FICHTNER

All-Energy Conference 2023, Glasgow

Pumped Storage Hydropower

British Hydropower Association

ENGINEERING CONSULTING

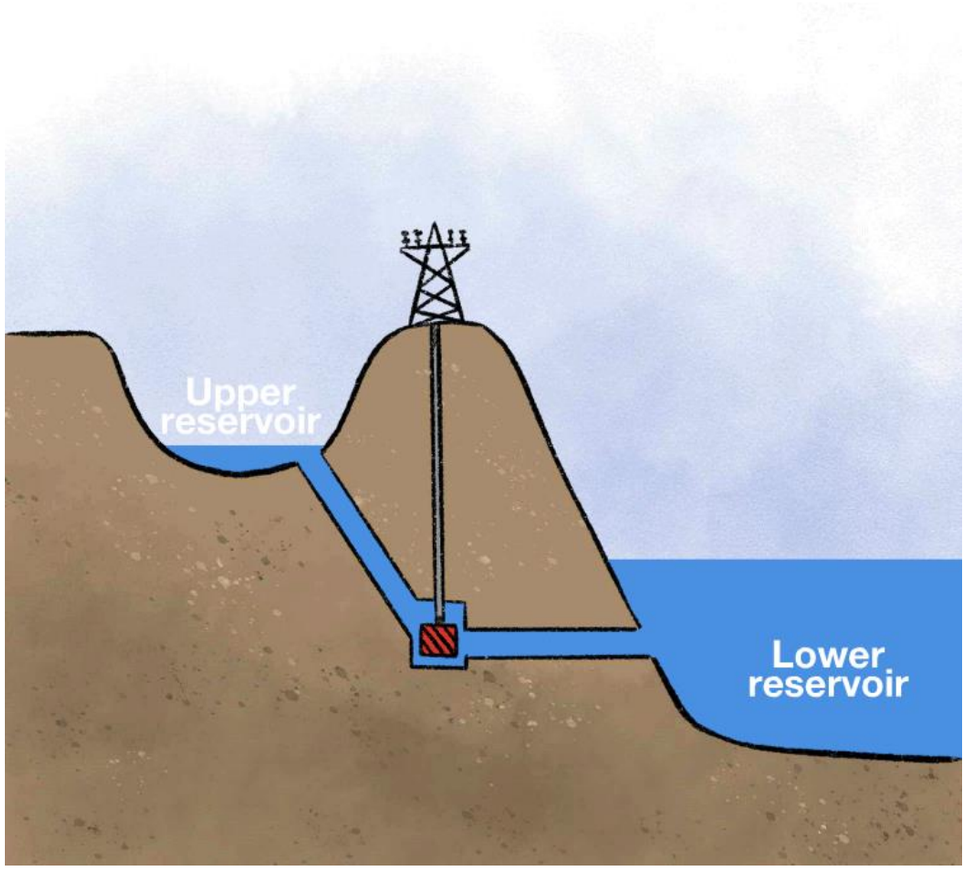
Agenda

1	Introduction
2	Role of pumped storage
3	Remaining Resource
4	Next Steps
5	Summary and Conclusion

1. Introduction

Pumped Storage Hydropower

- The biggest batteries on the network.
- … Also the oldest!
- When energy is in surplus water is pumped to the top of the hill.
- When the energy is required it is turbined back down.



https://theconversation.com/five-gifs-that-explain-how-pumped-hydro-actually-works-112610

Typical statistics (topology dictates)

Parameter	Value	Unit
Power	0.1-2	GW
Energy stored	1-30+	GWh
Round trip efficiency	>75	%
Response time	<3-5	minutes

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2. Background

Historical background

Original scenario

Stabilise inflexible thermal/nuclear generation

4 stations developed nationally between 1960 and 1980

- Total capacity ~3GW, 25GWh

Target net zero

UK government target for 100% zero carbon generation by 2035

Wind and Solar represent biggest renewable contributors in 2022

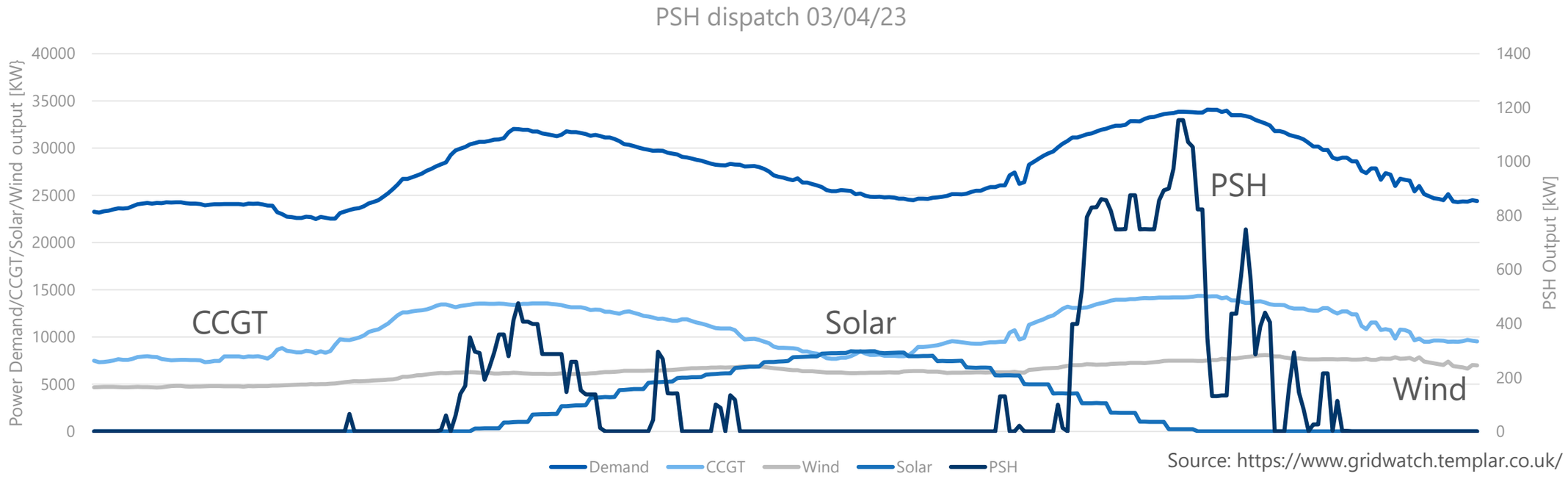
- Wind 26.8% of total generation
- Solar 4.4% of total generation
- Huge capacity increases in the pipeline for future
- What about intermittency…

https://www.hydropower.org/hydropower-pumped-storage-tool

2. Background

Daily example

Volatility of Wind and PV – Energy Balancing



Source: https://www.gridwatch.templar.co.uk/

Daily cycle:

- Solar energy peaks during the day with zero at night
- Wind generation according to prevailing weather, slower to change in output
- CCGT makes up the bulk of the rest
- PSH balances in the morning and evening peaks
- Without CCGT how will the gap be balanced?

2. Background

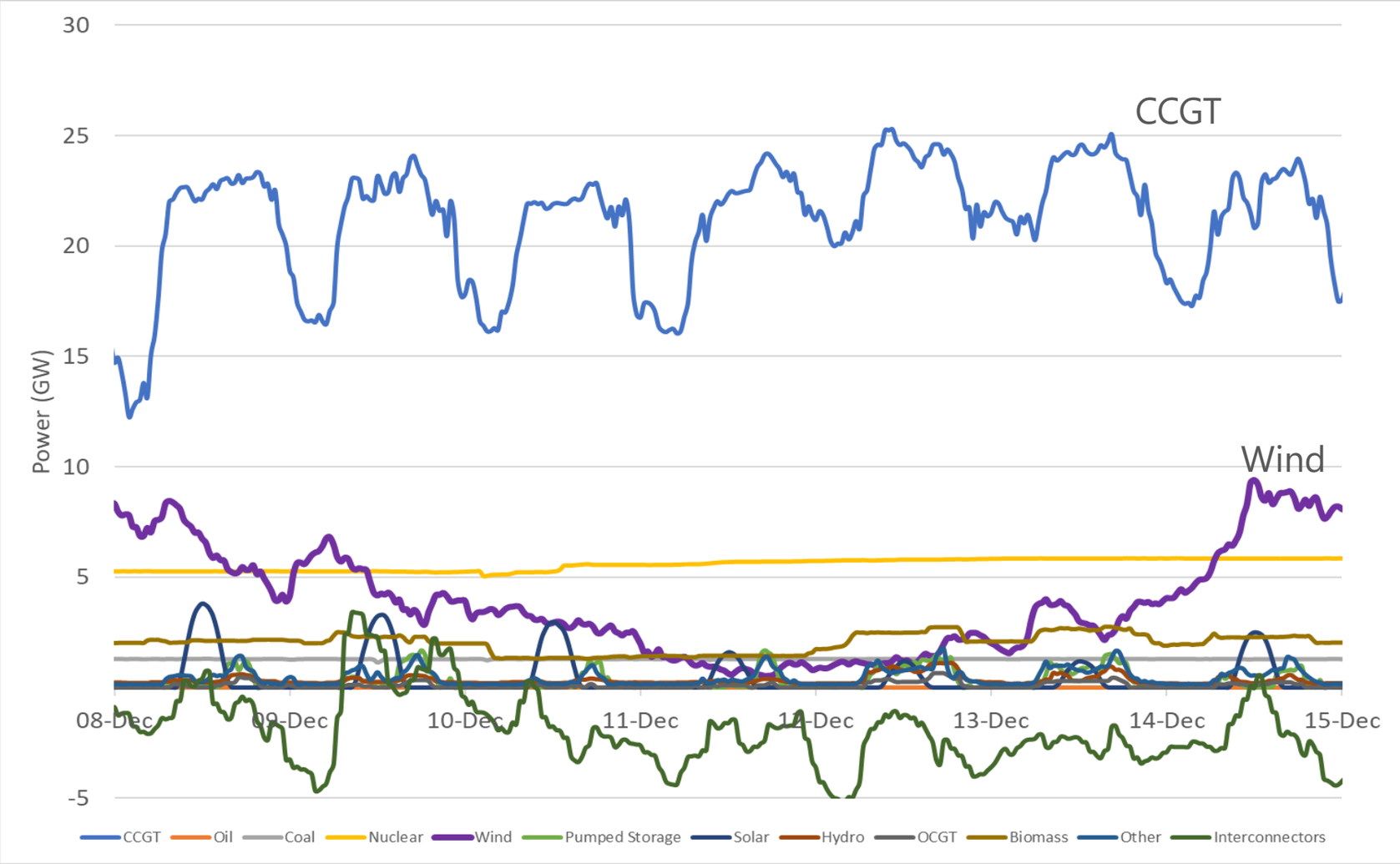
The challenge of Dunkelflaute – 8-15 December 2022

One cold, calm winter week

Over 3,500 GWh from Gas

Only 640 GWh from Wind

Over 3,500 GWh to decarbonise for a one week event!



Source: https://www.gridwatch.templar.co.uk/

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3. Remaining resource

Long duration storage capacity required

Future energy scenarios 2022 estimates 15-38GW of storage by 2035

Increase of up to 34GW in the next 12 years!!

Estimate includes all storage technologies including Lithium, LAES, CAES, V2G.

A challenge on this scale will require all available technologies!

So what role can Pumped Hydro play…

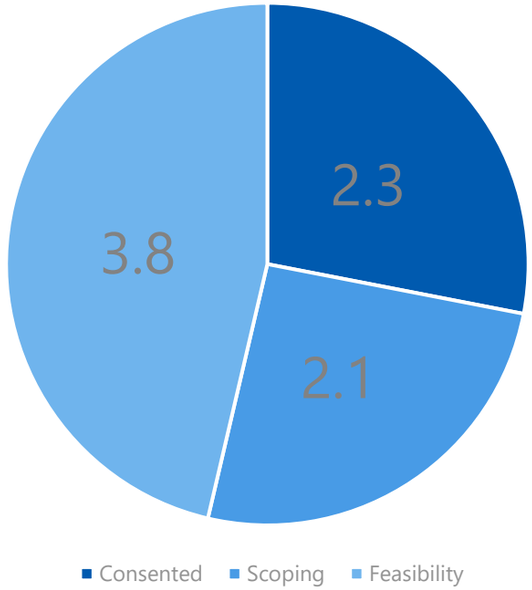
Currently there is at least 8GW, around 130 GWh, in various stages of development…

Is that all that UK pumped hydro can offer?

…we think not!

and we have the tools to find it!

UK PSH in Development [Capacity in GW]



3. Remaining Resource

Background to PumpIT

Pumped hydro identification tool

PumpIT is Fichtner's pumped storage identification tool

Developed 10+ years ago in Germany due to increased penetration of wind & solar and requirements for bulk energy storage

Common conception was that there is no space left in the country for Pumped Storage Projects

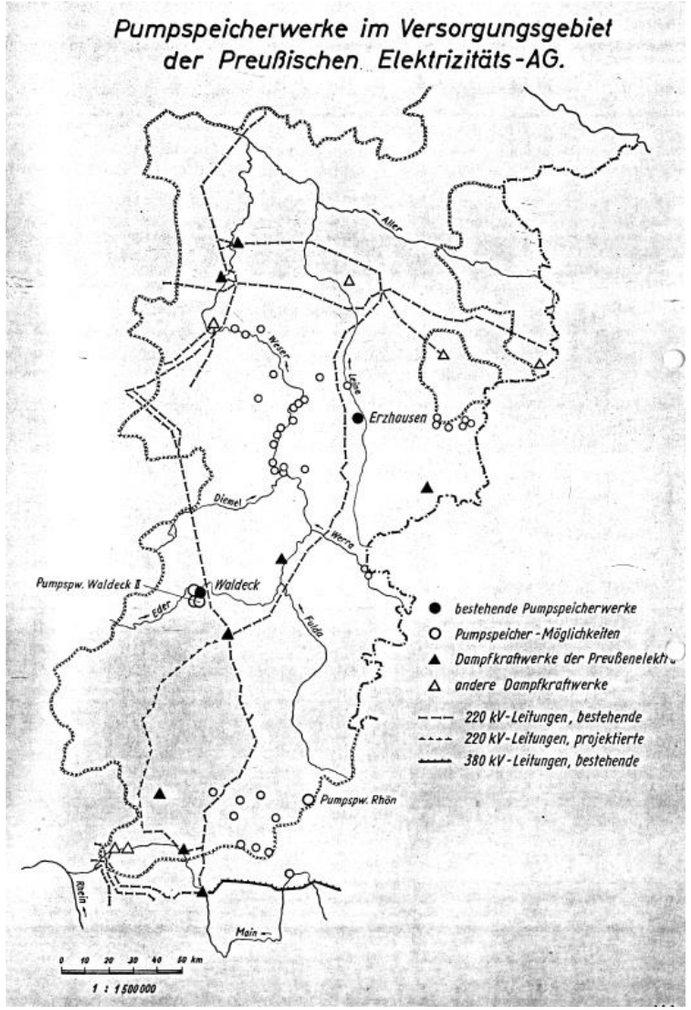
Conventional approach

Manually intensive desk studies, assessment of topographic maps for prospective reservoirs

PumpIT advantages

PumpIT provides a ranked short list of the most promising locations for pumped hydro development.

Can be efficiently applied to large areas to screen at entire country scale

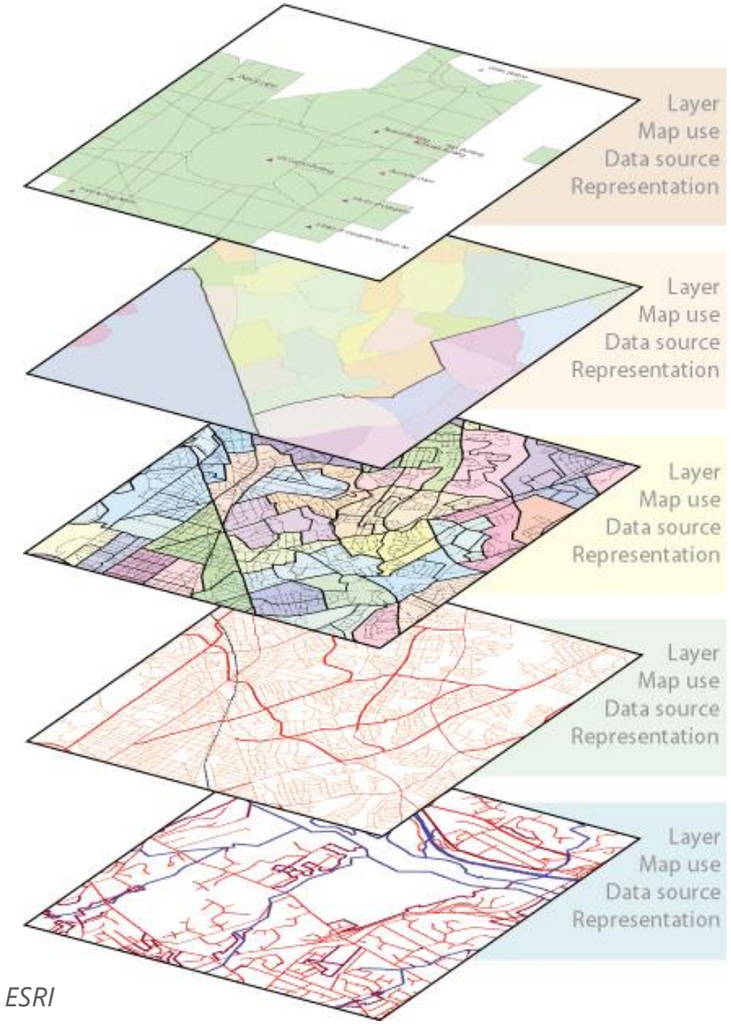


Source: Haus der Technik Essen e.V., 1966

3. Remaining Resource

Overview of GIS Approach

- Geographic Information System (GIS) based software tool.
- All data libraries, such as topography, hydrology, land use, geology, environmental and social aspects as well as proximity to existing infrastructure such as roads and electricity networks, are combined in a single model.
- PumpIT identifies suitable sites for pumped storage plants based on definable criteria (Head, waterway length, reservoir size, distance to infrastructure).
- Identified prospects meeting the criteria are then ranked in order of most promising for review by the Engineer.



Source: ESRI

3. Remaining Resource

Preliminary results from Scotland

Considering topology only for identification of

- upper reservoirs
- lower reservoirs

Excerpt of result

- Prospective reservoirs shown in red/blue

Image redacted

3. Remaining Resource

PSP Screening of Scotland

Potential upper and lower reservoirs

Preliminary criteria

- minimum head: = 200m
- minimum reservoir size: 5 Mio m3
- Maximum distance between reservoirs of 1km.

Image redacted

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3. Next Steps

Business case for Pumped Hydro

Why aren't we currently building these?

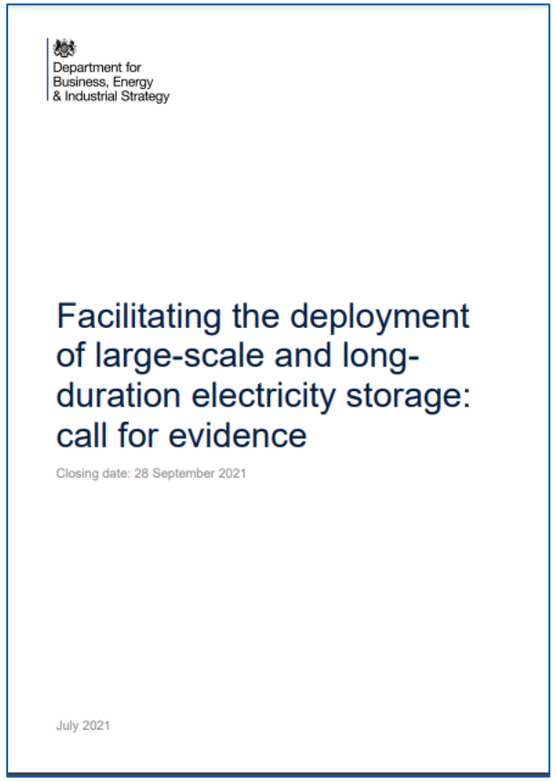
Capitally intensive projects with long build durations.

What certainty is there in the revenue model for developers?

Considered by BEIS with consultation launched in July 2021 and responded in August 2022.

Key extract:

"Considering these conclusions and as outlined in the British Energy Security Strategy, we will ensure the deployment of sufficient LLES to balance the overall system by developing appropriate policy to enable investment by 2024."



Department for
Business, Energy
& Industrial Strategy

Facilitating the deployment of large-scale and long-duration electricity storage: call for evidence

Closing date: 28 September 2021

July 2021

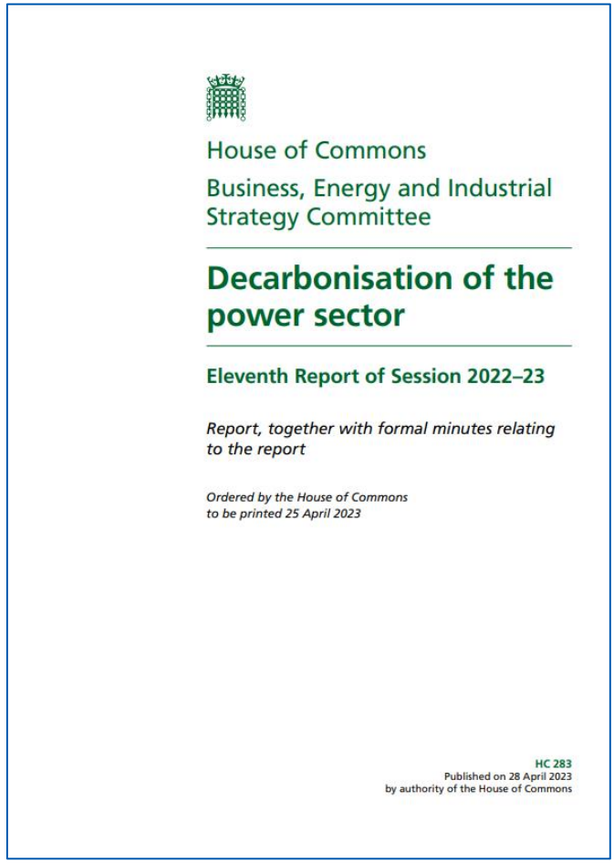
3. Next Steps

Business, Energy and Industrial Strategy Committee

Latest status -report published 25/04/2023

Key extract:

"The deployment of long-duration energy storage is essential to ensuring that a zero-carbon power system can operate 24/7, 365 days a year. These projects are capital intensive and face barriers to deployment due to a lack of long-term market signals. The Government's 2024 ambition to develop appropriate policy to enable investment in these technologies is welcome, but we are concerned that this has not been made enough of a policy priority."



House of Commons

Business, Energy and Industrial Strategy Committee

Decarbonisation of the power sector

Eleventh Report of Session 2022–23

Report, together with formal minutes relating to the report

Ordered by the House of Commons to be printed 25 April 2023

HC 283
Published on 28 April 2023
by authority of the House of Commons

3. Next Steps

Pump-IT in the UK

Fichtner is working with the BHA to prepare a screening of the UK.

The objective is to identify the technically feasible resource remaining.

Particular priority is given to grid constrained areas and enabling greater penetration of renewables.

We are seeking partners to work with us in the screening exercise.

The study will be submitted to Department for Energy Security and Net Zero.

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5. Summary and Conclusion

- UK government target of zero carbon electricity by 2035 requires more long duration storage.
- Pumped storage is uniquely placed to provide utility scale storage of intermittent renewables.
- To achieve net zero, the scale of storage necessary will require all technologies available.
- The common conception that all pumped storage locations have been developed is not correct.
- Fichtner has developed the PumpIT tool for efficient screening of large areas to identify new development sites.
- Fichtner is working with the BHA to apply PumpIT to the UK to demonstrate the available remaining resource.
- The findings of the study will be used to demonstrate the significant role pumped storage can play in de-carbonising the UK electricity grid.
- Promising signals are coming for funding mechanisms, but time is running out for 2035, decisive action is needed now.

FICHTNER

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