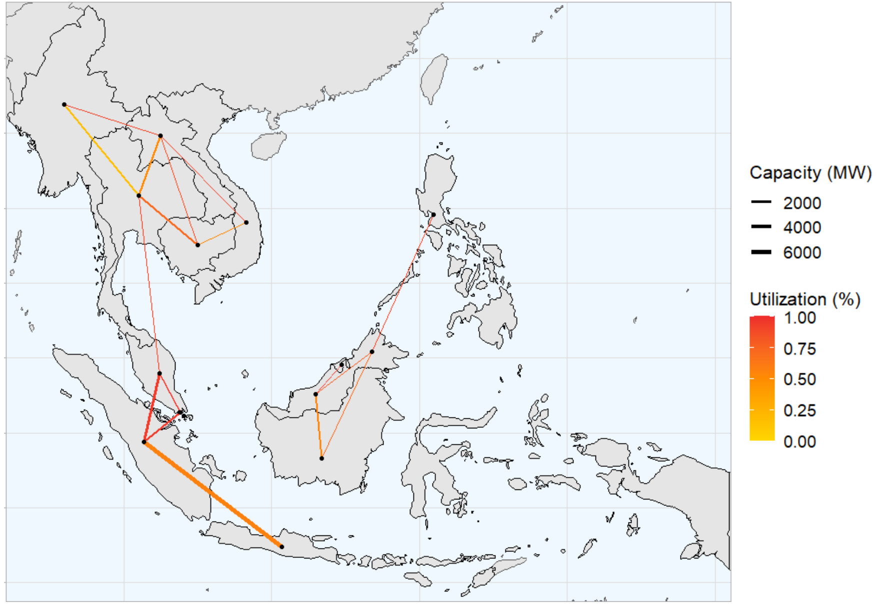
ASEAN Interconnections: Updated Power Plans (2040)

ASEAN Energy and Transmission Landscape

Data from the ASEAN Interconnection Masterplan Study (AIMS) III Phase 1 & 2 Update

Source: ASEAN Centre for Energy (2023)

Figure. Interregional Transmission in Southeast Asia – Updated Power Plans (2040)



Note: the transmission routes shown in the figure are representative lines connecting regions in Southeast Asia and are not exact routes.

Compared to Updated Power Plans (2025):

- Overall interregional transmission capacity rises from **4,250 MW to 17,550 MW**, with the largest increases happening along the following corridors: *Thailand-Cambodia* [+800 MW], *Malaysia (Sarawak)-Indonesia (Kalimantan)* [+600 MW], and *Thailand-Laos* [+400 MW].

- New transmission capacity is also added between 6 corridors, with the largest increase between *Indonesia (Java)-Indonesia (Sumatra)* [+6,000 MW].

Transmission Utilization:

- **Utilization at or above 90%**: *Malaysia (Peninsula)-Singapore, Thailand-Malaysia (Peninsula), Malaysia (Peninsula)-Indonesia (Sumatra), Philippines-Malaysia (Sabah), Malaysia (Sarawak)-Brunei, Laos-Vietnam, Indonesia (Sumatra)-Singapore,* and *Laos-Myanmar*.

- **Utilization at or below 50%**: *Thailand-Myanmar*.

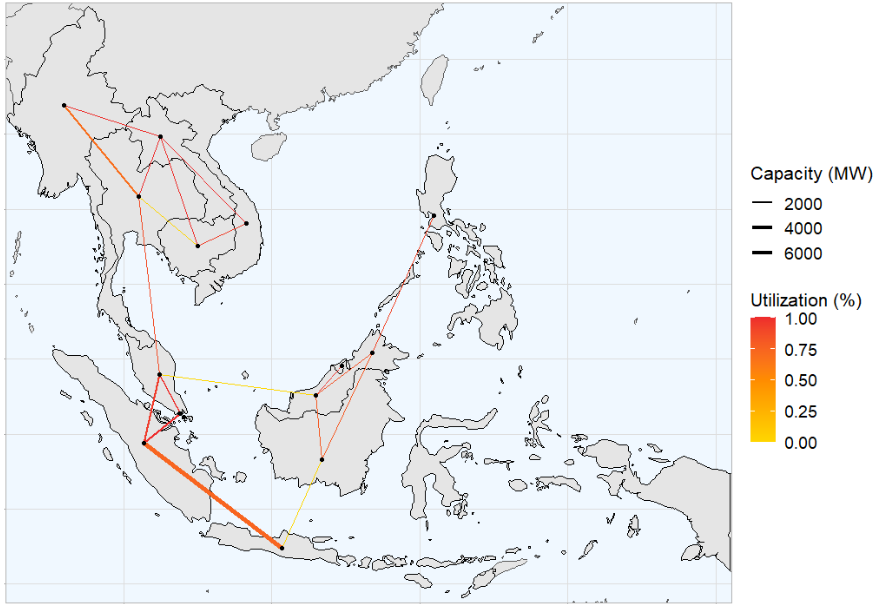
ASEAN Interconnections:
ASEAN RE Target (2025)

ASEAN Energy and Transmission Landscape

Data from the ASEAN Interconnection Masterplan Study (AIMS) III Phase 1 & 2 Update

Source: ASEAN Centre for Energy (2023)

Figure. Interregional Transmission in Southeast Asia – ASEAN RE Target (2025)



Note: the transmission routes shown in the figure are representative lines connecting regions in Southeast Asia and are not exact routes.

Compared to Updated Power Plans (2025):

- Overall interregional transmission capacity rises from **4,250 MW to 15,246 MW**, with the largest increases happening along the following new corridors: *Indonesia (Java)-Indonesia (Sumatra)* [0 MW to 7,943 MW], *Malaysia (Peninsula)-Indonesia (Sumatra)* [0 MW to 1,067 MW], and *Indonesia (Sumatra)-Singapore* [0 MW to 843 MW].

Transmission Utilization:

- **Utilization at or above 90%**: *Malaysia (Peninsula)-Singapore, Malaysia (Peninsula)-Indonesia (Sumatra), Philippines-Malaysia (Sabah), Malaysia (Sarawak)-Brunei, Thailand-Laos, Laos-Vietnam, Vietnam-Cambodia, Laos-Cambodia, Indonesia (Sumatra)-Singapore*, and *Laos-Myanmar*.

- **Utilization at or below 50%**: *Malaysia (Peninsula)-Malaysia (Sarawak), Indonesia (Java)-Indonesia (Kalimantan)*, and *Thailand-Cambodia*.

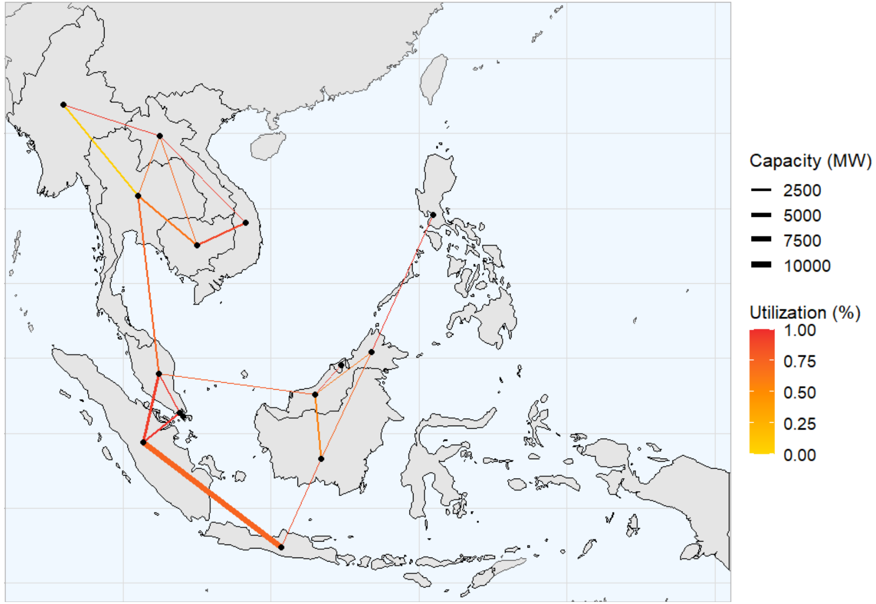
ASEAN Interconnections:
ASEAN RE Target (2040)

ASEAN Energy and Transmission Landscape

Data from the ASEAN Interconnection Masterplan Study (AIMS) III Phase 1 & 2 Update

Source: ASEAN Centre for Energy (2023)

Figure. Interregional Transmission in Southeast Asia – ASEAN RE Target (2040)



Note: the transmission routes shown in the figure are representative lines connecting regions in Southeast Asia and are not exact routes.

Compared to ASEAN RE Target (2025):

- Overall interregional transmission capacity rises from **15,246 MW to 24,414 MW**, with the largest increases happening along the following corridors: *Indonesia (Java)-Indonesia (Sumatra)* [+2057 MW], *Malaysia (Peninsula)-Indonesia (Sumatra)* [+1,063 MW], and *Vietnam-Cambodia* [+1,025 MW].

Transmission Utilization:

- **Utilization at or above 90%**: *Malaysia (Peninsula)-Singapore, Malaysia (Peninsula)-Indonesia (Sumatra), Philippines-Malaysia (Sabah), Malaysia (Sarawak)-Brunei, Laos-Vietnam, Vietnam-Cambodia, Indonesia (Sumatra)-Singapore*, and *Laos-Myanmar*.

- **Utilization at or below 50%**: *Thailand-Myanmar*.

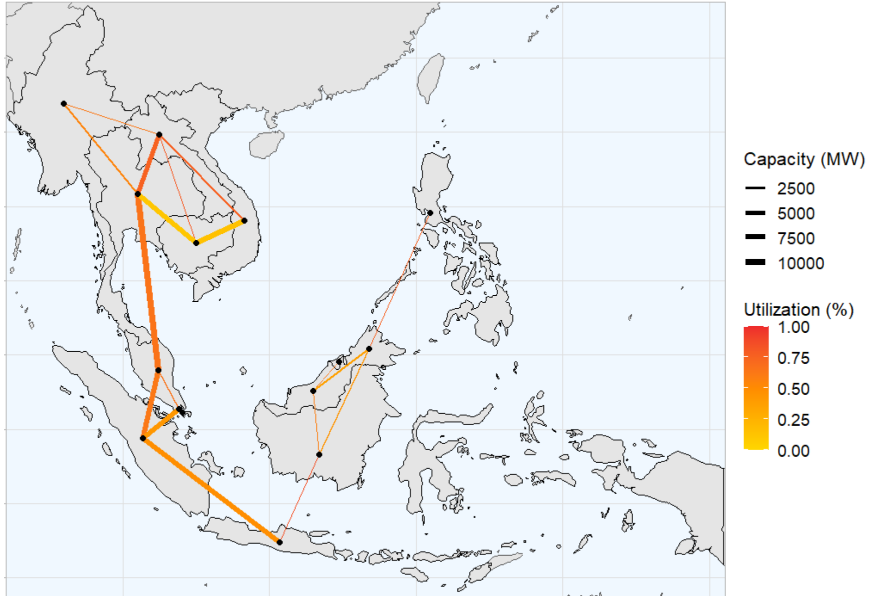
ASEAN Interconnections:
High RE Target (2025)

ASEAN Energy and Transmission Landscape

Data from the ASEAN Interconnection Masterplan Study (AIMS) III Phase 1 & 2 Update

Source: ASEAN Centre for Energy (2023)

Figure. Interregional Transmission in Southeast Asia – High RE Target (2025)



Note: the transmission routes shown in the figure are representative lines connecting regions in Southeast Asia and are not exact routes.

Compared to ASEAN RE Target (2025):

- Overall interregional transmission capacity rises from **15,246 MW to 66,659 MW**, with the largest increases happening along the following corridors: *Thailand-Malaysia (Peninsula)* [+9,637 MW], *Malaysia (Peninsula)-Indonesia (Sumatra)* [+8,933 MW], and *Indonesia (Sumatra)-Singapore* [+7,756 MW].

Transmission Utilization:

- **Utilization at or above 90%**: N/A.
  - **Utilization at or above 80%**: *Laos-Cambodia* and *Indonesia (Java)-Indonesia (Kalimantan)*.

- **Utilization at or below 50%**: *Malaysia (Sabah)-Malaysia (Sarawak), Vietnam-Cambodia, Thailand-Cambodia, Malaysia (Sabah)-Indonesia (Kalimantan), Indonesia (Sumatra)-Singapore,* and *Indonesia (Java)-Indonesia (Sumatra)*.

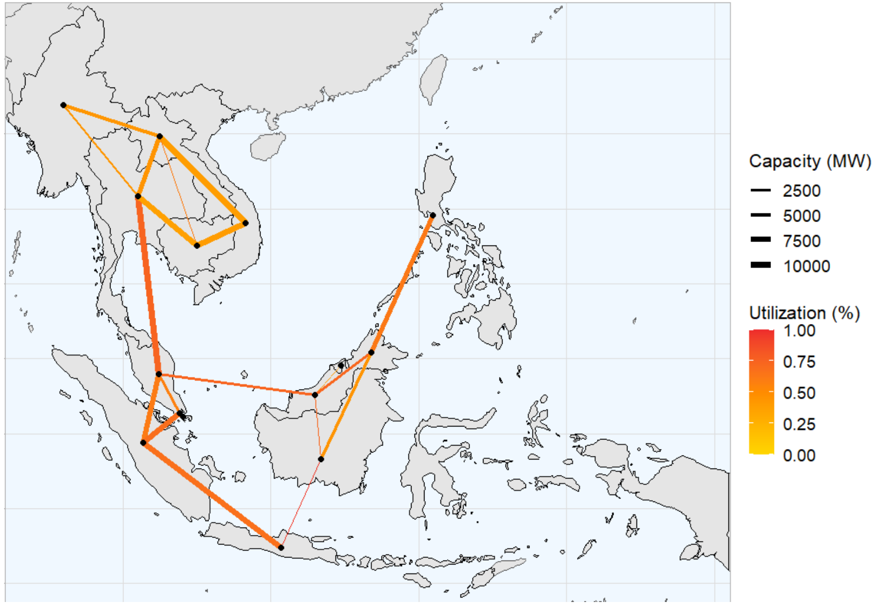
ASEAN Interconnections:
High RE Target (2040)

ASEAN Energy and Transmission Landscape

Data from the ASEAN Interconnection Masterplan Study (AIMS) III
Phase 1 & 2 Update

Source: ASEAN Centre for Energy (2023)

Figure. Interregional Transmission in Southeast Asia – High RE Target (2040)



Note: the transmission routes shown in the figure are representative lines connecting regions in Southeast Asia and are not exact routes.

Compared to High RE Target (2025):

- Overall interregional transmission capacity rises from **66,659 MW to 104,605 MW**, with the largest increases happening along the following corridors: *Laos-Vietnam* [+8,858 MW], *Philippines-Malaysia (Sabah)* [+5,447 MW], and *Laos-Myanmar* [+3,848 MW].

Transmission Utilization:

- **Utilization at or above 90%**: *Indonesia (Java)-Indonesia (Kalimantan)*.

- **Utilization at or below 50%**: *Malaysia (Sarawak)-Brunei, Thailand-Laos, Laos-Vietnam, Thailand-Myanmar, Vietnam-Cambodia, Thailand-Cambodia, Malaysia (Sabah)-Indonesia (Kalimantan),* and *Laos-Myanmar*.

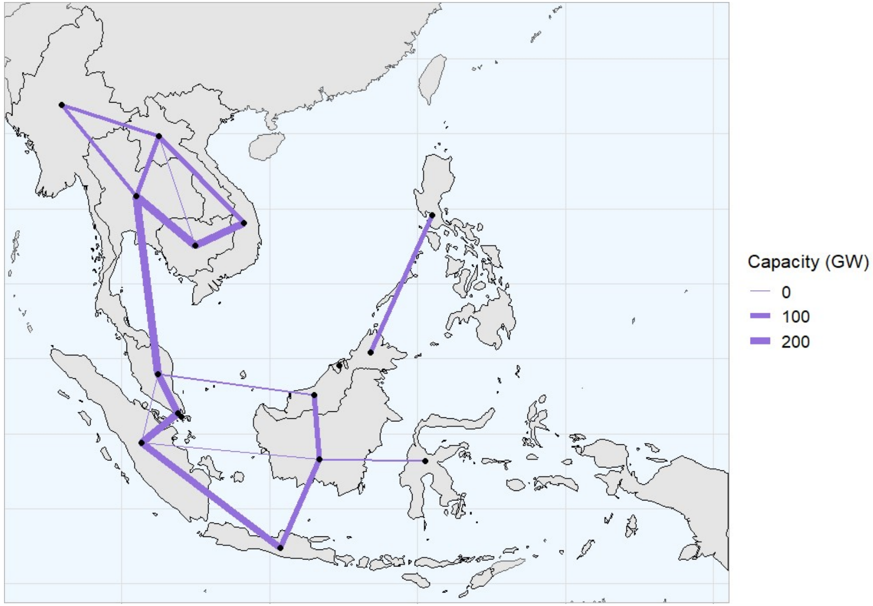
ASEAN Interconnections: DNV Study – Regional Cooperation (2050)

ASEAN Energy and Transmission Landscape

Data from the DNV ASEAN Interconnection Study

Source: DNV (2024)

Figure. Interregional Transmission in Southeast Asia – DNV Regional Cooperation (2050)



Note: the transmission routes shown in the figure are representative lines connecting regions in Southeast Asia and are not exact routes.

Compared to AIMS III Study:

- The DNV ASEAN Interconnection study focuses on a 2050 net-zero scenario for the region, including options for hydrogen to be used as a seasonal storage option (while the AIMS III study does not look at interconnector capacity required for full regional decarbonization).
- Overall interregional transmission capacity rises from **104,605 MW (AIMS III High RE Scenario in 2040) to 2,155,000 MW (DNV Regional Cooperation Scenario in 2050)**, an approximately 21-fold increase.
- The DNV study does not set limits on the amount of interconnection capacity that can be built along the AIMS III transmission corridors, and includes an additional corridor between Indonesia (Kalimantan) and Indonesia (Sulawesi).
- Vietnam, Cambodia, and Indonesia (Java) are key importers while Laos, Thailand, Malaysia, Indonesia (Sumatra), and Indonesia (Sulawesi) are key exporters of electricity.

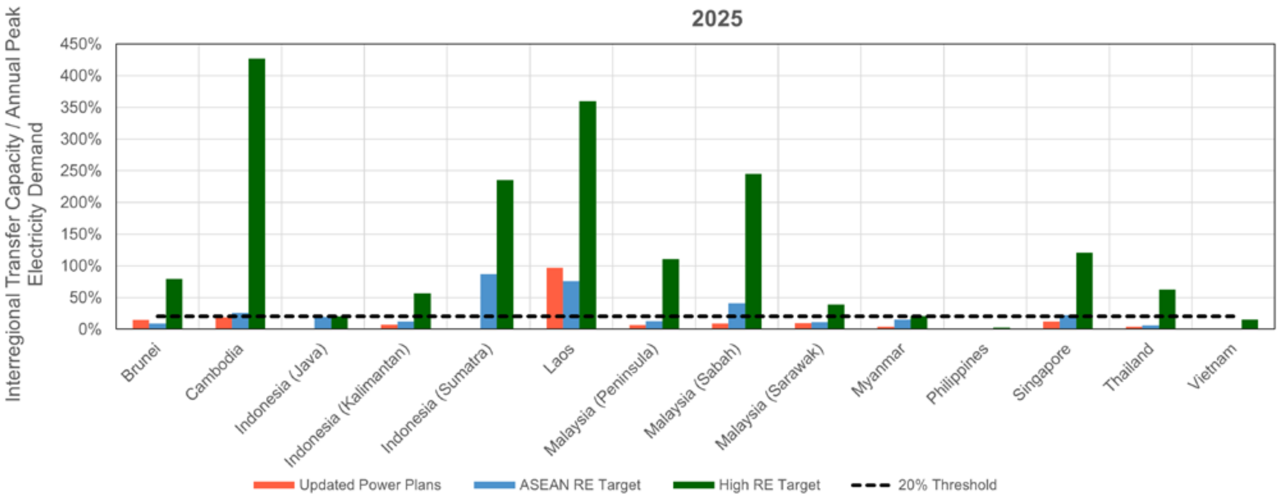
Interregional Transfer Capability vs. Peak Demand: 2025

ASEAN Energy and Transmission Landscape

Data from the ASEAN Interconnection Masterplan Study (AIMS) III Phase 1 & 2 Update

Source: ASEAN Centre for Energy (2023)

Figure. Interregional Transfer Capacity as a Percentage of Annual Peak Electricity Demand for ASEAN Countries in 2025 Across Different Future Scenarios



Increasing interregional transfer capacity as a percentage of annual peak electricity demand could help reduce the risks of supply shortfalls and thus bolster domestic and regional energy security.

Below 20% Threshold Across All Scenarios:

Philippines and Vietnam.

Below 20% Threshold in the "Updated Power Plans" and "ASEAN RE Target" Scenarios:

Brunei, Indonesia (Java), Indonesia (Kalimantan), Malaysia (Peninsula), Malaysia (Sarawak), Myanmar, Philippines, Thailand, and Vietnam.

Source: 20% threshold based on Deyoe et al. (2024)

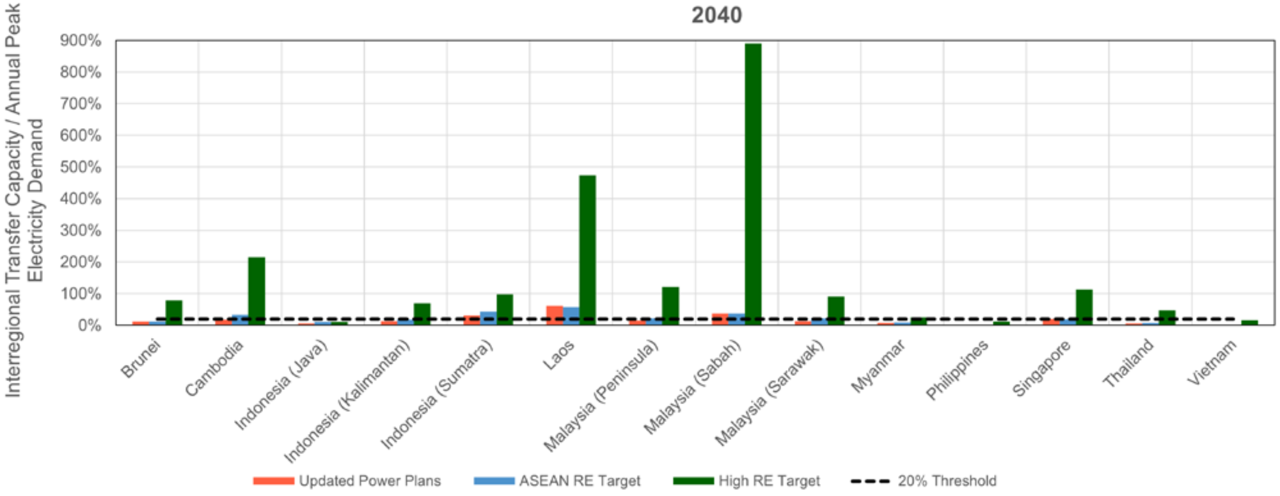
Interregional Transfer Capability vs. Peak Demand: 2040

ASEAN Energy and Transmission Landscape

Data from the ASEAN Interconnection Masterplan Study (AIMS) III Phase 1 & 2 Update

Source: ASEAN Centre for Energy (2023)

Figure. Interregional Transfer Capacity as a Percentage of Annual Peak Electricity Demand for ASEAN Countries in 2040 Across Different Future Scenarios



Increasing interregional transfer capacity as a percentage of annual peak electricity demand could help reduce the risks of supply shortfalls and thus bolster domestic and regional energy security.

Below 20% Threshold Across All Scenarios:

Indonesia (Java), Philippines, and Vietnam.

Below 20% Threshold in the "Updated Power Plans" and "ASEAN RE Target" Scenarios:

Brunei, Indonesia (Java), Indonesia (Kalimantan), Myanmar, Philippines, Singapore, Thailand, and Vietnam.

Source: 20% threshold based on Deyoe et al. (2024)

Laos-Thailand-Malaysia-Singapore (LTMS-PIP) Interconnection

"Pathfinder" project demonstrating the technical and economic feasibility of multilateral power trading in ASEAN using existing transmission infrastructure.

Source: IEA (2019)

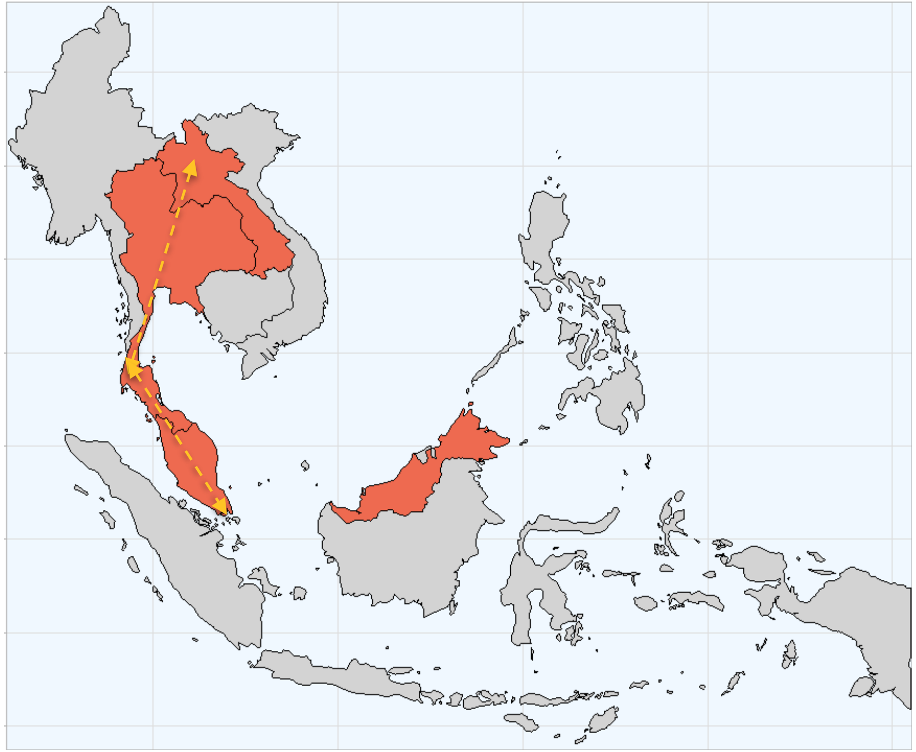
- **First phase (2022)**: Up to 100 MW of hydropower traded from Laos to Singapore via Thailand and Malaysia.
- **Second phase (2024)**: Multilateral and multidirectional cross-border power trade from Laos and Malaysia of up to 200 MW.

Source: EMA (2024)

The Brunei Darussalam, Indonesia, Malaysia, and the Philippines Power Integration Project (BIMP-PIP) was launched in 2023 and will require new infrastructure to interconnect the countries on Borneo with Palawan Island in the Philippines using onshore and offshore links.

Source: IEA (2024)

Figure. Illustrative Pathway of the LTMS-PIP Interconnection



Conclusion

- Key Takeaways
- Next Steps

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Key Takeaways:
Geographic Diversity of Resources and Demand

ASEAN has a geographic diversity of renewable energy resources that can be leveraged via interregional transmission:

- Strong solar resources throughout all regions, and strong wind and hydropower resources in the North subregion.

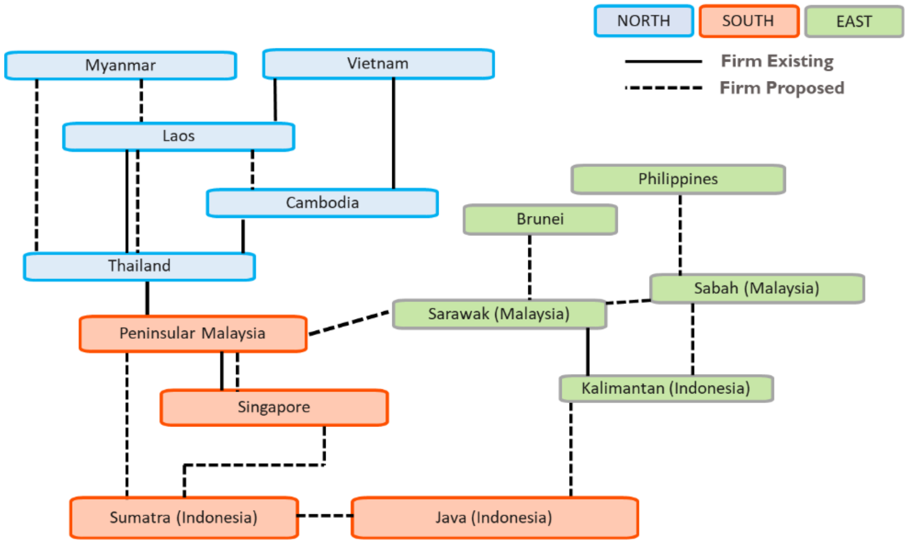
ASEAN countries will experience growing electricity demand, but at different rates:

- Combined anticipated electricity consumption in the South and East regions in 2030 is approximately equal to that of the North region.

There is an opportunity to transport renewable electricity from the North to the South and East regions:

- The only existing or proposed connection between the North region and the other two regions is between Thailand and Malaysia (Peninsula). This could create a bottleneck for electricity transport during extreme events.

Figure. ASEAN Subregions from AIMS III Study



Source: ASEAN and HAPUA (2021)

Key Takeaways:
Interregional Transmission Capacity

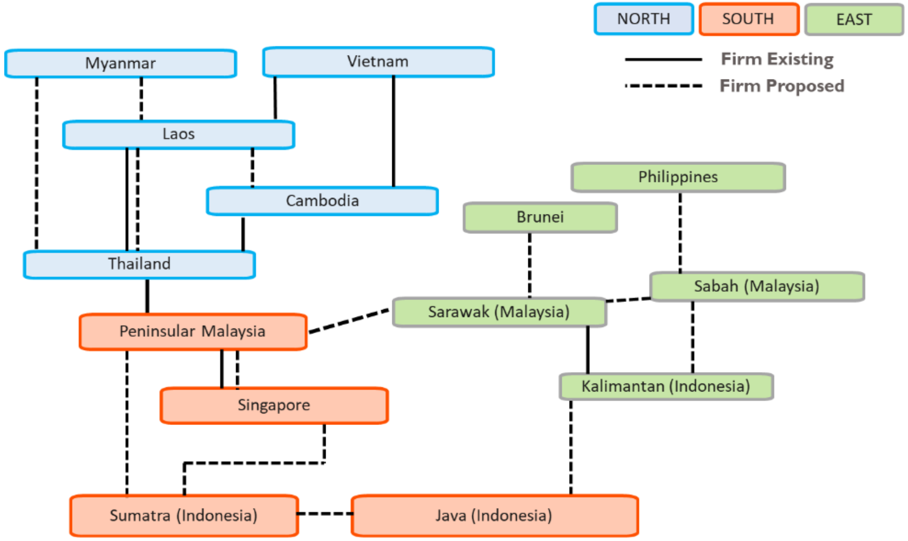
ASEAN interregional transmission capacity is expected to grow significantly through 2040 to meet renewable energy targets:

- 19 total corridors (12 new interregional connections proposed, not including additional subsea lines).

Several regions in ASEAN could have insufficient transfer capacity in 2040.

Several transmission corridors could have high utilization in 2040, which could lead to congestion.

Figure. ASEAN Subregions from the AIMS III Study



Source: ASEAN and HAPUA (2021)

Potential Next Steps

Coordination:
Coordinate subsea cable development plans to take advantage of shared investments and infrastructure costs.

Integration:
Integrate planned subsea cables between ASEAN countries into regional power system modeling to assess costs and benefits.

Implementation:
Implement country or regional standards such as a minimum interregional transfer requirement to ensure sufficient interconnections exist and can provide cost savings, emissions reductions, resilience, and energy security.

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Thank You

NREL/PR-7A40-91200

National Renewable Energy Laboratory (NREL)
Pacific Northwest National Laboratory (PNNL)

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