



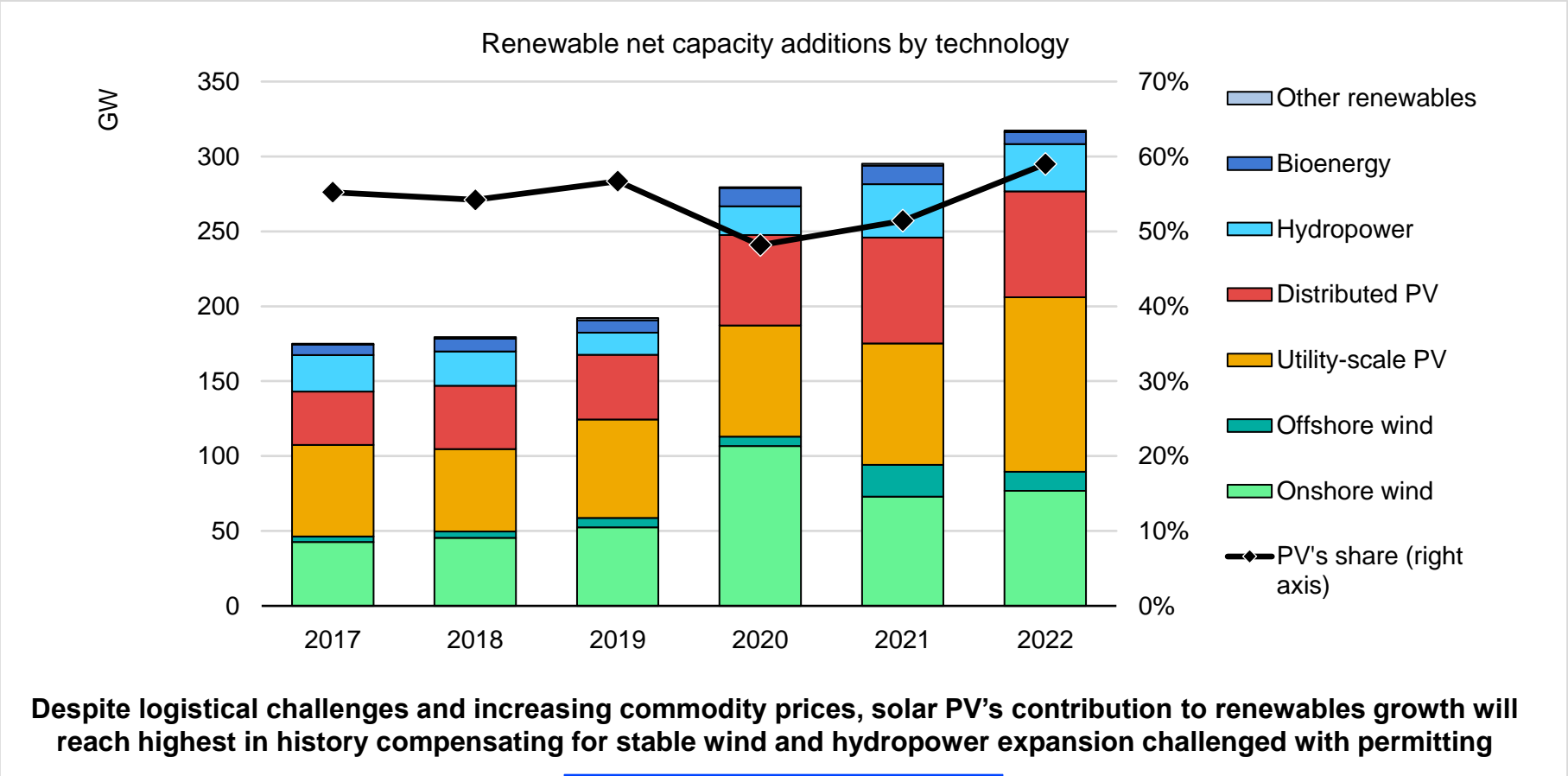
Role of Renewables for Energy Security Opportunities and Challenges

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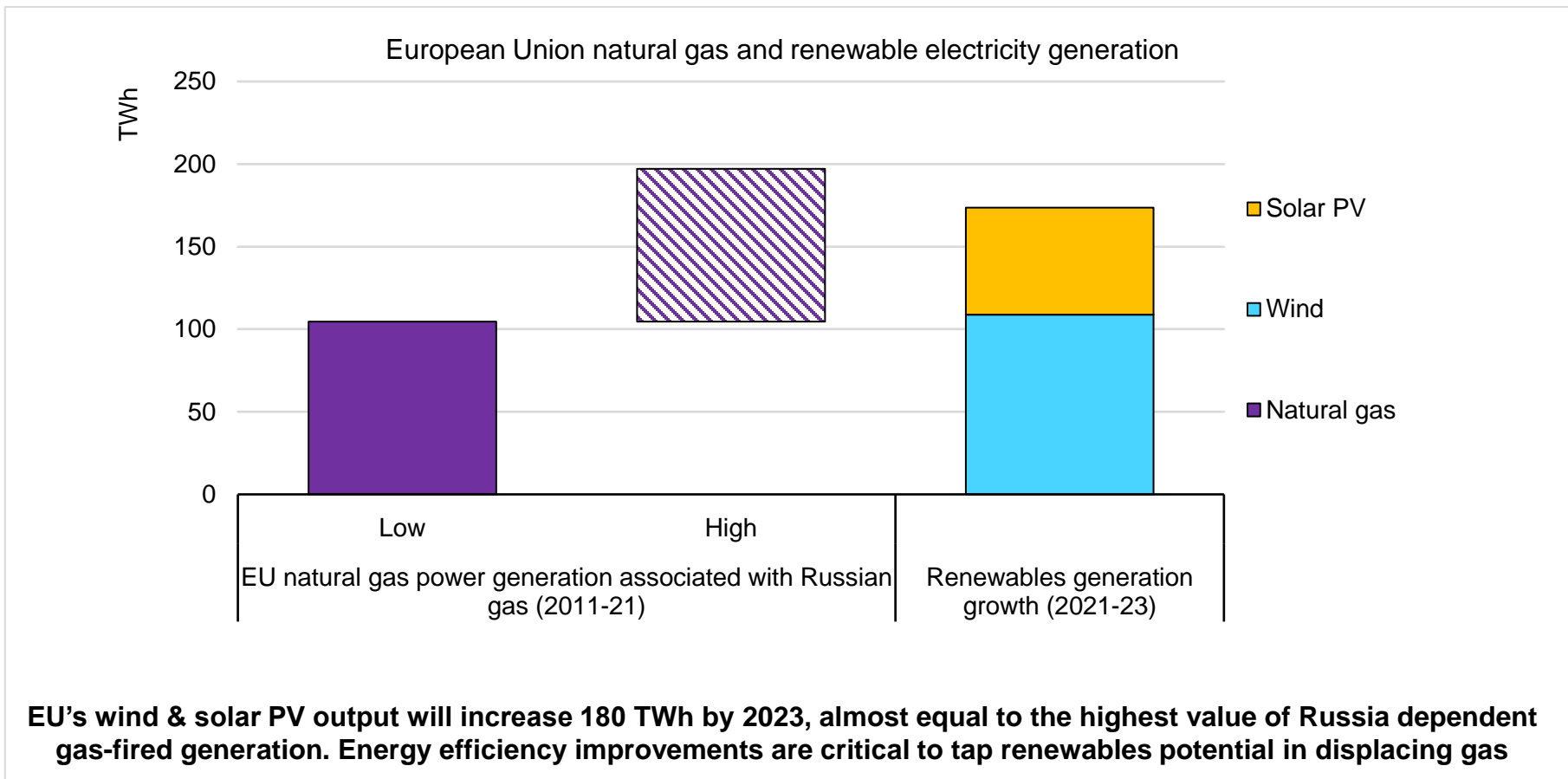
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- Renewables – a paradigm shift in energy security principles
- Short-term considerations
 - Short-term forecast and potential for gas substitution
 - Competitiveness and affordability
 - Role of bioenergy
 - Need to diversify PV supply chains
- Long-term considerations & challenges for secure integration of very high RE shares:
 - Role of renewables in IEA NZE scenario
 - Ensuring system stability – IEA/RTE study for France
 - Managing seasonal variability – current IEA work
 - Role of low-emission fuels

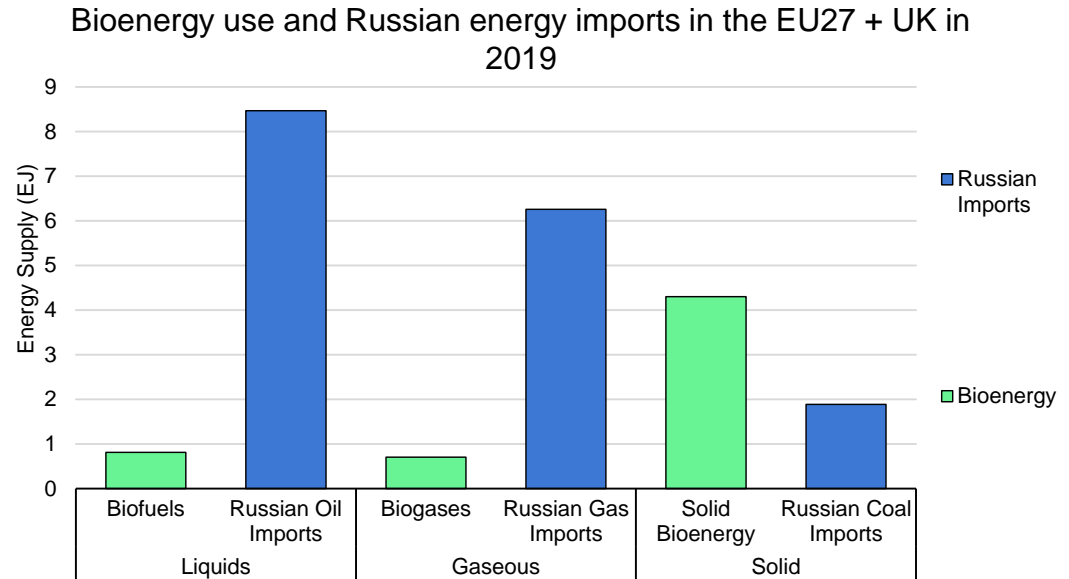
Renewables to mark another growth record in 2022 driven by PV



Wind & PV has the potential to reduce EU's dependence on Russian gas

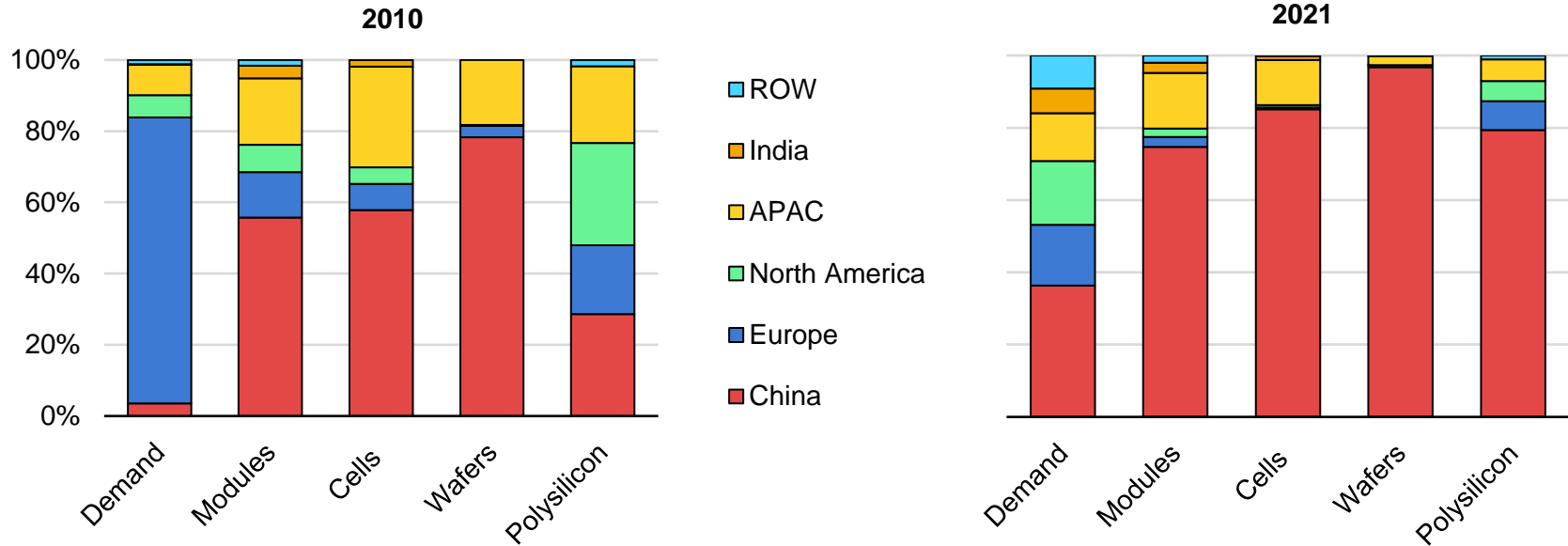


- Bioenergy already makes an important contribution to the diversity and resilience of our energy systems.
- From the end use perspective bioenergy offers a quick and commercially available drop-in solution for fossil fuels.
- There is room to expand bioenergy use in a sustainable way.
- Innovation plays a crucial role in widening the feedstock base to lignocellulosic wastes and residues.



China currently dominates global solar PV supply chains

Solar PV manufacturing capacity by country and region, 2010-2021

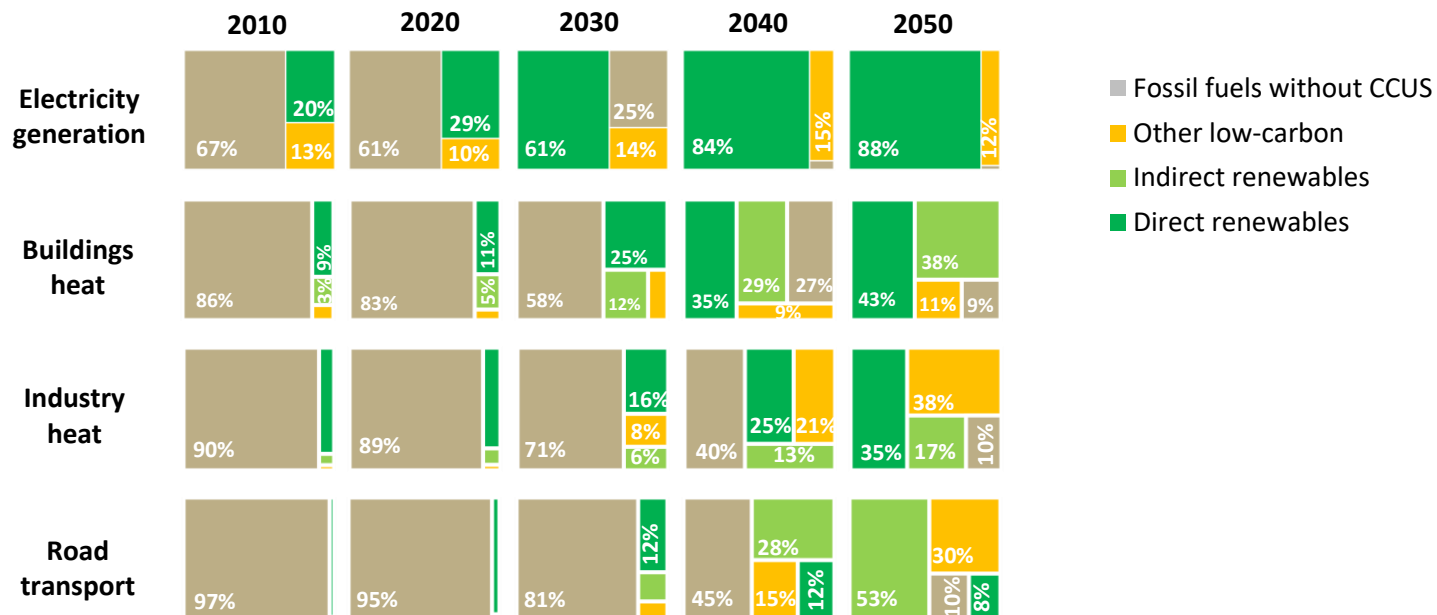


Chinese policies have enabled economies of scale and supported innovation across the supply chain, resulting in 80% cost declines and helping solar PV to become the cheapest electricity generation source globally.

Long-term opportunities & challenges

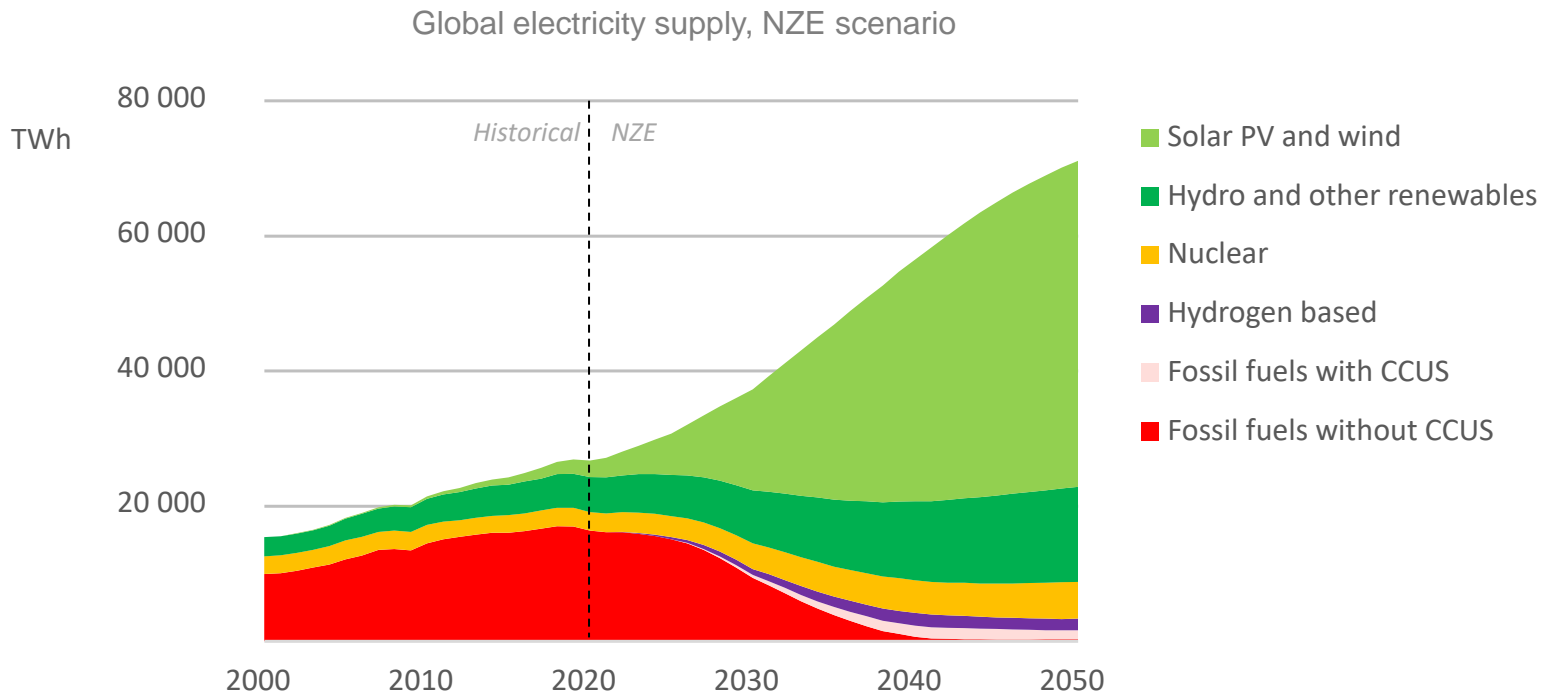
Renewables are a major driver of emissions reductions

Fuel shares in total energy use in selected applications in the NZE



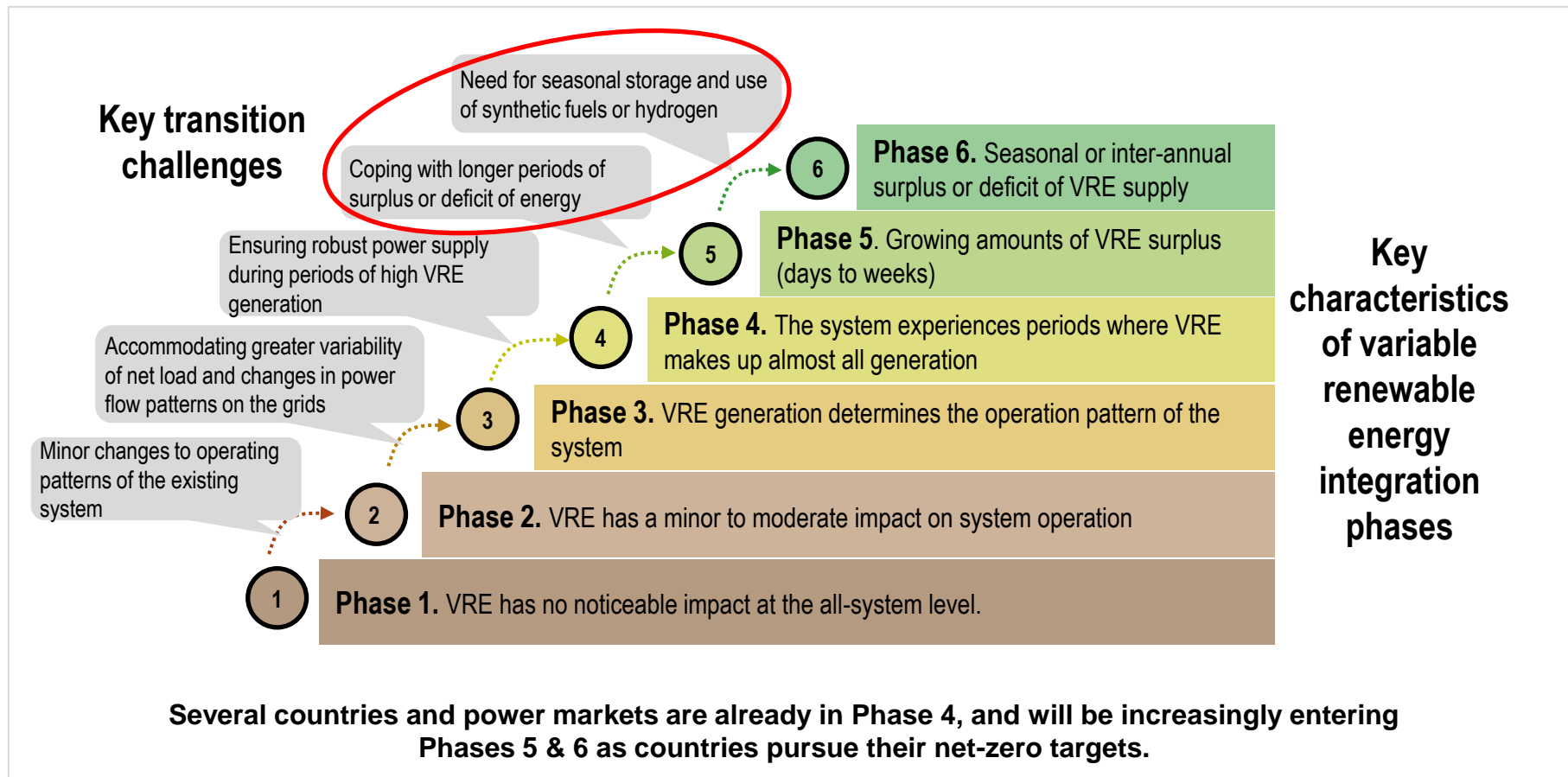
Renewables are central to emissions reductions in electricity and they make major contributions to cut emissions in buildings, industry and transport both directly and indirectly.

Renewable electricity leads the way to net zero

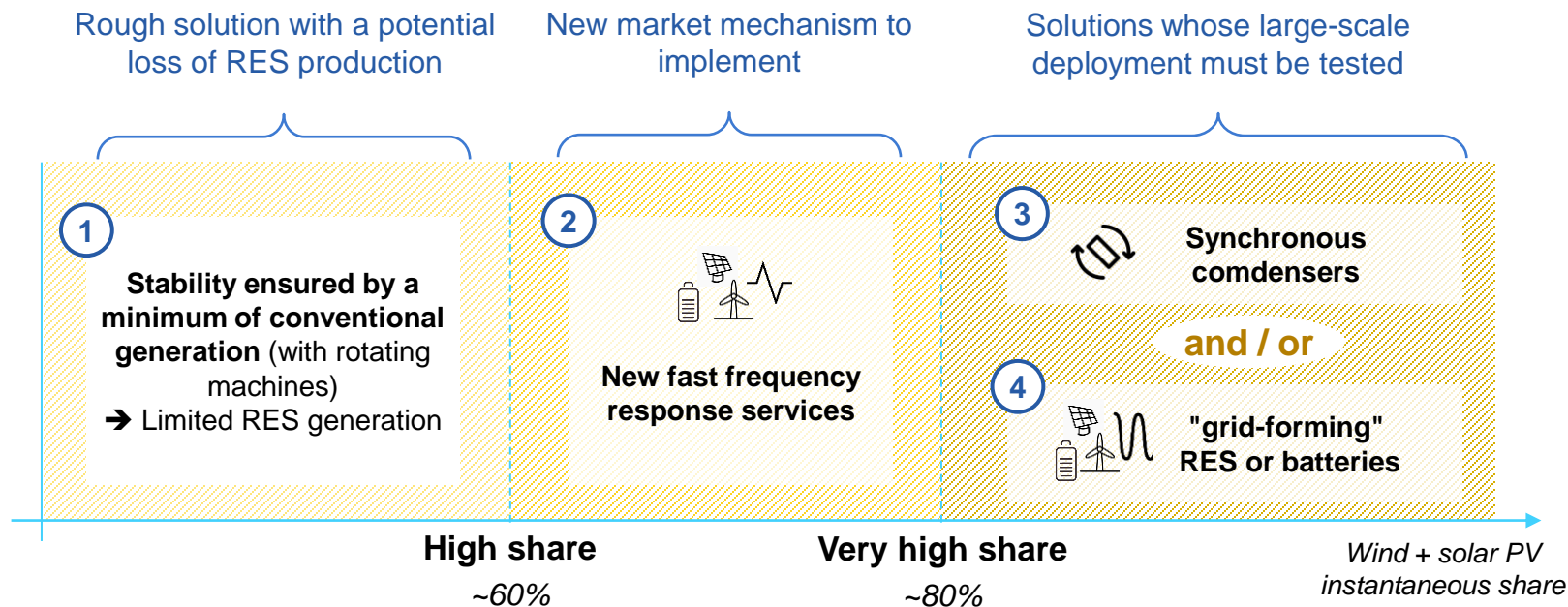


In our net zero pathway, renewables make up nearly 90% of electricity generation in 2050, propelled largely by solar PV and wind. More than 12 000 TWh are utilized to produce merchant hydrogen

Six phases of renewables integration



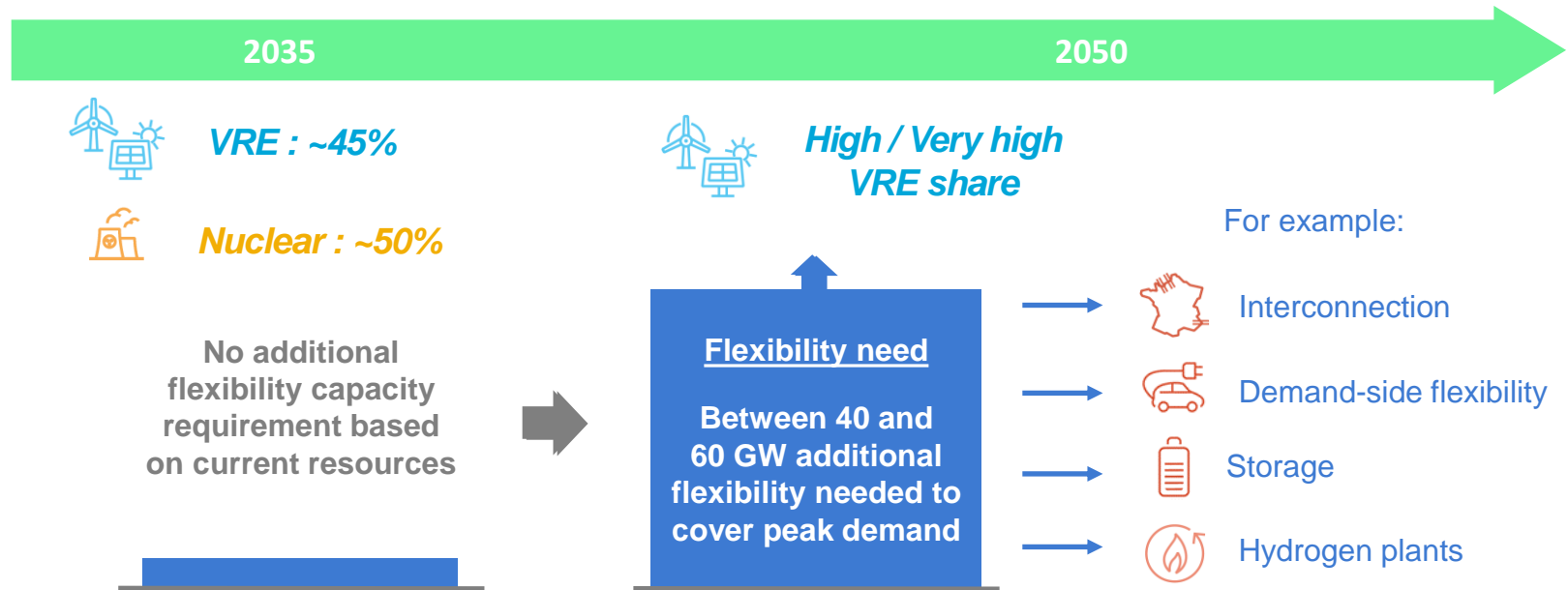
Maintaining system inertia will be a key challenge, but solutions are emerging



Scientific consensus shows technological solutions for keeping system stability without conventional generation exist in several cases, but they need to still be tested and proven at large-scale.

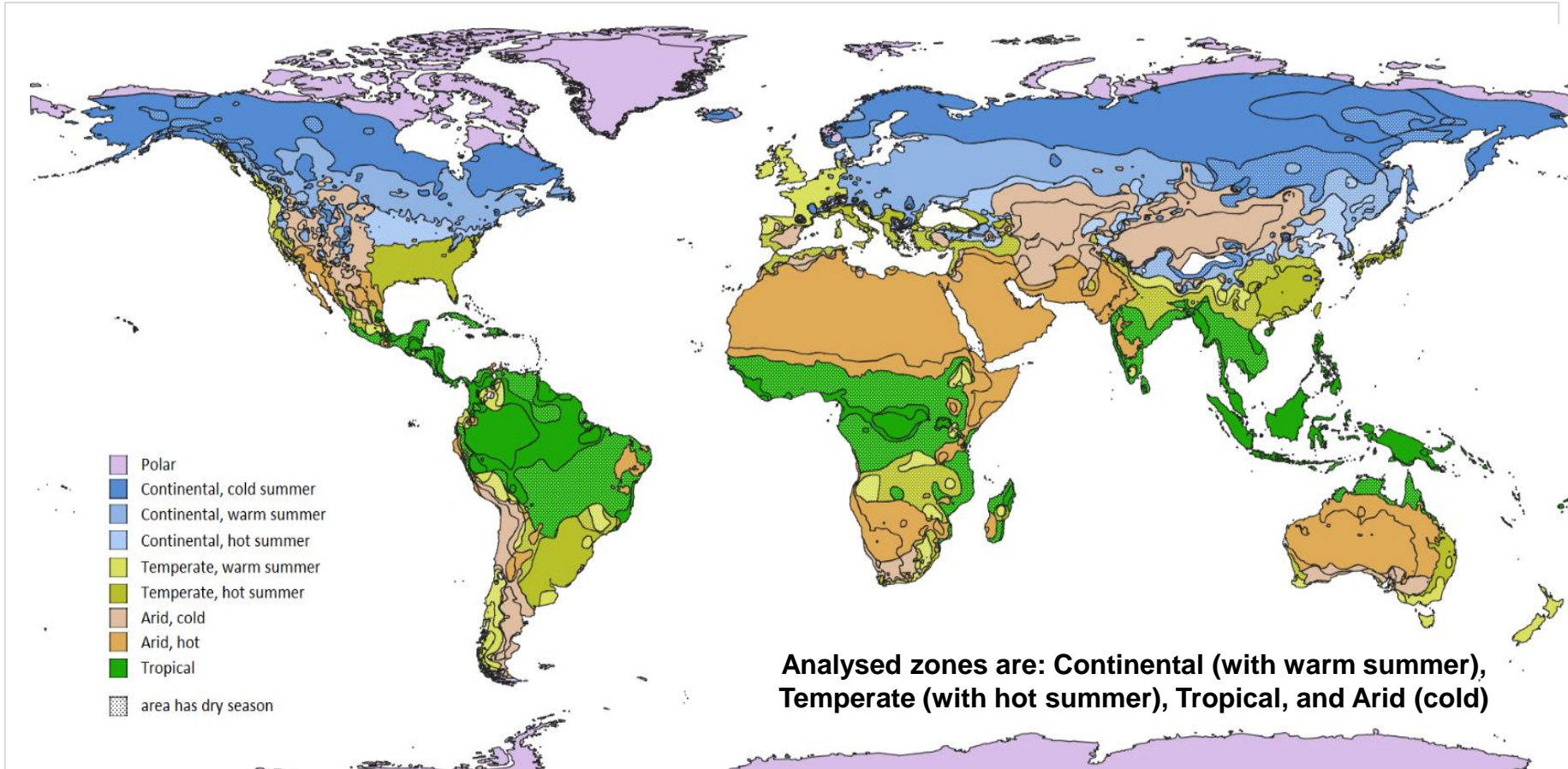
Managing adequacy with increased variability in the system

Long-term evolution of flexibility requirements in France



Integrating high shares of renewables will require developing a mix of flexibility resources, including generation, demand response, large-scale storage and well developed transmission networks

Current work focuses on four key climatic zones



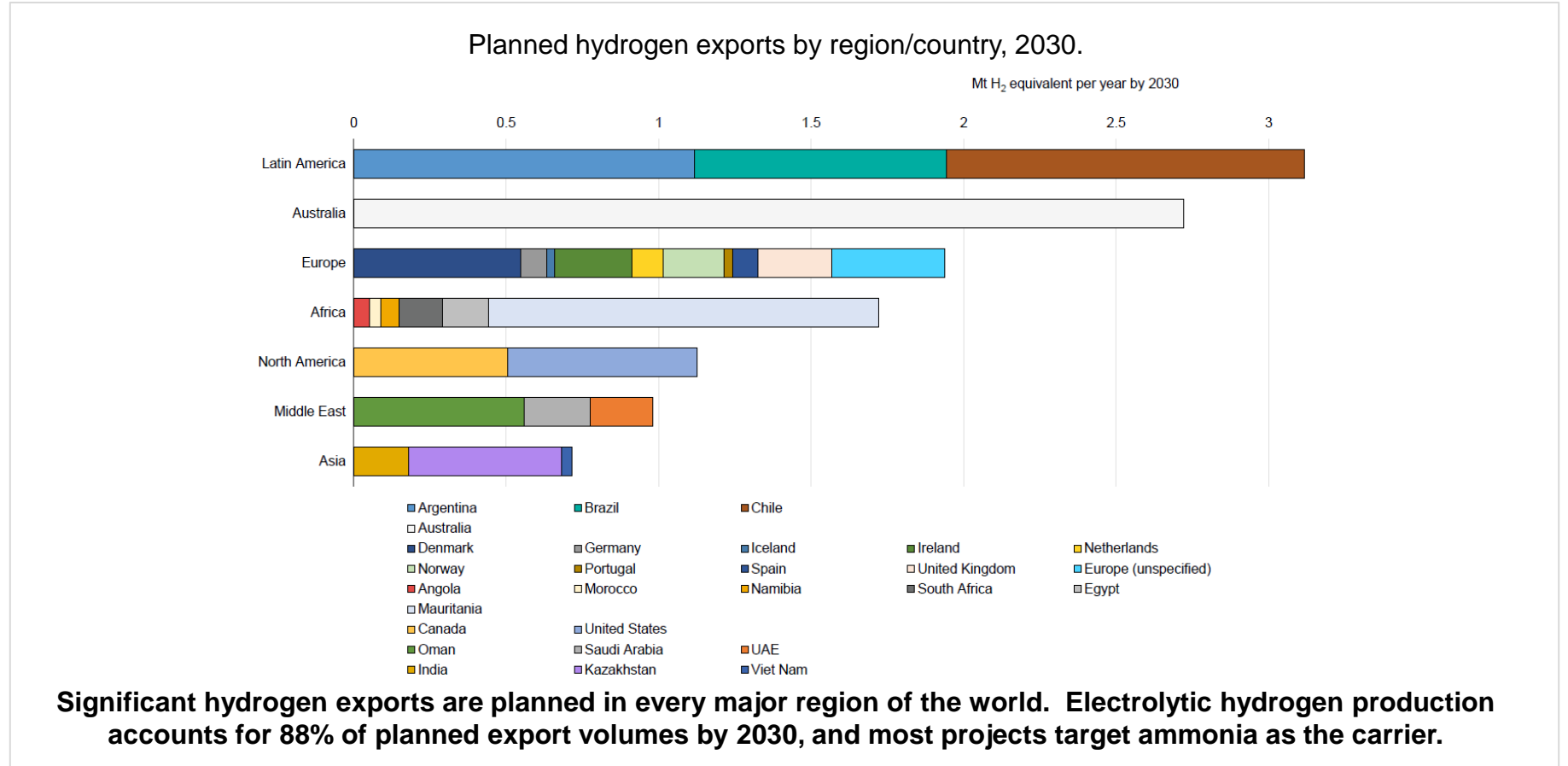
Seasonal patterns emerge from the interaction of demand and VRE supply

Key distinguishing seasonal attributes of analysed climate regions.

	Seasonal demand profile	Size of peak load	Hydro availability	Seasonal wind & PV complementarity
Tropical				
Arid, cold				
Temperate, hot summer				
Continental, warm summer				

Challenges to integrate renewables over long time periods increase with strong mismatches between demand and renewables supply on a seasonal scale.

Low-emissions H2 exports reach 12 Mt by 2030 based on project pipeline



Significant hydrogen exports are planned in every major region of the world. Electrolytic hydrogen production accounts for 88% of planned export volumes by 2030, and most projects target ammonia as the carrier.

- Renewable energy increases energy security through diversification and reduced costs.
- Secure and cost-effective integration of very high shares of VRE crucial to meet climate targets.
 - All forms of flexibility needed: stronger grids & interconnections, dispatchable low-emission power plants, affordable storage, demand-side response.
 - New solutions to maintain system stability are emerging but need to be proven at scale
- International trade of hydrogen and derived fuels can enhance global energy security. Current project pipeline needs to further expand.
- All forms of renewables needed in combination with energy efficiency and flexible resources.