Power Grid Interconnections to Accelerate Asia's Energy Transition

Energy Transition in APAC and Japan's Role

Mr. Matthew Wittenstein

Chief of Section, Energy Connectivity, UN Economic and Social Commission for Asia and the Pacific

15 March 2024

ESCAP
Economic and Social Commission for Asia and the Pacific

About UN ESCAP

The United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP) is one of five UN regional hubs

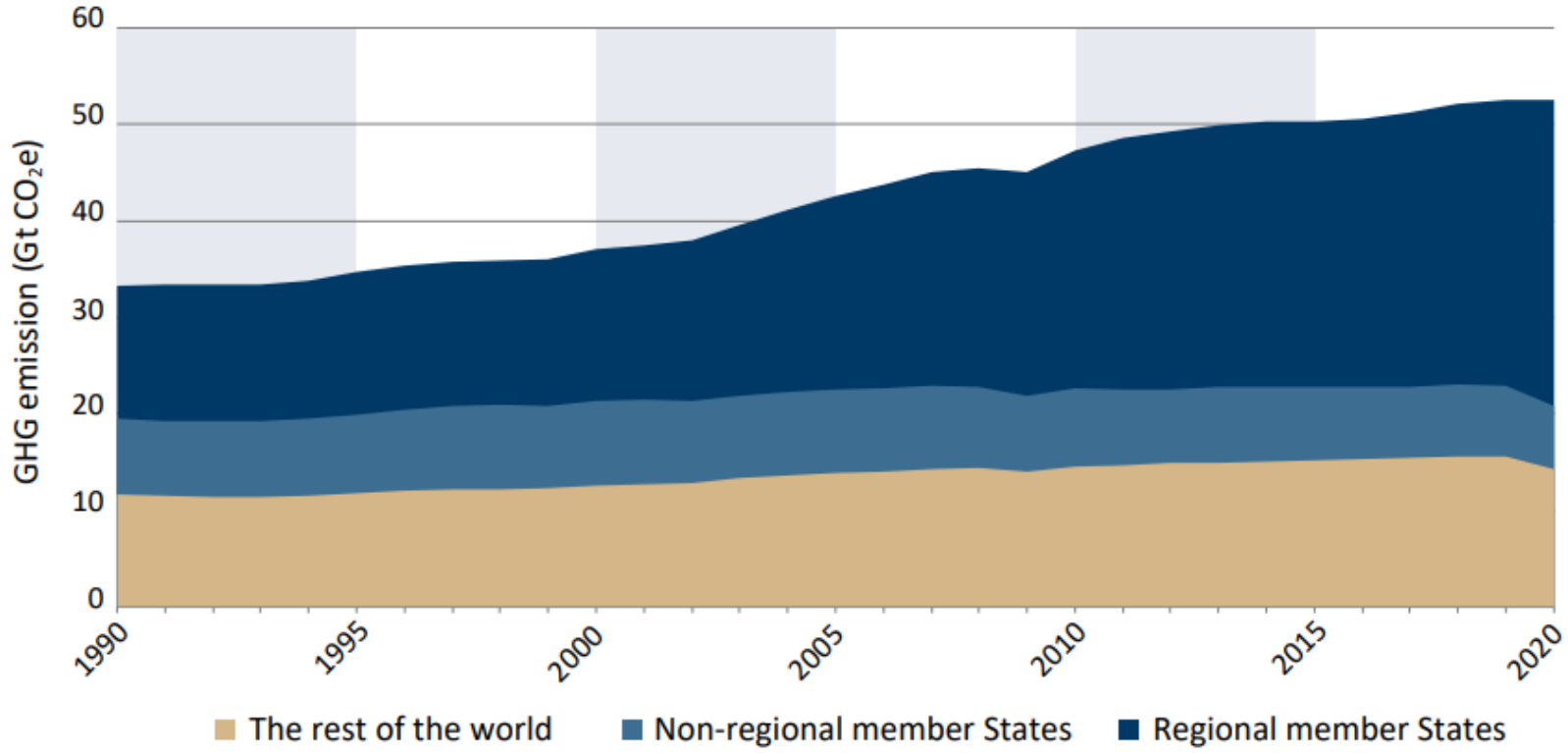
- 53 member States
- 9 associate members

Promotes inclusive and sustainable economic development in the Asia-Pacific region, and supports implementation of the 2030 Agenda for Sustainable Development.

Energy Division areas of work: (1) Achieving SDG 7; (2) Enabling energy connectivity; (3) Energy transition and the extractive industries

Asia-Pacific is a main driver of global GHG emissions

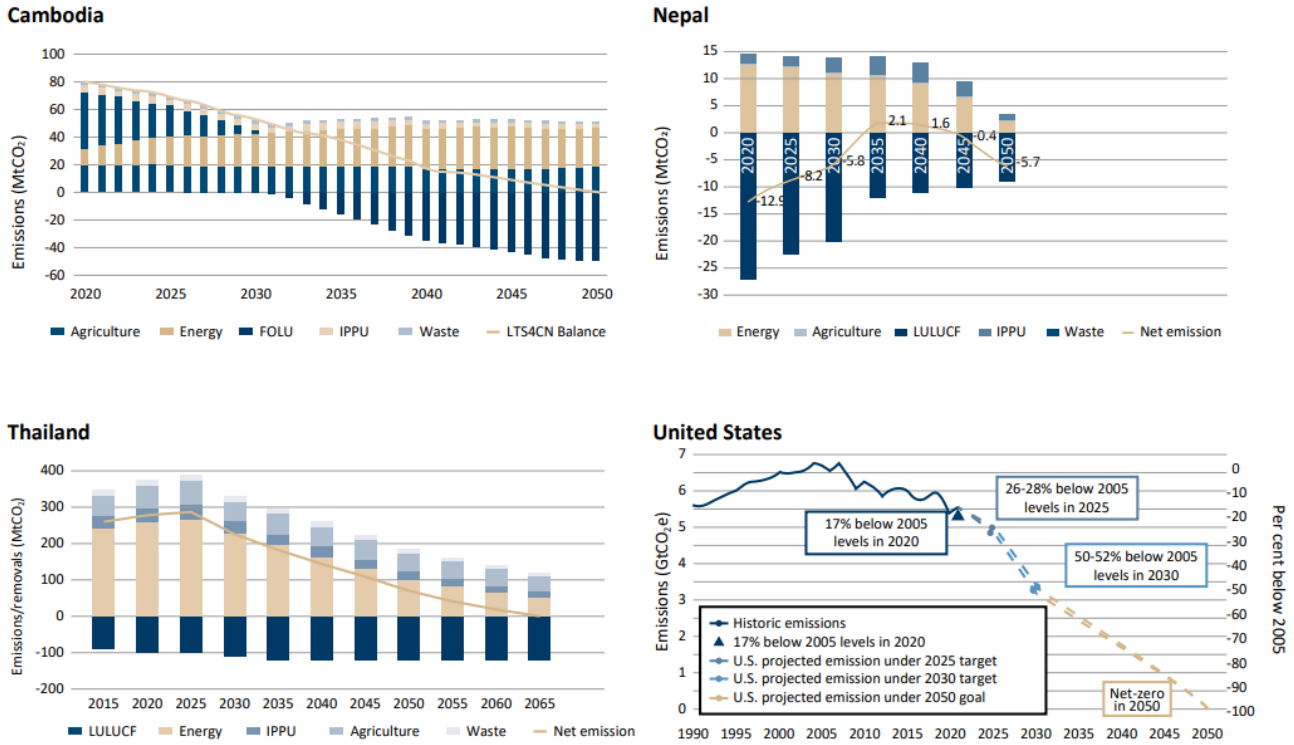
Greenhouse gas emissions trends in the Asia-Pacific region compared to the rest of the world, 1990–2020 (GtCO2e)



Sources: Intergovernmental Panel on Climate Change, AR6 Synthesis Report: Climate Change 2023 (2022). Available at www.ipcc ch/ report/sixth-assessment-report-cycle/; and European Commission, “Historical emissions data”, Emissions Database for Global Atmospheric Research. Available at https://zenodo.org/record/5566761#.ZABspXZBzIW.

Increasing number of net-zero and low-emission strategies

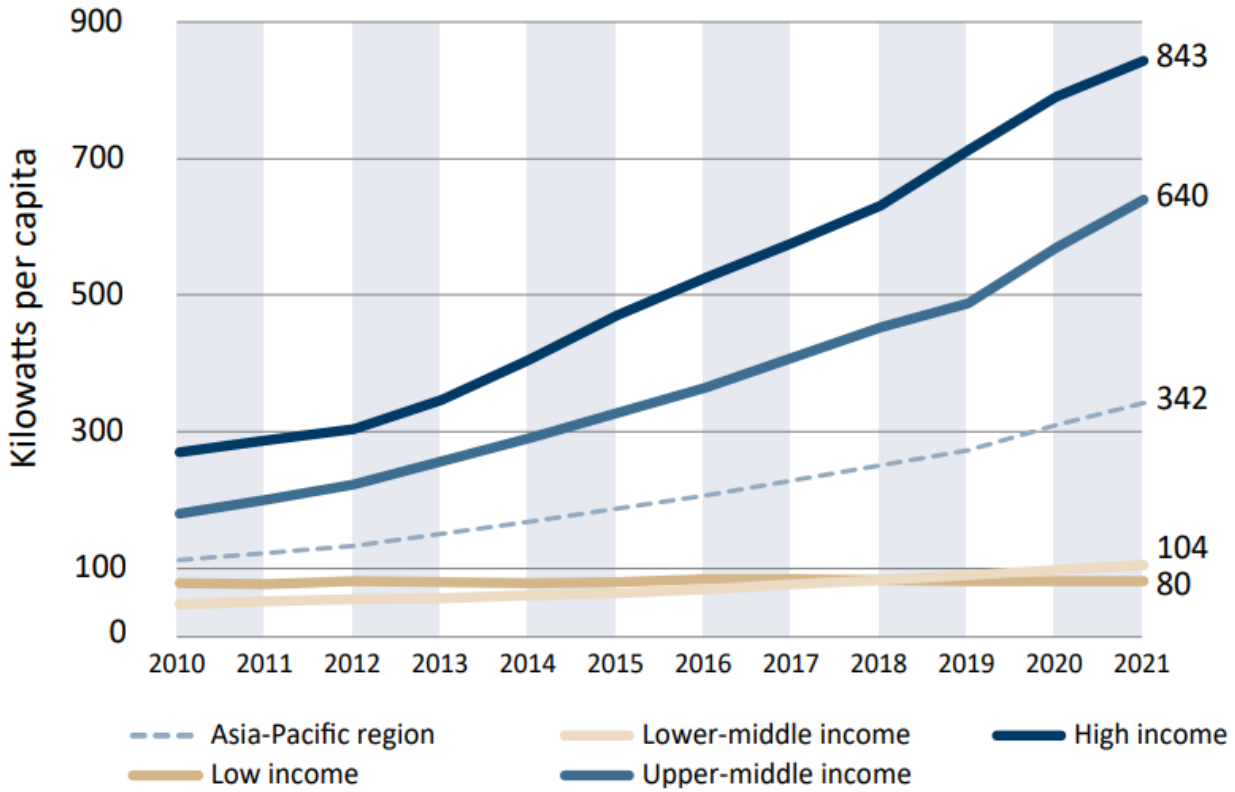
Long-term low-emission development strategies of selected Asia-Pacific countries



Source: United Nations Climate Change Long-term Strategies portal (see chap. 1, table 1.1). Notes: FOLU, forest and other land use; IPPU, industrial product and processes use; LTS4CN, long-term standing strategy for carbon neutrality; LULUCF, land use, land use change and forestry

Poorer countries are struggling to deploy RE

Renewable electricity capacity per capita, by Asia-Pacific income group

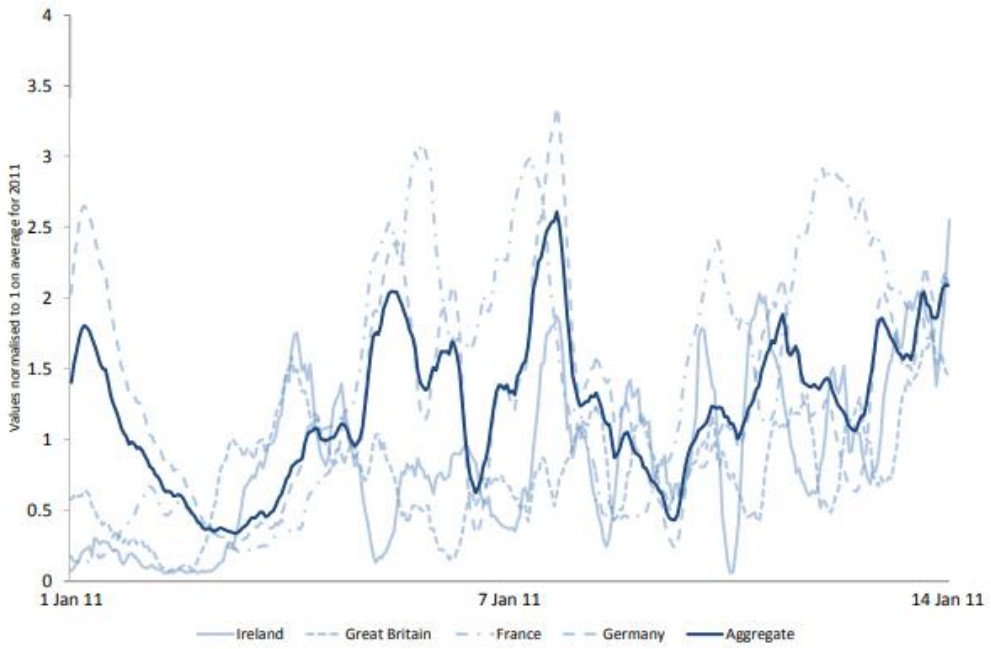


Source: ESCAP calculations based on data from International Renewable Energy Agency, Renewable Capacity Statistics 2022 (Abu Dhabi, 2022).

The need for larger, more integrated power systems

Power system connectivity is a tool that can **lower costs**, **improve energy security**, and **enable decarbonization**

Figure 11. Variability of wind output for four European countries, 1 January to 14 January 2011

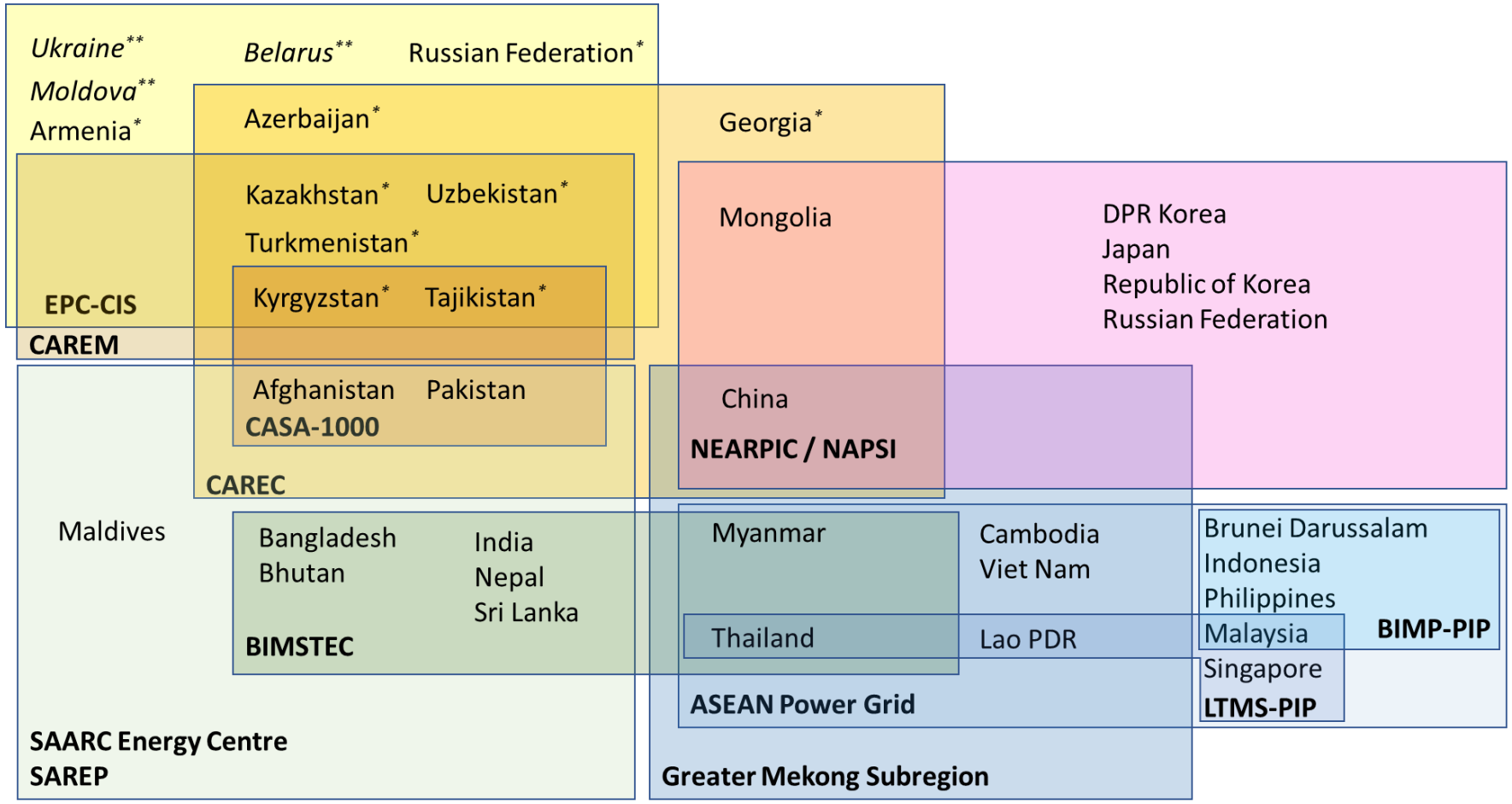


Source: Seamless Power Markets (IEA, 2014)

ESCAP's Regional Roadmap on Power System Connectivity

Planning	• Develop a regional master plan (Strategy 2) • Coordinate cross-border transmission planning (Strategy 6)
Financing and development	• Mobilize investment in cross-border infrastructure (Strategy 7)
Operations	• Move toward multilateral trading, competitive markets (Strategy 5) • Co-ordinate cross-border system operations (Strategy 6)
Cross-cutting	• Build trust and political consensus (Strategy 1) • Develop intergovernmental agreements (Strategy 3) • Coordinate, harmonize, and institutionalize policy and reg frameworks (Strategy 4) • Build capacity, share information, data, best practices (strategy 8) • Ensure coherence of connectivity with the SDGs (Strategy 9)

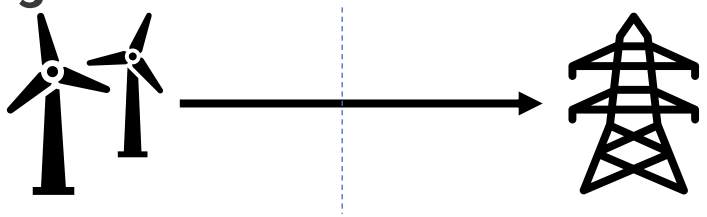
Multilateral connectivity initiatives in the region



* Member of UN ESCAP and UN ECE
** Member of UN ECE only

Models of cross-border integration

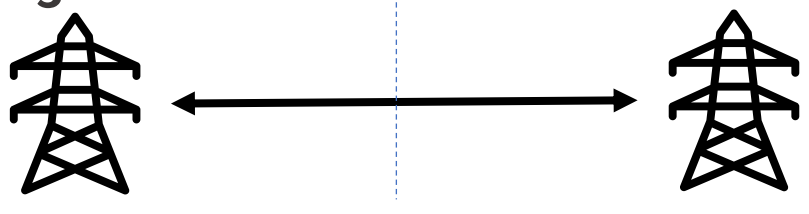
Point-to-grid:



- Allows for increased certainty of resource type and availability
- Enables integration of external resources into domestic system without considering conditions of host system
- Easier to measure costs and benefits (limited spillover effects)
- Limits potential for resources optimization at system level
- Limited potential for bidirectional and multilateral trade

- Example: Thai imports of hydropower from Lao PDR

Grid-to-grid:

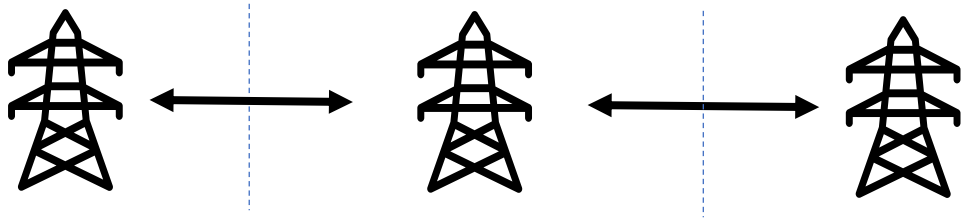


- Allows for flexible bidirectional and multilateral trade
- Allows for increased optimization at system level (helpful for security, RE integration)
- Harder to measure costs and benefits (increased spillover effects) – implications for cost sharing
- Requires increased data sharing
- Requires increased harmonization of grid codes, operational procedures
- Benefits from presence of regional institutions

- Example: Malaysia <-> Singapore; EU market coupling

Models of cross-border integration

Shared backbone

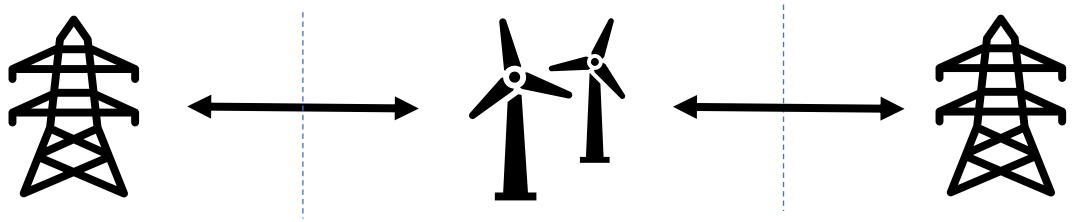


- Enables multilateral trading
- Enables increased regional optimization of resources while also allowing some resources to 'opt out'
- Potential for free-riding (avoiding investments in domestic grid by utilizing backbone grid)
- Easier to measure costs and benefits (limited spillover effects)

- Example: SIEPAC (Central America)

No operational backbone grids in Asia; some at various stages of consideration or development

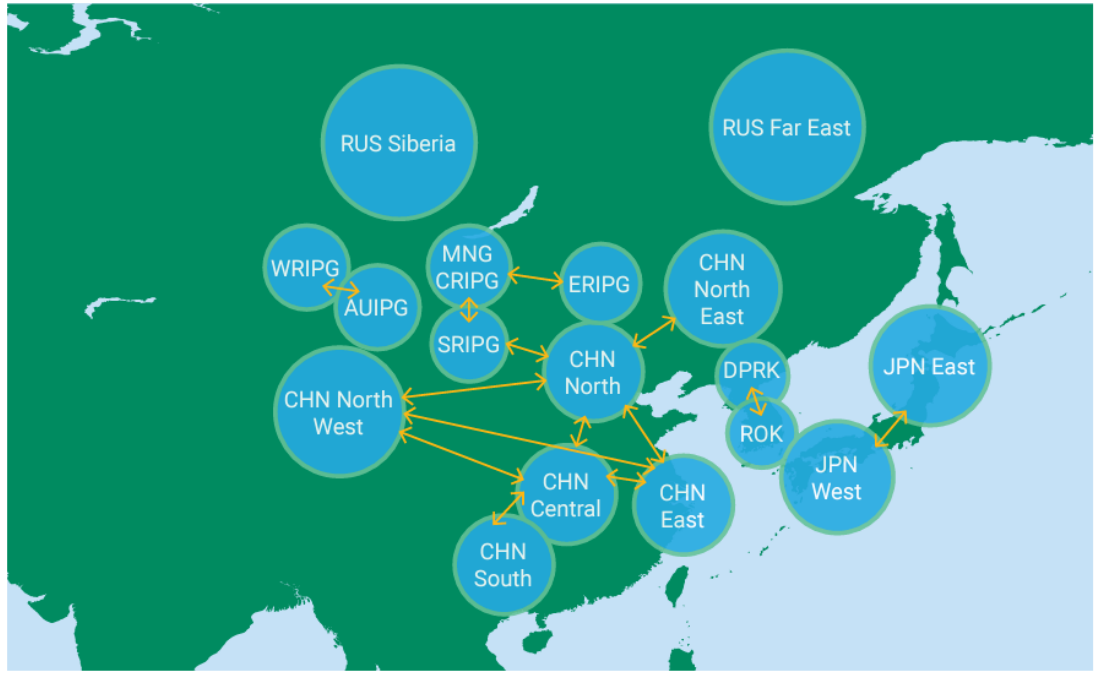
Hybrid:



- Combined interconnector and generation resource(s) (typically RE)
- Enables interconnection of remote resources among multiple countries / jurisdictions while also facilitating bidirectional trade
- Enables increased utilization of both grid and generation
- Currently being used for offshore wind resources in Europe
- Requires closely integrated system operations and clear cost sharing / recovery method

- Example: Belgium <-> Norway (feasibility study)

North-East Asia: Benefits of connectivity



⟷ Existing transmission connections (baseline connectivity)

MNG CRIPG Mongolia Central Region Integrated Power Grid; MNG WRIPG Mongolia Western Region Integrated Power Grid; MNG AUIPG Mongolia Altai-Uliastai Integrated Power Grid; MNG SRIPG Mongolia Southern Region Integrated Power Grid; MNG ERIPG Mongolia Eastern Region Integrated Power Grid; CHN North China North; CHN Northwest China Northwest; CHN Central China Central; CHN South China South; CHN East China East; CHN Northeast China Northeast; DPRK Democratic People's Republic of Korea; ROK Republic of Korea; JPN West Japan West; JPN East Japan East; RUS Siberia Russian Federation Siberia; RUS Far East Russian Federation Far East.
Source: SEI

North-East Asia has:

- Significant and diverse RE potential
- Growing demand
- Net-zero emission targets (China, Japan, Republic of Korea, Russian Federation

Limited level of interconnection, all bilateral between China, Mongolia, and Russian Federation

Numerous proposals for multilateral interconnection:

- Northeast Asia Power System Integration (NAPSI)
- Asian Super Grid
- North-East Asian Energy Interconnection (NEAEI)

Full report available at: https://www.unescap.org/kp/2023/green-power-corridor-north-east-asia-roadmap

North-East Asia: Benefits of connectivity – lower costs

Differences in electricity production costs by region and scenario

Source: SEI

Connectivity lowers system costs

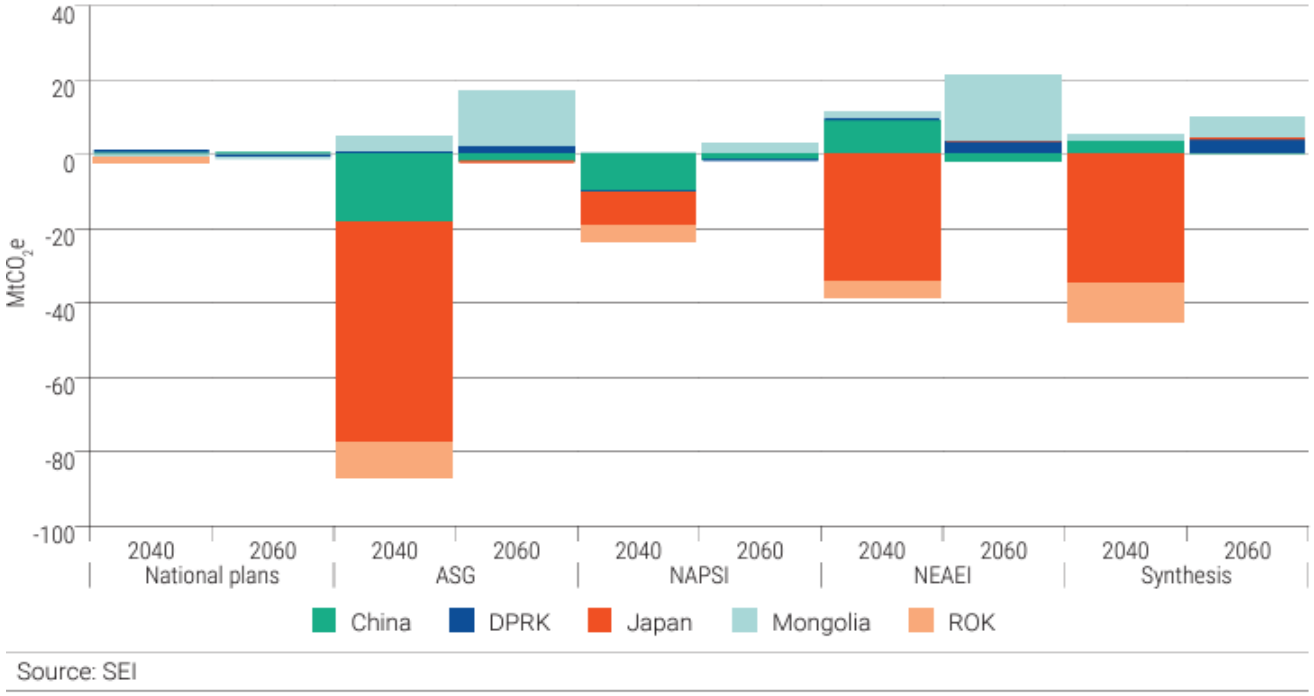
More interconnection reduces system costs by:

- Providing access to higher quality, lower cost RE resources
- Increasing utilization of resources / limits curtailment
  - Also has security benefits
- Allowing for mutual beneficial trading arrangements

Full report available at: https://www.unescap.org/kp/2023/green-power-corridor-north-east-asia-roadmap

North-East Asia: Benefits of connectivity – faster energy transition

Changes in in GHG emissions by scenario



Source: SEI

Integration <u>accelerates</u> energy transition

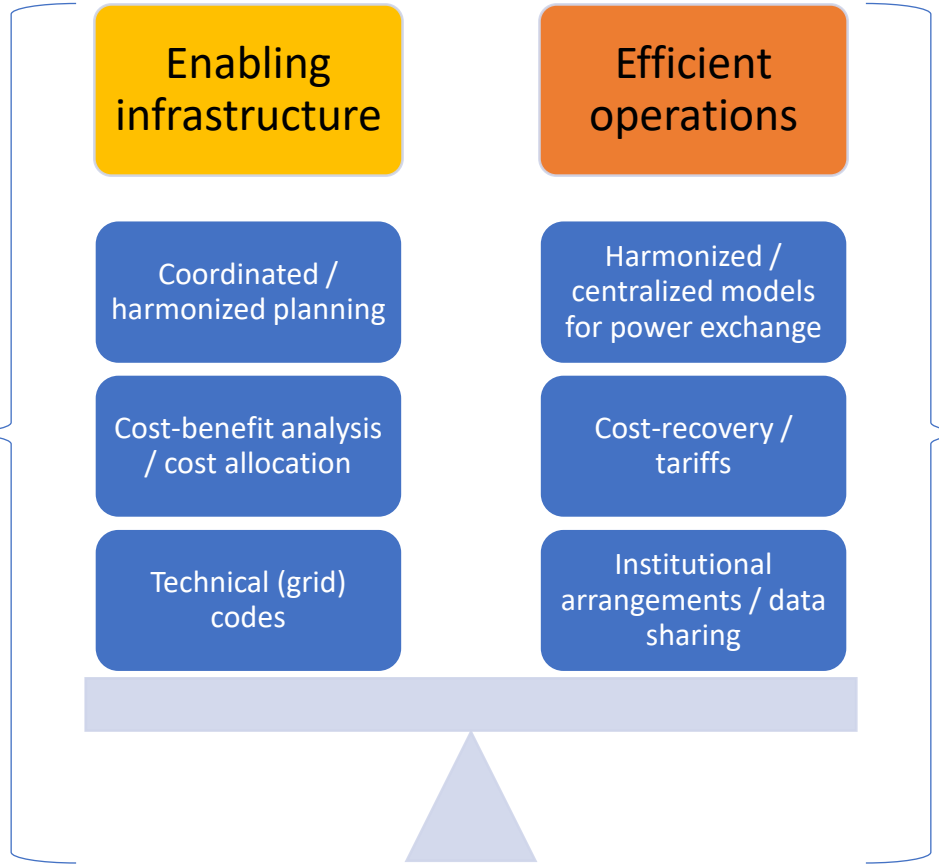
Investing in transmission helps to:

- Accelerate investment in RE – access to grid and demand enables increased investment
- Optimize the use of RE – reduces curtailment, allows for regional ‘resource smoothing’
- More rapidly reduce GHG emissions (more RE GW and GWh)

Full report available at: https://www.unescap.org/kp/2023/green-power-corridor-north-east-asia-roadmap

Accelerating progress on power system connectivity

Incentives aligned with long-term system needs
- Grids
- Generation

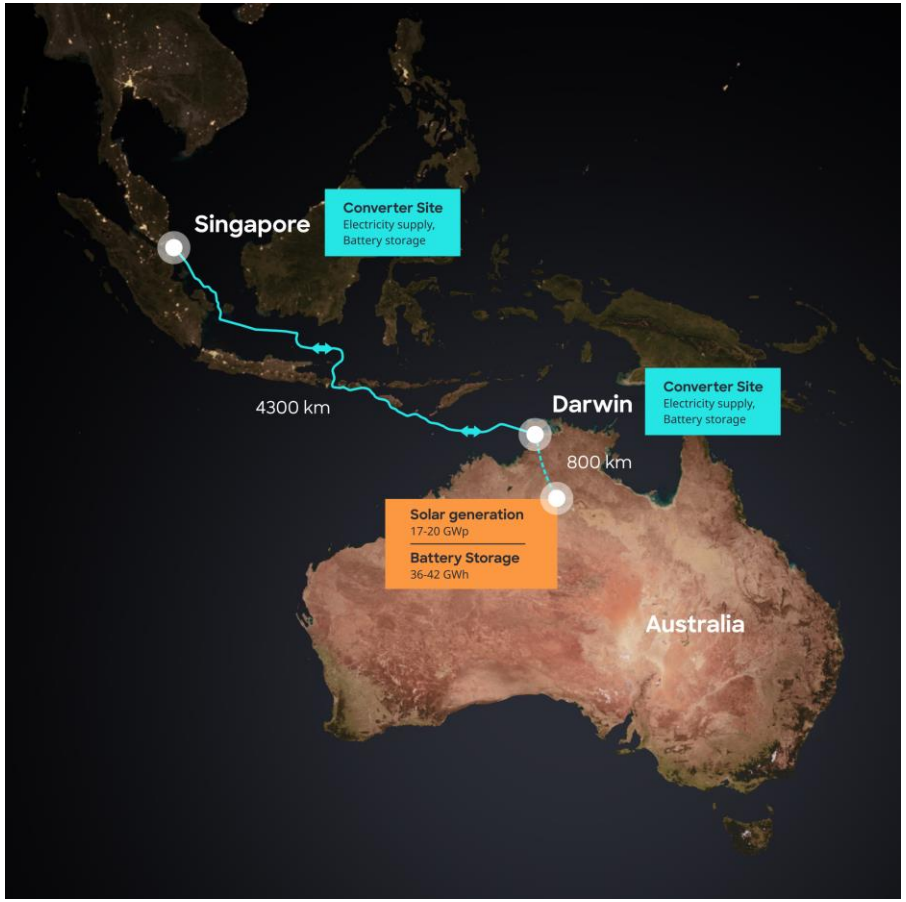


Incentives aligned with short-term system needs
- Security
- Flexibility

Political will and alignment with sustainable development (NDCs, RE targets)

Long-term needs: Innovation is leading to increased ambition

Australia-Asia Power Link (SunCable)



Singapore plans to import at least 4GW of low-carbon power (30% of total demand) by 2035:

- Open RFP process
- Must integrate into Singapore's wholesale market structure

Operational requirements drive technology choices:

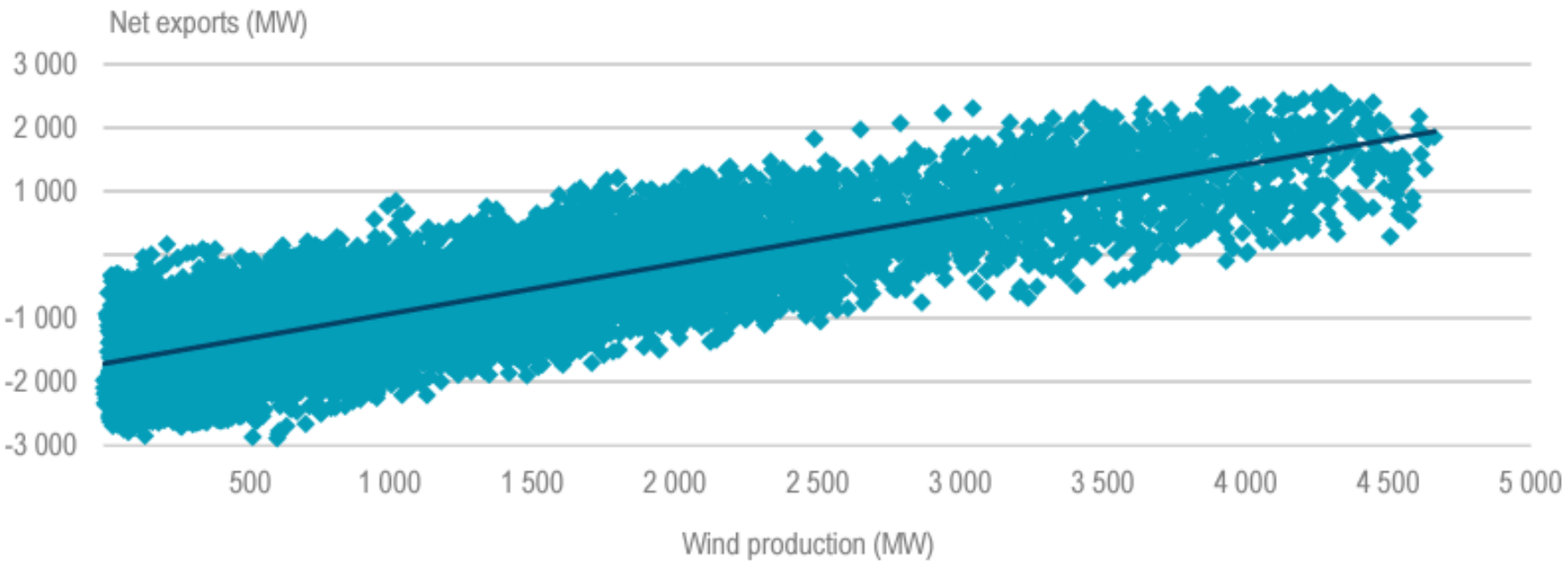
- Low-carbon requirement - maximum 0.15tCO2e/MWh within five years of commercial operations
- Must be able to provide system services (regulation and reserves)
- Should aim to be as reliable as domestic generation (90% availability)

SunCable's strategy:

- Leverage high-value solar resource and low-cost, low-impact land
- Develop RE at scale: 4GW for domestic use, 1.75 GW to Singapore
  - Pair with storage to ensure 24/7 delivery
- Take advantage of cost reductions in HVDC technologies
- Develop HDVC manufacturing facilities

Short-term needs: Flexible interconnection enables RE integration

Net exports vs wind production, Denmark

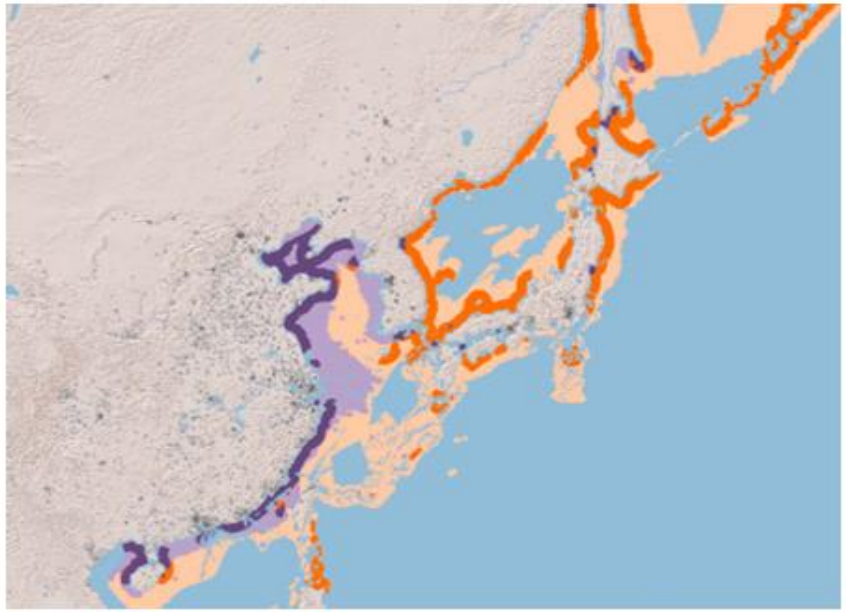


Grid-to-grid interconnection allows Denmark to integrate high shares RE economically and securely

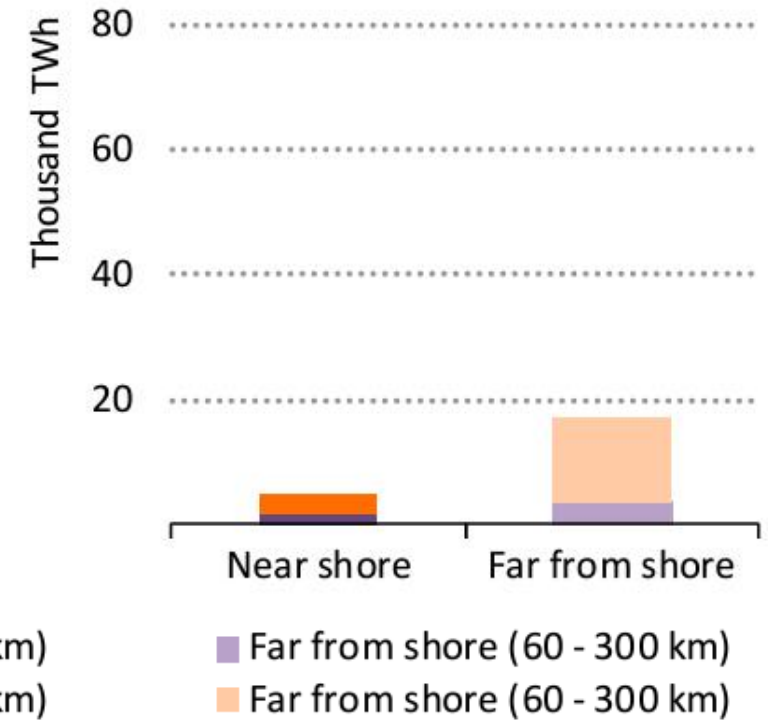
- Share of RE: 81% of generation
- Trade with neighbors driven by economic criteria
- Allows for increased resource diversity, flexibility
- High level of electricity security

Connectivity and off-shore wind

Technical potential for offshore wind, East Asia



Shallow water (10 - 60 m): Near shore (<60 km)
Deeper water (60 - 2 000 m): Near shore (<60 km)

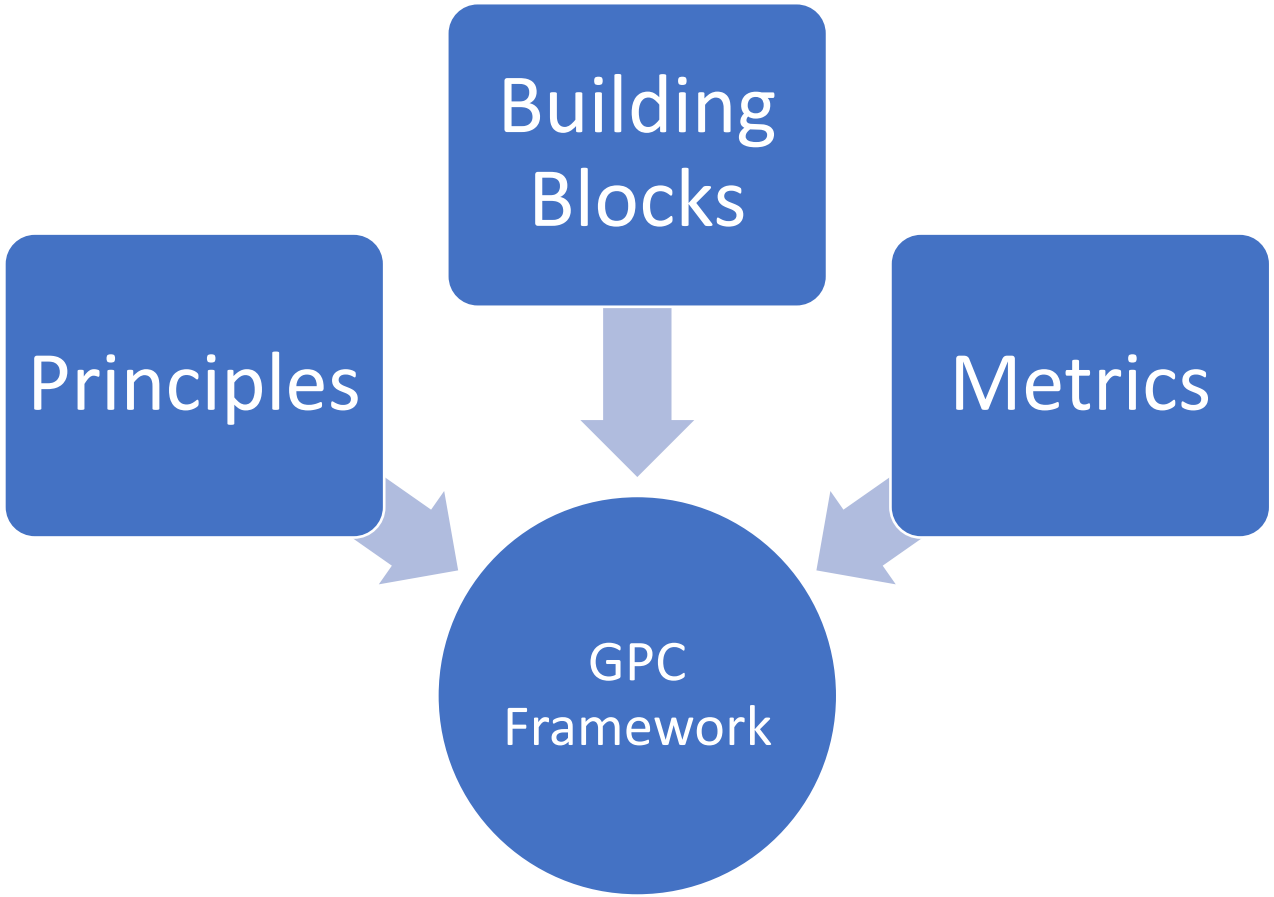


Source: IEA, Offshore Wind Outlook 2019

Japan has significant untapped offshore wind potential

- IEA estimates offshore wind could meet 900% of Japan's demand in 2040 (9,074 TWh)
- Could also be used to produce hydrogen (10 GW offshore wind = ~1 Mt green hydrogen)
- Challenges: Deep water, high development costs
- Opportunity: floating offshore, hybrid interconnections (pair with hydrogen production; joint development with Korea)

Sustainable power system connectivity: ESCAP's Green Power Corridor Framework



Connectivity can <u>enable</u> sustainable development, if utilized properly.

The GPC Framework aims to provide

- Practical and relevant **principles** to guide the development of connectivity initiatives
- **Building blocks** to structure and orient connectivity initiatives
- A set of **metrics** to enable the measurement of connectivity projects against relevant criteria (in development)

Some key takeaways

- Interconnection accelerates energy transition
  - Improves the economics of RE development
  - Enables RE integration through resource smoothing and increased flexibility
  - Helps to maintain high levels of security as RE share increases
- As RE shares grow, benefits of interconnection also increase
  - Requires deeper integration at technical and institutional levels
- Grid-to-grid integration combined with multilateral trading enables secure and efficient RE integration
  - Important to balance cross-border and domestic grid development
  - Hybrid interconnection models more complex to build and operate but have multiple benefits
- Alignment with sustainability must be considered at all stages of development

ESCAP

Economic and Social Commission
for Asia and the Pacific