

IEA WORK ON FUTURE ELECTRICITY SYSTEMS

Power grids, demand response and the low carbon transition

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Founded in 1974

- Formed in wake of 1973 oil embargo with mission to promote member country energy security - autonomous agency of the Organisation for Economic Cooperation and Development (OECD)

29 member countries

- **Asia Pacific**: Australia, Japan, Republic of Korea and New Zealand
- **North America**: United States, Canada
- **Europe**: Austria, Belgium, Czech Rep, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey and United Kingdom
- **European Commission** also participates in the work of the IEA

Decision-making body: Governing Board

- Consists of member country representatives
- Under the Governing Board, several committees are focusing on each area

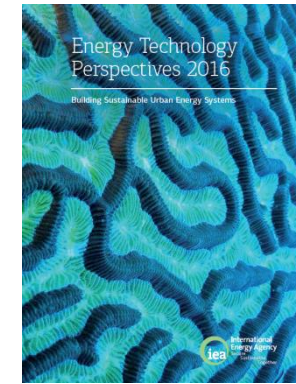
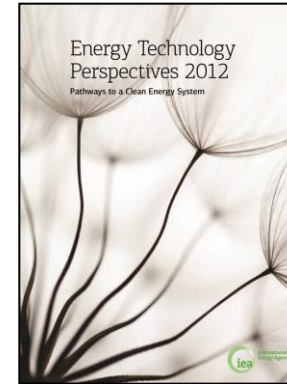
Secretariat:

- **Staff of around 230**, mainly energy experts and statisticians from member countries

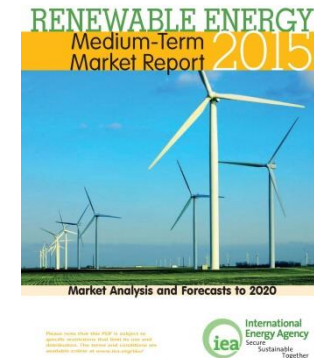
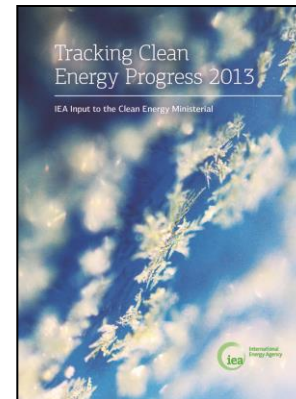
IEA Energy Technology Activities



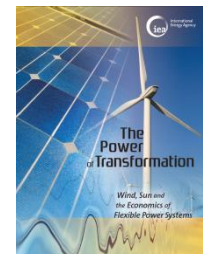
■ Where do we need to go?



■ Where are we today?



■ How do we get there?



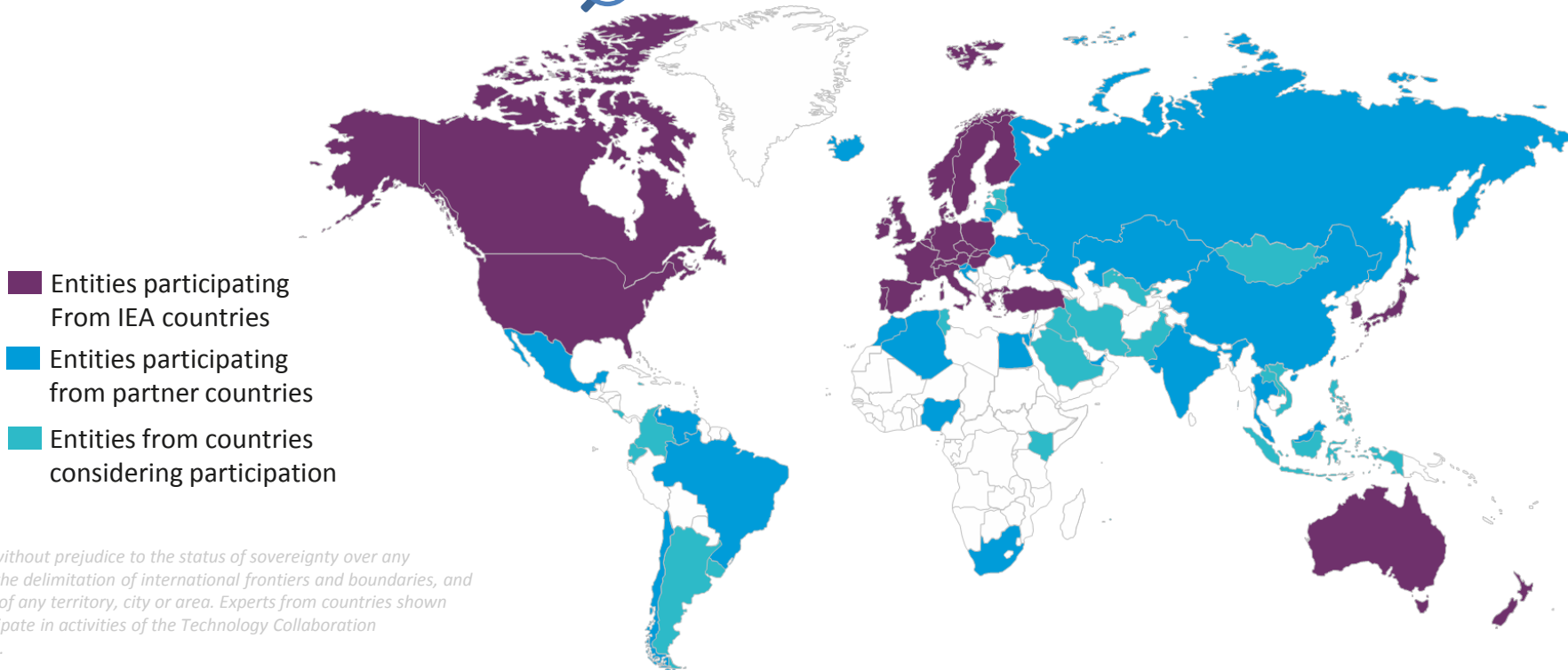
Technology Collaboration Programmes



TCPs are created or discontinued according to energy policy challenges

Currently 39 TCPs

- Cross-cutting activities
- End use and energy efficiency
- Fossil fuels
- Fusion power
- Renewable energy and hydrogen



Power plays a critical role in the 21st century energy system



■ The important role of electricity

- Accounts for 40% of primary energy consumed in OECD countries
- Accounts for 42.5% of energy-related global CO₂ emissions
- Growing pillar of energy security for electrified and digitalised economies

■ A transformation is already underway

- Demand declines or stagnates in all OECD Europe
- Wind and solar power represent 11.3% of capacity in IEA countries
- New technologies changing the power generation landscape

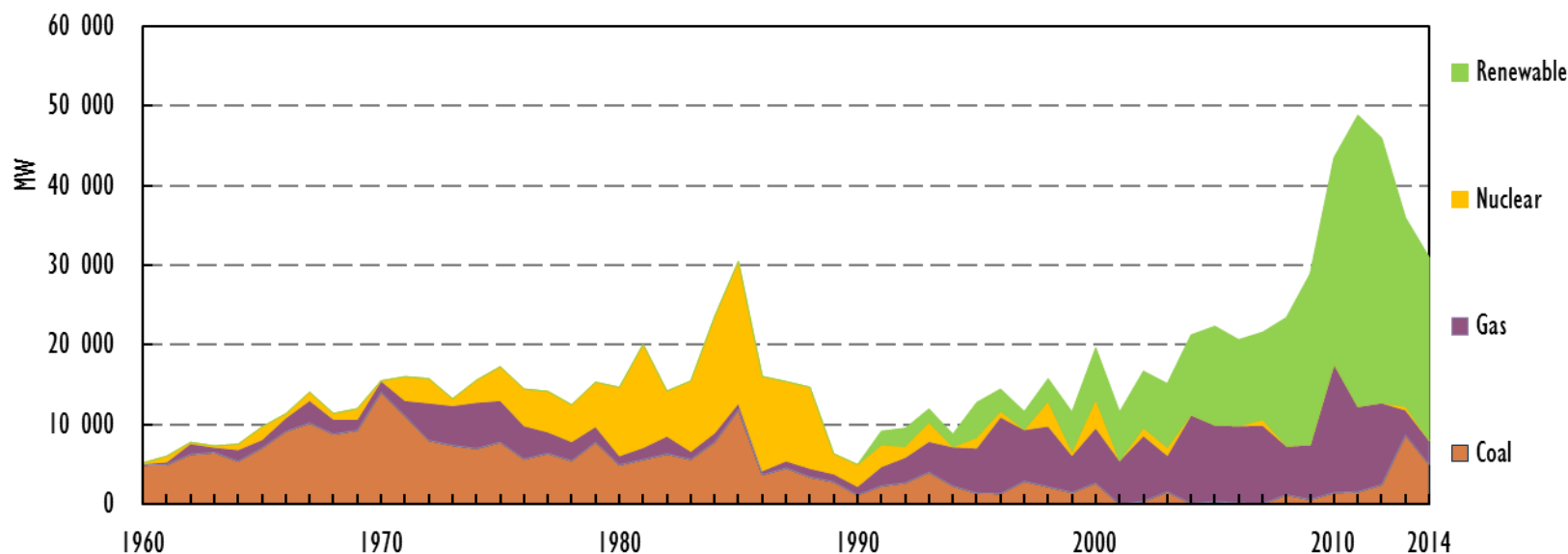
■ Competitive markets under-deliver

- Rapid deployment of renewables has been policy-driven
- Future of utilities in low-carbon power system

■ New technologies, market design initiatives and reforms

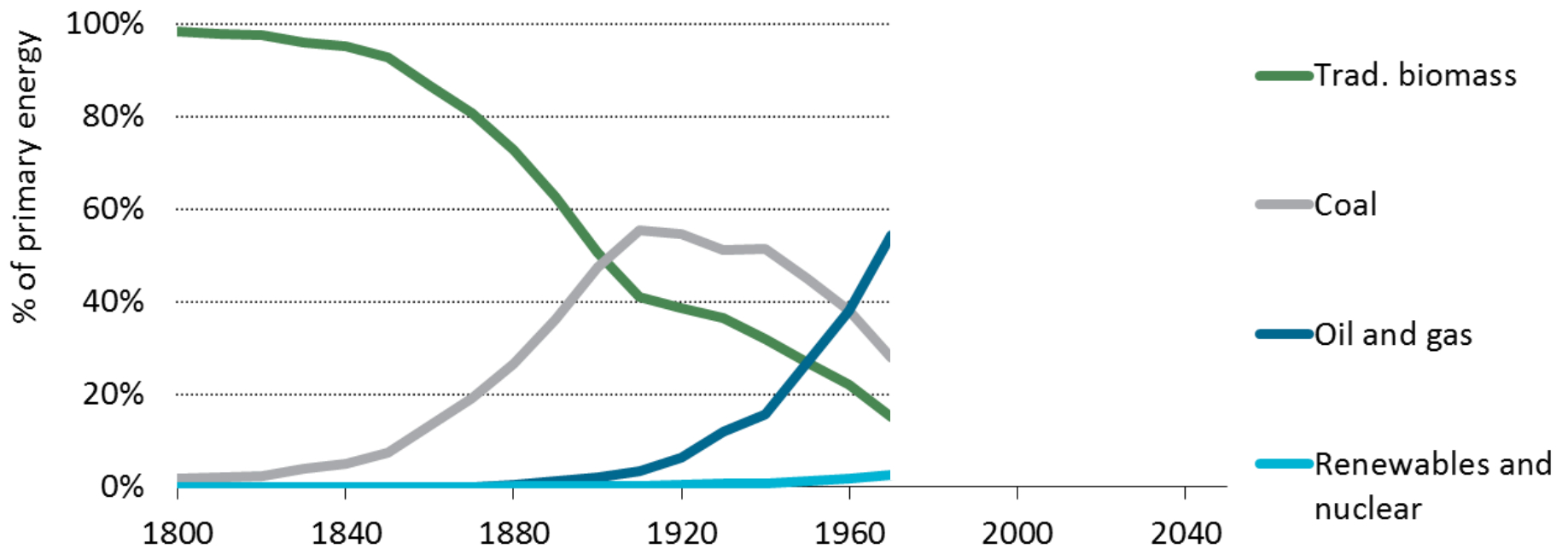
Technology options and choices are changing

Capacity additions in OECD Europe by technology, 1960-2013



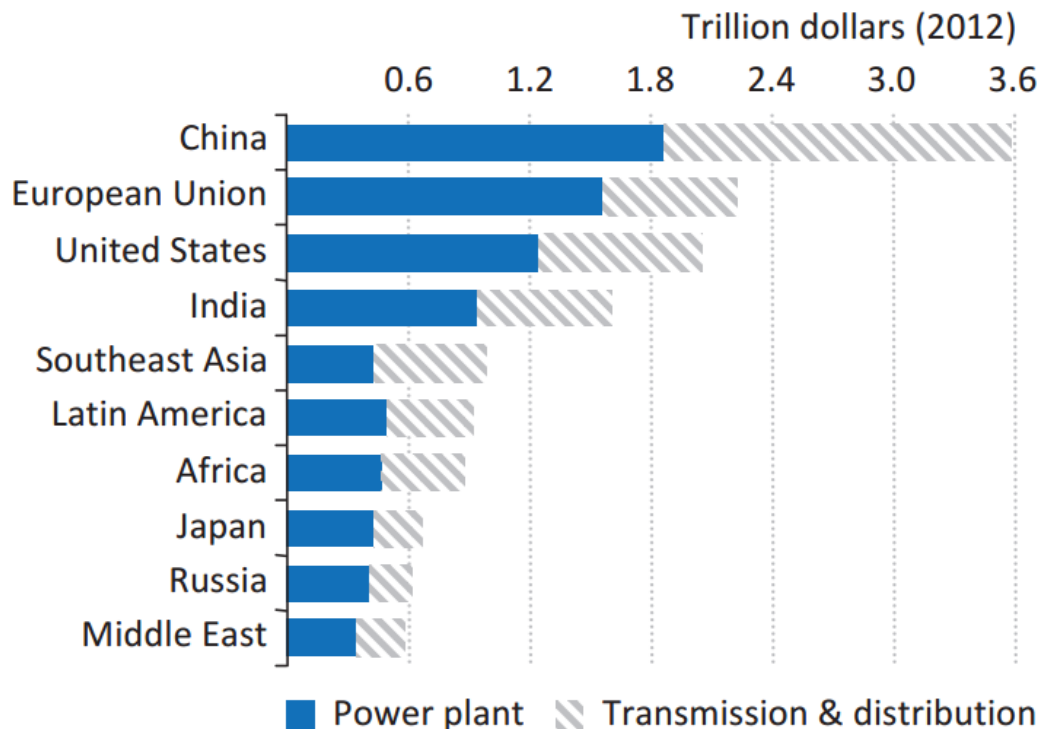
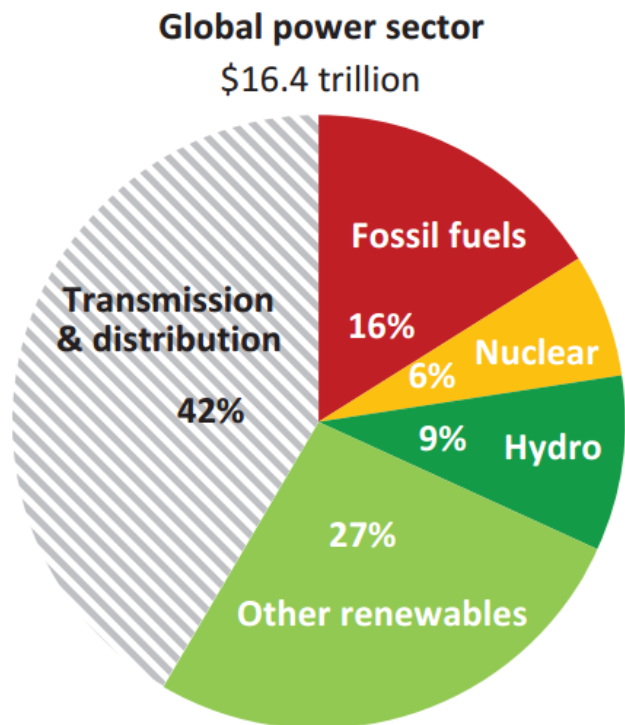
More than 45% of existing thermal capacity was built prior to 1990, and massive investments are needed in new power plants and networks.

The energy sector innovates slowly...



Data from Smil (2010) and IEA (2015), 2DS scenario

Power grids are a key enabler of a low carbon future

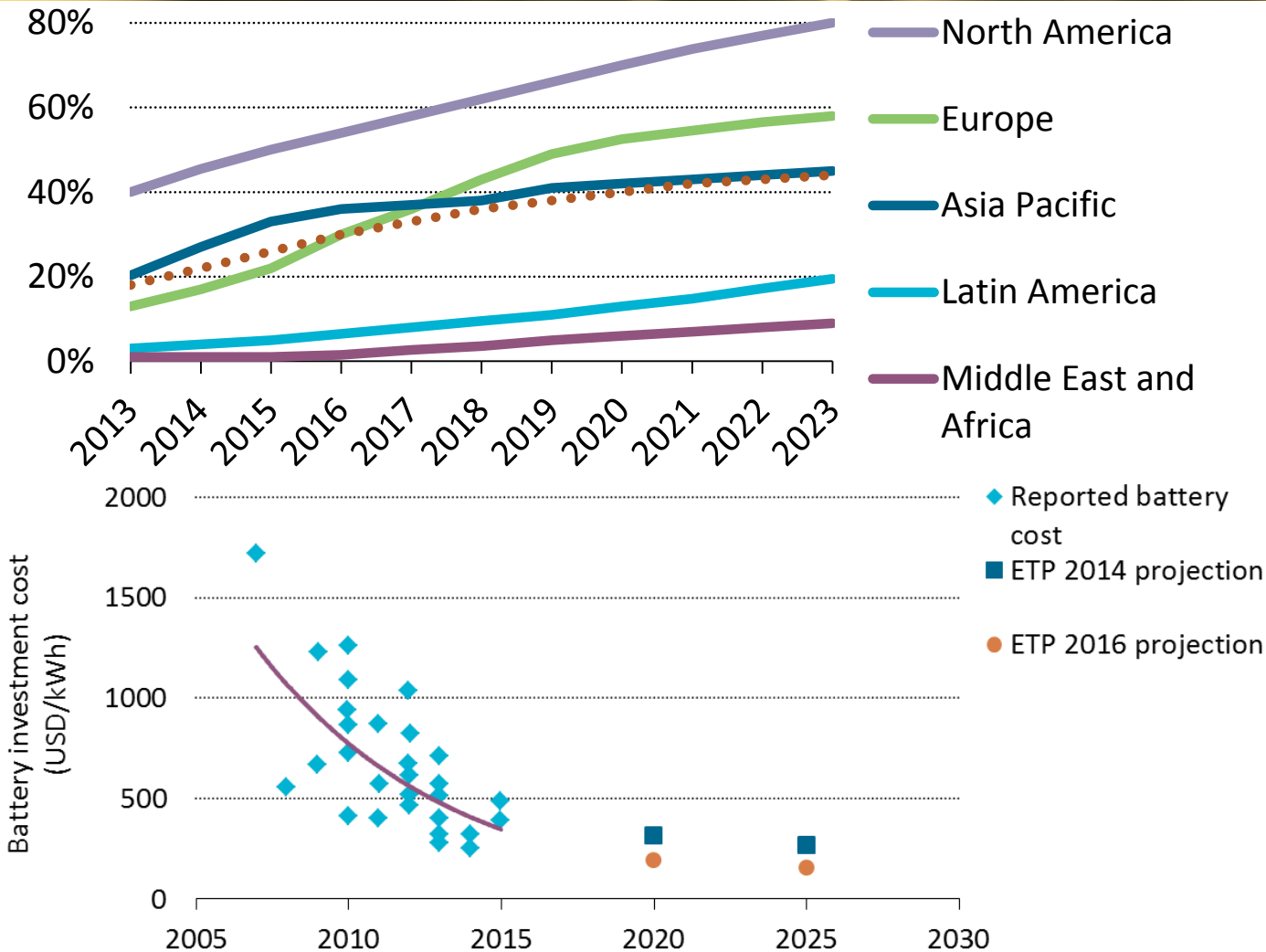


WEO: 8.4 trillion in grid investments by 2040, with half of all power transmission assets requiring replacement or upgrade

Alternative and distributed energy is accelerating



Smart metering becoming mainstream, residential-scale batteries are next



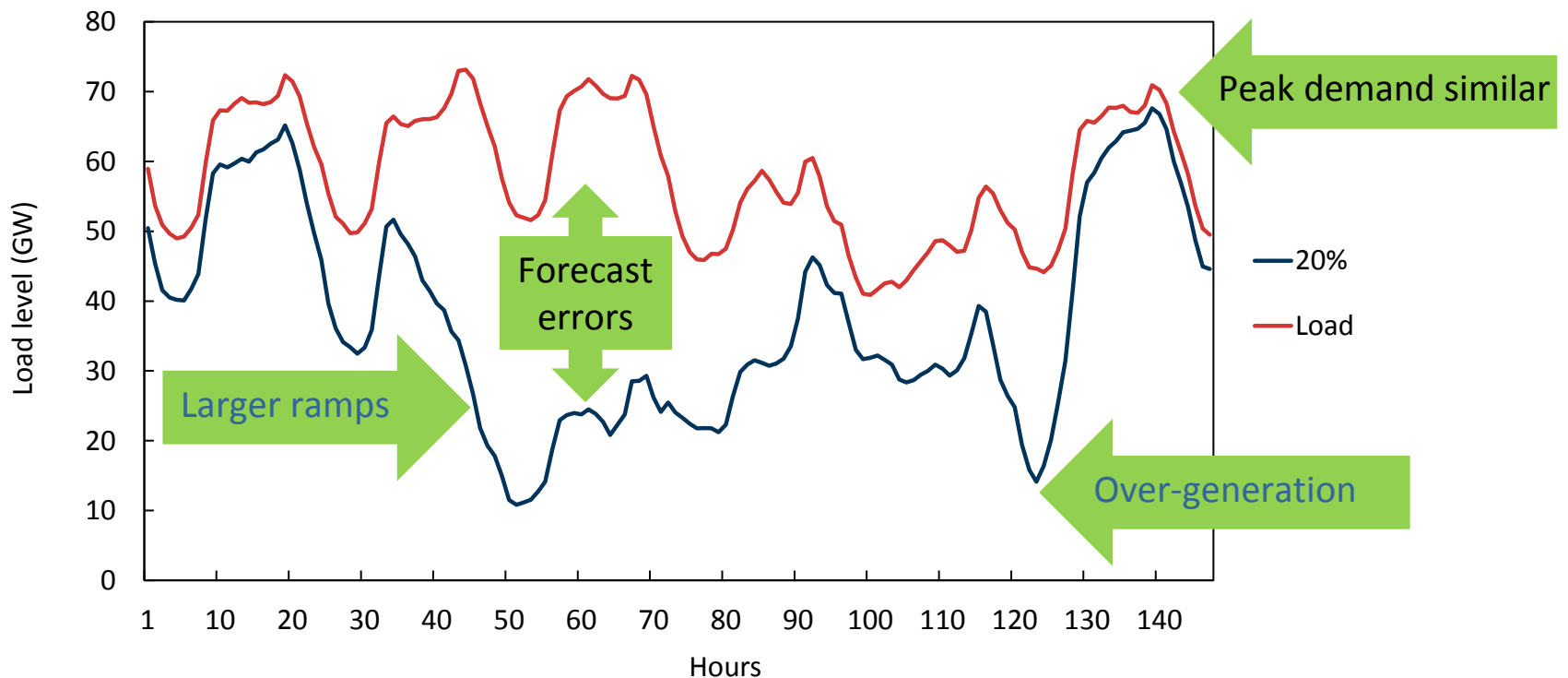
Smart meters

Batteries

➔ Consumers increasingly looking for more control, insight on their energy use

Operating the system becomes more challenging as the technology mix shifts

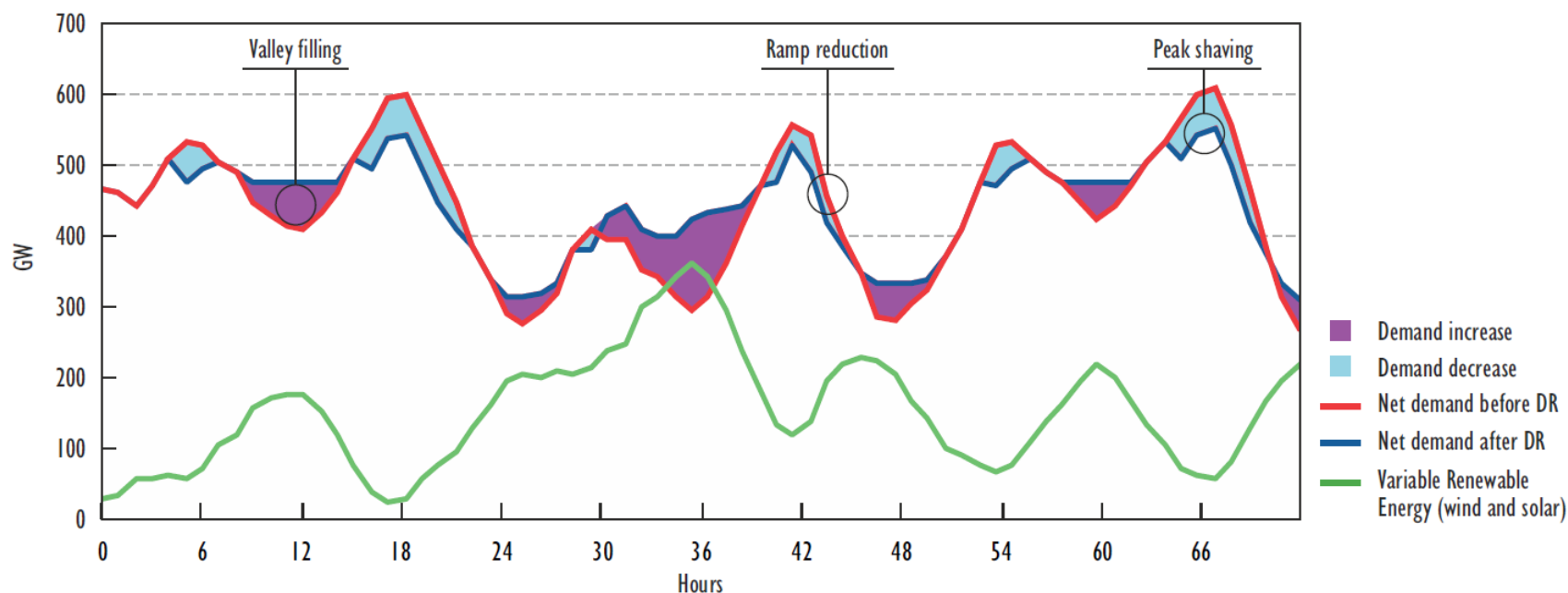
Integrating variable renewables creates new challenges



Short-term markets with a high temporal and geographic resolution can compensate for forecast errors and ensure flexible and secure system operations.

Demand response can bring many benefits

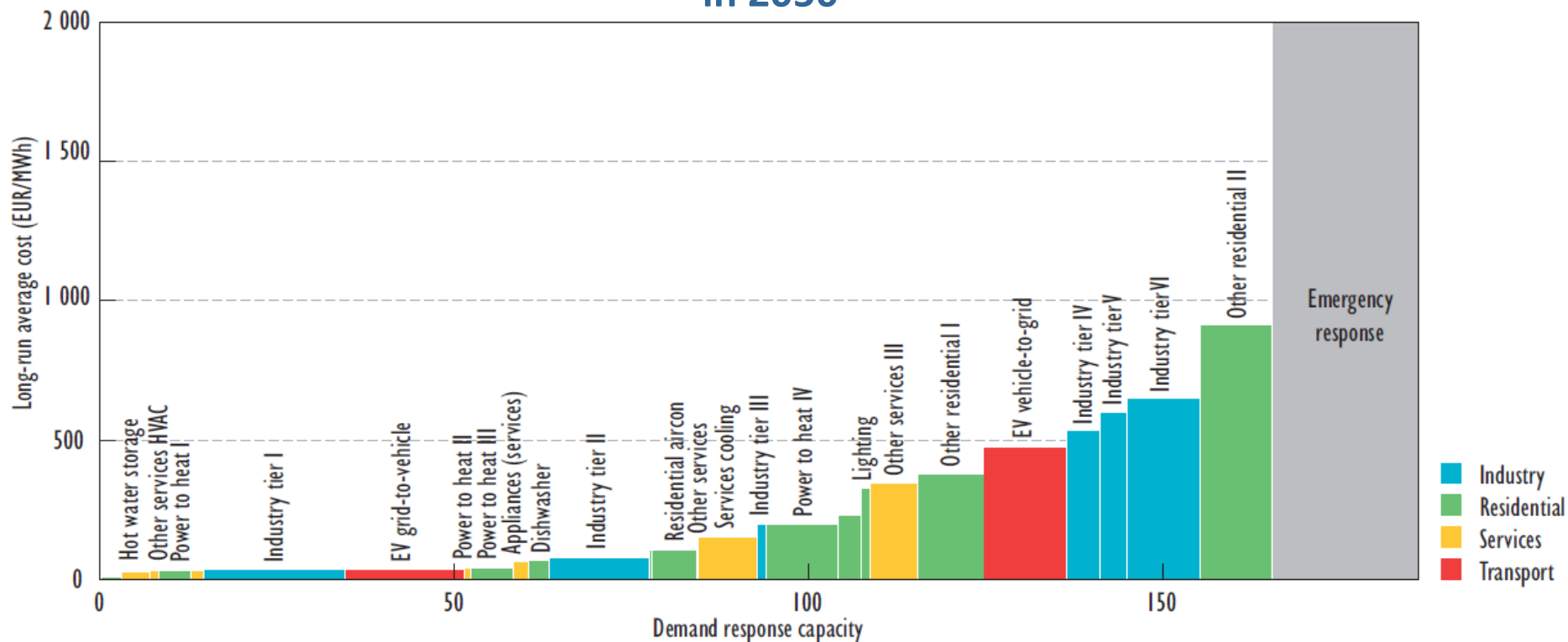
The different roles of demand response with high share of renewables (illustrative)



With new technologies, small consumers can contribute to flexibility and must be treated in a technology-neutral fashion.

High demand response potential

Modelled demand response and supply curve in the European Union in 2050

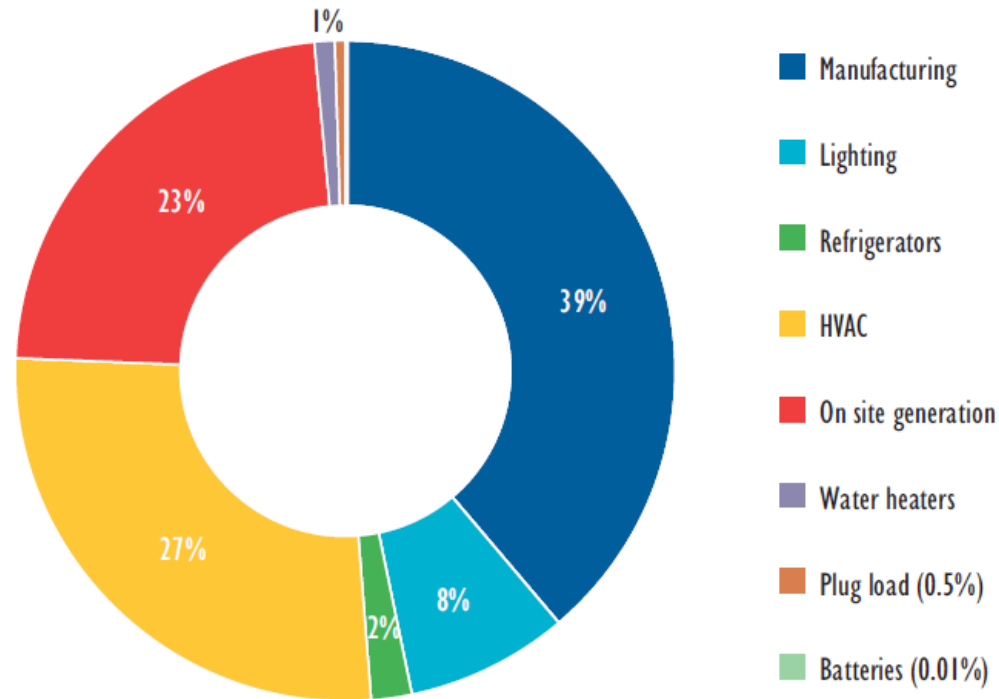


In the European Union, demand response potential could exceed 150 gigawatts (GW) by 2050.

Large-scale deployment will increasingly require automated solutions



Source of demand response in PJM (2014/15 delivery year)

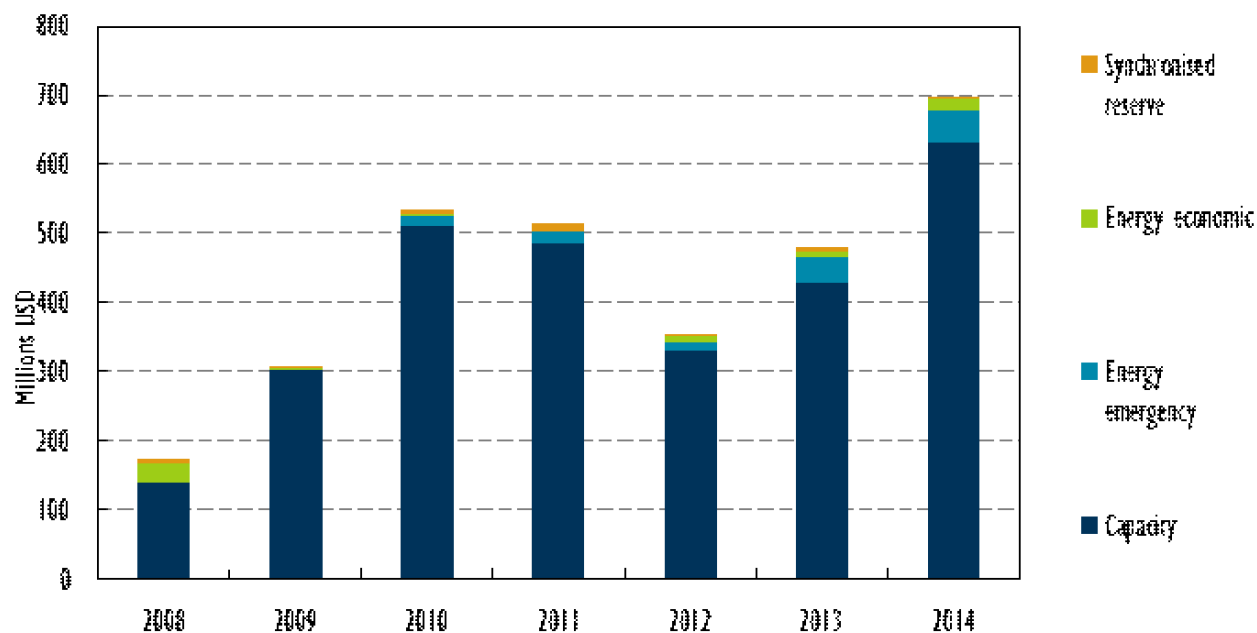


Key technologies contributing to DR need to be identified; e.g. in PJM, manufacturing processes, HVAC, on-site generation and automated lighting systems form 97% of the source.

Most revenue for DR participants are from capacity mechanisms



Demand response revenue by market in PJM 2008-14

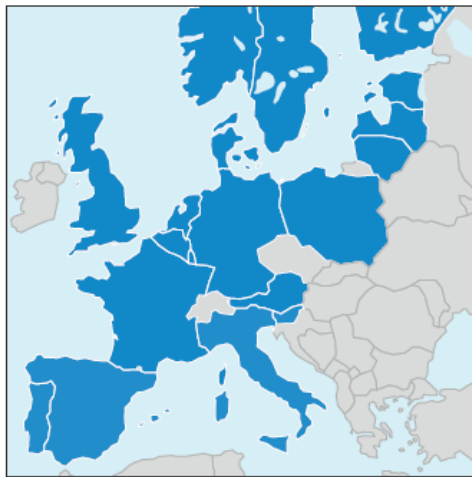


Emergency revenue, which includes capacity and emergency energy revenue, increased by 42.3%, from \$475 million in 2013 to \$675.7 in 2014.

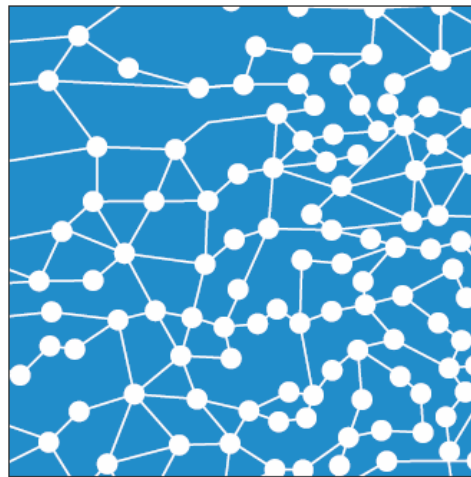
Efficiency of competitive markets should be reinforced



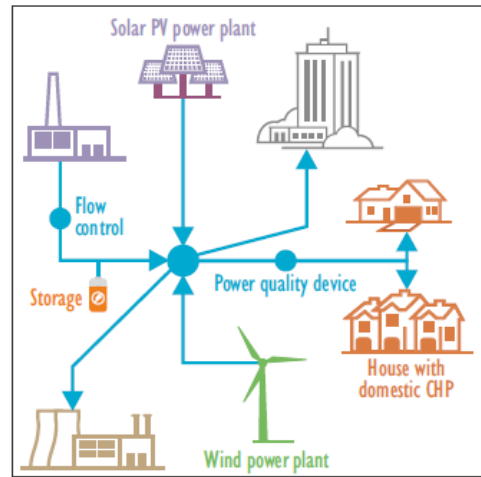
Continental markets



Locational markets



Local, distributed market

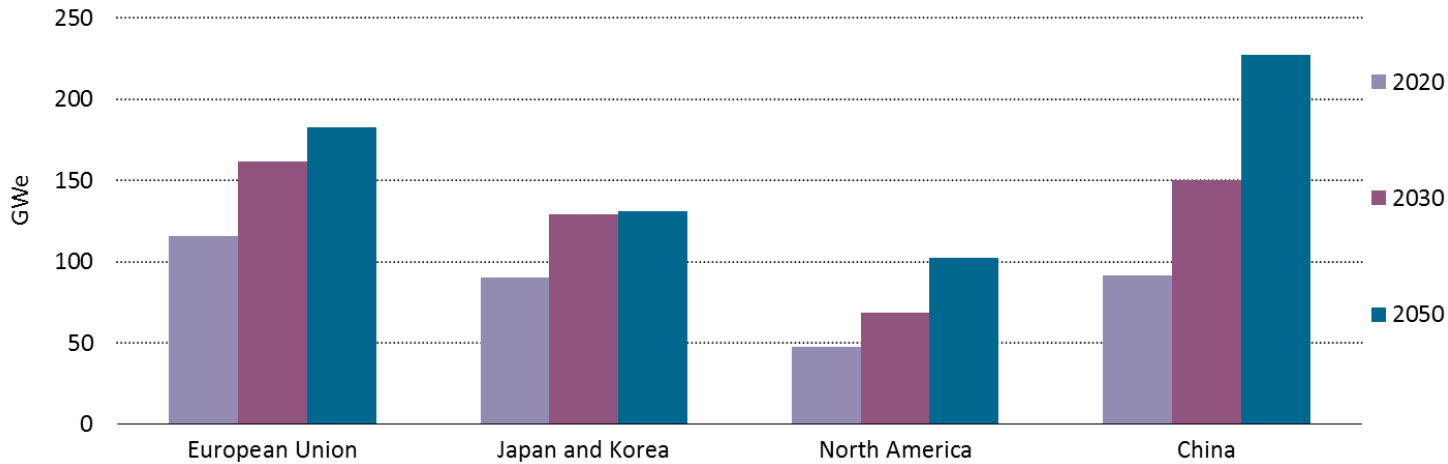


This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

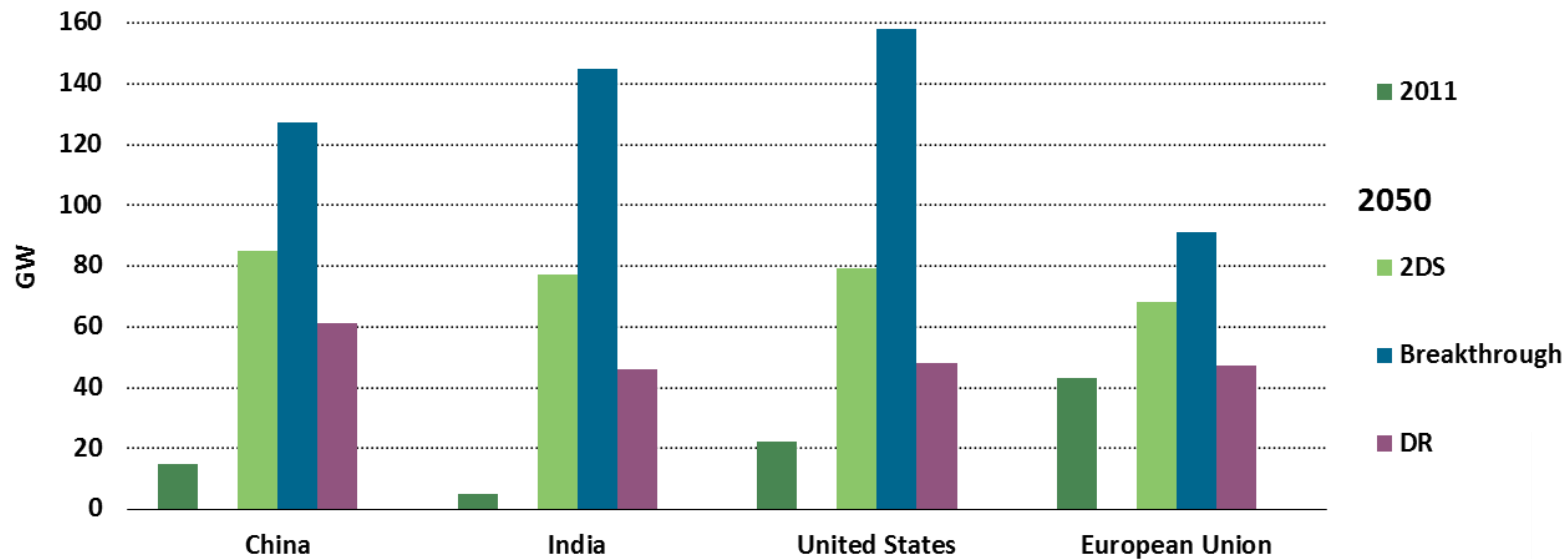
Short-term markets are pivotal to integrating wind and solar power and tapping the full potential of distributed resources and neighbouring markets.

Future demand for flexibility

DR potential



DR vs everything else



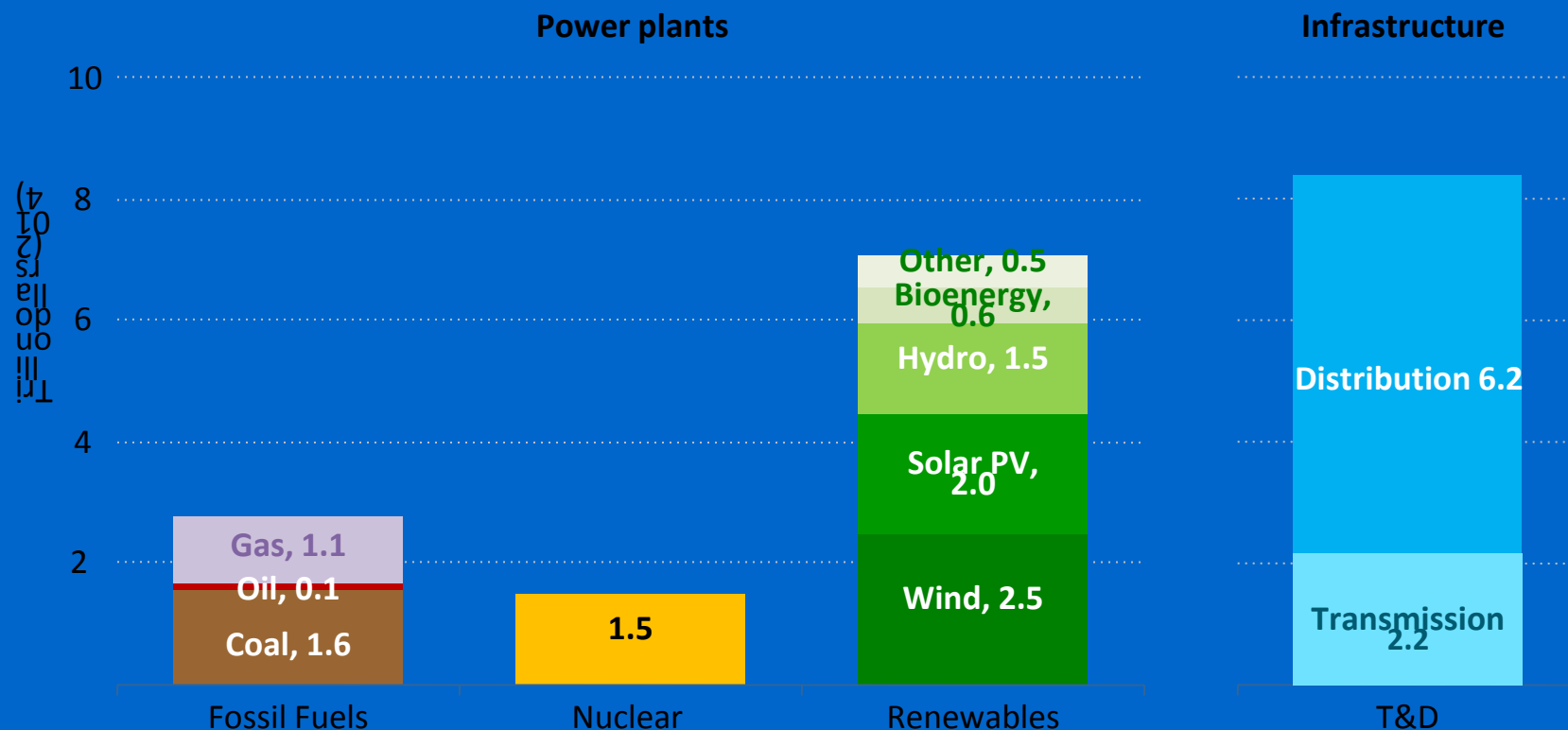


Thank you

Low-carbon and networks require the largest investment



Global power sector cumulative investment by type, 2015-2040



Source: WEO

In OECD Europe, new transmission investments needed will require modernising the regulatory framework and looking beyond local interests.