Energy storage in the UK

21st March 2023

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Leading in the Net Zero Transition

Leading capabilities and investment pipeline position SSE as UK's clean energy champion

Positive policy progression with stable regulatory frameworks

>£5bn/year sector investment in GB[1]

Electricity Networks

Over 20% of planned GB investment

50 GW offshore wind target by 2030

Offshore Wind

Enabling delivery of c.20% of UK's offshore wind target

16 – 20 GW onshore wind target by 2030[2]

Onshore Wind

Targeting up to 20% of Scotland's onshore wind additions

Hydro options

Coire Glas would more than double UK's long term duration storage capacity

Distributed energy

Developing options for GW-scale battery pipeline

CCUS & Hydrogen

Developing options for '1st of a kind' CCUS & hydrogen projects

UK AMBITION

FULLY DECARBONISED UK POWER SYSTEM BY 2035

+20 GW low-carbon flexibility needed by 2030 to ensure security of supply[3]

[1] *Includes current draft RIIO-ED2 plans*
[2] *Scottish Government draft Onshore Wind Policy Statement targets 8-12 GW of installed onshore wind capacity additions by 2030*
[3] *Smart Systems and Flexibility Plan 2021, needed to achieve offshore target*

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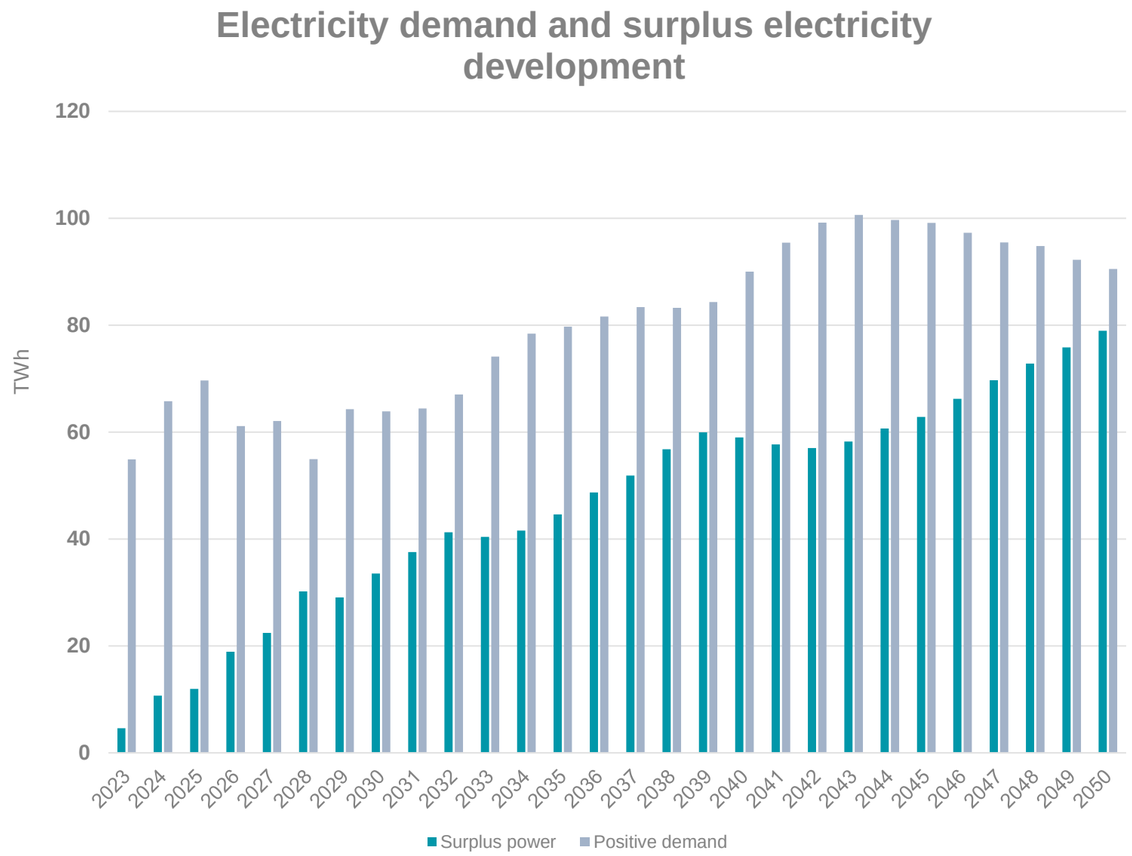
Growing Need for Flexibility in the UK

An expanding wind and solar fleet will lead to more intermittency and more volatility in power output

- The UK government has targeted 50 GW of installed wind capacity - from c.25.7 GW today - and a five-fold increase in installed solar capacity from its current capacity of 14GW, by 2035
- A growing intermittent fleet and greater electrification of demand sectors will lead to an increasing need for flexible power capacity
- **Energy storage will play a key role in providing flexible capacity** along side thermal power plants. Energy storage capacity can take advantage of the growing surpluses in power output, (see chart) helping to reduce curtailment and feeding the captured power back to the system during periods of high demand
- A range of energy storage technologies will be required to deal with future challenges to the UK power system such as wind droughts, growing volatility and maintaining sufficient ancillary services



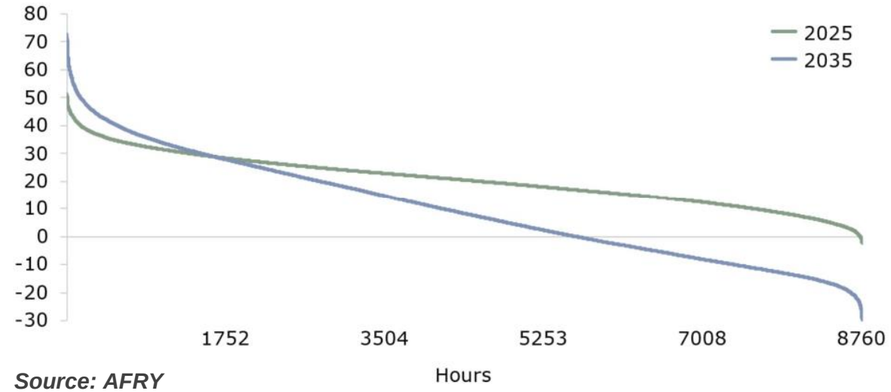
Source: SSE

Growing Need For Flexibility in the UK

The flexible fleet in the UK needs to be larger and more diverse to meet system volatility

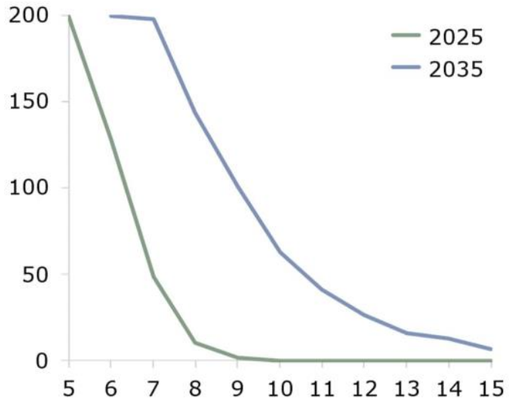
- A diverse range of storage options and technologies will be vital for security of supply, helping to bridge the gap between growing periods of excess generation and of low renewable output
- The largest **increases in contestable demand** are expected to hit **62 GW over a 7 hour period by 2050**, principle due to the growing size of the intermittent power fleet. This is up from around 30 GW over the same time period in 2030
- As there is currently 51.7 GW of flexible capacity in the UK (including interconnectors) the **need for a build out of the flexible fleet is clear**
- While there will be a need for a build out of medium and long duration energy storage, there is **also a growing need for fast-ramping generation**. We expect this need to increase by over 20GW from now until 2050

Duration curves for hourly residual demand (GWh)



Source: AFRY

Frequency of >5GW/hr residual demand ramp rates (hr/year)



Source: AFRY

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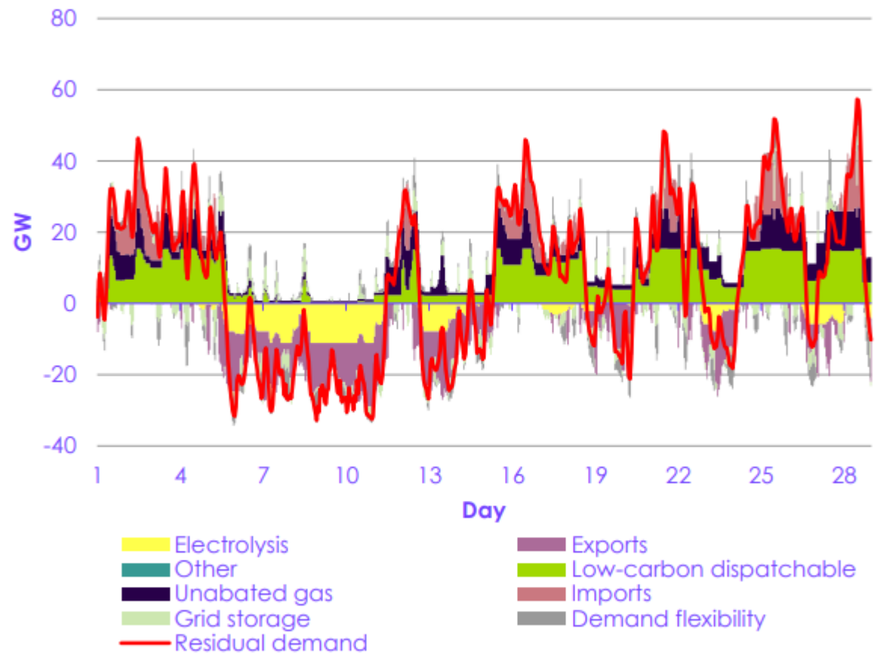
Hydrogen in Power Generation

Hydrogen power will be key in meeting the demand for decarbonised power generation

- Hydrogen could play an important role as **long-duration energy storage** in the future UK energy system
- Most system modelling, including BEIS' 2050 projections, suggest that **hydrogen use in power generation can reduce overall system costs**
- **Blending** of hydrogen with natural gas allows for a reduction in carbon intensity of gas-fired power plants with a limited need for significant infrastructure changes
- Hydrogen-fired capacity is expected to be cheaper than Power CCS at **lower load factors**

Figure 2.4 Meeting the highest four-week period of residual demand in 2035 (Central scenario)



Source: AFRY (2023) *Net Zero Power and Hydrogen: Capacity Requirements for Flexibility*.
Notes: Residual demand is demand required to be met after taking account of generation from renewables, nuclear, BECCS, and other inflexible generation. Dispatchable low-carbon generation includes gas CCS and hydrogen. Chart based on 2012 weather patterns, representing a 'normal' weather year.

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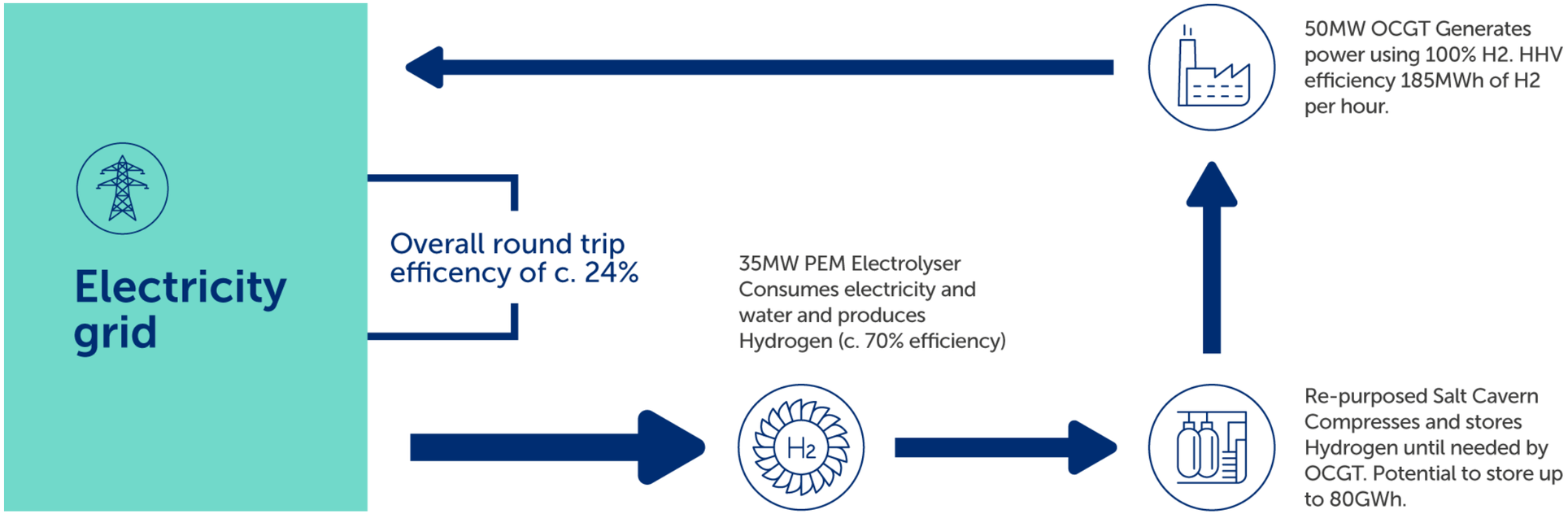
Need for Hydrogen Storage

Hydrogen power needs large-scale hydrogen storage to operate effectively

- There is a strong and clear need for storage to support H2 power generation.
- Both Blue and Green hydrogen production needs storage to efficiently support power generation demands due to the differences in hydrogen production and hydrogen demand
- Power is therefore in a position to provide an early key anchor demand for storage, with wider system value expected in the medium term as the market develops.
- Wider system value includes operational efficiencies, strategic backup and support for different offtake options

Aldbrough Hydrogen Pathfinder

Large-scale demonstrator across H2 value chain - domestic green security of supply



SIEMENS energy

BLACK & VEATCH

- First step in plan for large scale hydrogen production, storage and power in the Humber
- Submitted for funding into the Government's Net Zero Hydrogen Fund 'Strand 3' with successful projects announced in Q1-23 and operational by Q4-25
- SSE sole developer at this stage

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Large Scale Hydrogen Storage

Gas storage today… hydrogen storage tomorrow

Aldbrough Gas Storage

- Nine salt cavern stores – each roughly the size of St Paul's Cathedral – holding natural gas
- Operated on merchant basis, injecting gas when prices are low and releasing gas when consumer demand is higher
- Major project recently completed to return two caverns to service, boosting energy security ahead of tight winter

Aldbrough Hydrogen Pathfinder

- Pathfinder project entered into Net Zero Hydrogen Fund; demonstrator would unite hydrogen production, storage and power generation in one location by mid 2020s
- Consists of 35MW electrolyser; one converted salt cavern with capacity of c.20GWh; 50MW OCGT operating on 100% hydrogen
- Support evidence base for wider deployment of flexible hydrogen power, and underpin plans for larger-scale Aldbrough Hydrogen Storage project

Aldbrough Hydrogen Storage

- Jointly with Equinor, developing plans for what could be one of the world's largest hydrogen storage facilities
- Proposed facility, located within East Coast Cluster, could be operational by 2028 with initial expected capacity of 320GWh
- Project plans to store low-carbon hydrogen either within the existing facility or at a new hydrogen storage site

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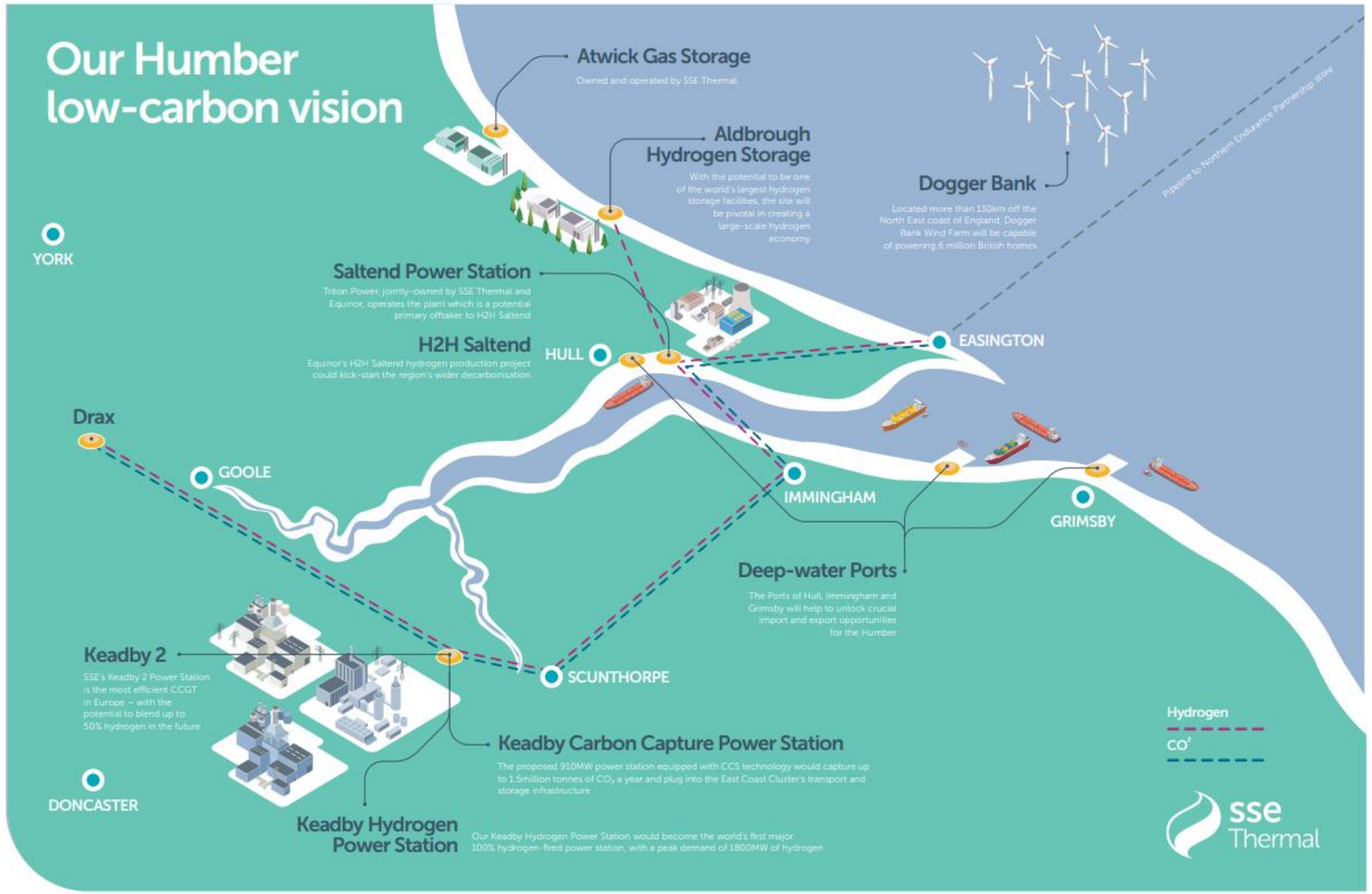
Existing Low Carbon Humber Projects

- Keadby CCS - shortlisted project in Track 1 cluster sequencing process
- Keadby Hydrogen – world's first major 100% H2 fired power station
- Aldbrough Hydrogen Storage – one of the world's largest storage units
- Aldbrough Pathfinder – uniting storage, production and power
- Keady 2 - hydrogen blending options at existing sites
- Hydrogen electrolysis projects



PRESENCE ACROSS UK INDUSTRIAL CLUSTERS

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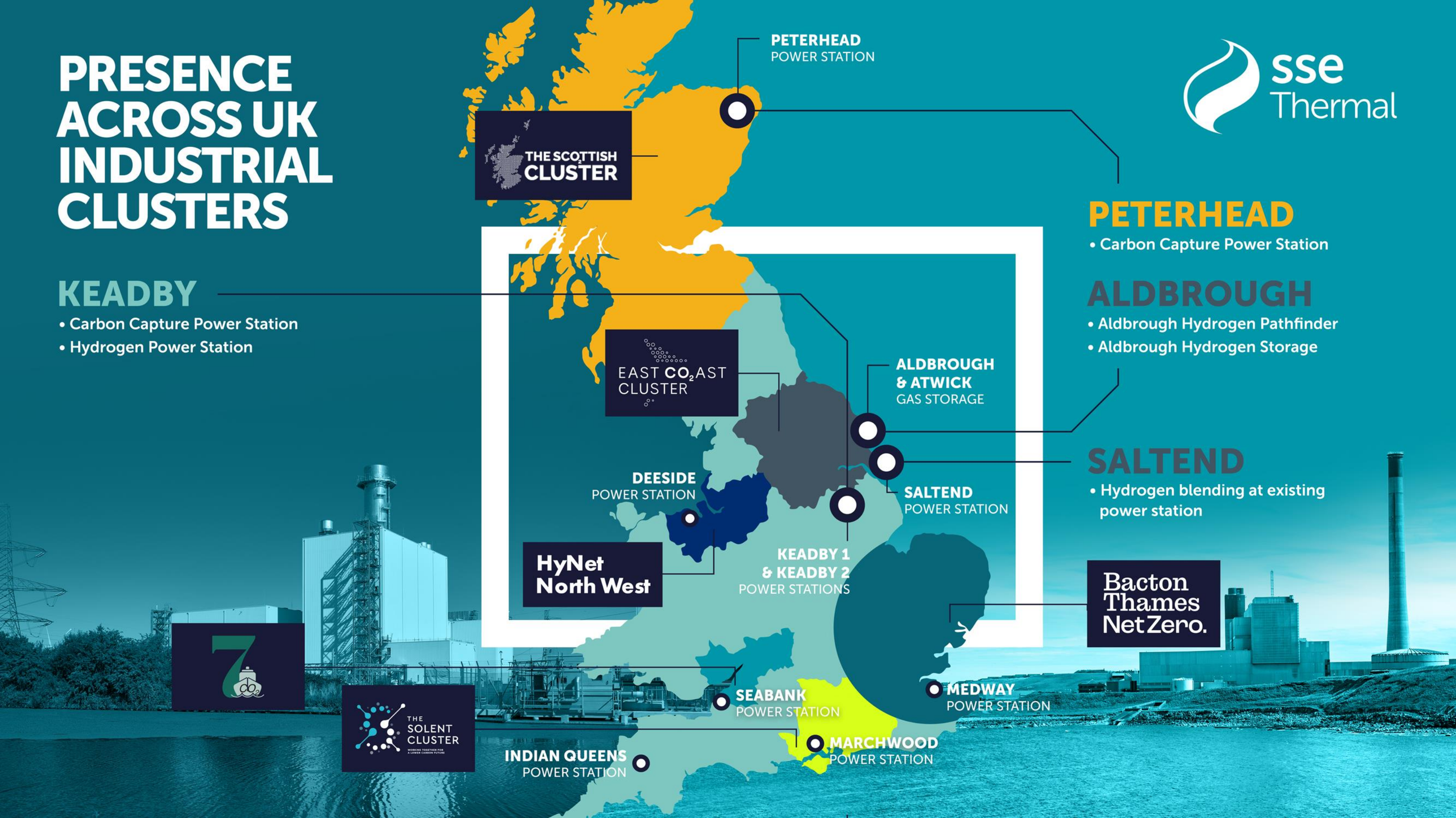

PETERHEAD

- Carbon Capture Power Station

KEADBY

- Carbon Capture Power Station
- Hydrogen Power Station

ALDBROUGH

- Aldbrough Hydrogen Pathfinder
- Aldbrough Hydrogen Storage

SALTEND

- Hydrogen blending at existing power station

SSE's Battery Developments

Grid-scale battery storage pipeline growing at pace to meet future fast-ramping flexibility needs

- SSE's experience of developing and operating renewable and flexible assets puts it in a strong position to exploit opportunities in this growth market
- First battery project construction now under way at Salisbury
- Assessing >1GW additional opportunities

Project		Capacity (MW)	Stage
	Salisbury	50	In construction
	Ferrybridge	150	Consented
	Fiddlers Ferry	150	In planning
	Monk Fryston	320	Planning appeal

Source: SSE

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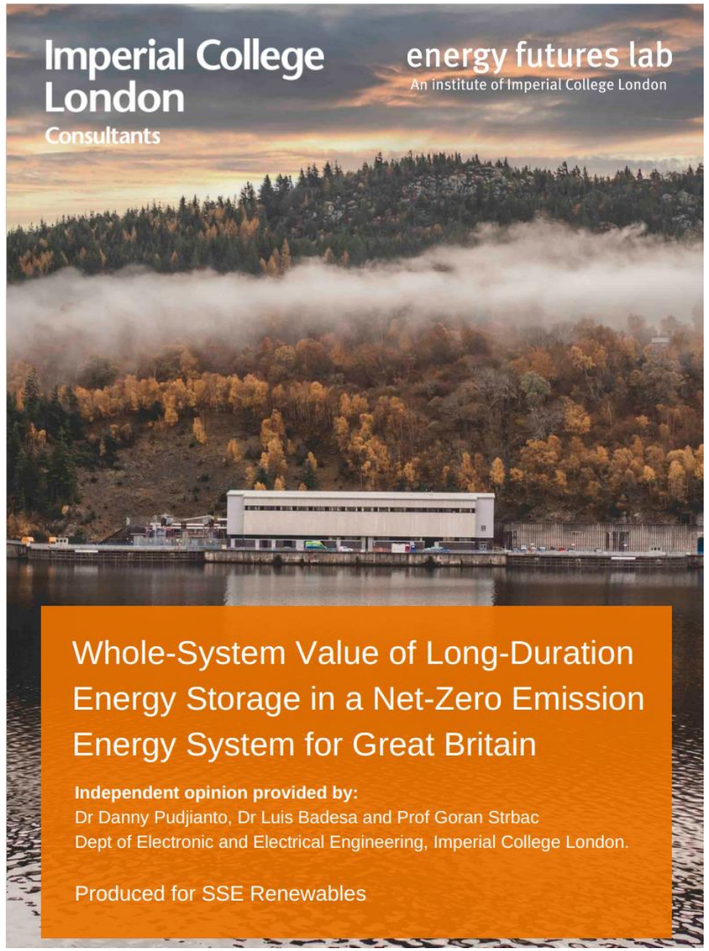
Corie Glas Pumped Hydro Energy Storage

Corie Glas strengthens SSE's portfolio with large-scale and cost-effective* energy storage



- **Specifications**
  - Capacity: 1296 MW (4 x 324 MW)
  - Stored energy: 30 GWh
- **Key benefits**

Would more than double Great Britain's existing electricity storage capacity.

Low carbon, medium-term energy storage – crucial for the UK to transition to a net-zero carbon emission system

Cheaper than other low carbon electricity generation technologies

Reduces wind curtailment in the GB electricity system

Can provide critical ancillary services needed for integrating a high penetration of renewable generation, e.g. frequency response

*A study by independent researchers found that investing in 4.5GW of pumped hydro storage could save up to £690m per year by 2050

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Thank you

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