British Hydropower Association

The British Hydropower Association (BHA) is the leading trade membership association solely representing the interests of the UK hydropower industry and its associated stakeholders in the wider community.

Our Mission is to drive growth in the sector by engaging, influencing and promoting Hydropower, Tidal Range and Pumped Storage Hydro, as firm, renewable power, providing critical infrastructure for achieving Net Zero, Energy Security.

In the UK, there are currently 2.8GW of Pumped Storage Hydro (PSH) across 4 projects that can deliver 27GWh of cycled storage. Those 4 schemes were state funded over 60 years ago, to consume overnight Nuclear generation, due to the inability of nuclear to be able to ramp up and down to meet the changing profile of demand. As was the case then, and increasingly now, PSH has a vital role in balancing the grid, as we have an increasing penetration of renewables online.

There are currently 7.8GWs across a pipeline of 6 projects with 135GWhs of storage. Progress is stalled whilst developers await the Government's decision on delivering a suitable long term price stabilising mechanism, which is suggested could be met by a 'cap and floor' giving investors' confidence and therefore lowering the cost of capital. This decision is expected at some point in 2024. The BEIS committee in their recent report, 'Decarbonising the Power Sector' recommended that this decision is brought forward to 2023. The BHA agree and highlight the cost of decision delay on value to the consumer:

- **Investor flight:** global competition for investment in particular, the USA's Inflation Reduction Act and EUs 'Green Deal Industrial Plan', planning and consenting delays, unfavourable taxation via business rates adds up to the UK becoming less favourable than overseas . **The availability and cost of capital should be a key determinate in bringing forward this decision.**
- **Grid barriers:** huge amounts of Transmission and Distribution upgrades required, taking a very long time and leading to connection dates as late as 2045.
    - **Congestion:** There has been an 8-fold increase **in the cost of managing congestion on the transmission network** since January 2010 and this trend is set to increase to up to £3bn per year by 2035 even after more transmission and distribution lines are built.
    - **Curtailment:** Increased congestion leading to curtailment costs of up to £62m / day (according to the National Audit Office)
    - **Rebalancing:** The Electricity System Operator (ESO) – originally envisaged as purely a residual balancer to reposition the market – is increasingly acting more as a central dispatcher, frequently re-dispatching more than 50% of demand (compared to only 10% in 2008).
- **Capacity Market:** Meets the challenge of intermittency, 57% of which is met from gas. DESNZ plan for this generation to be met by Hydrogen and gas with CCuS in the future – both are emerging technologies expected to scale, but there is risk of time

slippages and cost. There is a key question of how will the Net Zero grid meet a period of 3 weeks of low wind?

PSH is proven, reliable and deliverable, with 80% of the supply chain in the UK, projects will bring jobs and economic value as highlighted in the Biggar Economics report just released. PSH is an intergenerational asset (100+ years) that will deliver well beyond 2050 – true energy security. The wider systems benefits and factors stated above must be considered alongside leveilised cost of energy to really understand the best value for consumers.

The industry is poised to deliver and implores the government to bring forward this key decision, as suggested by the BEIS committee, to begin the delivery of these critical infrastructural assets that will bring benefits to this generation and the ones to come.

The need for long duration storage

1. *How sensitive is the amount of storage needed to assumptions about the future balance of supply and demand on the grid? What role could nuclear power, fossil fuel generation with carbon capture and storage, or other energy technologies, play in reducing the need for energy storage on a net zero grid? What role could greater grid interconnectivity between Great Britain, Northern Ireland and other nations play in addressing the imbalance between supply and demand? What role could demand-side management of electricity play in reducing the dependence on storage?*

   What impact will future climate change have on demand – for example, how much will the seasonal differences in power demand change with warmer winters and greater use of air conditioning?

The energy system has been rapidly changing towards a Net Zero system, meaning the risks within the system are also changing. Storage and flexibility will be key to meeting the increasing penetration of intermittent renewables on the grid and the following factors will increasingly need to be countered:

- Increased demand (including peaks) with electrification of heat and transport;
- Increase in intermittent renewables;
- Increase in unpredictability of Net demand (total demand minus intermittent renewables);
- Increased stress events on the grid;
- Requirement for huge amounts of reinforcement to balance the increase in offshore wind and requirement for massive power transfers – what is the risk around the timeline for delivery?
- Increasingly vulnerable to weather anomalies – dunkelflaute, cold snaps, increased demand for heating and cooling, extreme weather including flooding a risk to critical infrastructure, power outages from storms etc

- Removal of linepack and the storage that affords – less storage capacity means more system risk. *“gas networks transport three times the energy that electricity networks do”*
- Expectation of technologies to scale and deliver within the timeframe given – risk of slippage and impact of that slippage.

This presents huge amounts of variables, with different sets of risks. The ESO FES is a credible, well modelled set of scenarios that is continuously reprised, reviewed and the updates published annually and the ‘Leading the way’ scenario should be front and central to the Government’s overall plan for decarbonisation.

This table and graphic produced by Simon Gill demonstrates the problem we are facing as we move away from fossil fuels, which are easily stored and massively flexible. Focus has been on the TWhs of generation that need to be replaced but has been woefully lacking in the other key benefits of fossil fuels storage and flexibility.

- Convention hydropower (with reservoir) currently provides 900Whs of storage
- Pumped storage hydropower with 2 reservoirs has the additional benefit of pumping and creating load onto the grid as well as generation and there is currently 26GWh. with a project pipeline that could deploy a further 135GWh
- Currently battery storage gives 2.6GWh
- There is much talk of Hydrogen picking up some of the storage requirements. This may well be the case in the longer term, but in the near time, we do not have storage facilities, transmission or enough Hydrogen to meet significant generation. Hydrogen will also be part of a global market and costs are uncertainty. If we are wanting an energy system that gives value to consumers and affordable energy, this is a big unknown and a risky variable.
- Tidal Range will also have storage and a key part of flexibility will be matching generation to local demand. Tidal Range would be close to centres of increasing demand (electricity demand in places like Liverpool or Cardiff will increase by 2.5x with electrification of heat, transport and indsutry) This is why a whole system solution needs to be considered, where is generation located, when will it generate, where will it be consumed and when.

Decarbonising UK energy storage: securing net zero.

For all the progress we have made in developing battery storage, almost all the UK's energy storage remains in the form of fossil fuels.

That fossil fuel storage is reducing – energy stored in coal has decreased with the closure of coal fired power stations, and gas storage has shrunk following the closure of major natural gas storage facilities such as Rough.

But that storage capacity hasn't been replaced.

An agile energy system can reduce our reliance on energy storage, but it can't remove it. We need storage to manage intermittent renewables, we need it to maintain an operable electricity system, and we need it to ensure a secure supply of energy for heat, transport, industry and electricity.

A net zero energy system needs to tackle the challenge and scale of energy storage directly. And we need to think beyond batteries to technologies that can store energy over days, weeks, and critically across seasons.

Energy storage is central to making sure that a net zero energy system is achievable and secure.

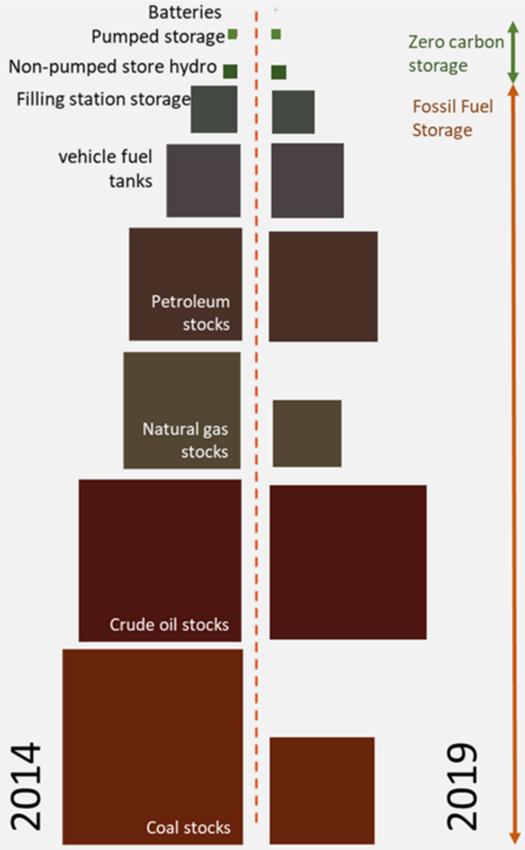

Figure 1: Energy Storage in the UK energy system in 2014 and 2019. The area of each square represents either the storage capacity or the stocks held.

There are huge risks associated with not fulfilling the requirement to meet capacity adequacy. The ESO's Resource adequacy in 2030s recognises this and states:

"It is well known that technologies such as nuclear, carbon capture storage (CCS), hydrogen power generation and new long-duration storage are among the potential candidates. However, the trade-offs and critical paths are less well understood. These options typically have long lead times to deliver; lead times that could be much longer than the timescales in the current Capacity Market arrangements, which is the main mechanism for delivering new capacity to ensure security of supply"

For a secure, stable and operable grid we need to have flexibility at local levels on the distribution grid and national levels on the transmission grid. Smart Local Energy Systems (SLES) will become more common with community scale decarbonisation of heat, PSH is a proven method to give long lasting flexibility and storage at transmission level.

Interconnectors are incredibly useful, and the cap and floor has been a brilliant success in enabling deployment. However, they do not offer energy security, and are open to other risks that increasing generation and storage in the UK will not be susceptible to. For example hostile actors. The interconnectors should be seen as an opportunity to export, as the UK has sufficient indigenous energy resources to become a net exporter of clean, green energy.

Large Nuclear, by its nature, is baseload and very inflexible and comes with the cost of disposing of the waste forever. SMRs are an emerging technology and could be useful, however, there has been scant regard to how communities will consider having an SMR near them? Again, the issue of waste.

Storage technologies

3.Which technologies can scale up to play a major role in storage? Which timescales for storage are different technologies most suited to? Is there a preferred technology for medium-duration and long-duration storage? What are the technology readiness levels for these energy storage technologies? Is it possible to produce enough domestic green hydrogen to fulfil long-term energy storage demand needs? Is there a distinct role for technologies that store heat instead of electricity?

PSH will be key in reducing curtailment and creating a more secure, flexible and economic grid. (Imperial College study shows reduction in systems costs with increased storage) 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.

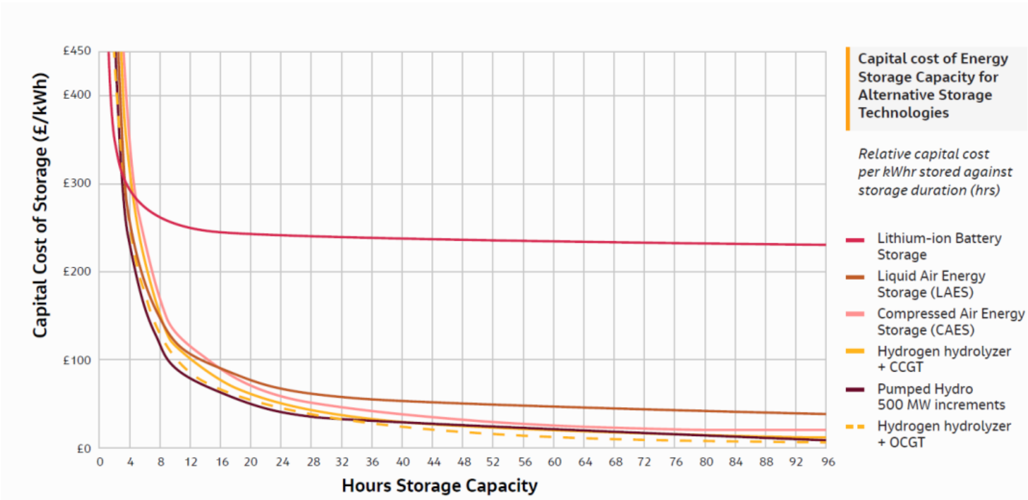

Figure 1: Cost comparison for Energy storage

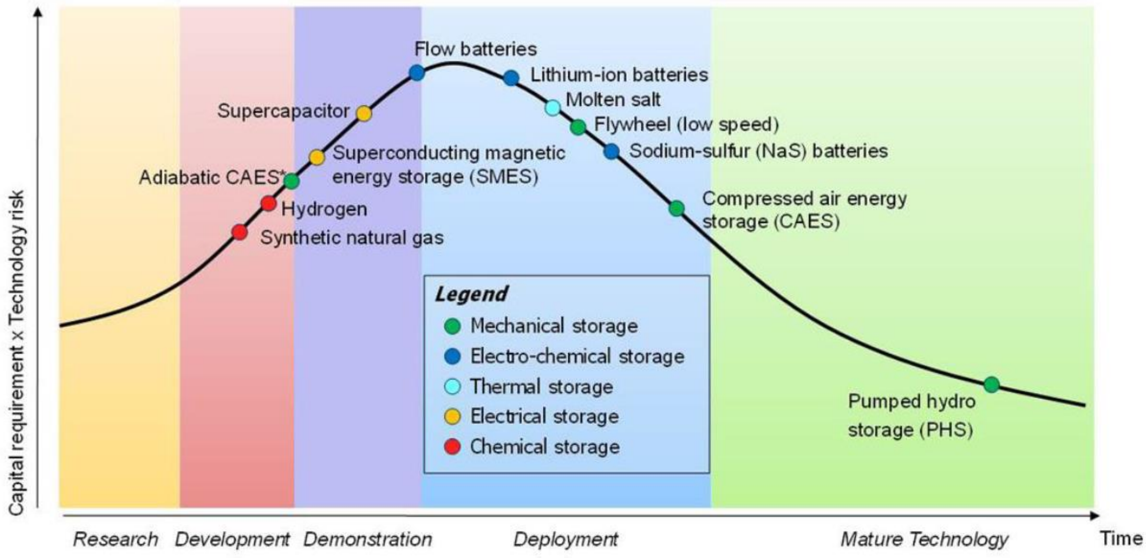

Figure 2: Technology Maturation curve The Benefits of Pumped Storage Hydro to the UK, Scottish Renewables, 2016

PSH can deliver for 4 hours or up to days or weeks. It is a proven and simple technology, with lifetimes expected to be more than 100 years. Unlike batteries it does not degrade with use.

Policy support

4. What policy support is currently in place to support deployment of storage technologies? Is it sufficient to support deployment at scale? How good is the economic case for long-duration energy storage? What policies and market structures need to be put in place to make the business case viable?

How will the grid need to change to support long-duration storage? Which stakeholders (e.g. energy companies, the Electricity System Operator, National Gas) should be planning for these changes? What role does the Review of Electricity Market Arrangements need to play to support medium- and long-duration storage development? Is the Government's current reliance on market actors and technology competitions likely to deliver the storage needs on time?

There needs to be a whole systems approach and a better understanding that the grid is physics and can only work within those laws. REMA and competitions are all expecting that the market will deliver the 'lowest cost' solution, when we need a 'best value' solution that considers multiple other factors including grid stability, security and operability over the long term (not just until 2050). The government must move away from a competitive and technology 'agnostic' approach and realise we need more technology specific solutions that are focused on delivering what the grid needs.

PSH and Hydropower have been providing inertia onto the grid for 100 years and inertia is becoming increasingly important to grid stability as we turn down and off large spinning thermal generation.

A key consideration is deliverability risk and expected timeline slippages of new or emerging technologies that are expected to scale and deliver large volumes of storage. Any new technologies, like Hydrogen or CCUs must have strict timeline evaluations so if there are slippages, then there are mitigations in place.

Deploying and utilising a proven technology, that is considered safe, reliable, and long-lasting should be a no-regrets solution that Government should pursue with haste. As stated above, replacing fossil fuels means 3 things, kWh, Storage and flexibility, the Government's policy has been good on the first, but much less defined with a lack of understanding of the importance on the 2nd and 3rd.

Technology readiness and deployment

5. *How well developed is the UK industry across different storage technologies, such as hydrogen or redox flow batteries? How does the UK compare to global competitors in these industries? Are there any storage technologies that have a significant export potential for the UK?*

   For which technologies does the UK have significant existing research or industrial capacity? Is the Government doing enough to support the industry to grow and drive exports and economic growth?

The British Energy Security Strategy doubled the commitment laid out in the Hydrogen Strategy. It commits up to 10 GW of hydrogen production capacity by 2030, with at least half coming from green hydrogen.

House of Commons Science and Technology Committee published, "The role of hydrogen in achieving Net Zero" on the 14th December 2022.

"The report highlights the large concerns it has around the belief that Hydrogen and CCUS will deliver a cost effective and reliable solution and warns against this being a 'panacea'.

"The rapid expansion of renewable energy provides important possibilities for the mass production of green hydrogen in the future. But currently, we heard there is unmet need for renewable-sourced electricity to contribute directly to our power supplies as demand for electricity rises in both domestic and industrial settings."

"The use of green electricity in producing, through electrolysing water, hydrogen for use as a fuel inevitably involves the loss of energy through the inefficiency of all such industrial processes. That said, we heard that if there was a large proportion of the electricity grid based on renewables, green hydrogen production might become very cheap during periods of low electricity consumption.

To make a large contribution to reducing greenhouse gas emissions in the UK, the production of hydrogen requires significant advances in the economic deployment of CCUS and/or the development of a renewable-to-hydrogen capacity. The timing of these is uncertain, and it would be unwise to assume that hydrogen can make a very large contribution to reducing UK greenhouse gas emissions in the short- to medium-term."

6.Beyond the cost of deploying long-duration energy storage, what major barriers exist to its successful scale up (e.g. the availability of a skilled workforce, the ability to construct the necessary infrastructure on time, or safety concerns around new technologies)? Are there sufficient training schemes in place to ensure the UK has the workforce to deliver the energy storage the grid will need? How long is it likely to take to develop the necessary infrastructure?

The essential skills required for PSH projects are expected to be largely available in the UK, and transferrable from other construction projects. While we anticipate that specialist mechanical/electrical equipment may be imported, around 70% of the project expenditure will be on civil works and based in the UK. A recent independent report commissioned by Scottish Renewables report found that the six PSH projects currently under development could deliver £5.8 billion of economic benefit and almost 15,000 jobs by 2035.

Next steps and international perspectives

7.What steps should the Government take now to ensure this storage can come online later in the current decade? Can the UK learn from other countries that have successful policies for supporting large-scale energy storage, or from pilot projects elsewhere?

The UK are in a competitive Global market for investment (IRA etc) jobs and skills and the longer we delay the more risk we are adding to the ability to reach NZ? We should have a 'first mover' advantage with our existing PSH plant, but we are rapidly losing this as the PSH global pipeline grows.