

Consultation on PFAS Restriction: Public Response

This paper will discuss the wider implications of excluding electrochemical energy storage technologies which are dependent on PFAS from the European market.

██████████ is currently developing iron-air batteries for multi-day energy storage at grid scale. Our product can discharge energy for 100 hours through an innovative reversible rusting process, and is based on iron, air and water as our key materials. ██████████ is B2B, and will deliver batteries to industrial customers, energy developers and other businesses.

Our first projects will be deployed in the United States in 2024, with European projects expected in 2026. Our European operations are currently supported by a small team within Europe, with an expectation to grow rapidly over the coming years. ██████████'s technology aims to bring solutions to several key challenges for Europe's electricity markets; solutions which would be severely impacted by a PFAS restriction. Two key areas are resilience and the integration of renewable energy.

Regarding resilience, in the coming decades, electricity demand in Europe is expected to climb between 40-50%, with enormous seasonal variation in the shape and type of generation.¹ As a result, policymakers must consider the volume of carbon-free generation resources that must be added to meet growing electricity demand, and the types of resources that will maintain that electricity supply reliably during all hours of the year. Offshore wind resources, for example, produce higher generation output due to increased wind speeds, but they also experience lull periods with reduced output that can last for up to 5 days. During such events, the grid requires resources that can deliver energy when it is needed, without increasing carbon emissions.

Today, thermal generation in the form of open-cycle gas turbine and coal generation is largely not used to provide system reliability. However, many of these will be retired by the early-2030s, straining a system which will become increasingly dependent on variable wind and solar generation. ENTSO-E estimates that 60GW of thermal generation is at risk of becoming economically unviable by 2030, which they underline as a material challenge for Europe's energy security.² While governments may take action to extend the lifetime of some plants through targeted supports, such investments are best made into technologies fully aligned with a decarbonized power system.

Multi-day energy storage (MDS), such as that provided by ██████████'s technology, is critical to providing resilience in a fully decarbonized system. As stated in the European Commission's Staff Working Document on Energy Storage, long-duration energy storage "becomes more

¹ENTSO-E & ENTSG, *TYNDP 2022 Scenario report*

https://2022.entsoe.eu/wp-content/uploads/2022/04/TYNDP2022_Joint_Scenario_Full-Report-April-2022.pdf

² ENTSO-E, *European Resource Adequacy Assessment 2022* <https://www.entsoe.eu/outlooks/eraa/2022/>

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necessary as the share of renewable generation increases and as fossil-fuelled generators are phased out".³ While the exact impact of MDS depends on the levels of deployment and wider characteristics of the system, modeling undertaken in conjunction with system operators and third parties has consistently demonstrated clear benefits across a number of metrics. Specifically, in markets analogous to the European Union, we have found the following benefits:

- In the United Kingdom, MDS can reduce curtailment by up to 89% at key points of congestion. [REDACTED] worked with National Grid ESO to examine the economics of using energy storage technologies as an alternative to wires in order to mitigate congestion on the UK grid.⁴ The results showed that the optimal lithium-ion configuration reduced curtailment by up to 2%, while the optimal aqueous metal-air configuration reduced curtailment by up to 89%.⁵ In our model, this led to more than 2.4TWh of increased renewable energy consumption, saving hundreds of millions of tonnes of CO₂. In New England, MDS could lower the system cost of a fully decarbonized grid by 19%, and reduce renewable curtailment by up to 83%.⁶
- In Minnesota, MDS could reduce the total resource need in a 400 MW peak load 24/7 carbon free portfolio by 25%. [REDACTED]'s modeling, undertaken with Great River Energy and the University of Minnesota, showed that MDS would further deliver a system which makes maximum use of all assets, reducing investment costs while meeting the demands of a wide variety of weather years.⁷
- In California, long-duration energy storage (LDES)⁸ could enable the state to meet reliability standards while accelerating its climate trajectory. [REDACTED]'s modeling, undertaken with E3 on behalf of the California Energy Commission, found that portfolios which retire in-state gas via deployment of LDES were found to achieve cost parity, or in some cases cost savings, relative to those which retain existing fossil gas.⁹

In addition to the climate related resilience benefits of multi-day storage, avoiding the need for continued imports of fossil fuels for thermal generation has positive implications from an economic and energy security perspective. In contrast to imported fuels, [REDACTED]'s primary materials are iron, air and water. This means significantly reduced reliance on critical raw

³ European Commission, *Staff Working Document: Energy Storage - Underpinning a decarbonised and secure EU energy system*
<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023H0320%2801%29&qid=1679302898964>

⁴ [REDACTED] & ESO, *Energy Storage to Support the UK Transmission Grid*, [REDACTED]

⁵ Aqueous metal-air batteries are category of electrochemical storage which includes iron-air batteries

⁶ TO BE INCLUDED BASED ON FINAL PUBLICATION

⁷ Enabling a True 24/7 Carbon-Free Resource Portfolio for Great River Energy with Multi-Day Storage, [REDACTED]

⁸ California defines LDES technologies as having durations of 8 hours or more and based on non-lithium-ion technologies. The analysis for the California Energy Commission does not differentiate between LDES and MDS asset classes.

⁹ Assessing the Value of Long Duration Energy Storage, E3, available at <https://www.energy.ca.gov/event/workshop/2023-05/staff-workshop-long-duration-energy-storage-analysis>

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materials, which in turn adds to Europe's strategic autonomy. With the potential for European manufacturing which leverages domestic supply chains for the vast majority of components and materials, [REDACTED] can support a resilient and secure energy system.

Multi-day energy storage is also critical for the integration of renewable energy to the system. As stated in the Staff Working Document on Energy Storage, "with the deployment of more renewable energy sources and short-term flexibility technologies, the need for energy 'shifting' solutions becomes greater. As a result, the system requires more energy that can be stored for longer durations."¹⁰ Specifically, MDS can capture renewables that would otherwise be wasted due to insufficient momentary demand or infrastructure constraints.

In one specific case, [REDACTED] worked with National Grid ESO to examine the economics of using energy storage technologies as an alternative to wires in order to mitigate congestion on the UK grid.¹¹ The results showed promise for energy storage: all technologies showed the potential to reduce curtailment and increase renewables utilization. At the "B7a boundary" in the UK system, a primary north-south transmission boundary and one of the most congested boundaries in the UK, the optimal lithium ion configuration reduced curtailment by up to 2%, while the optimal aqueous metal-air configuration reduced curtailment by up to 89%. In our model, this led to more than 2.4TWh of increased renewable energy consumption, saving hundreds of millions of tonnes of CO2.

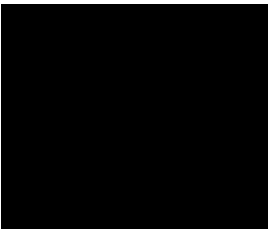
Taken together, there is a clear system benefit in terms of resilience, cost and climate from the deployment of multi-day energy storage. While [REDACTED] is not positioned to comment definitively on the ability of technologies without PFAS to deliver on this potential, we can make a number of general remarks.

1. [REDACTED]'s technology consistently plays a major part in the lowest cost builds for decarbonised portfolios. Restricting our entry to the European market would have direct, if as yet undefined, cost impacts for European consumers.
2. Within our parameters, specifically 100 hour duration, there are no commercially available alternatives. The average newly installed pumped hydro installation has a duration of 10-20 hours.¹²
3. While hydrogen could be used to store energy over multi-day and seasonal periods, there are a number of considerations.

¹⁰ European Commission, *Staff Working Document: Energy Storage - Underpinning a decarbonised and secure EU energy system*,
<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023H0320%2801%29&qid=1679302898964>

¹¹ [REDACTED] & ESO, *Energy Storage to Support the UK Transmission Grid*,
[REDACTED]

¹² Bloomberg New Energy Finance, *Pumped Hydro: A Primer*,
https://genexpower.com.au/wp-content/uploads/2021/10/pumped_hydro_a_primer.pdf

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- a. Cost effectiveness of hydrogen for long duration storage relies on geological (as opposed to tanked) storage due to the scaling costs of longer durations. However, Gas Infrastructure Europe's 2021 study, in collaboration with Guidehouse, finds that Europe's potential for hydrogen storage (264.7TWh) falls well short of needs (466.4TWh).¹³
 - b. While there are some pilot projects underway for cavernous hydrogen storage, they remain relatively small, with just 4TWh announced.¹⁴ This is compounded by the long lead times of projects, meaning delivery will fall well short of requirements pre-2030 and compounding the need for alternatives.
 - c. There are no commercially available gas turbines currently able to combust hydrogen at high purities.

¹³ Guidehouse, *Picturing the value of underground gas storage to the European hydrogen system*, https://www.gie.eu/wp-content/uploads/filr/3517/Picturing%20the%20value%20of%20gas%20storage%20to%20the%20European%20hydrogen%20system_FINAL_140621.pdf

¹⁴ Remarks of Michael Kohl, Commercial Managing Director, RWE Gas Storage West GmbH at *Hydrogen Horizons: Empowering the Power System with long-term seasonal storage*, https://hydrogeneurope.eu/events/?he_event=R8kjbKL9mnD3XGr