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.
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?

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

<table>
<thead>
<tr>
<th>Site</th>
<th>Date commissioned</th>
<th>MW capacity Generation</th>
<th>GWh capacity</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dinorwig</td>
<td>1983</td>
<td>1,728</td>
<td>10.4</td>
<td>First Hydro</td>
</tr>
<tr>
<td>Foyers</td>
<td>1974</td>
<td>300</td>
<td>6.4</td>
<td>SSER</td>
</tr>
<tr>
<td>Ffestiniog</td>
<td>1963</td>
<td>360</td>
<td>1.8</td>
<td>First Hydro</td>
</tr>
<tr>
<td>Cruachan</td>
<td>1966</td>
<td>440</td>
<td>7.6</td>
<td>Drax Hydro</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>2,828</strong></td>
<td><strong>26.2</strong></td>
<td></td>
</tr>
</tbody>
</table>
## Pumped storage hydro

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

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, 2/3rd generation in winter, peak demand. Reservoir Hydro is dispatchable. Run of river is less intermittent than wind and solar.
A receipt for a stable grid: A diverse technology mix

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
• 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.

Why do we need Pumped Storage Hydro?
### Price stabilisation mechanisms to enable deployment

<table>
<thead>
<tr>
<th>currently deployed</th>
<th>Hydropower:</th>
<th>Pumped Storage Hydro:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2GW (900GWh storage)</td>
<td>2.8GW (27GWh)</td>
</tr>
<tr>
<td>Pipeline</td>
<td>1GW</td>
<td>7.8GW (135GWh)</td>
</tr>
</tbody>
</table>

**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](https://www.ccclimit.org.uk/) Delivering a reliable decarbonised power system called for 15GWs of PSH by 2035
Whole systems: a stable, operable, de-carbonised grid

- 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

- 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.