Making a positive difference
for energy consumers

Energy Innovation Summit

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Agenda

- **Why**:
  - Why Long Duration Energy Storage (LDES) will be important in the future energy system?
- **What**:
  - What can provide this LDES?
- **How**:
  - How the Strategic Innovation Fund can enable innovation in this space?

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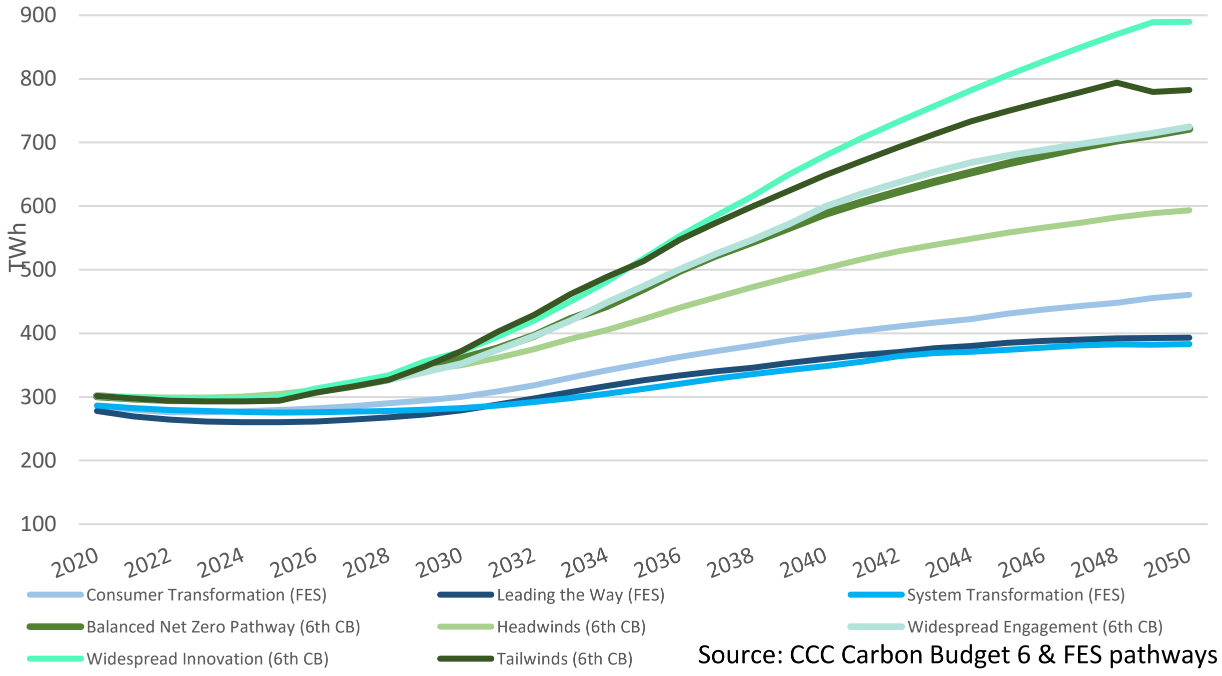
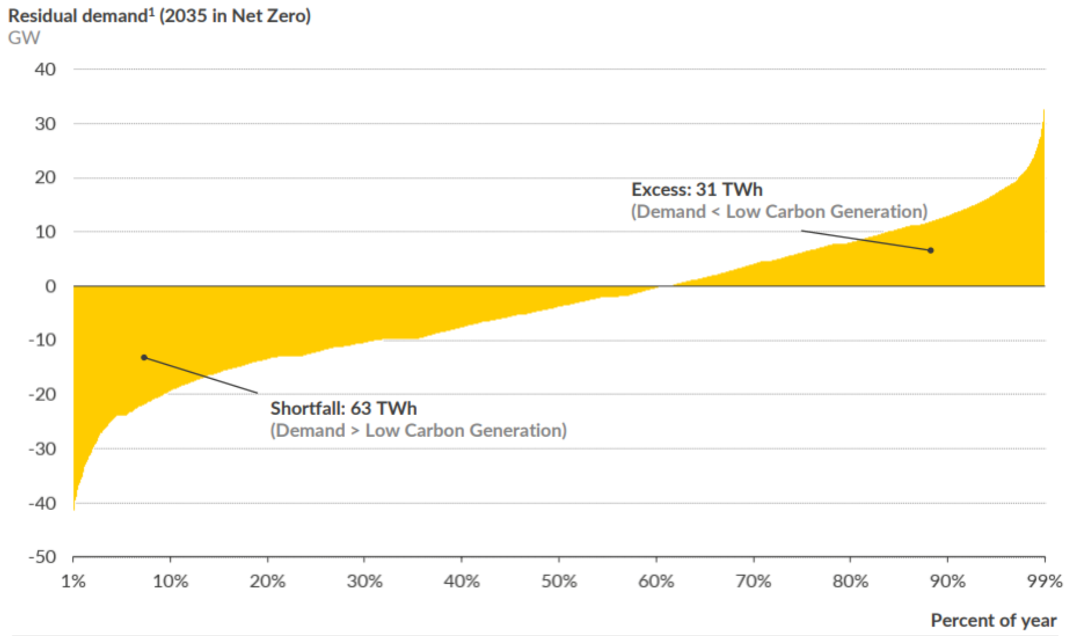
Why we need storage

Overall electricity demand grows substantially from late 2020s. Increased overall demand will also see increased demand peaks.



Source: CCC Carbon Budget 6 & FES pathways

Future is powered by intermittent, weather-driven system with supply imbalances from intra-day to seasonal.



1) Includes generation from wind, solar, nuclear, biomass and interconnector flows

Source: Aurora Energy Research

<u>Meeting net zero - two trends underpinning grid decarbonisation:</u>

1. Significant expansion in renewable generation capacity, with a transition to weather-driven generation mix.
2. Growth in electricity demand, due to increased electrification in transport and heating sectors.

<u>Concerns</u>:

- Shift in location of generation reflecting resource (wind and solar), exacerbating network congestion issues.
- How to bring abundant low carbon energy to consumers in a cost-optimal way.

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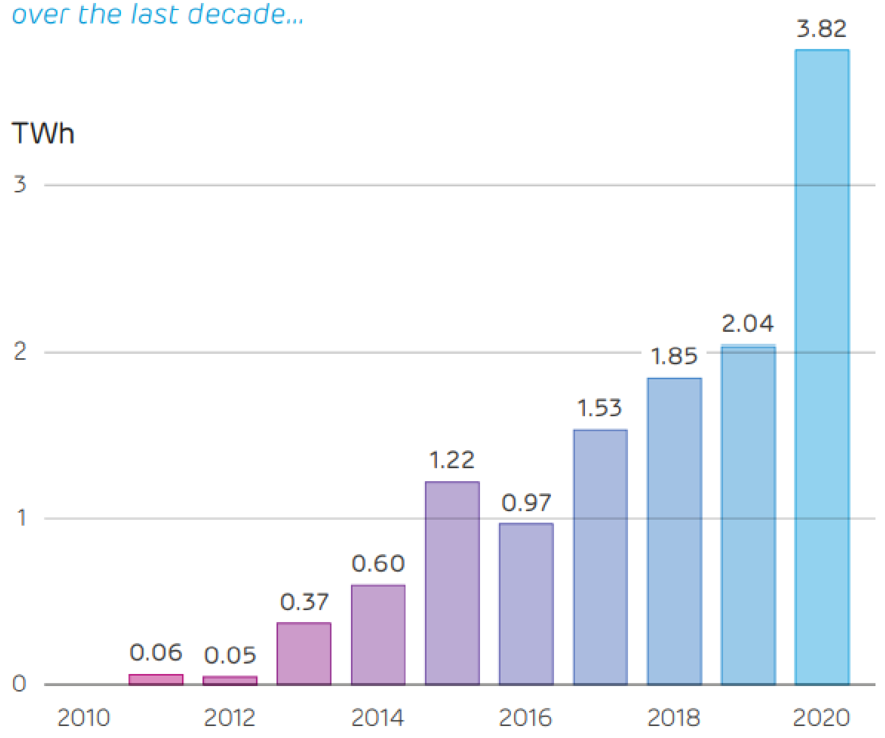
What impact can storage have on renewables?

Without storage in 2035, 31TWh excess electricity generation may need to be curtailed

- 10GW offshore wind capacity in 2020, generating 48.9TWh
  - Curtailment of 3.8TWh (8%) at a cost of **£282mil**
- Expanding to 40GW offshore wind capacity by 2030: curtailment will worsen unless storage or more cables
- Storage itself is not generation, but can capitalise on surplus renewables generation for periods of shortfall
  - Although renewables not firm power, storage changes this by ensuring security of supply and avoiding curtailment (makes firm)
  - System modelling shows the GB future energy system could be subjected to extended periods of wind drought which if addressed via long duration storage, can save £13-24bn across the system
- LDES could lower system costs by 2.5% by 2035 (Aurora)
  - 4.5GW LDES with capacity of up to 90GWh could save up to £690mil in system costs annually by 2050 (ICL)
- Aurora report (2022): GB needs up to 24GW of LDES by 2035 to integrate wind power into the grid- Long duration electricity storage in GB | Aurora Energy Research (auroraer.com).

Annual curtailment of wind energy in Britain over the last decade…



➢Investing in LDES alongside renewables can reverse consumer bill increases by shifting away from gas

Record wind output and curtailment | Q4 2020 Quarterly Report | Electric Insights

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The need for LDES storage

Significant majority of GB energy storage capacity is pumped hydro storage. Current storage capacity is largely short duration.

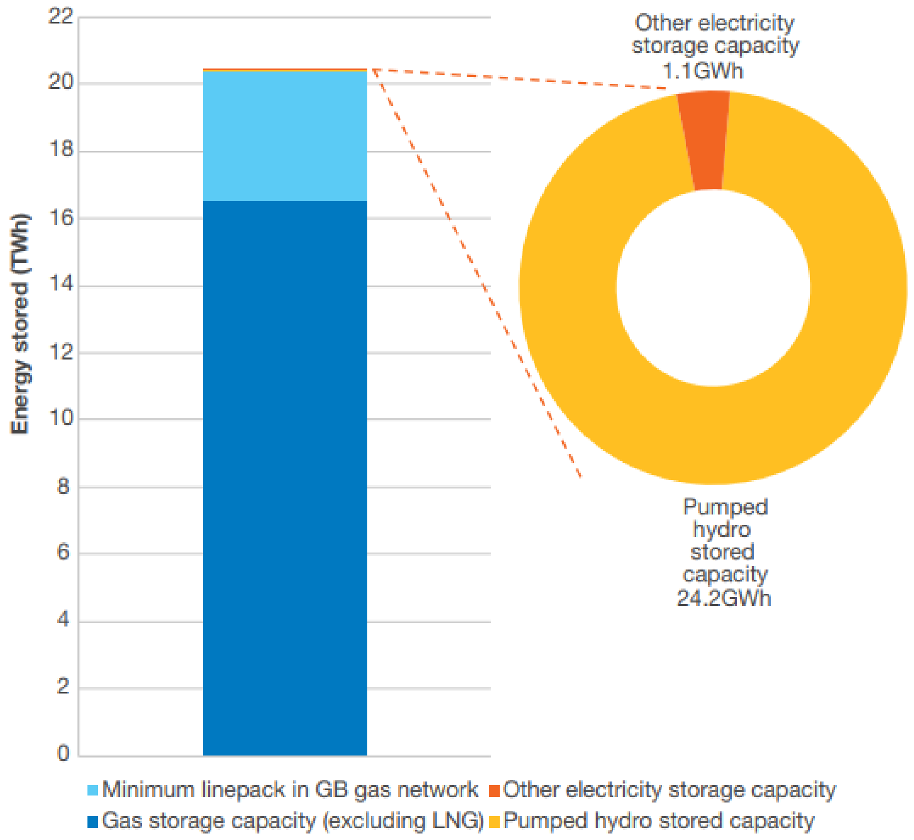
Long Duration Energy Storage (LDES) is typically defined as being capable of 4+hours of discharge, with storage capabilities across days, weeks and months.

Benefits:

- Balancing supply/demand through: 1) fast-acting response for inertia/frequency stabilisation purposes, 2) within-day balancing (moving energy between days as the weather changes) and 3) ensuring adequacy needs are met across the seasons.
- Addressing energy network constraints – particularly via a more localised approach to supply/demand balancing
- Network reinforcement deferral at both transmission and distribution level, minimisation of imported grid energy.

LDES allows managing system during extended periods of low/no renewable supply. A key innovation needed here are around developing viable business models

Figure FL.1: Electricity and gas storage capacity in 2020



We need a diversity of LDES solutions across duration and technology type to meet different needs and minimise uncertainty risk around future tech development

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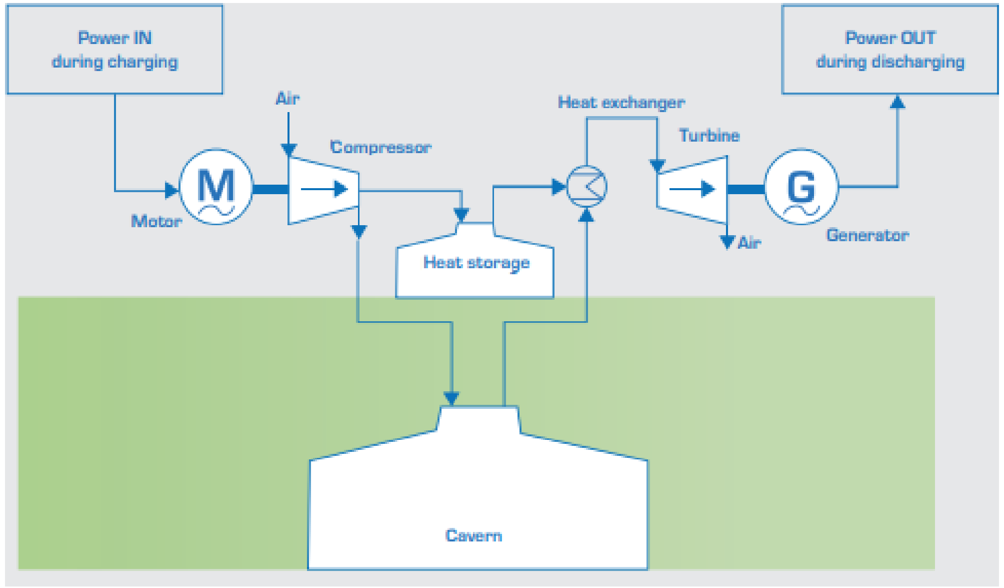
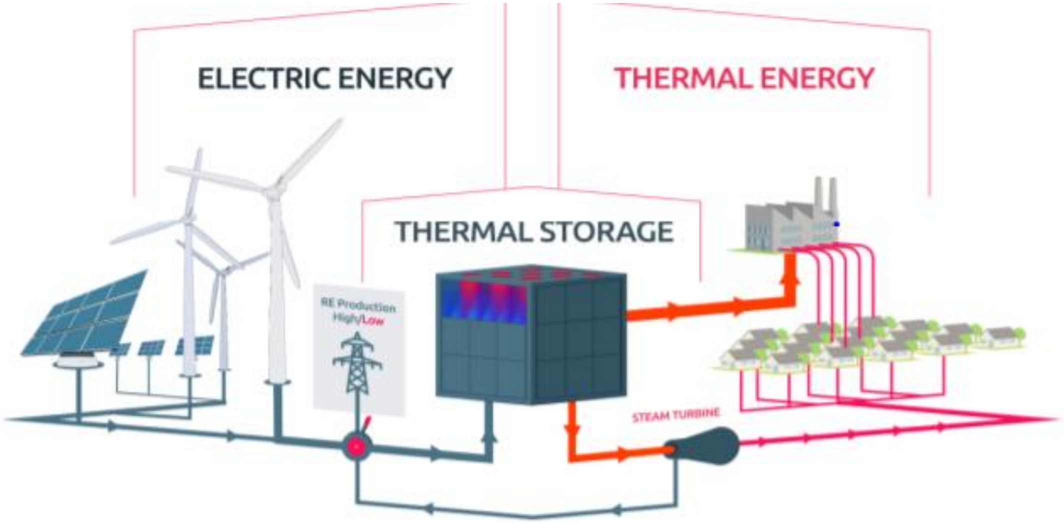
Long Duration Energy Storage

- **Batteries**
  - Lithium-ion - chemical reaction moving lithium ions causes battery charge/discharge; degradation over cycles (5000+)
  - Vanadium Redox Flow (VRFB) - Electrolytes stored in separate tanks meet, exchange ions, causing charge/discharge; long lifespan (20,000 cycles)
- **Compressed air (CAES)** – air is compressed and stored underground in air-tight caverns (location-specific); when released, expanding air drives turbines producing electricity
  - Diabatic – uses gas to heat the air to expand it before the turbine
  - Adiabatic – reuses captured heat to heat the air to expand it before the turbine (see diagram; novel tech)
- **Thermal** – Uses energy to increase temperature of molten salt, which can then be used when it cools to heat water to steam to run turbines (see diagram; novel tech)





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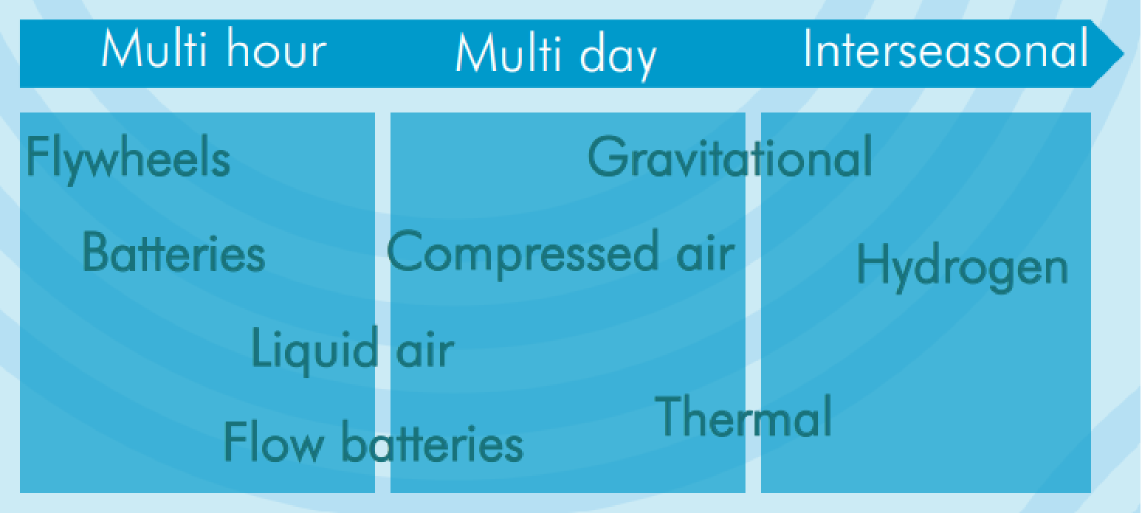
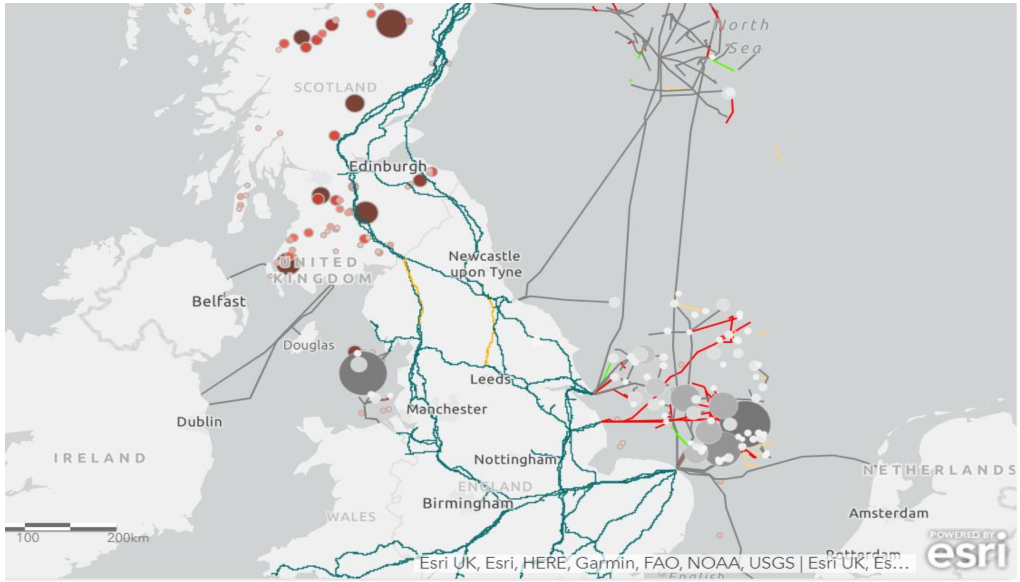
Long Duration Energy Storage

- **Hydrogen storage**
  - Hydrogen is well suited to very long-term or inter-seasonal storage.
  - It is an example of an LDES which can integrate both generation and storage to form a loop. In theory hydrogen stores could be stocked up in the summer, when renewable generation potential is high, and discharged in winter, when demand for energy peaks.



Source: Regen, ‘Electricity storage: Pathways to a Net Zero Future’



- UK geology lends itself to the development of large scale hydrogen storage. Salt caverns in the North West and North East could be developed to store hydrogen in close proximity to the HyNet and East Coast clusters. There are also aquifers located around the British coast.

Source: University of Edinburgh, ‘UK Hydrogen Storage Database’

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Introduction to Strategic Innovation Fund

WHAT IS THE SIF?

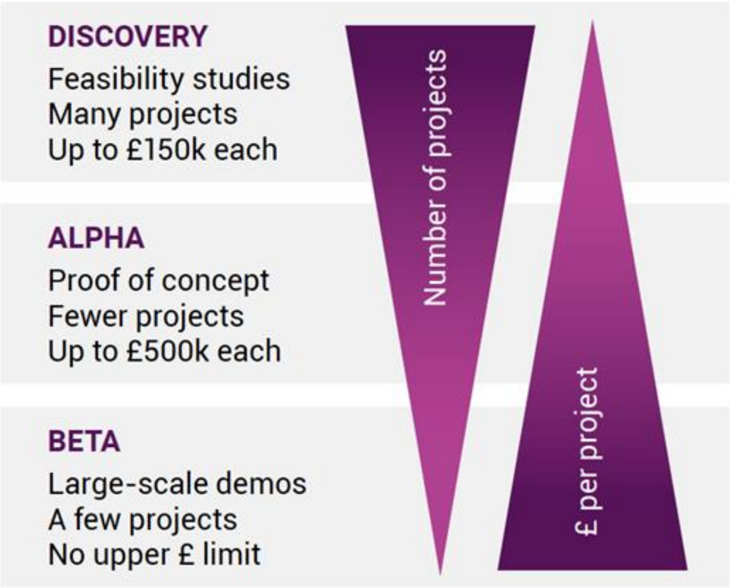
The SIF (Strategic Innovation Fund) is a **£450m fund** designed to drive the innovation needed to **transform gas and electricity networks** for a low-carbon future, with the investment from 2021-26.

- focuses on **'big, strategic, risky'** projects, with projects typically being within the 3-8 TRL range.
- **funding drawn through compulsory levy** (consumers paying). Only licensees and their partners can access the fund.
- **part of RIIO-2** price controls.

VISION

1. To **find and fund** ambitious, innovative projects which can facilitate the UK's transition to net zero, at lowest cost to consumers.
2. To **help transform the UK into the 'Silicon Valley' of energy.**

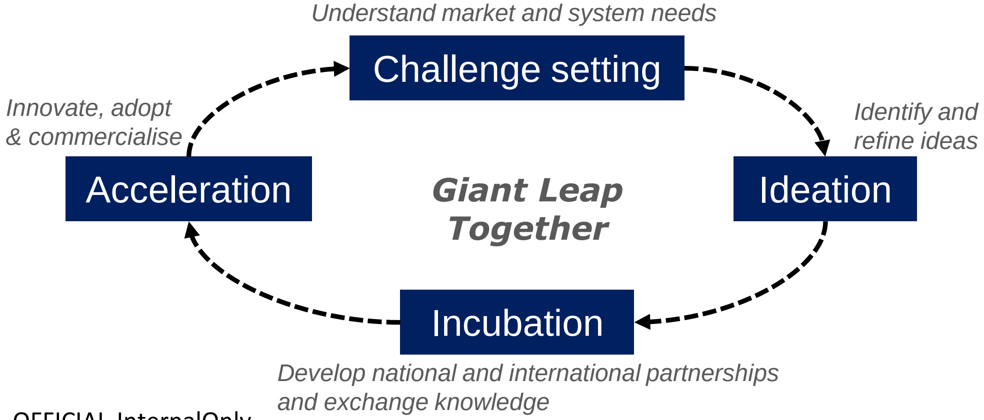
SIF FUNDING MODEL



The SIF utilises a phased funding model (roughly aligned in scale to pre-seed, seed and Series A). This allows us to:

- De-risk the funding by ensuring scrutiny at each phase of funding
- Create a coordinated funding timeline for the innovation landscape to work to

SIF OPERATING MODEL



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Role of SIF

Technical

- An important piece of evidence for LDES deployment is how its operation interacts with electricity and gas networks.
- SIF is the primary mechanism for large scale innovation in electricity and gas networks.
- LDES innovation involves working with a range of stakeholders like technology developer, energy networks, academics, supplier, renewable generator etc

Commercial

- Network and system operation markets could offer revenue streams for LDES, but needs innovation in business models and commercial arrangements.
- SIF supports non-technical innovation, including in business models, data, processes and social aspects

Regulatory

- LDES is a relatively new system asset and therefore might need changes to regulation and market frameworks.
- SIF projects work closely with Ofgem and DESNZ teams and have the opportunity to explore changes to and influence these frameworks

SIF is set up to support complex multi-partner innovation projects and is open to participation of any relevant energy sector actors

SIF Challenges: Innovation Challenges are set for the market to respond to, allowing Ofgem to provide strategic steering to innovation

Round 3 Challenges:

Whole system network planning and utilisation to facilitate faster and cheaper network transformation and asset rollout

Novel technical and market approaches to deliver an equitable and secure net zero power system

Unlocking energy system flexibility to accelerate electrification of heat

Enabling Power-to-gas [P2G] to provide system flexibility and energy network optimisation

Challenges with storage elements

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Innovation Challenge 2 Aims

Innovation Challenge 2: Novel technical, process and market approaches to deliver an equitable and secure net zero power system

Context

- Further research and innovation is required to understand the roles of thermal storage, batteries, mechanical storage, and hydrogen in providing services to the energy system.
- As noted in the Operability of High Renewable Electricity Systems Report by the National Infrastructure Commission (NIC) and the System Operability Framework by the Electricity System Operator (ESO), aspects including inertia, short circuit level, voltage control, system restoration, loss of mains protection and fault ride through will need to be met to operate a safe and secure system

Project Scope

- Effectively managing peak demand and stability through increased flexibility including over longer time periods [multiday and seasonal].

What this could look like...

- LDES is a

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Innovation Challenge 3 Aims

Innovation Challenge 3: Unlocking energy system flexibility to accelerate the electrification of heat

Context

- Heat pumps alone have the potential to add 14TWh of electricity demand to the system by 2030.
- Flexibility will be needed to support shifting or reducing heat demand at times of system stress
- Technology solutions like thermal energy storage (TES) and long-duration storage can help to decouple electricity demand and supply, to minimise system costs and maximise renewable consumption. However, these technologies are relatively unused and further analysis is needed to understand the value to the energy system

Project Scope

- Improving local heat supply and demand analysis and coordination to support energy network planning
- Effectively managing peak demand and stability through increased flexibility including over longer periods (multi-day and seasonal)

What this could look like…

- LDES is a

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Innovation Challenge 4 Aims

Innovation Challenge 4: Novel technical, process and market approaches to deliver an equitable and secure net zero power system

Context

- Electrolysers can play a critical role in providing a balancing demand load to use renewables effectively, with flexibility value delivered by electrolysers to manage system with high penetration of renewable generation
- There is an opportunity for providing the system with long-duration (>12 hours) storage services, currently only available through pumped hydro, compressed air and some thermal storage technologies

Project Scope

- Optimising electrolyser deployment and operation to unlock whole system value
  - Demonstrating electrolyser and similar technologies' capability for providing system services
  - Increase electrolyser participation in flexibility services
- Commercial and technical innovation to secure system benefits from hydrogen storage deployments
  - Increase consideration of system aspects such as constraints management when siting electrolysers
  - Improved understanding of business models and technical design for long duration hydrogen storage to provide system service

What this could look like…

- LDES is a