ENERGY STORAGE

PORTLAND PORT DORSET

NEW SOUTHERN UK HYDROGEN HUB

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CONTENTS

SECTION 1.

INTRODUCTION

Energy storage is a critical component of any energy network. Large-scale storage helps balance winter and other shorter term peak energy demands and provides insurance against supply disruption such as the War in Ukraine.

Additional storage is needed urgently to strengthen our energy system resilience and to compensate for declining domestic gas production, which will leave the UK increasingly exposed to supply shocks.

Energy storage also needs to evolve to serve our changing energy mix. National Grid's Future Energy Scenarios report ("FES", July 2022) forecasts a steep increase in offshore wind and hydrogen usage in the coming decades, and both will require hydrogen storage. Since the pace of the transition to hydrogen will be gradual, storage facilities need to be flexible and local or part of regional hubs.

The new Portland energy storage facility planned by UKEn (a UKOG plc subsidiary) is large-scale and can be developed quickly to help address the current energy crisis and cushion the future energy transition. The facility will be hydrogen ready from inception, include green H_2 generation and can enable a new superhub on the South Coast, tied into both the Solent Cluster (SGN-Exxon-Macquarie) and an H_2 import/export terminal at Portland.

SECTION 2.

MORE ENERGY STORAGE IS NEEDED

Energy storage provides redundancy against production risks (supply chain or plant failure) and Winter and other Peak demand. The quantum of redundancy is a policy assessment that is not static.

In different timescales, geopolitical events and the energy transition will change our energy system and its storage component.

The war in Ukraine has triggered the most dramatic re-assessment of the European energy market supply risk in the last 40 years.

The increase in wholesale gas price from 40 - 50p/therm to 150 - 500p/therm translates into an excess cost of GBP£25bn for gas consumption alone.

The similarity of price behaviour on both sides of the English Channel shows the degree of interconnection between the UK and continental European gas markets.

PHOTO: ISTOCK

SECTION 2.1.

THE CHALLENGE: HEIGHTENED GEOPOLITICAL RISK AT A TIME OF DECLINING DOMESTIC GAS PRODUCTION

Since 2015, UK gas imports (non-domestic or Norwegian) in winter, have increased from 0% to 10% (net of gas storage)[1]. UK LNG import capacity provides this. However, with declining North Sea production, the UK will become as exposed as the EU to non-domestic suppliers by 2030 (illustrated in Figure 1). The EU Winter exposure stands at 28%[2] (including the benefit of a gas storage capacity equivalent to 38% of Winter demand) and is particularly exposed to Russian gas supply, which provides 40% of the EU gas consumed today.

The UK only imports 6% of its gas from Russia but suffers from the EU's heavy reliance on Russian imports. As the EU and UK seek to reduce the dependence on Russian gas, they will compete and work together to expand imports from the same suppliers.

[1]Xodus Group Analysis. Exposure in Winter being gas consumption minus domestic/Norway production and storage.
[2]Xodus Group Analysis

UK DOMESTIC GAS PRODUCTION & WINTER EXPOSURE

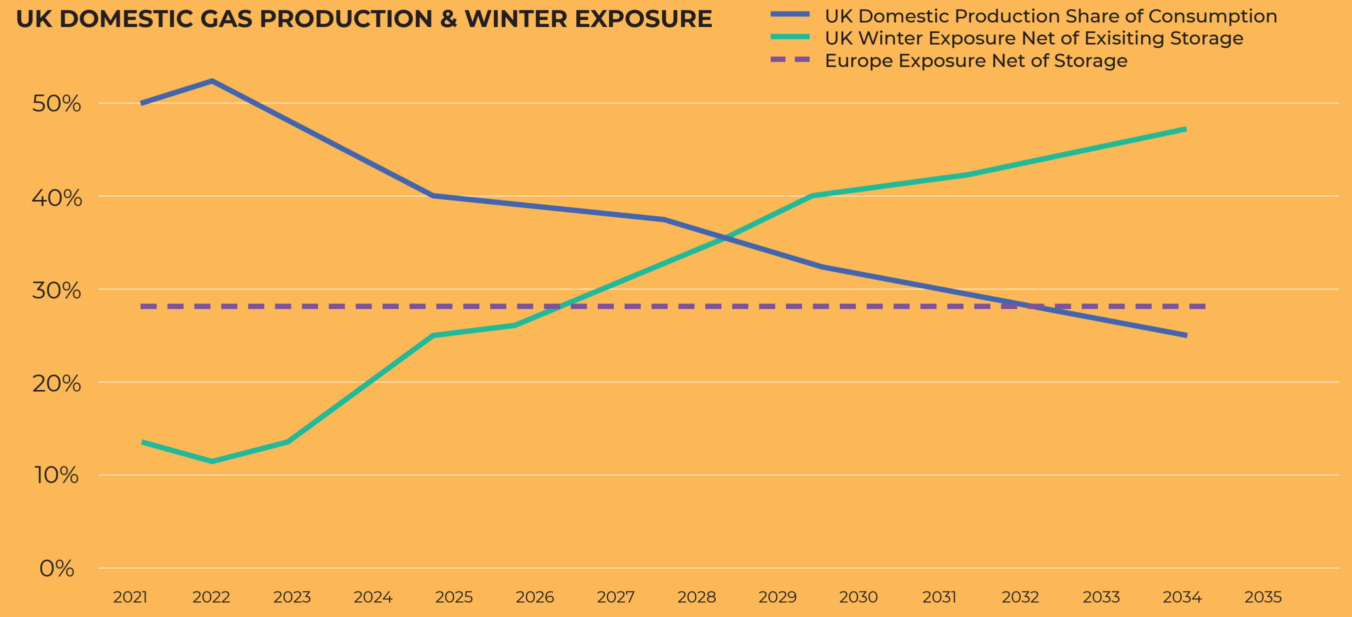
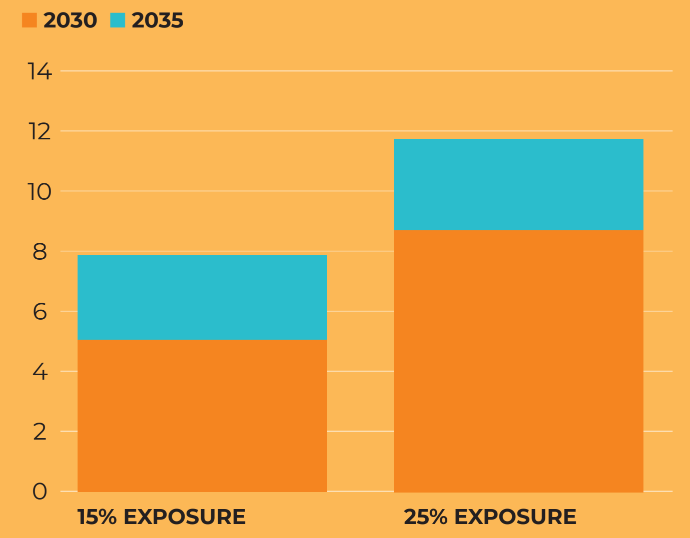


Figure 1: Domestic production outlook and risk in the system

ADDITIONAL STORAGE TO LIMIT WINTER EXPOSURE DETERIORATION (BN M³)



ENERGY STORAGE CAN HELP MANAGE THIS SUPPLY SHOCK COST EFFICIENTLY

Governments and energy companies are pursuing many policies to mitigate the gas supply crisis in the medium term. Typical gas supply project alternatives take 5 to 7 years to implement, whether developing a new field in the North Sea, increasing LNG supply (new gas field and infrastructure), reducing demand, or adding storage capacity.

Energy storage is a compelling complement to increasing LNG supply/capacity:

Mitigate Supply Risk	• Additional LNG supply will need to be sourced to replace Russian gas. This does not remove geopolitical or supply risk entirely.	• Aside from US LNG supply, most import options carry geopolitical and or development risk (Middle East, Africa).
Cost-efficient if combined with LNG infrastructure	• It is cheaper to use storage to manage Winter peak demand rather than oversizing the LNG transport infrastructure.	
Reduce Russian leverage on remaining exposure	• With additional storage, the UK and EU could import some Russian gas in summer but not in winter, thus reducing Russia's threat of cutting winter supply.	• This approach would reduce the overall cost as the combination of Russian gas with storage is cheaper than LNG supply.

Energy storage fits well with the energy transition's medium to long-term infrastructure needs:

Our energy system is transitioning, and the outlook 10 to 20 years hence needs to be considered.

- LNG commitment might require 15 to 20-year contracts for new supply starting in 2030/2032, taking the commitment to early 2045 or 2052. Shorter contracts are not less expensive as they need to provide the same return but on a shorter timeframe to the LNG developer.
- However, most scenarios contemplate transitioning from natural gas to increased electrification and hydrogen well before 2050. In these forecasts, the natural gas demand decreases sharply with time.
- When balancing the use of LNG and storage, we need to consider this outlook. Gas storage infrastructure can be repurposed to accommodate hydrogen in a way LNG infrastructure cannot.

2 or 3 additional storage facilities in addition to Rough are needed

Mitigate Supply Risk	• By 2030, 5 to 8 billion cubic meters (bn m3) of additional storage capacity might be needed, increasing to 8 to 12 bn m3 by 2035, as shown in Figure 1. • The higher range would keep the UK winter exposure (to external suppliers) as it is today, whilst, at the lower range, the new storage capacity would limit the increase to 25%. If storage is used to cover 50% of this gap, this would require 4 – 6bn m3 by 2035. Considering the re-opening of Rough facility, the requirement balance is 2 to 4bn m3 or 2 to 3 new facilities
2-3p/therm	The gross cost of building 2 to 3 storage units (alongside Rough) would amount to 2-3p/therm on the average household gas price[3].

[3] Xodus Group Analysis. The Gross Cost is an estimate of the annual running expense for the capex and opex cost of building 3 new storage facilities

THE HYDROGEN ECONOMY WILL REQUIRE SIGNIFICANTLY MORE ENERGY STORAGE

The Hydrogen Economy will require many times the increased energy storage capacity needed to address the global gas supply crisis.

Hydrogen becomes a dominant component of the UK energy system under three of the four FES scenarios :

- Consumer Transformation
- System Transformation
- Leading the Way

The FES estimates the need for between 17 and 32 bn m³ of storage capacity compared to 2.4 bn m³ today. This is significantly above the range of possible new additional storage identified in the previous section.

In the "Steady Progression" scenario natural gas remains dominant over hydrogen and consequently, with declining supply, significantly increased natural gas storage will be needed.

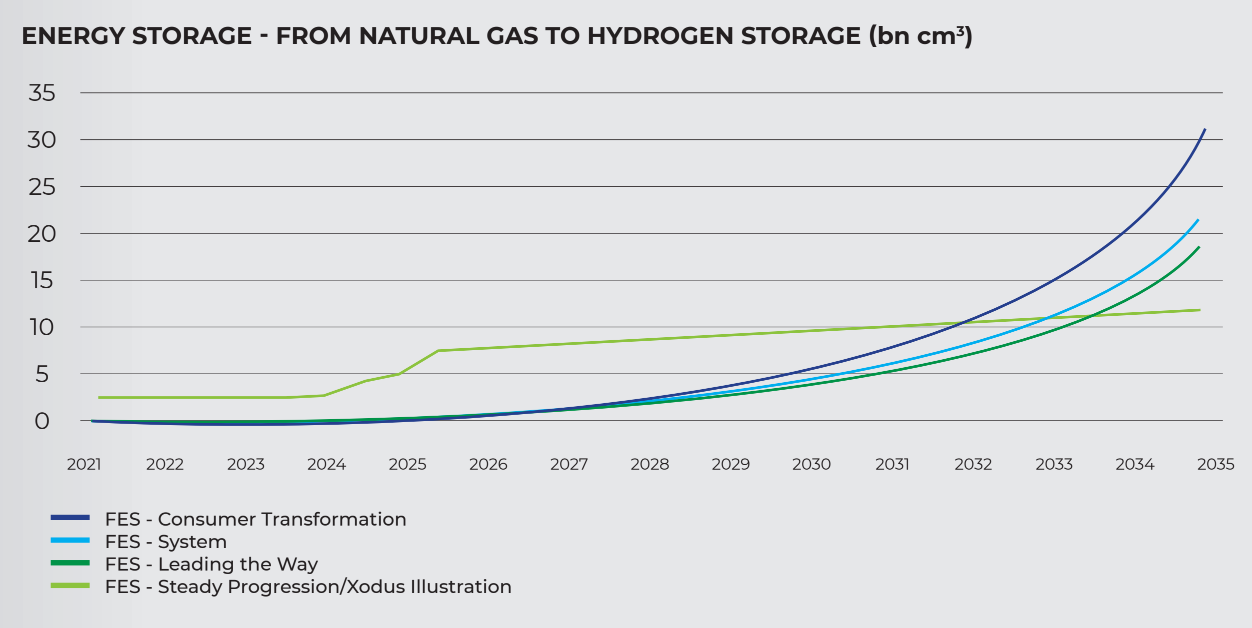


Figure 2: Forecast Hydrogen Storage Need, based on FES 2022[4]

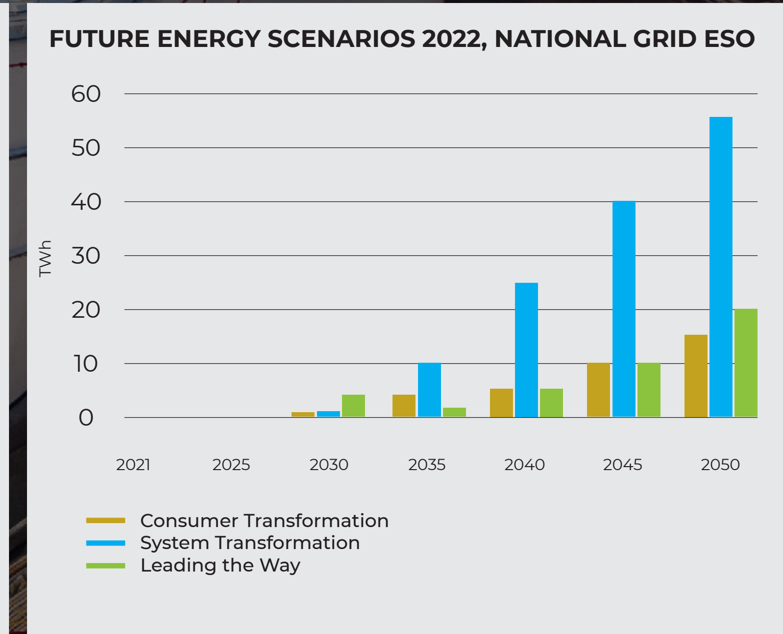


Figure 3: Hydrogen Storage Requirements

WHY DOES THE HYDROGEN ECONOMY NEED MORE PHYSICAL ENERGY STORAGE?

Hydrogen's energy density is less than natural gas.

For the same amount of energy, hydrogen requires 3.3 times the volume of natural gas.

Hydrogen will be used as a medium to long-term storage vector

The unique capability to store energy from excess offshore wind power (in the form of green hydrogen from electrolysis) offers a new element of the future energy system i.e., a "hydrogen battery". Hydrogen therefore does not just simply replace natural gas or diesel as a combustion fuel. Offshore wind will continue to be ramped up and has a natural partner in the "hydrogen battery".

PHOTO: iSTOCK

[3]Xodus Group Analysis. The Gross Cost is an estimate of the annual running expense for the capex and opex cost of building 3 new storage facilities
[4]Xodus Group Analysis. FES "Steady Progression" does not include an energy storage forecast, this curve is an illustration by Xodus Group based current capacity, adding 6bn m³ and then growing the capacity by 2% a year. All curve shows has an illustrative roll-out towards the 2050 targets.

SECTION 3.

UNDERGROUND SALT CAVERNS BEST FIT MID-LONG TERM HYDROGEN STORAGE NEEDS

Unlike the UK and European natural gas networks, hydrogen infrastructure is at a very different stage of maturity: demand and supply increasing from a low base.

Consequently, hydrogen storage infrastructure needs to be flexible and grow with each regional market.

Salt caverns are ideally suited to this purpose as they can be added as modules and are a proven technology.

Small volumes of hydrogen gas can be stored like natural gas in tanks but large volumes can only readily be stored in salt caverns or depleted gas fields.

	SALT CAVERN	DEPLETED GAS FIELD
Description	A cavern in a salt rock formation	Depleted Gas Field mostly offshore
Depth	500-2,500m	>2,500m
Example	Stublach	Rough
Capacity (bn m³)	0.5 – 1.5	3 +
Modular Capacity (bn m³)	Yes, 0.1 per cavern	No
Cushion Gas[5]	10%	30-50+%
Use for Hydrogen Storage	Since 1970 in Teesside	No
Location in the UK	4 areas onshore	Mostly North Sea offshore
Size	Medium to Large	Large to Very Large
Cost	Medium[6]	High[7]

COST

Depleted gas fields are not cheaper storage than salt caverns as they will require significant capex: pipelines, compressors, valves, and wells must be reengineered to accommodate pure hydrogen.

Opex cost will be high due to higher monitoring cost (more leakage risk for smaller hydrogen molecules, many decommissioned wells, offshore location) plus the higher impurities risk from remnant methane might require secondary hydrogen processing.

Depleted gas fields must operate with more cushion gas than salt caverns, a costly capital investment.

On balance, modular artificial salt caverns are more advantageous in enabling a ramp-up in storage capacity and hydrogen economy roll-out. Salt cavern storage is a well-established technology.

[5]As a percentage of storage nameplate capacity
[6]Construction costs around £0.8 – 1bn for 1 billion m3
[7]Two bn for Rough as per article https://www.business-live.co.uk/economic-development/rough-return-16b-plan-britains-20984442

THE HYDROGEN ECONOMY NEEDS MEDIUM SIZE MODULAR STORAGE IN ITS ROLLOUT PHASE

5

Investments are in progress in the hydrogen value chain. The government (Growth Plan 2022), has indicated its intention to support 5 hydrogen projects including two salt cavern storage facilities, one for each of the two Track #1 decarbonisation clusters (the HyNet Cluster, NW; East Coast Cluster, Humber).

✓

This reaffirms the importance of storage for the hydrogen economy. The government's approach to support regional clusters in the energy transition frames the type of storage needed in the energy transition's next phase. Salt caverns provide the right capacity for regional clusters in terms of size and flexibility.

1-2

For example, the current largest planned hydrogen plant in the UK, Saltend (East Coast Cluster) with a 600MW capacity will require the storage capacity of 1-2 caverns and its expansion to 1,800MW would require 4 additional caverns which can be added once they are needed.

2030s

The capacity of a depleted gas field might become relevant when much larger hydrogen refineries are in operation (5 – 10 GW) or as part of a nationwide pipeline network as envisaged by National Grid for the early 2030s ("Project Union").

✓

At the current pace of development, salt caverns are advantageous for hydrogen storage versus depleted gas fields.

[8] The storage needs of the most advanced hydrogen projects are between 0.2 to 0.7 bn m3 per project individually and 1.5 bn m3 cumulatively for the UK by 2030 (cf. Table 2, assumes 20% of storage capacity vs 12 to 30% in the FES 2050 scenario).

The UKEn site is located on the Isle of Portland between the South Wales and Southampton industrial hubs and is an opportune site for the South and South West of England and the closest to London and the South East.

SALT CAVERN LOCATIONS

The UK has three sizeable potential hydrogen salt cavern storage areas governed by underlying geology. They are attractively located next to the UK main industrial hubs that will provide some of the early demand for hydrogen. Both the Hynet and East Coast Cluster have access to salt cavern sites.

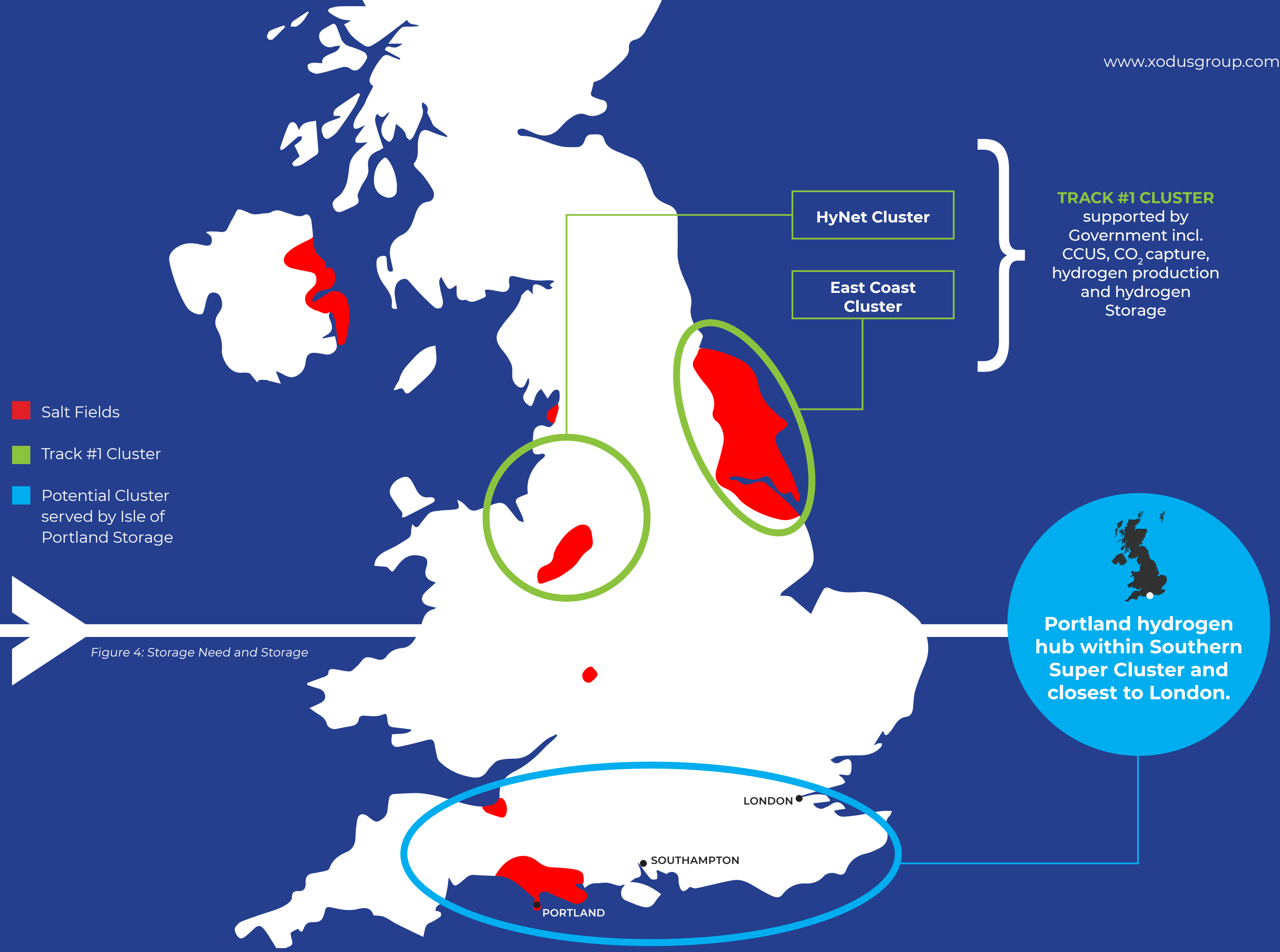


Figure 4: Storage Need and Storage

SECTION 4.

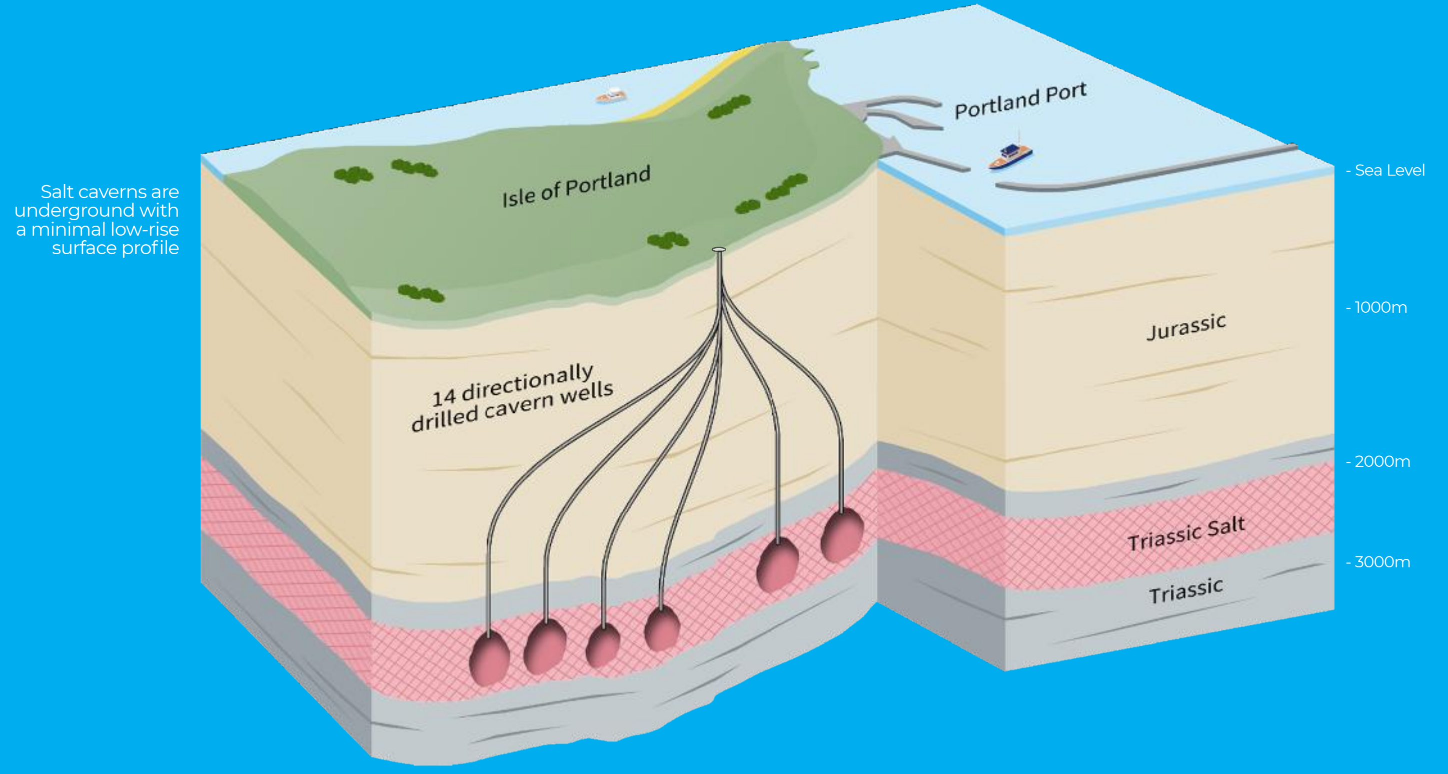
A NEW H_2 STORAGE HUB IN PORTLAND TO ADDRESS THE CURRENT CRISIS AND ENABLE THE SOLENT CLUSTER AND SOUTHERN SUPER CLUSTER

The UKEn energy storage project is located on the Isle of Portland.

- The initial construction of 14 new salt caverns
- will provide 1.2 billion m³
- increasing the UK underground storage capacity by around 70% (before any possible reopening of Rough offshore storage).

PHOTO: ALAMY

SECTION 4.1.



AN ADVANCED PROJECT TO MATERIALLY INCREASE THE UK'S ENERGY STORAGE CAPACITY

A gas storage facility on the Isle of Portland has been considered for many years. In 2008, a project to build salt caverns received planning approval.

UKEn (UK Energy Storage), a subsidiary of UKOG plc, has revived and upgraded this project, signing a lease option with Portland Port Limited.

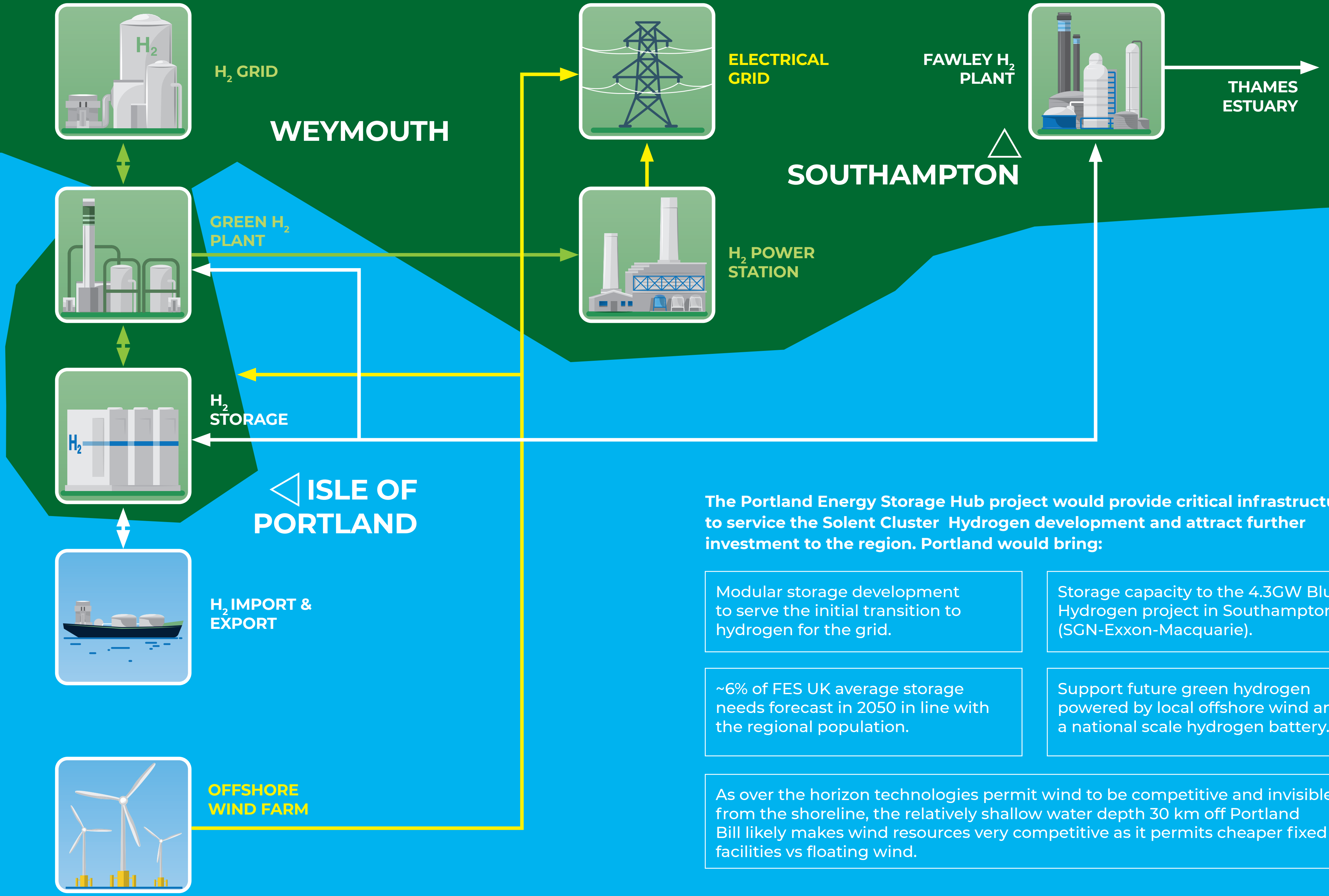
The facility's design has been improved to reduce its construction cost, minimise its carbon footprint and make it hydrogen ready, integrated with green hydrogen production and offshore renewables from inception.

The storage facility could be operational by 2027/28.

A TOOL TO ENABLE THE SOLENT CLUSTER AND SOUTHERN SUPER CLUSTER

Several regional hubs are being developed to accelerate UK decarbonisation (CCUS) via hydrogen, such as HyNet, and Teesside-Humber. The Solent Cluster aims to build a similar hub to decarbonise the industries and energy needs of the Solent area. Portland has the ability to expand to serve a Southern Super Cluster and the London area.

Figure 5: UK Portland Hydrogen Hub and Solent Cluster



The Portland Energy Storage Hub project would provide critical infrastructure to service the Solent Cluster Hydrogen development and attract further investment to the region. Portland would bring:

- Modular storage development to serve the initial transition to hydrogen for the grid.
- Storage capacity to the 4.3GW Blue Hydrogen project in Southampton (SGN-Exxon-Macquarie).
- ~6% of FES UK average storage needs forecast in 2050 in line with the regional population.
- Support future green hydrogen powered by local offshore wind and a national scale hydrogen battery.
- As over the horizon technologies permit wind to be competitive and invisible from the shoreline, the relatively shallow water depth 30 km off Portland Bill likely makes wind resources very competitive as it permits cheaper fixed facilities vs floating wind.

INSPIRING CHANGE FOR A RESPONSIBLE ENERGY FUTURE

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