Connecting Asia: One region, one grid

Research paper, October 2021

Regional grid integration is accelerating rapidly with initiatives such as the European Commission's 2030 framework for climate and energy (which includes a 15% electricity exchange target for 2030) and the One Sun One World One Grid (OSOWOG) initiative. However, the Asia Pacific, despite its rapid energy demand growth and need for renewable energy, is behind in grid integration. This research by Sun Cable highlights the opportunity of grid integration for the Asia Pacific region.

The Importance of grid interconnection technologies for future energy systems

An evolution in high voltage direct current (HVDC) now makes it feasible to connect energy grids over much longer distances in an economical manner. This evolution in HVDC includes improvements in voltage, reliability and operations (Exhibit 1).

EXHIBIT 1

The evolution in HVDC technology now makes it feasible to connect grids over much longer distances

Voltage improvements

HVDC system voltages have increased at **10.6%** **per annum** over the last 20 years

Reliability improvements

Fault rates have decreased by **80%** over last 20 years

Operational improvements

Depths of cable laying have increased to **3,000** **metres**

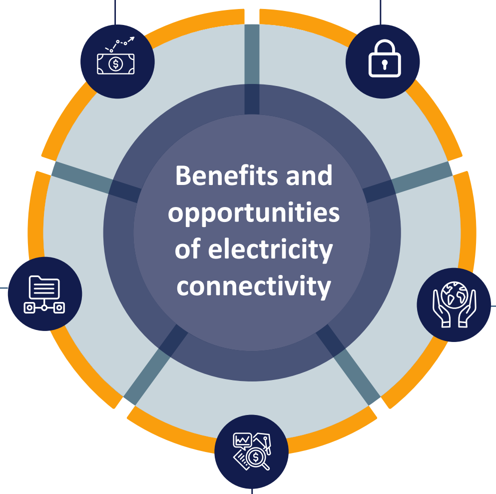
Grid interconnectors allow electricity to be transmitted between regional grids, improving economies of scale and helping to balance demand during peak periods. Interconnection is particularly important as the penetration of variable renewable energy increases. As highlighted in Exhibit 2, grid connectivity brings a range of benefits.

EXHIBIT 2

Regional grid integration can provide a host of benefits

Economic & Financial
- Revenue generation
- Optimising the use of regional resources
- Supporting an emerging international energy (electricity) market
- Enabling least cost dispatch

Security
- Reducing the import dependency
- Reducing the impact of resource constraints
- Reduce vulnerability to force majeure
- Reinforcing system stability



Technical & Operational
- Increasing load factor of power plants and networks
- Reducing the impact of plant downtime
- Sharing ancillary services
- Addressing shortages

Environmental
- Improving economies of scale for new renewable energy supplies
- Support development of renewable energy
- Optimising the energy mix
- Increasing the share of renewable energy

Social
- Price stabilization
- Addressing shortages and enhancing access
- Enhancing energy access

SOURCE: UNESCAP

Grid connectivity is particularly beneficial in Asia for several reasons:

- **Leveraging the region's diverse renewable energy assets**. The Asia Pacific has vast amounts of renewable energy potential. Take Southeast Asia for example. As a region, Southeast Asia has the potential to be the largest geothermal energy hub in the world, thanks to significant geothermal endowments in Indonesia and the Philippines. Indonesia alone has 29 GW in geothermal potential that it is currently developing[1]. Southeast Asia also has the potential to account for 16 percent of global estimated hydropower production capacity by 2050. Regional power integration can support renewable energy development by aggregating output over a large geographic region and deploying a mix of renewable technologies to help reduce the variability of renewable power supply and increase the resilience of the system.

- **Significant cost savings.** There are large potential cost savings from grid integration, particularly by reducing the required generating capacity. Research by the Economic Research Institute for ASEAN and East Asia (ERIA) has estimated that there could be net savings to the ASEAN power system of up to **US$9.1 billion** by 2035 through an integrated transmission system enabling the growth of

[1] ADB research: https://www.adb.org/news/features/developing-indonesia-s-geothermal-power-potential

renewables.[2] An integrated transmission system will lead to lower O&M costs due to reduced labour costs, material repair costs, and travel costs. Additionally, in the "no-grid" case, countries such as Singapore and Brunei with smaller transmission systems relative to the scale of the installed generation, require higher reserves. However, with the integrated power grid, lower supply reserve margins are required for the same 24-hour loss of load expectation, thereby reducing costs. Previous research work by the Asian Development Bank (ADB) investigated the economic costs and benefits arising from electricity interconnection and trade between the countries of South Asia and between South Asia and the Central Asian region bordering Afghanistan. This study evaluated six existing or planned transmission interconnections between India and Bhutan, Nepal, Sri Lanka, Bangladesh and Pakistan as well as between Pakistan and Afghanistan. The study demonstrated clear benefits, including lowering of electricity costs and required generating capacity, and create annual benefits of **US$3.9 to $4.1 billion**.[3]

- **Reducing carbon emissions and air pollution.** An integrated grid will facilitate the use of renewable sources of energy for electricity generation, thereby reducing emissions and pollution. The renewable electricity component of the total ASEAN electricity supply is forecast to be between 36 percent to 52 percent by 2040 under the ASEAN member states target scenario (ATS) and ASEAN progressive scenario (APS) respectively, in the fifth ASEAN Energy Outlook. Hydro power is anticipated to be the dominant source of renewable electricity followed by Solar PV. Per capita greenhouse gas emissions will increase by a factor of 1.5 and 1.2 under ATS and APS respectively, versus 1.9 under business as usual. This equates to 2,168 million tonnes of CO2e under APS versus 3,460 million tonnes of CO2e under business-as-usual in 2040. The difference in CO2e emissions between the business-as-usual and APS scenario is equal to the greenhouse gas emissions produced by almost 300 million vehicles annually.

- **Strengthening public finances.** Enhancing competitive renewable electricity generation can help reduce the need for expensive energy subsidies in Asia. The International Energy Agency (IEA) estimates that APAC countries spent at least US$78 billion on fossil fuel subsidies in 2019. US$61 billion was spent on oil products with the rest being spent on coal, electricity and gas. As more sectors of the economy electrify their energy demand (e.g., by transitioning ICE vehicles to Electric Vehicles) , the need for fossil fuel subsidies is likely to reduce thereby strengthening the fiscal position of these countries.

Grid connectivity in Asia is behind Europe

Grid integration in the Asia Pacific region currently is behind other regions of the world. For example, 70% of HVDC cable demand from 2022-25 is forecast to be in Europe (Exhibit 3).[4] In Europe, ~11.5% of electricity generated is traded among member states. In Asia this number is only ~0.3%. Many large economies such as Korea, Japan, Australia, do not have electricity import- export at all, and China imports only 0.1% of its total generation (Exhibit 4).

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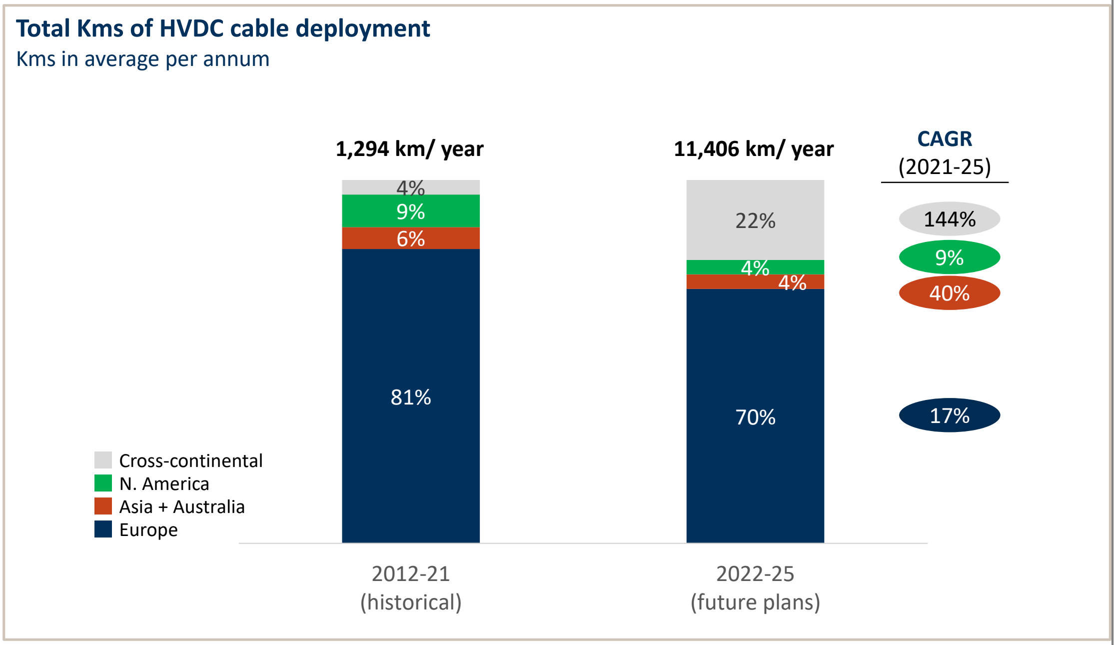
[2] Economic Research Institute for ASEAN and East Asia (2014), Investing In Power Grid Interconnection In East Asia. Available at: http://www.eria.org/RPR-FY2013-23.pdf

[3] Asian Development Bank (2015), *Cross-border power trading in South Asia: A techno economic rationale*. Available at: https://www.adb.org/sites/default/files/publication/173198/south-asia-wp-038.pdf

[4] Data from 4C Offshore Global Cable and Offshore Wind Projects Database, Global Data Upcoming Interconnections projects, Amplitude; Sun Cable analysis.

EXHIBIT 3

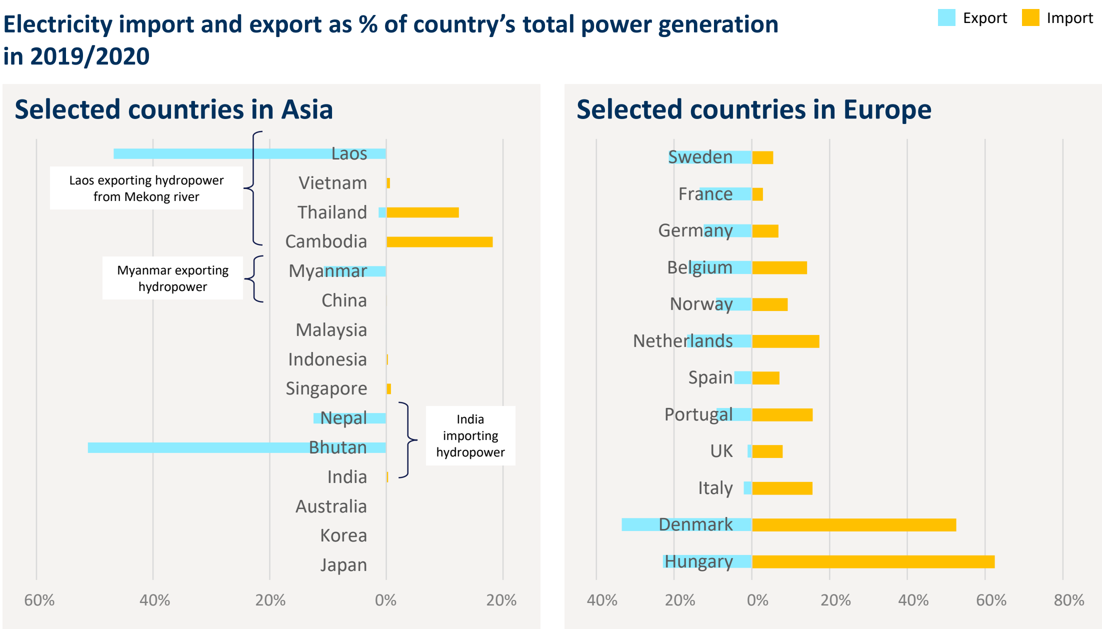
Europe is currently dominating HVDC demand



Note: Excluding overhead lines; Projects with Med/ High probability of executing; Annual demand "smoothed" based on manufacturing start date and target commission dates
SOURCE: Amplitude, 4C, Global Data

EXHIBIT 4

In Europe, ~11.5% of total generation is traded among member states; In Asia, this share is only ~0.3%



Average Imports: **0.3%**
Average Exports: **0.3%**

Average Imports: **12.0%**
Average Exports: **11.5%**

SOURCE: IEA OECD electricity statistics 2020, EnAppSys, Government websites

Moreover, export of electricity primarily takes place between neighbouring countries on a long-term bilateral basis. For example, India imports electricity from neighbouring Nepal and Bhutan, Laos exports almost half of its hydropower generated on the Mekong River to neighbouring countries – Thailand, Cambodia, Vietnam etc. Laos exported ~24TWh or $1.33B in 2019, making it the 9th largest exporter of electricity in the world (more than Russia or Netherlands with ~20TWh of export). However, even with this volume the grid development is slow in comparison - Laos currently supplies electricity mostly via a 115- 230kV transmission lines (500kV export lines only exist between Laos and Thailand)[5].

On the other hand, in Europe, interconnectors are supporting a much more robust electricity market enabling day- ahead/ intra- day trading, efficient price discovery, load- balancing and integration of intermittent supply from renewables. It took Europe more than 40 years to develop its system. In 1980, the amount of electricity import / export stood at ~100TWh, it has since quadrupled reaching >400TWh in 2019. However, due to the greater maturity of the HVDC manufacturing industry, it is possible to do this transformation 2x faster, achieving similar results to Europe within two decades (provided there is appropriate support).

The potential upside from grid connectivity in Asia is significant

As a thought experiment, we estimated the potential benefits to the Asia Pacific region if by **2040** we could match Europe's **2020 target** of cross-border electricity trade of 10% (which they have currently exceeded) and potentially achieve 15% (the **EU target in 2030**). This would achieve the following benefits:

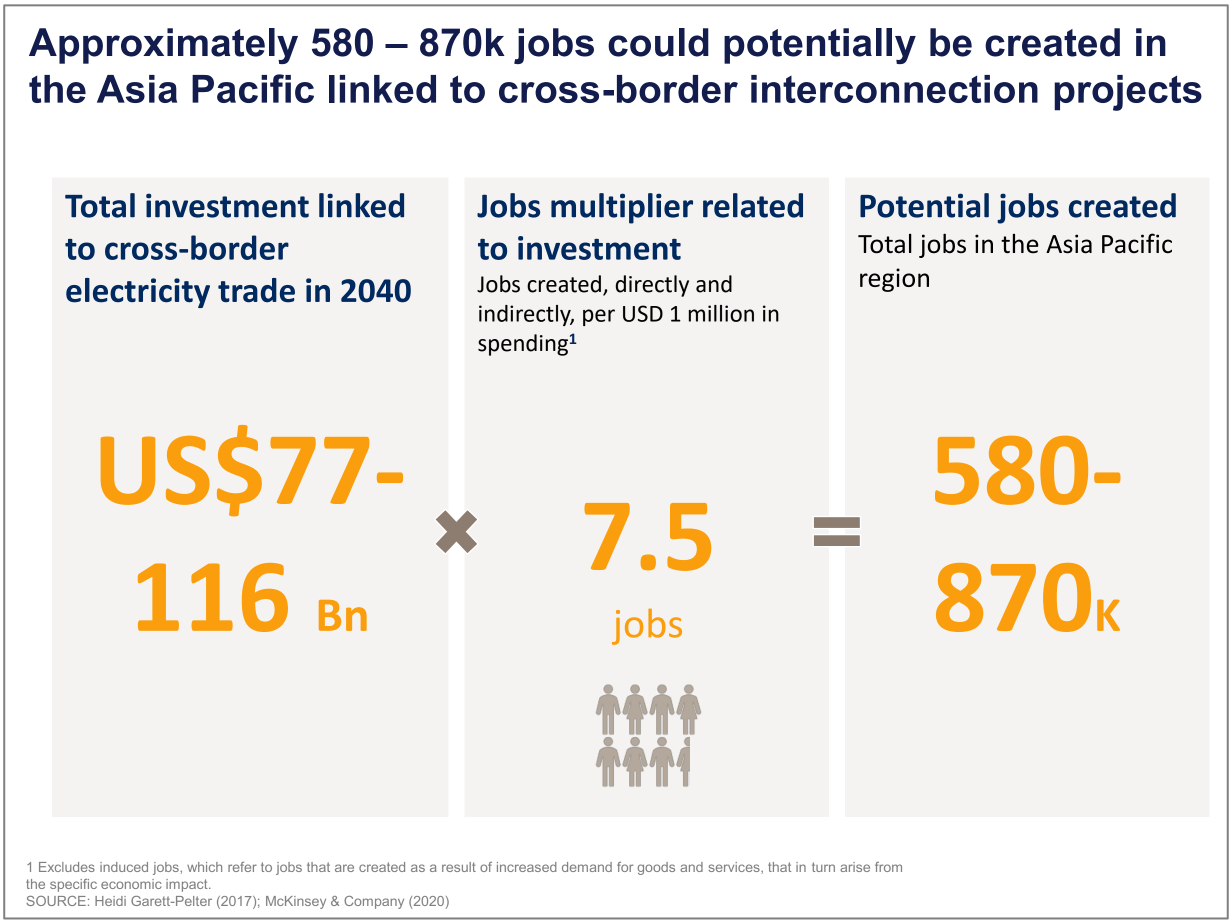
- **Large new electricity market.** Approximately 2,150 - 3,225 TWh of electricity in Asia Pacific[6]would be traded. Based on current retail electricity prices in each market, this is an annual market opportunity of US$329-493 billion. There are large economic multipliers from this. For example, the indirect (linked to supply chain inputs) and induced benefits (linked to demand it creates downstream, including from wages) could be **7.5x** this **number**.
- **Investment and jobs.** The investment associated with just the transmission component of this would be roughly US$77-116 Billion.[7] This is an underestimate of the capital investment as it ignores the renewable energy, battery investment, voltage source converter investment, etc. Based on a job's multiplier from renewable energy projects, this could create approximately 580,000 - 870,000 jobs. Applying the same multiplier of 7.5 for induced indirect and induced spending, this level of investment could trigger approximately US$580-870 billion in economic activity in Asia Pacific.

[5] The Study on Power Network System Master Plan in Lao People's Democratic Republic by Japan International Cooperation Agency, Henry Stimson Center.

[6] Refers to ASEAN, Japan, South Korea, Taiwan, India, Sri Lanka, Pakistan, Bangladesh, Nepal, Bhutan, China, Australia, and New Zealand.

[7] Assuming capex of ~ $30/MWH for HVDC and UHVDC lines.

EXHIBIT 5



- **Carbon savings.** Assuming this electricity could displace coal (which is 56% of generation in the Asia Pacific) and natural gas (12% of electricity supply), this could reduce roughly **2,050-3,070** MtCO2e[8] per annum, which is equivalent to ~**2-3x** the entire emissions of Japan (~1,150 MtCO2e in 2019).

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A connected Asia could help transform the energy systems in Asia, delivering jobs, new business opportunities, and major reductions in emissions. Making it a reality is our goal and we hope to work with likeminded organisations and governments to do just that.

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[8] Assuming an emissions intensity of 0.92 tCO2e/MWh for coal and 0.62 tCO2e/MWh for natural gas.