Key messages from the report

Technical feasibility

▶ It is technically possible to operate stable power systems with very high shares of wind and solar generation (e.g., 70 to 80 %), provided that key investments are made in grid stability technologies and appropriate procurement is implemented.

Enabling policies and actions

▶ Delivering low-cost, high-wind and solar power systems will require:

- Setting a strategic vision supported by appropriate planning.
- Ensuring that key aspects of market design reduce investor risk and support efficient capital allocation by incentivising the deployment of grid and flexibility technologies.
- Implementing grid regulations that minimise delays in the connection and integration of new technologies into the system.
- Applying digital and AI-based capabilities to manage power systems more efficiently.
- Addressing potential supply chain and workforce bottlenecks.
- Enabling demand side flexibility through consumer engagement and product design.

Balancing electricity supply and demand

▶ Energy supply and demand can be balanced in high wind and solar systems using a range of already available storage and flexibility technologies:

- For short durations (up to eight hours), batteries are likely to be a low-cost solution, and demand-side flexibility (DSF) has significant potential.
- For medium-long durations, multiple increasingly cost-effective solutions are available.
- The highest costs will be associated with delivering ultra-long-duration balancing.

Total system costs

▶ Future total system costs per kWh in high wind and solar systems can be comparable to or lower than today's fossil fuel-based systems in almost all countries. These costs will be:

- Lowest in countries with strong solar resources and predominantly short-duration balancing needs (e.g., the low-latitude global sunbelt such as India, Thailand, Mexico, Australia).
- Highest in countries primarily dependent on wind and with significant long-duration balancing needs (e.g., the high-latitude global wind belt such as the UK, Japan, Germany).

In the near and medium term, transitional costs (e.g., from legacy contracts and initially expensive technologies) could be significant and must be carefully managed.

Last mile decarbonisation

▶ The final stages of power system decarbonisation will be the most expensive, especially in high-latitude, wind-dependent countries , given the higher costs of low-utilisation assets to ensure security of supply. Governments should strike a pragmatic balance between:

- Driving towards complete power system decarbonisation.
- Shifting the primary policy focus to accelerating electrification once a very low carbon intensity (e.g., below 30 grams per kWh) has been achieved.

Grid expansion and costs

▶ Major investments will be needed in both transmission and distribution grids, with total grid length and annual investment requirements expected to grow two to three times by 2050. However, costs can be significantly reduced through the deployment of innovative grid technologies (IGTs) and demand side flexibility (DSF).

Rapid electrification is essential to scale electricity demand in line with grid expansion, enabling lower grid costs per kWh.