Energy
Transitions
Commission

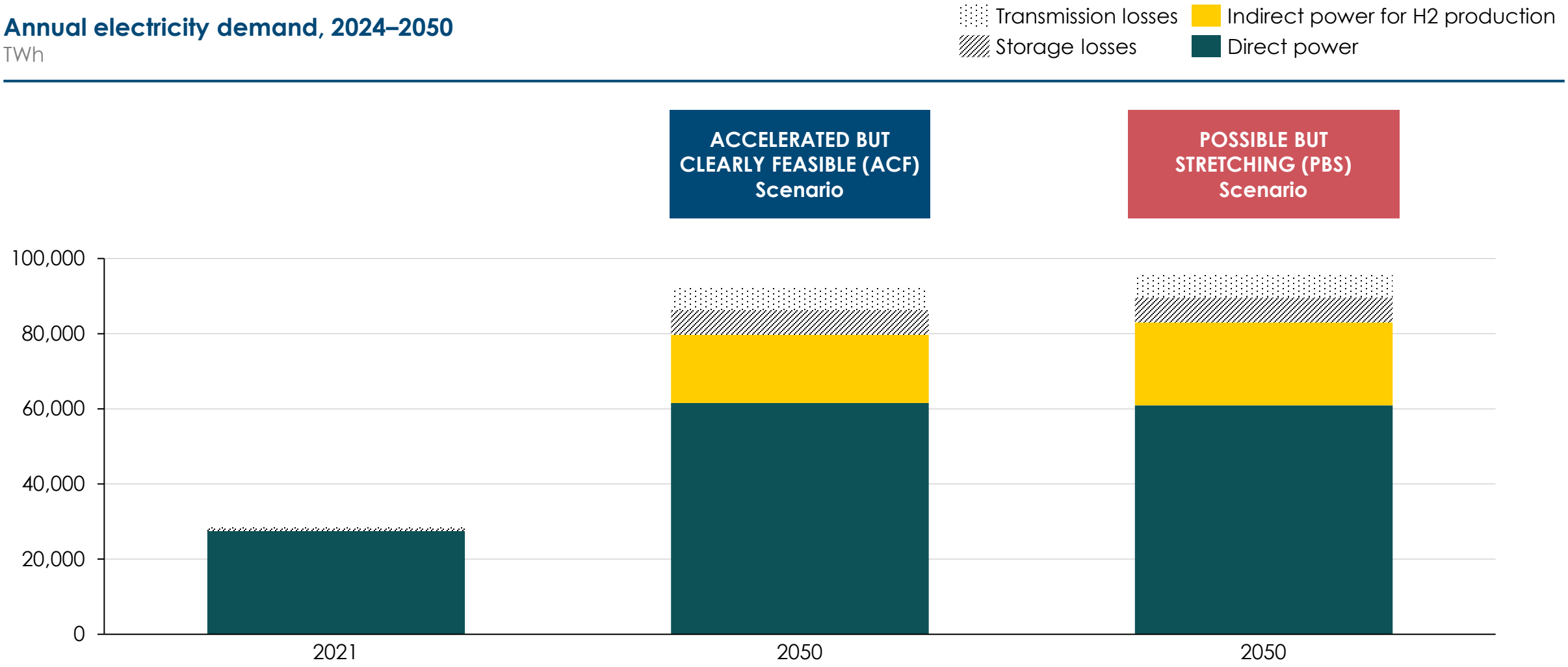
The Big Challenge
Storage Supporting the Energy Transition

Energy Storage Summit
19th February 2025

Reaching net-zero by mid-century relies on massive clean electrification

Annual electricity demand, 2024–2050

TWh

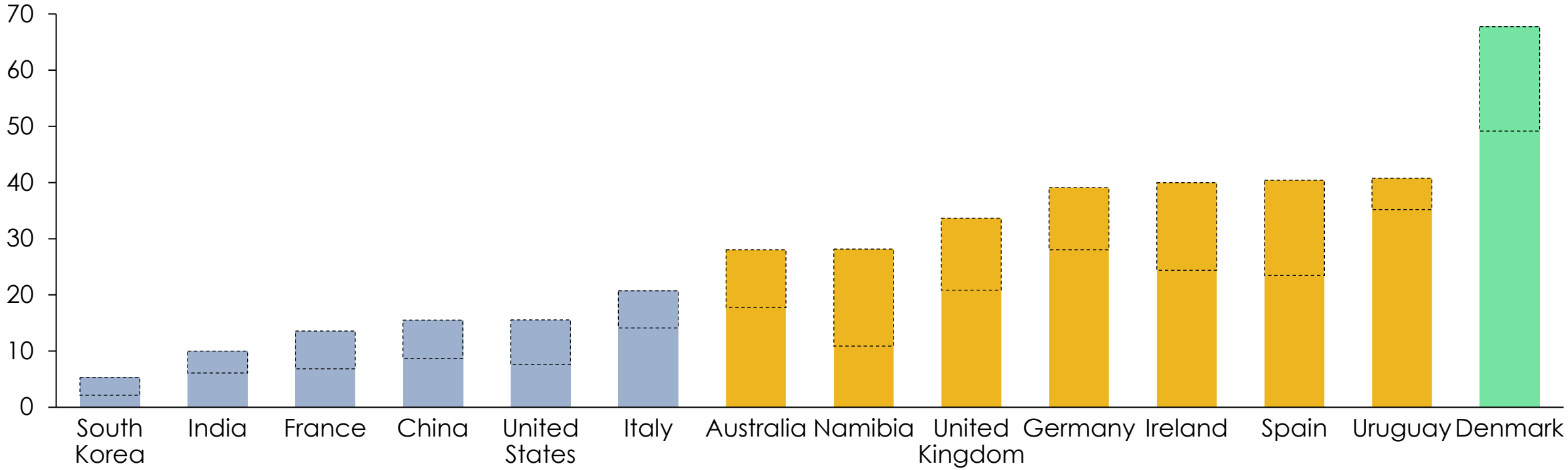


Source: Systemiq analysis for the ETC (2024)

Wind and solar are growing as share of global power generation

Annual wind and solar share and corresponding system integration phase in selected countries

% Wind and solar annual electricity generation, 2018, 2023



This points to three phases of system operation:

- Initial steps to bring in renewables
- Renewables start to make up almost all generation in some periods
- Renewables dominate generation

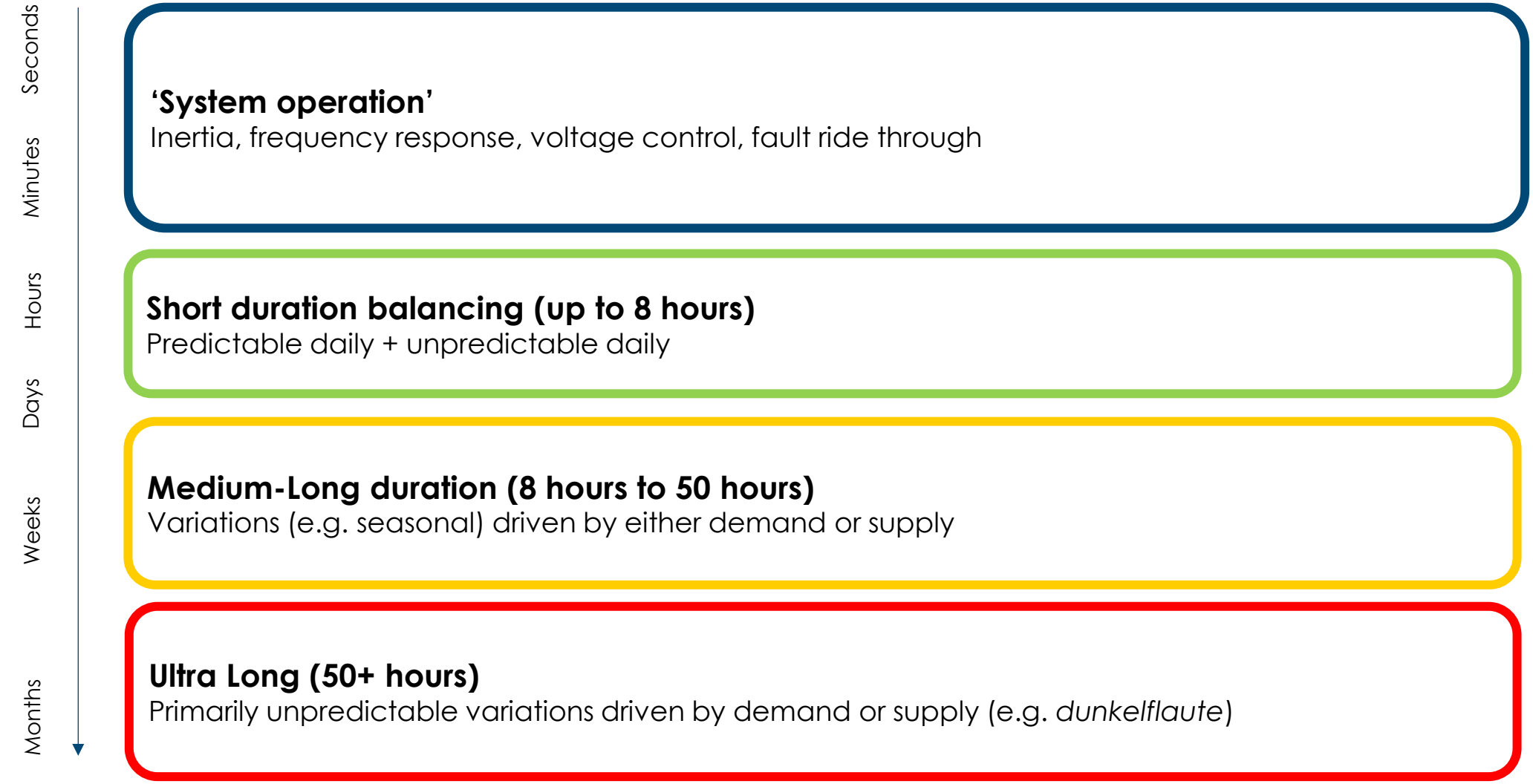
2023

2018

Source: Ember (2024), *Electricity Data Explorer, featuring latest available data (2023)*

Systems will need to meet different balancing durations

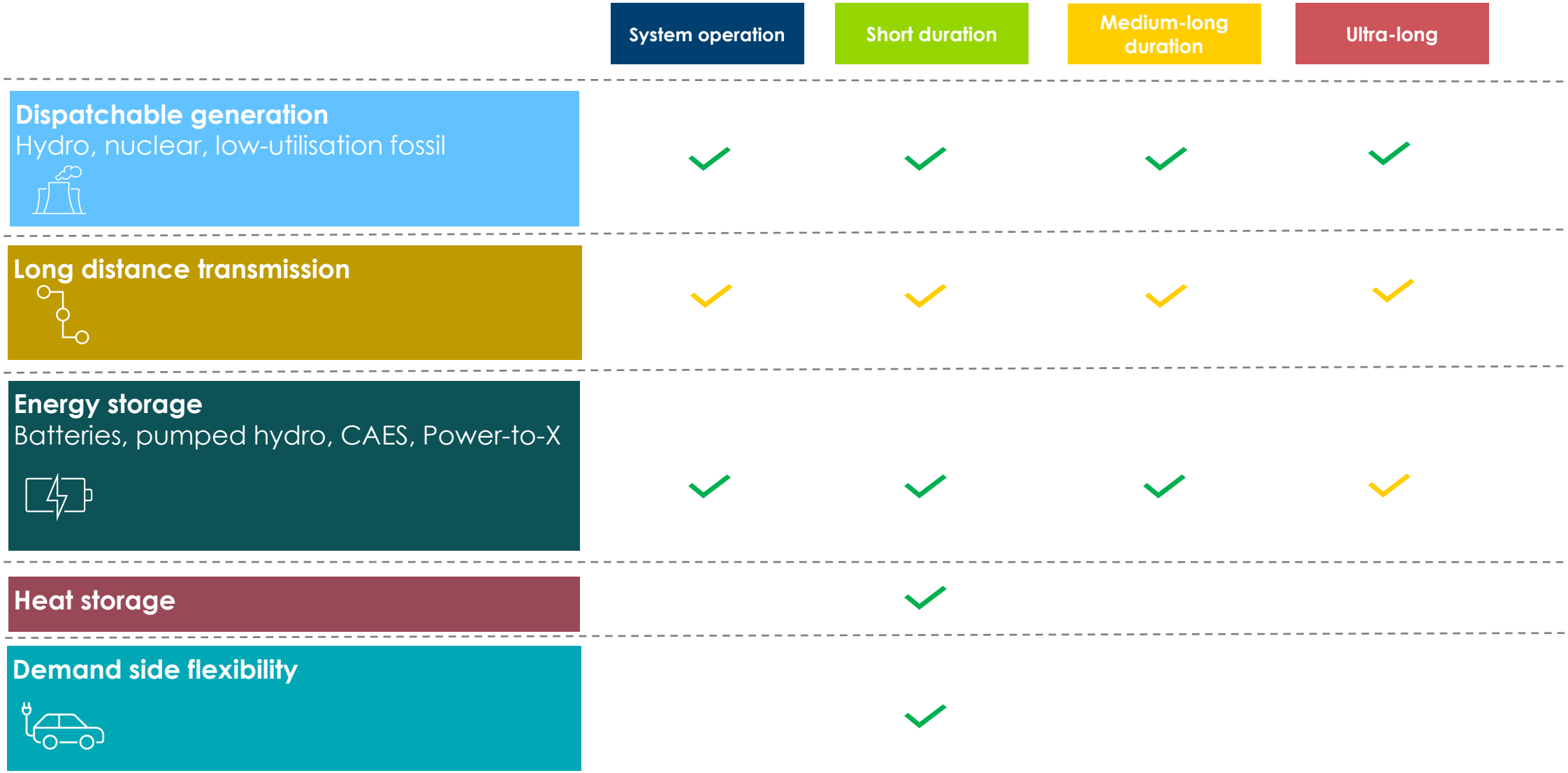
A high-renewable power system must be able to meet several challenges…



Challenge that existed in fossil system, but now needs to be met with new technologies

New challenges that must be met for high-renewables power systems due to intermittent nature of generation

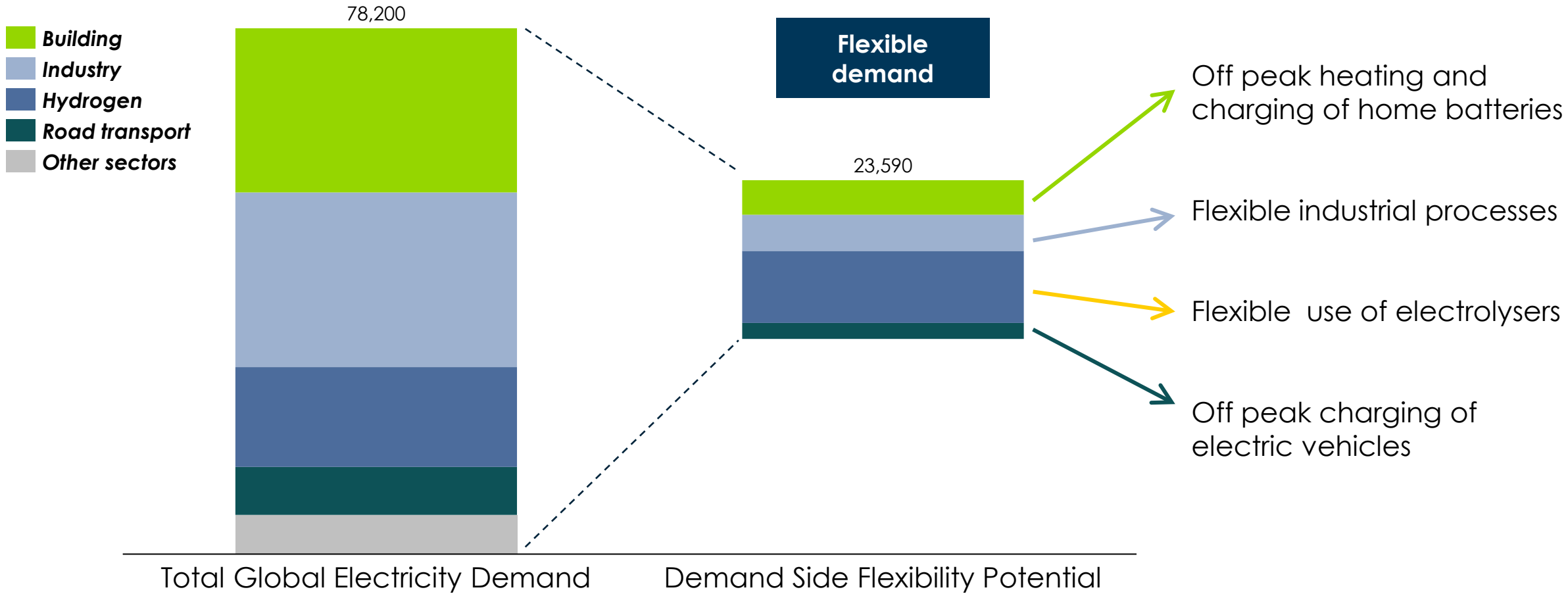
There are a set of balancing options across durations



Notes: 1. Limited nuclear capacity for flexible ramping. 2. Li-ion storage is utility-scale and behind-the-meter. 3. Emerging tech night include gravitational storage and molten sands storage. 4. Examples of Power-to-X include the production of H2 from electrolysis and re-conversion of hydrogen in power via gas turbines or fuel cells. 5. Residential and commercial standard heating needs6. Including hydrogen electrolysis, where production can be shifted to optimal times. Source: Systemiq analysis for the Energy Transitions Commission (2024)

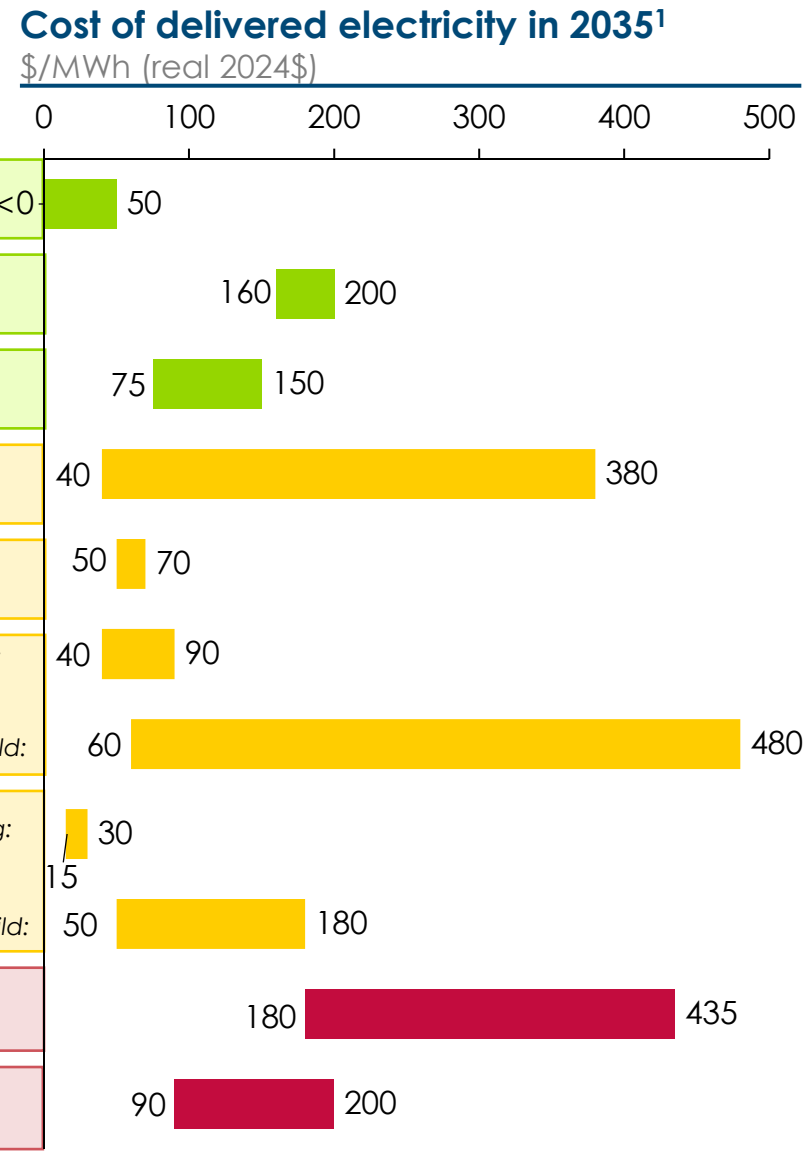
Demand side flexibility: 30% of electricity demand in 2050 could be flexible

Demand Side Flexibility (DSF) potential 2050, TWh



The costs associated with different balancing durations vary significantly

Balancing needs	Key zero-carbon balancing technologies across durations
Short / hourly duration (up to 8 hours)	• Demand-side flexibility
	• Lithium-ion and sodium-ion batteries
	• Heat storage
Medium-Long duration (up to 50 hours)	• Energy storage (pumped hydro, compressed air, batteries)
	• Long-distance transmission (for balancing)
	• Running nuclear flexibly
	• Running hydro flexibly
Ultra-long (50 hours+)	• H2 in CCGT, CCS on CCGT (low utilisation)
	• Unabated gas (low utilisation)



[1] The DSF range assumes that DSF can reduce total system costs at the lower end (through reducing overall demand) and that upgrades to smart, DSF-capable systems incurs a net cost at the upper end. LCOS calculations assume electricity input cost of $0.06/kWh. All batteries are full LCOS calculations including cost of electricity usage. Heat storage source based on Rondo heat battery LCOS and BNEF thermal LCOS figures for solid state and molten salt storage. Other figures are based on ETC analysis.

6 action areas to unlock balancing technologies for clean power systems

Strategic vision & planning

- **Smart targets for deployment –** including renewables, grids, energy storage, and flexibility
- **Accurate models and forecasting** – to help set targets and enable integration of new technologies
- **Political will for the transition** – To enable both phasing down of fossil, and plans for flexibility deployment (including across borders)

Market design

- Market access
- De-risked revenue streams
- Pricing signals (incl. locational pricing, carbon pricing)

Grid regulations

- Reform of grid fees
- Evolution of connection rules
- Modernisation and harmonisation

Data, AI and smart grids

- Data and AI modernisation
- Advanced metering and digitalisation

Supply chain, workforce and financing regimes

- Supply chain concerns
- Workforce education
- Anticipatory financing

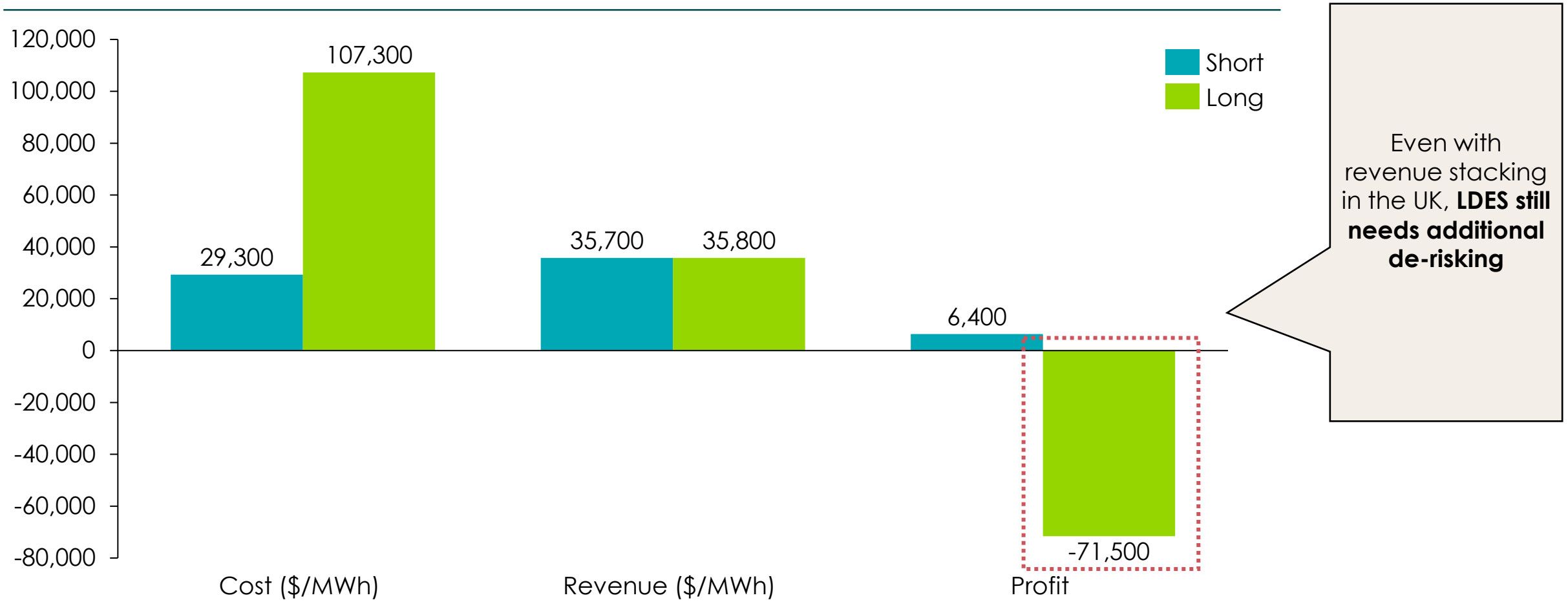
Consumers

- Consumer engagement and trust-building

Even with revenue stacking, additional de-risking needed for LDES

UK Short and long-duration energy storage revenue model, 2023

All markets stacked, £/MW



Source: ETC calculations, Modo Energy, National Grid ESO. Note: We assume a BESS of 80MW as this is the average size BESS project in the UK in 2023. Other assumptions include; 500 cycles per year, OPEX of $£/kWh, 8% annualization factor, 93% lifecycle efficiency and electricity at $0.06/kWh. For revenue modelling, we also assume that the revenue stack would be 55% frequency response, 5% balancing mechanism, 20% wholesale and 20% capacity market, as per figures from Modo Energy for 2023. We also assume for revenue stacking that the battery would play across all markets; in reality, this would require extensive data and workforce management that make it unlikely. We also assume that the battery would play in both T4 and T1 capacity auctions.