International Energy Agency

The evolution of Southeast Asia’s power systems

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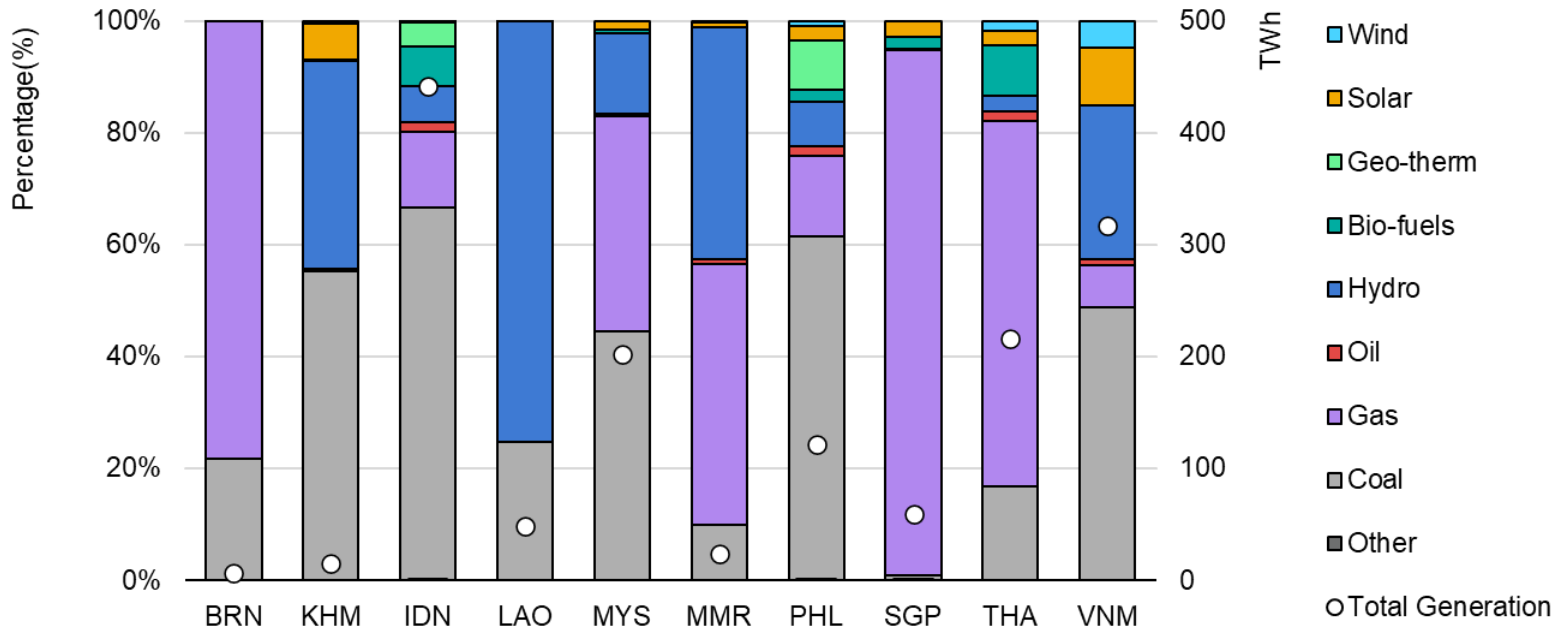
A Flexible and Distributed Power System: Storage, Grids, and Interconnectors DDW
Asia Clean Energy Forum 2025, 6 June

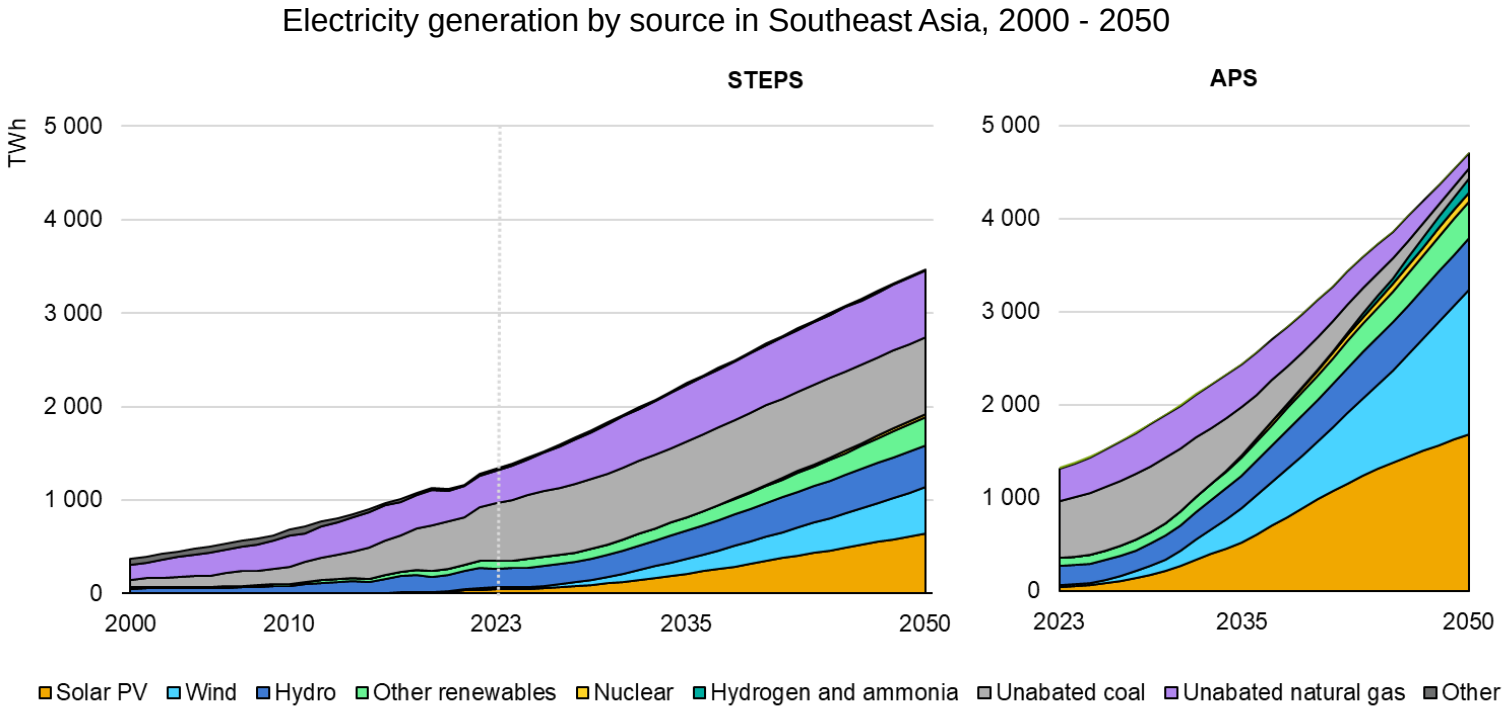
Fossil fuels remain the primary source of supply in ASEAN today

Power generation mix by fuel by ASEAN member country, 2024



Despite the rapid growth in renewables, most of the region's electricity demand continues to be met by fossil fuel generation in the short to medium term

Growth of variable renewables (VRE) increases flexibility needs



Led by solar PV, renewables are set to enter a period of rapid expansion, supplying over 50-90% of Southeast Asia's electricity by 2050. Flexibility sources need to keep up with the growth of VRE

Framework guides phased, timely implementation of VRE integration measures

Phases of VRE integration framework

Low phases

Phase 1: VRE has no significant impact at the system level

Phase 2: VRE has a minor to moderate impact on the system

Phase 3: VRE determines the operation pattern of the power system

High phases

Phase 4: VRE meets almost all demand at times

Phase 5: Significant volumes of surplus VRE across the year

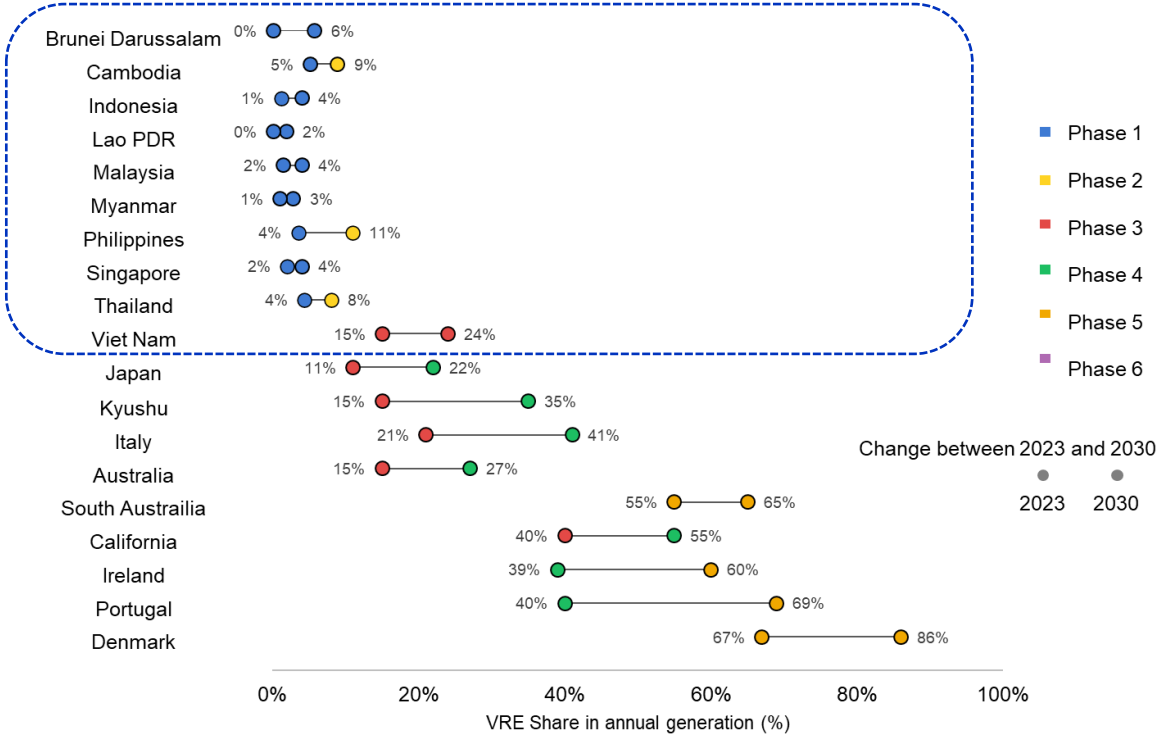
Phase 6: Secure electricity supply almost exclusively from VRE

VRE = variable renewable energy

The framework allows policy makers to identify VRE integration measures that need to be prioritised at each phase to ensure its timely implementation.

ASEAN’s power systems are in low phases through 2030

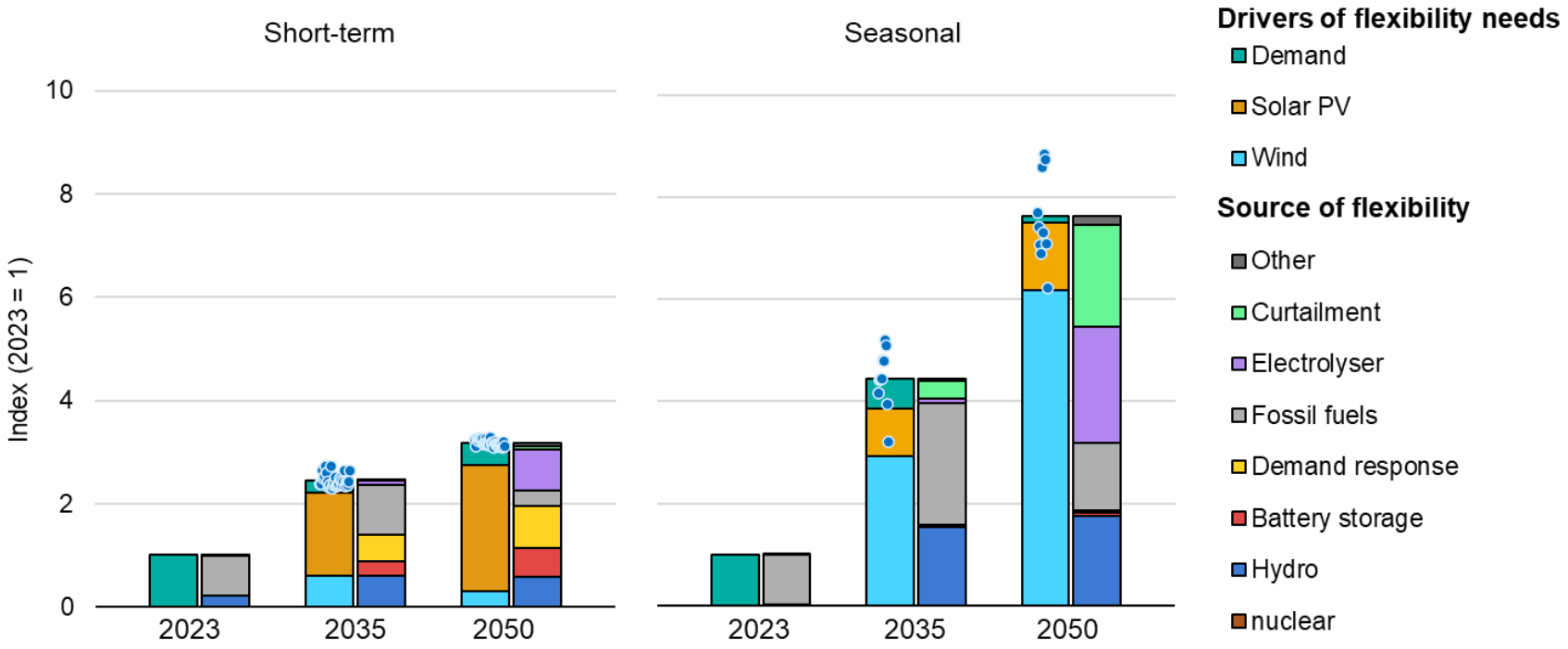
VRE integration phase assessment for SEA countries and comparison with higher-phase systems (2023 and 2030)



The challenges that SEA countries will experience are characteristic of low phases of VRE integration with relatively limited impacts.

Flexibility needs in the region continue to increase to 2050

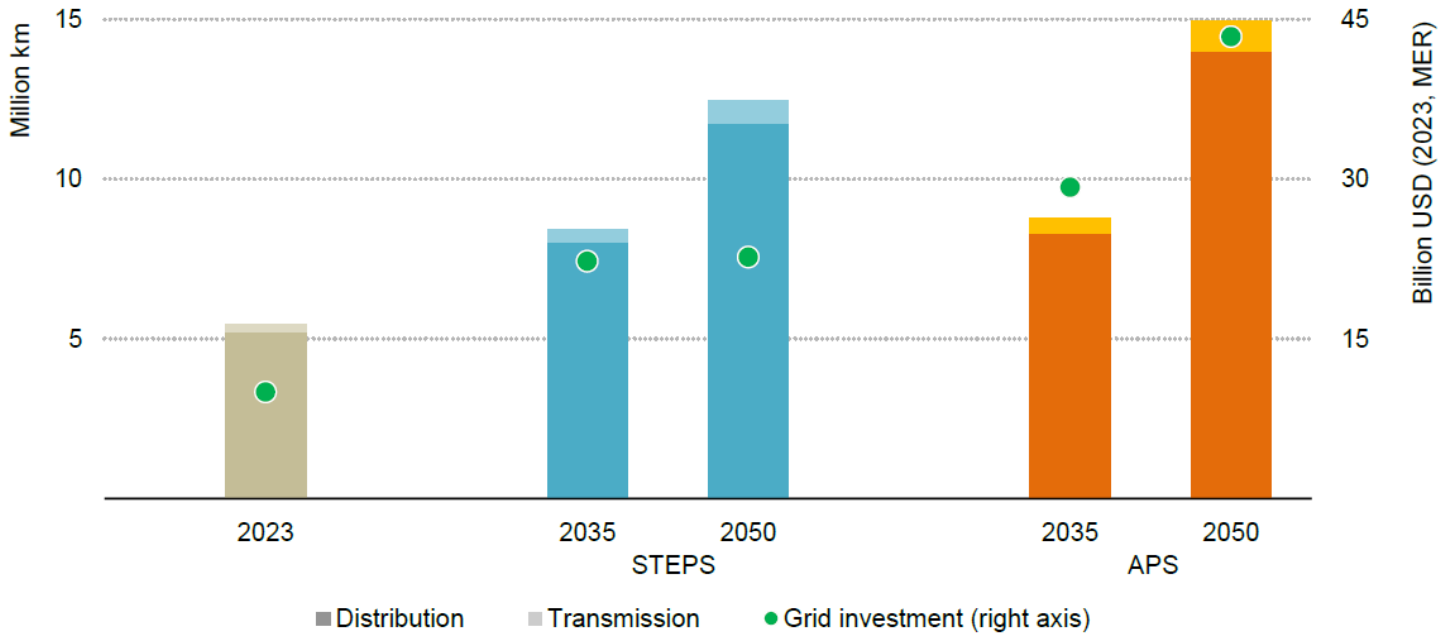
Short-term and seasonal flexibility needs and supply by technology in Indonesia 2023-2050



New technologies like batteries and demand response will join thermal power plants and hydropower to meet flexibility needs in the longer term

Expanding and modernising grids is a critical enabler of flexibility

Installed transmission and distribution line length, and annual average investment in grids by scenario, 2023-2050



Grid expansion and cross-border interconnection are key to meeting growing demand for access to clean electricity and require an increase in investment to deliver announced targets

Six key policy actions to accelerate effective VRE integration

Assess the system's preparedness for VRE integration by improving understanding of power system resources, identifying infrastructure needs, and gaps in funding, data and skills.

Ensure secure grid operation with clear requirements from VRE such as forecasting accuracy, asset visibility and controllability, and its reaction to disturbances.

Unlock flexibility from the existing power system to manage increasing variability by optimising dispatch, activating demand response, and making existing generation operate flexibly.

Design incentives to garner flexibility and system services from a wider range of sources by defining and quantifying the need and creating procurement frameworks.

Accelerate technology integration and innovation with regulatory, market, and strategic support to rapidly scale up and develop technologies that are key for long-term decarbonisation.

Adopt a holistic approach to power system planning, by integrating cross-sectoral dynamics, incorporating resilience in addition to security and efficiency and leveraging global expertise.

* System-friendly VRE refers to planning, operating or contracting solar and wind power plants in a way that supports the overall outcomes for the system.

Strong regional & international cooperation is key to a safer and more sustainable energy future for Southeast Asia

The new IEA Office will work with all countries in Southeast Asia and beyond to enhance energy security and accelerate clean energy transitions.