FREEPORT EAST
Felixstowe
Gateway 14
Harwich

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Hydrogen East Roadshow
26-29th February 2024
Lowestoft / Holkham / Colchester

Hydrogen East
Supporting the Hydrogen Economy across East Anglia

- **Overview of Freeport East**
- **Freeport East Hydrogen activities**

UK Freeports

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- Freeports are a flagship UK Government programme for driving economic growth, supporting innovation and hitting targets on Net Zero

- Freeports are a priority policy for the UK Prime Minister

- Freeport East is one of 12 freeports in the UK

- Freeports benefit from a range of investment incentives, including:
  - generous tax reliefs on land, capital, equipment and people
  - a bespoke freeport customs model to support importers/exporters
  - innovation and skills partnerships with direct access to UK Universities and research institutes
  - wider UK Government financial support and focus for investment across departments such as transport, energy and education

About Freeport East (1)

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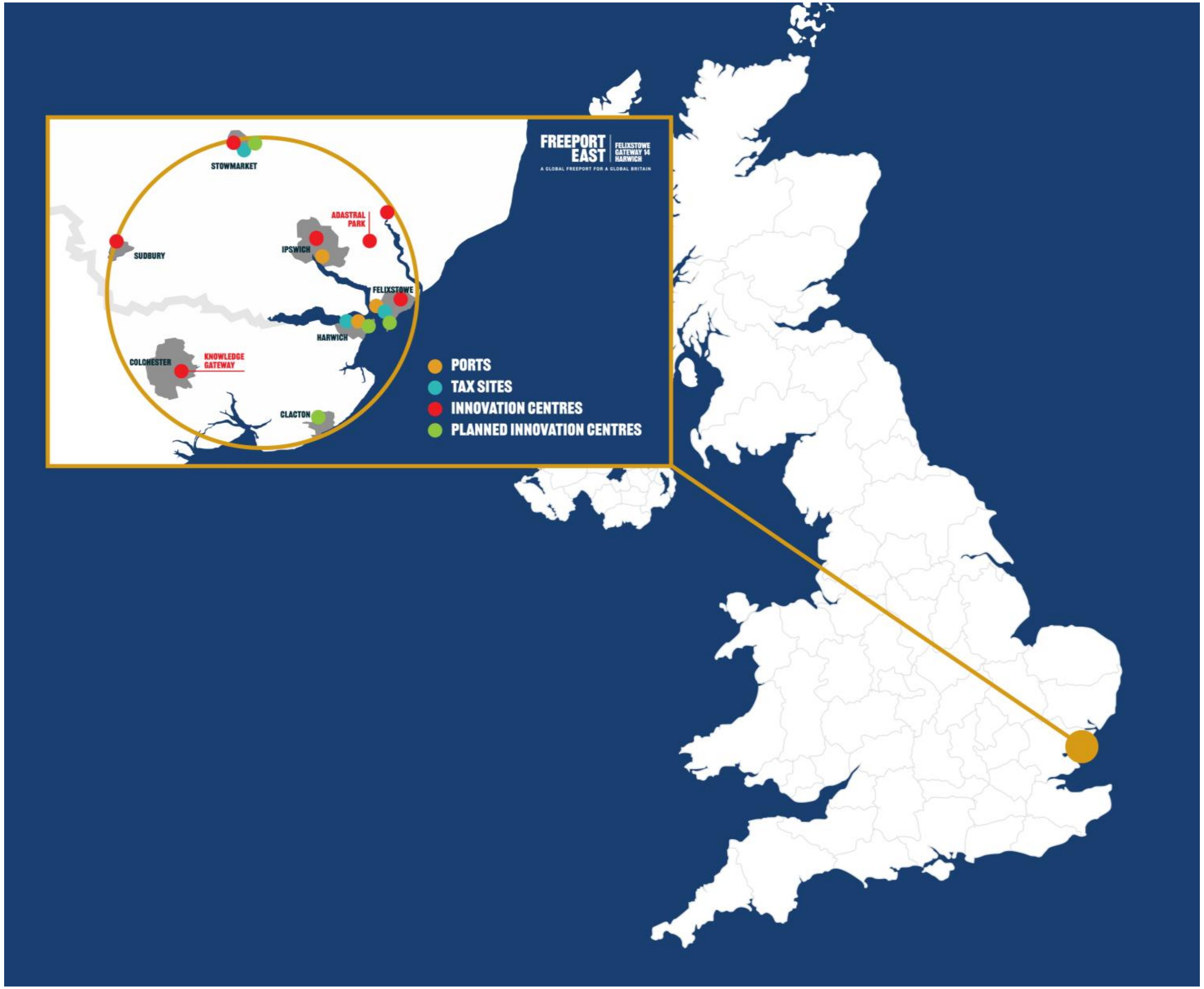

- Freeport East is a public-private partnership
- We bring together ports, Universities, innovation centres, research institutes, innovative SMEs and major international companies, together with national, regional and local Government
- Backed by the UK Government to deliver inward investment, drive our economy to net zero and support innovation
- Formed in 2022
- HQ in Harwich International Port
- We aim to form strong and innovative collaborations with industry that can attract funding and support new investment
- Freeport area covers over 1000sqkm with specific development sites with tax reliefs
- Green Hydrogen is a key focus sector
- Hutchison Ports and CK Hutchison are key partners and supporters of Freeport East

Freeport East Felixstowe

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- Over 30 hectares of land for new opportunities – a “freeport tax site”
- Unique location at crossroads for UK, European and Far Eastern trade
- UK’s biggest container terminal and primary port for Far East trade
- Direct Ro-Ro services to Europe
- Suited for cleantech and clean energy manufacturing, trade-based assembly & logistics and other sectors taking advantage of unique location
- Site owned and developed by Hutchison Ports
- 150MW Green Hydrogen plant under development between Hutchison Ports and Scottish Power Renewables
- Government tax reliefs available to support investment + wider innovation & skills support

Freeport East Harwich (Green Energy Hub)

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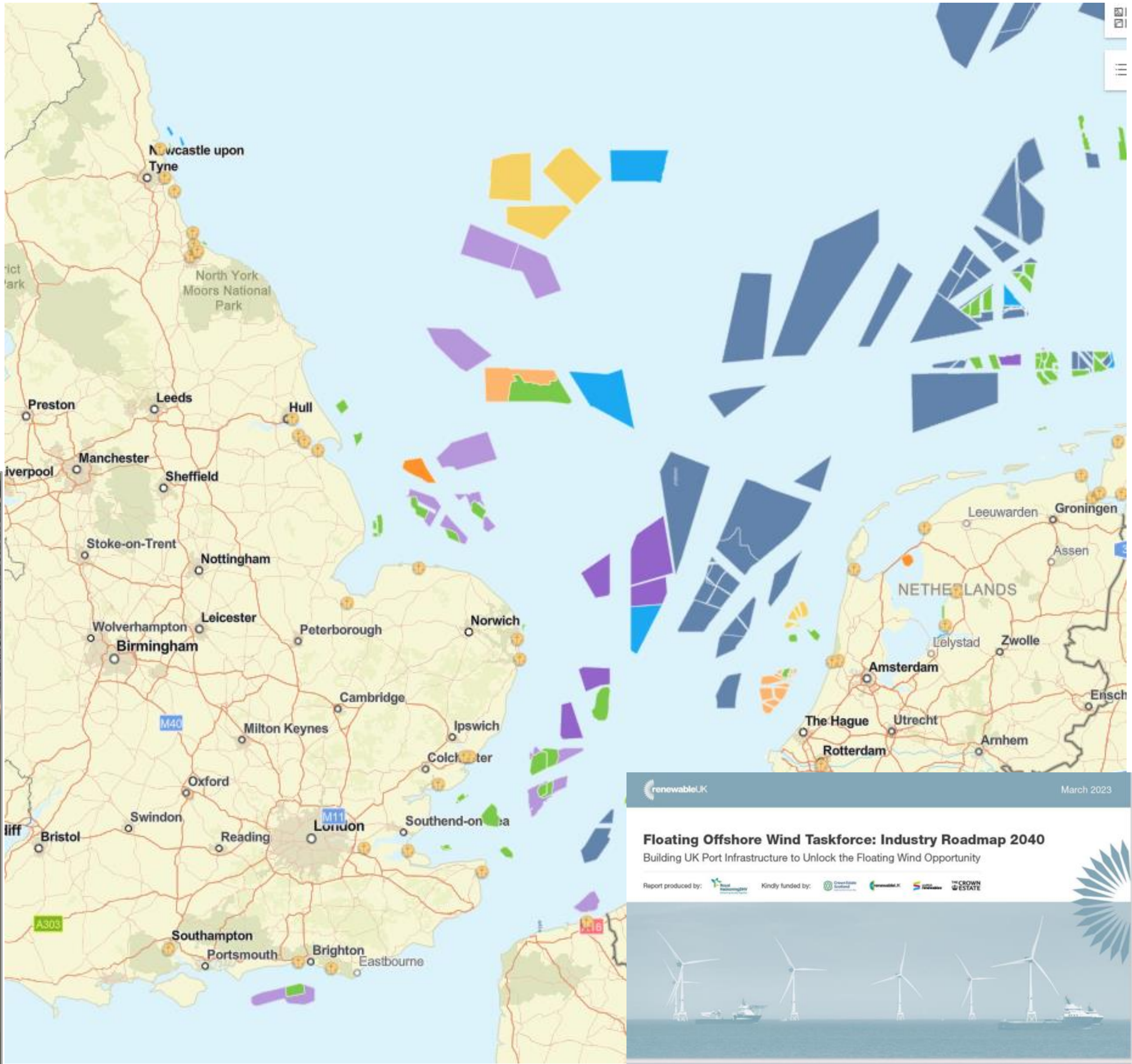
- Existing international port + 130 hectare expansion (Bathside Bay) to support offshore wind and clean fuel development (a “freeport tax site”)
- Able to support both fixed and floating offshore wind activities
- Optimal combination in UK waters of deep water (15m+), land availability (132ha) and quay length (1400m)
- Scope for clean fuels development to service land and maritime needs
- New innovation, skills and research facilities to aid clean energy industry
- History of offshore wind project support including Greater Gabbard and Galloper offshore windfarms
- Existing base for RWE O&M Facility; wider supply chain in offshore construction, maritime and logistics
- Government tax reliefs available to support investment



Freeport East Green Hydrogen Hub

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The Freeport East Green Hydrogen Hub brings together partners across the hydrogen value chain to co-develop projects and innovation partnerships – all supported by analysis on market opportunities in the Freeport East area and wider UK economy

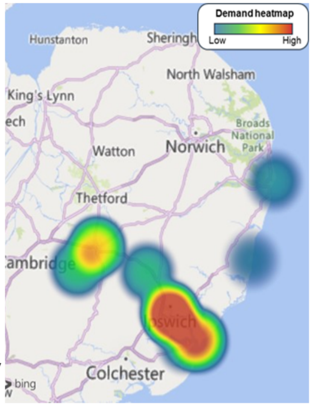
1. DEMAND SEGMENTATION AND TIME TO MATURITY ASSESSMENT

11 segments with potential hydrogen use cases within Freeport East area and the immediate region were identified as part of initial review

Short term (pre-2025)	Medium term (2025 – 2030)	Long term (post 2030)
HGVs	Off-highway	Rail FOCs
Buses	Fertiliser, Port Ops	Shipping
FMCG	Refinery	Rail TOCs
		Ferries

Key insights and commentary from our initial analysis:

- HGVs, Buses and FMCG can be early adopters in the region, making them attractive for pilot projects
- Maritime is a long term opportunity for derivatives, but port ops could come sooner if there is strong support from stakeholder groups
- Refining & fertilisers segments have credible offtakers who can benefit from fuel switching to hydrogen
- Rail at a national level has a weak case, but it's a viable alternative in East England due to preponderance of freight, & local electrification challenges.



2. DEMAND MAPPING,

140 tonnes per day of hydrogen offtake potential could be accessible across the region by 2030. Based on high level estimates this would require circa 550MW of installed capacity using typical electrolyser efficiencies as of 2023.

Noteworthy potential offtaker segments identified from the modelling could include Buses & Off-highway (c. 4tns/day), Petro-chemical refining (c.7tns/day), Port operations, (c. 10tns/day) HGVs (10-70 tns/day), FMCG (c. 32tns/day) & Fertilisers, (c. 49tns/day).

Beyond 2030, technology development becomes less certain; there may be sizable volumes (>100 tns/day) needed by HGVs especially given the large number of movements in and out of the regional ports. But there is competition from other technologies, e.g. electrification. Shipping fuels in the form of hydrogen derivatives such as ammonia could drive huge demand, as emphasis on decarbonising deep-sea shipping sector gathers momentum.

Offtakers are hub-based within the Freeport & dispersed beyond. Infrastructure barriers exist for both

Hydrogen demand hubs could emerge within the ports for refuelling of port operations & goods transport vehicles entering site – e.g. HGVs & Rail. Further afield, potential offtakers such as FMCG plants, and major construction projects etc., are more dispersed and require different storage & transport solutions. Infrastructure is currently limited, both within the economic zone, and in Eastern England. Strong demand potential and a coordinated strategy (e.g. with Project Union, a National Gas venture, and the Bacton Hydrogen Hub) is a key pre-requisite to drive infrastructure investment and development.

PILOT 1 - HGV & PORT OPS REFUELLING HUB AT FELIXSTOWE

Proves concept of multi-modal handling and refuelling

PILOT 1A – ADDITIONAL MARITIME REFUELLING HUB AT FELIXSTOWE

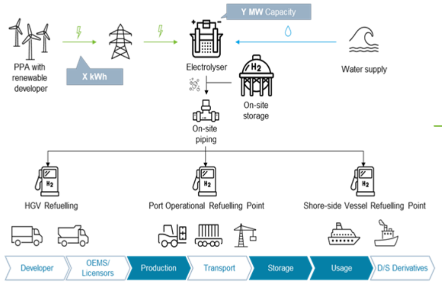
Proves concept of multi-modal refuelling of various sizes of vessels: CTVs, tugboats, service vessels etc.

PILOT 2 - PRODUCTION AND DELIVERY TO DEDICATED INDUSTRY WITHIN FREEPORT AREA

Proves concept of delivery to a dedicated local external offtaker via pipeline infrastructure

PILOT 3 - PRODUCTION AT PORT AND DELIVERY VIA TUBE TRAILER TO AN OFFSITE OFFTAKER

Proves concept of storage at production & offtake sites, along with tube trailer deliveries offsite



Types & Names of Organisations

Value Chain Mapping (Type of Partnership)

Funding Sources Available

*Diagram is illustrative of the potential opportunities, but the specific elements need to be scoped in more detail following further studies

The challenge of H2 transport …

- Traditionally hydrogen has been produced in volume close to where it has been consumed in volume
- If you **can** receive your H2 via pipeline you **should** …
- Otherwise
- Cooling the gas it to -260 deg C where it liquifies
- Or
- Pressurising it to 350 or 700 Bar
- Or
- Converting it to ammonia
- Which incurs both financial and energy costs to get it into **and** maintaining the respective conditions (and in the case of ammonia , converting back to hydrogen)

The only way is not Electrolysis...

- Energy Projects International (EPI)
- Winner of H2BECCS (Hydrogen Bioenergy with Carbon Capture and Storage Competition)
- Pure Pyrolysis Refined
- Using a 3 acre site at Great Blakenham (just West of Ipswich)
- Pyrolising waste to produce both hydrogen fuel gas and capturing the carbon in solid form (char)
- … which can be further refined into Carbon Black – feedstock for paint , plastics , tyres, cosmetics, Li-On batteries and carbon fibre
- Aiming to be producing nearly 200 kg per day by end of calendar year

Rux Energy – Rise of the MOF (1)

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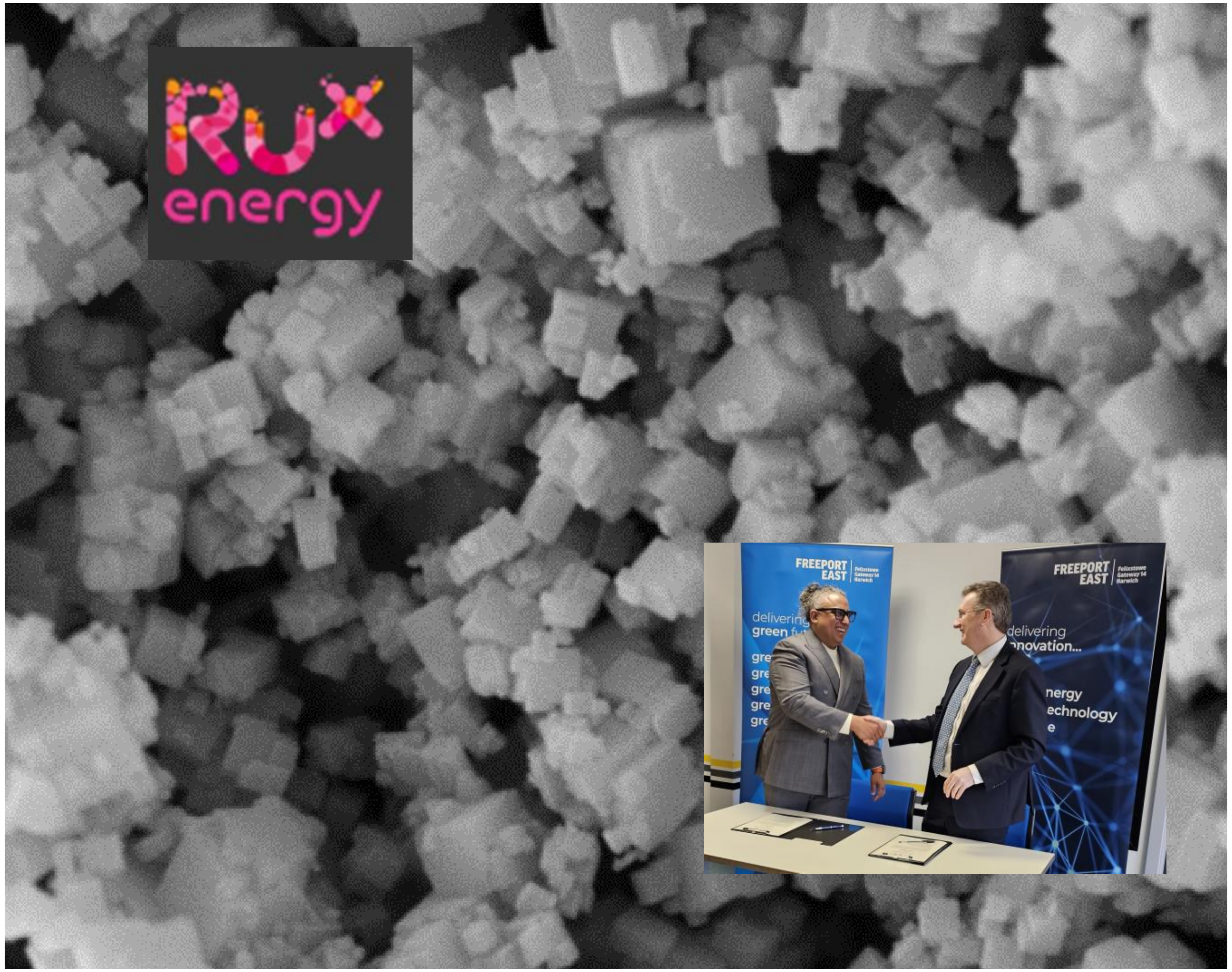
- Inward Investment to Harwich from a University of Sydney spinout
- Patented design for a metal-organic-framework
- An **enabling technology** to significantly reduce the cost of hydrogen transportation
- Working on both storage at
  - 120 bar = smaller and cheaper compressor needed
  - 30 bar = pressure at which H2 leaves electrolyser = no compressor needed
- 35 litre ambient MOF enabled storage tank being trialled currently
- A 300-400 litre tank launch next year
- 20’/40’ ISO tank container adaptation for transport/long duration storage is ultimate step



Rux Energy – Rise of the MOF (2)

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- Use cases
  - On-Vehicle fuel tanks (increasing capacity)
  - Fuel bowsers for large construction sites
  - Tanker trucks
  - Railway wagons (no tank wagon approved to carry H2 currently exists)
  - Tanktainers (ditto)
  - Long duration (possibly even interseasonal) H2 storage
  - Pilot boats , tugs and windfarm crew transfer vessels (onboard storage space a limiting factor)
- Rux also are
  - Part of the Singapore Pier 71 mari-tech accelerator
  - Part of the successful DFT Clean Maritime Demonstration Competition 4 bid SPOHL with Cranfield University and Carnot Engines for a cold ironing solution
  - Awaiting results of a joint bid to the UK-Australia Clean Hydrogen Competition

Examples of our hydrogen industry collaboration

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Storage & Distribution

Partnership with Australia-based Rux Energy to explore the application of metal organic frameworks (MOFs) for storage and distribution, with potential for multi-modal storage and rail/sea shipping.

Production

Supporting developers of new hydrogen production in Freeport East area, including Scottish Power at Felixstowe. Over 140 tonnes per day/500MW of local hydrogen demand forecast to 2030.

Hydrogen Propulsion Systems

Consortium of leading UK technologists developing hydrogen propulsion and shore-side hydrogen-optimised power options for cold ironing of ships.

Working with local unmanned maritime vessel manufacturers to explore alternative cleaner fuels.

Hydrogen Fueling Infrastructure & "Green Corridors"

Developing options for new hydrogen fuel stations, and passenger transport systems, whilst building partnerships for maritime and inland green corridors.

Freeport East hydrogen future

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- Maintain support for existing initiatives
- Eg Hydrogen vehicle refuelling facilities
- Eg Conversion of some existing HGV's to dual fuel
- Development of H2 ready rail wagons (and freight locomotives)
- What does vocational hydrogen training look like ?
- Can we capture the oxygen if we electrolyse at hospitals ?
- Hydrogen tanks are mainly built from or lined with carbon fibre – most of the fibres are sourced from China , Japan or South Korea – can we manufacture the fibres here ?
- Most of Freeport East's land use by area is agriculture - how do we decentralize h2 production for rural users
    - growing and fermentation of biocrops like miscanthus ?
    - Anerobic digestion of slurry ?
- Investigate clean shipping corridors – UK Shipping Office for Reducing Emissions (SHORE) announced £1.5 million for feasibility in green corridors (a zero emission maritime route between 2 ports).Pilots between NO/DK/NL and UK ports
    - Announced at London International Shipping Week in September 23 , repeated at COP 28 **– still** awaiting T's and C's
- Develop international links with strong interests in the hydrogen economy, including , but not exclusive to:- Rotterdam , Singapore , New South Wales , Western Australia , South Korea , Japan
- **Continue to COLLABORATE**

Further Info

- Hydrogen Offtake Assessment and Hydrogen Refuelling reports free to download from Freeport East website [Green Hydrogen Hub - Freeport East]
- Report on Green Transport Hub (hydrogen will figure in it) will be published in May 2024
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