FIELD

Maximising grid flexibility: the role of batteries

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INTRODUCTION TO FIELD

Field develops, builds and operates grid-scale battery storage projects

Field owns our battery storage projects end-to-end → from early development, through the entire 40-year life of the asset.

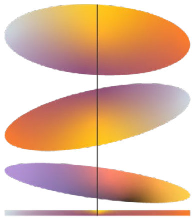
We have our own optimisation platform allowing us to trade our assets when live.

We are currently operating across UK, Spain, Italy & Germany.

1

Develop

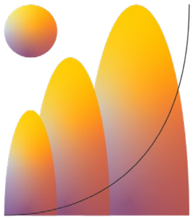
We develop projects ourselves from scratch, carefully designing our projects to minimise impacts. We also work closely with our suppliers during development.



2

Build

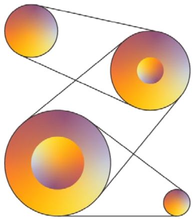
We outsource our construction to local third party contractors, however we have high quality in-house project managers and HSE oversight, ensuring our projects are delivered to schedule, and safely.



3

Operate

We have an in-house technology team building our own connection and optimisation platform, called Gaia. This defines trading actions and provided better operational data/oversight.




Typical Parts of a BESS site
Most BESS sites contain the same types of components, with only quantities changing depending on the desired power (MW) & duration (MWh).
Larger transmission connected sites also have a high-voltage substation.
Auxiliary transformer: Supplies low-voltage power to the battery cell cooling systems
Landscaping (WIP): Reduces visual impact of the site and promotes biodiversity
Acoustic fence: Reduces noise emissions from the site
Battery cells: Cells are contained in cupboard like 'racks' which are connected in a 'string' to a PCS. Newer battery designs use shipping-container sized modules instead of racks which increases energy density.
More cells = longer duration (hours)
High Voltage Switch Room: (contains circuit breakers to switch on / off each PCS)
Site welfare
Power Conversion System ('PCS'): The PCS connects the battery cells to the electricity grid, by using an 'inverter' to convert the 'Direct Current' from the battery cells into an 'Alternating Current' and a transformer to increase the voltage from 690V to match the public distribution system (33000V).
More PCS units = higher power (MW)

An example 200MW transmission-connected development

This site is about 5 hectares, most of which is not for the battery and substation compounds

Photomontages at Year 0 and Year 10 looking north

A RE- CAP ON CLEAN POWER 2030

The new government have announced their intention for all of our power to come from clean sources by 2030

NESO's advice is for 25 GW of short-duration storage, up from ~5 GW today

Proposed long-duration storage target is 81- 99 GWh of storage, up from 28 GWh (across 4 sites) today.

CLEAN POWER 2030

The network built in the next 5 years needs to be more than 2x what has been built in the last 10

2x onshore wind

3x solar

3x long-duration storage

3x offshore wind

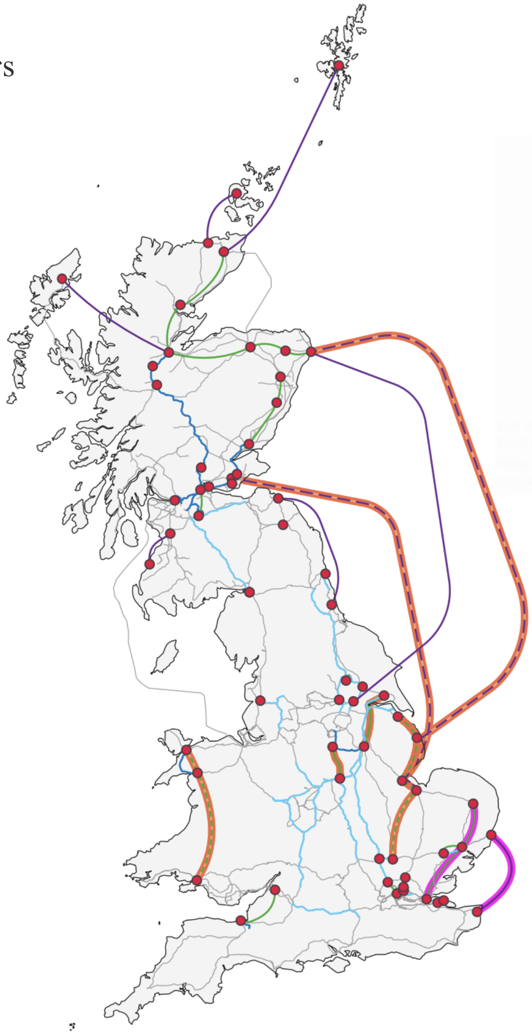
4x demand flexibility

5x battery storage

Collectively an investment programme averaging £40 billion annually

Not expected to put bills up

Will break the link between gas prices and electricity prices



WHY DO WE NEED BATTERY ENERGY STORAGE?

Batteries provide 4 key services

These services are considered in more detail in the following slides.

1. SECURE CAPACITY

- Batteries improve security of supply by providing capacity during peak demand periods and displace low-efficiency peaking plants. The Government ensure there is sufficient capacity using the **Capacity Market**

2. INTEGRATE RENEWABLES

- Batteries can help bridge any gap between supply and demand, absorbing excess power during times of high wind / solar generation and discharging it back into the grid during high demand periods. Principally this occurs in the **day ahead and intraday markets and the Balancing Mechanism**.

3. ADDRESS GRID BOTTLENECKS, REDUCING CURTAILMENT

- Batteries can help to reduce wind curtailment if they are located behind a constraint. The main market for this (at the moment) is the **Balancing Mechanism**.

4. PROVIDE GRID SERVICES

- Batteries can react in milliseconds to stabilise the grid (e.g. dynamic containment, balancing reserve)
- When connected at a transmission level (132 kV and above), batteries can provide a wider range of services (e.g. voltage control, inertia). These are **procured by NESO**, sometimes with longer term contracts.

↗ Modo Energy

2. **Integrate renewables:** As we shift from gas and coal to solar and wind, batteries will ensure supply continuity

OUR ENERGY IS COMING FROM CHANGING SOURCES

ELECTRICITY DEMAND IS FORECAST TO RISE

BATTERIES CAN PLUG THE GAP BETWEEN SUPPLY & DEMAND

Firm
Turned on and off at will

Coal

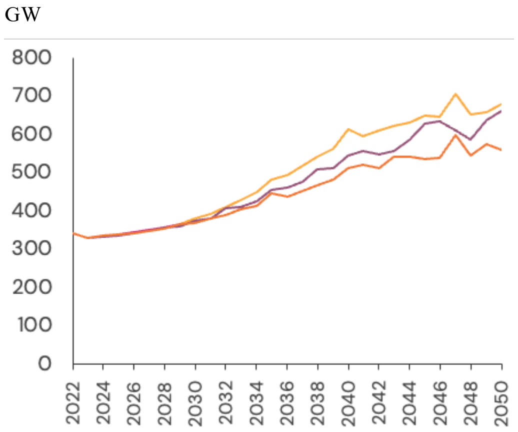
Gas

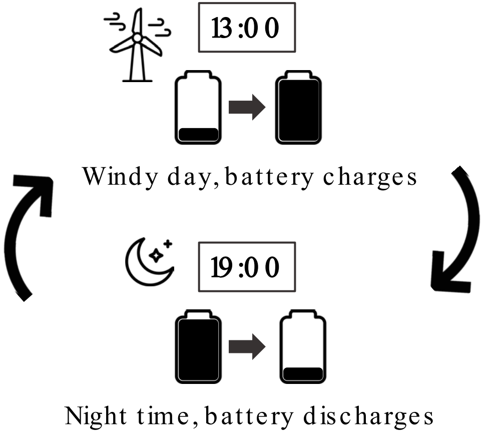
Variable
Turn on depending on weather & time of day

Solar

Wind

National Grid 2024 Future Energy Scenarios demand forecast





This ensures security of supply and that less energy is wasted during periods of high renewable output.
It also helps the national grid electricity system operator manage unexpected changes in renewable energy output or surges in demand.

↗ National Grid

3. Address grid bottlenecks: generation & demand in different places causes curtailment

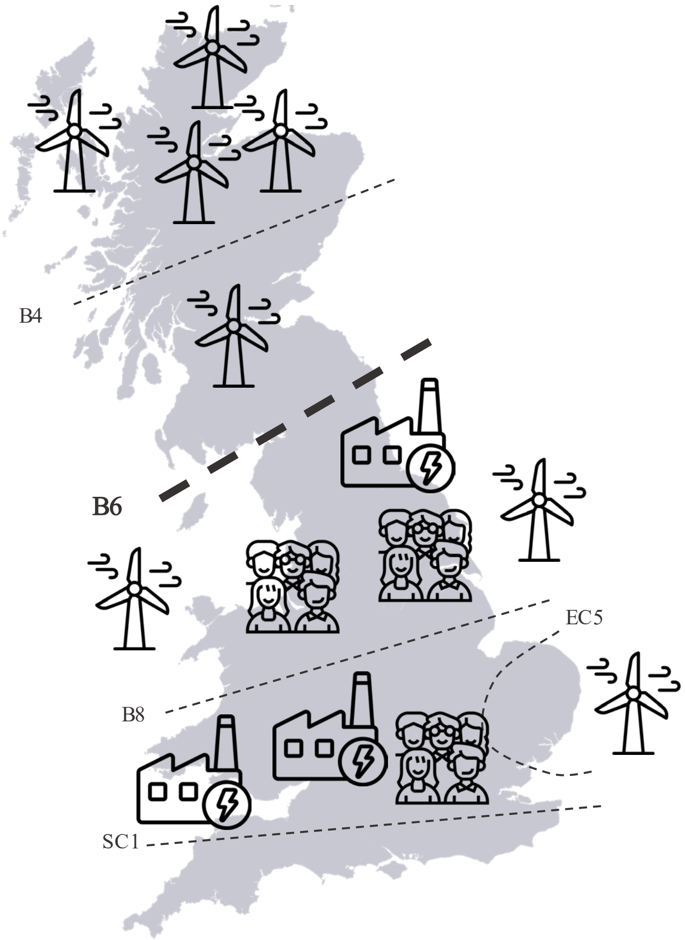
This creates an issue, often at the B6 boundary in particular, which is an area where grid infrastructure is highly constrained.

This results in curtailment. During high wind generation times power cannot be transported to where it is needed. Often wind farms are turned off with gas plants turned on to replace them.

The B6 blockneck added £920m to consumer bills in 2023; this could rise to £3.5b by 2030.

1. Typically 3 GW of **renewable energy** generation is turned off in the north.

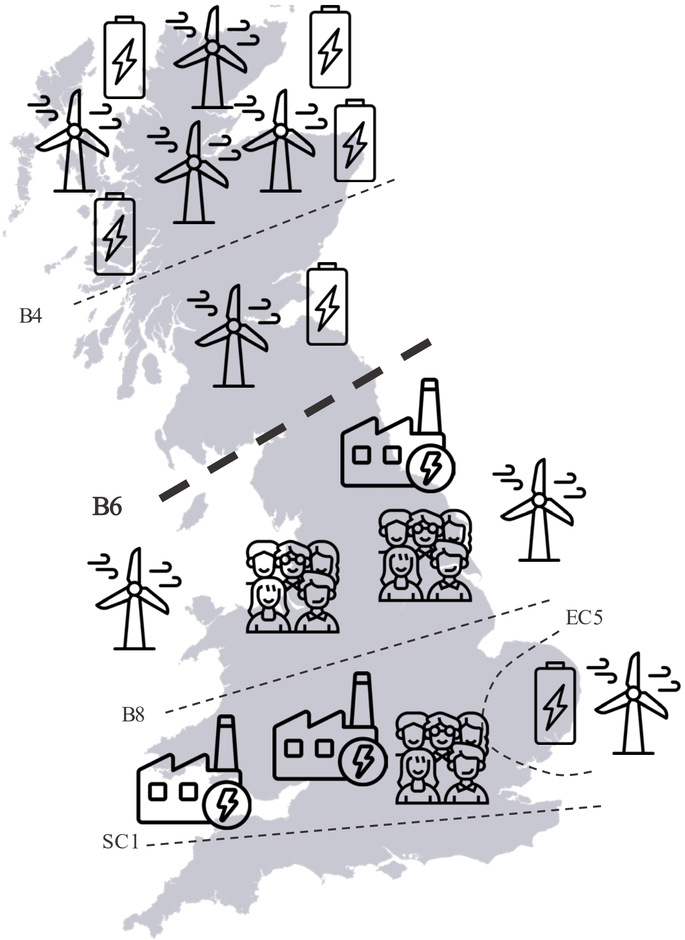
2. 3 GW of **gas generation** is turned on in the south to replace the energy (or interconnector schedules are modified)



↗ Field whitepaper "Battery storage: A key enabler for Clean Power 2030"

3. Address grid bottlenecks: batteries can help solve this problem

1. Batteries in the right locations and in particular in Scotland can avoid wind farms being turned off.
2. In this way, batteries can reduce the forecast £3.5b curtailment costs by 2030.
3. Batteries can also reduce some of the need for grid reinforcement and can enable higher pre-fault flows in OHLs.



↗ Field whitepaper "Battery storage: A key enabler for Clean Power 2030"

4. Provide grid services:

batteries can provide a host of services, particularly at high voltage

Batteries are able to ramp to full output within 1 second which makes them attractive for providing short-duration services that help keep the grid stable.

Connecting batteries at a transmission level (i.e. larger projects) allows a greater range of services to be provided.

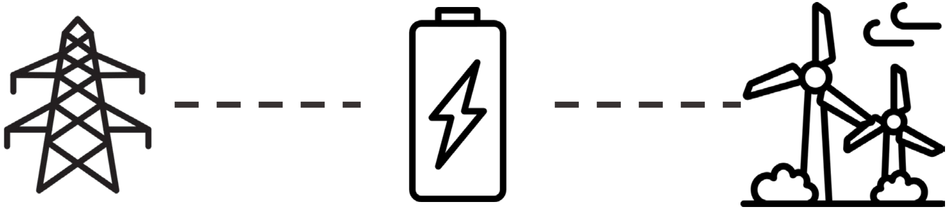
BESS CAN TECHNICALLY PROVIDE A VARIETY OF ANCILLARY SERVICES

Dynamic moderation

Dynamic containment

Dynamic regulation

Black start



Quick reserve

Slow reserve

Voltage control

Inertia

Provided at distribution & transmission level

Can only be provided at transmission level

THREE THINGS YOU MAY NOT KNOW ABOUT BATTERY ENERGY STORAGE

1. BESS projects can provide inertia and stability to ensure safe operation of the electricity network

NESO need an additional 10 - 15 GVA of Short-circuit level by 2030 in the north of Scotland and lower requirements in other areas.

Batteries with grid-forming inverters are a cost-effective way of providing this service.

OPTIONS FOR PROCURING MW-FREE INERTIA

1

Synchronous condenser with flywheel

Synchronous condensers with flywheels can provide up to ~4GW.s of inertia.

2

Transmission-connected batteries

A specially-designed 200MW battery can provide the same amount of inertia (and be a normal battery too).

Zenobe and Statkraft have both won contracts to provide inertia from batteries through NESO's Stability Pathfinder Phase 2.

Field narrowly missed out on a contract to provide inertia from our battery at Hartmoor in Stability Pathfinder Phase 3.

2. BESS prices are reducing so fast that projects can be a competitive alternative to pumped hydro

At 8-hour duration, possibly up to 12-hour duration, BESS projects will be competitive with pumped hydro projects.

Round-trip efficiency and response time of BESS projects is superior but BESS projects degrade and will require re-powering

KEY CHARACTERISTICS OF PSH VS LFP

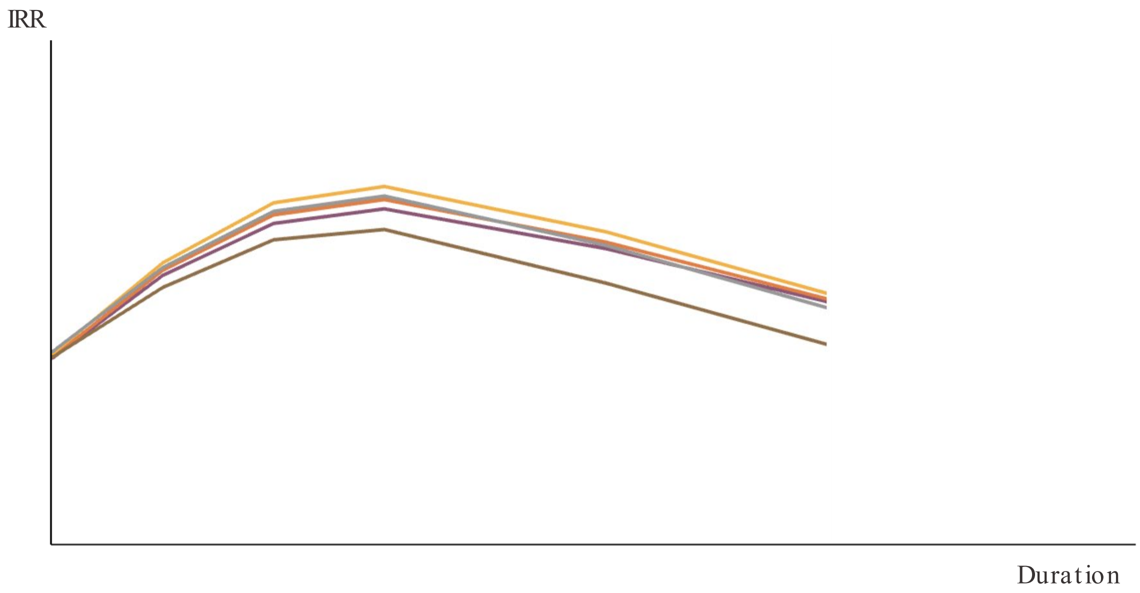
METRIC	*PSH*	*LFP*
Capex (2030 COD)	~£1,300/MW (increasing with inflation)	6-hour: ~£840/MW (reducing) 8-hour: ~£1,000/MW
RTE (%)	Typically 60-70%, can be up to 80% for newest tech	84 - 87%
Ancillary Services	All mandatory services under the grid code; SLC, inertia and reactive power based on generator characteristics	All mandatory services under the grid code; dynamic frequency response services; enhanced reactive power; SCL and inertia if grid forming
Response time from standstill	Seconds	Milliseconds
Cycles	Unlimited, minimal to no degradation	>10,000 cycles retaining 80% capacity at <0.25c
Lifetime (years)	60-80+; 40+ years switchgear, transformers etc.	15-20 (for cells, inverters) (80% capacity after 20 years); 40+ years for switchgear, transformers etc.
Typical development & planning time	Up to a decade or more	~2 years
Typical construction time	4-8 years	2 years
Construction Risk	High	Low
Location limitations	High, given size and topography required. Very limited sites available.	Low. <5% gradient preferred
Typical project size (MW)	Typically 400 MW up to 1800 MW	Typically up to 500 MW

↗ International Hydropower Association; PNNL; Solar Power World; BEIS

But developers will focus on shorter durations, which are economically more attractive

If NESO/DESNZ want 8-12 hour long-duration projects; batteries are a good option but operators will want support to improve returns

IRR VARIATION AS FUNCTION OF COD AND DURATION



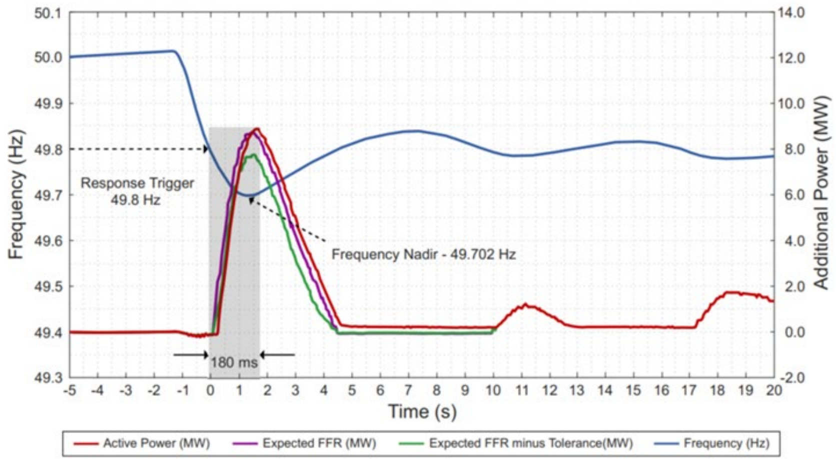
3. Batteries can have extremely fast response times

Ultra-fast response times should be useful to NESO, who currently procure "intertrip" services from wind farms.

A battery asset responding this fast can be thought of as providing an "inter-generate" service. They can add power into the system as fast as tripping a generator can remove it.

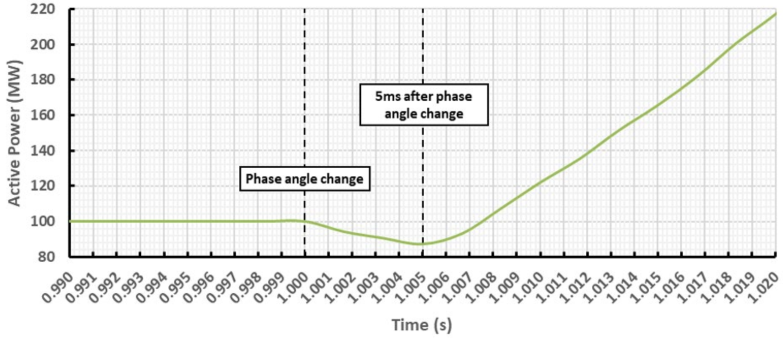
Network operators around the world are making use of this feature in so-called "grid booster" projects.

Full frequency response within 200ms of external setpoint



Statkraft Kilathmoy and Kelwin-2 Battery Performance

In Grid-Forming mode, a phase jump produces a ~1pu response within 20ms (1 cycle)



Field Stability Pathfinder phase 3 tender response

SUMMARY

Maximising grid flexibility: the role of batteries

1. SECURE CAPACITY

- Batteries improve security of supply by providing capacity that can be used during peak demand periods and displace low-efficiency peaking plants. The Government achieve this in the **Capacity Market**

2. INTEGRATE RENEWABLES

- Batteries can help bridge the gap between supply and demand, absorbing excess power during times of high wind / solar generation and discharging it back into the grid during high demand periods. Principally this occurs in the **day ahead and intraday markets**.

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↗ Modo Energy

QUESTIONS?