

APAC's Energy Transition Constraint Is No Longer Generation. It Is the Wires.

Why grid infrastructure is becoming the defining capital-allocation and bankability risk of the next decade.

Across the Asia-Pacific, renewable generation can now be financed, procured, and built faster than electricity networks can absorb, dispatch, and transport its output. The binding constraint on the next phase of the energy transition has migrated from the generation to the transmission systems, and more precisely, from engineering to institutions.

The constraint has moved from generation to the wires

For most of the past decade, the Asia-Pacific energy conversation has been a conversation about generation. Governments announced gigawatt-scale renewable targets, investors competed to deploy capital, developers assembled pipelines and renewable energy deployment records tumbled. The cost of renewable energy technology continued to fall to the point where, across most major markets in the region, new wind and solar has become the cheapest available source of commercial scale electricity. The uncomfortable consequence and the reality that the renewable energy industry faces is that a binding constraint on the energy transition has not disappeared. It has moved.

The constraint now sits in the transmission systems and grid networks. Renewable generation across the Asia-Pacific region is increasingly being commissioned faster than transmission systems can absorb, dispatch, and transport it, and the symptoms are no longer marginal. Connection queues can be measured in years, curtailment measured in tens of percent, deferred commercial operations, and in some cases risks of stranded investment assets.

The International Energy Agency (IEA) has been blunt about the diagnosis, describing insufficient grid capacity as a critical bottleneck to connecting new generation, storage and demand.¹ By 2025, more than 2,500 GW of renewable, storage and large-load projects were stalled in grid-connection queues worldwide,² including at least 1,700 GW of advanced-stage renewable projects, more than 600 GW of battery-storage projects and at least 150 GW of advanced-stage data-centre projects.³ Investment in electricity generation has increased by almost 70% since 2015 to approximately USD 1 trillion annually, while investment in electricity grids has risen at less than half that pace, reaching only around USD 400 billion per year.⁴ The IEA estimates that meeting forecast electricity demand through 2030 will require annual grid investment to increase by a further 50% from that level, alongside a substantial scale-up of grid-equipment supply chains and workforce capacity.⁵ The resulting imbalance is contributing to network congestion, delays in connecting new generation and demand, rising electricity prices, increasing renewable energy curtailment and more frequent instances of negative wholesale electricity pricing.⁶

This commentary advances a deliberately narrower and more demanding proposition than the familiar observation that transmission “matters”. The timing mismatch is substantial: the IEA estimates that planning, permitting and completing new grid infrastructure can take five to fifteen years, compared with approximately one to five years for new wind and solar facilities, one to three years for data centres and one to two years for EV-charging infrastructure.⁷ Sophisticated industry participants already accept this reality.

The proposition is this: the Asia-Pacific energy transition is now constrained less by generation technology, capital availability, developer competition, workforce capacity and resource quality than by the capacity of institutions, utilities, and regulatory frameworks to deliver network infrastructure at a pace consistent with renewable energy deployment ambition.

¹ International Energy Agency. (2026). ‘*Electricity 2026: Analysis and forecast to 2030.*’ IEA. p. 46.
https://iea.blob.core.windows.net/assets/b73798cb-e452-42b9-9d8a-07542de7a041/Electricity_2026.pdf

² International Energy Agency. (2026). p. 46.

³ International Energy Agency. (2026). p. 49.

⁴ International Energy Agency. (2025). ‘*World Energy Outlook*’. IEA, Paris. p19.
<https://iea.blob.core.windows.net/assets/9753df19-0a71-422a-b725-012c555763b3/WorldEnergyOutlook2025.pdf>

⁵ International Energy Agency. (2026). p. 46.

⁶ International Energy Agency. (2025). p19.

⁷ International Energy Agency. (2026). p. 46.

The scale of the coming system requirement reinforces this diagnosis. The IEA forecasts Asia-Pacific electricity demand to grow by an average of approximately 4.7% annually between 2026 and 2030, with the region accounting for 56% of global electricity use by 2030, up from 53% in 2025. Solar PV and wind are expected to meet approximately 86% of the region's additional electricity demand over the forecast period.⁸ The resulting task is therefore not simply to connect more generation, but to operate a substantially larger and more variable electricity system.

The deficit is real, but it is downstream of a governance problem. It determines where the risk sits, who carries it, and how it is priced.

THE EMERGING DEFICIT

A structural deficit, unevenly distributed

The transmission challenge is no longer solely one of moving electrons from generation to demand centres. It is increasingly a system-stability challenge.

As synchronous generation increasingly retires and inverter-based renewable energy generation increases, electricity systems are operating with lower short-circuit strength, higher non-synchronous penetration and greater sensitivity to control interactions⁹. Conventional grid-following inverters, which depend upon a stable voltage reference, become progressively less effective in weak grid environments. The implication is profound. Future transmission systems will require not merely additional capacity but a fundamentally different operating architecture in which grid-forming technologies provide synthetic inertia, fast frequency response, dynamic voltage support and black-start capability that were historically inherent characteristics of thermal generation¹⁰.

Grid access is therefore evolving from a physical infrastructure question into a system capability question, with direct implications for project bankability, grid-code compliance and long-term market participation.

The energy transition therefore requires not merely more grid, but in part a different grid.

GRID OPTIMISATION

The answer is not solely more wires

New transmission remains indispensable, but the IEA's 2026 analysis demonstrates that the near-term response cannot depend solely upon constructing additional corridors. Existing grids are generally designed around peak conditions and may retain considerable unused capacity at other times. The IEA estimates that regulatory reform and grid-enhancing technologies could collectively enable approximately 1,200–1,600 GW of advanced-stage projects currently stalled in connection queues worldwide.¹¹ Conditional or non-firm connection arrangements could account for approximately 750–900 GW of that capacity, while technologies and upgrades including dynamic line rating, advanced power-flow control, reconductoring and voltage uprating could unlock a further 450–700 GW.

⁸ International Energy Agency. (2026). p. 129.

⁹ AFRY. (2026). 'The next wave of power: Grid-forming solutions—Future-proof grid operations with proven grid forming strategies: How TSOs and DSOs can secure stability and unlock new value.' AFRY

¹⁰ AFRY. (2026).

¹¹ International Energy Agency. (2026). pp. 46–47.

The implication is consistent with this commentary's central proposition. The limiting factor is not whether the technologies exist, but whether regulatory frameworks, system operators and utilities are capable of procuring, approving and deploying them at scale.

THE CONVERSION PROBLEM

Southeast Asia does not lack capital. It lacks conversion.

One of the clearest contemporary framings of the deficit comes from the seventh edition of the Bain & Company and Standard Chartered green economy analysis. Of approximately USD 540 billion of green capital expenditure announced across Southeast Asia's power, grid, and electric-vehicle value chains through 2030, only around USD 315 billion sits on what the authors regard as a credible path to deployment under present conditions, which is a realisation gap of approximately 42%, or roughly USD 225 billion at risk of delay, cancellation, or non-materialisation.¹²

Bain & Company's conclusion is the one that should concentrate the mind of every lender and sponsor in the region, that this is a conversion problem, not a capital shortage. The point is reinforced by the cancellation data. Between 2021 and 2025, an estimated 50 to 60% of renewable projects in Vietnam, Thailand, and Indonesia were cancelled, attributed to system constraints consisting of unclear power purchase (PPA) structures, permitting, and grid connection.¹³

The conclusion is unambiguous. The green economy has a conversion problem, not a capital shortage, and Southeast Asia has 24 to 36 months to close the gap before an additional USD 80 billion in green capital expenditure is reallocated elsewhere.¹⁴

The conversion challenge will intensify against rapidly rising system demand. The IEA forecasts Southeast Asian electricity consumption to grow by approximately 5.3% annually from 2026 to 2030. Indonesia is expected to contribute 38% of the region's additional demand and Viet Nam 26%, while regional wind and solar generation grow at approximately 26% and 19% annually respectively, lifting their combined share of the electricity mix from around 4.5% in 2025 to about 9% by 2030.¹⁵ The region must therefore build network and flexibility capability not merely to absorb an existing renewable pipeline, but to serve a rapidly expanding electricity system.

Announced does not mean built, approved does not mean connected, committed does not mean deployed. Generation disconnected from network capacity is, in economic terms, infrastructure without a customer, and the time required to deliver the transmission and grid infrastructure is unforgiving.

The author's view and direct experience: the regional transition has passed the point at which generation ambition and capability is the relevant scarcity. The relevant scarcity is delivery capability, the institutional capacity to convert announced capital into connected and dispatchable megawatts. Capital now flows decisively to the markets and segments where commercial demand, policy, and grid readiness align, and stalls where they do not.

¹² Bain & Company & Standard Chartered. (2026). 'Southeast Asia's green economy report 2026: The new calculus' (7th ed.). Published 18 May 2026. <https://www.bain.com/about/media-center/press-releases/sea/southeast-asias-green-economy-2026>.

¹³ Bain & Company & Standard Chartered. (2026).

¹⁴ Bain & Company & Standard Chartered. (2026).

¹⁵ International Energy Agency. (2026). p. 143.

Transmission constraint status across five APAC markets

The constraint is regional, but it does not present identically.

The table on the following page maps its character across five markets, distinguishing developed systems with mature regulatory and cost recovery frameworks from frontier and emerging market systems.¹⁶

Market	Severity	Ambition / Installed Context	Binding Bottleneck
Australia	SEVERE	~6,000–10,000 km of new/upgraded transmission required depending upon ISP timing / scenarios; VRE expansion modelled at multi-fold scale	Connection queue complexity, long transmission lead times, multi-jurisdictional approvals and social licence
Vietnam	CRITICAL	Revised PDP8 targets total installed capacity of ~183–236 GW by 2030, with major solar and onshore/nearshore wind expansion	Grid congestion, curtailment risk, EVN under-investment/payment stress and slow offshore wind delivery
Indonesia	SEVERE	~71 GW new capacity under RUPTL 2025–34, ~70% renewable, with ~48,000 circuit-km of transmission planned	Archipelagic grids, resource / demand mismatch and delivery-rate gap
Mongolia	CRITICAL	Auction-based renewable IPP projects being advanced with five recent solar / BESS auctions achieving tariffs as low as 4.85c/kWh, with multilateral lender support for upcoming 100MW wind auction	Central Energy System dominance; aged transmission lines and grid.
South Korea	SEVERE	Backbone-grid expansion to 25,587 c-km by 2038 (~1.72× vs 2023)	Compulsory curtailment; renewable zones distant from industrial demand; grid facility shortage

Figure 1. Renewable-energy transmission constraint status across Asia-Pacific, 2025–26.

Source: The author's analysis; market data and footnotes.

¹⁶ Severity ratings are based on the Author's assessments. CRITICAL = constraint actively preventing commissioned generation from operating at full capacity; SEVERE = constraint materially limiting new development or causing significant curtailment; HIGH = constraint is a primary, manageable development risk. Market-specific data are footnoted in the body sections that follow.

Australia — the most advanced planning framework still confronts the same constraint

Based on the data and the author's project experience in Australia and throughout Asia-Pacific, Australia is instructive precisely because its electricity planning framework is among the most sophisticated and transparent in the Asia-Pacific region.

Through the Australian Energy Market Operator's (AEMO) Integrated System Plan (ISP), Australia has arguably developed one of the world's most detailed long-term electricity transition roadmaps, integrating generation, storage, transmission, reliability and emissions reduction objectives into a single coordinated planning framework.

The 2024 ISP identifies transmission as a foundational requirement of the energy transition rather than a supporting consideration. Under the ISP's Optimal Development Path (ODP), approximately up to 10,000 kilometres of new and upgraded high-voltage transmission infrastructure is identified across the National Electricity Market (NEM) by 2050 to connect geographically dispersed renewable energy resources to major demand centres and replace the essential system services historically provided by retiring coal-fired generation. The ODP anticipates a substantial expansion of utility-scale wind and solar generation by 2030, with continued large-scale growth to 2050, supported by significant investment in storage, consumer energy resources and flexible demand. The estimated annualised present value of utility-scale generation, storage, firming and transmission investment to 2050 is approximately AUD 106 billion, of which transmission represents approximately AUD 6 billion.¹⁷

The scale of transmission investment required is substantial. The AER's 2025 *State of the Energy Market* reports that the transmission projects identified through the ISP comprise an estimated investment portfolio of approximately AUD 47.6 billion (2023 dollars), including committed, actionable and future projects spanning every mainland NEM jurisdiction.¹⁸ At the same time, AEMO has reported significant cost escalation across transmission development, estimating that real costs for overhead transmission projects have increased by approximately 25%–55% and transmission substations by approximately 10%–35% relative to estimates used in the 2024 ISP.¹⁹ This domestic pressure mirrors a global pattern: the IEA reports that prices for key grid components have nearly doubled worldwide over the past five years.²⁰

These risks are no longer theoretical. HumeLink and Project EnergyConnect illustrate the delivery and cost risk inherent in the NEM's transmission build-out. HumeLink's estimated capital cost has increased materially since its 2021 RIT-T assessment, while Project EnergyConnect's forecast cost has also risen substantially from earlier estimates²¹.

The underlying diagnosis is clear. Renewable energy generation can generally be developed and commissioned more quickly than the transmission infrastructure required to connect it and deliver its output to load centres. While utility-scale wind, solar and battery projects may progress from

¹⁷ Australian Energy Market Operator (AEMO), '2026 Integrated System Plan' (Melbourne: AEMO, June 2026). p23. https://www.aemo.com.au/-/media/files/major-publications/isp/2026/2026-integrated-system-plan-isp.pdf?rev=f2f142d0a8d740a986f186da17bb8a9d&sc_lang=en

¹⁸ Australian Energy Regulator (AER), 'State of the Energy Market 2025.' p100. <https://www.aer.gov.au/publications/reports/performance/state-energy-market-2025>

¹⁹ AER, 'State of the Energy Market 2025', p5. citing AEMO Draft 2025 Electricity Network Options Report cost escalation estimates.

²⁰ International Energy Agency. (2026). p. 46.

²¹ See Transgrid, 'HumeLink: Material Change in Circumstance Assessment' (29 February 2024). <https://www.transgrid.com.au/media/q4snvri/humelink-material-change-circumstance-mcc-assessment-report-feb-24.pdf>; See also Australian Energy Market Operator, 'Integrated System Plan Feedback Loop Notice – HumeLink' (8 July 2024). https://www.aemo.com.au/-/media/files/major-publications/isp/2024/integrated-system-plan-feedback-loop-notice-humelink.pdf?rev=6397e53302804c3ebadc8bf33a2fco6d&sc_lang=en; See also Australian Energy Regulator, *Project EnergyConnect – Application to Reopen the 2023–2028 Revenue Determination* (2026).

development approval to operation within several years, major transmission corridors frequently require a decade or more to navigate planning, environmental approvals, land access negotiations, community consultation, regulatory assessment and construction.²²

The consequence is that transmission increasingly determines the pace of renewable deployment. AEMO has explicitly warned that delays in transmission delivery may impede the timely connection of new generation required to replace retiring coal-fired capacity, while the AER notes that transmission projects are critical to unlocking new renewable energy resources and maintaining reliability across the NEM.²³ Where network expansion fails to keep pace with generation development, congestion, curtailment, higher system costs and growing reliability challenges cease to be temporary implementation issues and instead become persistent characteristics of the transition itself.

The scale of the operational transition is also becoming clearer. The Australian government has a target of 82% renewable electricity in the NEM by 2030, and the IEA forecasts Australian renewable generation to grow by more than 8.5% annually through the decade, while coal's share of generation falls to approximately 27% by 2030.²⁴ More than 4.3 GW of grid-scale batteries are already operating in the NEM, with a further 12.6 GW in the development pipeline — a capacity roughly equivalent to the NEM's existing gas fleet. These resources mitigate, but do not remove, the need for inter-regional transfer capacity, particularly as rooftop solar increasingly creates periods in which local renewable production exceeds underlying demand.

Australia is also responding through procedural reform. The IEA identifies the NEM Access Standards Package 1 and the R1 Capability Assessment reforms as measures intended to streamline technical connection requirements for renewable generation, storage and network assets, impose clearer time limits on network responses, and reduce the risk that iterative requests for further information indefinitely delay approvals.²⁵

Australia therefore provides an important lesson for the broader Asia-Pacific region. If one of the world's most sophisticated electricity planning systems continues to identify transmission as the principal enabling infrastructure for decarbonisation, transmission constraints in less mature markets should be viewed not as isolated development challenges but as systemic transition risks.

DEPLOYMENT OUTPACING NETWORKS

Vietnam — the consequences of building faster than the grid

Vietnam ran one of the fastest renewable energy expansions ever recorded in a developing economy, driven by successive feed-in tariffs. However, due to regulatory, financial, and institutional challenges, there was underinvestment in Viet Nam's grid infrastructure from 2016 to 2020²⁶, leading up to and during the expansion period.

²² AEMO, '2024 Integrated System Plan'; AER, *State of the Energy Market 2025*. https://www.aer.gov.au/system/files/2025-08/State%20of%20the%20energy%20market%202025%20-%20Full%20report_o.pdf.

²³ AER (2025), noting approximately 5,000 km of transmission required by 2034 and 10,000 km by 2050, and that delays may impede timely delivery of generation reliant upon those upgrades.

²⁴ International Energy Agency. (2026). pp. 142–143.

²⁵ International Energy Agency. (2026). p. 59.

²⁶ Halsey, R., Do, N., Goel, S., Sharma, D., Suharsono, A., Beaton, C., & Benoit, P. (2025). 'State of transition: How state-owned power companies can drive energy transition in emerging economies.' International Institute for Sustainable Development. p23. <https://www.iisd.org/system/files/2025-07/state-power-companies-energy-transition.pdf>

The transmission system did not keep pace with the generation. Congestion concentrated in the high-resource southern and central provinces. By late 2023 the national dispatch centre reported some twenty overloaded points on the 220/110 kV network and around 220 renewable plants curtailing output.²⁷

In the National Power Development Plan for the 2021-2030 period, with a vision to 2050 (PDP8), the Government of Vietnam plans to construct 49,350 MVA and renovate 38,168 MVA of 500 kV substations, construct 12,300 km and renovate 1,324 km of 500 kV lines, construct 78,525 MVA and renovate 34,997 MVA of 220 kV substations, and construct 16,285 km and renovate 6,484 km of 220 kV lines²⁸ at an approximate cost of USD 14.9 billion to 2030.²⁹

Decision No. 768/QĐ-TTg issued on 15th April 2025 approved the revised PDP8 to include a more ambitious set of targets with onshore and nearshore wind energy to reach between 26GW and 38GW by 2030, with offshore wind estimated at 17GW by 2035. Solar power targets have been raised to between 46.5GW and 73.5GW, biomass power between 1.5GW and 2.7GW by 2030, and waste-to-energy between 1.4GW and 2.1GW by 2030. Higher targets are set for the period from 2031 to 2050.³⁰

The Government of Vietnam has responded on both the wire and the contract, and these are material steps. However, they do not retire the legacy exposure: a portfolio of 173 feed-in-tariff projects, worth in the order of USD 13 billion, remains in dispute, a substantial part of which turns on the interaction between project readiness and grid readiness. With accelerated and more ambitious targets to 2030 and beyond, transmission and grid deployment must accelerate faster than generation.

Having worked on inter-tidal and onshore wind farm projects in South Vietnam during the 2019/20 period, I witnessed firsthand the impact of grid constraints upon projects in construction and development. It has been encouraging to see the progression of transmission and grid build outs to date and even more encouraging to see the Government of Vietnam actively progressing the revised Power Development Plan 8.

FRONTIER CASE

Mongolia — Aged transmission but planned expansion

Mongolia presents the constraint in its most concentrated form.

The resource is not the limiting factor, as Mongolia holds some of Asia's strongest onshore wind and exceptional solar potential. The limitation is the system. The Central Energy System is highly centralised, dependent on ageing transmission with limited redundancy, and structurally exposed by geography. The load is concentrated in the north around Ulaanbaatar, while the best wind sits in the south, so power must travel long distances on lines that raise voltage-stability risk as variable output grows.

Here the significance moves beyond engineering and into finance.

²⁷ Halsey et al. (2025). p38. See also REGlobal <https://reglobal.org/evns-efforts-to-integrate-renewable-energy-into-viet-nams-grid>.

²⁸ PM Decision 500/QĐ-TTg On approving the National Power Development Plan for the 2021-2030 period, with a vision to 2050. Viet Nam Energy Partnership Group. https://vepg.vn/legal_doc/11844/.

²⁹ Ketelsen, T., Tien, L. T. H., Bien, T. Q., Lap, H. N., & Khanh, N. Q. (2023). 'Managing Viet Nam's grid: Issues for effective energy transition. *Energy Transition Partnership*.' pp 5-6. <https://www.energytransitionpartnership.org/wp-content/uploads/2024/06/Managing-Vietnams-Grid-Issues-for-Effective-Energy-Transition.pdf>

³⁰ Norton Rose Fulbright. (2025). 'Decree 57/2025: Key features and impact on direct power purchase agreements in Vietnam.' <https://www.nortonrosefulbright.com/en/knowledge/publications/b7fae014/decre-57-2025-key-features-and-impact-on-direct-power-purchase-agreements-in-vietnam>

For lenders, transmission constraint is dispatching uncertainty, curtailment exposure, and doubt over generation provisions. For sponsors it is a valuation input and dispatch risk. For the state it is the credibility of the transition strategy itself and a substantial budget constraint.

The point is illustrated by the multilateral programme now reinforcing the network. The World Bank's Fourth Energy Sector Project for Mongolia (P509161)³¹ frames transmission reinforcement explicitly as a mechanism to unlock private renewable energy investment. The European Bank for Reconstruction and Development (EBRD), the International Finance Corporation (IFC) and the Mongolian Government are also advancing plans for a number of transmission line expansions.

Further, Mongolia's Ministry of Energy has outlined a three-phase transmission development programme within its Green Transition Strategy 2025–2050 working documents. In the near-term phase to 2030, the programme targets voltage quality improvement to within $\pm 10\%$ tolerance, progressive upgrading of 110 kV infrastructure to 220 kV, achievement of N-1 reliability standards, and renewal of approximately 488 km of Central Energy System lines identified as priority rehabilitation.³²

Mongolia provides a clear example of how transmission infrastructure can become a substantial determinant of project bankability in frontier markets. The author's development and construction experience across several Mongolian renewable projects since 2013 has consistently demonstrated that grid capacity, transmission reinforcement and dispatch certainty often become more important to project feasibility and financing outcomes than resource quality itself.

Aged Soviet thermal power plants, transmission lines in many cases beyond their design life³³, and a dependence on coal have been political drivers for a considerable period of time, and it is very encouraging to see the current Government of Mongolia addressing the energy sector with transparent yet ambitious plans including transmission line expansions, five recent successful solar plant / BESS auctions, an upcoming 100 MW wind auction, amongst other plans to reduce reliance upon energy imports and increase Mongolia's energy security.³⁴

In a frontier single-buyer, centralised grid market, the transmission framework agreed for the first projects is not a project level detail. It is the template that determines whether the second and third generation of projects remain feasible and financeable at all.

THE COMING DEMAND SHOCK

Indonesia — ambition, archipelago, and a delivery-rate gap

Indonesia's 2025–2034 electricity supply business plan is, on paper, the most aggressive in the utility's history. 69.5 GW of new generation capacity is targeted, with 76% classified as non-fossil (low carbon) capacity³⁵, though that figure includes 10.3 GW of energy storage comprising pumped hydro and battery

³¹ World Bank. (2025). 'Mongolia — Fourth Energy Sector Project (Project Appraisal Document, Report No. PADHIO1138, P509161).' Washington, DC: World Bank, 10 September 2025.
<https://documents1.worldbank.org/curated/en/099091025184020288/pdf/P509161-be030ac3-9d58-4c8a-8d40-a692d074c350.pdf>

³² Ministry of Energy of Mongolia. (2026, May 22). 'Mongolia's energy green transition strategy 2025–2050: Summary of policy council deliberations [Working document].' Government of Mongolia.

³³ Ministry of Energy of Mongolia. (2026, May 22). The working document states that 44% of Mongolia's grid exceeds its design life. SAIFI (the frequency of supply interruptions) runs at 7 to 16 events per year against an international benchmark of 2 to 4. Transmission losses exceed 12%.

³⁴ Ministry of Energy of Mongolia (2026).

³⁵ PT PLN (Persero). (2025). 'Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) 2025–2034.' Launched 26 May 2025. Aligned with the national electricity general plan, RUKN 2025–2060 (approved 5 March 2025). See also International Institute for Sustainable Development. (2025). *State of Transition: How state-owned power companies can drive energy transition in emerging economies*. IISD that states 71GW of new capacity, 70% of which will be renewable energy.

systems, with pure renewable generation representing approximately 61% of new capacity. The programme is supported by 47,758 circuit-kilometres of new transmission lines and 107,950 MVA of substation capacity expansion, anchored by a "Green Enabling Super Grid" intended to overcome the structural mismatch between renewable energy potential concentrated in lower-density regions such as Sumatra, Kalimantan, Sulawesi, and Nusa Tenggara, and the centres of demand in Java, Madura, and Bali. Total investment is estimated at approximately USD 181 billion, of which transmission accounts for around USD 34 billion.³⁶

Ashurst's June 2025 analysis of the RUPTL identifies transmission infrastructure as one of the most significant and structurally complex components of the RUPTL 2025–2034 and notes that PLN is expected to be responsible for the development and funding of most of the new transmission and grid infrastructure with reference to possible PPP schemes. It remains to be seen whether any form of private participation beyond the classic EPC procurement model will be involved in the delivery of this important pipeline of projects and investments.³⁷ PLN's financial situation is constrained by significant debt and dependence upon government subsidies³⁸; it will need to overcome funding constraints for the ambitious yet essential transmission and grid requirements.

The credibility question appears to be one of pace. To meet these targets, Indonesia would need to build renewable capacity roughly five times faster in the first five years and eleven times faster in the second half of the plan than recent delivery rates, against a base in which only approximately 3.2 GW of renewables were added across 2018–2023, an average of around 0.53 GW per year.³⁹

The risk is therefore one of sequencing. If generation runs ahead of transmission, curtailment follows. If transmission runs ahead of demand, utilisation suffers. If neither moves quickly enough, thermal generation fills the gap by default. For an archipelagic system, that sequencing problem is acute, and it is a capital allocation problem before it is an engineering one.

The IEA's forecast reinforces the urgency of that sequencing challenge. Indonesian electricity demand grew by an estimated 6.7% in 2025 and is expected to grow by close to 6% annually through 2030. Coal supplied approximately 70% of generation in 2025 and, notwithstanding continued expansion of gas-fired and renewable output, is forecast still to supply approximately two-thirds of generation by the end of the outlook period.⁴⁰ Failure to align renewable, transmission and flexibility deployment would therefore not merely delay decarbonisation; it would prolong coal's system role as the default means of meeting incremental demand. The government's announced 100 GW solar programme — comprising 80 GW of village-based distributed solar with 320 GWh of battery storage alongside 20 GW of utility-scale solar — may reduce dependence on long-distance transmission in some locations, but the IEA notes that implementation faces technical, financial and supply-chain challenges, and it does not eliminate the need for coordinated distribution-system strengthening, storage integration and system operation.

The author's experience with developing and constructing renewable energy projects throughout Indonesia over the past decade has continued to demonstrate that capital availability, developer

³⁶ PT PLN (Persero). (2025).

³⁷ Draps, F., Neves Mandelli, J.-L., Baggett, S., & Trevanion, D. (2025, June 20). 'Indonesia's new power development plan: Highlights from the 2025–2034 RUPTL.' Ashurst. <https://www.ashurst.com/en/insights/indonesias-new-power-development-plan>.

³⁸ International Institute for Sustainable Development. (2025). 'State of Transition: How state-owned power companies can drive energy transition in emerging economies.' IISD. p45. <https://www.iisd.org/system/files/2025-07/state-power-companies-energy-transition.pdf>

³⁹ Bubb, M., Kasmali, M., Clugston, S., & Antonio, K. (2025, June 6). 'Powering Indonesia's future: Key takeaways from the 2025–2034 RUPTL.' Hogan Lovells. <https://www.hoganlovells.com/en/publications/powering-indonesias-future-key-takeaways-from-the-20252034-ruptl>.

⁴⁰ International Energy Agency. (2026). pp. 144–145.

appetite, IPP competition and suitable project sites exist. The challenge will be the roll out and sequencing of the RUPTL with a focus on transmission line infrastructure.

ADVANCED MARKET CONFIRMATION

South Korea — the same constraint in a high-capacity system

Korea confirms that the constraint is not a function of development stage.

The Institute for Energy Economics and Financial Analysis's (IEEFA) June 2025 report⁴¹ on bottlenecks to renewable energy integration in South Korea documents that renewable energy capacity increased sixfold from 2013 to 2023 while generation rose only threefold, a 2:1 ratio that is itself a measure of systemic curtailment. Renewable generation is particularly distant from demand centres requiring substantial geographical route siting with strong local resident opposition (which is causing delays of up to 11 years)⁴² and KEPCO's monopoly over transmission and distribution has inhibited efficient grid expansion, therefore compounding the structural imbalance.⁴³

75% of renewable energy generation capacity is concentrated in Jeollanam-do, Jeollabuk-do, Chungcheongnam-do, Gangwon-do, Gyeongsangbuk-do and Jeju, while 40% of national electricity consumption sits in Seoul and Gyeonggi, necessitating long distance high voltage transmission that the existing network cannot adequately support.⁴⁴

The offshore wind execution gap is the most striking single data point in the Korean market. Offshore wind projects holding EBLs (electric business licences) as of December 2024 totalled approximately 30 GW of licensed capacity, against approximately 124.5 MW of capacity actually installed, with grid connection difficulty cited alongside permitting and community opposition as the principal reasons for the delay.⁴⁵

The Seoul Economic Daily reported in April 2026 that building the 70 route, 3,855-kilometre backbone network by 2038 will cost approximately USD 52-54 billion, and that individual project delays are already compounding, with the structure such that each year of delay generates escalating opportunity costs.⁴⁶

The 11th Basic Plan long term transmission plan targets 25,587 circuit-kilometres by 2038, approximately 1.72 times the 2023 figure, with substation capacity of 187,560 MVA, approximately 1.52 times the 2023 level.⁴⁷

IEEFA's March 2025 analysis of the 11th Basic Plan concludes that Korea's renewable energy transition is projected to reach its 32.9% target only around 2038, at least 15 years behind the global average of approximately 30% renewable energy generation (on a hydro-inclusive basis), being a lag attributable not to resource scarcity or capital shortage but to the structural failure of transmission infrastructure to keep pace with generation deployment.⁴⁸

⁴¹ Institute for Energy Economics and Financial Analysis. (2025, June). 'Bottlenecks to renewable energy integration in South Korea.' IEEFA. p4. https://ieefa.org/sites/default/files/2025-06/IEEFA%20Report_Bottlenecks%20to%20renewable%20energy%20integration%20in%20South%20Korea_June2025.pdf

⁴² Institute for Energy Economics and Financial Analysis. (2025, June). p6. Citing Yonhap. Power demand to double in 2051, power grid construction continues delaying. 06 May 2024.

⁴³ Institute for Energy Economics and Financial Analysis. (2025, June). p 4, 6.

⁴⁴ Park, Y. W., Jo, J. O., Sagong, D., & Kim, C. H. (2025, September 25). 'Renewable energy 2025: South Korea.' Chambers and Partners Global Practice Guides. <https://practiceguides.chambers.com/practice-guides/renewable-energy-2025/south-korea>

⁴⁵ Park et al. (2025)

⁴⁶ Seoul Economic Daily. (2026, April 30). 'Korea's power grid bottleneck worsens as transmission projects stall.' <https://en.sedaily.com/finance/2026/04/30/koreas-power-grid-bottleneck-worsens-as-transmission>

⁴⁷ International Energy Agency. (2025). 'Korea 2025: Energy policy review.' IEA. <https://iea.blob.core.windows.net/assets/21b0a0d2-6b9a-435d-b591-c65fb76399d6/Korea2025.pdf>. See also Park et al. (2025).

⁴⁸ Institute for Energy Economics and Financial Analysis. (2025, March 31). 'South Korea's 11th power plan makes partial progress towards decarbonization.' IEEFA. <https://ieefa.org/resources/south-koreas-11th-power-plan-makes-partial-progress-towards-decarbonization>

Korea has recognised the constraint and is responding. The 11th Basic Plan, the planned East Coast–Seoul HVDC link and the national backbone-network programme are intended to close the gap, although on timelines that continue to lag generation deployment.

Korea’s response is increasingly combining network expansion with locational flexibility procurement. In 2025, the Korea Power Exchange conducted the country’s first nationwide battery energy storage auction, tendering 540 MW (3,240 MWh) of six-hour-duration storage and awarding 565 MW (3,390 MWh), with projects concentrated in the south-western regions carrying the highest variable-renewable penetration. The 11th Basic Plan also targets an average of approximately 8 GW of additional renewable capacity annually and approximately 4.2 GW of flexibility resources, primarily battery storage, by 2030.⁴⁹ These measures acknowledge that the constraint cannot be resolved through transmission construction alone, although storage does not substitute for the long-distance network capacity required to move renewable electricity to Seoul and Gyeonggi.

The 30 GW licensed, 124.5 MW installed gap in Korean offshore wind is a precise measure of what happens when that logic is applied to generation approvals without applying it simultaneously to the transmission infrastructure required to evacuate them.

THE CAPITAL ALLOCATION FRAME

Transmission risk as a bankability risk

The most consequential reframing for the next decade is to stop treating grid connection as a binary completion event, connected or not connected, and to start treating it as a continuous performance risk that runs for the life of the asset.

A connection agreement confers a contractual right to connect. It does not guarantee that the network will accept the generation without curtailment, at the times the revenue model assumes, for the duration of the financing. In a growing number of APAC markets, that gap between the right to connect and the ability to be dispatched is precisely where value is destroyed. The distinction will become more pronounced as system operators increasingly adopt conditional or non-firm connection arrangements, under which a project may obtain earlier physical access to the network but remain contractually exposed to output restrictions until reinforcement is completed — or, in some cases, for the life of the connection.⁵⁰

For developers

- Grid-connection risk is a primary development risk, not a residual one. It must be assessed at feasibility stage, priced into the financial model with an explicit curtailment reserve, and allocated in the EPC and PPA structure. A model that books full P50 generation revenue from commercial operation without a curtailment assumption, a connection contingency in the programme, and explicit provisions for grid-operator delay is a model that will not survive contact with the region’s networks.
- In systems where network capacity is scarce, a mature and demonstrably deliverable connection-queue position may be a valuable project asset. Its value should not, however, be assumed merely from its nominal place in a queue: regulators are increasingly identifying and removing duplicate, speculative and non-progressing (“phantom”) applications in order to reallocate capacity to projects with stronger prospects of delivery.⁵¹

For lenders and independent engineers

The independent engineer’s grid connection review must become a substantive technical assessment of the network’s actual capacity to absorb the project’s output at the connection point, not a perfunctory read of the connection agreement’s terms.

⁴⁹ International Energy Agency. (2026). pp. 141–142.

⁵⁰ International Energy Agency. (2026). pp. 52–56.

⁵¹ International Energy Agency. (2026). p. 49.

In demonstrably constrained grids, a reasonable level of curtailment should be modelled in the base-case energy-yield assessment rather than confined to a remote downside sensitivity.⁵² The appropriate assumption is nevertheless market- and node-specific. At particular nodes and in demonstrably constrained areas of Vietnam, Korea, Mongolia and the NEM, curtailment may be an operating condition rather than a remote risk event, and a P50 yield that ignores it is a number that will not be achieved. The IEA cautions, however, that eliminating curtailment entirely may itself be economically inefficient: allowing some curtailment can enable more projects in connection queues to be connected at a faster pace while grid expansion proceeds, and the efficient level of curtailment must be assessed jointly with network capacity, demand structure and available system flexibility.⁵³ The lender's concern is therefore not whether curtailment exists, but whether its expected magnitude, allocation and compensation have been properly assessed and reflected in the financing case.

This is also where the multilateral development finance institutions earn their position in frontier markets such as Mongolia. Concessional transmission investment is the instrument that converts an unbankable resource into a financeable project.⁵⁴

The Author's view: in a transmission-constrained market, the lender's real exposure is not whether the plant is built but whether the system will take what it produces. The due-diligence question that matters is no longer "is there a connection agreement?" but "what will the network actually accept, when, and for how long?"

THE DISPUTE DIMENSION

Where the constraint becomes a dispute

When the constraint crystallises, it produces a category of dispute that is distinct from the construction delay, payment, and force majeure claims that have historically dominated energy litigation and arbitration.

The defining feature is that the generating asset may be functioning exactly as designed with the turbines being available, panels producing, battery operational, yet the electricity cannot be dispatched. The source of loss shifts from generation capability to system capability, and three dispute types recur:

- Grid readiness and commercial operation disputes — the plant achieves mechanical completion, but energisation, testing, or network connection remain incomplete, raising contested questions of delay responsibility, liquidated damages, and the certification of commercial operation.
- Curtailment and deemed generation disputes — the plant is available, but dispatch is restricted, and the parties divide over whether contracted revenue accrues on available or only on delivered generation.
- Grid code compliance disputes — fault-ride-through, system-strength, inertia, or grid-forming requirements are imposed or tightened after financial close, and the parties contest whether the resulting cost falls to the developer or the EPC contractor.

There is also a treaty-level dimension that sophisticated sponsors should not overlook. The substantial body of Energy Charter Treaty⁵⁵ jurisprudence arising from Spain's retrospective reforms to renewable energy support schemes demonstrates that investor-state disputes need not arise solely from expropriation or tariff reductions but may also emerge where governments materially alter the regulatory framework upon which investment decisions were predicated. The Spanish cases⁵⁶ ultimately

⁵² International Energy Agency. (2026). p. 50-51.

⁵³ International Energy Agency. (2026). p. 51.

⁵⁴ International Renewable Energy Agency. (2025). 'Renewable power generation costs in 2024.' IRENA, Abu Dhabi — documenting that, with generation costs now competitive across most APAC markets, grid access rather than levelised cost is increasingly the binding non-cost constraint on deployment in developing Asia. The treatment of curtailment as a base-case rather than a downside assumption is the author's base position for energy-yield assessment in constrained networks.

⁵⁵ Energy Charter Treaty, opened for signature 17 December 1994, 2080 UNTS 95 (entered into force 16 April 1998), art. 10(1).

⁵⁶ See *Eiser Infrastructure Ltd & Energía Solar Luxembourg S.à r.l. v Kingdom of Spain*, ICSID Case No. ARB/13/36, Award (4 May 2017), esp. 363 characterising the disputed measures as a "total and unreasonable change". Notably, the award was subsequently annulled on grounds relating to arbitrator disclosure: Decision on Annulment (11 June 2020). Compare Charanne

turned less upon whether states possess the sovereign right to regulate, which they undoubtedly do, and more upon the extent to which regulatory change was consistent with investors' legitimate expectations and whether those changes were disproportionate in their economic effect.

The analogy to transmission is not one of tariff support but of regulatory architecture. Curtailment frameworks, deemed generation provisions, dispatch priority rules, grid code obligations, ancillary service requirements and emerging grid-forming obligations are themselves regulatory instruments. As transmission systems become more complex and increasingly reliant upon inverter-based resources, these rules may become as economically significant to project viability as tariffs themselves.

The Spanish decisions are particularly instructive because many tribunals drew an important distinction between expectations of regulatory stability and expectations of regulatory consistency. While investors were not entitled to assume that legislation would remain immutable for the life of an asset, they could reasonably expect that the essential characteristics of the investment regime would not be radically, unexpectedly or disproportionately altered after capital had been committed.

That reasoning may become increasingly relevant in future APAC transmission disputes. Where governments materially alter curtailment methodologies, remove deemed generation entitlements, impose substantial new grid compliance obligations, or retrospectively reallocate transmission risks to project owners, investors may seek to invoke legitimate expectation doctrines under applicable investment treaty protections. Such claims would remain highly fact-specific and would ordinarily require evidence of a sufficiently specific commitment, a material departure from that commitment and an applicable treaty framework capable of engaging the conduct in question.

Whether this ultimately produces a new generation of transmission-driven investor-state disputes remains uncertain. However, the Spanish experience offers an important lesson: energy transition disputes need not arise because states regulate, but because the manner, timing and proportionality of that regulation may fundamentally alter the economic assumptions upon which long-term infrastructure investments were made.

THE REAL CONSTRAINT

The constraint is institutional, not technical

The least comfortable observation is also the most important.

The transmission challenge facing the Asia-Pacific is not, in the main, a technical problem. The engineering is largely known. High voltage and HVDC transmission can be built, grid-forming inverters and synchronous condensers can hold a low inertia system together, advanced protection and storage systems can manage variability. These are solved or solvable problems. What is not solved is delivery.

Renewable energy generation can be deployed faster than transmission and grid infrastructure given that renewable energy generation is generally characterised by standardisation, modularity, established global supply chains, benefits of lessons learned and available capital. Transmission on the other hand suffers from being location, land, permit, community and politically specific over substantial geographics. Generation outpaces transmission, generally being delivered at twice the pace. The IEA states that grids take 5 to 15 years whereas solar and wind take 1 to 5 years⁵⁷, a substantial mismatch.

Permitting remains slow, land acquisition remains contested and difficult, State utilities remain financially constrained by years of below cost tariffs and are in challenging positions to fund the capital programme the transition requires.

Transmission planning remains institutionally disconnected from generation planning, so the two pipelines advance on different clocks. And regulatory approval for a single line routinely takes longer than the renewable projects it is meant to serve.

B.V. & Construction Investments S.à r.l. v Kingdom of Spain, SCC Arbitration No. 062/2012, Award (2016), in which the claimants failed.

⁵⁷ International Energy Agency. (2026). p. 46.

The pace of transmission is therefore set by governance capability, not engineering capability, and governance capability is far harder to scale. My direct experience developing and constructing projects in Mongolia, Indonesia and Vietnam suggests that most developers struggle with the legal basis, financial implications and at times the understanding of transmission lines and grids. Many jurisdictions are silent on the legal basis for a developer to construct transmission lines over a certain voltage, and the assumption is that the grid will be “ok” and a responsibility of the State utility. The costs, time, land acquisition, environmental, social and legal uncertainties can be catastrophic for a project.

Capital can be raised in a quarter. An institution capable of routing, approving, and delivering a 500 kV line across three jurisdictions and hundreds of land parcels cannot. This is a simple reality, in conjunction with the stark reality of how the State will fund.

CONCLUSION

The wire problem is the energy-transition problem

For most of the past decade the relevant question was how much renewable generation could be built. That question has been answered. The question that now determines the success of the Asia-Pacific energy transition and push for energy security is whether the transmission systems and the institutions that build it can keep pace with what is already coming. On present evidence, across most of the region, the honest answer is no.

That answer reshapes the risk profile of projects, the structure of project finance, the allocation of contractual responsibility, and the character of the disputes that follow.

It should reshape due diligence and decision making accordingly. And there must be a different lens on transmission systems, the possible grid constraints, and implications of such.

My firm view is that transmission has ceased to be a secondary engineering consideration and has become one of the principal determinants of whether energy transition objectives can be met at all, and that the binding limit is institutional capacity, not technology or capital.

For the boards, lenders, sponsors, and counsel reading this, four questions are now unavoidable, and they should be asked at feasibility, not later in the development lifecycle, and certainly not at the time that a dispute arises:

- When is a renewable facility truly capable of commercial operation? When it is mechanically complete or when the network can accept its output?
- Does the connection agreement confer a right to connect, or a right to be dispatched, and which one does the financial model assume?
- In this market, is curtailment a risk event to be sensitised, or an operating condition to be modelled as base case?
- Can the relevant institution, the planner, the regulator, the utility, etc actually deliver transmission at a pace consistent with the generation already committed to its grid?

The answers will of course vary by market. The discipline of asking them should not. The wire problem is no longer somebody else’s problem to acknowledge in a risk register and then ignore. It is the problem.

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References

CASES

Charanne B.V. & Construction Investments S.à r.l. v Kingdom of Spain, SCC Arbitration No. 062/2012, Award (2016).

Eiser Infrastructure Ltd & Energía Solar Luxembourg S.à r.l. v Kingdom of Spain, ICSID Case No. ARB/13/36, Award (4 May 2017); Decision on Annulment (11 June 2020).

SECONDARY SOURCES AND OTHER MATERIALS

AFRY. (2026). *The next wave of power: Grid-forming solutions—Future-proof grid operations with proven grid forming strategies: How TSOs and DSOs can secure stability and unlock new value.* AFRY. <https://afry.com>

Australian Energy Market Commission. (2023). *Review of the generator performance standards.* AEMC.

Australian Energy Market Operator. (2024). *2024 integrated system plan for the National Electricity Market.* AEMO. <https://www.aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp>

Australian Energy Market Operator (AEMO), *2026 Integrated System Plan* (Melbourne: AEMO, June 2026). p23. https://www.aemo.com.au/-/media/files/major-publications/isp/2026/2026-integrated-system-plan-isp.pdf?rev=f2f142d0a8d740a986f186da17bb8a9d&sc_lang=en

Australian Energy Regulator. (2025). *State of the energy market 2025.* <https://www.aer.gov.au/publications/state-energy-market-reports/state-energy-market-2025>

Bain & Company, & Standard Chartered. (2026). *Southeast Asia's green economy report 2026: The new calculus (7th ed.).*

Bubb, M., Kasmali, M., Clugston, S., & Antonio, K. (2025). *Powering Indonesia's future: Key takeaways from the 2025–2034 RUPTL.* Hogan Lovells.

Decree No. 57/2025/ND-CP (Vietnam) (2025).

Draps, F., Neves Mandelli, J.-L., Baggett, S., & Trevanion, D. (2025, June 20). *Indonesia's new power development plan: Highlights from the 2025–2034 RUPTL.* Ashurst. <https://www.ashurst.com/en/insights/indonesias-new-power-development-plan>

Energy Charter Treaty, opened for signature 17 December 1994, 2080 UNTS 95 (entered into force 16 April 1998), art. 10(1).

Government of Viet Nam. (2023, May 21). *PM Decision 500/QĐ-TTg On approving the National Power Development Plan for the 2021-2030 period, with a vision to 2050.* Viet Nam Energy Partnership Group. https://vepg.vn/legal_doc/11844/

Halsey, R., Do, N., Goel, S., Sharma, D., Suharsono, A., Beaton, C., & Benoit, P. (2025). *State of transition: How state-owned power companies can drive energy transition in emerging economies.* International Institute for Sustainable Development. <https://www.iisd.org/system/files/2025-07/state-power-companies-energy-transition.pdf>

Institute for Energy Economics and Financial Analysis. (2025, June). *Bottlenecks to renewable energy integration in South Korea.* IEEFA. https://ieefa.org/sites/default/files/2025-06/IEEFA%20Report_Bottlenecks%20to%20renewable%20energy%20integration%20in%20South%20Korea_June2025.pdf

Institute for Energy Economics and Financial Analysis. (2025, March 31). *South Korea's 11th power plan makes partial progress towards decarbonization.* IEEFA. <https://ieefa.org/resources/south-koreas-11th-power-plan-makes-partial-progress-towards-decarbonization>

-
- International Energy Agency. (2026). *'Electricity 2026: Analysis and forecast to 2030.'* IEA. https://iea.blob.core.windows.net/assets/b73798cb-e452-42b9-9d8a-07542de7a041/Electricity_2026.pdf
- International Energy Agency. (2025). *'Korea 2025: Energy policy review.'* IEA. <https://iea.blob.core.windows.net/assets/21b0a0d2-6b9a-435d-b591-c65fb76399d6/Korea2025.pdf>
- International Energy Agency. (2025). *'World Energy Outlook.'* IEA, Paris. <https://iea.blob.core.windows.net/assets/9753df19-0a71-422a-b725-012c555763b3/WorldEnergyOutlook2025.pdf>
- International Institute for Sustainable Development. (2018). *'Eiser v. Spain. Investment Treaty News.'* <https://www.iisd.org/itn/2018/10/18/eiser-v-spain/>
- International Renewable Energy Agency. (2025). *'Renewable power generation costs in 2024.'* IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2025/Jul/IRENA_TEC_RPGC_in_2024_2025.pdf
- Ketelsen, T., Tien, L. T. H., Bien, T. Q., Lap, H. N., & Khanh, N. Q. (2023). *'Managing Viet Nam's grid: Issues for effective energy transition.'* Energy Transition Partnership. <https://www.energytransitionpartnership.org/wp-content/uploads/2024/06/Managing-Vietnams-Grid-Issues-for-Effective-Energy-Transition.pdf>
- Ministry of Energy of Mongolia. (2026, May 22). *'Mongolia's energy green transition strategy 2025–2050: Summary of policy council deliberations [Working document].'* Government of Mongolia.
- Norton Rose Fulbright. (2025). *'Decree 57/2025: Key features and impact on direct power purchase agreements in Vietnam.'* <https://www.nortonrosefulbright.com/en/knowledge/publications/b7fae014/decre-57-2025-key-features-and-impact-on-direct-power-purchase-agreements-in-vietnam>
- Park, Y. W., Jo, J. O., Sagong, D., & Kim, C. H. (2025, September 25). *'Renewable energy 2025: South Korea.'* Chambers and Partners Global Practice Guides. <https://practiceguides.chambers.com/practice-guides/renewable-energy-2025/south-korea>
- PT PLN (Persero). (2025). *'Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) 2025–2034.'*
- REGlobal. (n.d.). *'EVN's efforts to integrate renewable energy into Viet Nam's grid.'* <https://reglobal.org/evns-efforts-to-integrate-renewable-energy-into-viet-nams-grid>
- Seoul Economic Daily. (2026, April 30). *'Korea's power grid bottleneck worsens as transmission projects stall.'* <https://en.sedaily.com/finance/2026/04/30/koreas-power-grid-bottleneck-worsens-as-transmission>
- Transgrid. (2024). *'HumeLink: Material change in circumstance assessment report.'* <https://www.transgrid.com.au/media/q4snvri/humelink-material-change-circumstance-mcc-assessment-report-feb-24.pdf>
- World Bank. (2025). *'Mongolia — Fourth Energy Sector Project (Project Appraisal Document, Report No. PADHIO1138, P509161).'* Washington, DC: World Bank, 10 September 2025. <https://documents1.worldbank.org/curated/en/099091025184020288/pdf/P509161-be030ac3-9d58-4c8a-8d40-a692d074c350.pdf>
- Yonhap News Agency. (2024, May 6). *'Power demand to double in 2051; power grid construction continues to be delayed.'* (Cited in IEEFA, 2025.)
-