FREEPORT EAST GREEN HYDROGEN HUB

Strategic analysis of the role of hydrogen in driving green corridors and transport decarbonisation at Freeport East

AUGUST 2023

FOREWORD

Decarbonisation of our transport systems will require the action of multiple parties along extended transportation corridors that can stretch from the very local, to the truly global.

Freeport East sits at the heart of these decarbonisation efforts. It includes, at Felixstowe, the biggest container port in the UK and regularly hosts the world's largest ships connecting to over 700 destinations around the world. Other active ports at Harwich and Ipswich also contribute to a local economy that is home to hundreds of companies involved in the transportation sector as well as helping to transport goods and people throughout the UK and overseas.

As Freeport East looks to help drive our regional economy towards net zero in a manner that delivers benefits across our communities, it is clear that green hydrogen and related clean fuels have the potential to play an important part in delivering on decarbonisation and energy security, while offering unique investment and employment opportunities.

The East of England is already a clean energy powerhouse of international significance, comprising a range of renewable generation, innovation & R&D assets but also the deep skills and experience to match. It is in our national interest that the region's capabilities are deployed to drive forward decarbonisation across the transport sector.

Our previously published analysis set out how the Freeport East area could create demand for over 500MW of hydrogen demand by 2030, without counting the needs of the maritime sector and the wider region. Developments to deliver this green hydrogen capacity, making use of our abundant clean energy resources and local technological know-how, are already progressing.

But decarbonisation and facilitating the growth of green hydrogen use will also require investments to transform the maritime sector as well as our inland refuelling infrastructure. This report sets out the opportunities for Freeport East to work with a range of public and private sector partners, investors and innovators to enable green hydrogen and related fuels to support transport decarbonisation and deliver end-to-end green transport corridors.

We hope the report will be of interest to all those involved in decarbonisation of transport in and beyond Freeport East, including the policy makers, businesses and investors who will play a key role in driving forward the changes we need to see. The report is intended to add to the information available to develop viable investment propositions whilst also signposting the level of ambition we have at Freeport East and the opportunities we want to pursue, bringing benefits to our local communities, the wider UK and those markets to which we connect. We welcome the opportunity to hear from anyone interested in the opportunities raised in the report.

We are also grateful to the Department for Levelling Up, Housing and Communities for their funding for this work and wider support for the freeports programme.

Steve Beel
Chief Executive
Freeport East

CONTENTS

FreeportsHub

GLOSSARY

BEV	Battery Electric Vehicle
C&M	Construction and Manufacturing
CCUS	Carbon Capture Usage and Storage
CMDC	Clean Maritime Demonstration Competition
CTV	Crew Transfer Vessel (e.g. for offshore wind farm servicing)
EPC	Engineering Procurement Construction
EV	Electric Vehicle
FCEV	(Hydrogen) Fuel Cell Electric Vehicle
GHG	Greenhouse Gas
GSC	Green Shipping Corridor
Hydrogen	Hydrogen
HGV	Heavy Goods Vehicle
HRI	Hydrogen Refuelling Infrastructure
HRS	Hydrogen Refuelling Station
ICE	Internal Combustion Engine
IMO	International Maritime Organisation
LCOH / LCOE	Levelised Cost of Hydrogen/ Electricity
NZHF	Net Zero HydrogenFund
PAX	Passenger Vessel
PoR	Port of Rotterdam
RoRo	Roll On Roll Off (Type of Freight Vessel)
RTGC	Rubber Tyred Gantry Crane
SMR	Steam Methane Reforming (when combined with CCUS produces blue hydrogen)
SRN	Strategic Road Network
SZC	Sizewell C (at Sizewell Nuclear Power Station)
TCO	Total Cost of Ownership
TEU	Twenty Equipment Unit (20ft container equivalent)

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INTRODUCTION

Background to the study

INTRODUCTION

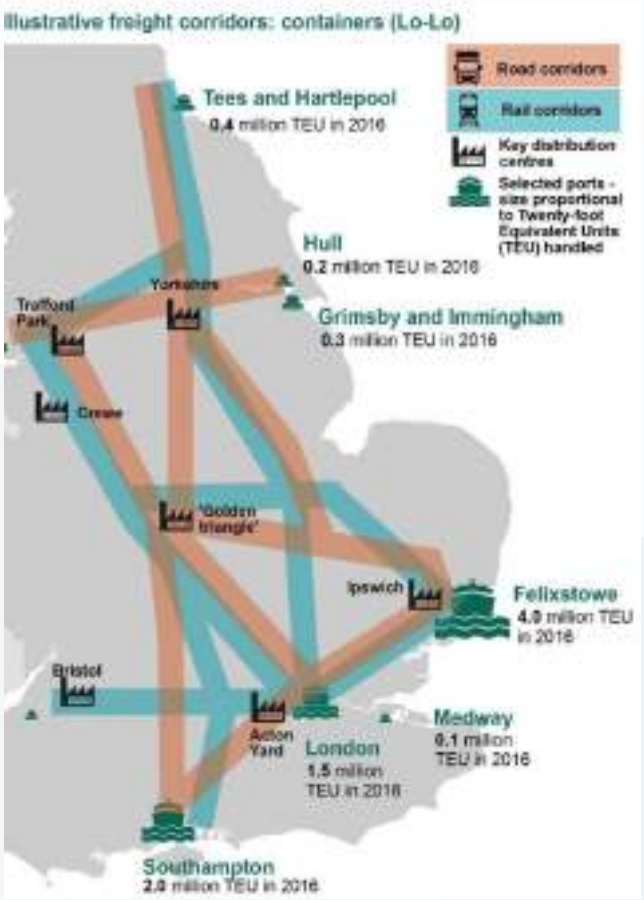
Freeport East aims to support end-to-end decarbonisation of transport with green corridors extending from inland locations in the UK to/from global destinations (see images on next page)

Ports will play a key role in the green maritime transition by serving as energy hubs, providing both shore-side electricity and infrastructure for storing and fuelling ships with green fuels, as well as supporting first movers and green corridors. [11] Furthermore Freeport Hub national level studies into Hydrogen refuelling infrastructure have shown ports are at the nexus of cost efficient supply and high demand driven by HGV volumes on nearby strategic roads. [12]

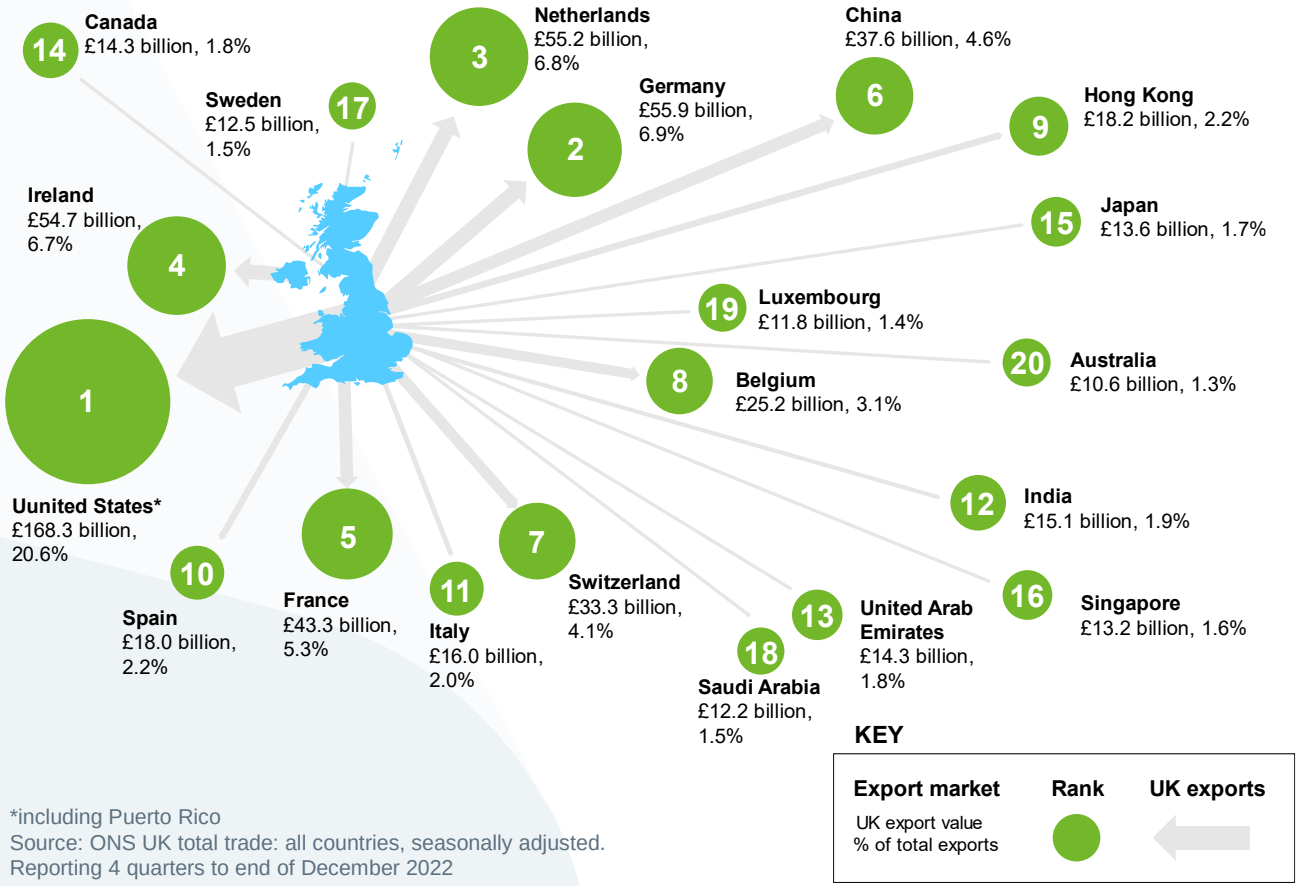
Hence this report looks at maritime, refuelling and green corridors collectively as discrete pieces that overall contribute to Freeport East connecting inland UK industrial and commercial sectors with the rest of the globe.

INTRODUCTION

UK rail and road connectivity corridors



Top UK Export destinations



*including Puerto Rico
Source: ONS UK total trade: all countries, seasonally adjusted.
Reporting 4 quarters to end of December 2022

BACKGROUND TO THIS STUDY

There is an opportunity for Freeport East to play a role in the development of Hydrogen Refuelling Infrastructure and to be a catalyst in engaging stakeholders to pursue Maritime Decarbonisation for the region.

The Freeport Hub had previously supported Freeport East by undertaking a detailed demand mapping exercise for low carbon Hydrogen usage in the Freeport East economic areas and adjacent regions. The data and insights from the report produced is helping to build and garner widespread support for the Freeport East Green Hydrogen Hub development vision. To help develop the next phase of market engagement, two components were identified as critical:

1. **Analysis of maritime decarbonisation potential using Hydrogen derivatives** as alternative fuel pathways. Comprised of:
   - **Task 1A**: Assessment of volume potential of vessels entering Freeport East ports, along with decarbonisation options for shipping fuels and bunkering challenges.
   - **Task 1B**: Assessment of green shipping corridors and potential for partnerships
2. **Assess regional potential for Hydrogen Refuelling Infrastructure development** to engage stakeholders across the value chain interested in progressing opportunities related to refuelling projects, primarily for HGVs (primary use case) and other secondary applications (e.g. Port Operations).
   - **Task 2:** Assessment of primary / secondary refuelling use cases and TCO modelling to support HGV fleet transition.

Aerial view of the Port of Felixstowe [70]

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY – TASK 1A MARITIME DECARBONISATION POTENTIAL ASSESSMENT

Global green fuel shortages means Maritime decarbonisation will be challenge. Freeport East can potentially use its geographical advantage to either bunker vessels locally or export hydrogen derivatives to bunker ports in the future

4400 vessels passed through ports at Freeport East last year

- Typically these are Lo-Lo & Ro-Ro of 20k-100k tns
- Many originate from Singapore and China and stop en-route at PoR, where bunkering takes place.
- Cost identified as key driver on where ships bunker

E-Methanol in 2020s, and E-Ammonia in 2030s, will most likely be viable green fuels for shipping in the region

- Dual fuel Diesel-Methanol vessels currently being procured for delivery in late 2020s
- Ammonia technical maturity and safety case further behind, but roll-out expected by 2030s

What this means for Freeport East

No bunkering infrastructure at present, but this could be developed due to global shortages

- Over half of the world's bunkering is provided by 10 port hubs, but the clean transition will disrupt supply chains
- Freeport East is positioned near 5GW of offshore wind, with further clean power potential once SZC is operational in 2030s
- PoR, 2nd biggest bunkering port in the world is building green fuel import terminals, presenting export opportunities. Also, potential opportunities to become a satellite bunkering location of PoR

Up to 187tpd of potential Hydrogen needed by 2035 requiring c. 450MW of electrolyser capacity

- Potential hydrogen derivative volumes in the region (if capturing 5% of PoR's bunkering volumes) are given in the table on the right.
- Shipping represents more demand than all other local industries combined.
- By 2050 this could scale to over 1000tpd and c. 2.3GW of electrolysis

***Above**: Applicability of various green fuels by ship type.*
***Below:** Estimated potential hydrogen feedstock demand at Freeport East ports*

Potential Hydrogen Demand for Maritime Fuels at Freeport East linked ports

Fuel	Year	Hydrogen (tpd)	Electrolysis Capacity (MW)
E-Methanol	**2035**	65	235
E-Methanol	**2050**	293	1057
E-Ammonia	**2035**	122	221
E-Ammonia	**2050**	736	1327

EXECUTIVE SUMMARY – TASK 1B GREEN SHIPPING CORRIDOR ASSESSMENT

Green shipping corridors may enable Freeport East to unlock the aforementioned advantages, by partnering with European ports to supply bunkering, derivatives and/or hydrogen feedstocks

GSCs share risks of decarbonisation amongst stakeholders across the value chain

- 21 international GSC initiatives underway since 2021. Aim is to implement six from 2025.
- Barriers/challenges appear to exist on green fuel availability and engagement with shipping lines to mobilise demand.

The Silk Alliance is a potential model for European ports to follow to aggregate supply and demand

- Silk Alliance is trying to overcome barriers by clustering supply chains at regional ports feeding the main bunker port at Singapore.
- PoR already have a separate GSC with Singapore, which could be leveraged to form a new alliance/cluster at the European end of this GSC

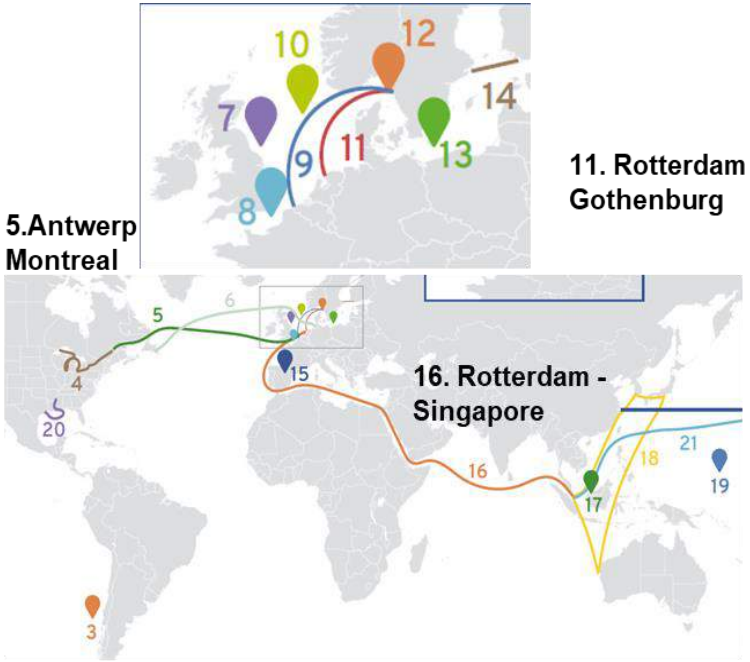
What this means for Freeport East

Freeport East as a convenor of stakeholders may have a crucial leadership role to play in a potential local GSC.

- Of 21 initiatives, GSC leadership is typified by government or public-private partnerships, which is similar in profile to the Freeport East organisation

2025 horizon makes it preferable for Freeport East to partner with existing initiatives

- Potential to engage PoR and Antwerp on their GSC projects & possibilities of supporting ship bunkering
- This could either be on the Silk Alliance model of exporting derivatives to the central hub (i.e PoR) or by establishing bunkering locally at Freeport East regional ports



Map of proposed Green Shipping Corridors

EXECUTIVE SUMMARY – TASK 2 HYDROGEN REFUELING INFRASTRUCTURE ASSESSMENT

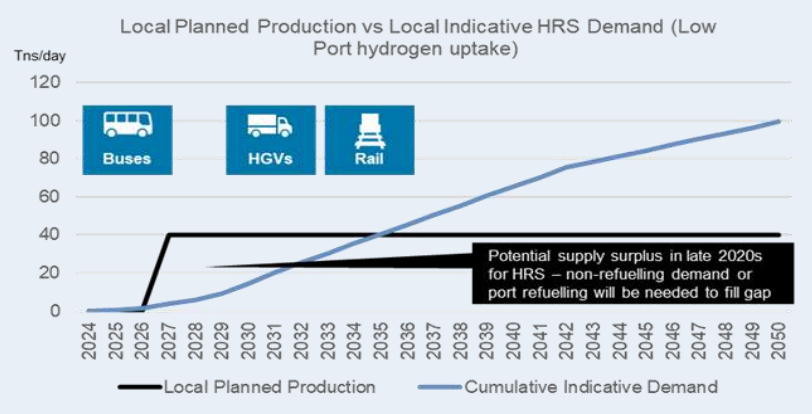
Local hydrogen refuelling is an attractive proposition, but will rely on HGVs to scale. Modelling indicates hydrogen FCEV HGVs to be cost competitive by mid 2030s

Planned/announced Green Hydrogen projects aim to provide 40tpd by 2027

- 100MW Green Electrolyser planned at Felixstowe port site.
- Further capacity potential at SZC and Great Blakenham

Local Hydrogen potential volume from HGVs of up to 70tpd, based on successful fleet transition

- Potential for early adoption in 2020s before scaling up in the 2030s.
- Secondary use cases such as port operation vehicles & buses could have crucial role to kick-start initial refuelling demand



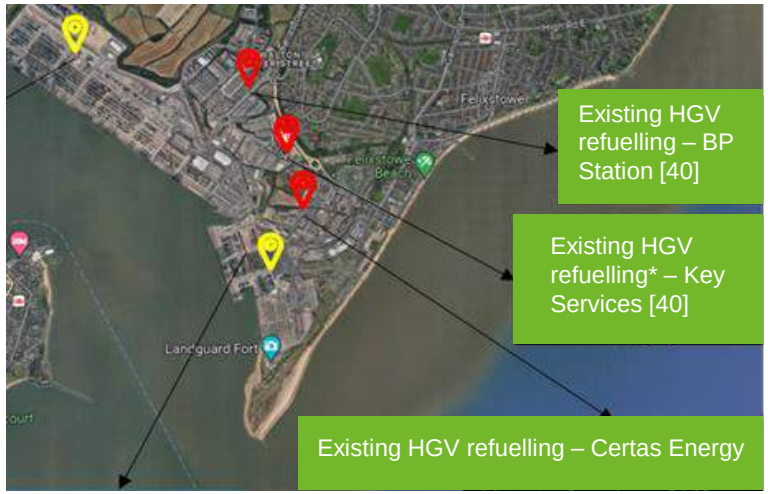
What this means for Freeport East

Scenarios modelled suggest large local HRS (4tpd) supplied by tube trailer from a large electrolyser has the lowest TCO

- At pump costs of <£5/kg are achievable with subsidies by 2035
- Initial modelling suggest a local HRS would potentially require a utilisation rate of >65% to be viable

Three potential strategic sites for HRS at existing fuel stations

- These would benefit from the local 100MW electrolyser reducing transport costs
- Further out there is potential to create refuelling hubs at sites like Port One logistics park and services off busy A14 road with heavy HGV movement, which also has potential to provide Hydrogen to bus depots/refuelling hubs near Ipswich.



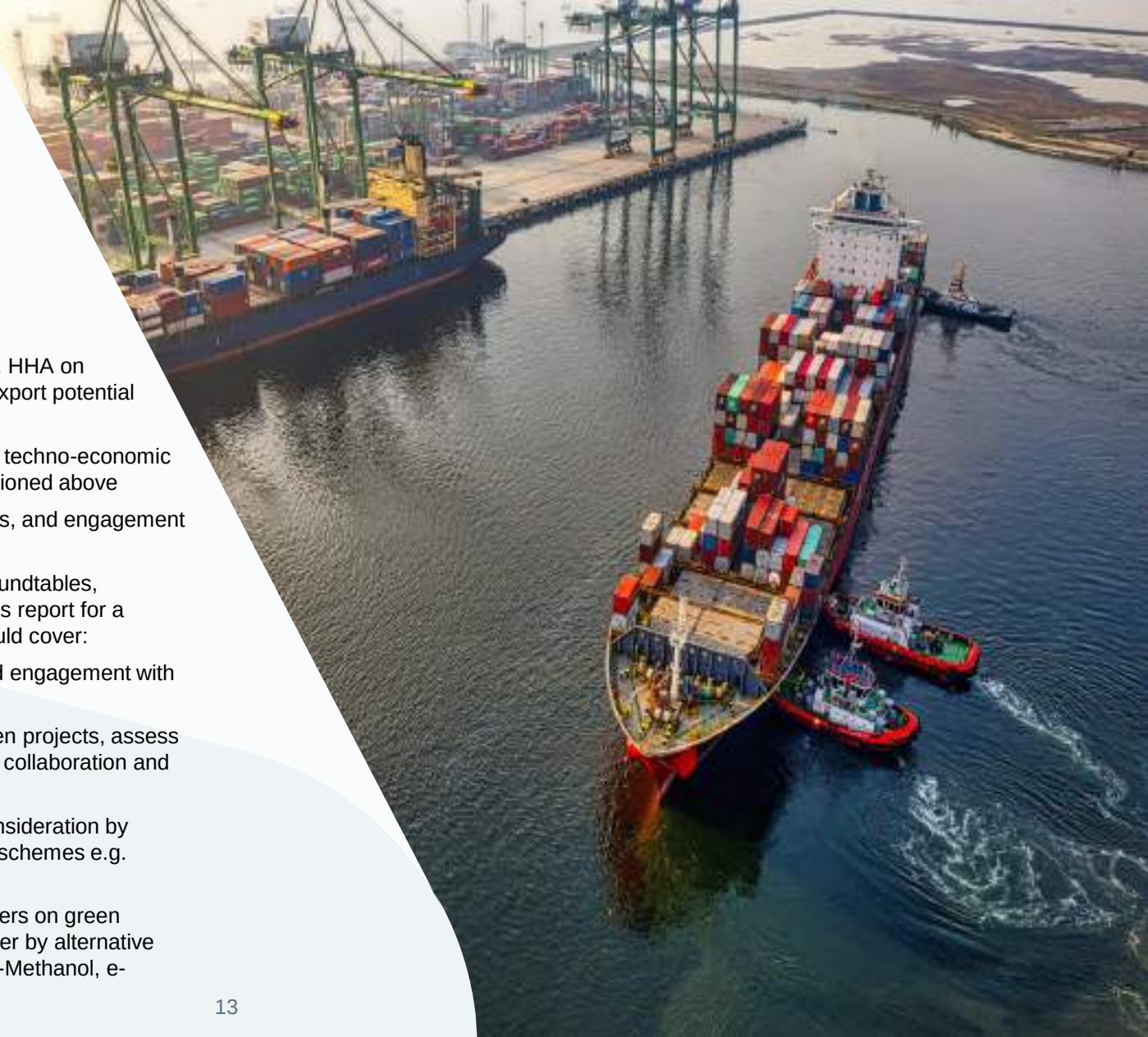
Map of existing HGV refuelling locations at Felixstowe

RECOMMENDED NEXT STEPS - MARITIME

The following activities could be pursued to build on the detailed assessment in this report:

Maritime Opportunity

- Engagement with key regional stakeholders e.g. Hutchison Ports, HHA on exploring bunkering opportunities and/or developing facilities to export potential Hydrogen derivative fuels to PoR as described in this report.
- Working with stakeholders to explore the potential to undertake a techno-economic feasibility study to support infrastructure development plans mentioned above
- Sharing of the maritime potential volumes with potential producers, and engagement on their production site plans and timelines.
- A programme of engagement, ideally a series of workshops or roundtables, with interested local stakeholders on the potential described in this report for a Methanol and/or Ammonia production facility in the area. This could cover:
  - Research into potential Methanol and Ammonia producers and engagement with them to determine interest in entering the regional/UK market.
  - The purpose of these would be to establish viability of Hydrogen projects, assess barriers and mitigations, and pursue potential opportunities for collaboration and funding.
  - Review potential pilot/demonstrator projects that are under consideration by stakeholders and access to potential UK Government funding schemes e.g. Clean Maritime Demonstration Competition
- Engagement with Port of Rotterdam and Freeport East stakeholders on green shipping corridors and the potential for supporting Rotterdam either by alternative fuel bunkering at Felixstowe and / or export of alternative fuels (e-Methanol, e-Ammonia) to PoR.



RECOMMENDED NEXT STEPS – REFUELLING INFRASTRUCTURE

The following activities could be pursued to build on the detailed assessment in this report:

Hydrogen Refuelling Opportunity

- Sharing of report's TCO findings with local hauliers and discussions between hauliers & OEMs developing FCEV HGVs to discuss trial demonstrators.
- Sharing of findings and initiating engagement with local/regional refuelling station operators (e.g. Certas, Key Fuels, BP) to determine interest in repurposing of pumps at their local stations for Hydrogen refuelling.
- Roundtable discussion / workshop to be held between local hauliers, refuelling station operators, and potential Hydrogen producers to discuss their Hydrogen plans and to align each stakeholder's plan into a coherent overarching plan for the area.
- Work with Hutchison Ports and their OEM supply chain to determine possible timescales for transitioning of port operation vehicles/ machinery to Hydrogen fuel cells.
- Work with Sizewell C and local councils to support their transition and procurement of Hydrogen for buses and determine a suitable location for bus depots / refuelling hubs.

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CONCLUSIONS & NEXT STEPS

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FREEPORT EAST CAN ACT AS A CONVENOR OF STAKEHOLDERS TO DEVELOP OPPORTUNITIES FOR HRI DEVELOPMENT AND DRIVE MARITIME DECARBONISATION IN THE REGION

Maritime Decarbonisation Opportunity

4400 vessels entered Freeport East regional ports last year. Analysis of vessel types indicates e-Methanol and e-Ammonia fuel pathways are the two standout decarbonisation options.

- Shipping traffic volumes in the region can potentially support close to 450MW of local electrolysis for Hydrogen derivative fuel production by 2035.
  - By 2050 it could scale to 2.3GW. Methanol demand could be the leading driver from late 2020s, with Ammonia scale up in the 2030s.
  - This compares to just 100MW of announced electrolysis capacity at Felixstowe to date, demonstrating the potential scale up opportunities.
- Existing European bunkering market is dominated by Port of Rotterdam (PoR), however they will struggle to produce locally the required volumes
  - Rotterdam handles 20x the tonnage of Felixstowe and is building import terminals for derivatives. It is lacking in local clean electricity capacity to produce the required volumes.
  - Freeport East region has access to 5GW of offshore wind capacity, and in the future potential for hundreds of MWs of green electrolysis hydrogen production from announced projects in the region and sites like Sizewell C who are looking into Hydrogen production
- GSCs may be an avenue for Freeport East to engage with PoR– either as a secondary bunkering port or as a supplier of derivative fuels or H2 feedstock
  - At this stage partnering with nearby ports could be pursued. A model based on the Silk Alliance could be valuable for the North Sea area given the fuel supply challenges.
  - Freeport East as a convenor of stakeholders may have a crucial local GSC leadership role.

Hydrogen Refuelling Opportunity

A 100MW project is expected to come online in 2026/2027 in the region and aims to supply 40tpd. HGV demand will drive HRS, but scaling of demand may be delayed until the 2030s

- Local HGV total volume potential for HGVs is estimated c. 70tpd at the higher end of the range
- Local hauliers tend to see FCEVs as a longer term option so HGV HRS hydrogen demand may only reach a mass scale tipping point in the 2030s.
- Other multi-modal secondary use cases will be critical to lay the seeds for the initial demand. Short to mid term opportunities exist within potential use cases for port side operations and bus depots/hubs at Ipswich (both for local buses and Sizewell C related operations during the construction period)
- A large local new build HRS (4tpd) supplied from a large electrolyser plant by tube trailer was the lowest TCO option
  - FCEV HGVs are seen to be competitive in the Freeport East region from 2030s
  - A large HRS could be located at an existing refuelling site at the port of Felixstowe; supplied by the planned 100MW electrolyser.
  - At pump costs of <£5/kg are achievable with subsidies by 2035
- Initial modelling shows a local HRS would require a utilisation rate of >65% to be viable
  - Potential to reduce this further via supply from subsidised hydrogen production
- Further reduction in LCOH across the most competitive LCOH scenario and HRS utilisation figures is possible with dedicated pipeline infrastructure which has not been modelled in this report

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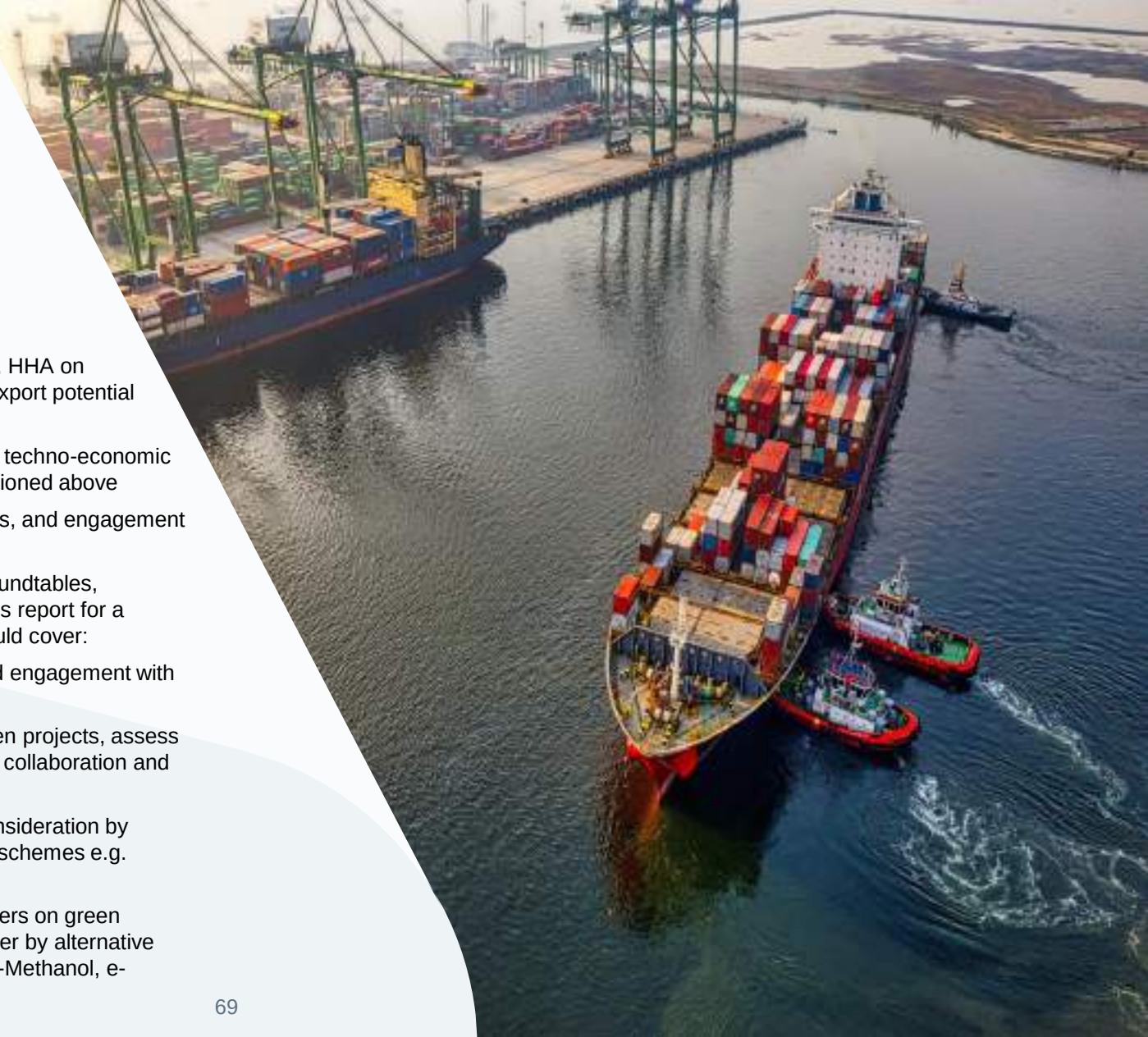

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