International Energy Agency

Planning for flexibility in transitioning systems

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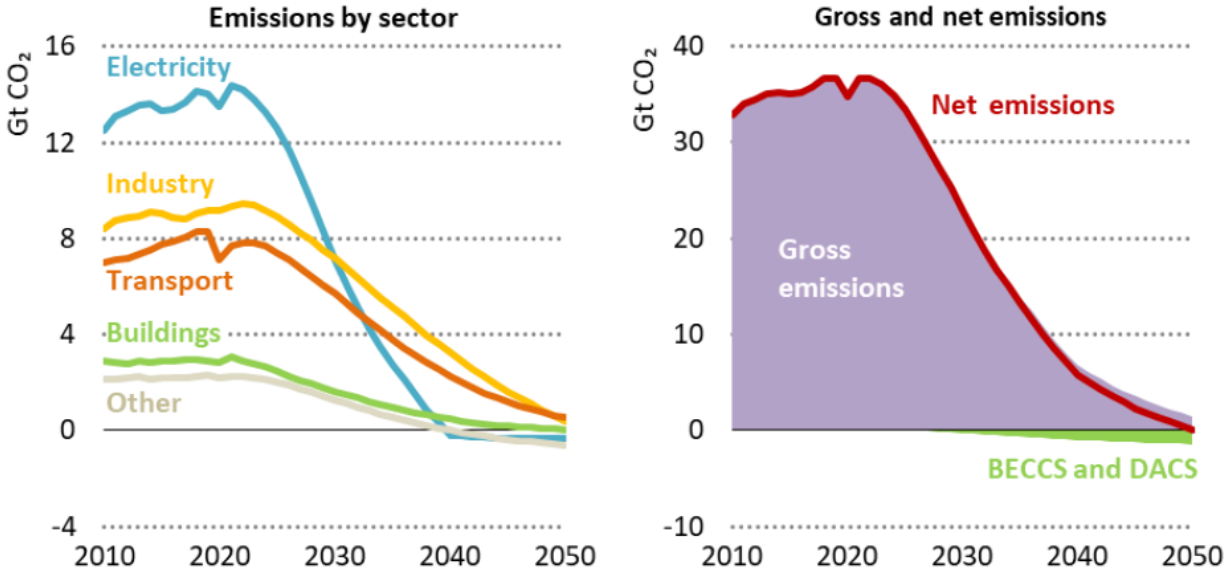
Future of the Grid, 13 September 2023, Johannesburg, South Africa

Clean electricity is a key driver of decarbonisation

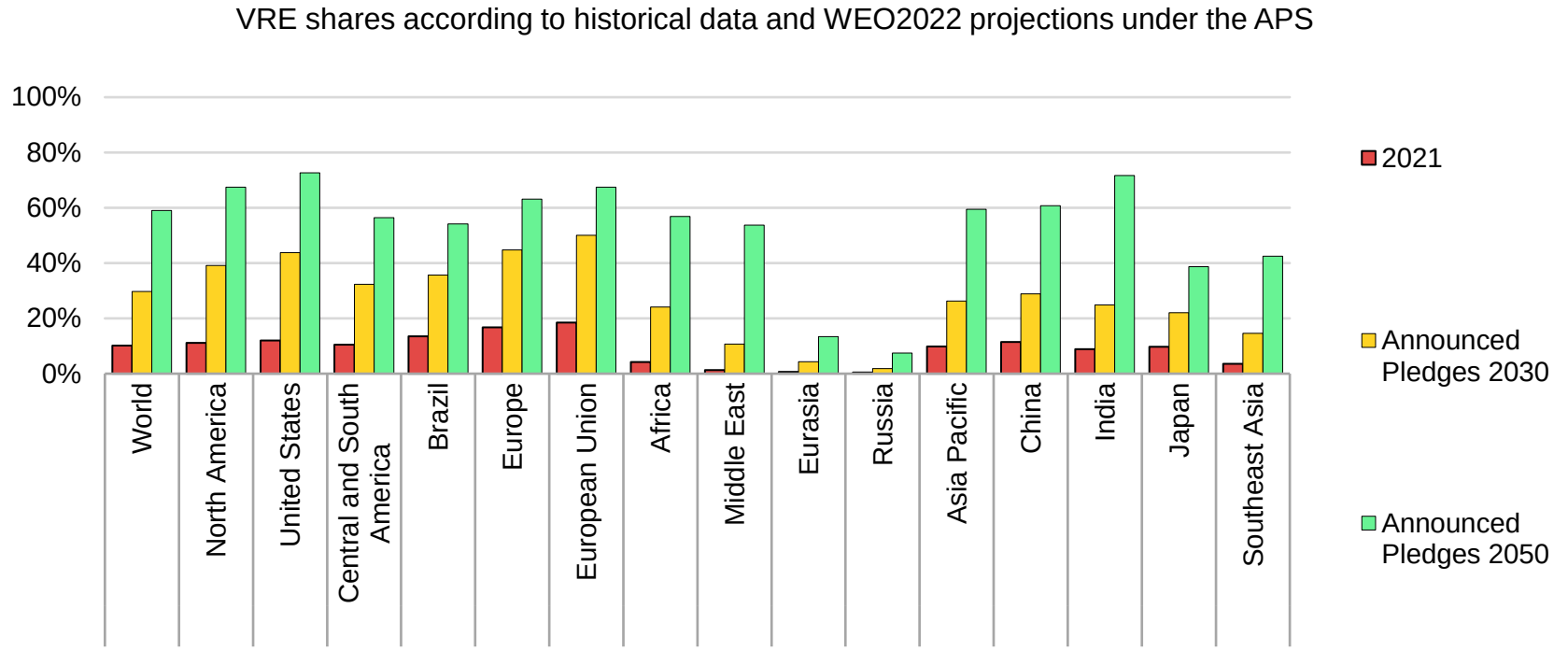
Energy-related CO2 emissions by sector and gross and net emissions in the NZE Scenario, 2010-2050



Source: IEA (2022), World Energy Outlook

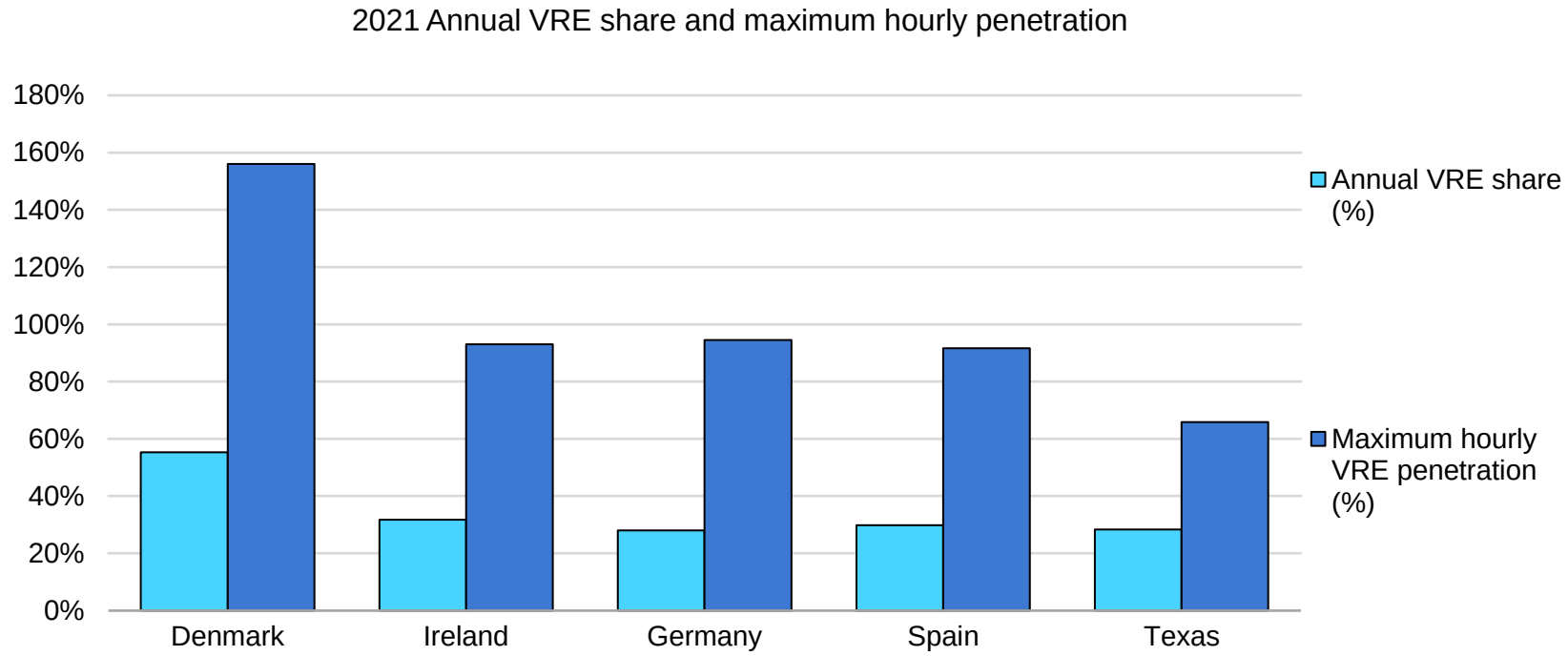
The power sector leads emissions reduction in 2030, but all sectors contribute to the net zero emissions goal, with residual emissions in 2050 balanced by atmospheric removals

Announced pledges towards net zero will see huge growth in VRE shares



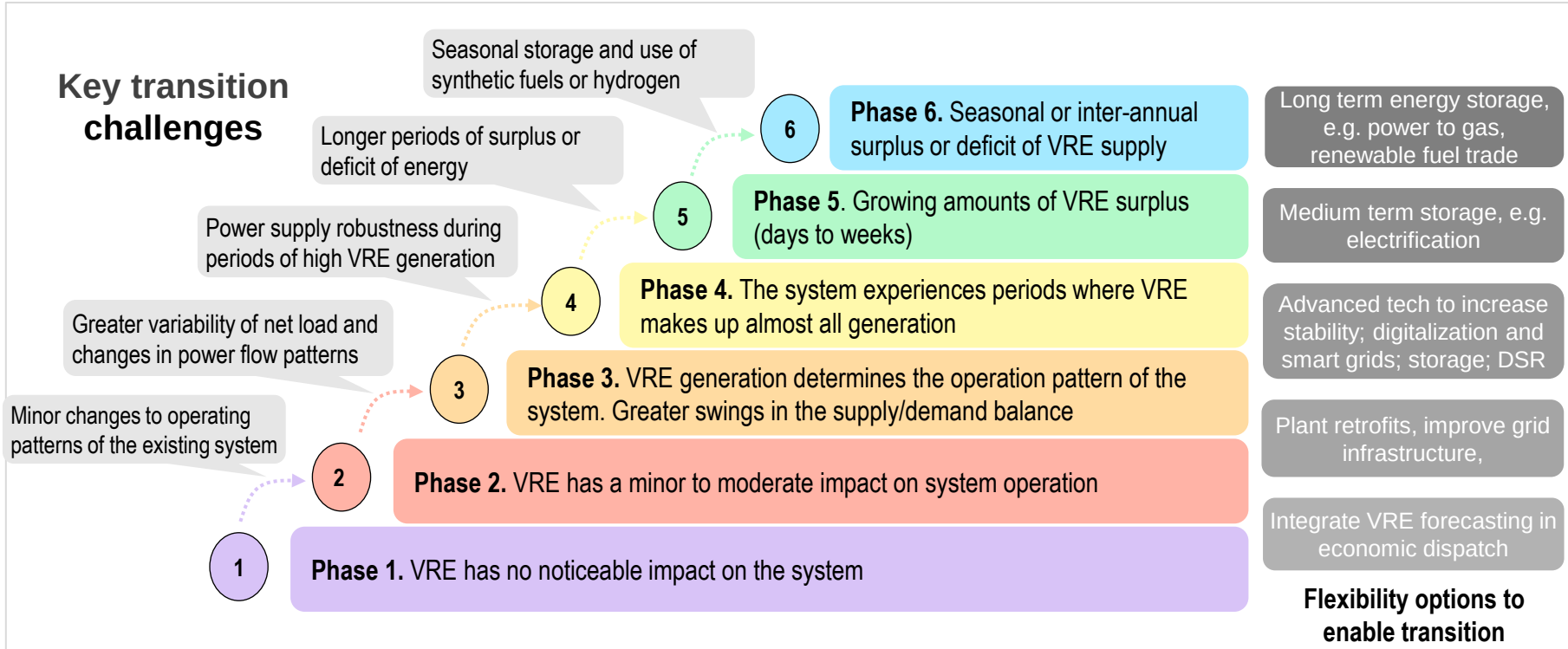
More countries are expected to deploy higher shares of renewables towards the end of the decade under WEO-2022 projections – including in many developing economies

Annual vs instantaneous VRE share…



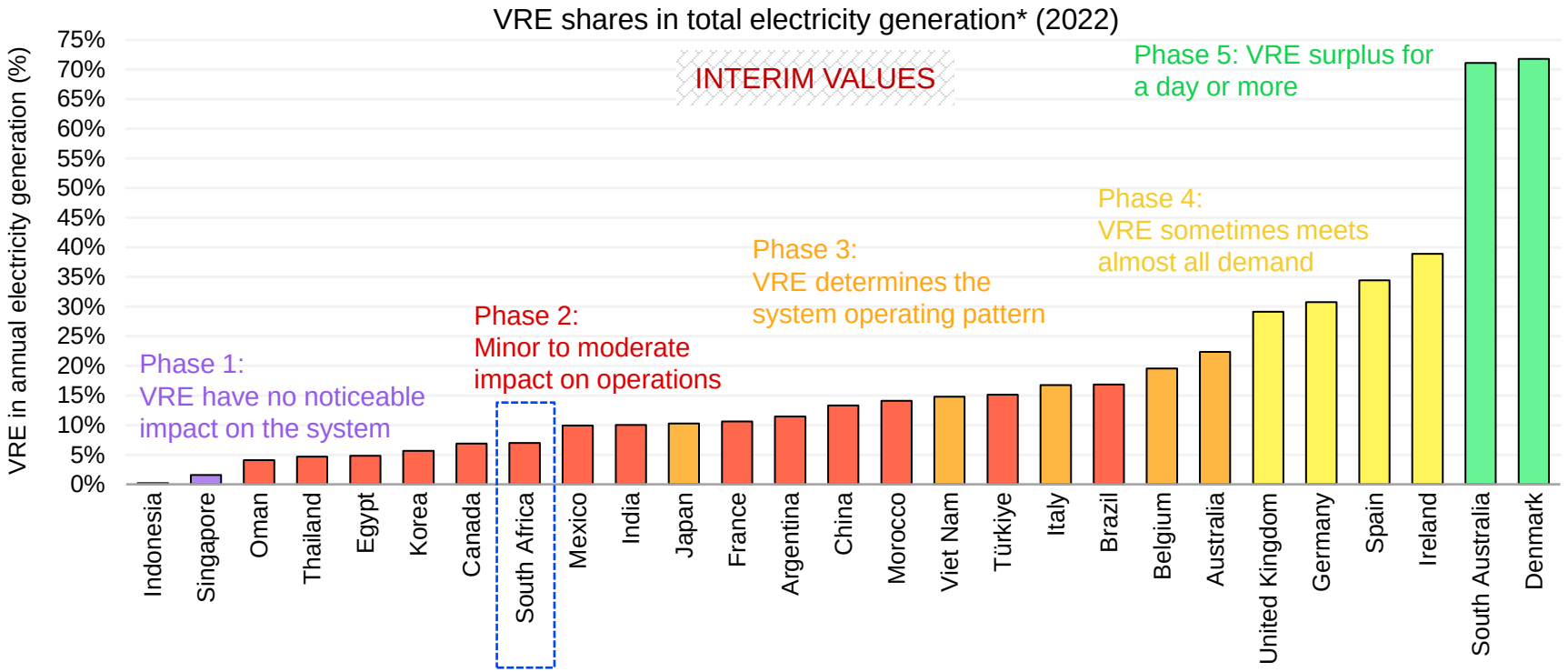
As countries and regions are attaining higher shares of VRE generation, they are also experiencing much higher instantaneous VRE infeed levels in certain periods of the year

Phases of system integration and evolving priorities



Key challenges in each phase that should be addressed for moving up to higher levels of integrating VRE in the power system

Planning ahead for system integration of variable renewables (VRE)

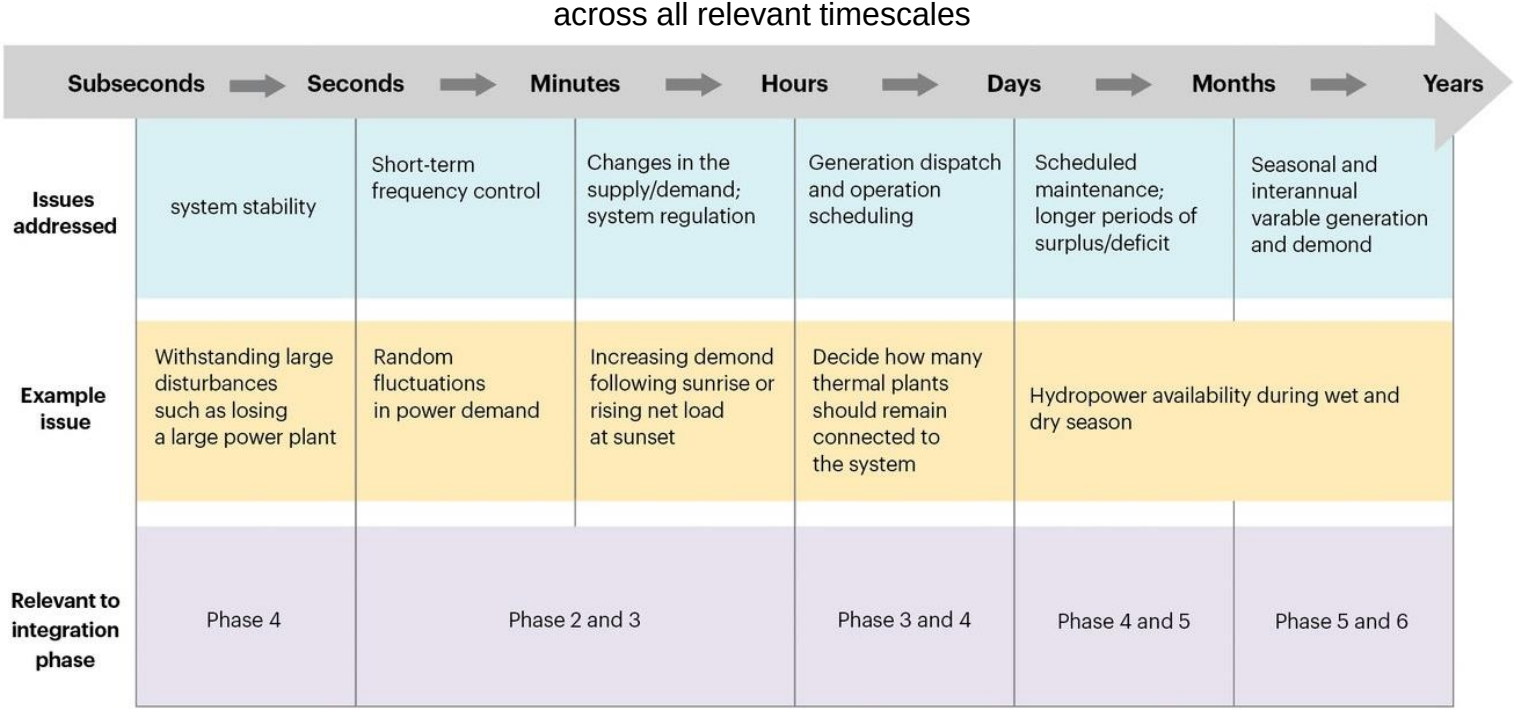


* VRE country shares for 2022 are based on estimates by IEA of both the VRE and total generation, USA estimates are based on hourly data from EIA

Various regions have demonstrated successful integration of VRE.
As we move towards even higher levels of VRE, we must continue expanding the flexibility of power systems.

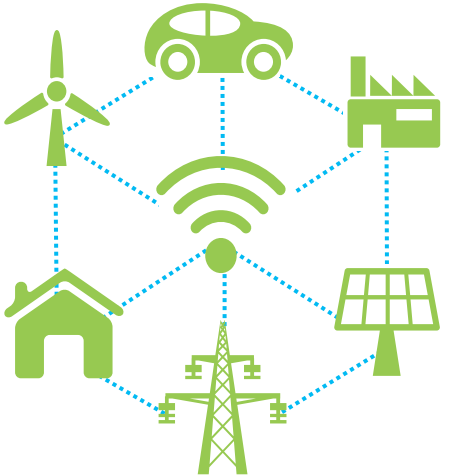
Power system flexibility occurs across different timescales

The ability of a power system to reliably and cost-effectively manage the variability and uncertainty of demand and supply across all relevant timescales



Understanding the system's current and future flexibility needs is key for all power system actors

System flexibility: Identifying and engaging with the right actor is key

Institutions and actors ("Who")	Policy, market and regulatory frameworks ("How")	Hardware and infrastructure ("What")
Typical decision makers	*Categories of interventions*	*Flexibility Asset types*
Energy ministry	*Energy strategies* *Legal frameworks* *Policies and programmes*	
Regulatory agency	*Regulatory frameworks and decisions* *Power sector planning exercises* *Retail electricity pricing*	
System operator, electric utility, standards body	*Power market rules and codes* *System operation protocols* *Connection codes*	

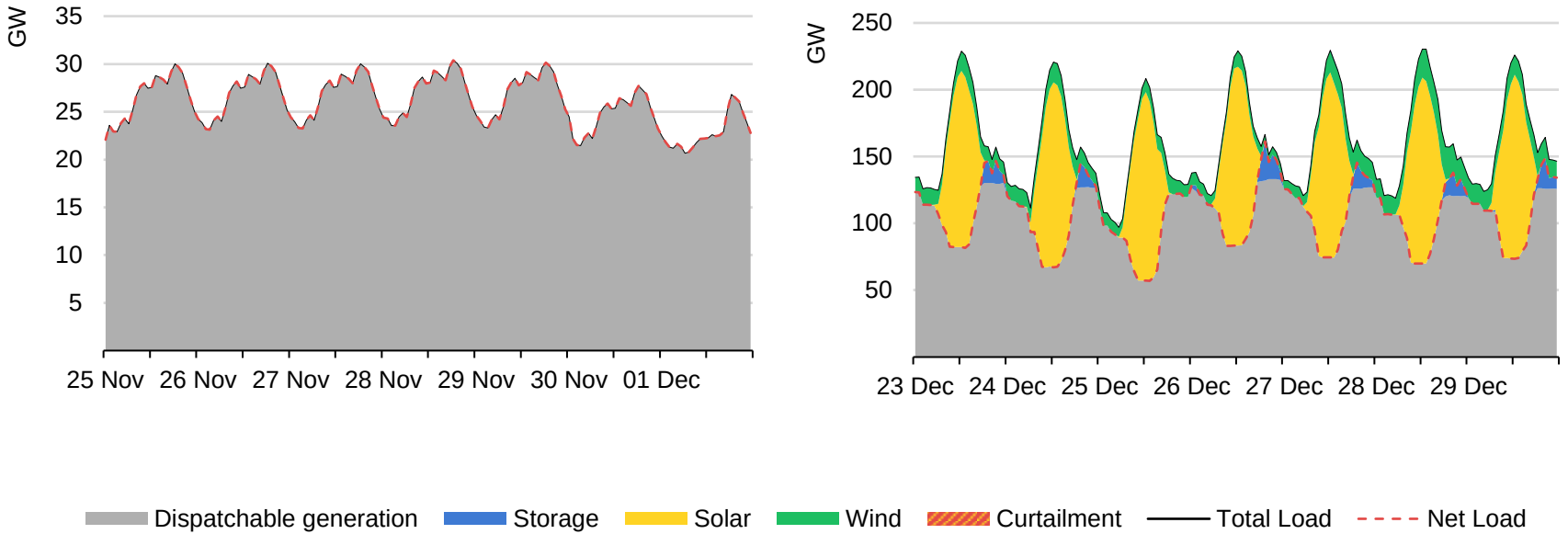
Source: IEA, Status of Power System Transformation 2019 (2019)

A range of approaches to enhance power system flexibility are available at different levels of decision making. The institutional context defines the set of instruments available to boost system flexibility.

IEA analysis of evolving flexibility requirements

Daily flexibility requirements in a Indonesia in 2019 and 2050 APS

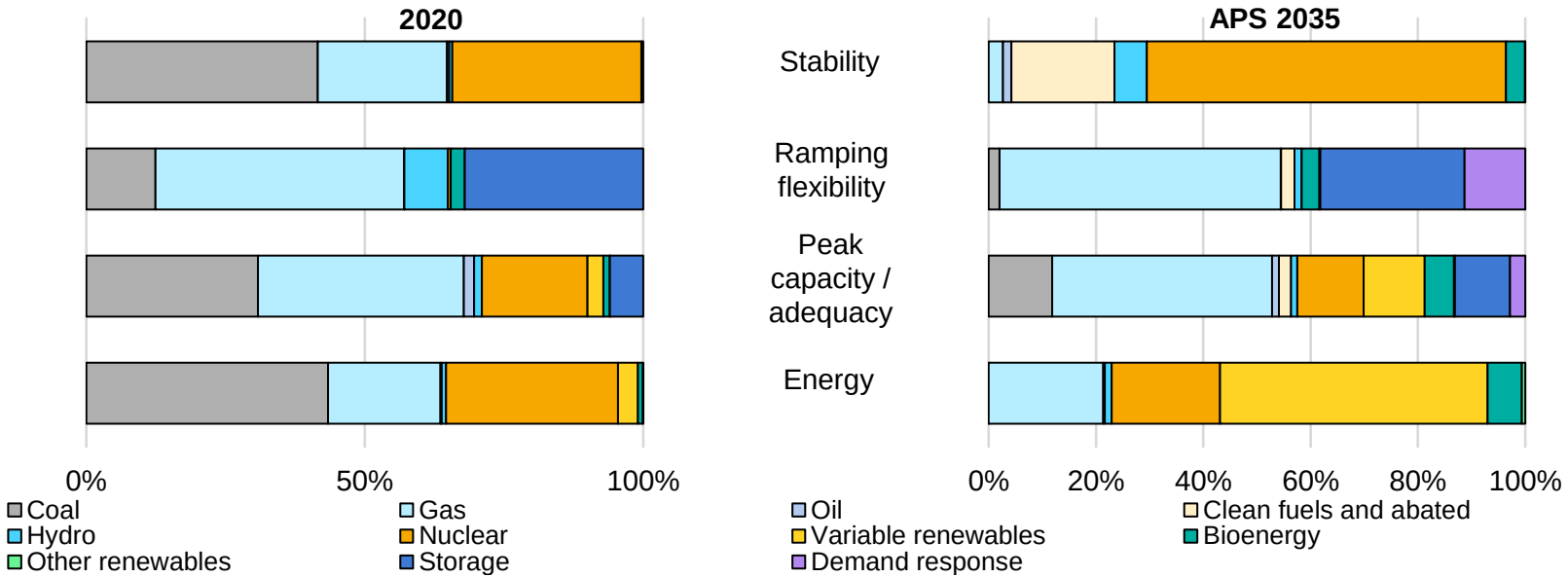
Power system dispatch by technology in Indonesia under the WEO2022 Announced Pledges Scenario



Greater wind and solar development will be complemented by a very flexible demand, smart EVs and flexible electrolysers, and various storage options.

Sources of energy and services change on a pathway to net zero

Energy and service contributions of different technologies to maintain electricity security in Korea, 2020 and 2035 APS

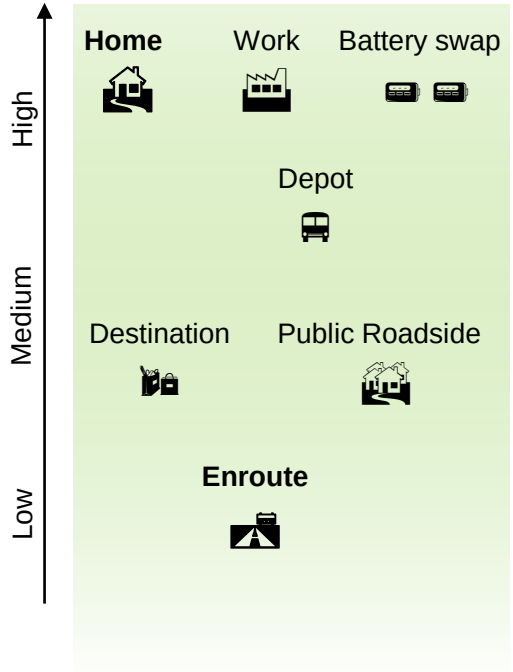


Source: IEA (2021), Reforming Korea's Electricity Market for Net Zero

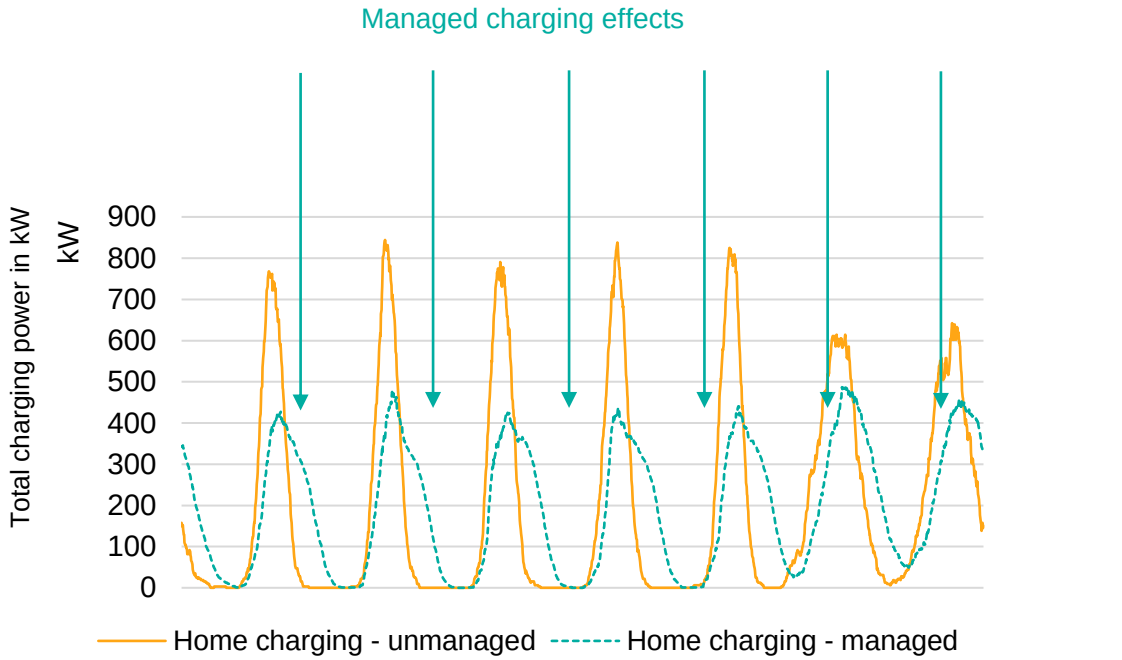
The policy framework needs to evolve to recognise new sources of value in the power system and enable the participation of a broader range of technologies

Opportunities of road transport electrification

Flexibility opportunity
with managed charging



Power demand profile from EV charging
of 1000 private cars driving (one week)

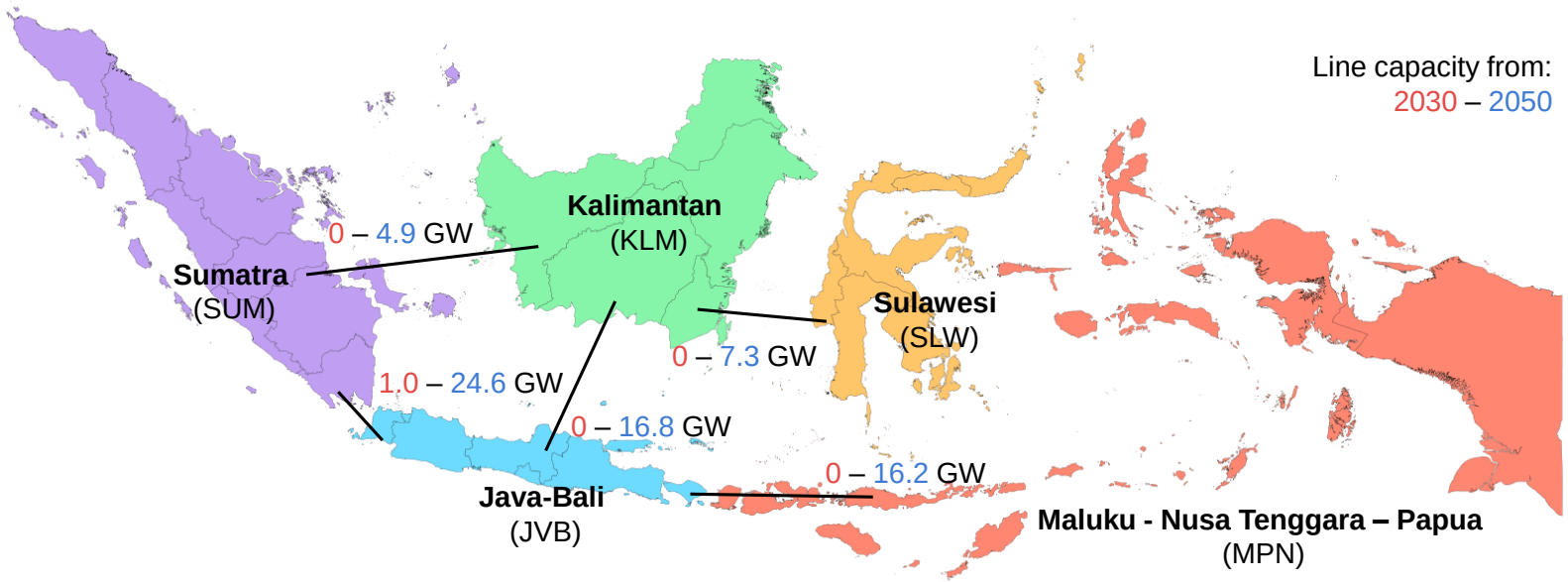


Source: IEA, Electric Vehicle Charging and Grid Integration Tool

Managed charging unlocks demand flexibility, reduces peak demand and grid congestions, and accelerates electricity decarbonisation.

Analysis of long-term projections provides visibility of grid constraints

Expansion of inter-regional electricity grids in Indonesia (2030-2050) under the APS scenario

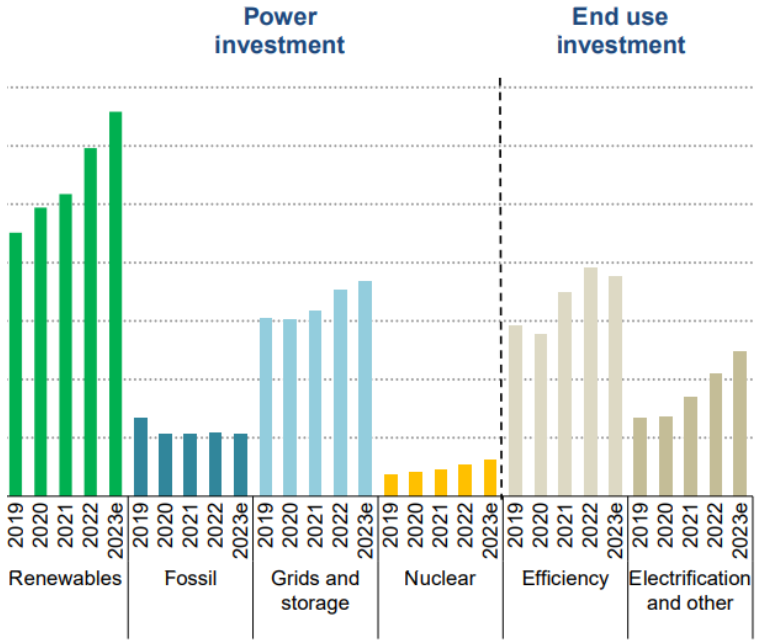


Source: IEA (2022), An Energy Sector Roadmap to Net Zero Emissions in Indonesia

Inter-regional grids can connect sources of renewables generation with demand centres as well as boosting access to sources of flexibility

Past decade saw average investment in grids of USD 300 billion per annum globally

Energy sector investment, 2019-2023e



Source: IEA (2023), World Energy Investment.

Public announcements by government and industry in terms of expected investment in the coming decades do not clearly indicate strong commitments in comparison with renewables and end use electrification.

Development times for grids

Typical deployment time for electricity grids, solar PV, wind and EV charging sta

So ment.

SPECIAL REPORT ON GRIDS

COMING IN Q4 2023

lectricity grid deployment is complex, involves many stakeholders and can take many years, which makes advanced planning critical to support clean energy transitions

Renewable Integration and Secure Electricity unit

- The RISE has engaged in both country/ region-level work as well as deep-dives into specific topics
- This has included reports, workshops and other technical assistance in:
  - Brazil
  - Korea
  - India
  - Indonesia
  - China
  - Thailand
  - Morocco
  - ASEAN region