

LCR GREEN HYDROGEN VISION



Executive Summary
September 2023



EXECUTIVE SUMMARY

By 2030, 21 hydrogen hubs across Liverpool City Region (LCR) could be producing and consuming 1,000 GWh of hydrogen

This would require over 220MWe of electrolyzers to be installed across LCR and over 200,000 tonnes of CO₂ would be avoided each year

To achieve the vision, over £800m must be invested in decentralised hydrogen infrastructure. For projects to be operational by 2030, development must begin in the next few years

To advance the hydrogen economy across LCR, the Combined Authority (LCRCA) should establish a Hydrogen Development Forum, open to local private and public organisations

LCRCA can act as a catalyst for the local H₂ economy by decarbonising its municipal fleets and allowing private businesses access to the infrastructure

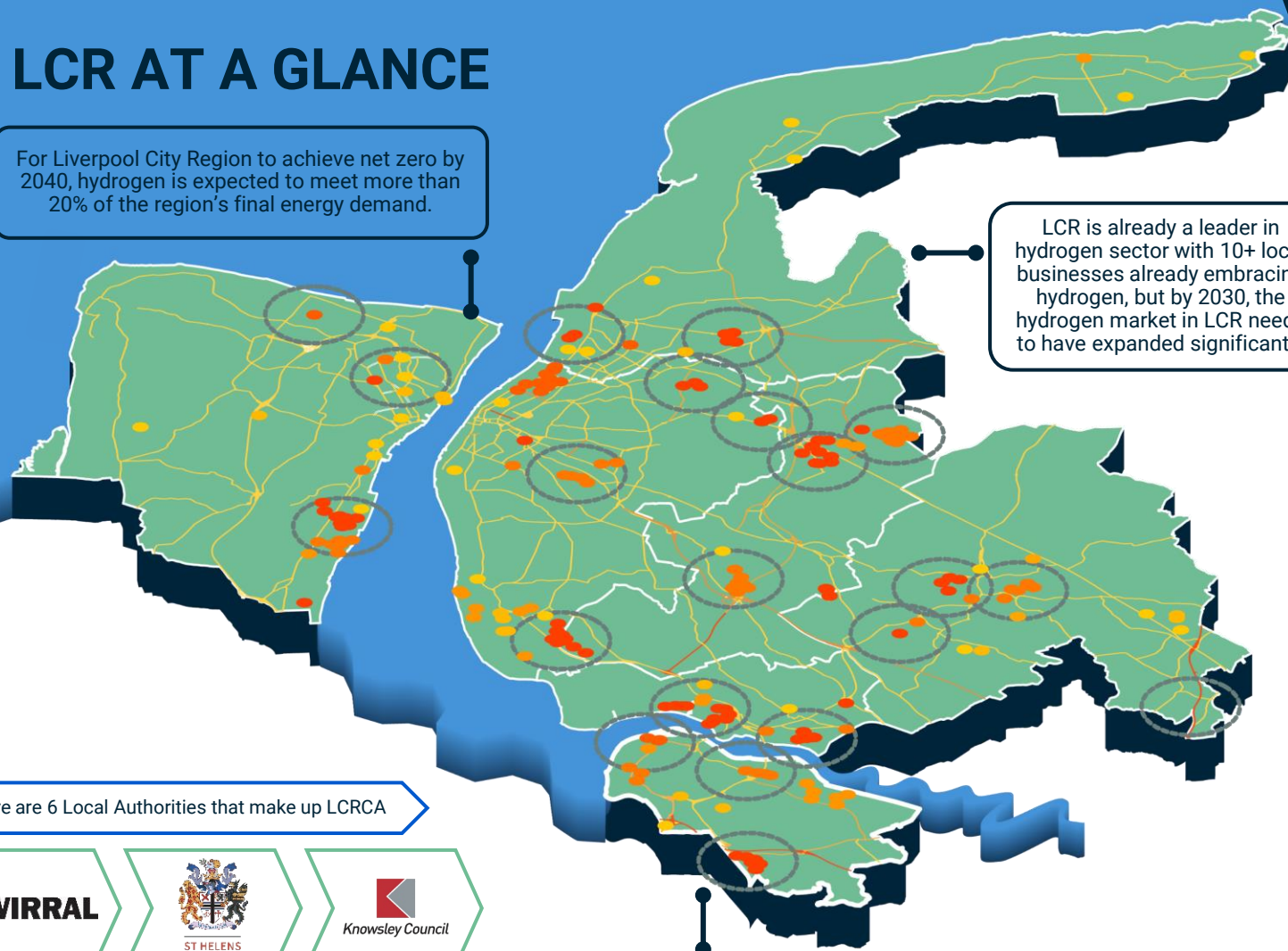
Ten Local Priorities for LCR's Hydrogen Stakeholders



LCR AT A GLANCE

For Liverpool City Region to achieve net zero by 2040, hydrogen is expected to meet more than 20% of the region's final energy demand.

LCR is already a leader in hydrogen sector with 10+ local businesses already embracing hydrogen, but by 2030, the hydrogen market in LCR needs to have expanded significantly



21 strategic sites have been identified across the city region for decentralised green hydrogen production and demand. These 'hydrogen hubs' could act as early projects to stimulate the local hydrogen market on the path to net zero

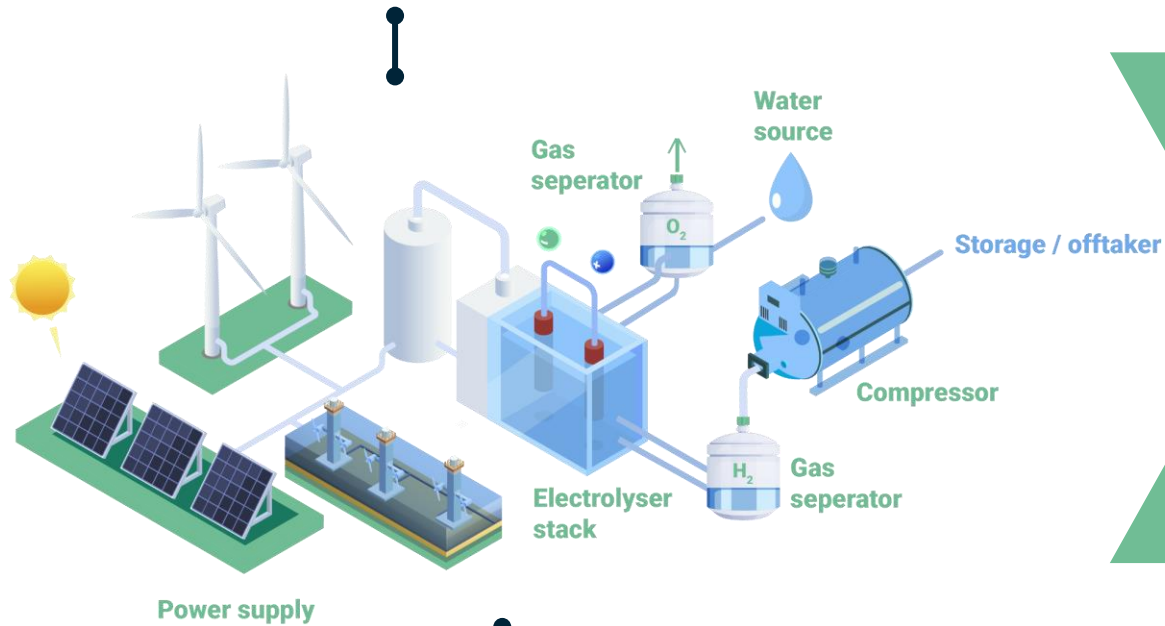
There are 6 Local Authorities that make up LCRCA

KEY 2030 LCR STATS:

- 21** Potential hydrogen hubs across LCR
- 1,048** Gigawatt hours per annum (GWh/a) of potential hydrogen demand
- 224** Megawatts (MWe) of electrolyser capacity
- 10+** Local business already embracing hydrogen
- 226,000+** Tonnes of CO₂ saved each year from 2030
- 570+** New hydrogen jobs created in LCR by 2030
- £810m+** Investment opportunity in decentralised hydrogen production and refuelling infrastructure

WHAT IS HYDROGEN?

Hydrogen is often given a colour based on its method of production. **Green hydrogen** is zero carbon hydrogen produced through electrolysis powered by renewable electricity



Although hydrogen has attracted much attention in recent years as a decarbonisation fuel, it has actually been produced and consumed in Liverpool City Region for over **125 years** as an industrial feedstock

Hydrogen is the most abundant element in the universe but on earth, it is mainly found in water (H_2O) or in hydrocarbons, such as CH_4

Hydrogen gas (H_2) can be extracted from these compounds and is currently widely used as a feedstock in the chemical industry

99% of current global H_2 production is from fossil fuels and is highly polluting, however, zero carbon H_2 can be produced from water using electrolysis

H_2 is also a chemical store of energy and can be combusted or used in a fuel cell to produce heat or electricity

As no carbon is released in this process, H_2 is a promising decarbonisation solution that is expected to meet 20 - 35% of the UK's final energy demand by 2050

LOCAL HYDROGEN PIONEERS

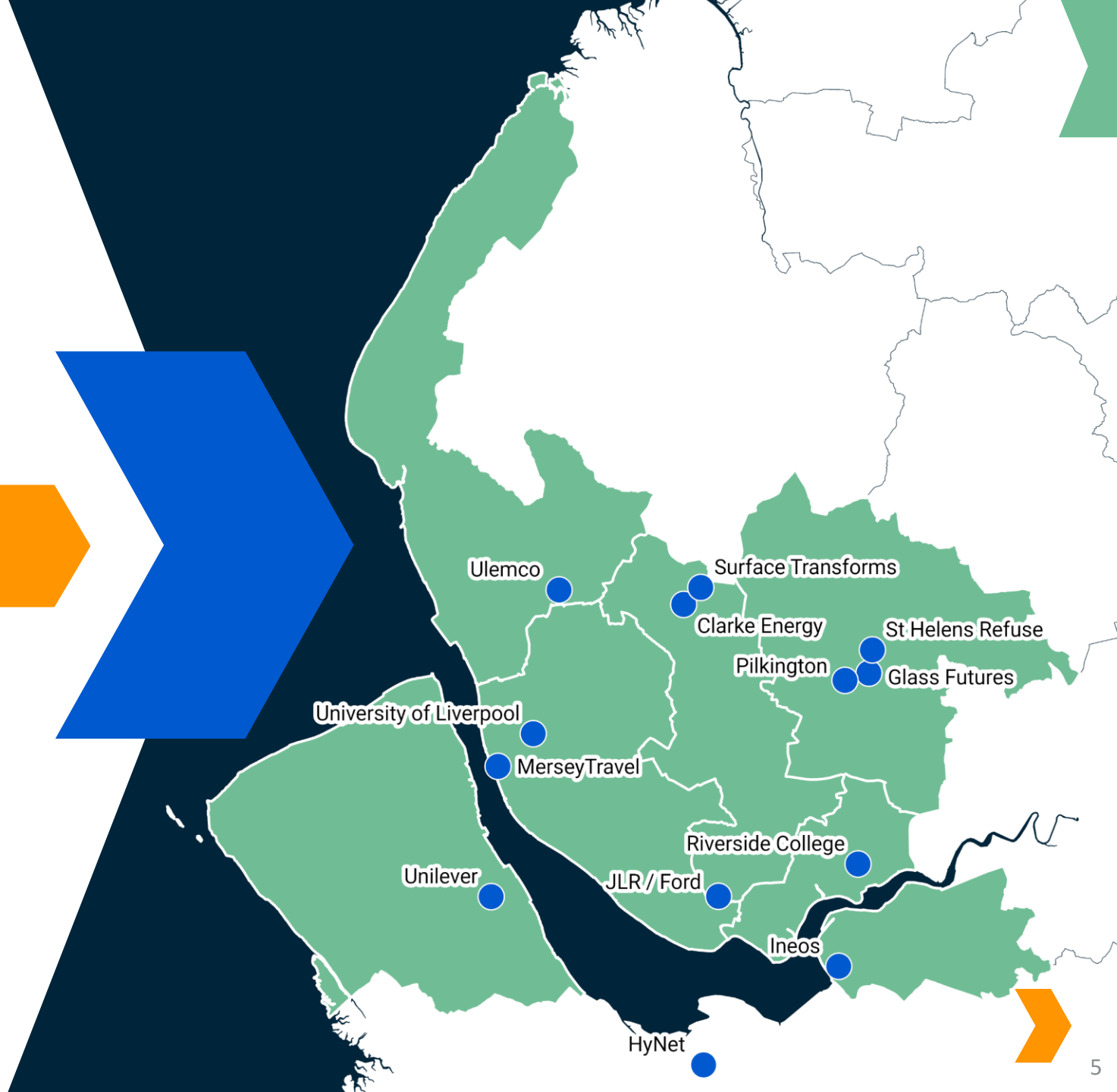
Liverpool City Region is home to many innovative organisations engaged in pioneering hydrogen activity

Many of these organisations already have a wealth of experience handling hydrogen or have made bold commitments to utilise hydrogen going forwards

No other region in the UK has such a dense cluster of advanced hydrogen knowledge and skills

The prevalence of hydrogen experience in the region is also reflected in the familiarity of the local authorities with hydrogen safety and planning regulations

This means that LCR is well placed to swiftly take advantage of the economic and environmental hydrogen opportunity



LCR GREEN HYDROGEN VISION FOCUS

No hydrogen pipelines are expected in LCR by 2030 so all hydrogen must be produced on site or delivered in tube trailers, or potentially as ammonia where it will be cracked back into hydrogen

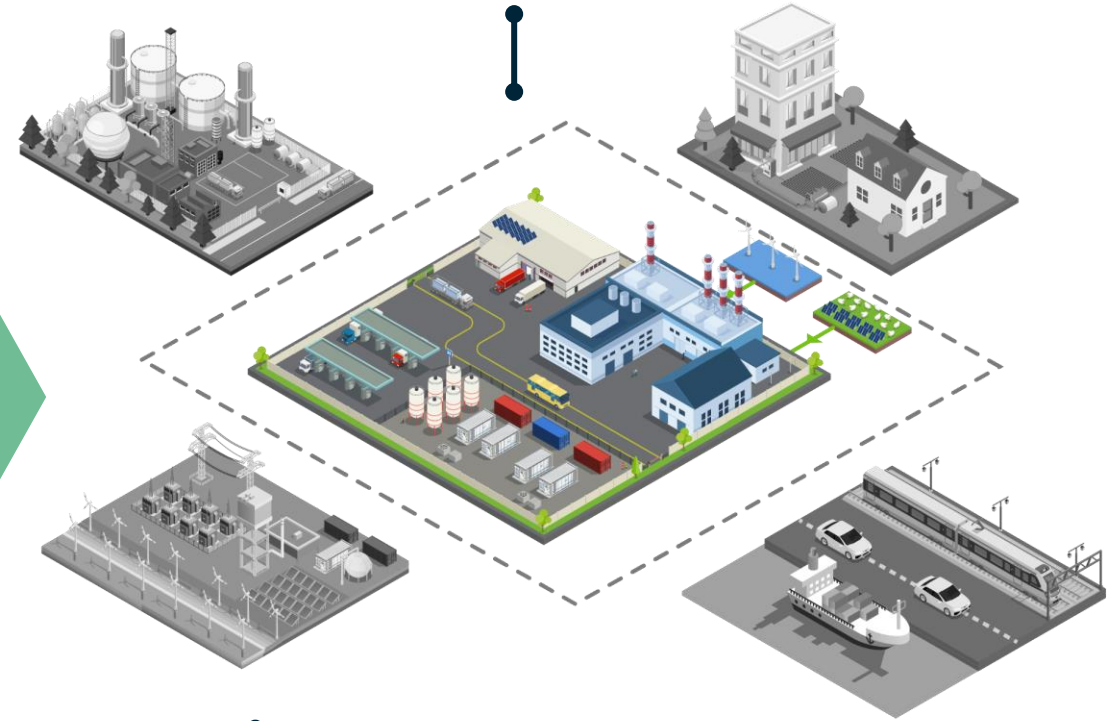
The LCR Green Hydrogen Vision is focussed on decentralised green (electrolytic) hydrogen production, although provides some commentary on the centralised piped solutions that are likely to play a major role in the region in the 2030s and beyond

This study concentrates on the use of hydrogen for high temperature heat in industrial operations, and as fuel for municipal fleets and freight & logistics, in decentralised **hydrogen hubs**

Due to the 2030 timeframe and nature of business within LCR, the use of green hydrogen in certain sectors has not been included in the study

Hydrogen will play a critical role in the excluded sectors beyond 2030 and should be a key area of innovation and development in the 2020s

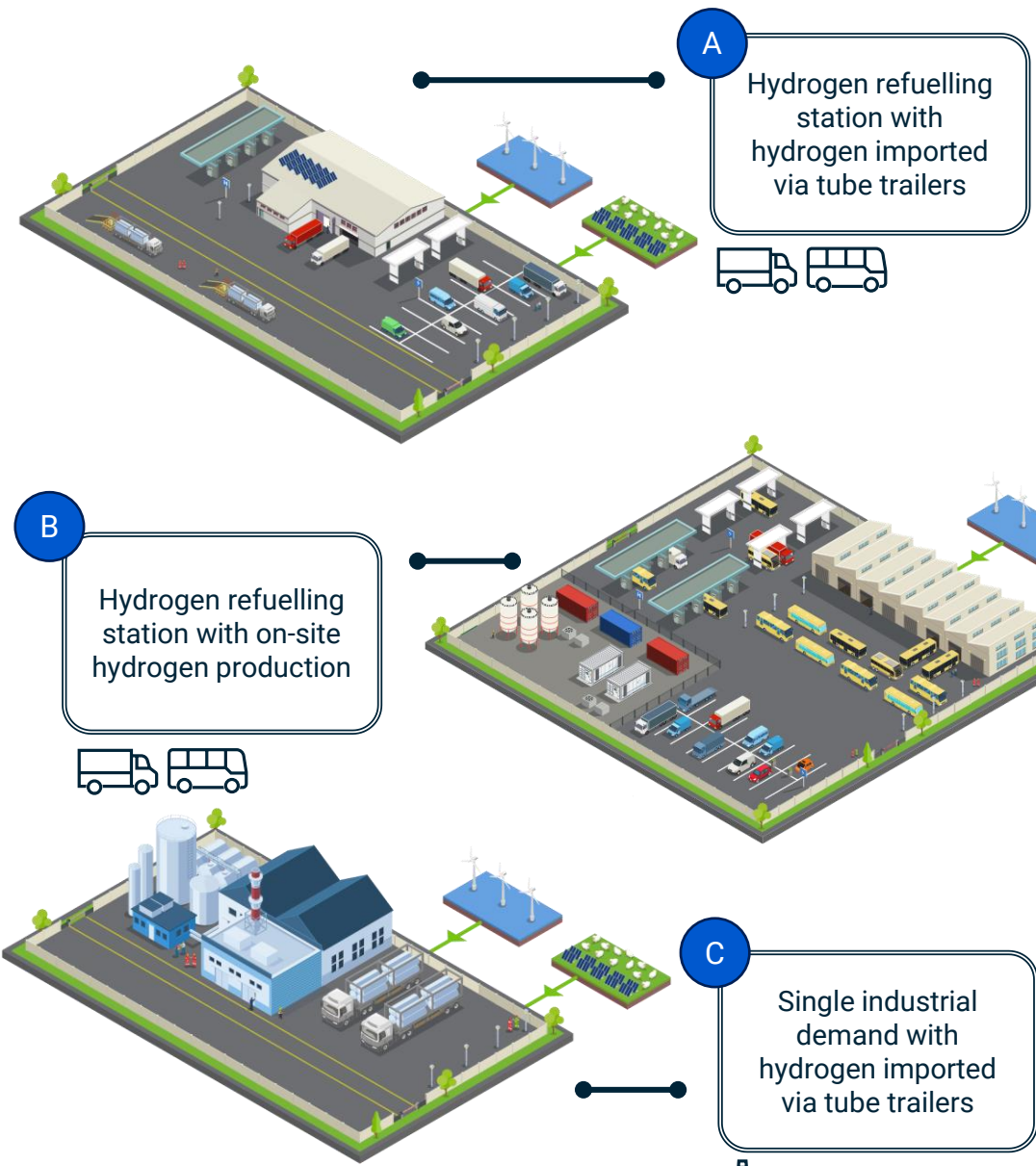
The role of hydrogen for residential and commercial heating is still to be determined by government policy, and even so, it is unlikely to play a major role before 2030 so it is not in scope of the study



Other excluded sectors include: petrochemicals, power generation, cars, and non-road transport (maritime, aviation, trains)



WHAT ARE HYDROGEN HUBS?



Hydrogen hubs are ecosystems of hydrogen production and demand and can be categorised by the nature of their demand and the location of the hydrogen production

Simple hubs consist of one demand type (industry or mobility) and are likely to be the earliest projects

Complex hubs involve multiple hydrogen demands and are likely to involve shared infrastructure

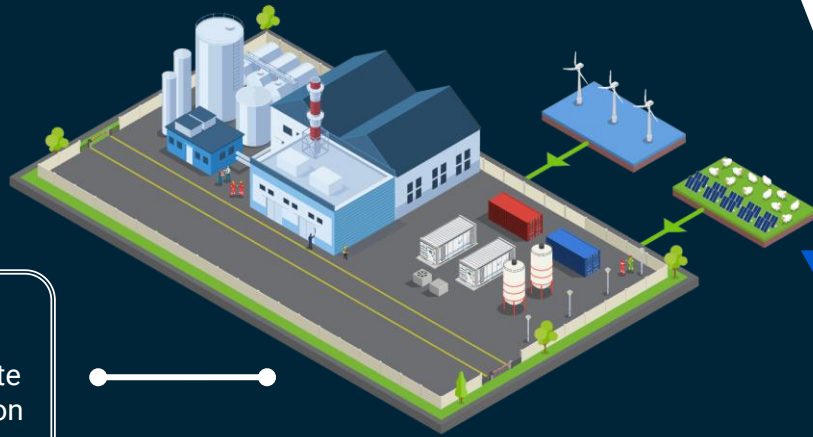
Hubs are expected to increase in complexity over time as additional consumers integrate to the hubs

As national hydrogen infrastructure develops these hubs could connect to pipelines and become prosumers

HYDROGEN HUBS

D

Single industrial demand with on-site hydrogen production



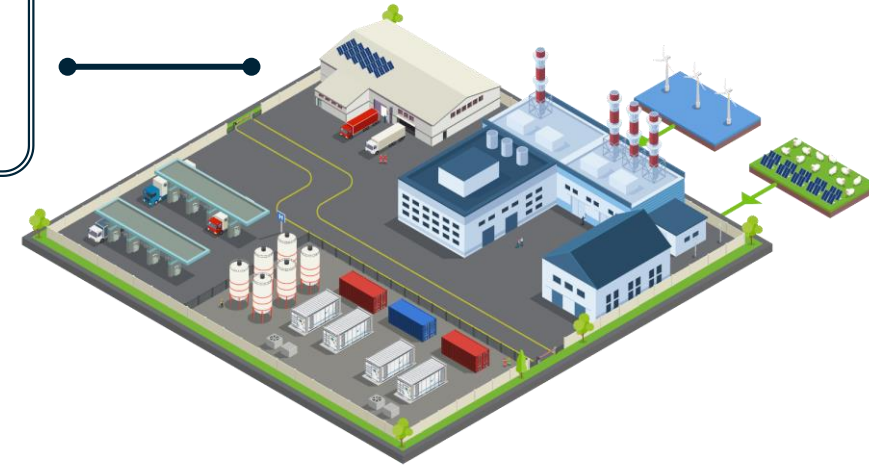
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Multiple industrial sites with on-site hydrogen production



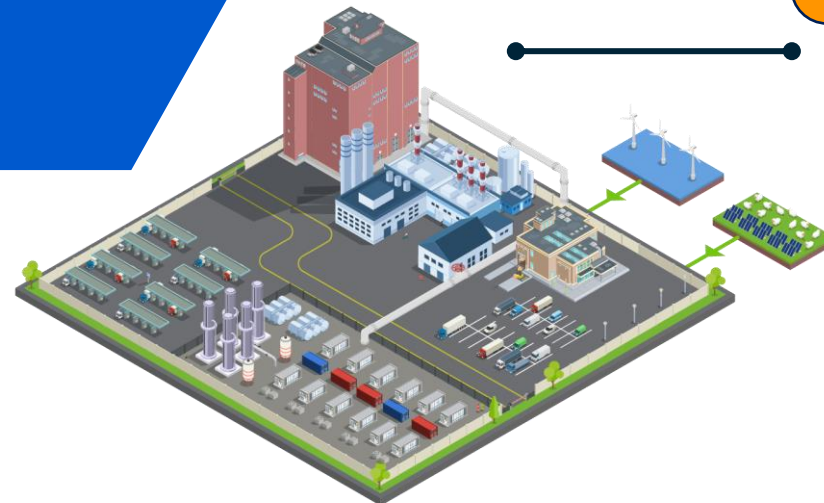
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Hydrogen refuelling station and single industrial demand with on-site production



G

Hydrogen refuelling station and multiple industrial demands with on-site production



HYDROGEN POTENTIAL IN LCR

The potential for hydrogen use across LCR is a function of the current fossil fuel use and future economic activity within the region

The hydrogen forecast developed in this section is calibrated against a 2021 baseline for natural gas and petroleum consumption within industrial operations, municipal fleets and freight & logistics

Each of these sectors and sub-sectors have been assigned a decarbonisation pathway based on national future energy scenarios which have been adjusted to capture the influence of local policy

These scenarios were further refined by incorporating feedback from local businesses around their expected decarbonisation plans to 2030 and beyond

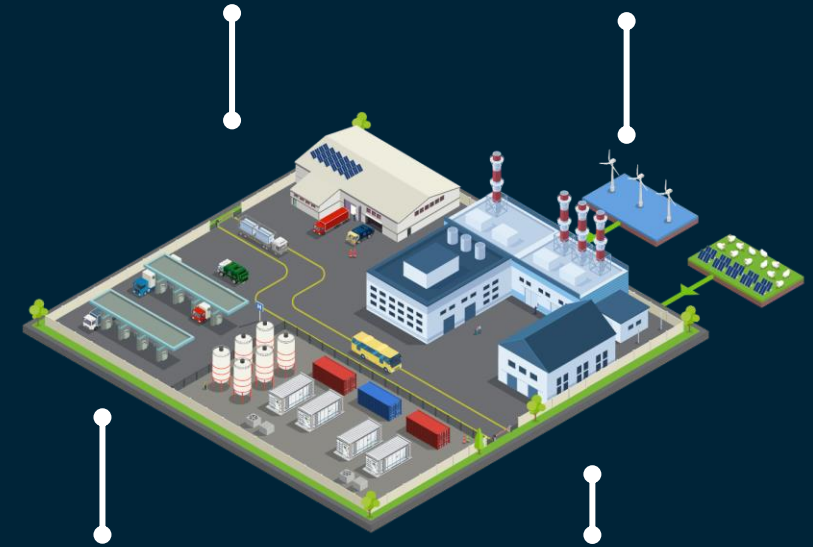
The hydrogen potential outlined in this section demonstrates the significance of the changing energy landscape in LCR and the size of the challenge to achieve net zero by 2040

Municipal Fleets

Buses and refuse vehicles could reach net zero by being electrified or converted to hydrogen, depending on their fuel duty cycle, operating conditions and depot locations

Industrial Operations

The natural gas currently consumed by industry could be electrified, replaced with biofuels or converted to hydrogen, depending on the industrial processes



Freight & Logistics

Heavy Goods Vehicles could be electrified or converted to hydrogen, depending on their payload, distance travelled and operating schedule

Different users are likely to require different solutions and decarbonisation decisions will be based on the technical and economic feasibility of each option, as well as the availability and accessibility of infrastructure

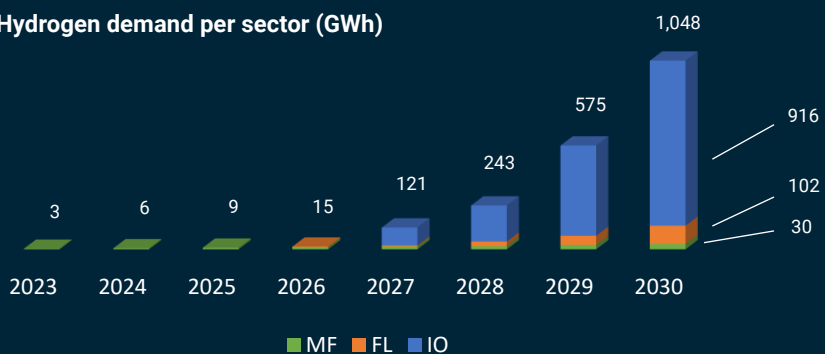
HYDROGEN ADOPTION SCENARIOS

The methodology behind the hydrogen adoption scenarios for each sector is summarised in the full LCR Green Hydrogen Vision Report

These scenarios identified 1,048 GWh of high potential hydrogen production and demand by 2030

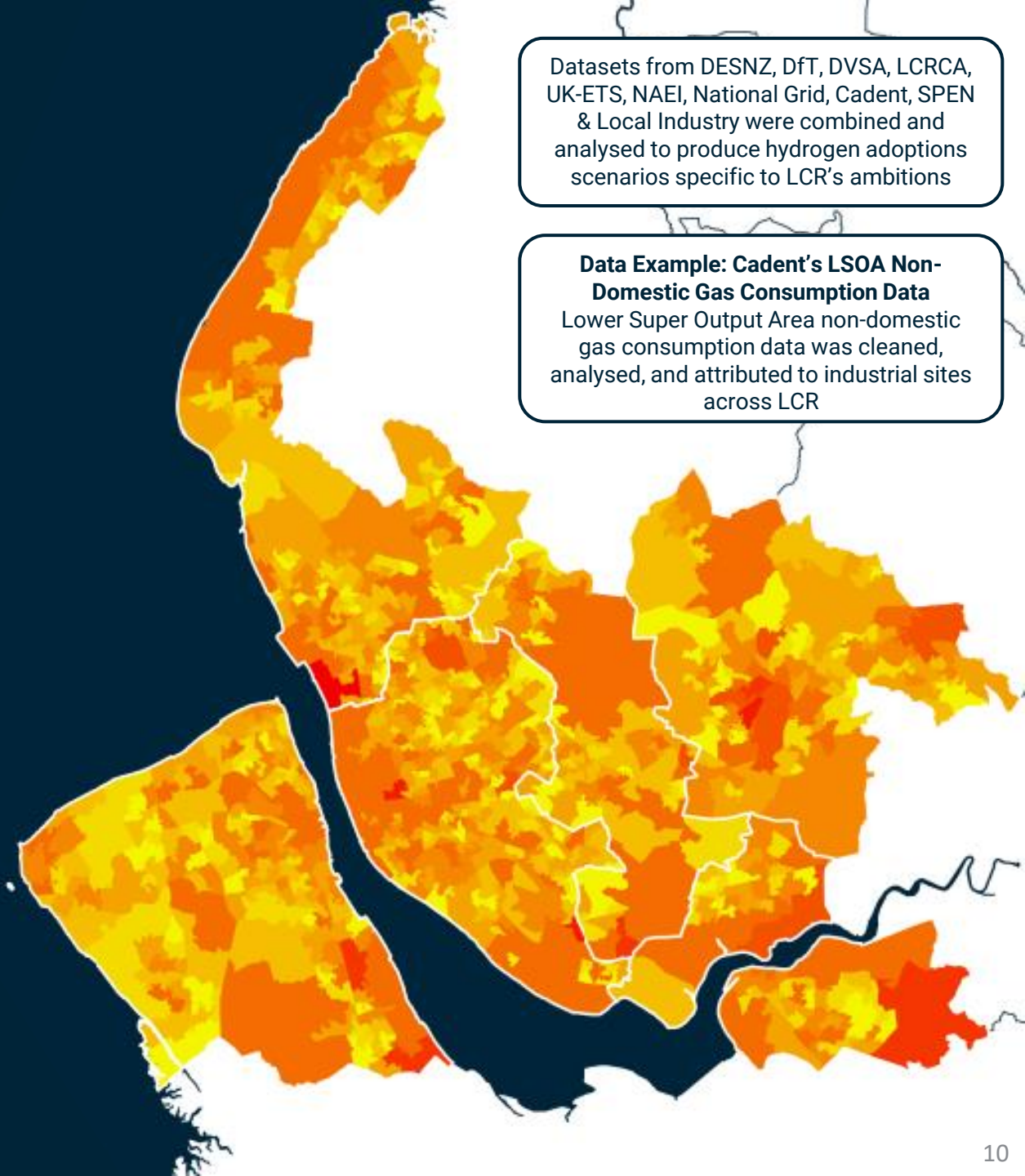
It is expected that the majority of the production will emerge from 2026 in-line with the UK Government's annual Hydrogen Allocation Rounds

Hydrogen demand per sector (GWh)



Datasets from DESNZ, DfT, DVSA, LCRCA, UK-ETS, NAEI, National Grid, Cadent, SPEN & Local Industry were combined and analysed to produce hydrogen adoptions scenarios specific to LCR's ambitions

Data Example: Cadent's LSOA Non-Domestic Gas Consumption Data
Lower Super Output Area non-domestic gas consumption data was cleaned, analysed, and attributed to industrial sites across LCR



HYDROGEN DEMAND CLUSTERS

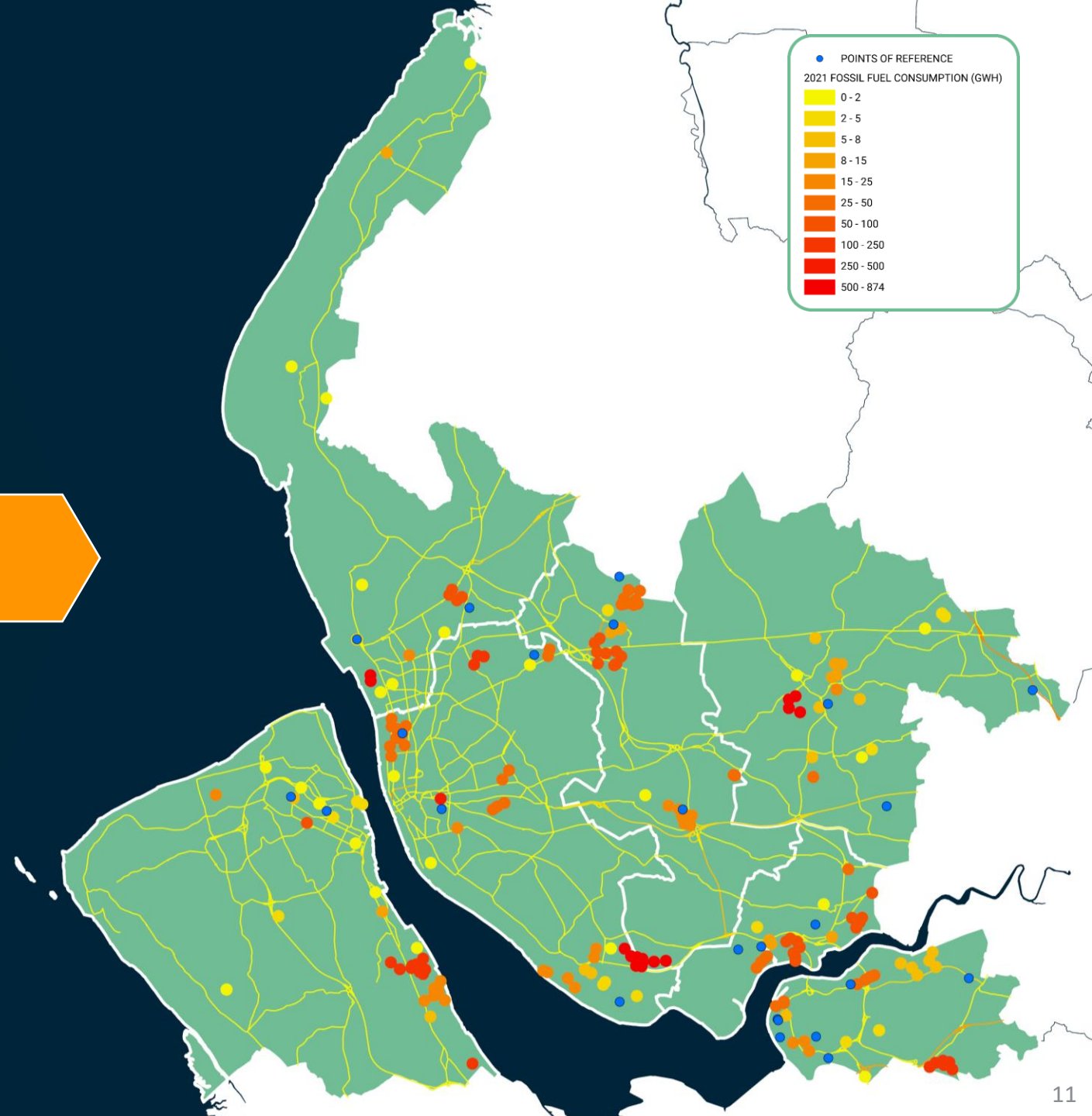
Individual point demands can be clustered if they are located within reasonable proximity of each other

If a site was part of a cluster, then the hydrogen demand from each site was summated to show an overall demand for that cluster

These clustered demands could be serviced by shared hydrogen infrastructure, reducing the cost of hydrogen production

The data on the map adjacent shows the aggregated demand for sites that are joined together as a cluster. Clusters with high demand are shown in red.

These clusters of demand represent potential hydrogen hubs that could be developed and are explored in more detail in the Projects section of the report



POTENTIAL PROJECTS

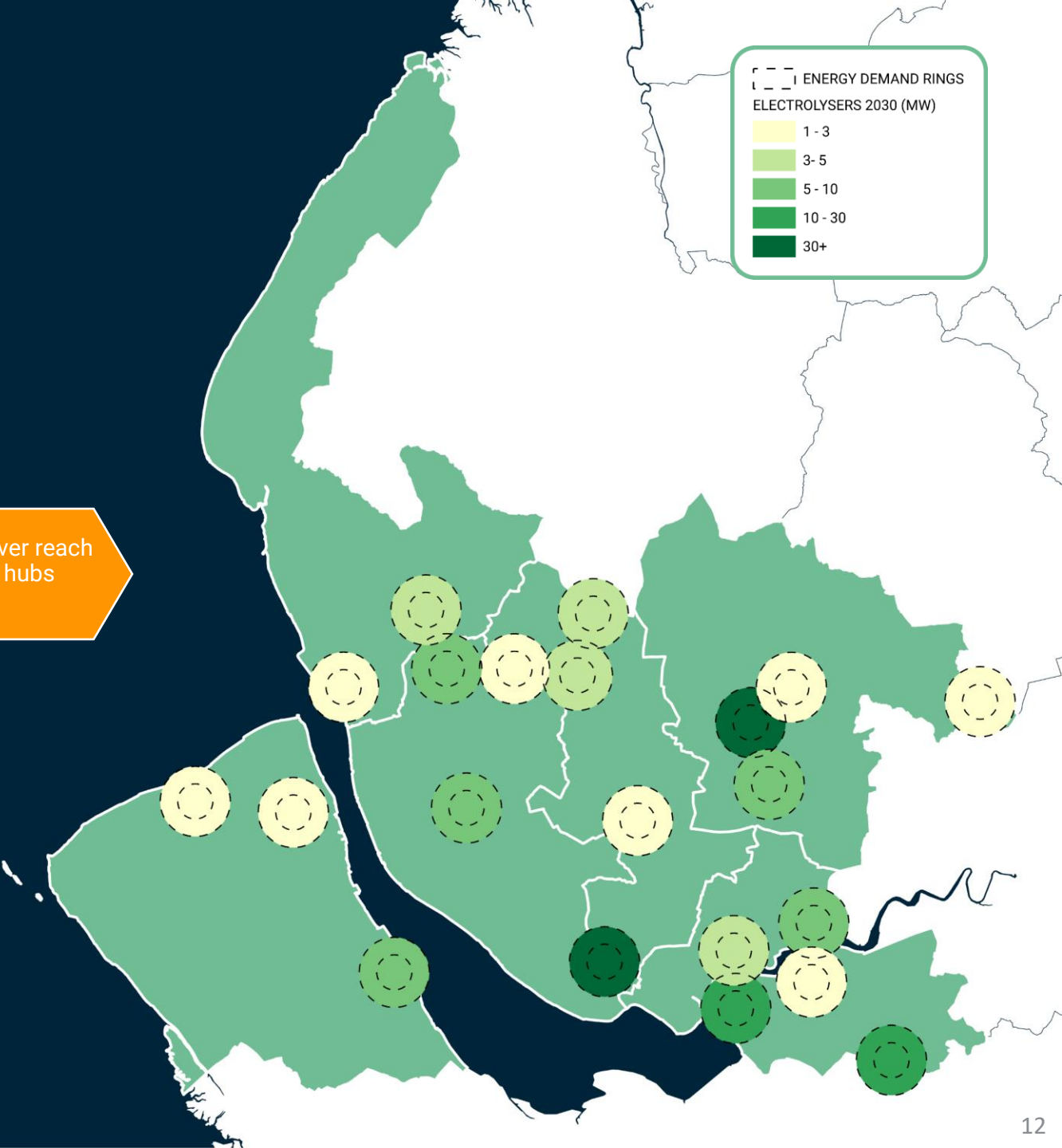
21 potential hydrogen hubs have been identified across LCR, with at least 2 in each Local Authority area.

Existing fossil fuel demand at these hubs was converted into a maximum net zero hydrogen demand. Within this upper limit, a net zero hydrogen demand was calculated based on the specific characteristics of the hub

Some hubs could reach their net zero hydrogen demand by 2030, while others may never reach this threshold. It is expected that there will be a phased approach to development and hubs may grow in size and complexity over time

The potential for each project should be assessed in isolation and the summation of all hubs should be viewed as a maximum potential for the region

The following slides summarise the most significant hubs in each Local Authority and information on all the hubs across LCR can be found in the main report



HALTON IN 2030



LOCAL AUTHORITY AREA TOTAL

Up to **£213m** investment

58.5MWe electrolyser

292GWh/a hydrogen demand

60,500 tonnes/a CO_{2e} avoided

5 potential hubs

150 new jobs

HUB 1: 3MG

£20m - £25m investment

5MWe electrolyser

20GWh/a hydrogen demand

5,500 tonnes/a CO_{2e} avoided

Key customers: logistics fleet

HUB 2: RUNCORN

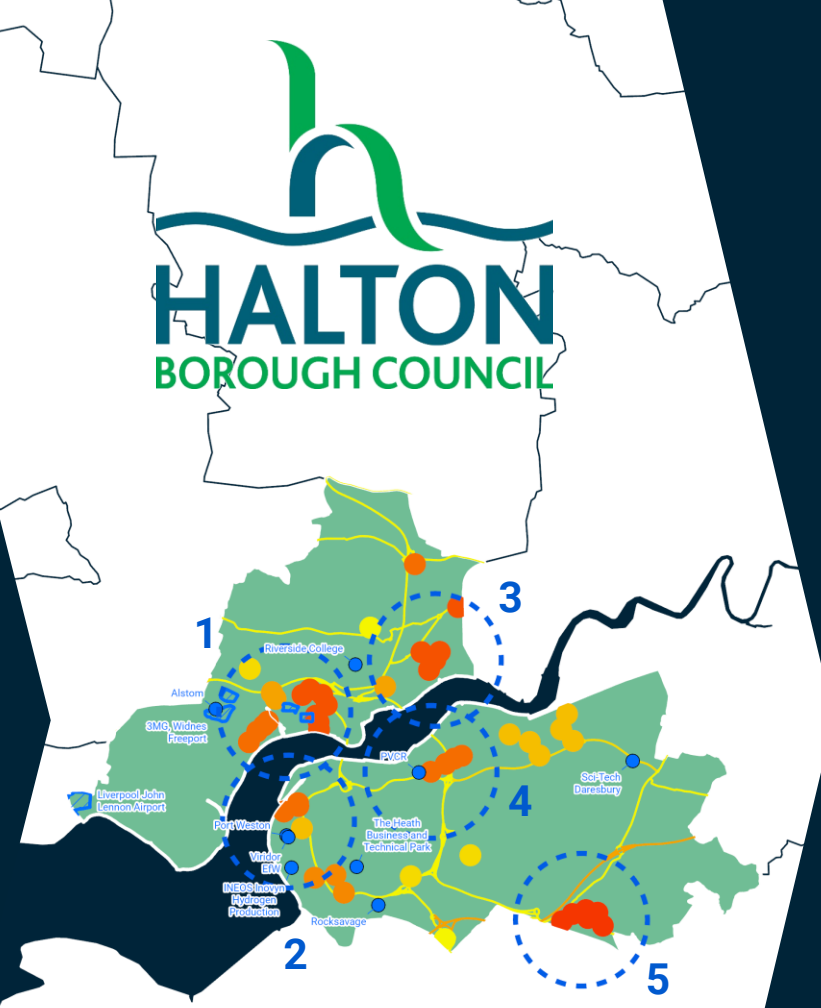
£70m - £100m investment

30MWe electrolyser

165GWh/a hydrogen demand

33,000 tonnes/a CO_{2e} avoided

Key customers: INEOS, local logistics and waste vehicles



HUB 3: WIDNES

£20m - £30m investment

7.5MWe electrolyser

35GWh/a hydrogen demand

7,000 tonnes/a CO_{2e} avoided

Key customers: Emerald Kalama

HUB 4: ASTMOOR

£1.5m - £2.5m investment

2MWe tube trailer import

8GWh/a hydrogen demand

2,000 tonnes/a CO_{2e} avoided

Key customers: logistics fleets

HUB 5: PRESTON BROOK

£35m - £55m investment

14MWe electrolyser

64GWh/a hydrogen demand

13,000 tonnes/a CO_{2e} avoided

Key customers: Diageo, DHL, Saint-Gobain, Teva



2030 Investment

£70m - £100m

RUNCORN



2030

2040

30MWe electrolyser

Possible HyNet connection

165GWh/a hydrogen demand

>1,000GWh/a hydrogen demand

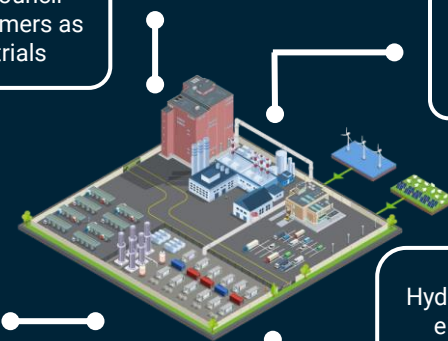
33,000 tonnes/a CO_{2e} avoided

>200,000 tonnes/a CO_{2e} avoided

Low carbon hydrogen production at INEOS has the potential to be expanded significantly for on-site demand and export to local mobility users. One of these could be a new refuelling station at Viridor's Energy from Waste facility. A separate development is also possible at Port Weston. By 2040, there is potential to combine with the HyNet pipeline and the HySecure project.

Local mobility such as Hoyer and Halton Borough Council could be potential customers as well as nearby industrials

Viridor EfW plant could provide power input to a hub and its waste vehicles act as customers



In addition to byproduct hydrogen from chemical processes, INEOS have alkaline water electrolysis that is likely to scale up over the remainder of the decade

Hydrogen produced is likely to either be used for on-site consumption in boilers at INEOS or compressed for refuelling local mobility

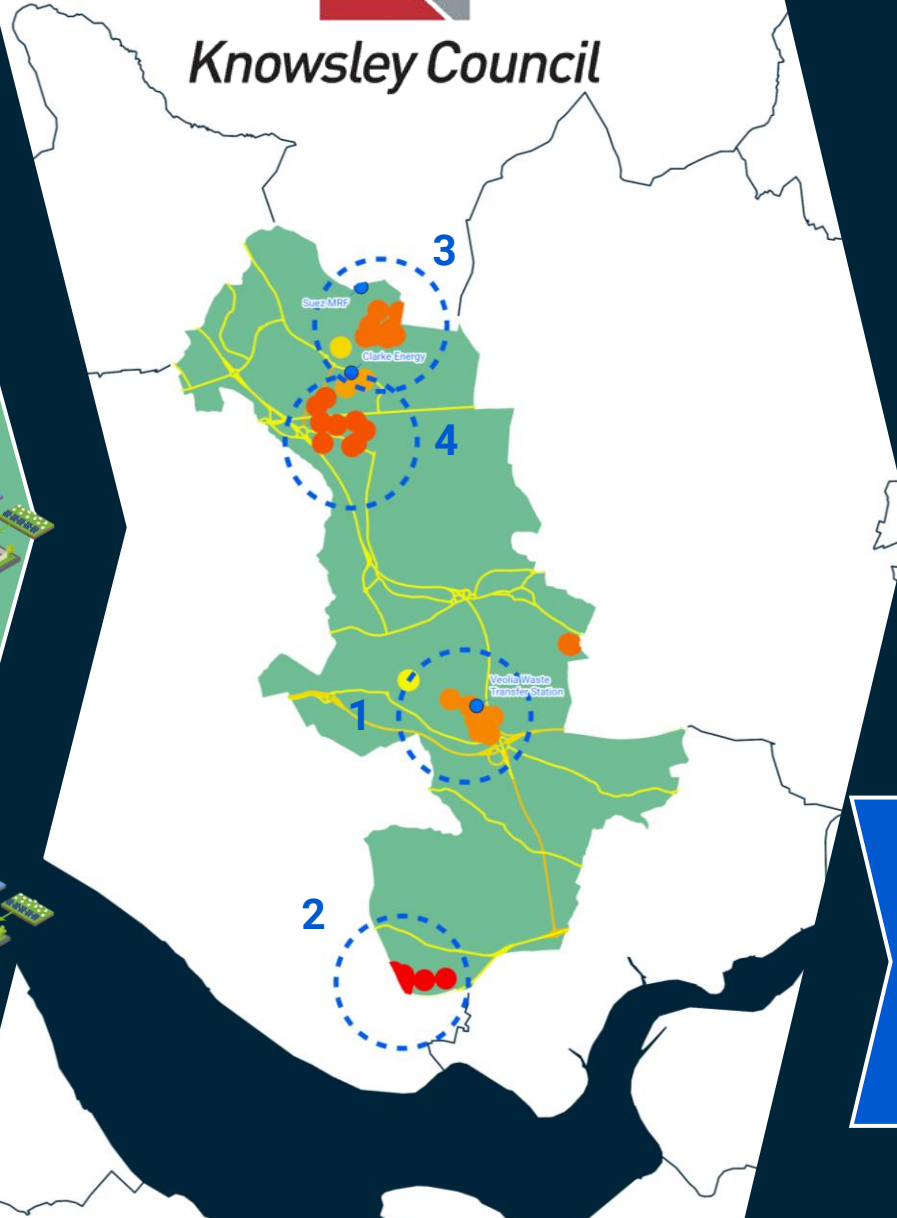
More than 5TWh/a of potential demand at Rocksavage Power Station but very unlikely to convert to hydrogen before 2030.



KNOWSLEY IN 2030



Knowsley Council



LOCAL AUTHORITY AREA TOTAL Up to £163m investment

47MWe electrolyser → 214.5GWh/a hydrogen demand → 45,000 tonnes/a CO_{2e} avoided

4 potential hubs 115 new jobs

HUB 1: HUYTON £1.5m - £2.5m investment

2MWe tube trailer import → 9GWh/a hydrogen demand → 2,200 tonnes/a CO_{2e} avoided

Key customers: logistics fleet

HUB 2: SPEKE / HALEWOOD* £150m - £220m investment

70MWe electrolyser → 323GWh/a hydrogen demand → 66,000 tonnes/a CO_{2e} avoided

Key customers: automotive, pharmaceuticals and mobility

*hub shared with Liverpool – 50% of metrics allocated to each LA total

HUB 3: KNOWSLEY BUSINESS PARK NORTH £15m - £25m investment

5MWe electrolyser → 22GWh/a hydrogen demand → 5,100 tonnes/a CO_{2e} avoided

Key customers: waste vehicles



HUB 4: KNOWSLEY BUSINESS PARK SOUTH £15m - £25m investment

5MWe electrolyser → 22GWh/a hydrogen demand → 4,700 tonnes/a CO_{2e} avoided

Key customers: Eurovast, Saputo Dairy, or Newsprinters + mobility



CLARKE ENERGY

Globally renowned supplier and operator of hydrogen CHPs

SURFACE TRANSFORMS

Manufacturer of carbon ceramic brakes producing hydrogen as a byproduct



KNOWSLEY BUSINESS PARK NORTH

2030 Investment
£15m - £25m



5MWe electrolyser

10MWe electrolyser

22GWh/a hydrogen demand

45GWh/a hydrogen demand

5,100 tonnes/a CO_{2e} avoided

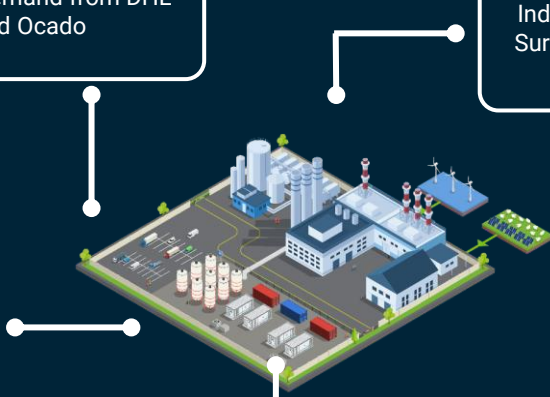
10,000 tonnes/a CO_{2e} avoided

Opportunity for Baker Hughes, Surface Transforms and the refuse vehicles at Suez MRF to provide the initial anchor demand. Then potential to expand and serve wider business park users

Mobility demand from DHL and Ocado

Industry: Baker Hughes, Surface Transforms and Ames Goldsmith

Suez MRF is a key destination for refuse vehicles in LCR. Strategic location for refuse refuelling development



Wider business park could be connected to production hub or Knowsley South Infrastructure

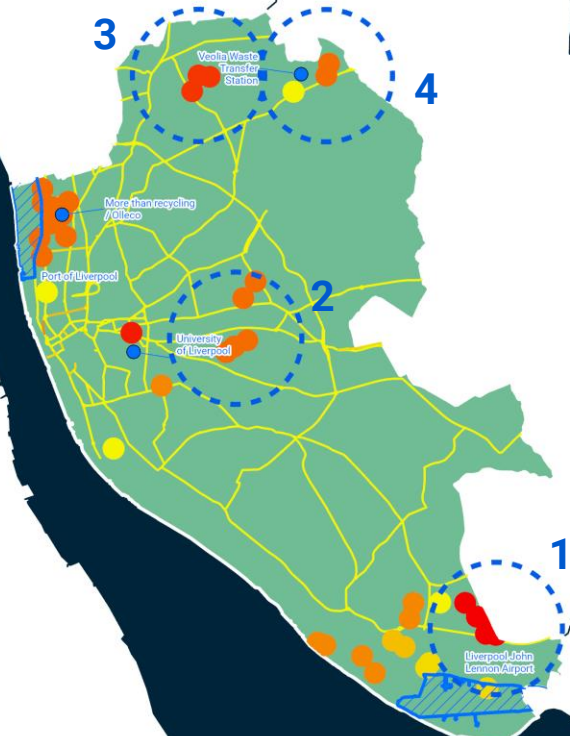


Knowsley Business Park South Hub

LIVERPOOL IN 2030



Liverpool City Council



LOCAL AUTHORITY AREA TOTAL

Up to **£195m** investment

53.5MWe electrolyser

245.5GWh/a hydrogen demand

50,900 tonnes/a CO_{2e} avoided

4 potential hubs

137 new jobs

HUB 1: SPEKE / HALEWOOD*

£150m - £220m investment

70MWe electrolyser

323GWh/a hydrogen demand

66,000 tonnes/a CO_{2e} avoided

Key customers: automotive, pharmaceuticals and mobility

UNIVERSITY OF LIVERPOOL

Centre of excellence for hydrogen research

HUB 2: WAVERTREE

£20m - £35m investment

7.5MWe electrolyser

35GWh/a hydrogen demand

7,300 tonnes/a CO_{2e} avoided

Key customers: food manufacturers and local buses

HUB 3: AINTREE

£25m - £35m investment

8MWe electrolyser

36GWh/a hydrogen demand

7,100 tonnes/a CO_{2e} avoided

Key customers: The Jacob's Bakery

HUB 4: GILMOSS

£2m - £15m investment

3MWe electrolyser or tube trailer

13GWh/a hydrogen demand

3,500 tonnes/a CO_{2e} avoided

Key customers: buses and other logistics demand

*hub shared with Knowsley – 50% of metrics allocated to each LA total

2030 Investment
£150m - £220m

SPEKE / HALEWOOD



2030

2040

70MWe electrolyser

Possible HyNet Connection

323GWh/a hydrogen demand

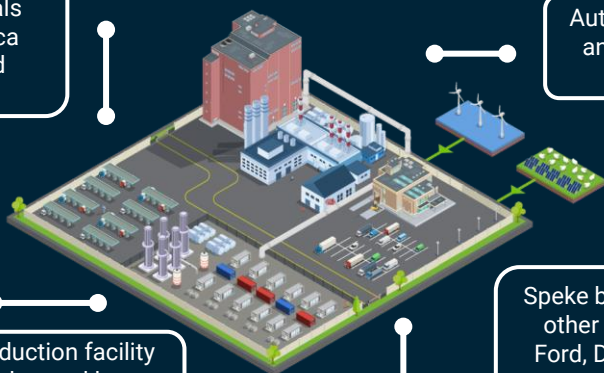
473GWh/a hydrogen demand

66,000 tonnes/a CO_{2e} avoided

95,000 tonnes/a CO_{2e} avoided

A large multi-use hub that would be developed out in phases. On-site hydrogen production likely to be constrained by electrical import capacity rather than demand so 70MWe is ambitious. HyNet connection possible in 2030s.

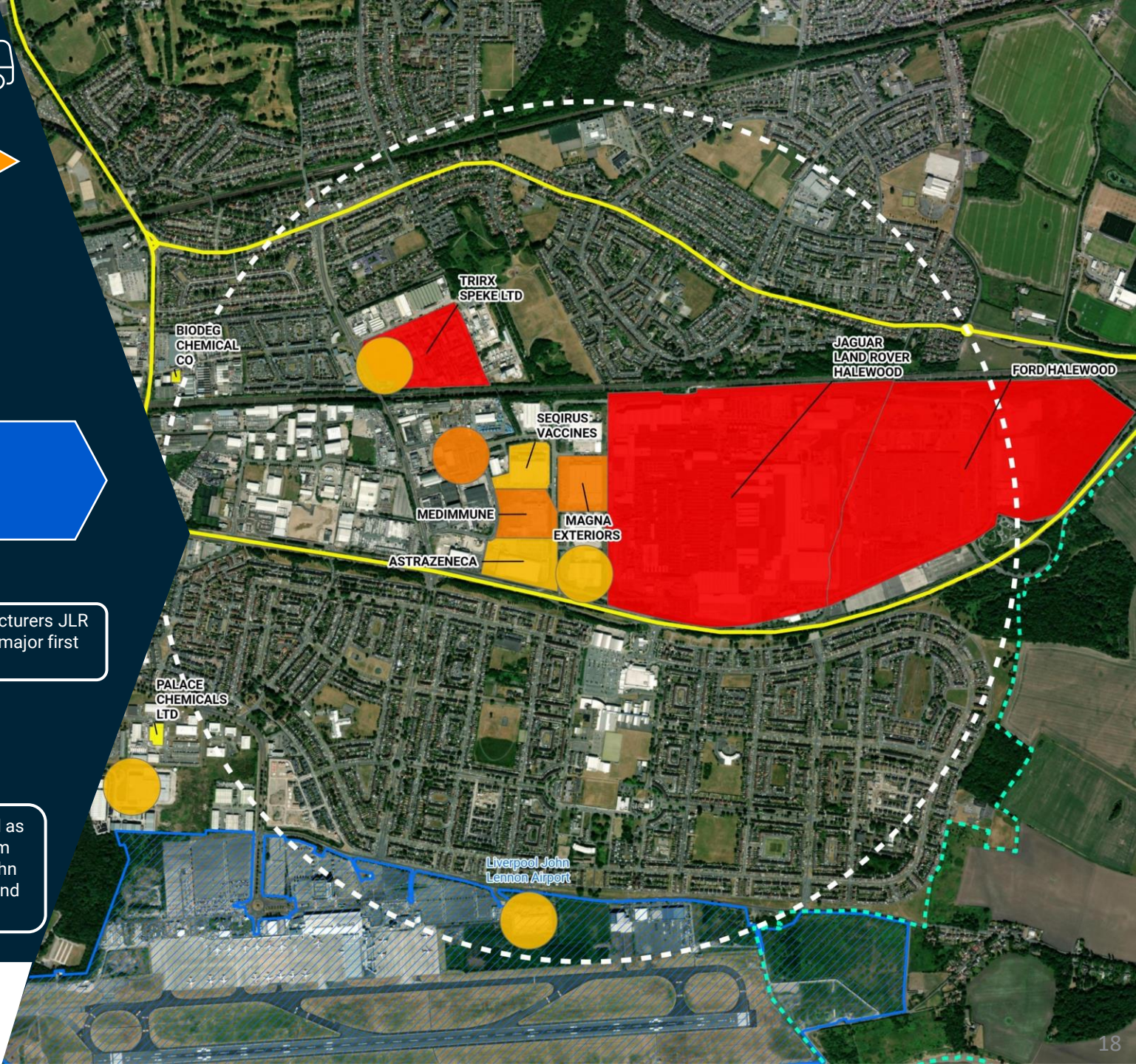
Also potential demand at pharmaceuticals TriRx, AstraZeneca and Seqirus and Medimmune



Automotive manufacturers JLR and Ford could be major first movers

A large on-site production facility could meet some demand but a piped connection from HyNet is more likely by 2040

Speke bus depot, as well as other F&L demand from Ford, DHL, Liverpool John Lennon Airport, Fedex and Biffa



SEFTON IN 2030

LOCAL AUTHORITY AREA TOTAL

Up to £35m investment


7MWe electrolyser

33GWh/a hydrogen demand

8,200 tonnes/a CO_{2e} avoided

2 potential hubs

25 new jobs



HUB 1: PORT OF LIVERPOOL


£2m - £15m investment

3MWe electrolyser or tube trailer

15GWh/a hydrogen demand

3,800 tonnes/a CO_{2e} avoided


Key customers: port equipment and freight demand



OTHER SITES OF INTEREST:

Port of Liverpool

Growth opportunity for the port region through decarbonised freight operations, future ammonia imports and maritime decarbonisation




HUB 2: SWITCH ISLAND


£15m - £20m investment

4MWe electrolyser

18GWh/a hydrogen demand

4,400 tonnes/a CO_{2e} avoided

Key customers: Allied Bakeries and mobility



OTHER SITES OF INTEREST:

Health and Safety Executive
Headquartered in Bootle. Key institution in ensuring the safety of the hydrogen economy



ULEMCO

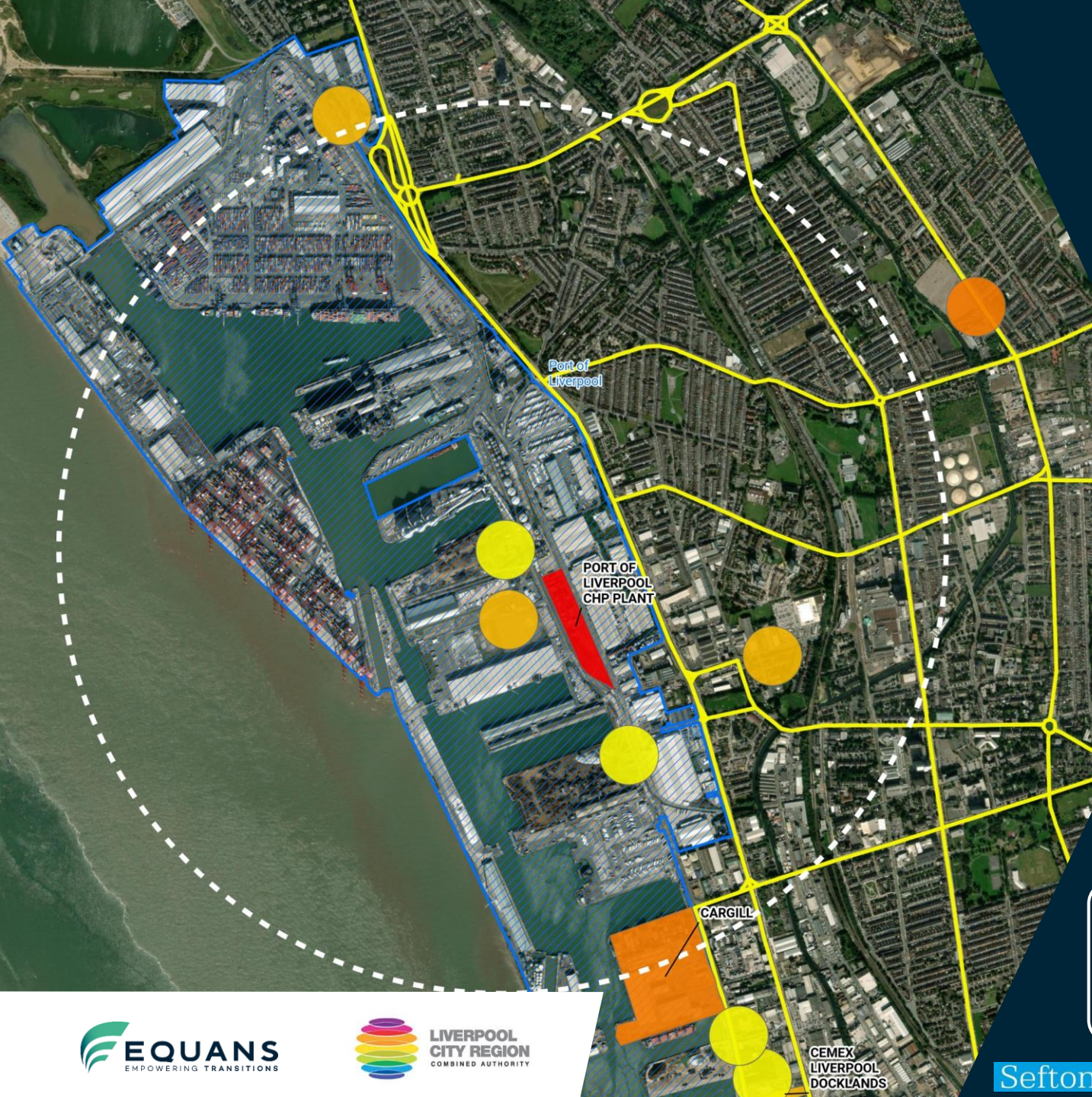
Provider of hydrogen mobility solutions in the UK for over a decade





PORT OF LIVERPOOL

2030 Investment
£2m - £15m



3MWe electrolyser or tube trailer

Potential HyNet Connection

15GWh/a hydrogen demand

>500GWh/a hydrogen demand

3,800 tonnes/a CO_{2e} avoided

>100,000 tonnes/a CO_{2e} avoided

Initial development services freight demand at the port. By 2040, there could be major potential demand from Port of Liverpool CHP and maritime applications/export, but both would require a HyNet connection to be viable

Port vehicles, such as tugs, could be a key early customer

There are significant numbers of mobility users such as Bootle Bus Depot, Maritime Transport, Abbey Logistics, Mark Thompson, McBurney, United Utilities, DX Networks, Olleco, EMR and Turners



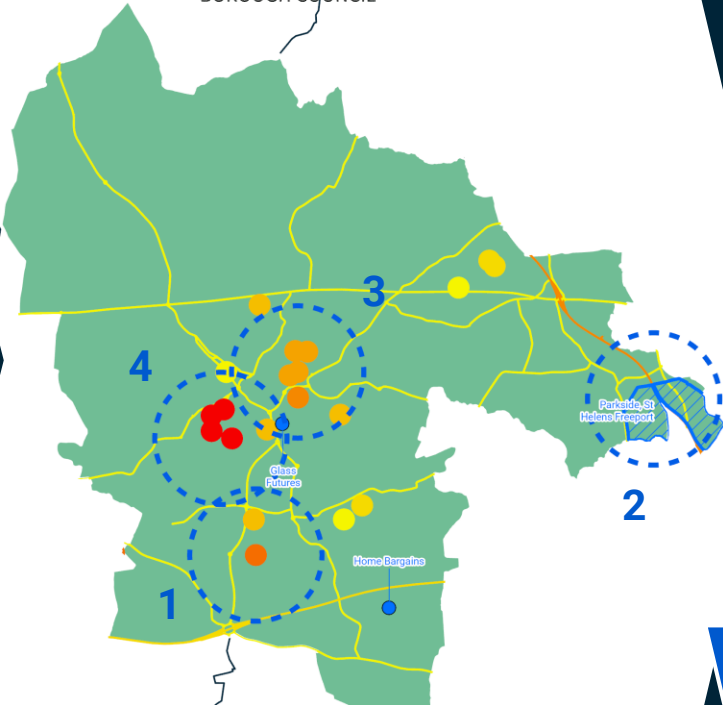
Demand from industry unlikely to feature directly as CHP powers heat network which is unlikely to run on dedicated electrolytic hydrogen

There is potential for significant maritime demand to develop in 2030s and 2040s, especially as ammonia import becomes available

ST HELENS IN 2030



ST HELENS
BOROUGH COUNCIL



LOCAL AUTHORITY AREA TOTAL

Up to **£158m** investment

43.5MWe electrolyser

198GWh/a hydrogen demand

47,600 tonnes/a CO_{2e} avoided

4 potential hubs

110 new jobs

HUB 1: LEA GREEN

£20m - £35m investment

7.5MWe electrolyser

35GWh/a hydrogen demand

7,000 tonnes/a CO_{2e} avoided

Key customers: Nippon Glass and mobility

HUB 2: PARKSIDE

£12m - £20m investment

3MWe electrolyser

15GWh/a hydrogen demand

3,800 tonnes/a CO_{2e} avoided

Key customers: no current demand but forecast to be mostly logistics

HUB 3: ST HELENS NORTH

£1.5m - £2.5m investment

1MWe tube trailer import

3GWh/a hydrogen demand

800 tonnes/a CO_{2e} avoided

Key customers: local buses and municipal fleet and other mobility

HUB 4: ST HELENS SOUTH

£75m - £100m investment

32MWe electrolyser

145GWh/a hydrogen demand

36,000 tonnes/a CO_{2e} avoided

Key customers: Pilkington and Nijman Zeetank

GLASS MANUFACTURING

St Helens is home to major glass manufacturer Pilkington who are in embracing hydrogen, and Glass Futures who support innovation in this field

ST HELENS H₂ REFUSE TRUCK

St Helens Borough Council were one of the first Local Authorities in the country to purchase a hydrogen powered waste vehicle

2030 Investment
£75m - £100m

ST HELENS SOUTH



2030

2040

32MWe electrolyser

Possible HyNet Connection

145GWh/a hydrogen demand

310GWh/a hydrogen demand

36,000 tonnes/a CO_{2e} avoided

62,000 tonnes/a CO_{2e} avoided

Potential for 32MW project at Pilkington Greengate, with refuelling infrastructure, by 2030. However, electrical import capacity, space and potential HyNet connection in 2030s may limit development on-site hydrogen production

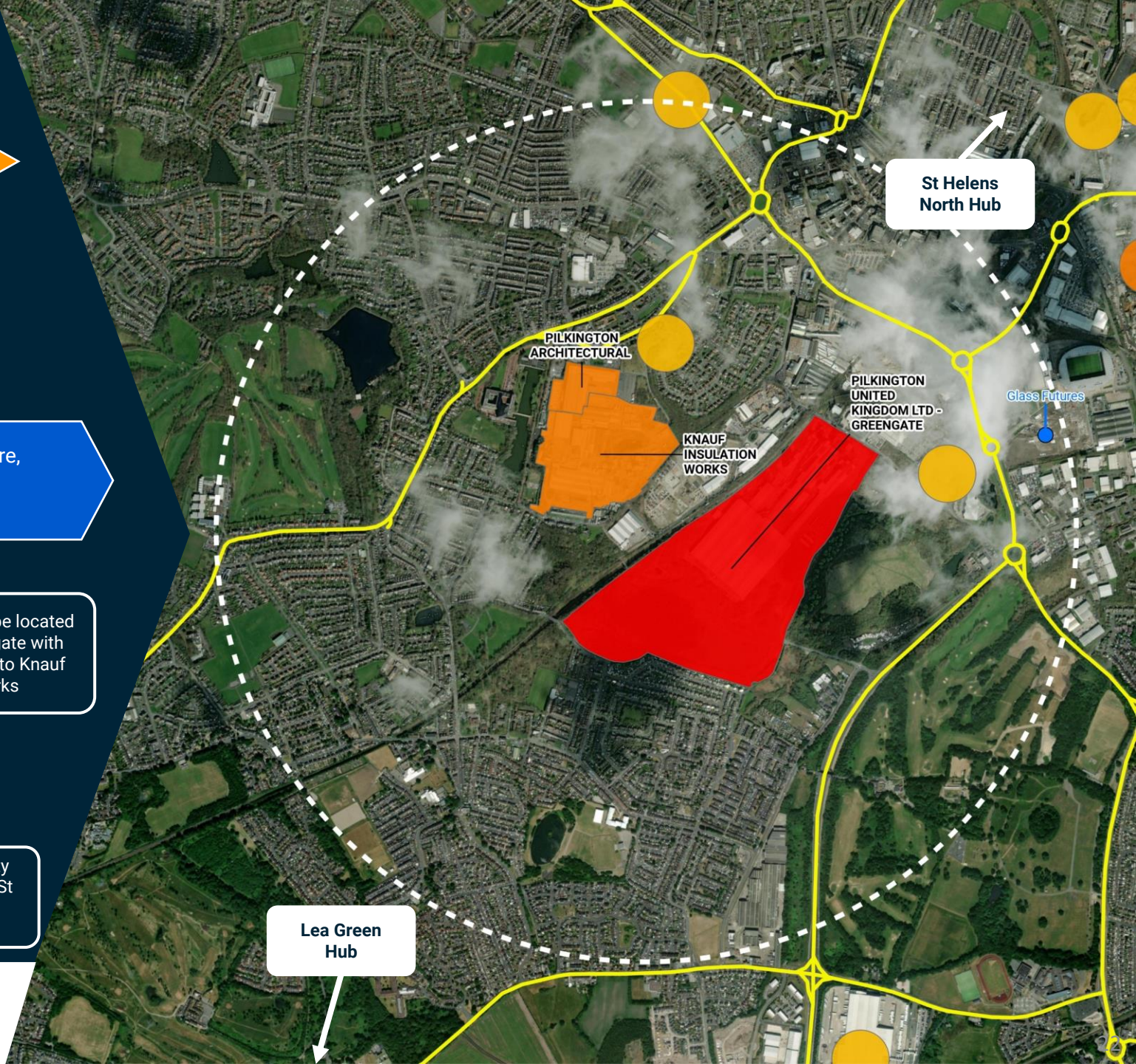
Pilkington's F&L partner Nijman Zeetank would use refuelling infrastructure on-site.

The first phase is to be located at Pilkington Greengate with potential expansion to Knauf Insulation Works



It is expected that the HyNet pipeline will service St Helens in the 2030s. If so, there is potential growth for future industrials in the region

Some additional capacity for tube trailer export to St Helens North Hub and Glass Futures



WIRRAL IN 2030

WIRRAL

LOCAL AUTHORITY AREA TOTAL

Up to **£46m** investment

14MWe electrolyser

63.5GWh/a hydrogen demand

14,000 tonnes/a CO_{2e} avoided

3 potential hubs

32 new jobs

HUB 1: BROMBOROUGH

£25m - £30m investment

9MWe electrolyser

40GWh/a hydrogen demand

8,800 tonnes/a CO_{2e} avoided

Key customers: Unilever, Cereal Partners UK and local mobility

HUB 2: WIRRAL WATERS

£2m - £12m investment

2MWe electrolyser

9.5GWh/a hydrogen demand

2,300 tonnes/a CO_{2e} avoided

Key customers: local buses and future freepoint demand

HUB 3: MORETON

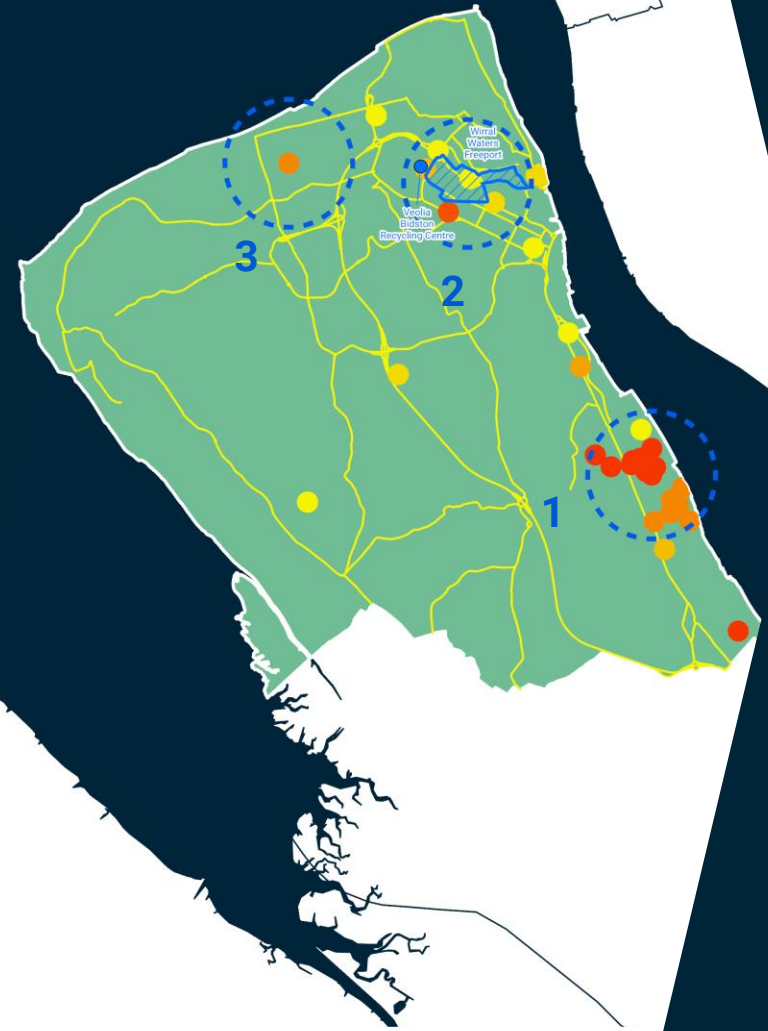
£1.5m - £3.5m investment

3MWe tube trailer import

14GWh/a hydrogen demand

2,900 tonnes/a CO_{2e} avoided

Key customers: Premier Foods and its logistics fleet



HYNET

The most advanced low carbon hydrogen cluster is located very close to Wirral and could provide a piped solution to the LA

UNILEVER

One of the first businesses to test hydrogen in industrial-scale boilers in the UK



BROMBOROUGH

2030 Investment
£25m - £35m



2030
9MWe electrolyser

40GWh/a hydrogen demand

8,800 tonnes/a CO_{2e} avoided

2040
15MWe electrolyser or HyNet

70GWh/a hydrogen demand

14,000 tonnes/a CO_{2e} avoided

Initial phase focussed around Unilever with small refuelling facility before connection to CPUK. Longer term demand for wider hub could be met through larger electrolyser or HyNet connection

Mobility demand from logistics providers for industrials like Great Bear Distribution and Abbey Logistics

Major industrial demand from Unilever and Cereal Partners

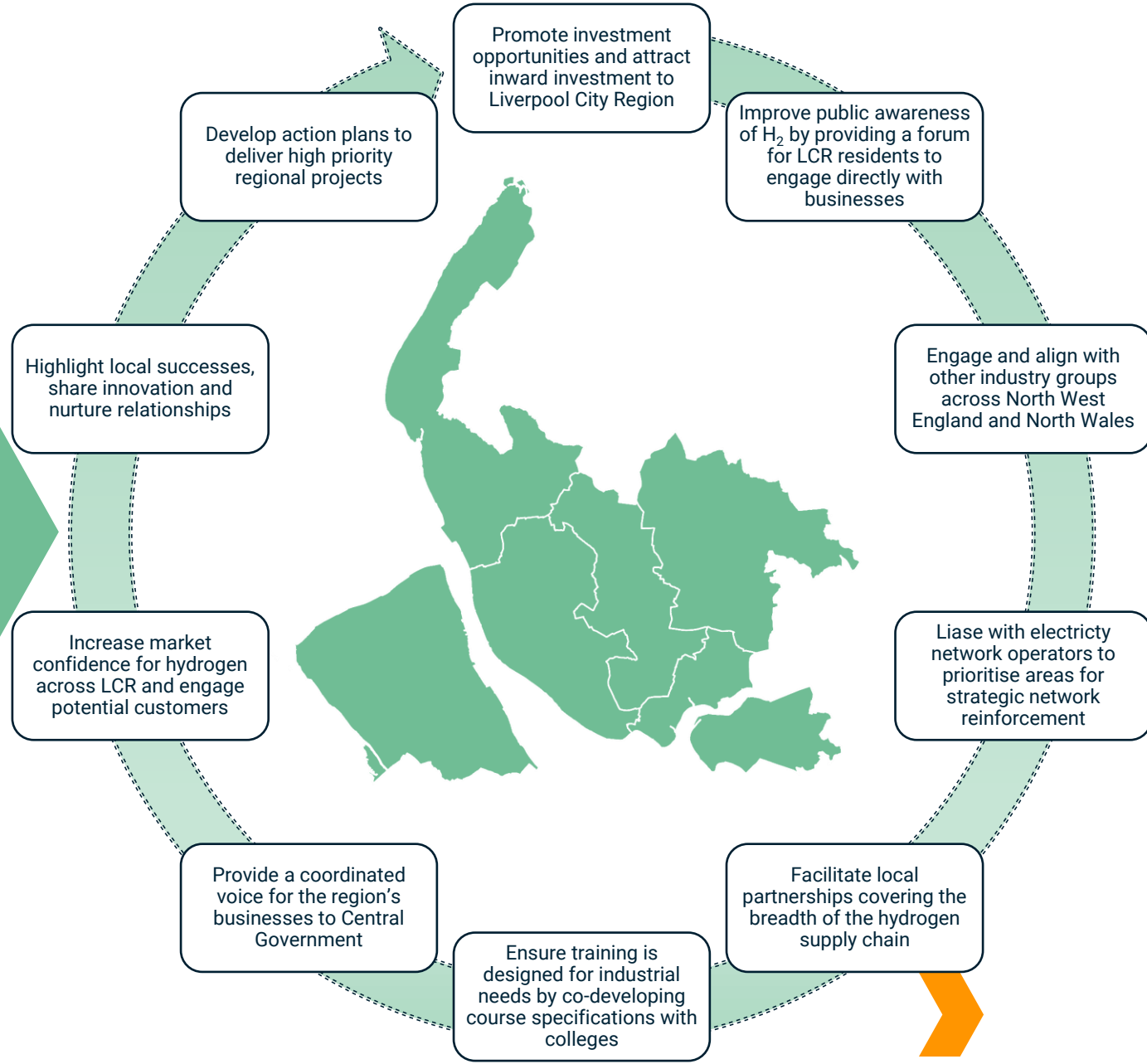
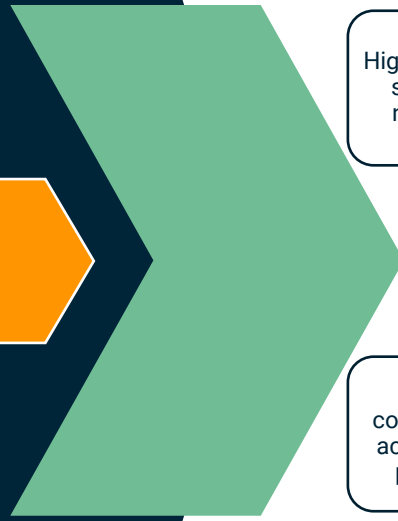


Additional capacity could service municipal fleet demand from Biffa and Bagnall & Morris, as well as export to other refuelling stations in the vicinity

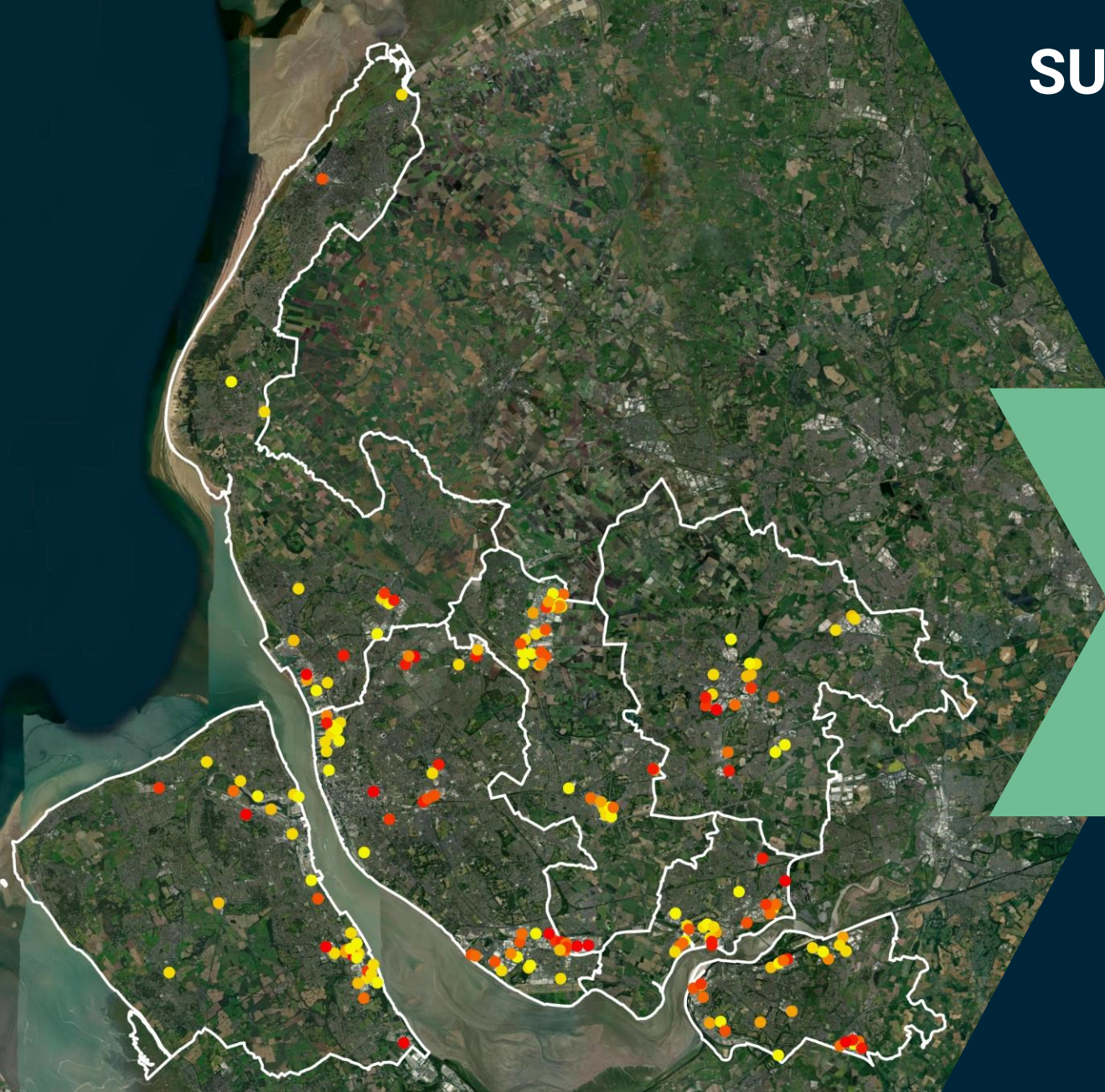
Later phase of hub could see it connected to HyNet

FROM VISION TO ACTION

- To advance the hydrogen economy across LCR, it is recommended that the Combined Authority establishes a Hydrogen Development Forum
- The forum would help to refine and steer the local hydrogen strategy
- The forum would be open to all private and public organisations across LCR who have an interest in the hydrogen economy
- The forum would enable bidirectional communication between businesses and the public to capture community feedback
- All organisations named or involved in this study would be key stakeholder for this forum



SUMMARY



The fossil fuel demand for industrial operations, municipal fleets and freight & logistics across Liverpool City region is 5,150 GWh

By 2030, 21 hydrogen hubs across the region could be consuming 1,050 GWh of hydrogen

This equates to over 224MWe of electrolyser capacity installed across LCR and over 220,000 tonnes of CO₂ avoided

LCRCA can act as a catalyst for this by decarbonising its municipal fleets and allowing private businesses access to the infrastructure

To achieve the vision, over £800m must be invested in hydrogen infrastructure. For projects to be operational by 2030, development must begin in the next few years. Additionally, the development of these projects could create over 570 new jobs



ABOUT EQUANS

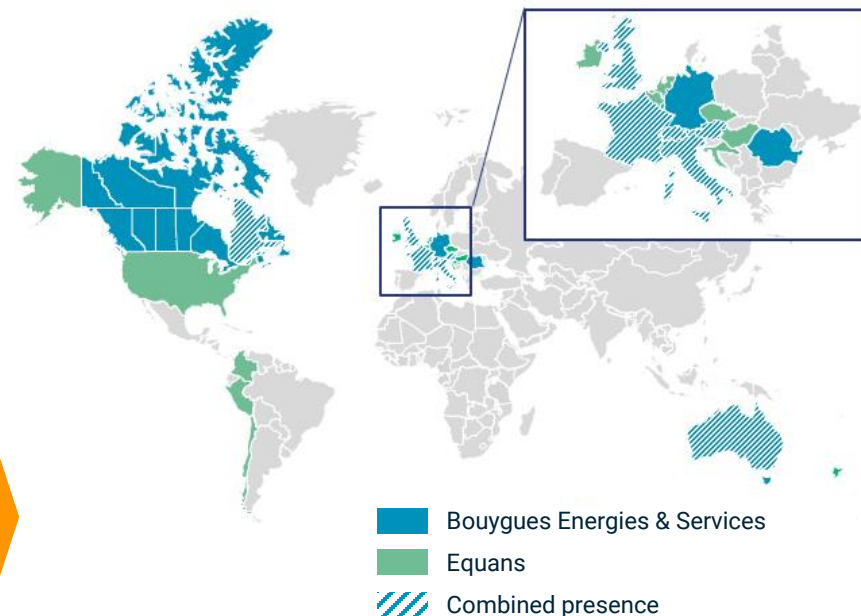
Equans is a world leader in providing technical and energy services. Equans has 90,000 employees working across 20 core countries and an annual turnover of more than €17 billion

Equans designs, builds, operates and maintains specialist solutions to support our customers navigate the energy, industrial and digital transitions that are changing the ways that we work, move and live

Equans delivers hydrogen solutions as part of an integrated energy offering. Equans has end-to-end hydrogen expertise and can support projects with technical expertise from conception, through delivery and into operations

Equans has deep hydrogen experience in the UK, France, Germany, Netherlands and Belgium and delivers projects using an international team of experts

More information of the Equans hydrogen offering which covers constancy, Pre-FEED, FEED, EPC and O&M can be found on the Equans website



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