LCPDelta

LONG-DURATION ENERGY STORAGE

AGENDA

- **The need for LDES**
- **European Hydrogen Storage Market Landscape to 2030**
- **UK case study**
- **Q&A**

Event agenda: https://netzeroweek.com/event-agenda/

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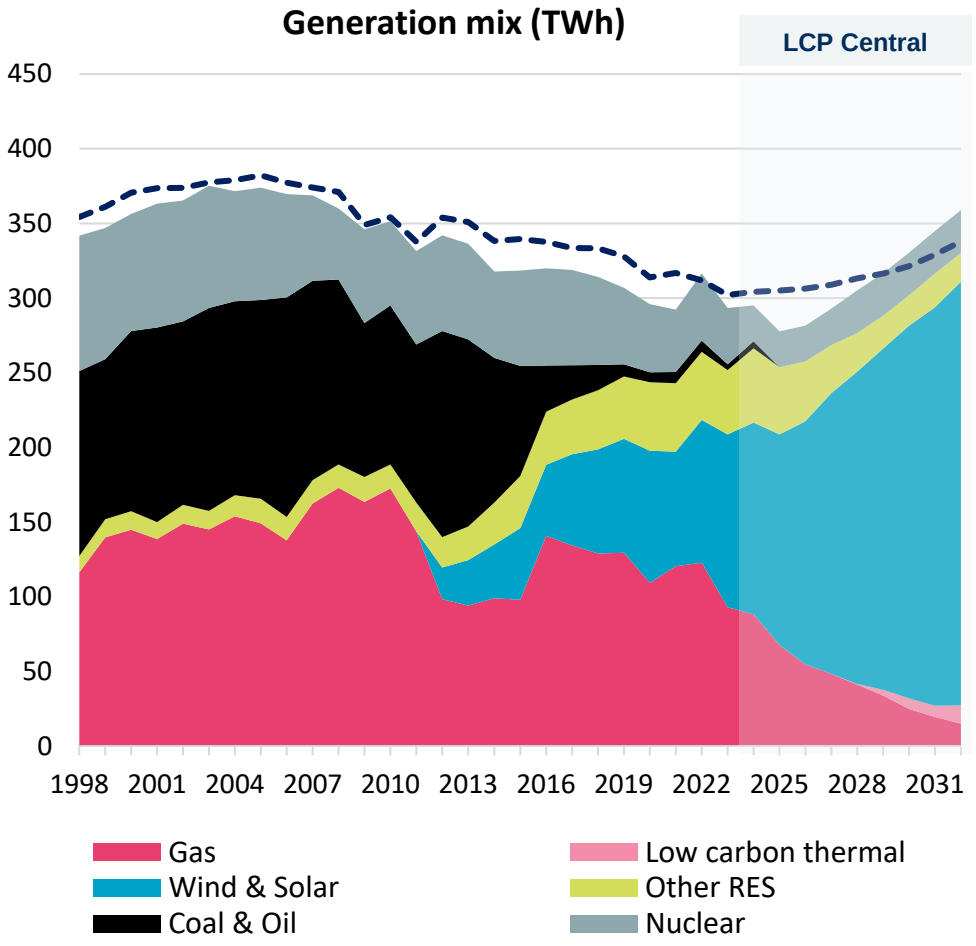
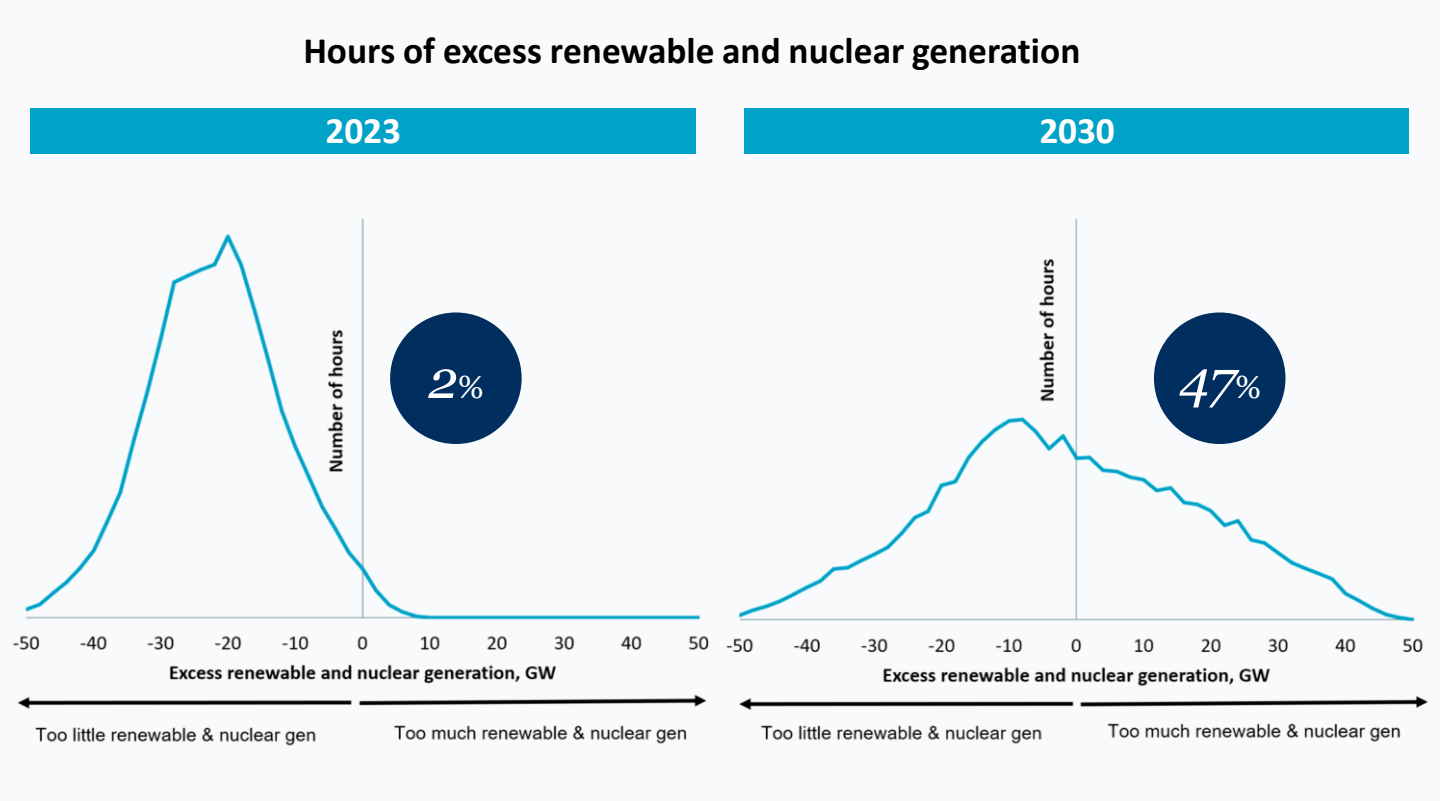
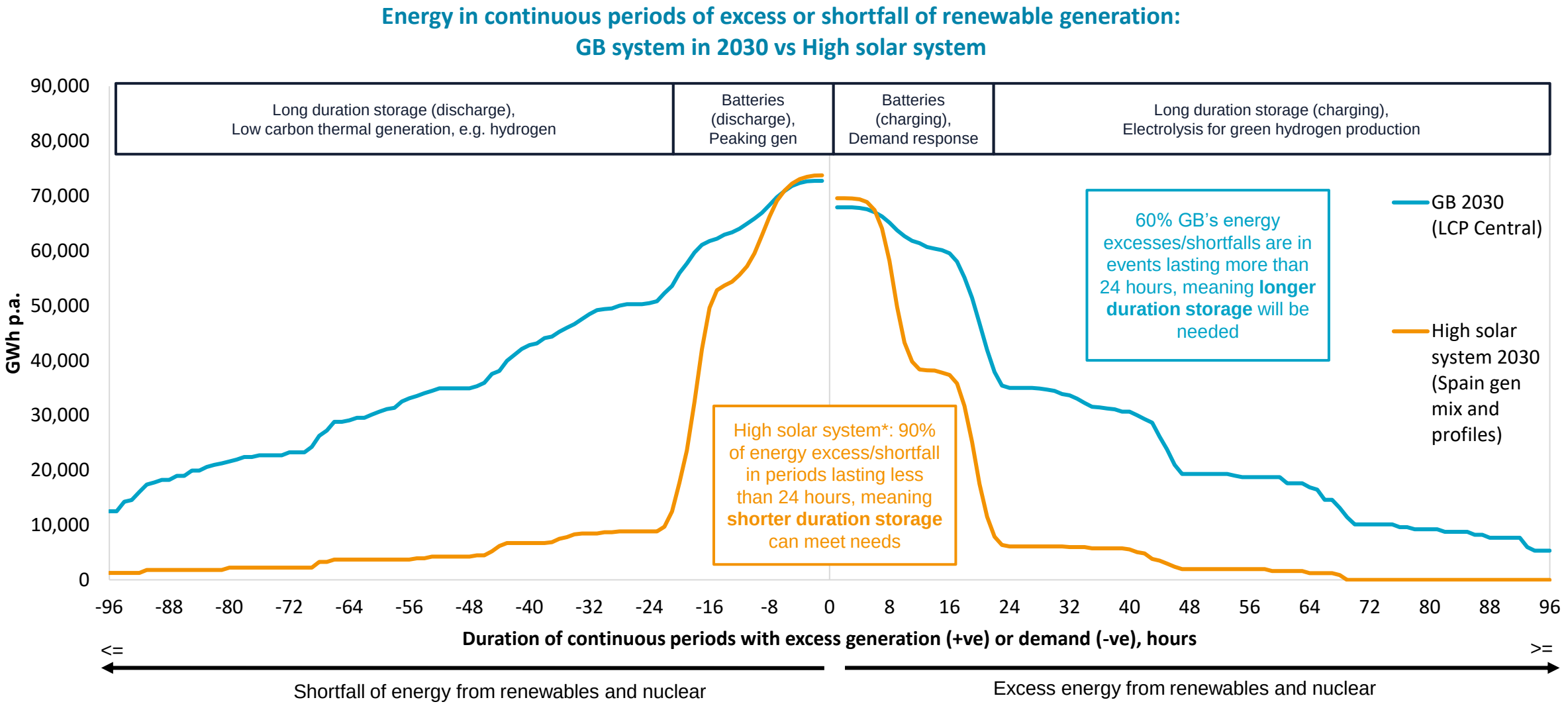
Evolution of GB Electricity Supply





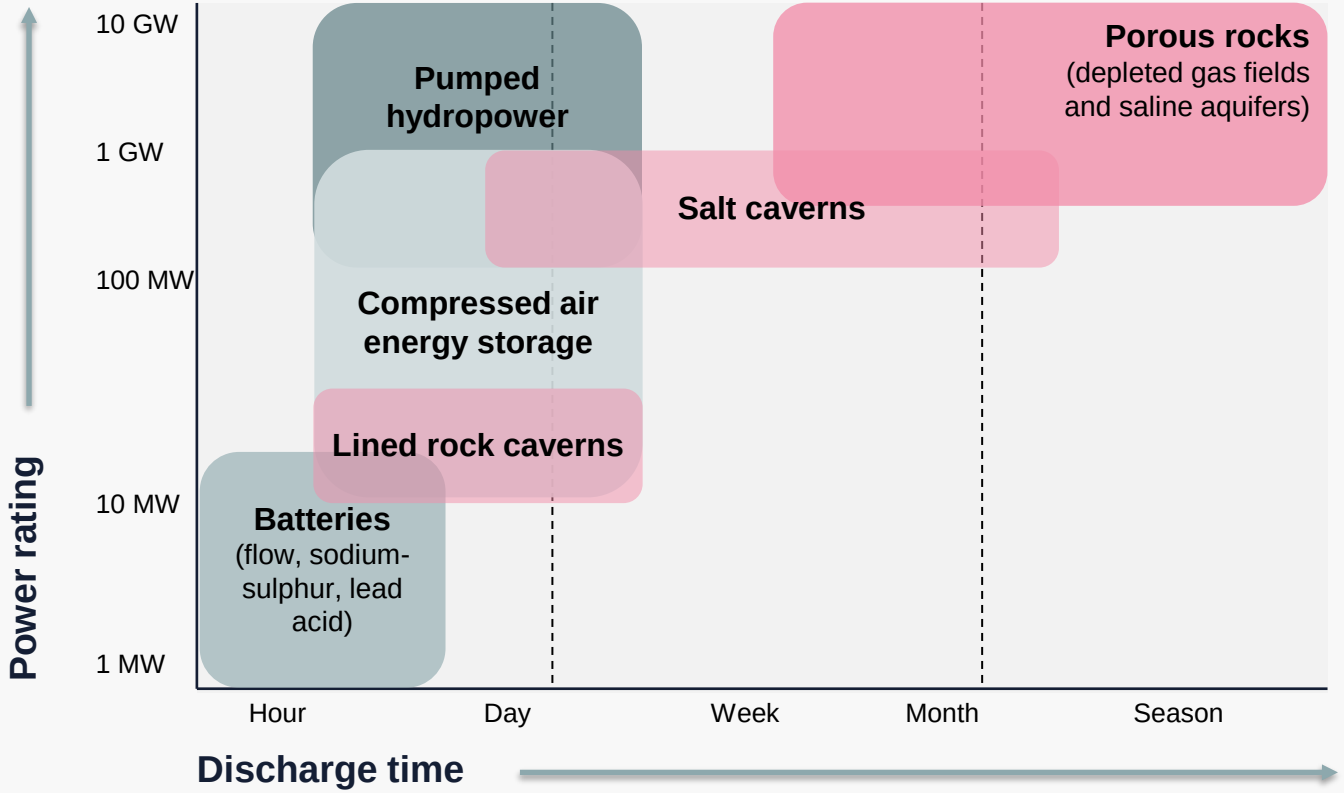
Need for longer-duration storage is particularly acute in GB



Long-duration energy storage

Storage asset types & role in the future energy system

Graph with power vs discharge time of different storage technologies



8 TWh underground hydrogen storage planned to 2030

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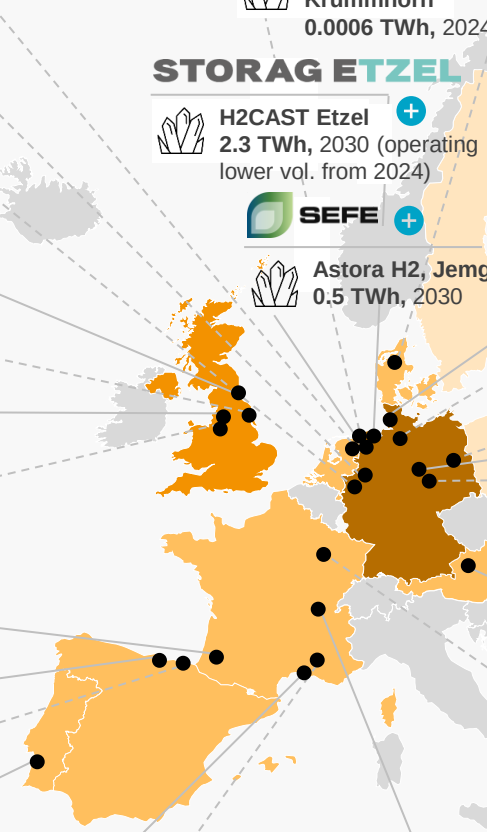
September 2023 Update

2030 Hydrogen storage
- >2 TWh
- 1 – 2 TWh
- 0.2 – 1 TWh
- < 0.2 TWh

Salt caverns | Depleted gas fields | Lined rock caverns

⊕ Commercial scale (≥0.2 TWh)



RWE ⊕
- **Get H2,** Gronau-Epe **0.13 TWh,** 2029

RWE ⊕
- **H2 Storage Xanten 0.14 TWh,** 2030-31

gasunie ⊕
- **Hystock,** Zuidwending **0.24 TWh,** 2028

uniper
- Salt cavern Krummhörn **0.0006 TWh,** 2024

GAS STORAGE DENMARK ⊕
- **Green Hydrogen Hub Denmark,** Lille Torup **0.25 TWh,** 2025

STORAG ETZEL ⊕
- **H2CAST Etzel 2.3 TWh,** 2030 (operating lower vol. from 2024)

SEFE ⊕
- **Astora H2, Jemgum site 0.5 TWh,** 2030

SSAB
- **HYBRIT,** Luleå **0.0004 TWh,** 2022

RAFFINERIE HEIDE
- **Westküste 100 0.003 TWh,** 2023

GAZ system
- **UGS Damasławek TBD,** 2030

sse Thermal **equinor** ⊕
- **Aldbrough Hydrogen**
  - **Pathfinder, 0.02 TWh,** 2025
  - **Storage, 0.32 TWh,** 2028

sabic
- **Teesside 0.027 TWh,** 1972

Inovyn ⊕
- **HyNet NW Keuper Gas Storage,** Cheshire, **1.38 TWh,** 2025 (est.)

Inovyn storengy
- **HySecure,** Crewe **0.04 TWh,** TBD

storengy ⊕
- **SaltHy,** Harsefeld **0.205 TWh,** 2030

EWE
- **HyCAVmobil,** Rüdersdorf **0.0002 TWh,** 2023

RWE ⊕
- **H2 Storage Staßfurt 0.21 TWh,** 2030-31

VNG Gasspeicher
- **Bad Lauchstädt Energy Park TBD,** 2026

TERÉGA ⊕
- **HyGeo,** Carresse-Cassaber **0.002 TWh,** 2024
- **HySoW, 0.5 TWh,** 2030

nafta
- **UGS Velke Kapusany 0.01 TWh** (est.) (increasing blend in NG ~0.18 TWh), 2025

enagas ⊕
- **H2 Storage North-1,** Santander **0.335 TWh,** 2029

MFGT
- **Aquamarine 0.01 TWh,** 2023

enagas ⊕
- **H2 Storage North-2,** Bilbao **0.24 TWh,** 2029

REN ⊕
- **Carriço 0.2 TWh** (est.), 2025 (increasing blend in NG)

Geostock
- **GEOGAZ H2,** Lavera **0.04 TWh,** 2028

storengy ⊕
- **GeoH2,** Manosque **0.24 TWh,** 2028

storengy
- **HyPSTER,** Bourg-en-Bresse **0.002 TWh,** 2023

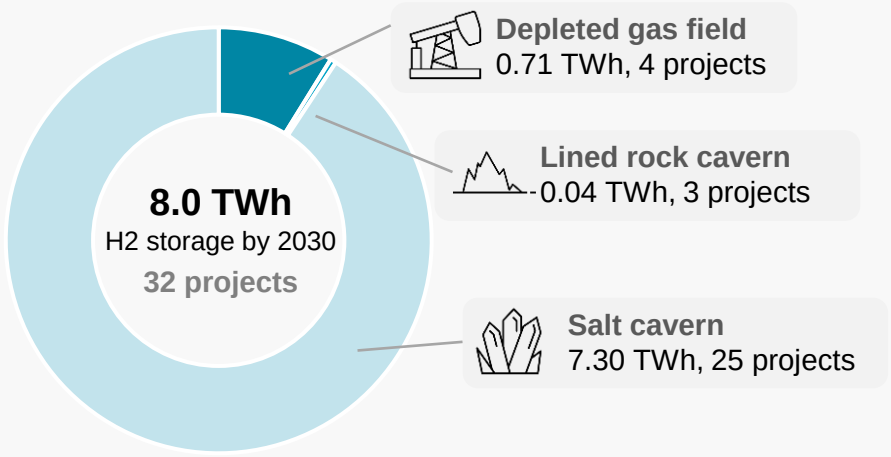
storengy
- **Cerville,** Nancy **TBD,** 2028 (est.)

RAG AUSTRIA AG ⊕
- **Underground Sun Storage,** Gampern
  - **0.004 TWh,** 2023
  - **0.52 TWh,** 2030

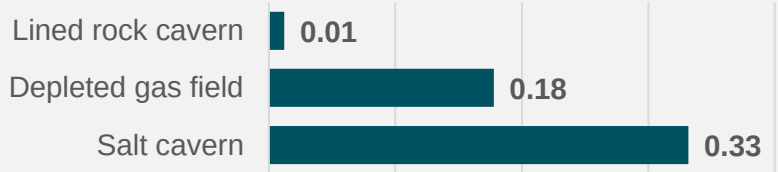
Hydrogen storage pipeline of 8 TWh by 2030 across Europe

Over 90% of storage capacity coming from salt caverns

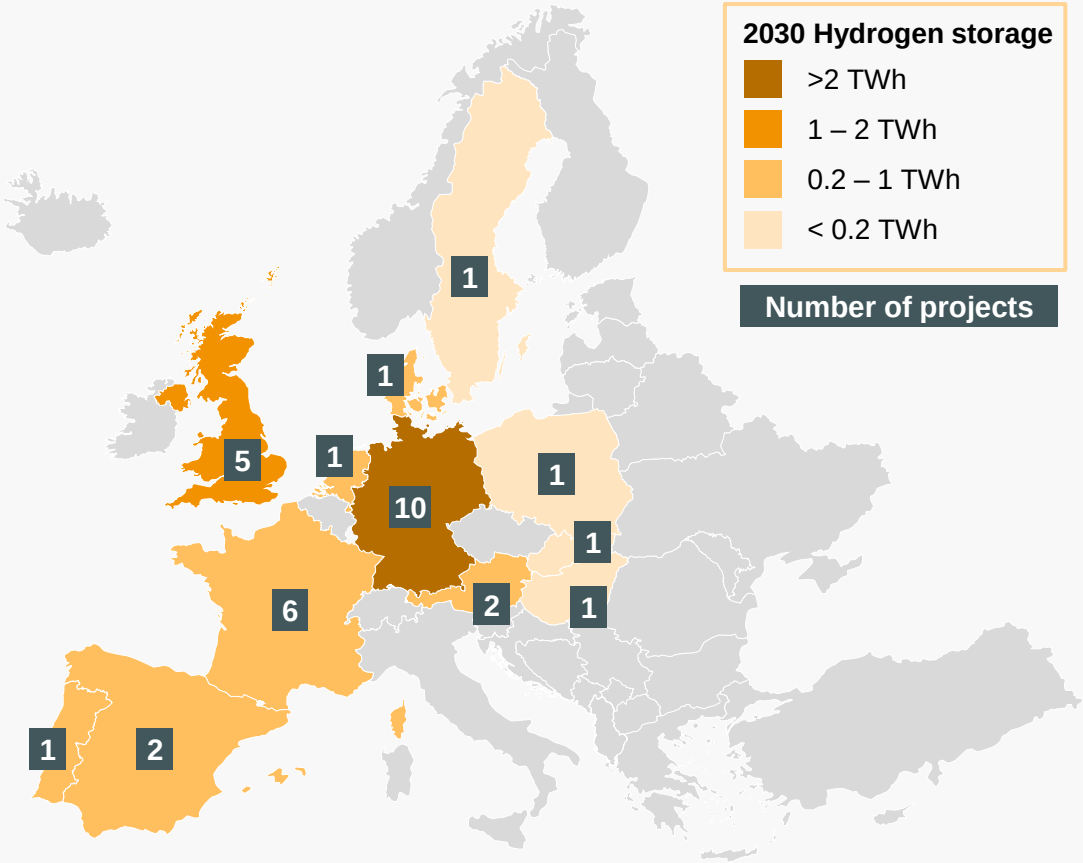
Hydrogen storage projects in Europe by 2030



Average project hydrogen storage capacity in Europe by 2030 (TWh)



Hydrogen storage planned project pipeline out to 2030



Case Study: 2030 UK hydrogen market – Inputs & Outputs

Annual hydrogen production to reach 27.8 TWh, 77% coming from blue H2

Model inputs

Production

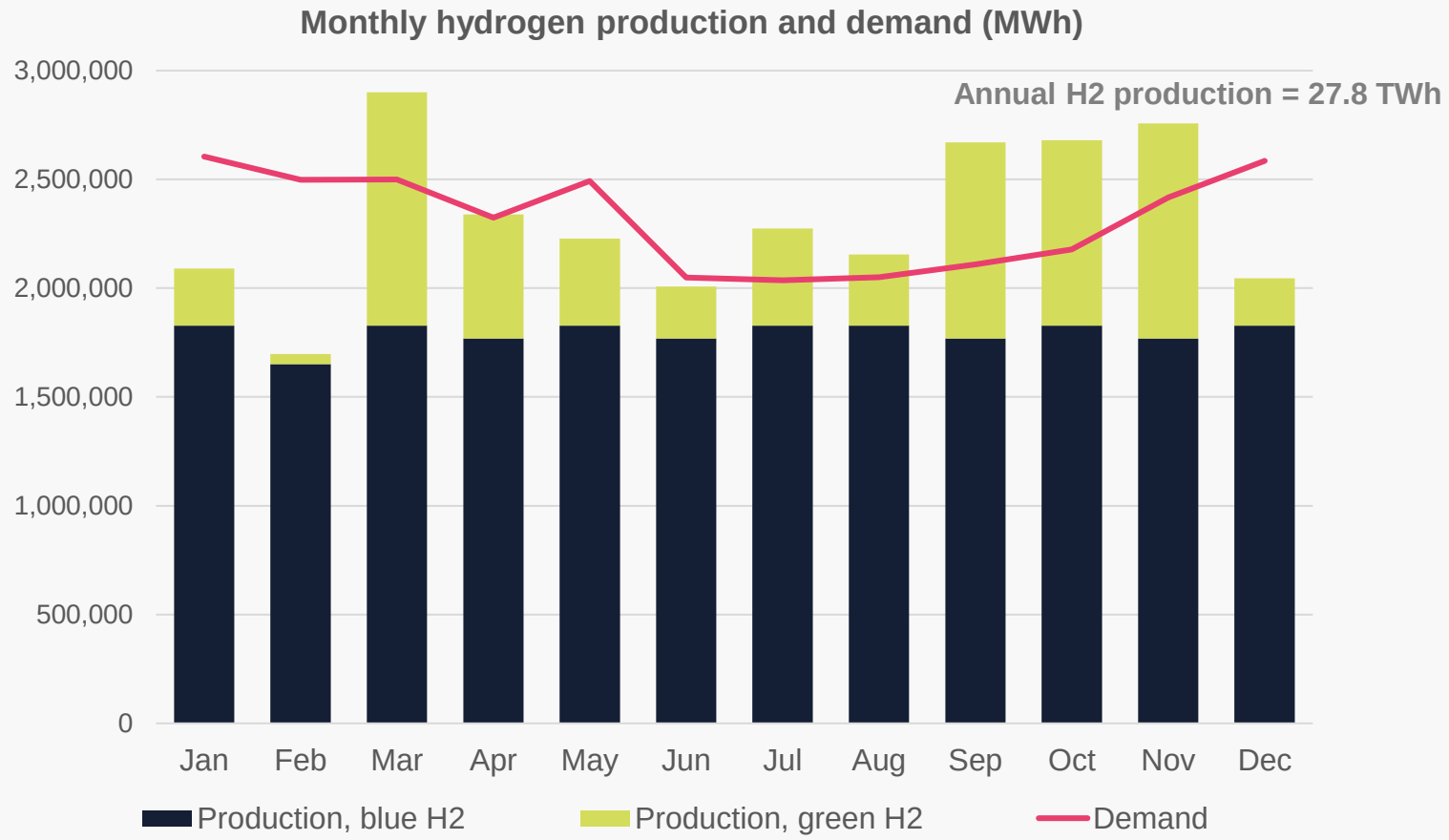
- **Green hydrogen:** 6.9 GW based on the pipeline in our project database, HYbase. LCP Delta's electricity dispatch model was used for this simulation.
- **Blue hydrogen:** 21.5 TWh annually to meet total annual demand after green hydrogen production.

Demand

Demand levels are based on the UK's hydrogen strategy and National Grid's 2023 Future Energy Scenarios as a benchmark.

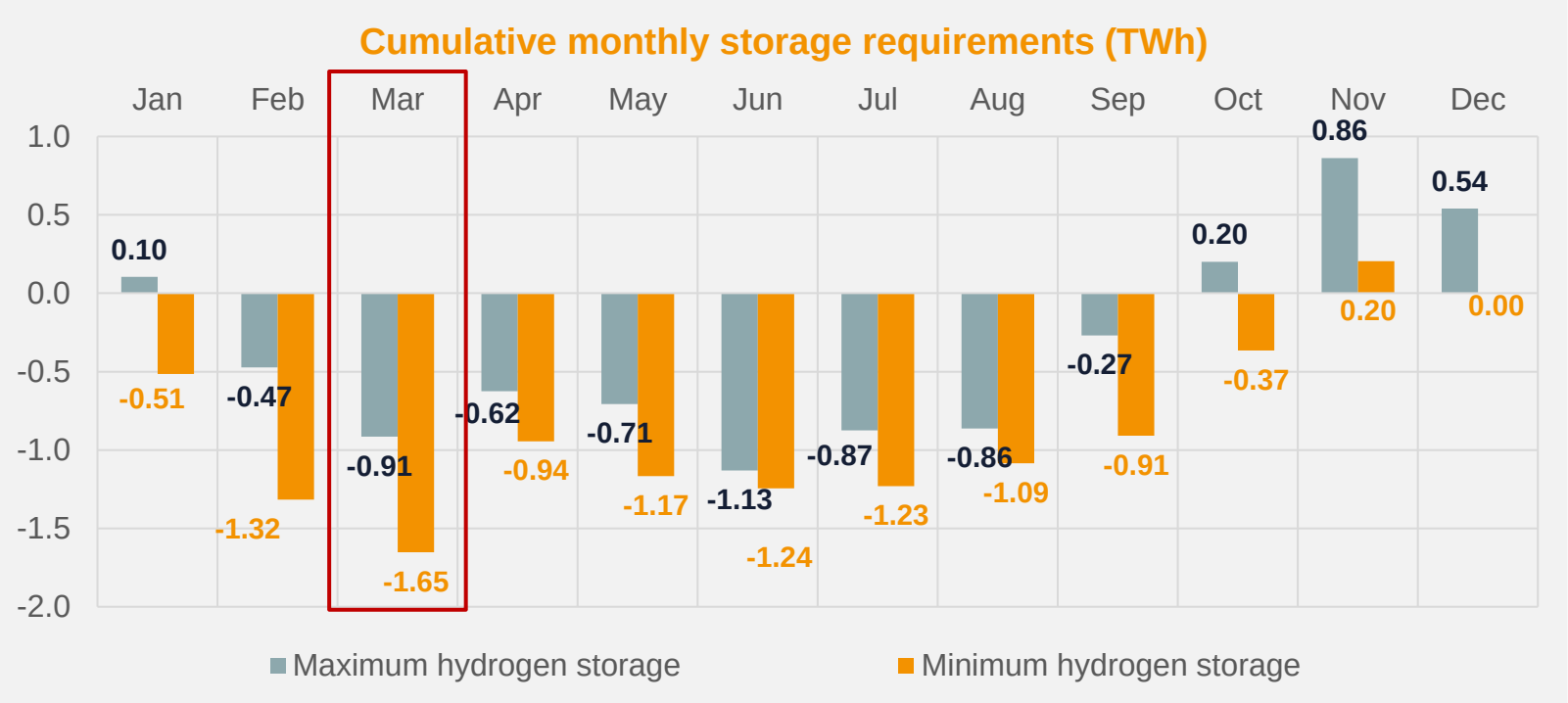
- **Industry:** 21.3 TWh
- **Transport:** 1.9 TWh
- **Power generation:** 4.6 TWh
- **Heating:** 0 TWh

Model output



1. Capacity volume requirements

Peak hydrogen storage capacity of 1.65 TWh met by current 2030 project pipeline of 1.85 TWh. Required storage corresponds to ~6% of the annual hydrogen demand.



2. Flexibility requirements

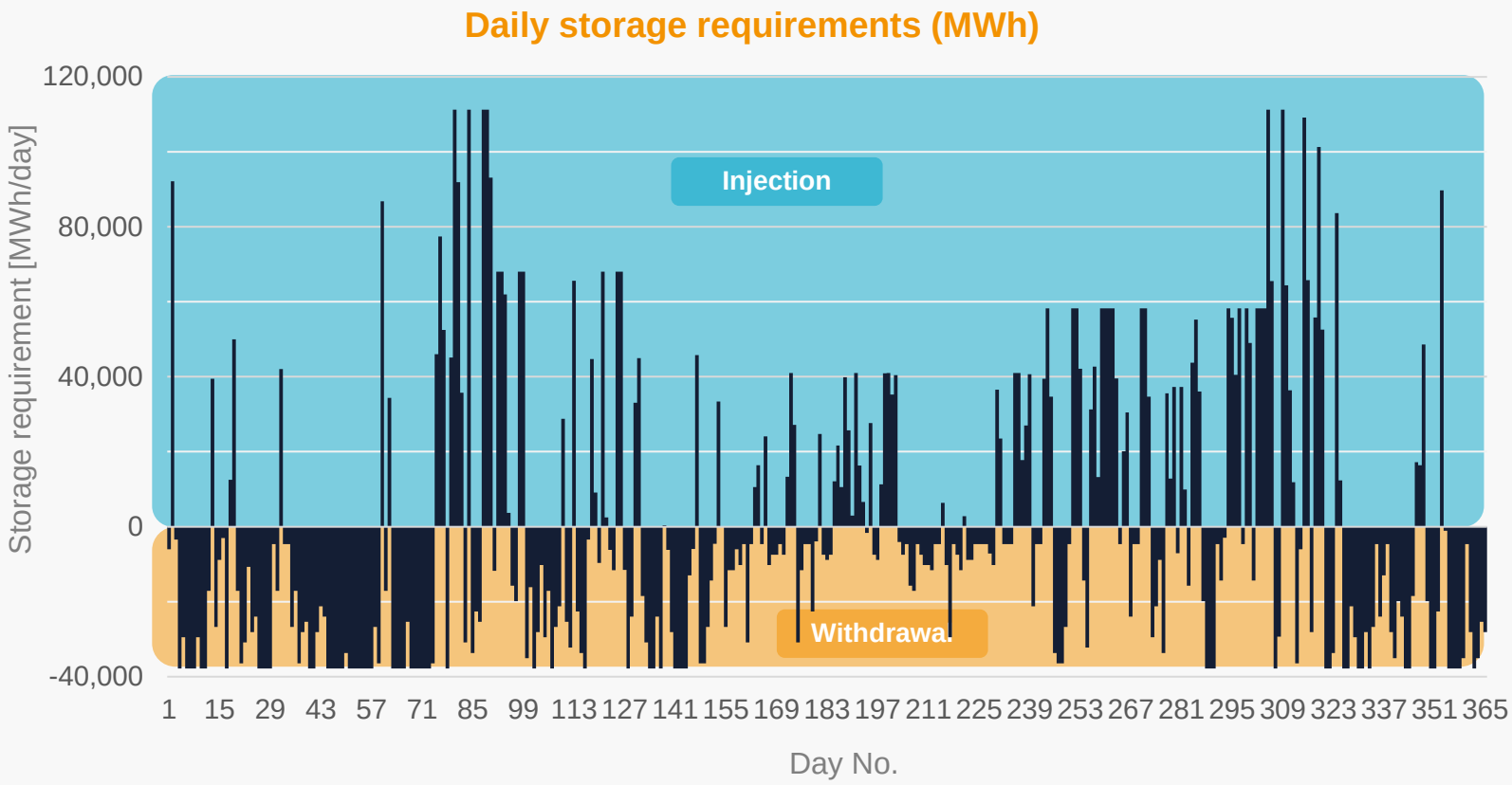
Maximum injection and withdrawal rates would not be met under the proposed project pipeline. Higher injection rates are required compared to withdrawal peak rates.

Max. Injection rates required
111 GWh/day

Max. Withdrawal rates required
38 GWh/day

Assuming a single well can reach injection / withdrawal rates of 3.5-7 GWh/day, quoted in engineering modelling studies investigating cavern properties.

Between 16-32 wells would be required to meet the peak injection requirements.



Outlook across Europe

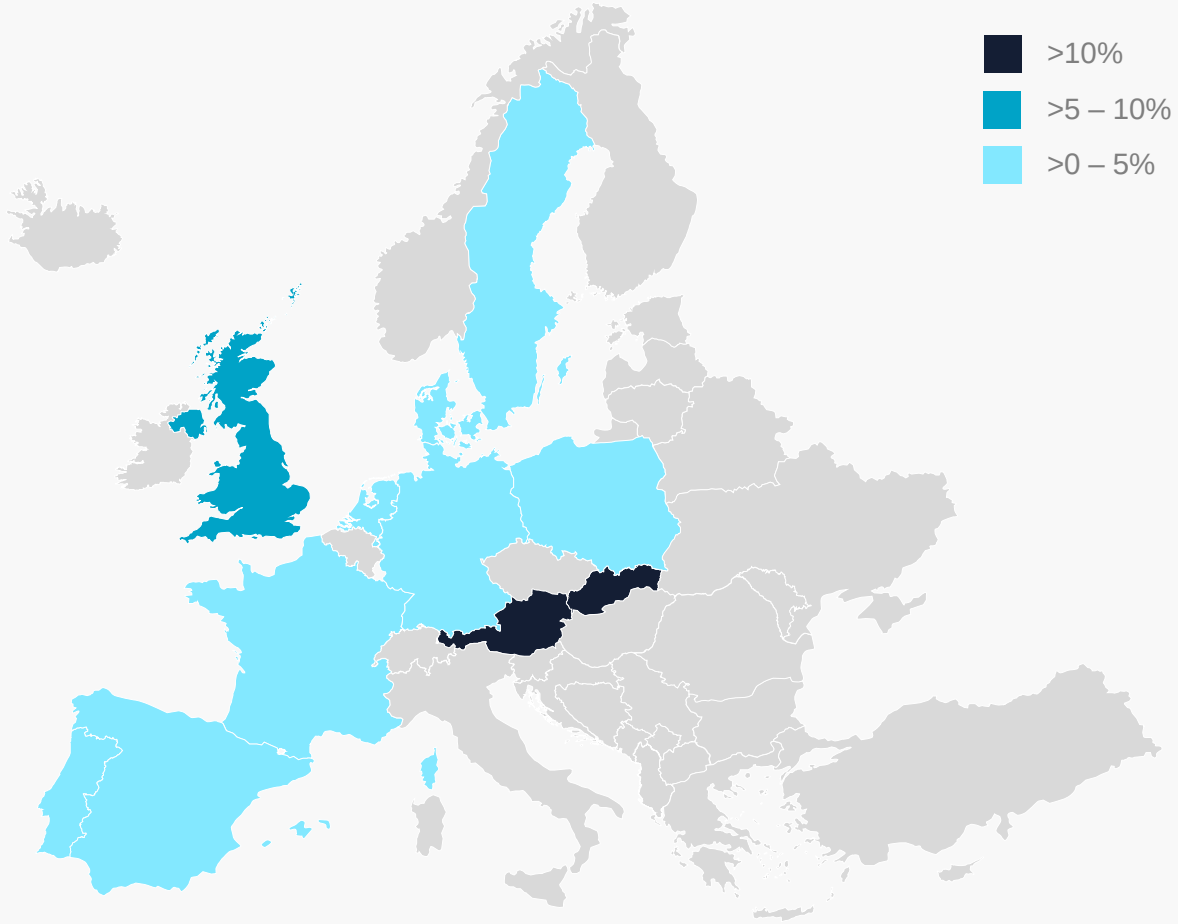
8 TWh of hydrogen storage is equivalent to storing 1% of the targeted H2 volumes

In the modelled UK 2030 scenario, storage equivalent of 6% of total hydrogen demand is required.

Under the RePowerEU strategy, the EU's goal for hydrogen availability is to produce 10 million tonnes of clean hydrogen and import an additional 10 million tonnes. Including UK this would **total ~810 TWh.**

8.0 TWh of hydrogen storage would only represent **1% of the total hydrogen available across Europe**, which again is likely to fall short.

Storage capacity as a share of the available clean hydrogen



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