



# Supporting Long Duration Energy Storage

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# The Faraday Institution

The UK's flagship programme for electrochemical energy storage

- research
- skills development
- market analysis
- early-stage commercialisation

Bringing together research scientists and industry partners on projects with commercial potential that will:

- reduce battery cost, weight, and volume
- improve performance and reliability
- develop whole-life strategies including recycling and reuse



**25**

Academic partners



**140+**

Industry partners



**500+**

Researchers from many disciplines

# 6 Years of High-quality Impacts in Energy Storage



The Faraday Institution has generated a great return on the UK's investment from a standing start in 2018



## Lead 10 major research programmes

across **25 UK universities** and research partners and **140+ industrial partners**



## United a community of 500+ researchers

**45% new to field**, to solve battery challenges through breakthrough science



## International collaboration

DSIT funded US UK joint battery research on recycling and cathode materials

Updated November 2024



## Supported 14 spin-outs to March '24

**36-fold return in further funding** from a £1m Faraday Institution investment  
**Employ 118** (with plans to expand to 200)



## 52 inventions identified

**20 patents** filed and **10** published



## Published 1,000+ scientific papers

**63%** in top 10% journals  
**47%** in top 10% most cited  
**42%** with international collaborators



## Bespoke training for 100 PhDs

for UK industrial and academic careers, and an additional **100+ affiliated** with our projects



## Shaped policy

through **21 Faraday Insights**, **16 major reports**, **14 national consultations**, numerous briefings including House of Commons and House of Lords inquiries



## Hosted 6 Royal Institution Events

attracting **340,000+** online viewers



# Ultra Low Cost Long Duration Energy Storage

# Ultra Low Cost Long Duration Energy Storage



- UK's climate and geography (with irregular solar irradiation, miles of windy coastline and cold dark winters) reliance on wind energy to replace fossil fuels.
- Lulls in wind across the whole country can last several days. Electricity during these long low-wind periods is currently provided by gas powered generation.
- Use of unabated gas will not satisfy longer term Net Zero targets and the additional costs of abatement and off-setting will make gas generated electricity more expensive.
- Can significantly reduce the cost of electricity supply if can find more economic ways to store the many TWh of energy required to supply electricity during prolonged periods when there is too little wind.
- UK wind energy may occasionally (up to five periods per year) be unavailable for periods longer than 100 hours - 5 days to 2weeks
- Taking a longer view, 10+ years, need technologies that can store energy, and provide it during these periods of low renewable energy output



UK wind farm locations

Source: [Renewable Energy Planning Database April 2024](#)

# UK market and demand for energy storage



The UK grid may require ~25 TWh of longer duration storage by 2050 to keep the lights on and keep power costs down  
Iterations of existing technologies will not meet requirements, especially cost – fundamental research is required

		Short duration	Long duration and seasonal
How big is UK demand for BESS?	Now	<ul style="list-style-type: none"> <li>5.7GWh (4.2GW) batteries operate on the UK grid today</li> </ul>	<ul style="list-style-type: none"> <li>2.8GW pumped hydro LDES</li> <li>Fossil fuels are meeting the remaining need for dispatchable energy</li> </ul>
	Future market size?	<ul style="list-style-type: none"> <li>NESO forecast UK grid battery storage of <b>22-27GW by 2030</b></li> <li>Modo Energy forecast growth to <b>240GWh (60GW) by 2050</b></li> </ul>	<ul style="list-style-type: none"> <li>FI low voltage network modelling shows 2050 winter peak demand may increase from 58GW now to up to 120GW: vast storage will be needed to ensure winter supply.</li> <li>FI analysis forecasts that LDES is likely to be in the region of <b>25TWh by 2050</b>.</li> <li>National Infrastructure Commission estimate that the UK requires <b>25TWh</b> of strategic energy reserve</li> <li><b>Annual UK cell demand for static storage could be ~100GWh (~\$5bn pa)</b> (FBC forecasts ~100 GWh pa cell production for EVs in 2035)</li> </ul>
	£ savings?	<ul style="list-style-type: none"> <li>PNDC estimate a £6-9bn investment in grid scale energy storage, V2G and home batteries could yield savings of around £17bn in network and generation investment</li> </ul>	<ul style="list-style-type: none"> <li>DESNZ estimated that just 20GW of LDES would provide a £24bn long term saving to consumers (3.3% of total system cost)</li> </ul>
What is the potential role for research?	<ul style="list-style-type: none"> <li>FI project supporting the <b>scale up of UK sodium battery manufacture</b>: sodium BESS potentially has lower critical mineral content, geopolitical risk and cost than LFP</li> <li><b>Policy proposals to support domestic BESS manufacture and supply chains</b></li> <li>Offtake agreements for BESS could be used to <b>attract UK LFP gigafactory investment</b>, supporting EV LFP cell manufacture</li> </ul>	<ul style="list-style-type: none"> <li>The need for long duration energy storage has been clearly identified by government: <b>NESO and DESNZ have stated that storage plays a key role in UK energy security</b></li> <li>Existing technologies (electrochemical and beyond at various TRLs) are not meeting requirements for the renewable driven 2050 grid</li> <li><b>This challenge will not be solved by incremental changes</b> to existing technologies – for electro chemical solutions new, significantly lower cost batteries with different characteristics will be required</li> <li>There is a clear case <b>for fundamental battery research</b> to explore new solutions</li> </ul>	

# Up to 25TWh of new energy storage is needed to support the UK renewables transition



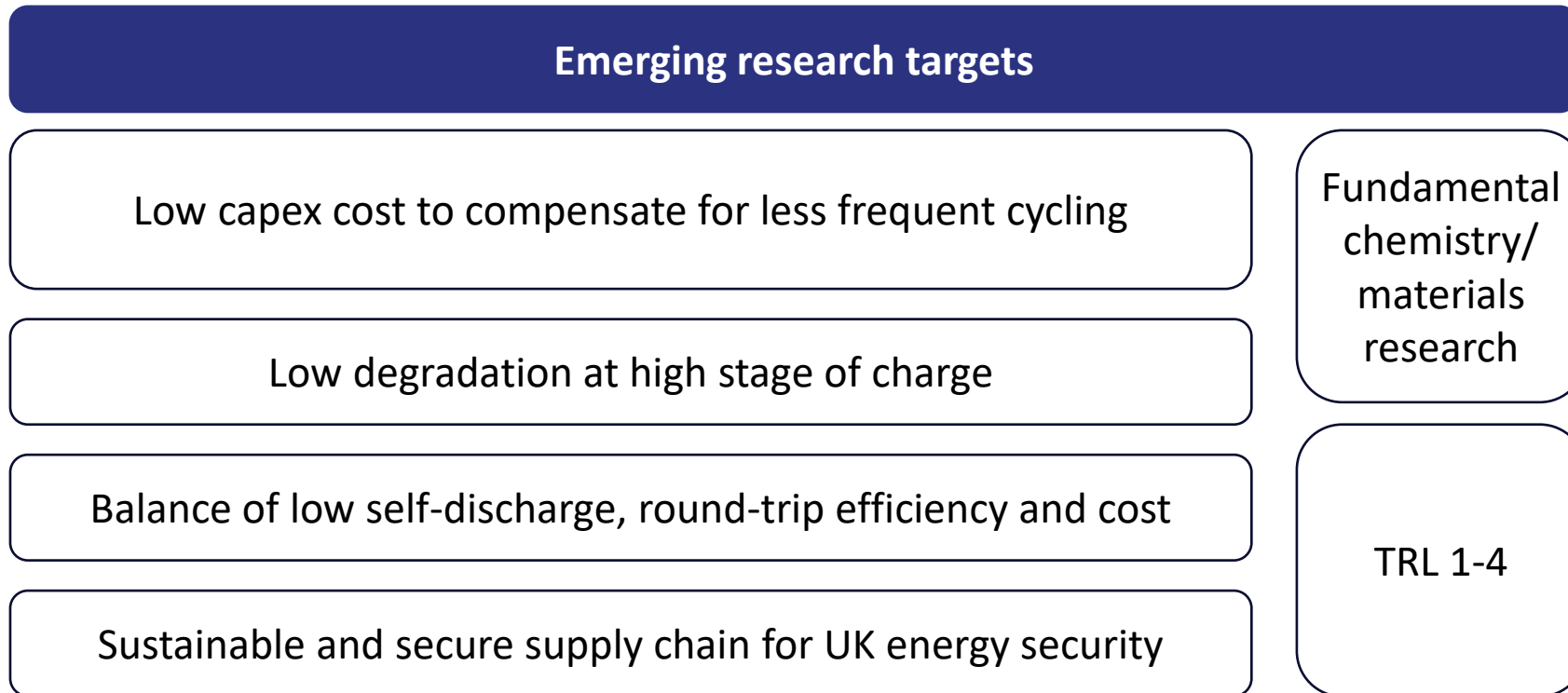
	Short duration	Medium-long duration	Seasonal
Discharge duration	<ul style="list-style-type: none"> <li>0 to 6 hours</li> </ul>	<ul style="list-style-type: none"> <li>6 to 160 hours</li> </ul>	<ul style="list-style-type: none"> <li>&gt; 160 hours</li> </ul>
Storage of all durations is needed to support the phase out of fossil fuels	<ul style="list-style-type: none"> <li>Fast frequency response / dynamic containment / grid stability</li> <li>Reducing peak cost of electricity e.g., winter evening peaks</li> </ul>	<ul style="list-style-type: none"> <li>Increasing renewable generation requires longer duration storage for days or weeks of low wind and low solar generation</li> </ul>	<ul style="list-style-type: none"> <li>Electrification of heat and vehicles will double winter electricity demand</li> <li>Seasonal storage needed to bridge longer low generation periods and supply extreme winter peaks</li> </ul>
Requirements are different for different durations	<ul style="list-style-type: none"> <li>1-2 cycles per day</li> </ul>	<ul style="list-style-type: none"> <li>~ 10 to 200 cycles per year</li> </ul>	<ul style="list-style-type: none"> <li>Less than 5 cycles per year</li> </ul>
	<ul style="list-style-type: none"> <li>High power, fast reaction (from 0.5s)</li> <li>Discharge times range from seconds to 4+ hours</li> </ul>	<ul style="list-style-type: none"> <li>Medium power and duration</li> <li>Fast response times not required</li> </ul>	<ul style="list-style-type: none"> <li>Low power, long duration</li> <li>Fast response not required</li> </ul>
	<ul style="list-style-type: none"> <li>Very high cycle life, high RTE</li> <li>Used frequently, multiple revenue streams so £/kWh lower priority</li> </ul>	<ul style="list-style-type: none"> <li>Gaps of multiple days between charge/discharge means low LCOS essential</li> </ul>	<ul style="list-style-type: none"> <li>Store at high SoC for months</li> <li>Revenue opportunities infrequent so extremely low capex required</li> </ul>
Landscape / existing technologies	<ul style="list-style-type: none"> <li><b>Chinese LFP is dominant technology</b></li> <li>Sodium emerging</li> <li><b>Market well established</b> and growing</li> <li>UK is among world leaders in BESS market innovation, despite challenges with market structure (skip rates, de-rating)</li> </ul>	<ul style="list-style-type: none"> <li>Fossil fuels currently filling gap</li> <li>Emerging technologies include compressed air, redox flow, metal-air – none well established at scale</li> <li><b>Multiple nascent technologies but all have issues</b> e.g. cost, RTE</li> <li>Lower cost Li/Na could supply up to 12 hrs</li> </ul>	<ul style="list-style-type: none"> <li>Fossil fuels currently filling gap</li> <li>Hydrogen is a potential solution but has many challenges including very poor round-trip efficiency (~30-40%).</li> <li>Pumped hydro is effective but cannot meet full demand and has limited growth potential</li> </ul>

Existing battery technology won't do the job.

# Ultra Low Cost Long Duration Energy Storage



- Specific use cases for long duration grid storage require a new breakthrough, not iterative change to existing lithium and sodium batteries



- Other characteristics including e.g. safety and system energy density will also be relevant

# Ultra Low Cost Long Duration Energy Storage



How do existing technologies compare?

No existing technology meets all the criteria

Emerging research targets	Battery technologies						Other technologies	
	LFP	Lead-acid	Redox-flow	High Temp	Sodium-ion	Metal-air	Pumped Hydro	Compressed Air
Low capex cost to compensate for less frequent cycling TBC <\$10/kWh	☐	☐	☐	☐	☐	●	☐	●
Low degradation at high stage of charge	☐	☐	☐	?	☐	?	●	●
Balance of low self-discharge, round-trip efficiency and cost	☐	☐	☐	☐	☐	?	☐	☐
Sustainable and secure supply chain for UK energy security	☐	?	?	☐	☐	☐	●	●
Low capex per kWh	●	☐	☐	☐	●	☐	☐	☐
Low self discharge	☐	☐	☐	☐	☐	?	☐	☐
Round Trip Efficiency	●	☐	☐	☐	●	☐	●	☐

Source: PNNL 2022 Grid Energy Storage Technology Cost and Performance Assessment

# Ultra Low Cost Long Duration Energy Storage

## What is needed?

- Novel technology, which could be a new or improved energy storage system, structure, mechanism, component, chemistry or other new approach;
- Develop viable solutions for long duration (~100 hours) and seasonal energy storage to support the high rate of renewable energy penetration on the grid;
- Demonstrate competitiveness vs current energy storage technologies in terms of cost, efficiency, safety, lifetime and environmental sustainability;
- Minimise the use of Critical Raw Materials in line with the UK's Critical Raw Minerals Strategy;
- Contribute to decarbonisation of the UK energy system

Novel technologies receiving investment include zinc bromide flow, metal hydrogen, iron air, iron salt, vanadium flow: may be fundamental issues with efficiency, degradation or cost to overcome and are yet to be proven at scale



# Technology Specification

## What must it do?

- Be modular, recyclable, and non-reliant on fossil fuels;
- Have the potential for economic viability at discharge durations of 100 hours or more. Our analysis shows this will require a **minimum system capital cost of \$10/kWh**;
- Be able to store 90% of their energy for extended periods (6 to 12 months) without top-up;
- Have the potential to be deployed and scaled using a UK/EU-based supply chain – product focused;
- Interoperable with or leveraging existing electricity infrastructures in ways that minimise system costs;

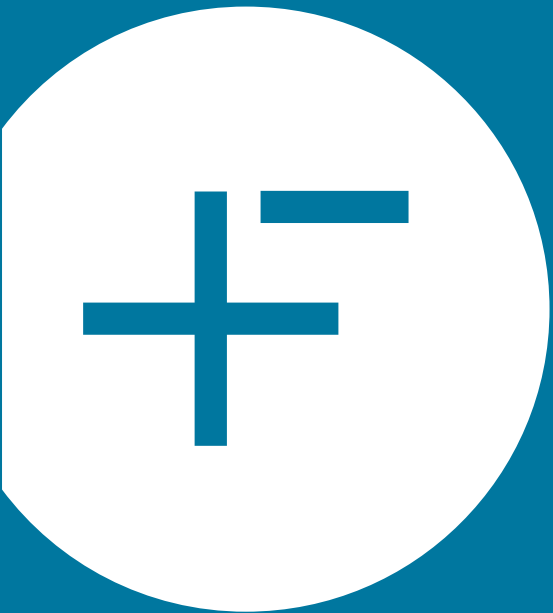


# Ultra Low Cost Long Duration Energy Storage

## What's happening?

- Co-Creation and Planning phase underway
- Open Call for larger research programmes launched in March 2026
- The Faraday Institution intends to fund up to two large research projects ~£1-2m





# Flow Battery Research

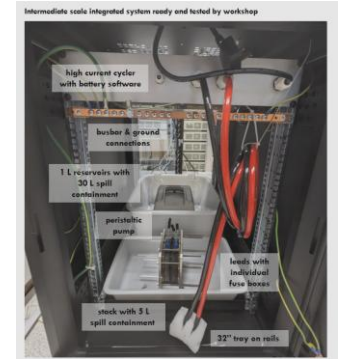
# Flow Battery Research

## High voltage redox flow batteries for demanding applications - University of Cambridge

- The project sought to develop air-stable, low-cost, electrolytes, which will degrade less and permit the use of higher voltages, creating lifetime cost advantages. Performance benchmarking at 1 kWh scale

## Single liquid flow batteries – University of Strathclyde & StorTera

- Benchmarking the graphite polysulfide single liquid flow battery technology and demonstrated an improvement to the technology's economic proposition, including reduced production costs of 50-70%, and a 20% increase in durability at small scales
- Simplified processes for formulating and reconditioning the active catholyte within the flow batteries with the aim of enabling battery installation, repairs and recovery to be carried out in-country by local engineers.



Stortera "S" Cell

## Soluble lead flow battery - University of Southampton/ SoLead Energy

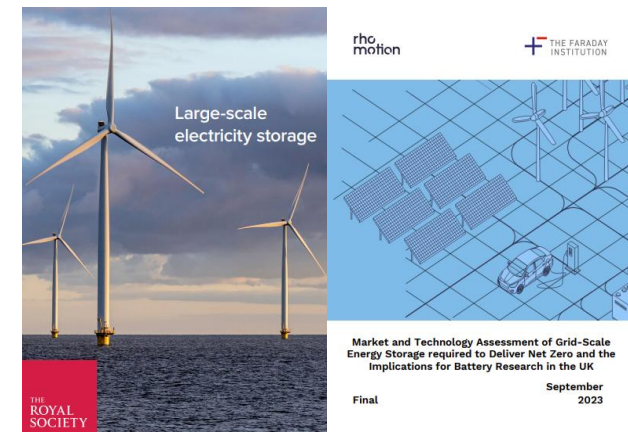
- Developed a containerized solution with >75% voltage efficiency and >80% coulombic efficiency
- Demonstrator system 5 kW stack, 16 kWh capacity
- Validated the key value propositions of low cost, safety and recyclability



# Other interventions



- Market & Technology Assessment of Flow Batteries for Developing Economies – to be published summer 2025
- [Faraday Insights - Issue 21: Batteries in Stationary Energy Storage Applications](#)
- [Market and Technology Assessment of Grid-Scale Energy Storage required to Deliver Net Zero and the Implications for Battery Research in the UK](#)
- [Large-scale electricity storage Issued: The Royal Society](#)
- The Faraday Institution sponsored the UK Flow Battery Network annual meeting in January 2025





Thank you