

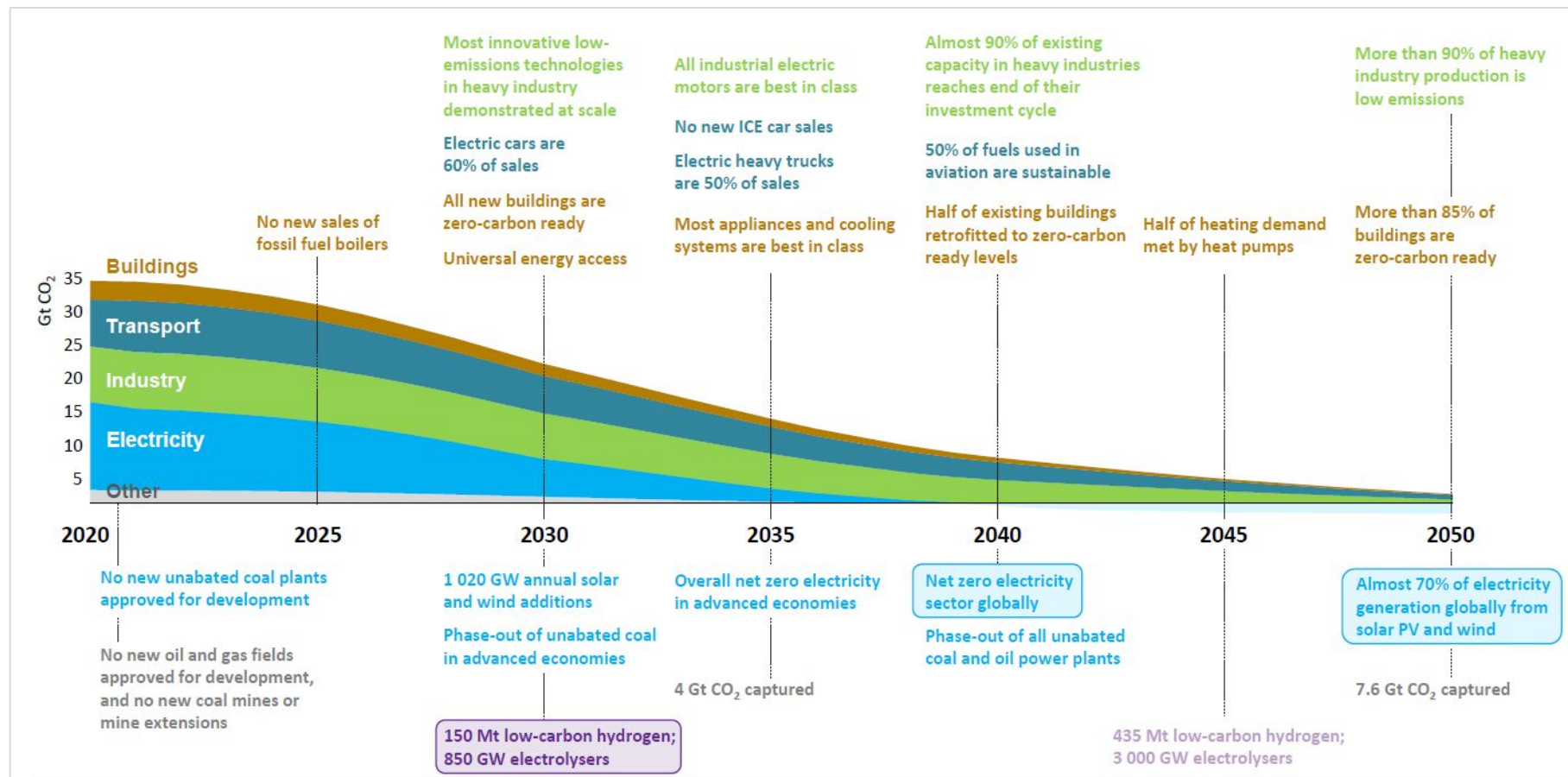


Electricity Markets: Fast-tracking Innovation in Energy Transition

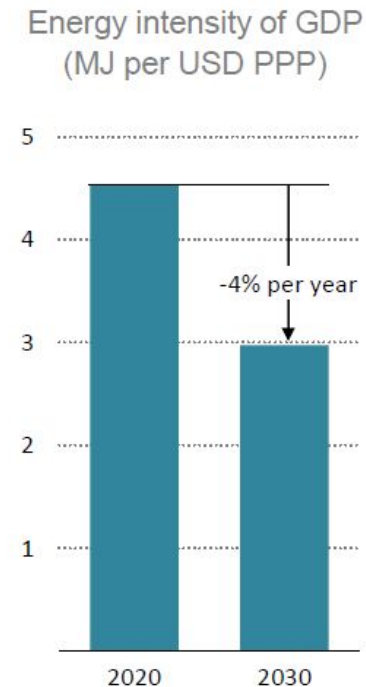
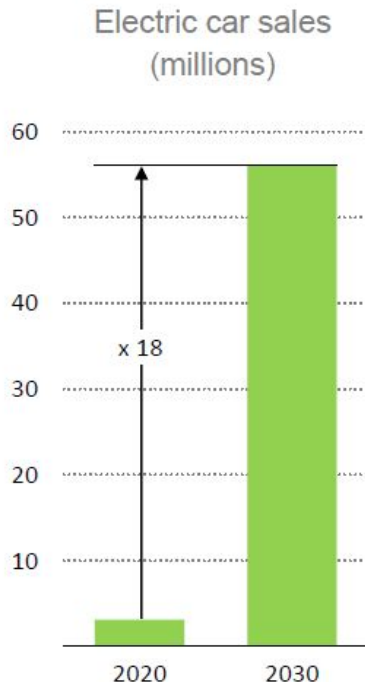
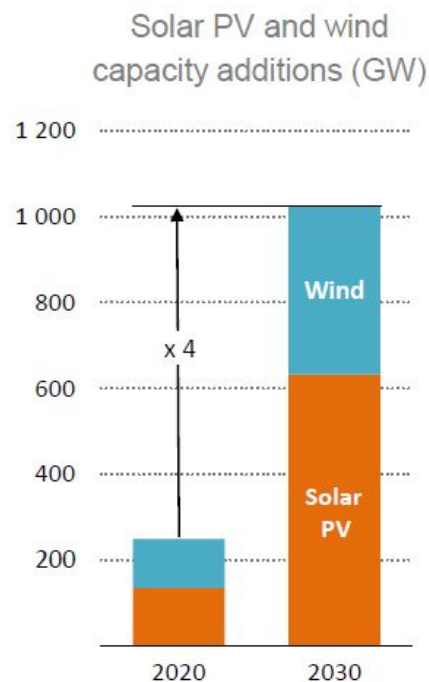
Pablo Hevia-Koch, Head of Unit, Renewable Integration and Secure Electricity

02 June 2023

Energy systems need to transform to meet long term targets

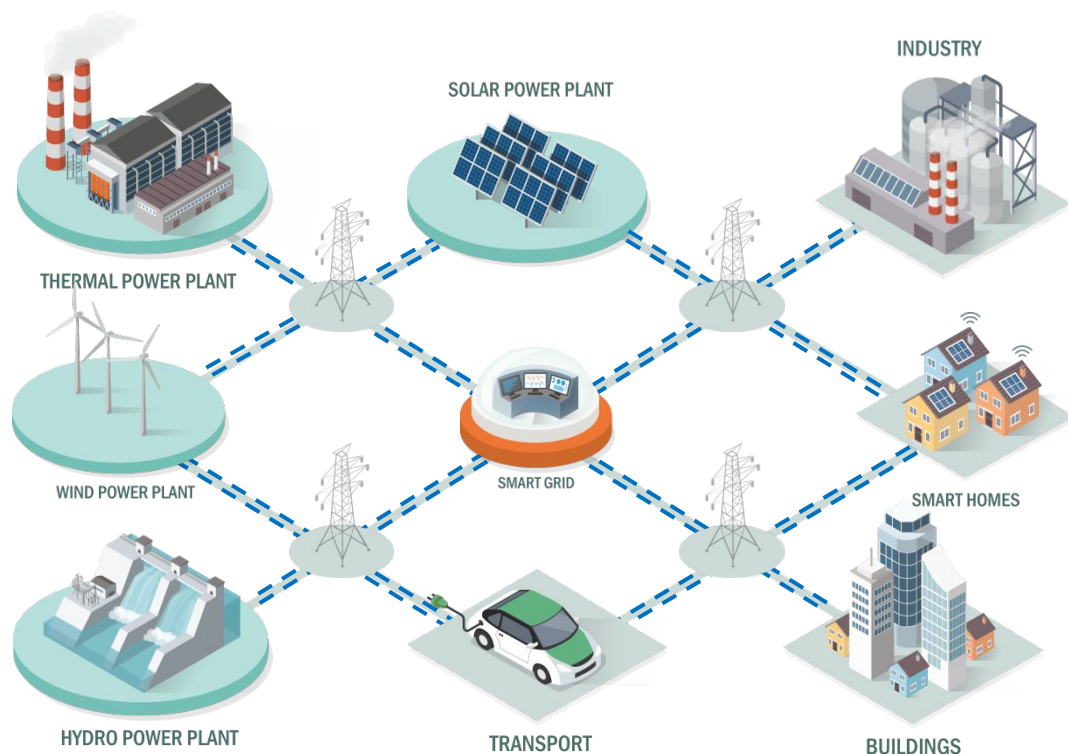


The next decade requires a massive clean energy expansion



Technologies for achieving the necessary deep cuts in global emissions by 2030 exist, but need to be deployed at unprecedented pace. Their technical characteristics imply fundamental change, particularly in the power sector.

Innovation will be critical at every level of the power sector



Traditional system

Centralised / dispatchable
High inertia and stability
Central planning
One way flows of energy and communication
Closed networks, few devices

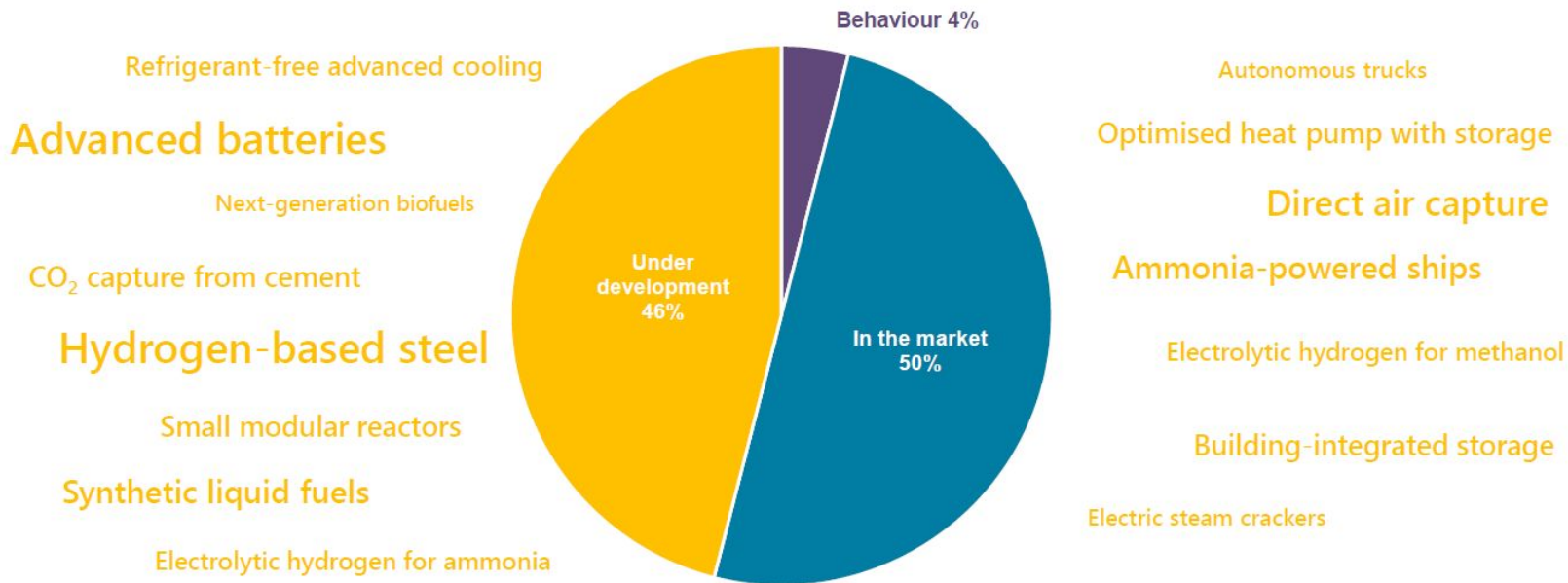


New system

Decentralised / variable generation
Low system inertia from rotating machines
Multiple actors / competitive markets
Two way flows of energy and communication
Open networks and many devices
Changing climate patterns

Half of emissions savings by 2050 still need technology development

CO₂ savings by technology maturity in 2050, NZE scenario

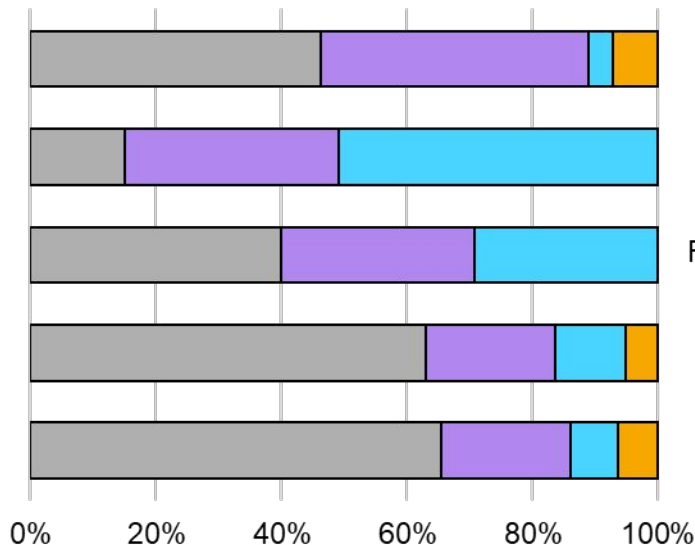


Unlocking the next generation of low carbon technologies requires more clean energy R&D and 90 billion in demonstrations by 2030. Without bringing new technologies onto the market, global net zero will not happen by 2050.

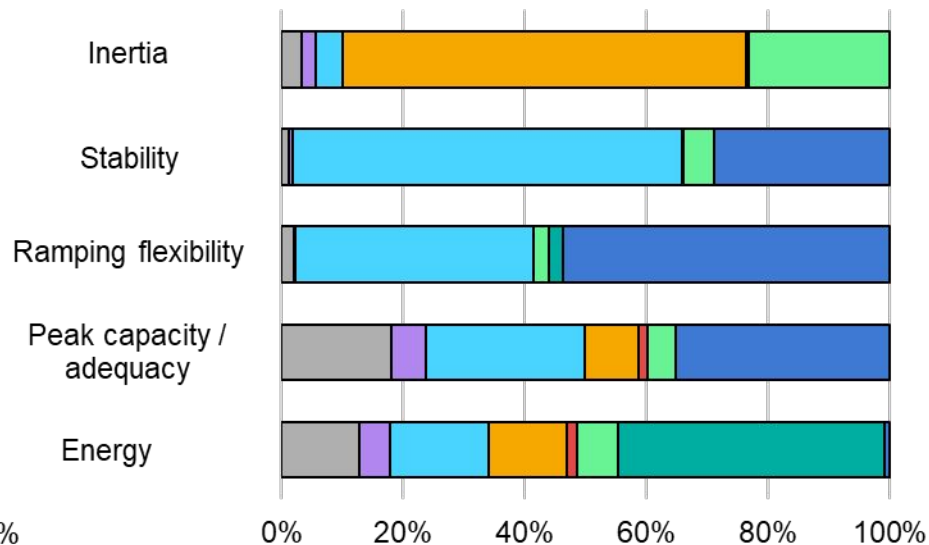
The technologies supplying electricity security will have to diversify

System services in Indonesia 2019 – 2050 (Announced Pledges Scenario)

2019



2050 APS

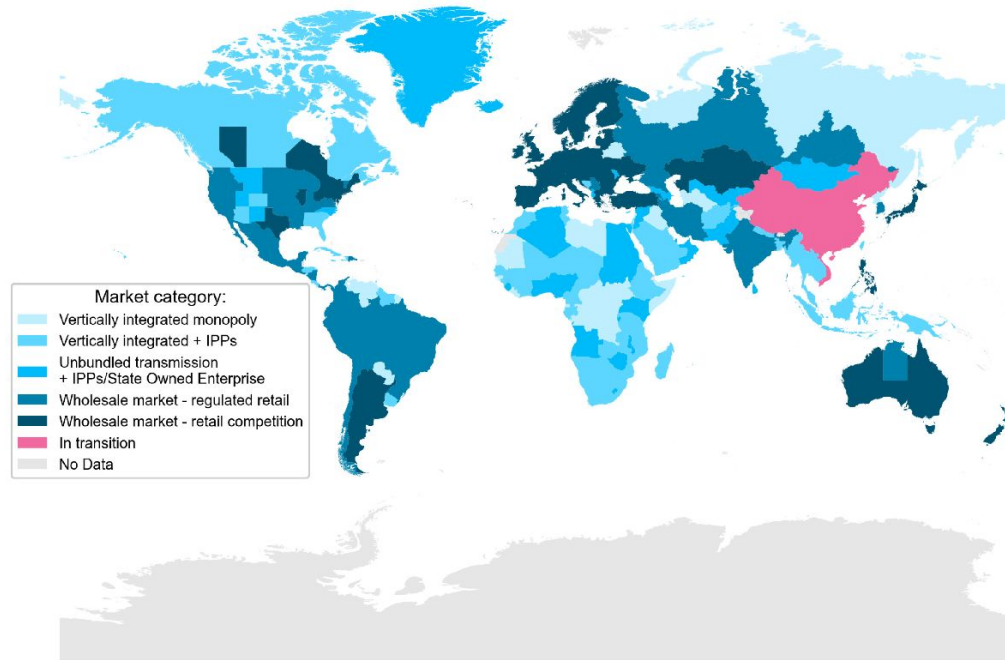


■ Coal ■ Gas ■ Hydro ■ Geothermal ■ Oil ■ Bioenergy & other renewables ■ Variable renewables ■ Storage & demand response

As fossil fuel plants retire and VRE grows, a variety of new sources will need to be rewarded and incentivised for their contributions to services supporting electricity security.

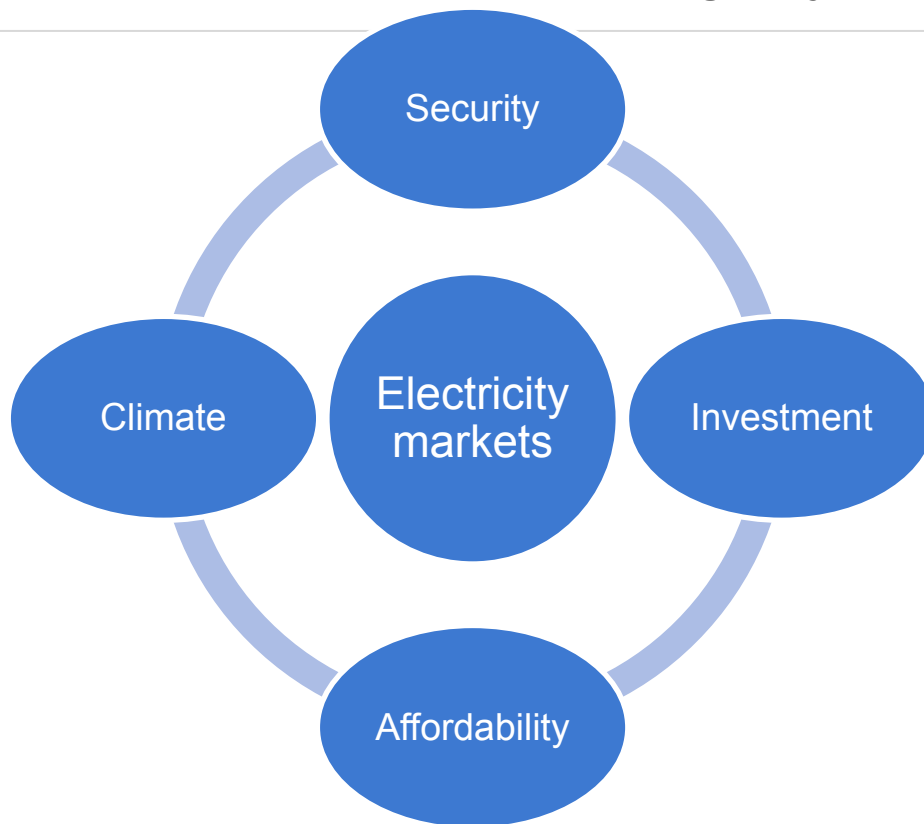
Investment signals depend on electricity markets in many regions

Status of electricity markets around the world in 2022



Around 70% of global electricity is consumed in systems with some form of electricity markets, which will grow to over 80% once China's liberalisation is complete

Markets optimise multiple, sometimes conflicting, objectives



Electricity markets need to meet the requirements of a highly complex physical system across extremely short to long timescales while balancing high-level goals of decarbonisation and affordability.

The Cobra Effect: ask and you shall receive

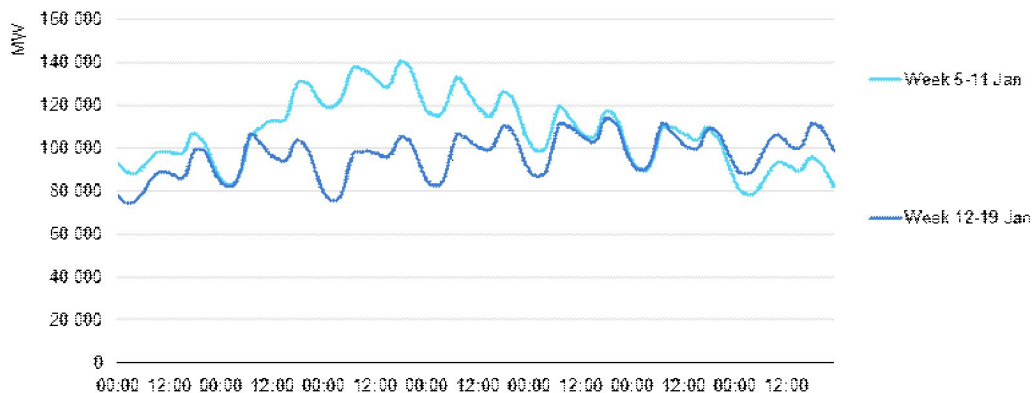
Goodhart's Law – Campbell's Law



PJM polar vortex showed flaws in capacity market design

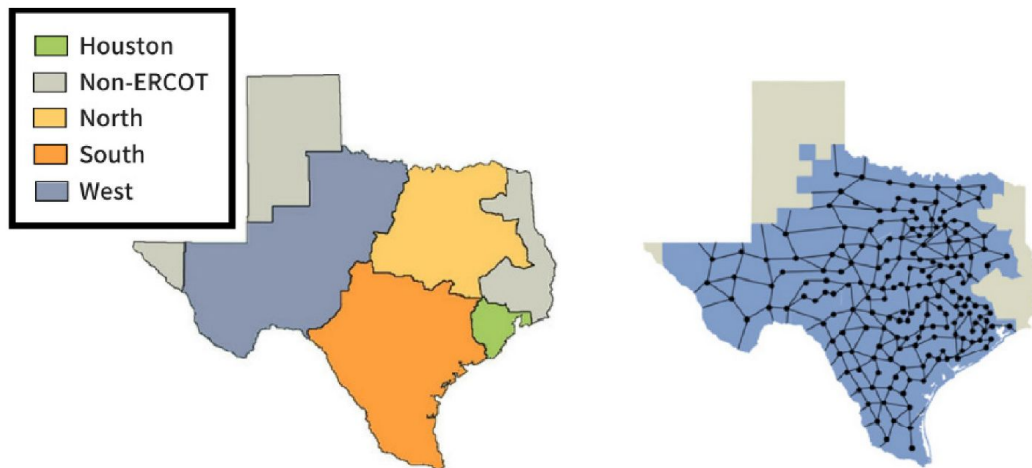
- 7 January 2014 – extreme cold weather pushes demand to 140 GW, 33% higher than normal conditions
- Although 177.5 GW of resources cleared the capacity market, 22% of units were under forced outages, and the market was short of the energy required to meet load with sufficient reserves.
- While PJM auction rules required that these units be available, the penalty for nonperformance was trivial compared to the revenues received

PJM hourly demand in January 2014



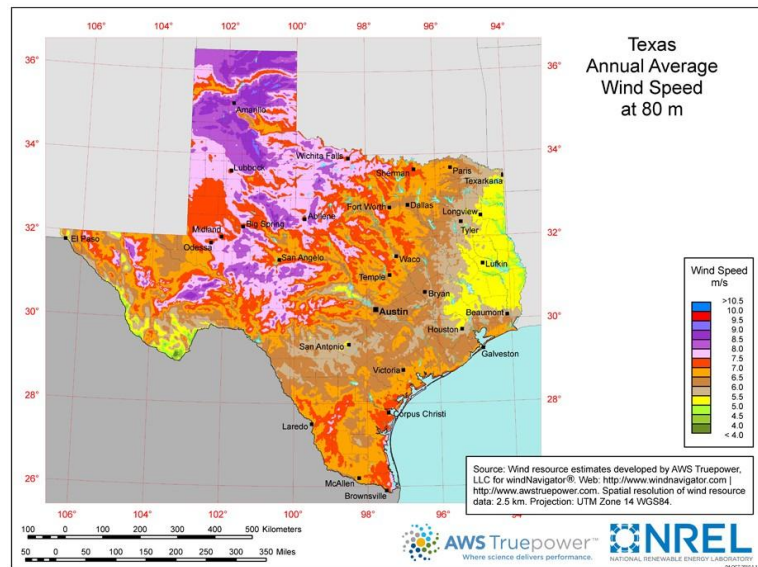
Locational price signals provide geography-aware value

Electric Reliability Council of Texas (ERCOT) market design transition from zonal (left) to nodal (right) prices

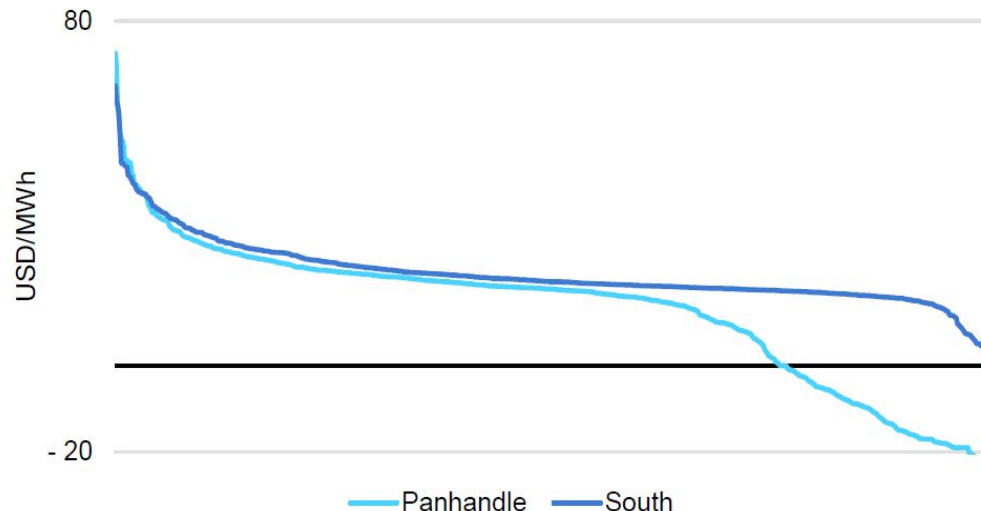


ERCOT nodal design shows how markets can benefit from a model that accurately reflects physical grid congestion. Matching the grid situation and market representation can increase efficiency for operation and investment.

Nodal prices reflect the locational value of resources



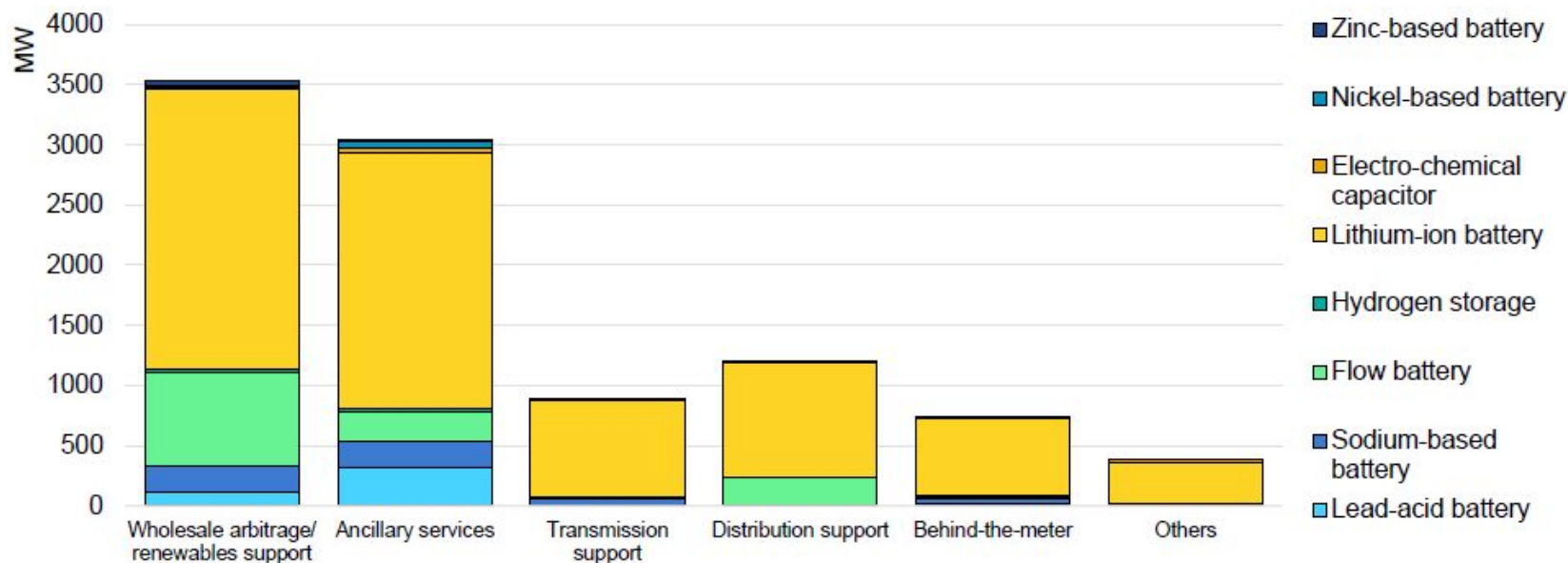
ERCOT day-ahead prices duration curve per hub in January 2021



Encouraging deployment of new generation where it adds the most value improves the integration of renewables and reduces the cost of grid expansion. Market design should enable value based on location and time.

Battery storage needs to tap into multiple value streams

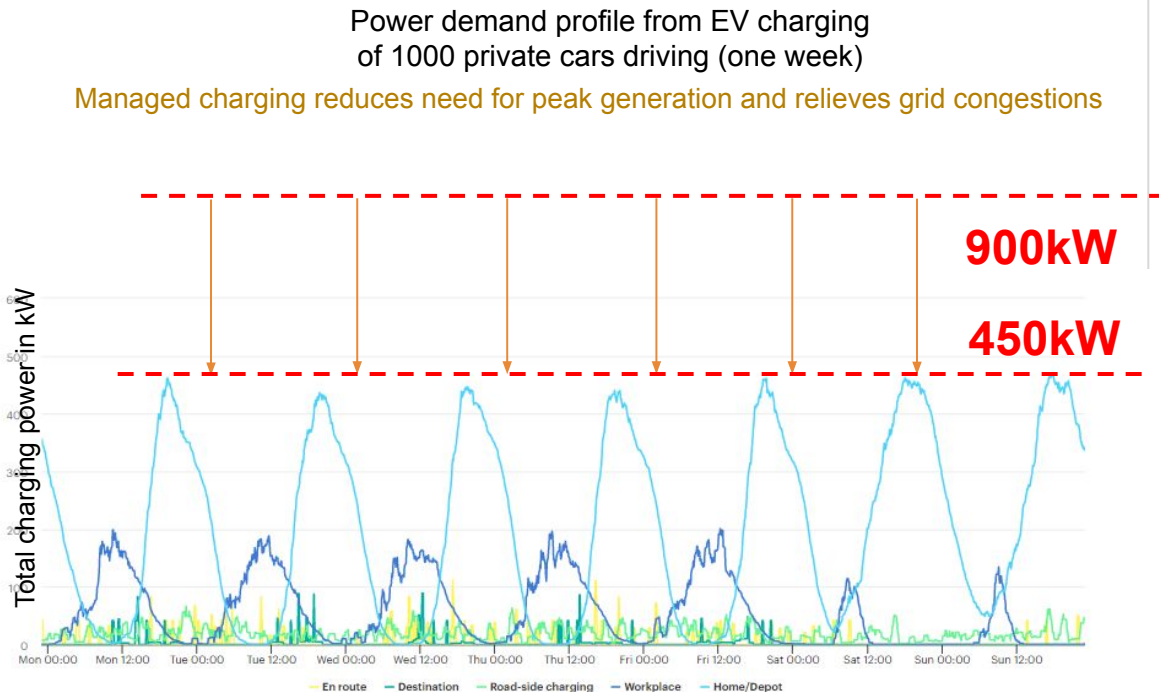
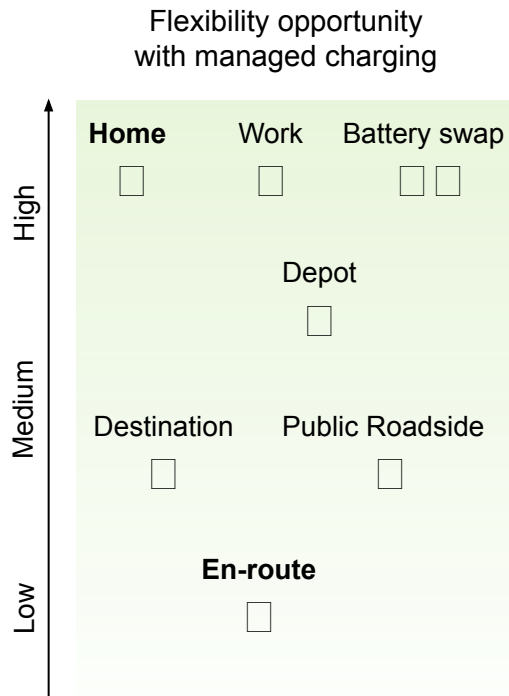
Deployment of battery storage technologies in different value streams, 1987-2020



Source: IEA analysis based on [DOE Global Energy Storage Database](#).

Among different storage technologies, batteries have followed the technology path of innovation, development and deployment, leading to massive cost reductions. However, electricity markets still need to evolve to reward batteries for all of their contributions.

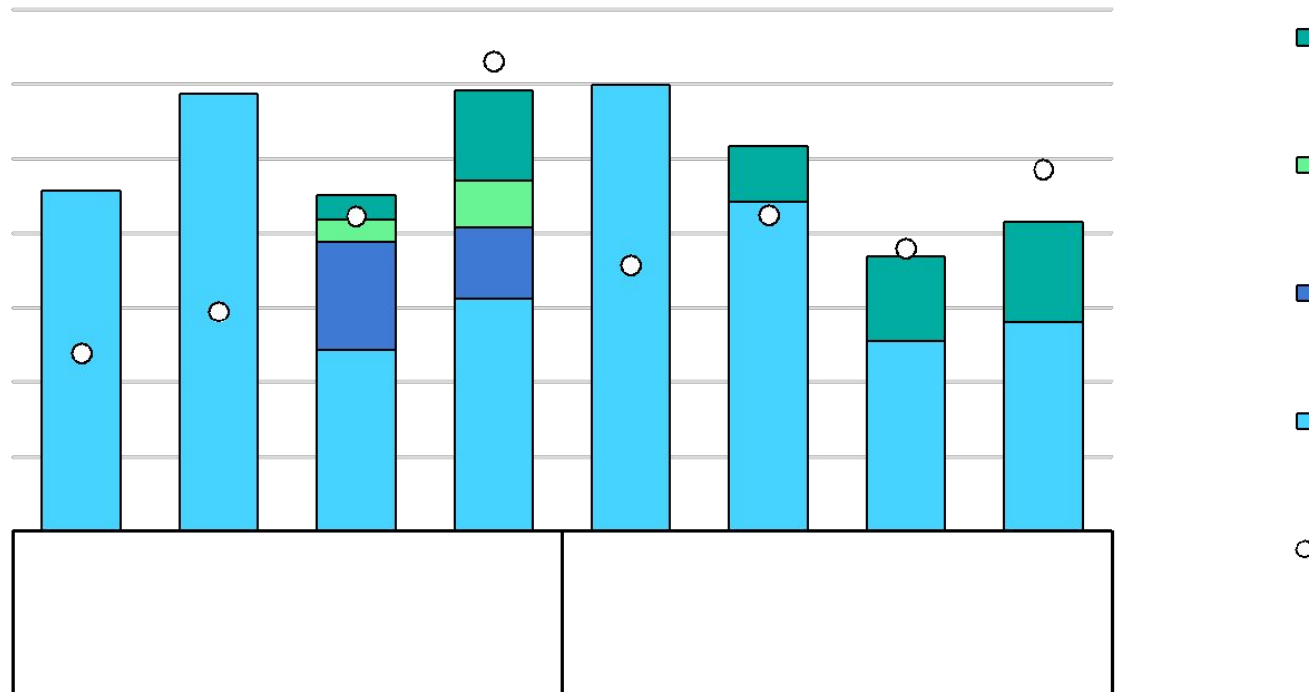
Electrification can be an opportunity and a challenge



To realise the opportunity of new flexible loads will require the right incentives from electricity markets from the early stages of deployment as well as breaking silos between sectors.

Clean procurement goal definitions determine the outcome

Procurement portfolios and procurement costs for annual and hourly demand matching in India and Indonesia, 2030



Companies setting hourly procurement goals will deploy more diverse assets that can contribute to flexibility and balancing, while annual goals focus on variable renewables.

- Over the next decade, **decarbonising the power system is essential to achieve net zero** goals, but will imply a significant change to how we operate systems
- The transition to a **decentralised power system is underway** with an increasing number of active links to other sectors of the economy, like transport, heat and industrial processes
- More than **half of the technologies needed are available today** but we need to start acting now to identify emerging power system needs
- **Enhancing market design will be crucial to enable new system services** and a greater diversity of actors in supply and demand

