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Energy Storage for a Brighter Future: Whole systems storage in the spotlight

BHA is the leading trade membership association solely representing the interests of the UK hydropower industry

Our Mission is to drive growth in the sector by engaging, influencing and promoting Hydropower, Tidal Range and Pumped Storage Hydro, making these technologies relevant within the Government's ambition to enable a decarbonised, secure grid by 2035.

Why are storage and flexibility so important?

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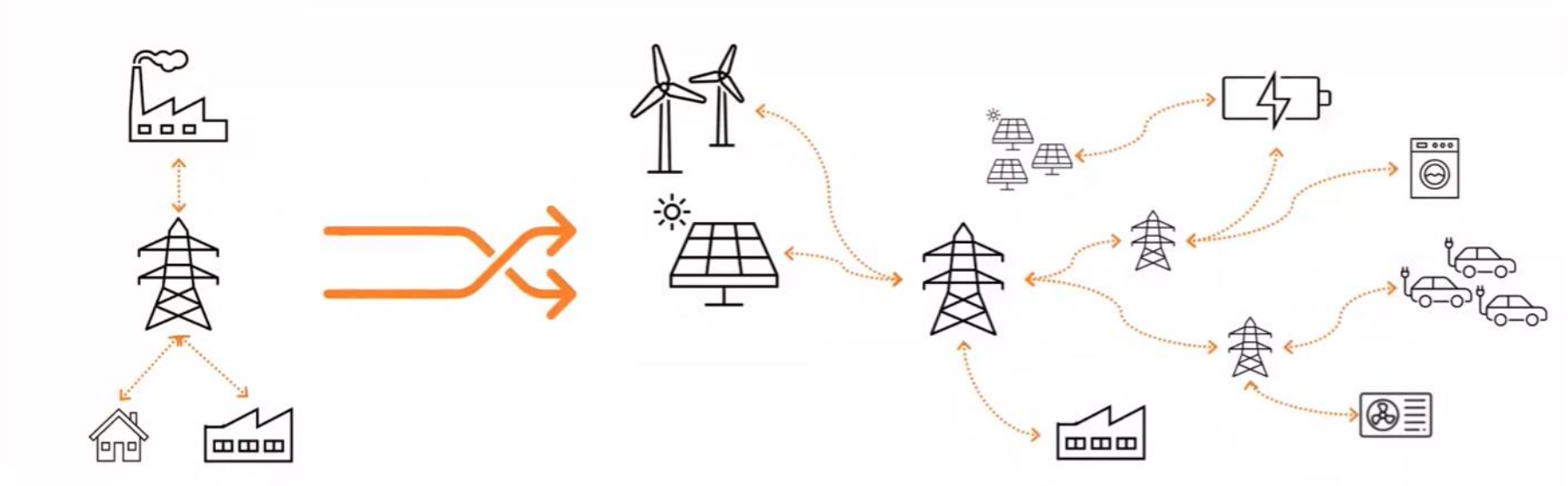
Fossil fuelled Centralised Grid

Intermittent renewables: De-Centralised Grid



- A decarbonised Grid will look very different with large % of intermittent renewables
- We need a lot more storage and flexibility and a smart grid.
  - Smart systems (Smart local Energy Systems – SLES)
  - Digitisation (visibility of generation across the grid T/D)
  - Innovation (active network management/ AI DSR)
  - Optimising the grid, accessing available headroom when the wind's not blowing

UK grid has, and is decarbonising very rapidly, so innovation is having to meet new needs

Why is storage so important?

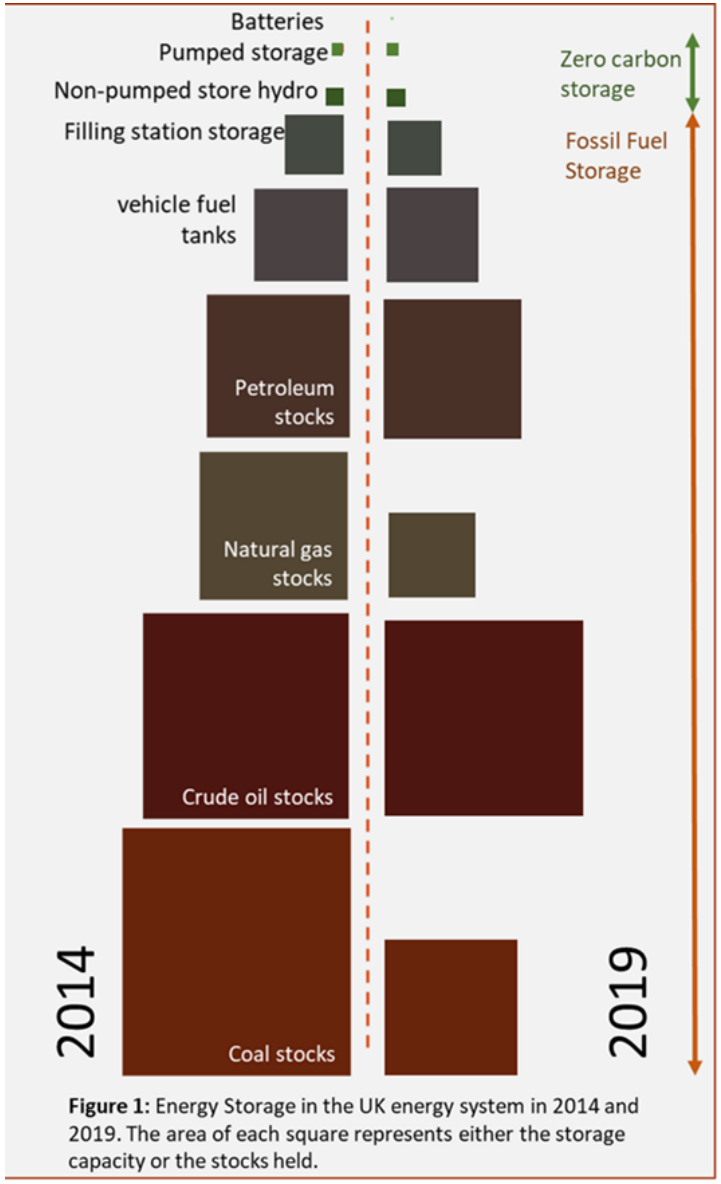


Figure 1: Energy Storage in the UK energy system in 2014 and 2019. The area of each square represents either the storage capacity or the stocks held.

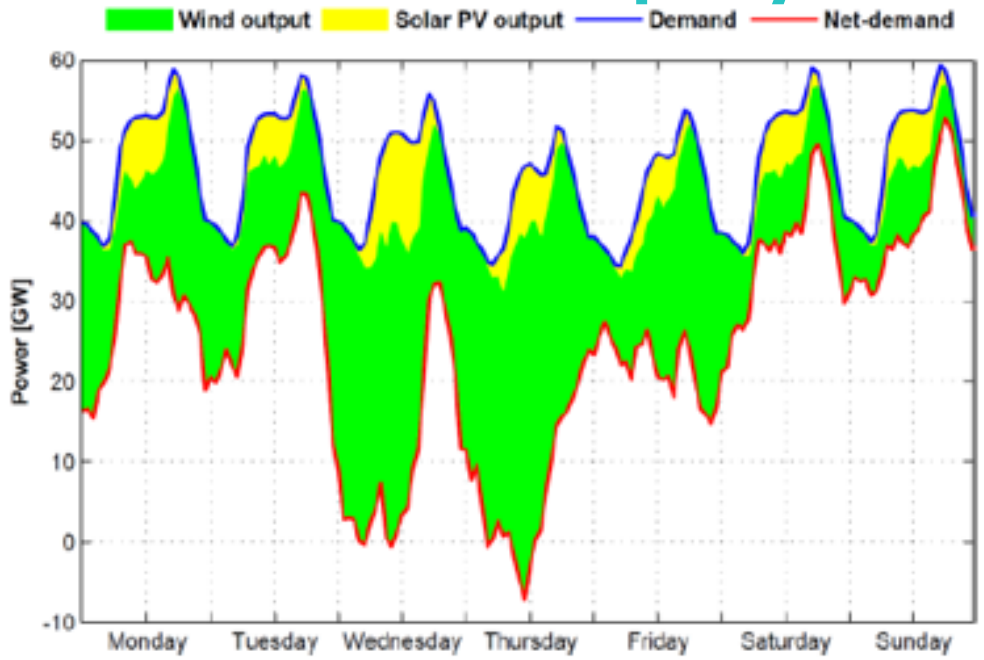
Simon Gill Strathclyde University

Storing Fossil fuels has always been convenient and relatively easy. Electricity is much harder to store and works on the basis of generation meeting immediate demand.

- Fossil fuel storage is reducing
- We need storage to manage increased % of intermittent renewables

In the UK reservoir hydro has storage of 900GWh

Resource adequacy



Resource adequacy, = Demand – intermittent renewables keeping the lights on when there's **wind drought**

What does storage do?

Storage in the energy system needs to play at least the following five distinct roles

1. Energy system resilience: inter-seasonal and inter-year storage of energy

Whole energy system (heat, transport, electricity, industry) reserves needed to deliver societal resilience to geopolitical and international-market shocks. Currently fossil fuel stocks likely move to hydrogen and its derivatives.

2. Inter-seasonal balancing of heat demand:

Heat is largest component of demand with largest variation between summer and winter. Currently fossil fuel stocks likely be hydrogen and derivatives.

3. Electricity system energy balancing:

Align renewable availability and demand as intermittency grows. By 2035 oversupply could be 25%, with excess renewables constrained off. Although there will be extreme durations (e.g. wind droughts of up to 3 weeks) the majority of renewable fluctuations are expected to be in the 10 – 50 hour. PSH ideal technology to support management of this issue.

4. Electricity network constraint management:

Network constraints currently tend to last for a few hours at a time but likely to increase in duration, lasting for a few tens of hour at a time. PSH ideal technology to support management of this issue.

5. Electricity system response, reserve and inertia:

Dynamic containment frequency response services delivered through short duration technologies such as 1 – 3 hour lithium ion batteries. PSH can easily deliver (and already does deliver) many, if not all, of these services including inertial response, frequency response, and operating reserves.

Pumped storage hydro

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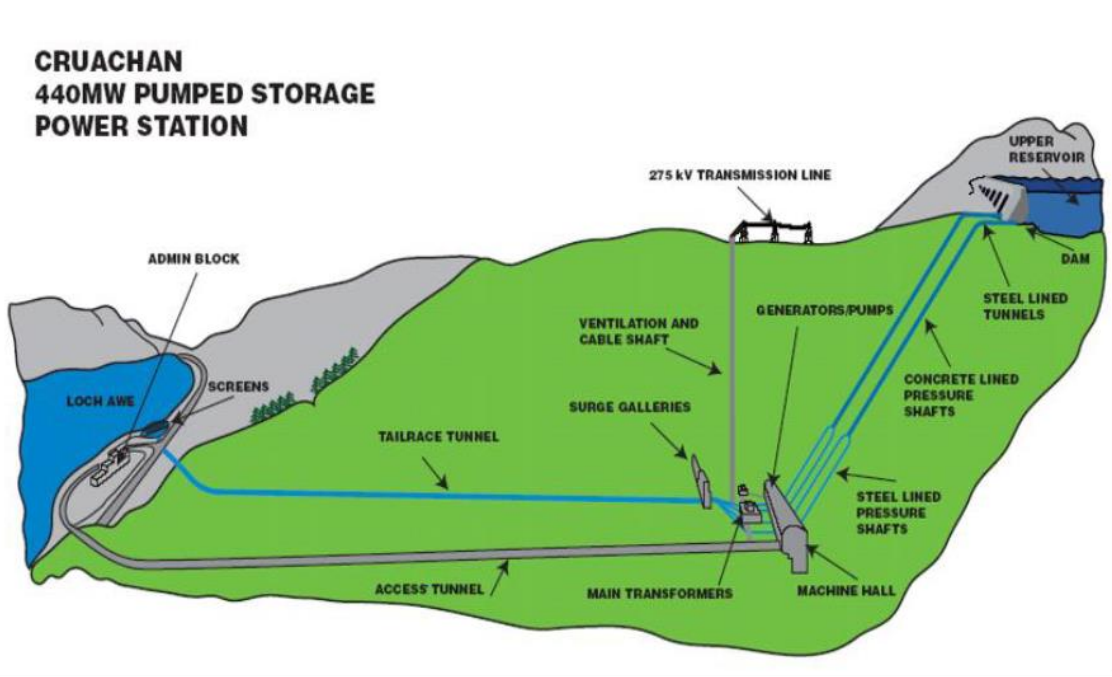
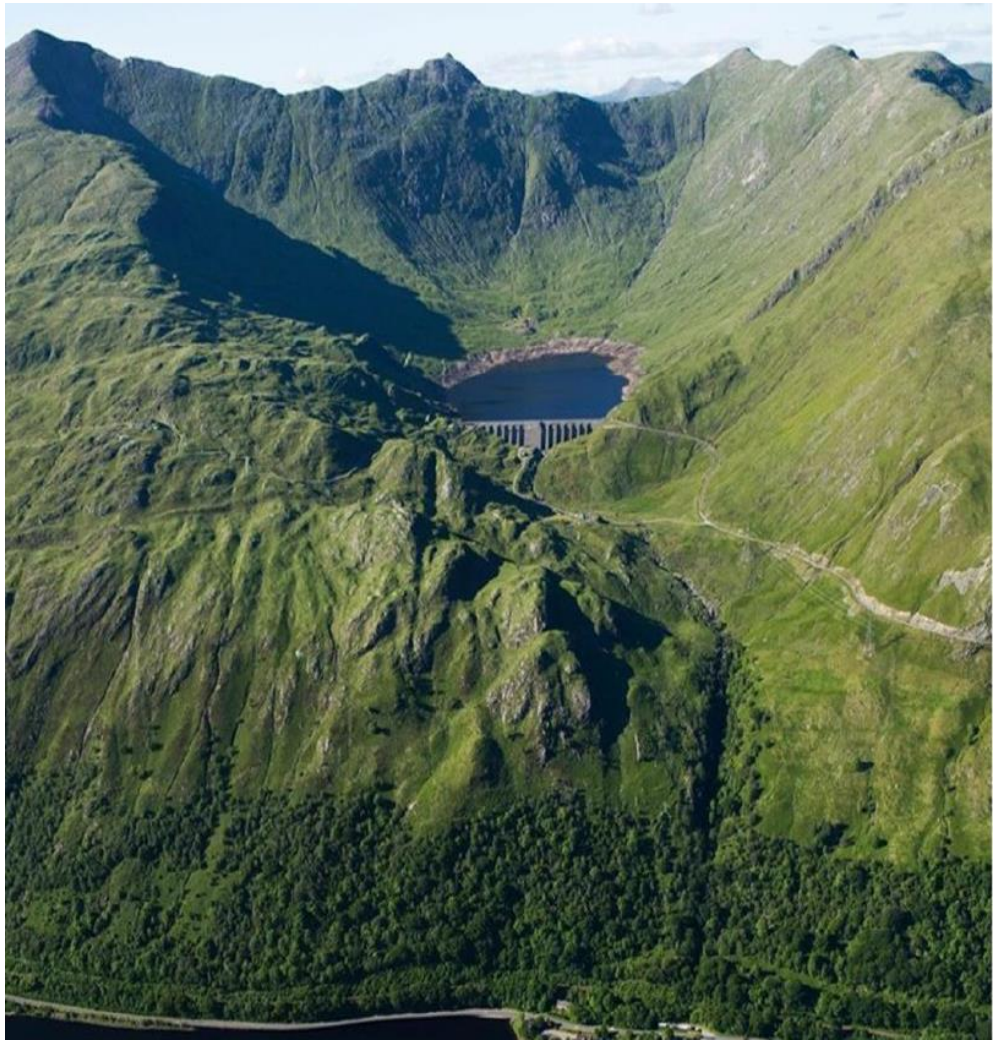
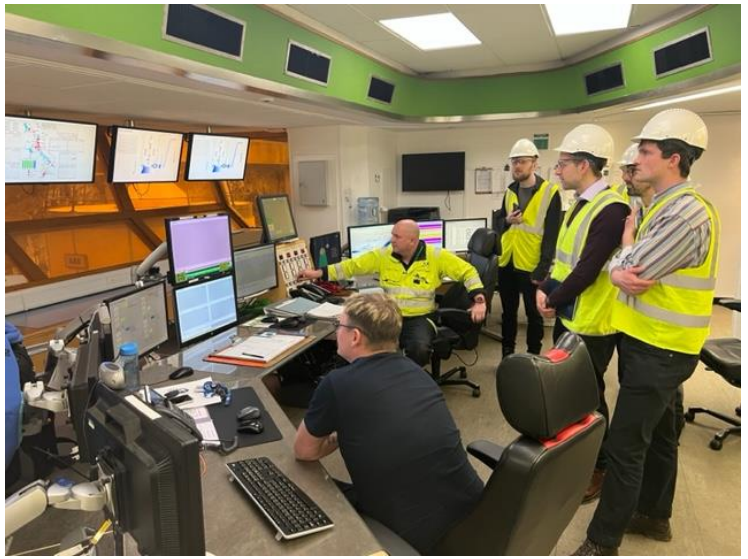
Site	Date commissioned	MW capacity Generation	GWh capacity	Owner
Dinorwig	1983	1,728	10.4	First Hydro
Foyers	1974	300	6.4	SSER
Ffestiniog	1963	360	1.8	First Hydro
Cruachan	1966	440	7.6	Drax Hydro
Total		**2,828**	**26.2**	

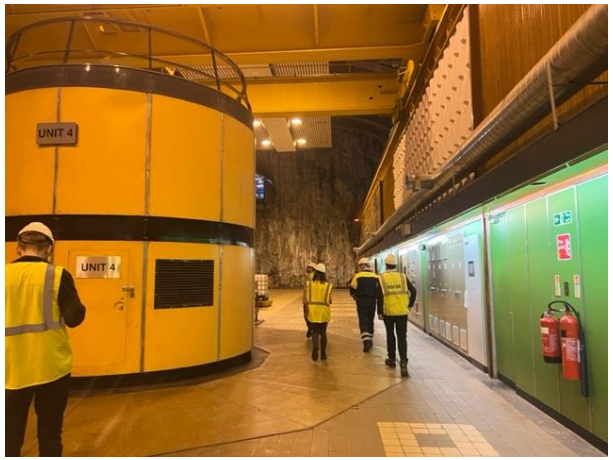




Pumped storage hydro

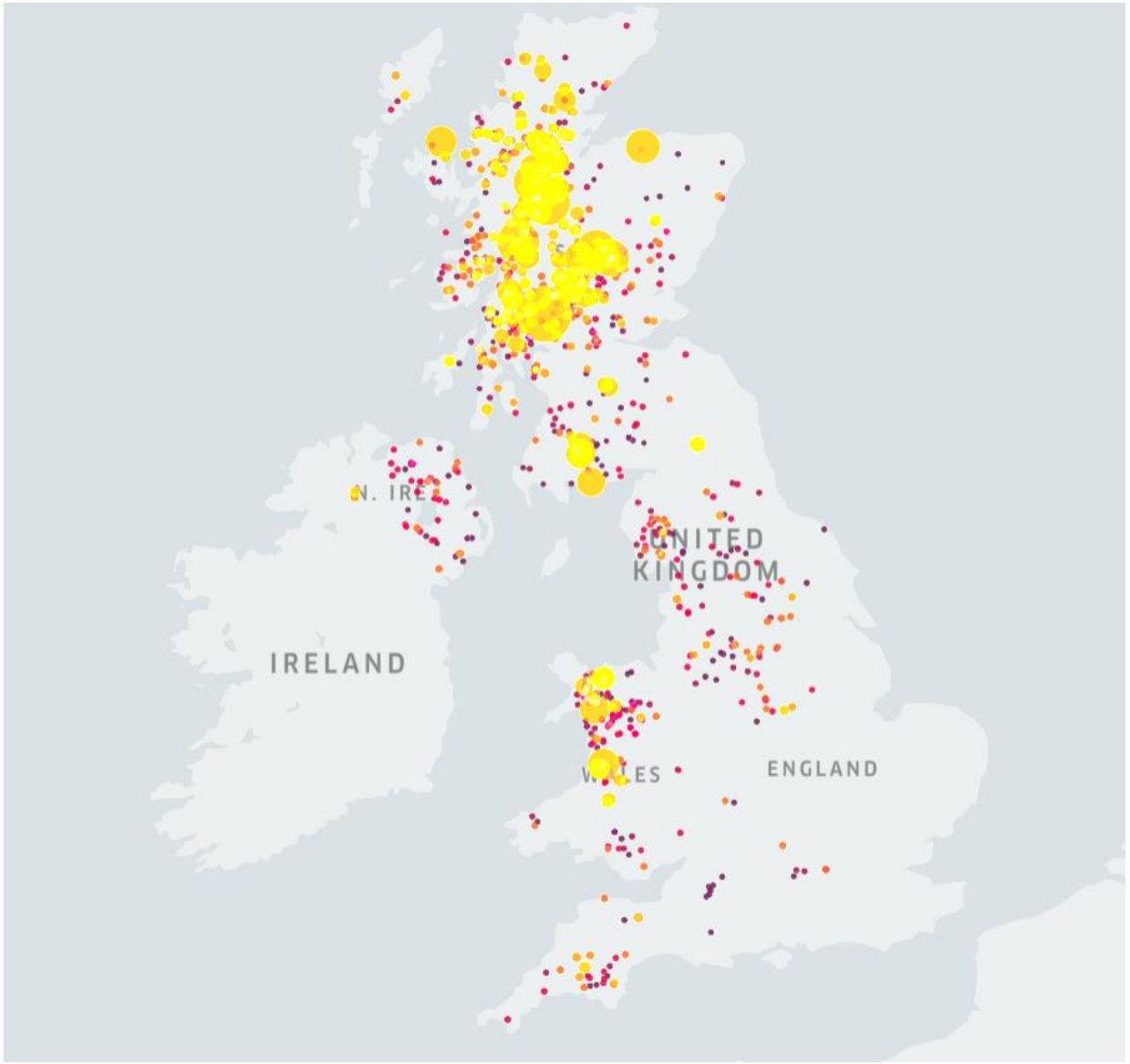
Site	MW capacity	GWh capacity
Coire Glas	1,500	30
Red John	450	2.9
Glenmucklock	400	1.5
Glyn Rhonwy (Wales)	100	0.7
Cruachan extension	600	tbc
Balliemeanoch	1,000	45
Corrivarkie	600	19
Dorothea (Wales)	450	2.1
Halviggan (England)	150	1.2
CCSQ (Wales)	100	0.6
Earba	900	32
Loch kemp	600	
Total	**6,850**	**135**





Operational since 1966
Concrete test: another 125 years

Hydropower projects in the UK



Total number of schemes: 1,657
Total Installed Capacity: 2 GWs
Total Generation: 5,496 GWhs
Storage capacity: 900 GWhs
Undeveloped potential: 1-3 GWs

Hydropower: 2% of annual UK generation, 2/3^{rds} generation in winter, peak demand.
Reservoir Hydro is dispatchable
Run of river is less intermittent than wind and solar.

A receipe for a stable grid: A diverse technology mix

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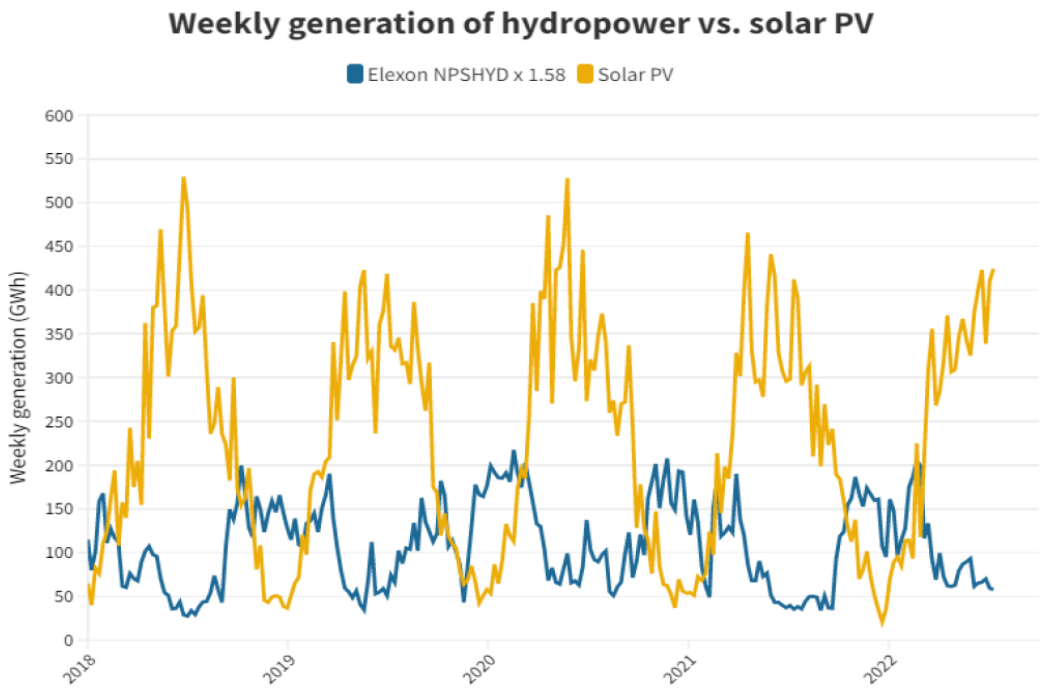
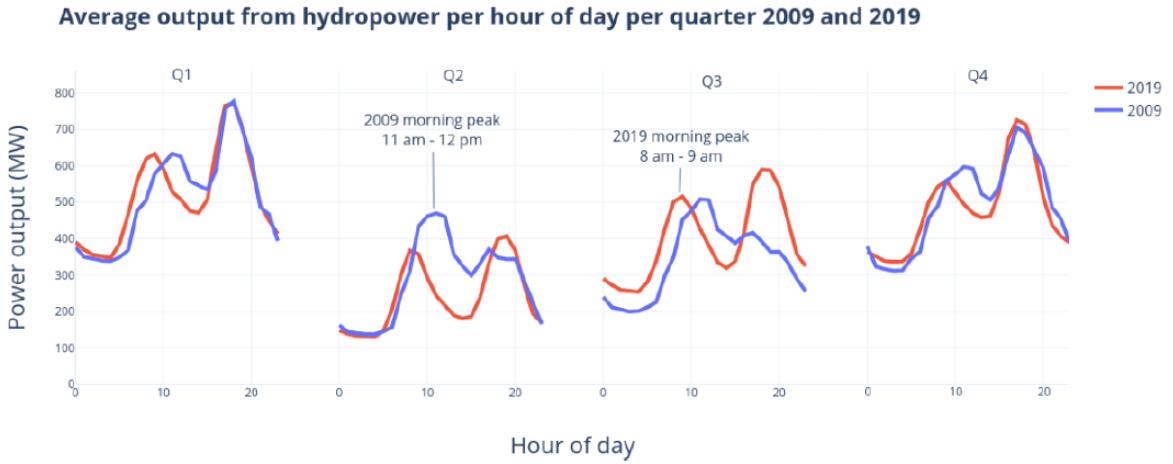
Seasonal demand: electrification of heat



The different patterns of generation from different technologies: Solar summer, Hydro winter

Load following



Hydropower is dispatched to meet the morning and evening peaks in demand

Taken from Birmingham University study looking at Hydropower resource in the UK, in 2022

Why do we need Pumped Storage Hydro?

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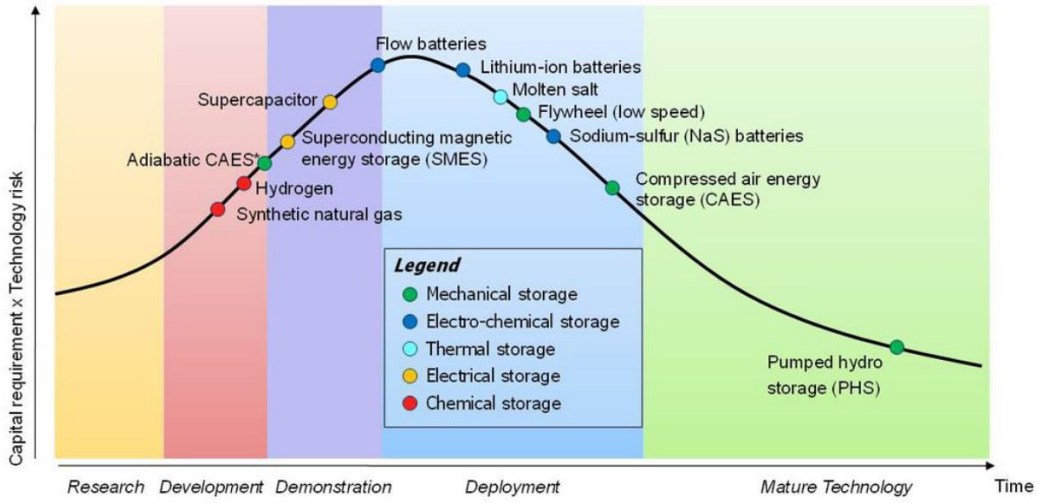
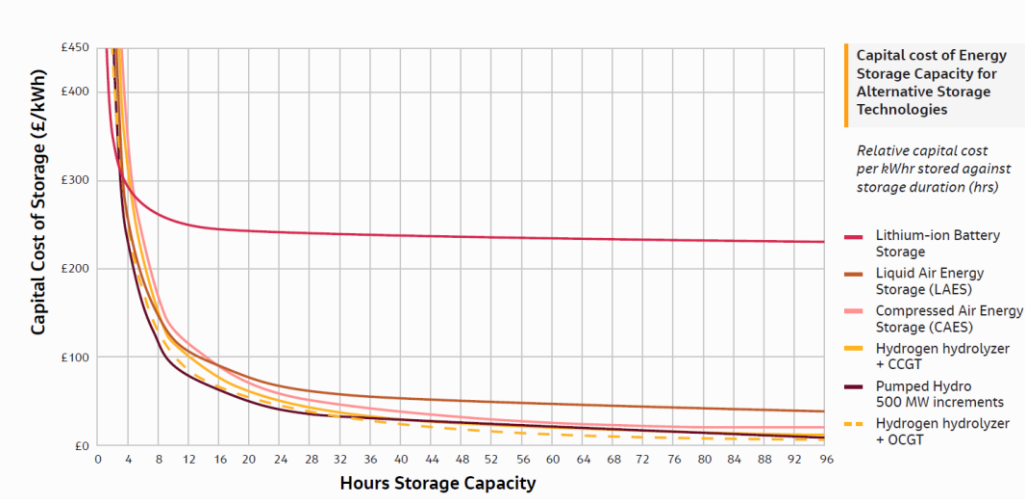
- A mature technology which has been deployed at scale for more than a century
- Energy storage capacity pipeline for several hundred GWh across GB
- Projects easily capable of delivering durations of tens of hours
- The lowest cost of storage on a £/MWh for the crucial 10 – 50 hour duration segment. Significantly beating batteries on costs per unit of energy stored at durations above around 6 hours
- High round trip efficiencies: comparable to some battery technologies, and significantly higher than hydrogen-based energy storage on a round trip (electricity to storage to electricity) basis.
- In contrast to interconnectors, fully controllable by the GB electricity market and system operator
- Delivers inertia (physical rather than synthetic), very fast frequency response, upward and downward reserve, resilience (black start), energy balancing on intra-day, day, and multiple day timescales, and relieving transmission constraints on the same set of timescales.





Price stabilisation mechanisms to enable deployment

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	Hydropower:	Pumped Storage Hydro:
Currently deployed	2GW (900GWh storage)	2.8GW (27GWh)
Pipeline	1GW	7.8GW (135GWh)
What is the BHA calling for?	CfD tweak for AR6: – Strike price £140/180MWh. – Reduce >5MW to >1MW. – Ring fence and aggregation potential for Capacity Market inclusion Move to 'Enhanced' Levelised Cost of Energy inc whole systems benefits. Replace 1 GW of coal with 1GW Hydropower.	A cap and floor mechanism to give price certainty CCC report Delivering a reliable decarbonised power system called for 15GWs of PSH by 2035

Whole systems: a stable, operable, de-carbonised grid

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- To deliver an operable, stable, secure net zero grid fit for the future the UK needs a **whole systems storage policy**
- We need to move away from current policy mantra 'the market will deliver' and 'Technology agnostic' and reverse engineer the solution.
- As with any recipe there needs to be specific quantities of key ingredients, not just the cheapest ingredient.
- As with investment portfolios, the best way to mitigate risk is to have a diverse portfolio.
- Scaling emerging technologies is always risky, deploying proven technologies should underpin this risk.
- However, there is a real risk that pumped storage hydro is crowded out of decision makers' minds as 'emerging technologies' eclipse the narrative.

The additional 6.85 GWs of Pumped Storage Hydropower can be deployed with the right price signals within the next 5-7 years. These decisions must be made now, and it should be considered to be a No Regrets, low risk of no delivery option

Summary: Whole systems storage in the Spotlight

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- PSH must have a central role within a wider energy storage portfolio, complementing chemical batteries (short duration) and hydrogen (very long duration).
- No technology on its own can deliver everything we need from energy storage, but no other mature technology can fill the gap that pumped storage needs to play.
- Is the only mature, cost-effective energy storage technology capable of delivering storage durations in the critical 10 – 50 hour duration bracket at scale.
- Is ideally suited for smoothing the vast majority of fluctuations associated with a net zero wind and solar fleet.
- Already proven, reliable and delivers a wide range of services, creating value for the energy system across timescale from sub-second to days.
- With 120+ year life, offers real energy security.