

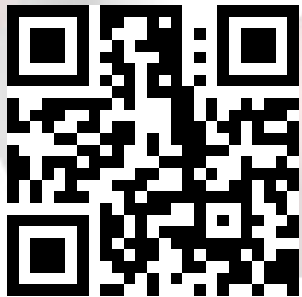
# CCS outlook for the UK

Carys Blunt

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University of Sheffield

[www.ukccsrc.ac.uk](http://www.ukccsrc.ac.uk)

26<sup>th</sup> September 2023



Engineering and  
Physical Sciences  
Research Council

The UKCCSRC is supported by the Engineering and Physical Sciences Research Council (EPSRC) as part of the UKRI Energy Programme

# UK CCS Research Community Network+



**2,100+** members

350+ *academic*  
550+ *ECR*  
350+ *associate*  
850+ *network*

**2** conferences per year

**500+** subscribed to webinar series

**60+** attendees on CCS training course



**Flexible funded research programme**

2017-2022: 24 projects funded  
2022: 13 projects funded

**ECR Programme**

Awaydays (virtual and in-person)  
Funding opportunities

**1,923**  newsletter subscribers

**7,238**  LinkedIn followers

**3,296**  (formally twitter) followers



# Policy and funding for UK CCS deployment



**November 2020:** [‘The Ten Point Plan for a Green Industrial Revolution’](#) (HMG, 2020) was published



**Point 8**  
Investing in Carbon Capture, Usage and Storage

Aim to “**establish CCUS in two industrial clusters by mid 2020s, and aim for four of these sites by 2030, capturing up to 10 Mt of carbon dioxide per year.**”

- The Industrial Decarbonisation Challenge (IDC) with £170M funding, this principally is co-funding FEED studies, with smaller amounts of research and cluster planning (Livesey, 2021)
- The £1bn CCS Infrastructure Fund, which will primarily support capital expenditure on CO<sub>2</sub> Transport and Storage networks and industrial carbon capture projects
- Business models being developed to provide 10-15 years of market-based support for CO<sub>2</sub> Transport and Storage, Power, and Industrial Carbon Capture, also for all types of low carbon H<sub>2</sub>

**15 March 2023:** UK Spring budget confirmed funding for Track 1 and Track 2 clusters when it was announced that the government is supporting investment in the energy system by making up to £20 billion available for early deployment of CCS

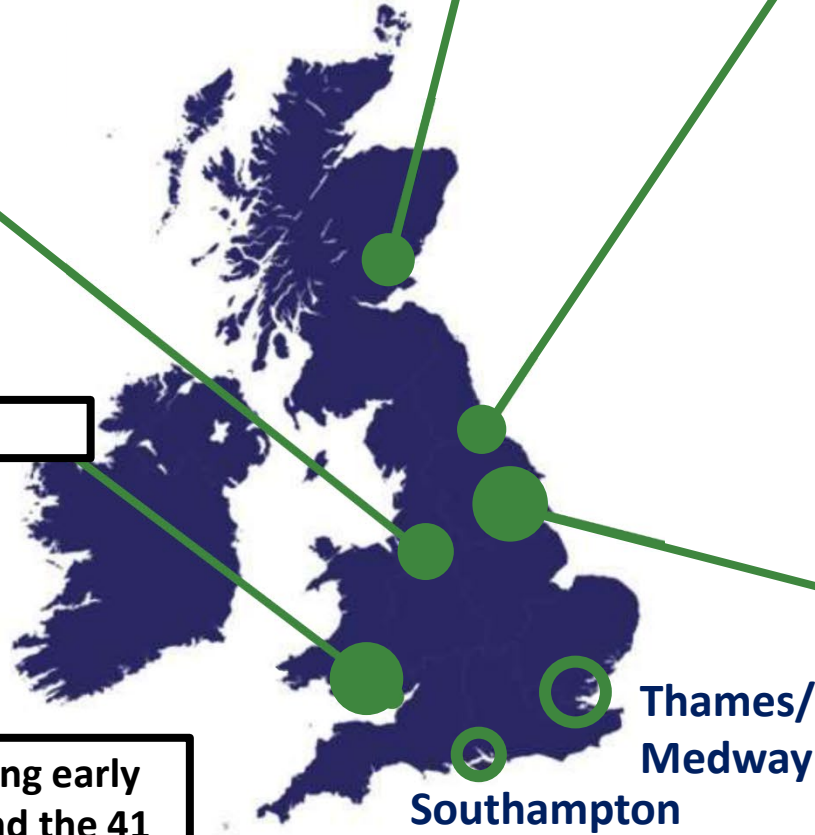
HYNET	
7	Making Net Zero Possible – Grain
13	Project Cavendish
14	HyNet Hydrogen Production Project (HPP)
32	Viridor Runcorn Industrial CCS
33	Protos Biofuels
34	Protos Energy Recovery Facility
35	Hanson Padeswood Cement Works CCS
36	CF Fertilisers Ince Capture Plant
37	Buxton Lime Net Zero
38	Carbon Dioxide Capture Unit - EssarOil UK
39	Emerge CCS

SCOTTISH CLUSTER	
8	Peterhead Carbon Capture Power Station
15	Acorn Hydrogen
16	Fife Hydrogen Hub
40	CO <sub>2</sub> Extraction from St Fergus Gas at SAGE Terminal
41	Acorn Capture

TEESSIDE	
2	Whitetail Clean Energy
3	Net Zero Teesside Power
4	Alfanar CCGT Teesside
9	H2NorthEast
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22	Redcar Energy Centre
26	Teesside Hydrogen CO <sub>2</sub> Capture

SOUTH WALES

HUMBERSIDE	
1	VPI Humber Zero
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6	C.GEN Killingholme
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21	Lighthouse Green Fuels
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25	ZerCaL250



Incomplete overview of UK CCS projects showing early clusters (solid green circles), some later ones and the 41 CO<sub>2</sub> capture projects selected for evaluation in March 2022

Thames/  
Medway

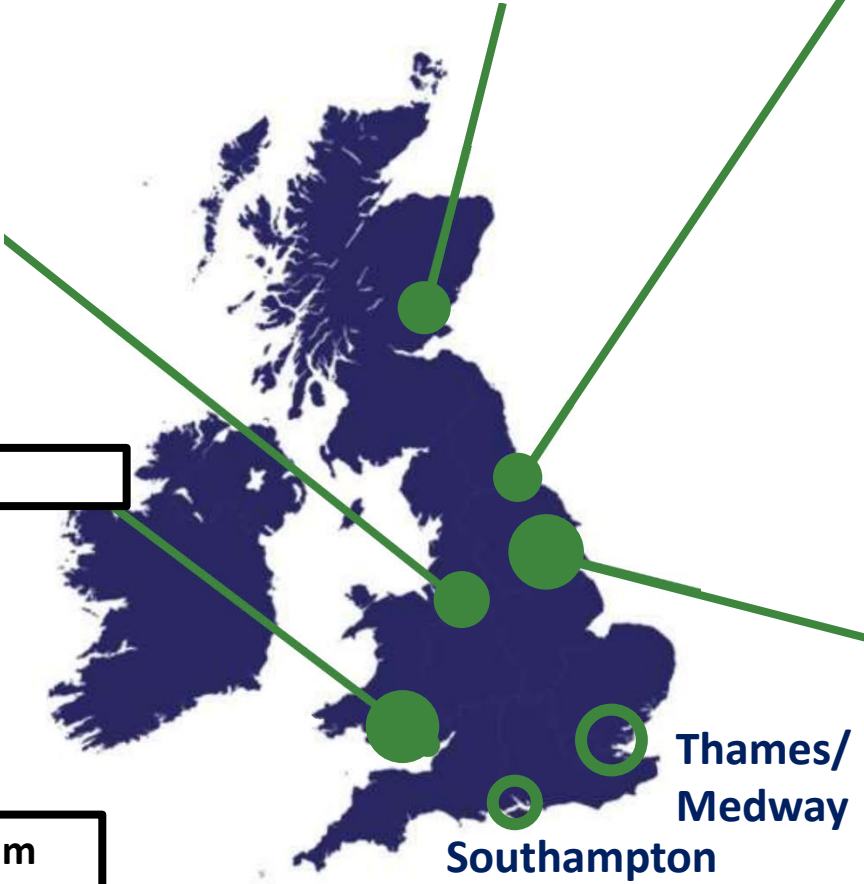
Southampton

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Projects in bold text made the interim cut of 20 in April 2022



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Type of project:  
 Black - Industry  
 Red - Power  
 Blue - Blue Hydrogen

Thames/  
 Medway  
 Southampton

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Thames/  
Medway  
Southampton

The 2 clusters and 8 projects selected for final negotiations in March 2023 highlighted in green

# CCS projects: Track-1 Negotiation List



Department for  
Energy Security  
& Net Zero

Notice  
**Cluster sequencing Phase-2: Track-1  
project negotiation list, March 2023**  
Updated 30 March 2023

## East Coast Cluster

Net Zero Teesside Power

bpH2Teesside

Teesside Hydrogen CO<sub>2</sub> Capture

Amine post-combustion capture

Advanced autothermal reformer

Amine post-combustion capture (retrofit to SMR)

## HyNet Cluster

Hanson Padeswood Cement

Viridor Runcorn Industrial CCS

Protos Energy Recovery Facility

Buxton Lime Net Zero

HyNet Hydrogen Production

Amine post-combustion capture

Amine post-combustion capture

Amine post-combustion capture (?)

Hydrogen lime kiln

Advanced autothermal reformer



## Cluster sequencing for carbon capture, usage and storage (CCUS): Track-2. The Track-2 process will establish 2 new clusters as part of the further development of CCUS.



Department for  
Energy Security  
& Net Zero

Government is committed to further development of CCUS, including through the Track-2 process which will establish 2 new clusters.

We are at this stage seeking 2 transport and storage (T&S) systems that:

- are located within the UK
- are able to credibly demonstrate that they have a clear pathway to rates of injection consistent with the at least 10Mtpa ambition by 2030
- do not form part of the HyNet or East Coast Cluster (ECC) Track-1 cluster proposals
- are able to credibly demonstrate that they can connect via pipeline to at least two projects for an initial phase of capture and non-pipeline transport in future phases

Government views the **Acorn and Viking T&S systems** as able to meet the Track-2 eligibility criteria, and best placed to deliver on the objectives for Track-2, subject to value for money and due diligence assessments.

Other T&S systems that are able to meet the eligibility criteria now have the opportunity to express an interest in being considered for Track-2.

# 2016: Delivering Cost Effective CCS in the 2020s – a new start

<https://ukccsrc.ac.uk/delivering-cost-effective-ccs-in-the-2020s/>



## Simple formula to deliver cost-effective CCS with offshore storage

**Cost-effective CCS = Multiple Sources + Large-scale Pipeline & Storage**

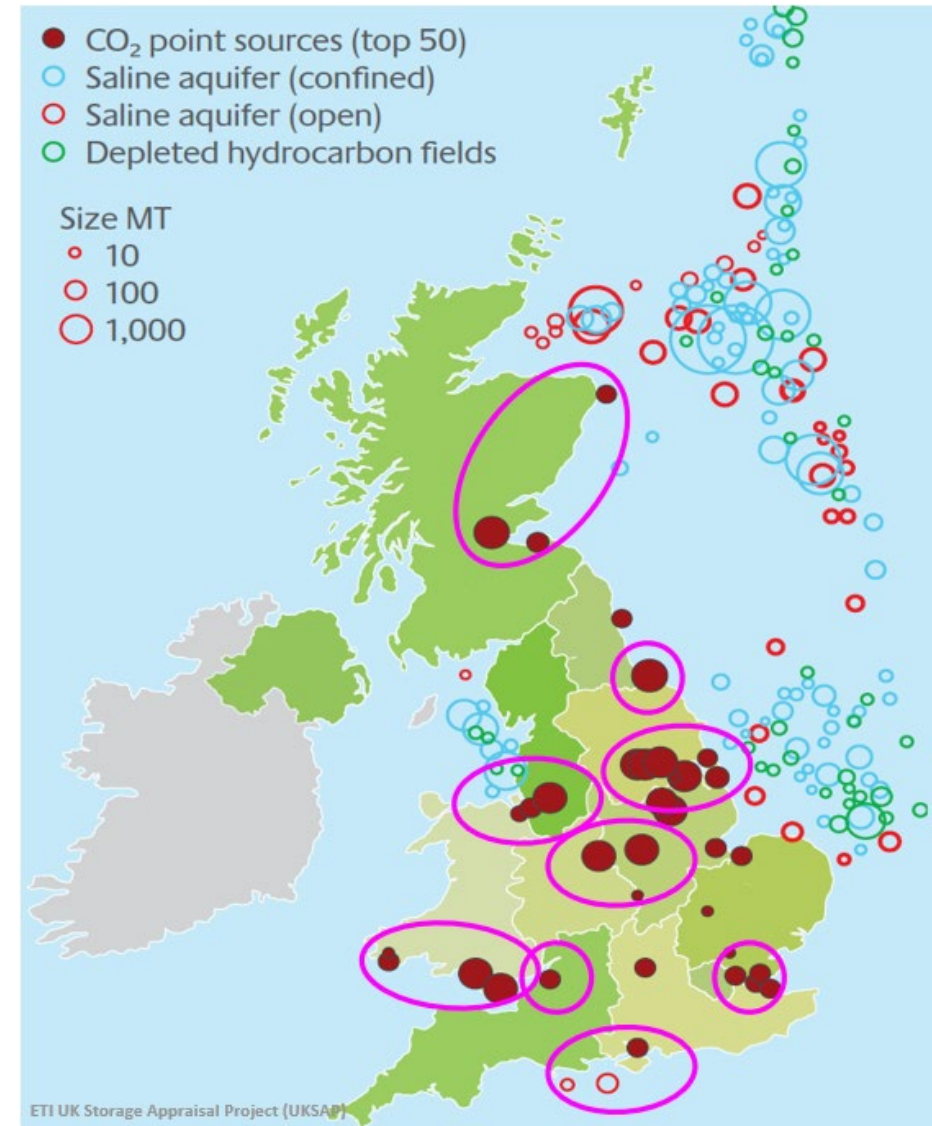
(>5 units per cluster)

(>10MtCO<sub>2</sub>/yr)

## Key points from ETI UK Storage Appraisal study\*:

- All of the nation's requirements for an aggressive CCS programme can be accommodated in the North Sea, to 2050 and beyond
- With a national plan including successful aquifer appraisal, this programme could be serviced by as little as **six shoreline hubs feeding less than 20 stores**, and having a net present infrastructure cost of less than £5bn
- **Without a national CCS infrastructure, the cost of reaching UK Climate Change targets will double** from a minimum of around £30bn per year in 2050
- **For successful commercialisation to be efficient, assets need to be shared** and onshore and offshore networks developed to achieve economies of scale
- Development of the **Southern North Sea is important as Eastern and South East England will be the country's largest emitters**
- Aquifers offer low cost storage facilities – appraisal work on these needs to start soon







\* <http://www.eti.co.uk/ccs-a-picture-of-co2-storage-in-the-uk/>



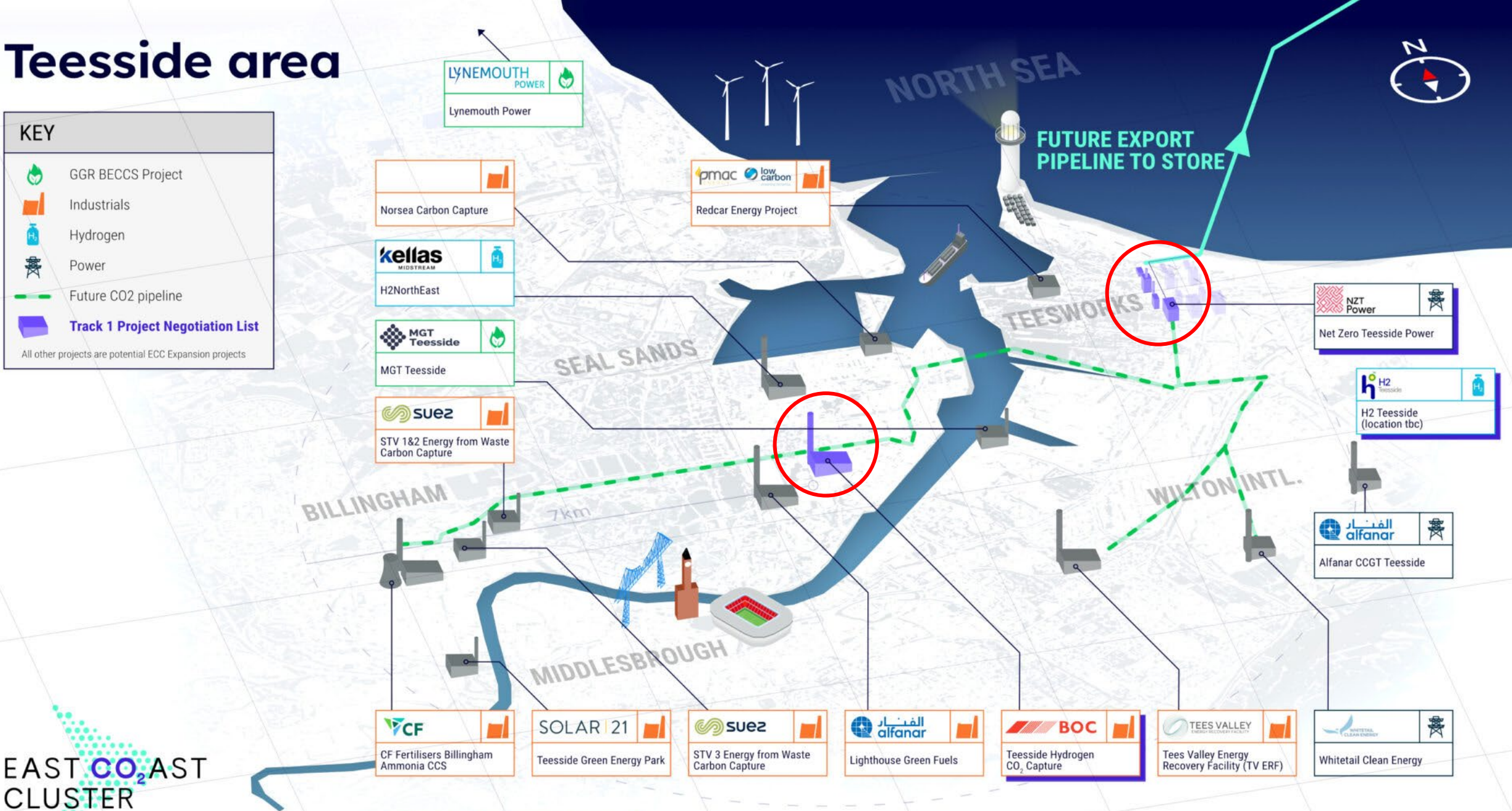


# Teesside area

**KEY**

-  GGR BECCS Project
-  Industrials
-  Hydrogen
-  Power
-  Future CO2 pipeline
-  **Track 1 Project Negotiation List**

All other projects are potential ECC Expansion projects



EAST CO<sub>2</sub> AST CLUSTER

• Pipeline routing for illustrative purposes only

<https://www.netzeroteesside.co.uk/>



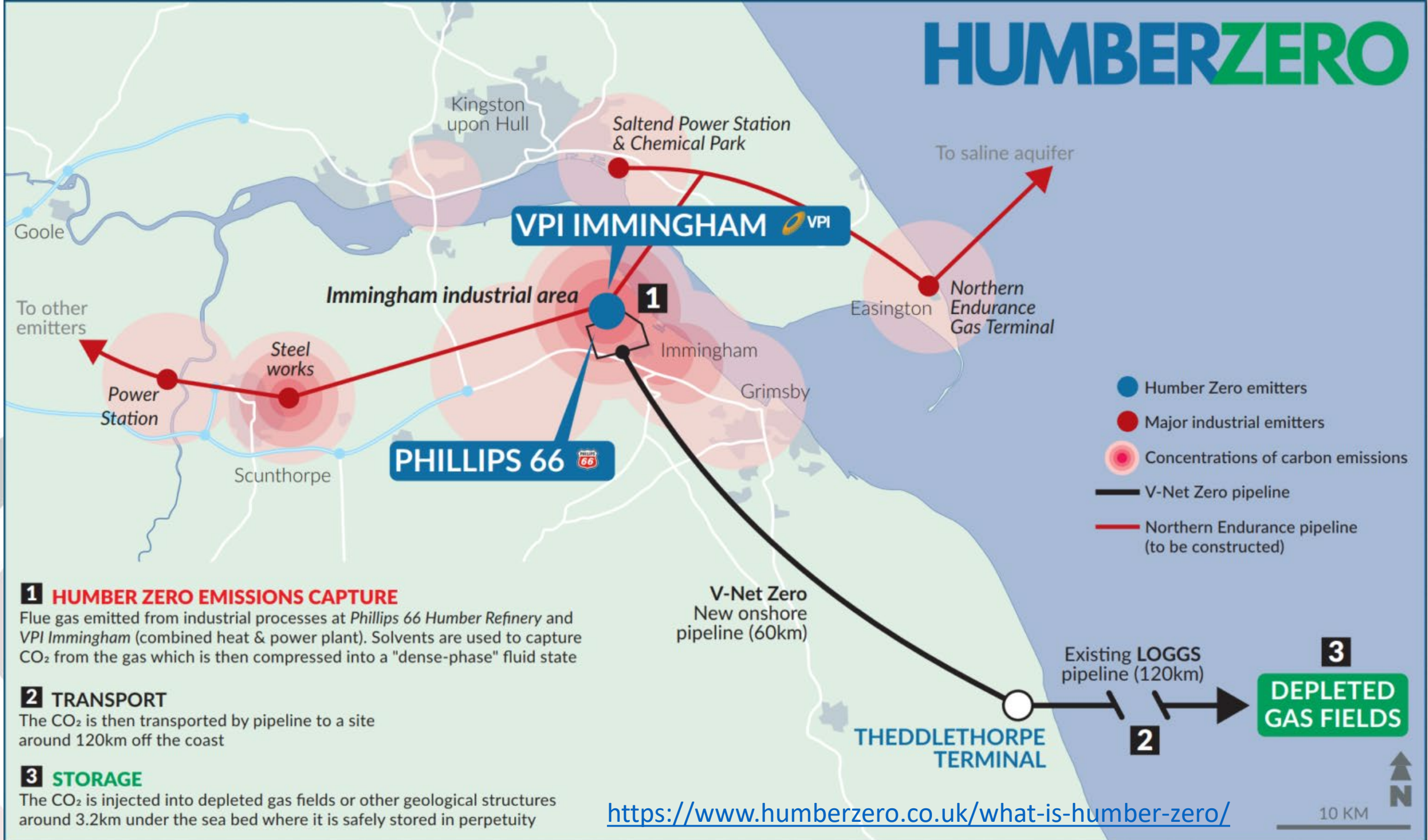
## KEY

-  INITIAL PHASES OF CADENT'S H<sub>2</sub> PIPELINE
-  FUTURE PHASES OF CADENT'S H<sub>2</sub> PIPELINE
-  CO<sub>2</sub> TRANSPORTATION AND STORAGE SYSTEM
-  FUTURE CO<sub>2</sub> PIPELINE CONNECTIONS
-  INDUSTRIAL CO<sub>2</sub> CAPTURE
-  CO<sub>2</sub> STORAGE
-  LOW CARBON H<sub>2</sub> PRODUCTION
-  UNDERGROUND H<sub>2</sub> STORAGE
-  INDUSTRIAL H<sub>2</sub> USER
-  FLEXIBLE H<sub>2</sub> POWER GENERATION
-  CO<sub>2</sub> SHIPPING
-  H<sub>2</sub> BLENDING FOR HOMES AND BUSINESS
-  H<sub>2</sub> FUELLING FOR TRANSPORT
-  H<sub>2</sub> FROM OFFSHORE WIND
-  H<sub>2</sub> FROM SOLAR AND WIND

<https://hynet.co.uk/about/>



# HUMBERZERO



## 1 HUMBER ZERO EMISSIONS CAPTURE

Flue gas emitted from industrial processes at *Phillips 66 Humber Refinery* and *VPI Immingham* (combined heat & power plant). Solvents are used to capture CO<sub>2</sub> from the gas which is then compressed into a "dense-phase" fluid state

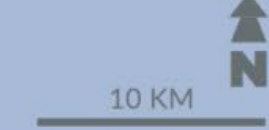
## 2 TRANSPORT

The CO<sub>2</sub> is then transported by pipeline to a site around 120km off the coast

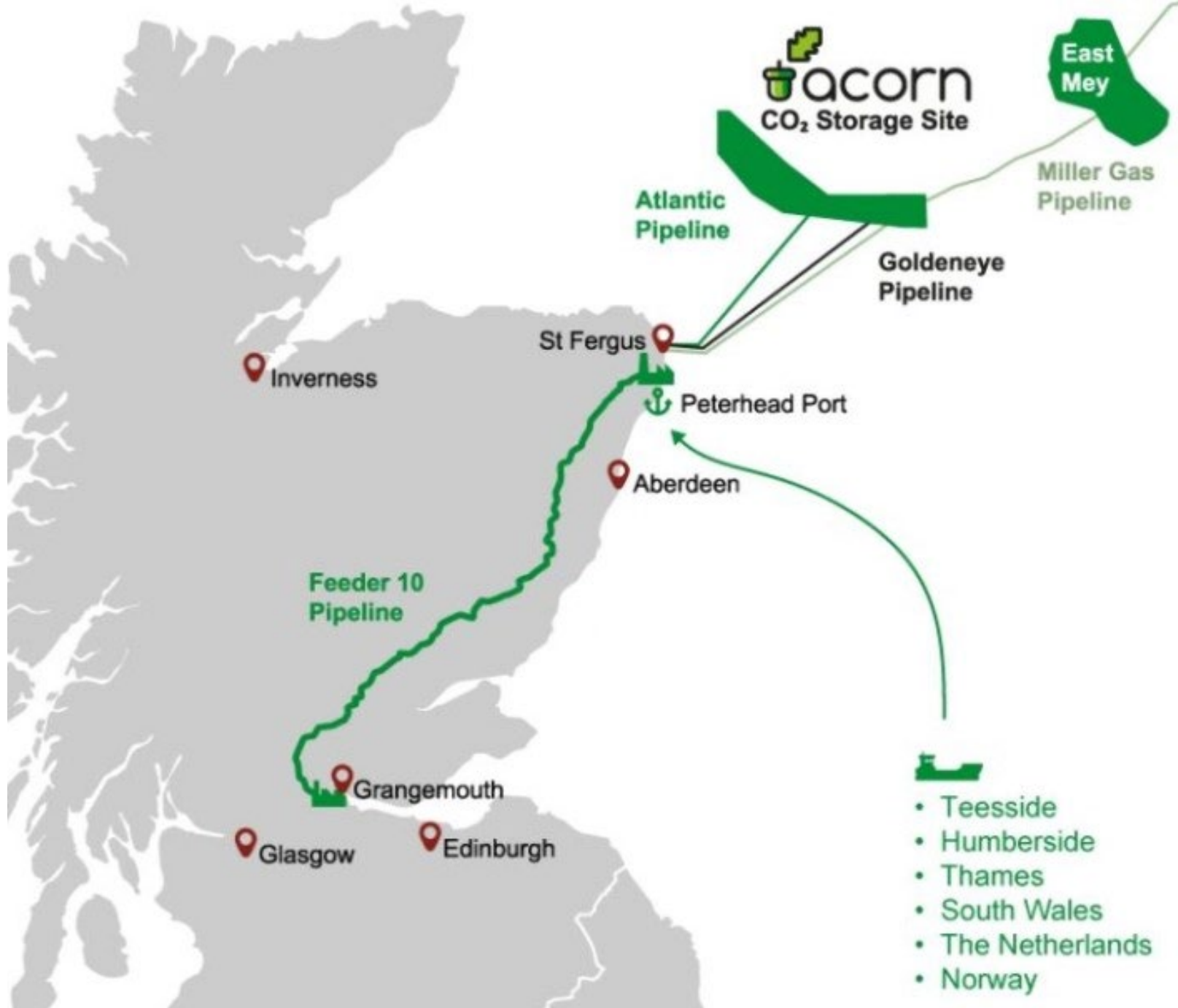
## 3 STORAGE

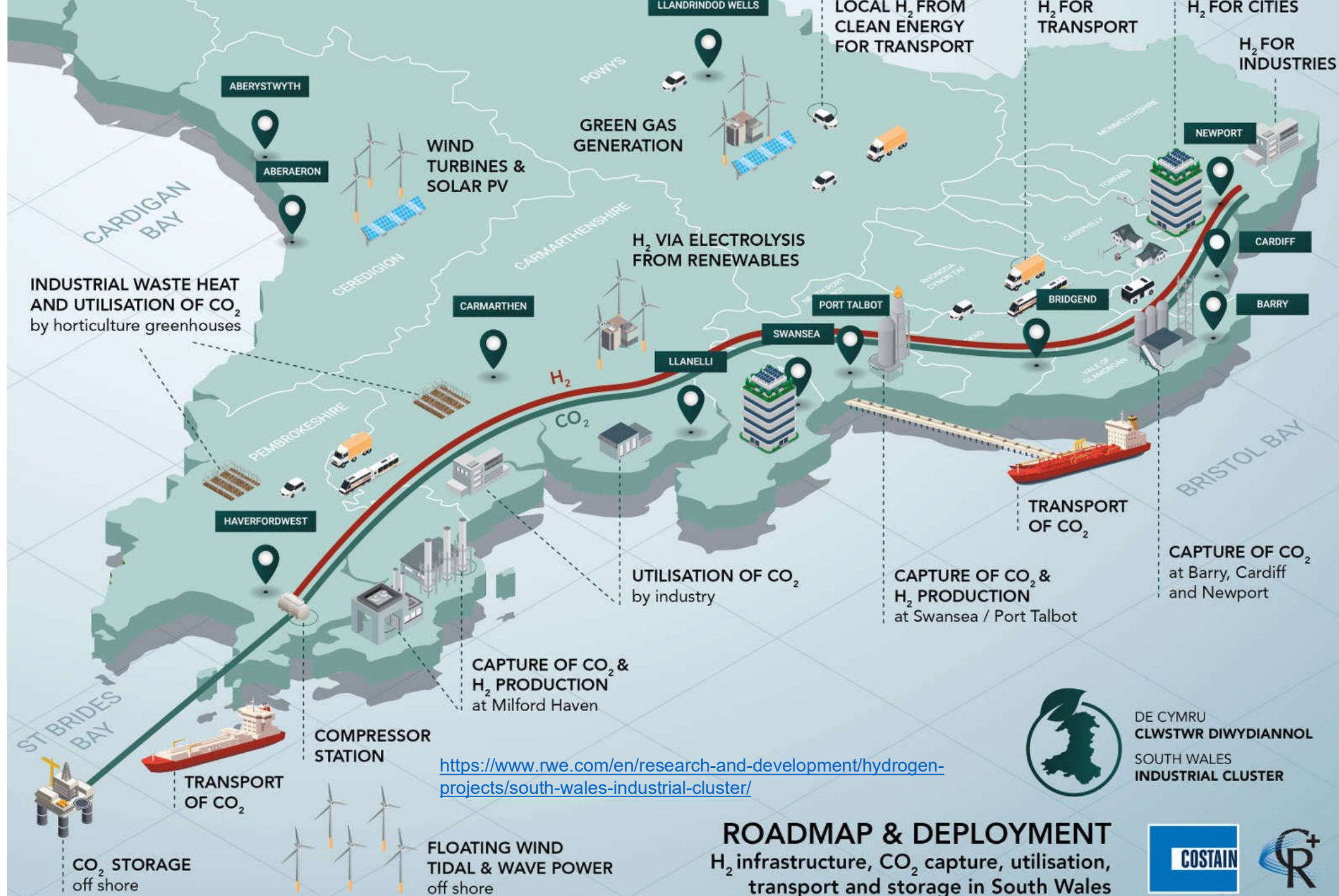
The CO<sub>2</sub> is injected into depleted gas fields or other geological structures around 3.2km under the sea bed where it is safely stored in perpetuity

<https://www.humberzero.co.uk/what-is-humber-zero/>









<https://www.rwe.com/en/research-and-development/hydrogen-projects/south-wales-industrial-cluster/>

DE CYMRU  
CLWSTWR DIWYDIANNOL  
SOUTH WALES  
INDUSTRIAL CLUSTER

**ROADMAP & DEPLOYMENT**

H<sub>2</sub> infrastructure, CO<sub>2</sub> capture, utilisation, transport and storage in South Wales

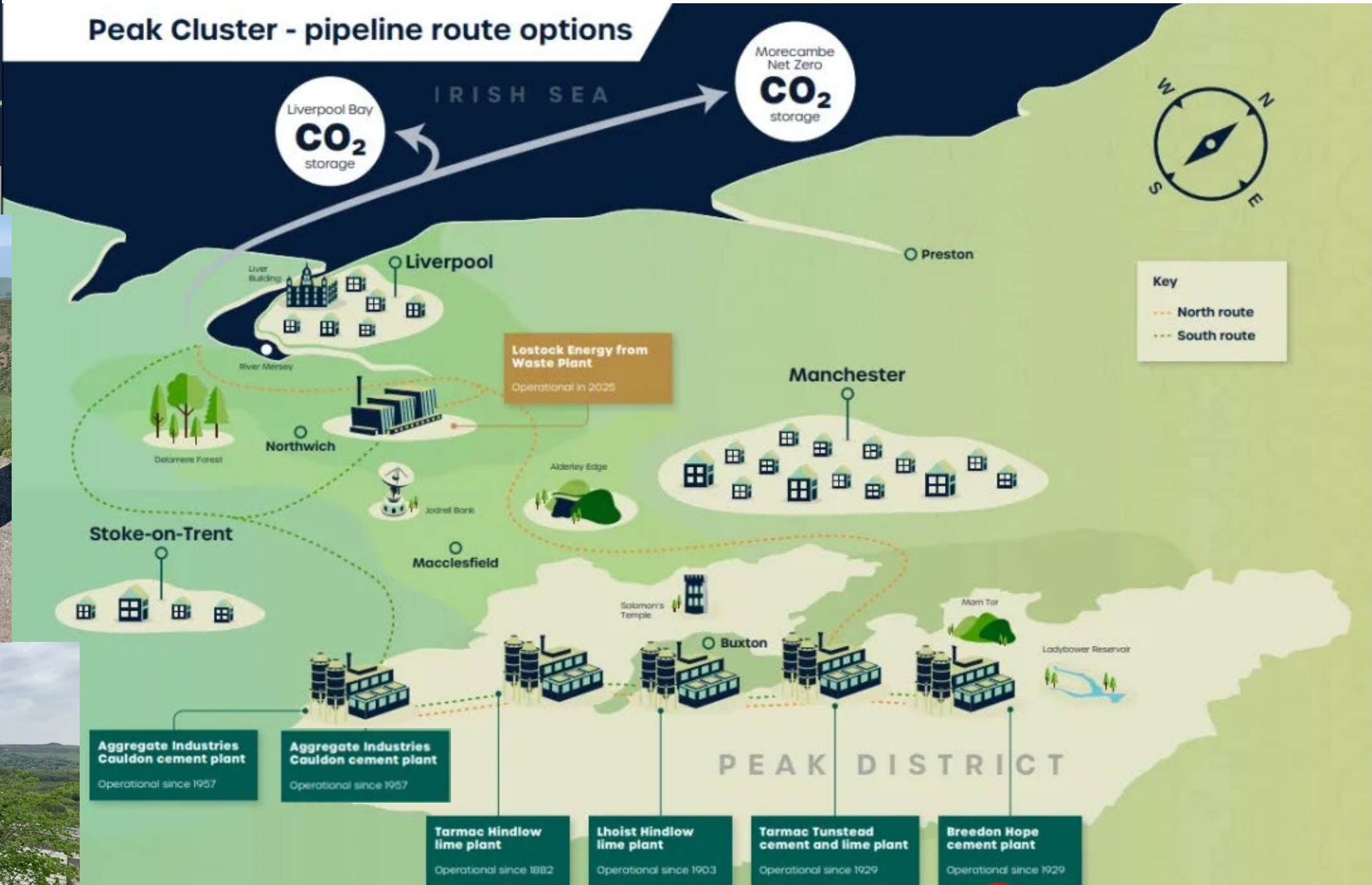








## Peak Cluster - pipeline route options



**Aggregate Industries Caudon cement plant**  
Operational since 1957

**Aggregate Industries Caudon cement plant**  
Operational since 1957

**Tarmac Hindlow lime plant**  
Operational since 1882

**Lhoist Hindlow lime plant**  
Operational since 1903

**Tarmac Tunstead cement and lime plant**  
Operational since 1929

**Breedon Hope cement plant**  
Operational since 1929

# Conclusions



UK CCS at an advanced stage following UKCCSRC initiated cluster-building discussions in 2016

- Two CO<sub>2</sub> pipeline clusters identified as 'Track 1', moving toward Final Investment Decision (FID), expected late 2023 or 2024
- Two further CO<sub>2</sub> pipeline clusters at an advanced stage of preparation
- Eight capture projects in first two clusters moving towards FID
- 100+ other capture projects at various stages of planning
- CO<sub>2</sub> shipping, rail and road transport also being planned



# Conclusions



- More detailed regulatory work is needed (<https://ukccsrc.ac.uk/best-available-technology-bat-information-for-ccs/>)
- The business models for free markets are also quite complex (<https://www.gov.uk/government/publications/carbon-capture-usage-and-storage-ccus-business-models>)
- Since 2016 the UK CCS community has grown nearly 100 times and are working **very** hard!
- **UKCCSRC membership** has grown from 1,600+ to 2,100+!
- **Horizon Europe** – UK CCS research community excited to be participating again as a fully associate member!

# Thank you

# Any questions?

Contact: [c.blunt@sheffield.ac.uk](mailto:c.blunt@sheffield.ac.uk)

Website: [www.ukccsrc.ac.uk](http://www.ukccsrc.ac.uk)

