WORLD ECONOMIC FORUM

In collaboration with Accenture & EPRI

Transitioning Industrial Clusters towards Net Zero

Initiative Introduction

August 2022

Industrial Clusters: The Net-Zero Challenge

With industry responsible for 30% of total global CO2 emissions, and more than ½ of these emissions occurring in industrial clusters, industrial clusters will be a critical player in accelerating the path to net zero.

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Industrial clusters are geographic areas where **co-located companies, representing either a single or multiple industries, provide opportunities for scale, sharing of risk/resources, aggregation and optimization of demand**.

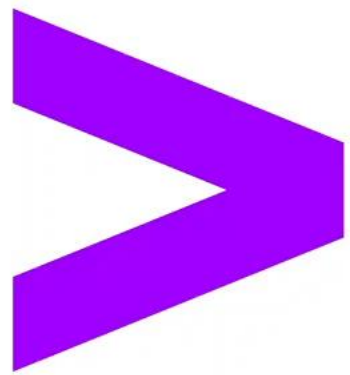
Industry composition

Geography

Existing infrastructure

Energy costs and policy

Source: Accenture's 2021 Net Zero Industrial Clusters Report



Initiative's Signatory Clusters

Today the eight signatory clusters of the initiative represent **344 million metric tonnes CO_2, 1.1 million jobs** protected and created, and **$182 billion contributed to the global GDP**

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7.2MT CO_2 emissions per year caused by industry

23.9% Industry contribution to GVA in 2019

204,000 Jobs in industry in the Basque Region

BASQUE NET ZERO

Brightlands Circular Space

5.8 MT CO_2 emissions per year caused by industry

20% Gross Value Added in 2019

8,100 Jobs from 110 companies and factories

TBC MT CO_2 emissions per year

TBC GDP generated per year in the State of Ohio

TBC Jobs protected

Ohio Clean Hydrogen Hub Alliance

H_2Houston Hub

220 MT CO_2 emissions abated by 2050

$100 bn GDP generated in the region by 2050

184,000 Jobs attributed impact by 2050

HyNet North West

10 MT CO_2 / year after 2030

£2.8 bn UK gross value added for UK 2022-2030

6,000 Permanent jobs created each year until 2030

8.2 MT CO_2 / year

£11.5 bn Estimated annual output of Kwinana

30,000 Skilled jobs in industrial area

KWINANA INDUSTRIES COUNCIL

Port of Antwerp Bruges

18 MT CO_2 emissions per year

€21 bn GDP generated per year in the region

164,000 Jobs protected

12.4 MT CO_2 /year after 2030

£18 bn GDP generated per year in East Coast Cluster

55,000 Jobs protected

ZEROCARBON HUMBER

Initiative impact

With greater than 10,000 industrial clusters globally, a subset of ~100 clusters would represent emissions larger than most countries

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#	Country	Emissions (Million Metric Tonnes)
1	China	12055
2	United States	5771
3	India	3363
4	Indonesia	1959
5	Russia	1924
	…	…
24	Italy	376
25	Nigeria	354
26	France	352
27	Egypt	351
28	Iraq	321

100 Cluster's Impact

1600 MT of CO_2

5% of total Global CO_2 Emissions

15% of Global CO_2 Industrial Emissions

$2.5 Trillion

Total GDP Contribution

17.8 Million

Direct Jobs

Source: Accenture Strategy Analysis, Climate Watch Data

The need for an integrated approach to establish a net-zero cluster

A holistic and collective approach is required to optimize emissions solutions and create an integrated energy system that maximizes system value outcomes across the cluster.

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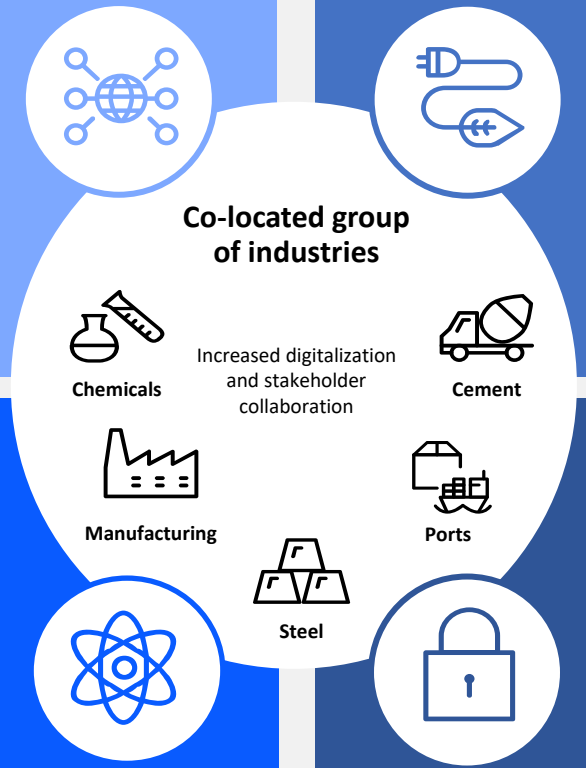
SYSTEMIC EFFICIENCY AND CIRCULARITY

- Increase circularity within a cluster through cross-entity waste utilization
- Integrate processes within a cluster to share energy and material streams
- Provide cost-effective system benefits outside the cluster

DIRECT ELECTRIFICATION AND RENEWABLE HEAT

- Electrify low-to-medium temperature and pressure processes
- Generate low-cost, renewable electricity and heat onsite (e.g. rooftop solar, biomass, CSP)
- Pursue shared infrastructure (e.g. microgrid, storage, flexibility)



HYDROGEN

- Leverage electricity and heat from nearby zero carbon sources (wind, solar, nuclear, biomass)
- Produce low-to-zero carbon hydrogen from the most economical source (e.g. blue, green)
- Use produced H_2 as an alternative fuel for hard-to-electrify industrial processes, building heating, and transport

CARBON CAPTURE, UTILISATION AND STORAGE (CCUS)

- Capture carbon from energy and hydrogen production
- Use captured carbon for industrial and manufacturing processes
- Store carbon underground where feasible

Source: Accenture's 2021 Net Zero Industrial Clusters Report

The Approach

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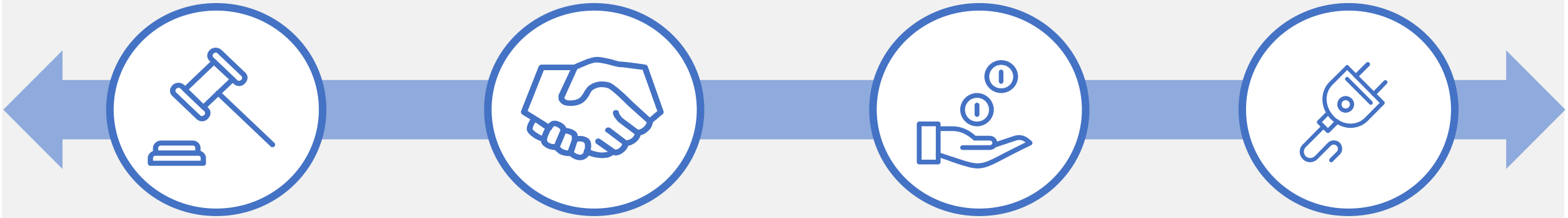
While every industrial cluster will be different depending on its make-up, the market where it operates, the technology it employs, a standardized approach is possible to accelerate the transition of the cluster to net zero.



Partnerships

How to build trust between competing companies both on supply and demand side?

Policy

Have enabling policies been developed to accelerate net zero industrial clusters?

Financing

What innovative options exist for financing?

Technology

While the initiative is technology neutral, there is a logical pathway to consider which applies to all clusters.

Initiative Operating Structure & Key Value Drivers for Participants

Our fit-for-purpose support is applied across different areas depending on a cluster's stage of development and needs

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	Partnership Facilitation & Coaching	Policy Analyses	Financing Analyses & Research	Technology Opportunity Support	Public Engagement	Global Cluster Community
Key questions to address…	• Whom do we need to **partner** with to achieve net zero? • What is our **vision and joint goal**? • What **partnership agreement and governance** needs to be in place? • What are the **resources** that each partner is willing to commit?	• What **industrial policies** do we need to support the transition? • How do we apply **diverse policy structures** from all regions? • How do we **work with national and local governments** to fulfil our vision?	• How do we develop the **long-term decarbonization funding strategy**? • How might we **maximize funding** from **all mechanisms** available? • How do we secure support from the **regulatory agencies and collaborate on the funding applications?**	• How might we engage with **pioneering technology initiatives**? • How might we identify **technology requirements** for the initiative? • How can a **holistic evaluation** (e.g., system value approach) be leveraged when considering anchor projects?	• How should the cluster's story be communicated to **maximize stakeholder buy-in**? • How can we **disseminate learnings and knowledge**? • How can we **showcase our leadership** to encourage and support other clusters?	• How can we build **momentum** and **strengthen the coalition of ambitious clusters**? • How can we **exchange knowledge** and learn from others? • How might we **collaborate** between clusters?
…with initiative support and resources	• Joint vision and GHG reduction goal development • Partnership facilitation including alignment on cornerstones towards a collaboration agreement/MoU • Potential partners identification across industries and regions	• Analyses by geography • Facilitated collaboration and public-private roundtables with key governments and civil society organizations	• Analyses by geography • Financing mechanism research access and roadmapping support • Financing deep dive workshops in selected regions	• Collaborative opportunity identification support • Best practices and access to global, ongoing innovation initiatives	• Global recognition and showcase of cluster's decarbonization leadership • Knowledge dissemination • Foreign investment attraction	• Knowledge exchange platform for peer-to-peer interactions among clusters • Potential joint project identification across regions

UK Research and Innovation

United Kingdom

Hynet and Zero Carbon Humber

Case Studies

UK Industrial Cluster Profile

While industry faces several challenges on the path to net zero, there are also sizeable social and economic opportunities from investments in low-carbon technologies through industrial clusters.

Challenge

~25%

The industrial sector accounted for 25% of total final energy consumption in 2017

~36 $MtCO_2$

Emissions from six identified industrial clusters, representing 10% of UK CO_2 emissions

2/3 by 2035

A 2/3 reduction in GHG emissions from 1990 levels is required by 2035 to stay on track for Net Zero and meet carbon budgets

Opportunity

1.5m jobs

1.5 millions jobs secured through the development of the UK's industrial clusters

15%

Of current UK CO_2 emissions could be captured a year by 2050 in Humber, equivalent to 53 $MtCO_2$, via CO_2 capture, blue hydrogen, BECCS, transport & storage projects.

£320bn

Annual exports and services provided by the UK's industrial clusters

£2.9-4.2bn

Of potential savings per year by 2050 through avoided CO_2 penalties for firms in the Humber region using carbon capture and storage

UK Research and Innovation

Sources: IEA, Industrial Clusters BEIS, Decarbonisation Strategy BEIS, Energy White Paper, Element Energy (1, 2), Zero Carbon Humber

HOW DID THE UK DEVELOP ITS INDUSTRIAL CLUSTERS?

BRYONY LIVESEY

Bryony Livesey - Innovate UK UKRI (External)

UK Government ambitions for CCUS

Source: Will Lochhead, BEIS Deputy Director, Industrial Carbon Capture and Hydrogen Business Models

Net Zero Strategy ambition to capture **20 – 30Mt** of CO^2 by 2030

£1bn investment through **CCS Infrastructure Fund**

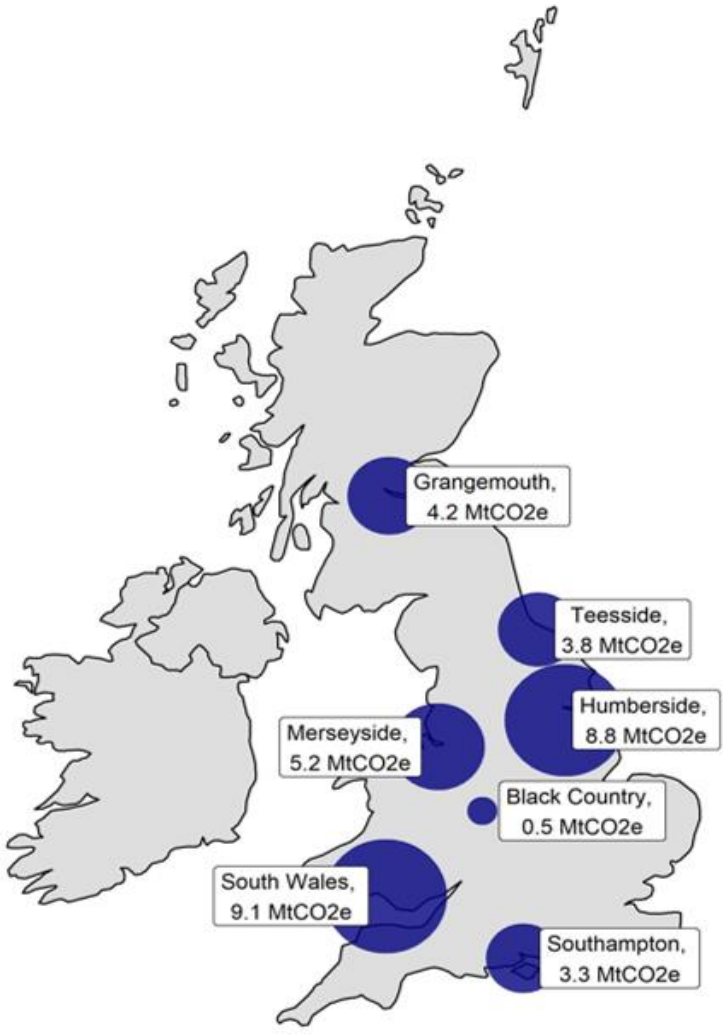
CCUS deployment at **HyNet Cluster** by **mid 2020s**

CCUS deployment at **North East Cluster** by **mid 2020s**

2 further clusters by **2030**

3 Business models being defined for Power CCUS, Transport & Storage, and Industrial Carbon Capture

Investing in carbon capture usage and storage could potentially deliver…		
Support for around **50,000 jobs** by 2030[3]	Up to **£1.bn** of public investment by 2025	Savings of around **40MtCO$_2$e** between 2023 and 2032, or **9%** of 2018 UK emissions



Map of major UK industrial cluster emissions from large point sites (2019). Source: NAEI 2019 data. Does not capture non-ETS emissions in a cluster.

UK Government ambitions for hydrogen

The **Energy Security Strategy** Set a **10GW** ambition by 2030

£240m Net Zero Hydrogen Fund provides CAPEX/DEVEX support

£100m For electrolytic H2 projects for 2023 through H2 Business Model

12,000 Jobs in the UK hydrogen industry by 2030, based on 10GW target

20GW of potential hydrogen projects identified in the UK pipeline (through to 2037)

66% UK Hydrogen companies already exporting to growing int. market

£12bn capital available from UK Infrastructure Bank with H2 as priority

World Economic Forum- Transitioning Industrial Clusters Towards Net Zero

Innovate UK

ZERO CARBON HUMBER

ABP ASSOCIATED BRITISH PORTS · BRITISH STEEL · centrica · drax · equinor · MITSUBISHI POWER

nationalgrid · px · sse Thermal · TRITON POWER · uniper · The University Of Sheffield. AMRC Advanced Manufacturing Research Centre

VELOCYS · INEOS Acetyls

EAST CO_2AST CLUSTER

Northern Endurance Partnership · bp · eni · equinor · nationalgrid ventures · Shell · TotalEnergies · Net Zero Teesside

EAST CO_2AST CLUSTER

- Cluster COD **October 2026**
- **17 Primary Emitter** projects
- **24.5 million tonnes CO_2** stored by 2030
- **20Mtpa** CO_2 injection rate by 2030
- **25,000 jobs** per year to 2050 (avg)
- **£2bn GVA** per year across the cluster

Northern Endurance Partnership

145km

103km

ENDURANCE

MIDDLESBROUGH

DARLINGTON

PROJECTS IN TEESSIDE
INCLUDING
Net Zero Teesside
BOC · bp · CF · kellas MIDSTREAM · NZT Power · sue2 · TV ERF · 8 RIVERS
UP TO 10 $MTCO_2E$ CAPTURED

YORK

LEEDS

SHEFFIELD

HULL

GRIMSBY

SCUNTHORPE

PROJECTS IN THE HUMBER
INCLUDING
ZEROCARBON HUMBER
drax · equinor · MITSUBISHI POWER · sse Thermal · TRITON POWER · uniper · VELOCYS
17+ $MTCO_2E$ CAPTURED


Aldbrough
SSE Thermal & Equinor's proposal for one of the UK's largest low-carbon hydrogen storage facilities.
H2H Saltend
Equinor's new low-carbon hydrogen production facility to fuel-switch the chemicals park, and new ammonia production facility for export opportunities. Hydrogen off-taker Triton Power CHP will provide decarbonised heat and power from upgraded Mitsubishi Power's gas turbines to users on the PX site and potentially beyond.
To Northern Endurance aquifer storage
Easington
Easington offers one of the potential locations to pump CO_2 from onshore infrastructure and export for safe and permanent storage in a North Sea aquifer via a subsea pipeline.
Deep-water ports
ABP's Humber ports provide deep-water facilities for international shipping of CO_2, green hydrogen and ammonia.
Drax
The largest decarbonisation project in Europe will convert the existing power station to bioenergy with carbon capture (BECCS) producing negative emissions.
Hull
Selby
Goole
Immingham
Grimsby
Scunthorpe
1600x972px
A63
A15
A180
M62
M180
Uniper's Humber Hub
Development of a hydrogen hub at its Killingholme site, with both blue and green hydrogen production.
British Steel
Ambitious plans across a range of technologies considering electrification, CCS and hydrogen to support carbon reduction and clean growth.
Keadby
SSE Thermal & Equinor's proposals for a new CCS-equipped power station and the world's first major 100% hydrogen-fired power station, at the existing Keadby power generation site.
Leeds
Sheffield
CO_2
Hydrogen

ECONOMIC BENEFITS OF THE EAST COAST CLUSTER – THE HEADLINES

25,000+

Jobs up to **2050**
(average per annum)

~ 41,000

Jobs peak in **2026**

Construction:
9,400 direct jobs/yr
12,300 indirect jobs/yr

Operations:
2,200 direct jobs/yr
13,300 indirect jobs/yr

25,000 additional
induced jobs/yr

£2bn +

Average GVA
up to **2050**

TELL US ABOUT THE TECHNOLOGY APPROACH OF THE CLUSTER AND HOW THIS UNLOCKS FUTURE PROJECTS?

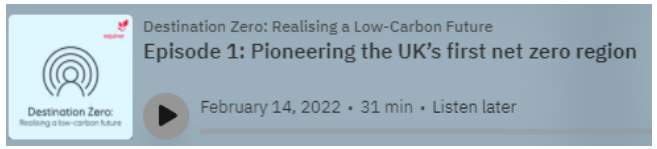
OONAGH O'GRADY

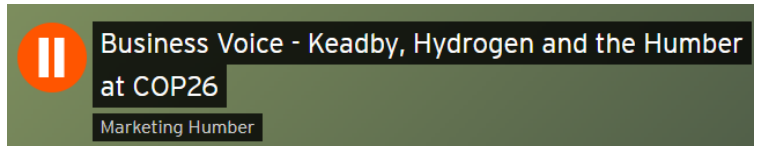

ASTI

Knowledge Dissemination

- **183** Partner Led Knowledge Dissemination Events detailed since Nov 2020.
- Increased Focus with KM Champions in place.
- Proactively identifying future opportunities allows for engagement and support from other partners to deliver maximum value.

Podcasts & COP26



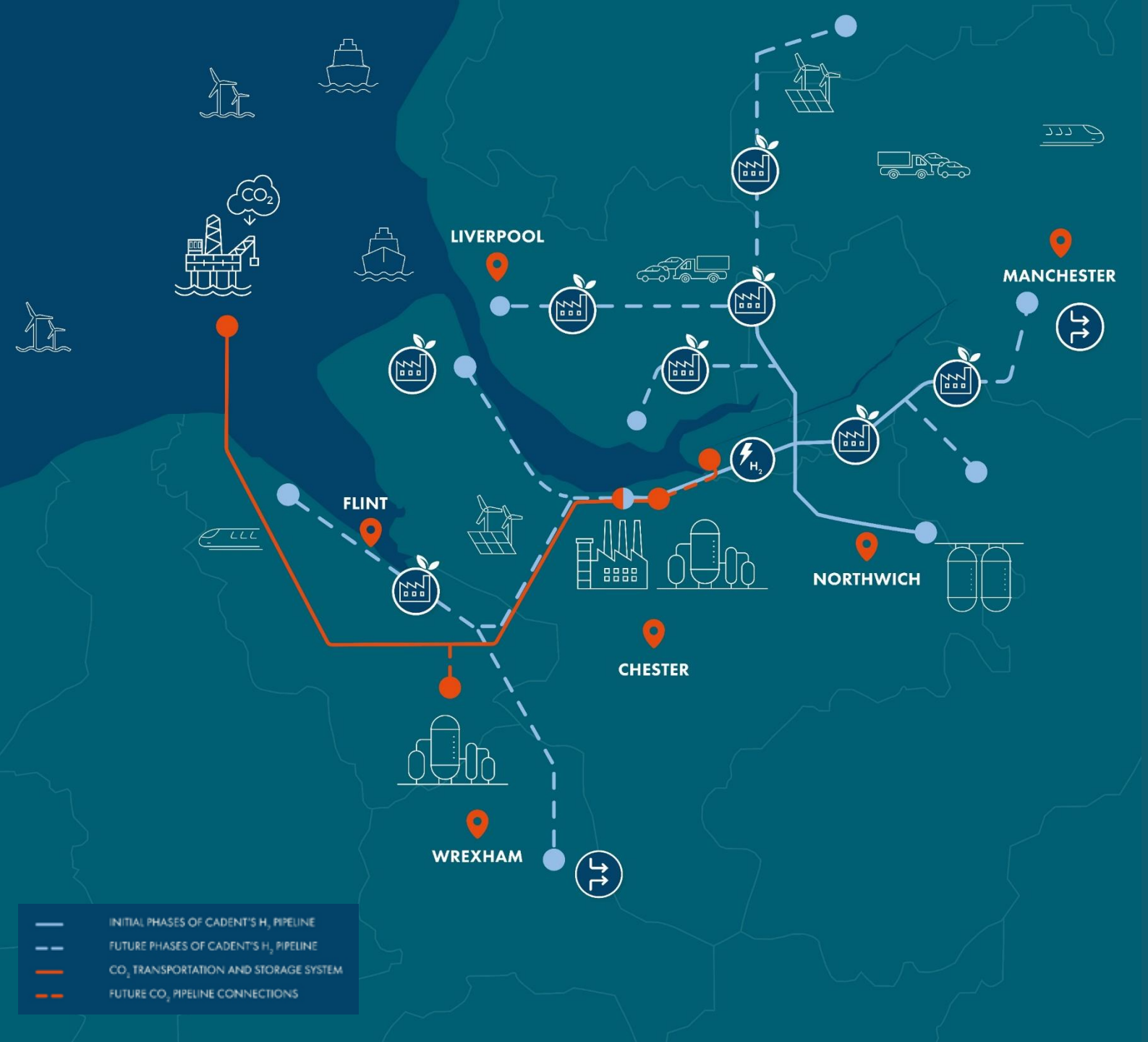


Energy Articles

Ministerial Visits

STEM events

Events & Presentations

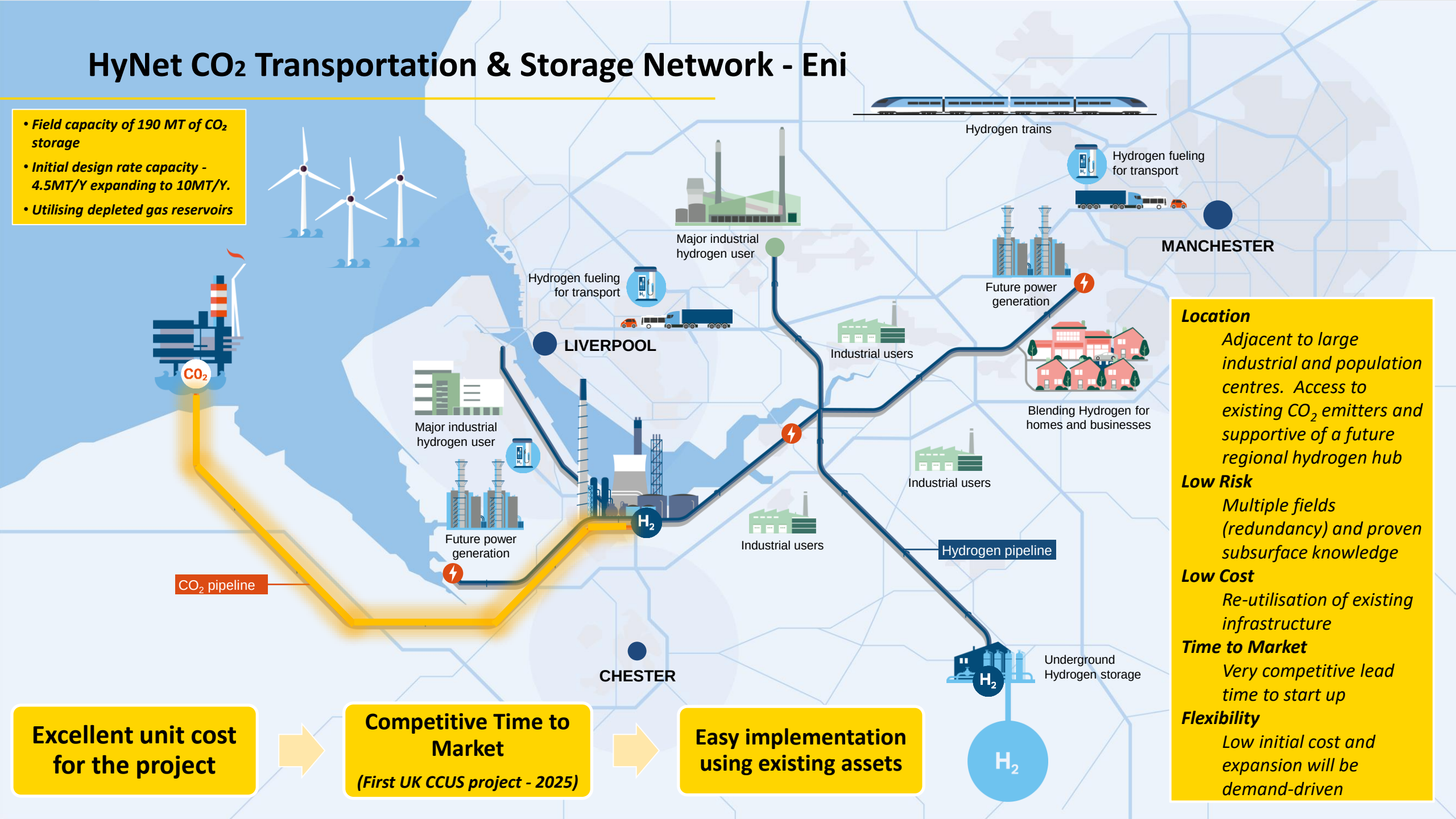


The HyNet Project Vision

- *CO_2 transport and storage infrastructure, delivering CO_2 to safe, permanent storage in Liverpool Bay, 30km offshore.*
- *Facilities to capture CO_2 emissions from new & existing industry from 2025.*
- *Low-carbon hydrogen production plants, with CO_2 capture.*
- *A hydrogen distribution network, delivering hydrogen to industrial consumers.*
- *Hydrogen buffer storage in underground salt caverns.*

HyNet CO_2 Transportation & Storage Network - Eni

- *Field capacity of 190 MT of CO_2 storage*
- *Initial design rate capacity - 4.5MT/Y expanding to 10MT/Y.*
- *Utilising depleted gas reservoirs*



Excellent unit cost for the project

Competitive Time to Market

(First UK CCUS project - 2025)

Easy implementation using existing assets

Location

Adjacent to large industrial and population centres. Access to existing CO_2 emitters and supportive of a future regional hydrogen hub

Low Risk

Multiple fields (redundancy) and proven subsurface knowledge

Low Cost

Re-utilisation of existing infrastructure

Time to Market

Very competitive lead time to start up

Flexibility

Low initial cost and expansion will be demand-driven


BUILDING A
FUTURE

HOW DID THE CLUSTER APPROACH HELP TO INCREASE THE NUMBER OF OFFTAKERS?

NICOLO AGGOGERI


TOGETHER WE CHARGE

HyNet Cluster: Key messages

- 19 MOU's signed with Prime Emitters
- > 25 MOUs signed with hydrogen customers
- Led by regional demand

Demand Driven

Fast & Deliverable

HyNet North West

Game Changer

Benefits

- Tracked 1 in Oct 2021
- FID by 2023
- Start-up in 2025
- First stage capacity 4.5MTPA
- 10MTPA capacity from 2030

- Up to 50% of the UK CCUS target by 2030
- 40% of the new UK low carbon hydrogen target by 2030
- 25% of regional emissions abated

- + 2.8B£ of GVA by 2030
- + 6B£ of GVA by 2050
- Delivers 6000 jobs/year for the first 10 years
- Protects 350,000 jobs in Hard to Abate Sectors

Thank you

Additional Resources

In collaboration with Accenture & EPRI

[Transitioning Industrial Clusters towards Net Zero Landing Page]

[Achieving net-zero future with industrial clusters Report]

[System Value Framework Overview & Analyses by Market]

[COP26 Video: Transitioning Industrial Clusters towards Net Zero]

COP26 Video: Signatory Cluster Vision (4 Videos)