Flying the flag for British Hydropower

From the British Hydropower Association

www.british-hydro.org

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Foreword From Our CEO

Low carbon energy technology diversity is key to a stable, operable, decarbonised grid alongside delivering national energy security and insulating the UK from the wider volatile global fossil fuel market.

The lack of technology diversity being brought forward through current policy decisions is largely down to the Government's drive for the cheapest kWh, however, lowest cost does not always translate to 'best value' to the consumer. The mantra that the 'market will deliver' and 'technology agnostic approach' belie the fact that each renewable energy technology has a different generation profile and brings something different to the grid.

Hydropower, Pumped Storage Hydro and Tidal Range are all inter-generational assets with benefits that are not captured in the narrow parameters of 'Levilised Cost of Energy', but are valuable, anchor assets that will pay dividends to UK plc over the long term. As grid flexibility and storage becoming increasingly important, so does the need to look at all technologies that can help deliver these key requirements.

The BHA is working hard to raise the profile of this valuable industry to ensure Policy Makers understand that Hydropower has been the backbone of stable, low carbon energy generation in the UK for over a century and why it is more important now than ever before.

Kate Gilmartin
CEO British Hydropower Association

Introduction

The **British Hydropower Association** is the leading trade membership association solely representing the interests of the UK hydropower industry and its associated stakeholders.

Our 'Vision And Mission'

Our Vision is to advance the industry and make UK Hydropower technologies applicable within the current context of climate change and the Government's ambition to decarbonise the grid by 2035.

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

What We Do

The BHA runs Industry events, providing opportunities and mechanisms for members to connect, learn, share and collectively work to overcome common barriers.
One of our key objectives is to ensure politicians, national and local government officials, network operators & regulators are aware of the benefits of hydropower, its needs and opportunities. We work hard to help build a supportive landscape to enable growth in the industry.

Hydropower in the UK

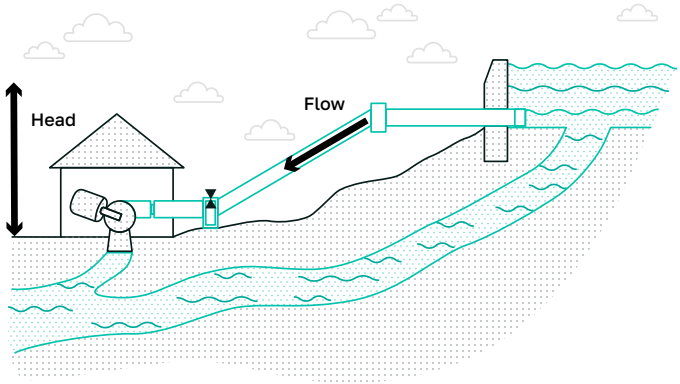
The United Kingdom has been a pioneer in hydropower development, utilising the flow of water for electricity generation since 1878 when the first 4.5 kW hydroelectric generator was put into operation to provide electricity for a single lamp at Cragside house in Northumberland.

Benefits Of Hydropower:

1. Proven and reliable, generating electricity in the UK since 1878.
2. Operational life of 80+ years and with refurbishment, a further 80+ years: true energy security.
3. Reservoir hydro offers low carbon, dispatchable generation (a key requirement for a decarbonised grid).
4. Provides inertia and other grid systems benefits.
5. A generation profile well matched to the UK's energy demand, ie baseload, winter generation, including peak demand.
6. The true value of Hydropower to the consumer, is replacing high cost and high carbon fuels such as gas peaking plant.

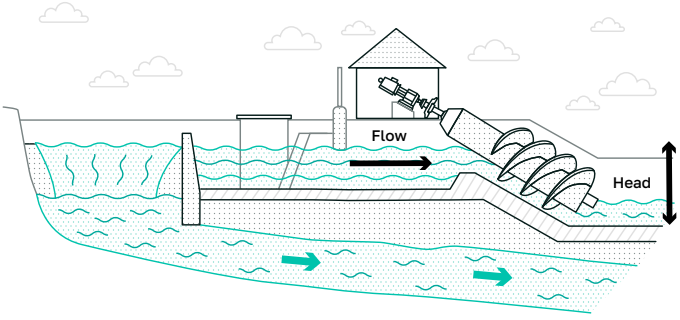
High Head Scheme

A high head scheme has a large 'head' or fall of water and an impoundment or dam where a penstock or 'pipe' takes the water down the gradient to a turbine where electricity is generated.
These vary from small kW schemes to large MW reservoir schemes with huge storage potential.



Low Head Scheme

A low head scheme has a large volume of water flow and a small 'head' or drop of water.
These schemes are usually sited next to a weir.



Key Facts For Hydropower In The UK

Total number of schemes:
1,657

Total Installed Capacity:
2 GW

Total Generation:
5,496 GWh

Storage capacity:
900 GWh

Undeveloped potential:
1-3 GW

Qualities of Hydropower

Historic Hydro:

In 1898 during the reign of Queen Victoria, the first hydroelectric turbine was installed to provide electric light at Balmoral Castle, since then, further turbines have been installed harnessing the water from the River Muick with the most recent being a 2MW Gilkes turbine, installed in 2020 under the reign of the late Queen Elizabeth II.

Nature sensitive Hydro

The pipeline image above shows how Hydro schemes can be located in some of the most protected and scenic settings in the UK, which can pose significant challenges to developers and operators to ensure safe and environmentally sensitive planning and practice. This RWE scheme at Cwm Dyli Hydro Power Station, in North Wales, needed a pipeline refurbishment after 30 years of service, which included a section on a steep incline on the side of Yr Wyddfa (Mount Snowdon). Now complete, the refurbished scheme will offer a further 30 years of generation.

Grid balancing Hydro

This powerhouse, which has been sympathetically designed to sit within the landscape, at Alt Na Moine, contains a 2MW hydro turbine, which is fed from a 150MWh storage reservoir. This Foster Turner Hydro scheme has great value with its ability to store and provide dispatchable electricity when required, helping to balance the grid.

As the UK faces increased issues with grid constraints, schemes like this will become part of a ‘smart’ digitalised grid and will be operated through innovations such as Active Network Management. Increasing Reservoir Hydro should be a focus for the Hydropower industry in the UK.

Community Hydro

The picture above shows the intake for the Lochaber Environmental Group community owned and operated scheme sitting neatly in the landscape, ensuring the scheme has low visible impact.

The intake comprises a small impoundment (or dam), a designated amount of water falls over the metal screen and down into a chamber and from there enters a buried pipe or ‘Penstock’ which carries the water downhill to the 547 kW turbine in the powerhouse.

This generates 2,000 MWh each year, enough to power 600 homes, returning any profit into a community benefit fund.

Key Requirements

For The Future Of The Hydropower Industry

A recent report by Biggar Economics suggests that existing Hydropower can give a value of **£1 Billion to consumers each year.**

A report by Birmingham University has stated that with a price stabilisation mechanism of £140-£180/MWh, the Hydropower industry can deliver a further 1GW of reliable, winter baseload low carbon energy generation.

This additional 1GW of Hydropower would further raise the value to consumers and cumulatively, over the long lifetime of Hydropower plants, this offers staggeringly good value for UK PLC.

The Industry is calling on Government to bring forward policy support that will allow 1GW Hydropower deployment through:

- Changes to the Contracts for Difference (CfD)scheme.
  - A reduction from the current 5MW minimum installed capacity (a legacy from the Feed in Tariff) to 1MW with the ability to aggregate pipelines of projects.
  - Setting a strike price at £160MWh to enable pipelines of shovel ready projects to move forward.
  - Allowing a Hydropower ring-fenced pot. Hydropower can not compete on cost with Wind and Solar, but it shouldn't need to, it should be compared to the cost of gas peaking plant, as that is what it can replace.
- Consideration of an "Enhanced" Levelised Cost of Energy, which considers whole systems benefits.
- Consideration of how technologies such as hydropower can replace high fossil fuel generation such as Coal and gas peaking plant.
- Review of how Hydropower's 900GWh of storage can be enhanced and increased.

152.5MW Sloy Power Station

Pumped Storage Hydro in the UK

Serving as a dynamic energy storage solution, Pumped Storage Hydro (PSH) involves two reservoirs at different elevations. During periods of low energy demand, surplus electricity is used to pump water to the higher reservoir. When demand peaks, the stored water is released, generating electricity. Fossil fuel gave us huge amounts of energy storage and also flexibility, as we decarbonise the grid and replace these fossil fuels with increasing amounts of intermittent Solar and Wind, we will need considerably more storage to cover periods of low wind and flexibility to ensure demand is always met in real time. Energy storage is crucial for keeping the lights on.

Existing Pumped Storage:

Total number of existing schemes:	**4**
Installed Capacity:	**2.83 GW**
Total Storage:	**26.2 GWh**
Last Pumped Storage Hydro built:	**1988**

Pipeline:

Projects in pipeline:	**12**
Installed capacity of pipeline:	**6.85GW**
Storage potential for pipeline:	**135GWh**
Build time:	**5-7 years**
Lifetime of Pumped Storage hydro:	**100+years**

The 4 turbines in the underground turbine hall at Cruachan.

What does pumped storage hydro bring to the UK?

Proven, Reliable And Deliverable

The 4 existing Pumped Storage Hydro schemes, inthe UK, were state funded over 60 years ago, to consume and store overnight generation from Nuclear, as nuclear was unable to ramp up and down to meet the changing profile of electricity 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 intermittent renewables online.

Upper and lower reservoir and the underground turbine hall.

Grid Resilience

PSH Is ideally suited for smoothing the vast majority of fluctuations associated with a net zero wind and solar fleet. It is a proven, reliable technology that can deliver a wide range of services, creating value for the energy system across timescales from sub-second to days.

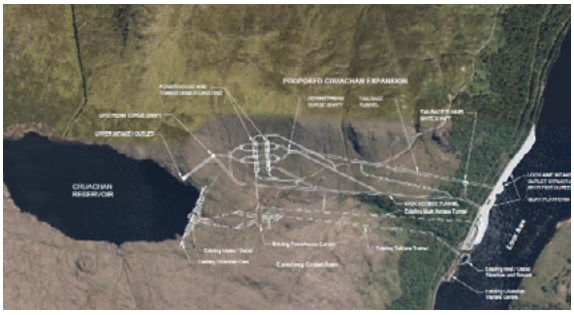
PSH delivers inertia (physical rather than synthetic), very fast frequency response, upward and downward reserve, resilience (black start), energy balancing on intra-day, day, and multiple day timescales, and relieving transmission constraints on the same set of timescales.

The subterranean access tunnel at Cruachan

Added Value

According to Imperial College London, ff deployed, **PSH could deliver grid system cost savings of up to £680m per year in 2050.**

A recent Biggar Economics report looking at the economic value of PSH found that **six PSH projects currently under development could deliver £5.8 billion of investment and almost 15,000 years of employment by 2035.**



Planning permission granted for a new 600MW pumped storage hydro plant adjacent the existing Cruachan facility

Challenges to the Grid and how PSH can help overcome them

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. PSH built in the right area, will help relieve congestion on existing transmission networks by storing the electricity close to the source.

The Control room at the Cruachan facility.

Curtailment:

This increased congestion is leading to curtailment costs of up to £62m / day (according to the National Audit Office). PSH situated in the right location can help prevent curtailment by providing flexible storage at optimum times.

Aging transformers need to be replaced with smart infrastructure.

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). The more flexibility and storage we have on the grid, the more this issue will be alleviated.

Transmission constraints pose a barrier to net zero, we need to accelerate innovation to enable us to 'sweat' our current assets.

Key Requirements

To Unlock Pumped Storage Hydro

Pumped Storage Hydro is a mature, proven technology.

With the right price stabilisation mechanism, the pipeline of projects can deliver an additional storage capacity of 135GWh to the UK Grid within the next 5-7 years. These projects are capable of delivering durations of tens of hours and offer the lowest cost of storage £/MWh for the crucial 10 – 50 hour duration segment. Significantly beating batteries on costs per unit of energy stored at durations above 6 hours.

Unlike interconnectors PSH is fully controllable by the GB electricity market and system operator, offering intergenerational energy security.

The pipeline of projects could bring significant additional value of £13.3-14.8 billion GVA and 228,700-253,700 years of employment.

The Industry is calling on Government to bring forward an Energy storage policy that recognises that all forms of energy storage must contribute to a stable, operable, secure grid.

Provide a 'Cap and Floor' price stabilisation mechanism that will allow the PSH pipeline to begin deployment by:

de-risking and unlocking investment for these capital intensive projects in a competitive global investment market, enabling cheaper financing;

- providing a Cap where revenues recover capex, opex and an allow cost of equity (with system efficiency incentive above the cap);
- providing a Floor – with a recovery of debt service requirement;
- protecting developers, owners and operators from global energy price volatility.

These decisions must be made now, and it should be considered to be a No Regrets opportunity with low deliverability risk.

Drax's Cruachan reservoir 440MW pumped Storage Hydro with a storage capacity of 7GWh.

Tidal Range in the UK

Tidal Range is a significant low carbon domestic, indigenous generation opportunity for the UK, offering energy security at scale, with multiple schemes along the UK Coast, especially in the West, from Cumbria to Somerset.

UK Statistics

- UK holds 10% of the world's tidal resource
- Potential for 20GW
- Generating 30 TWh/yr ~12% of UK demand

Tidal Range Challenges

- Large initial investment
- Complex environmental considerations
- Changes to water hydrodynamics
- Competition with other marine users

Advantages

- Mature & proven technology
- Included in the National Grid Future Energy Scenarios
- Non weather dependent
- Intergenerational assets with lifetime +120 years
- Durable, predictable & reliable
- Can provide low carbon, baseload power
- Generates near population densities Circumventing grid barriers
- Mitigation for flooding and coastal erosion

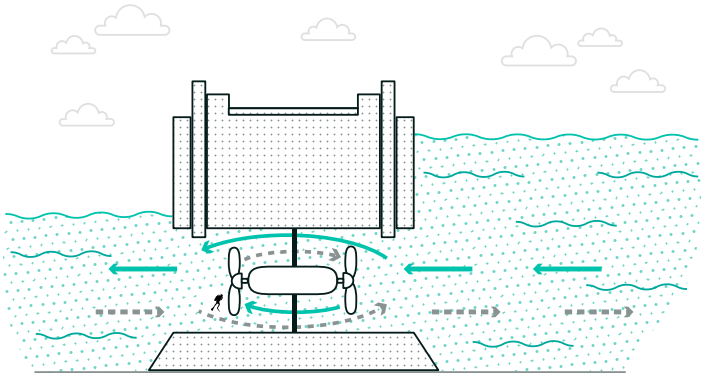
What can Tidal Range Bring to the UK?

Proven, Reliable And Deliverable

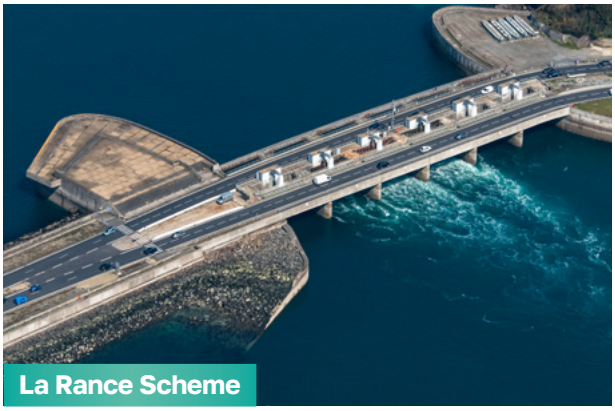
There are two very different types of tidal energy:
(i) tidal stream, which captures kinetic energy and needs large depth and high currents to be commercially viable;
(ii) tidal range, which needs an embankment (via a barrage or lagoon) and captures potential energy and needs shallow depth and a relatively high tidal range.

Tidal Range is very efficient in that large lagoons and barrages capture considerable energy.

Tidal range schemes are designed to last for **at least 120 years** offering predictable, indigenous renewable energy and also offering benefits of protection against coastal erosion, flooding, and defence against sea level rise.



Bi-directional turbine to maximise ebb and flood generation, turbine height 8-9m



La Rance Scheme

- Completed in 1966
- 24 Turbines & 6 Sluices
- 240 MW total capacity = 0.54 TWh/yr
- Turbine operation – Ebb only (and pumping)
- Passage of fish, without major problems
- Operationally with minimal turbine maintenance

Shiwa Scheme

- Completed in 2011
- 19 turbines
- 245MW total capacity
- Ebb and flood generation
- Designed for flood mitigation and agricultural purposes

Key Requirements

To Unlock Tidal Range's Potential

Tidal Range offers timetabled, non-weather dependent generation from long term assets with 120 year operational lifetime.

With a huge indigenous resource in the UK and with no other renewable technology offering these characteristics, the UK Government must focus on how to unlock this proven technology and bring forward this impactful industry.

The added value of regeneration benefits through the high UK construction and supply chain content, alongside flood and coastal erosion mitigation, will give strong locational benefits.

The ability to create large generation near centres of power demand circumvent the Grid constraint issues of off shore wind and offer real potential to deliver long term value to consumers.

The Industry is calling on Government to bring forward a new industry partnership approach that mirrors the framework set out to catalyse the off-shore wind industry 15 years ago.

- This must be less about creating market conditions and more tailored to deploy Tidal Range's added value including, a stable UK based supply chain with high quality engineering jobs and skills for UK PLC.
- Long term thinking and support through a stable price mechanism that ensures project development is insulated from the volatile global energy market.
- Consideration of the Regulated Asset Base model utilised by Sizewell C.
- Further work to review other longer-term funding instruments that could bring forward tidal range deployment.

Hydropower, the cornerstone of a decarbonised grid.

The historic legacy of hydropower in the UK is marked by its longevity, reliability, durability and not only enabling the deployment of the national grid to more remote areas but also giving the grid stability and consistently helping meet peaks in energy demand.

The longevity of hydropower has meant that hydropower schemes outlive all other energy generation technologies. Hydropower has watched the rise and fall of coal, gas, nuclear power plants and seen the repowering of the original wind farms, whilst consistently generating, decade after decade.

In recent years, the Government's focus has been to bring forward 'mass generation' and with the costs of wind and solar reducing rapidly, there has been a rapid expansion of intermittent renewables enabling an accelerated path towards decarbonising the grid.

Today, we are now firmly in the midst of the clean energy revolution, but policy makers must start to understand that a stable, operable, secure, decarbonised grid needs a solution based in physics, not the market. Further pursuit of the cheapest kWh needs to make way for delivery of technologies that will complement intermittent renewables and help balance the grid, not exacerbate the constraint issues that are causing us cost and delay as we transition away from fossil fuels.

As we look to the future, we need a clear energy policy based on a strong vision of what the UK's energy system can be, based on the key requirements to provide affordable energy and a resilient energy system fit for the next 3 generations.

The UK is endowed with an abundance of indigenous energy generation potential which can be the backbone of a clean energy system and minimising reliance on volatile global energy markets. The UK should have the aspiration to become a net exporter of energy.

With the rapid decarbonation of the grid, the UK is unpicking the challenges of what a smart grid will need to do, and needs to rapidly deploy a digitalised grid, Active Network Management, Smart Local Energy Systems (SLES) which offer an exciting opportunity for generators and consumers alike.

Energy policy must adapt to understand the complexities of a decarbonised grid and the opportunities of a diverse mix of energy generation that we will need to develop a stable, operable, resilient grid that will power the UK into the next decades.

Hydropower, as a reliable, proven, mature technology must be given the support necessary to continue its long term legacy as the work horse of renewable energy within the UK's energy system.

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