

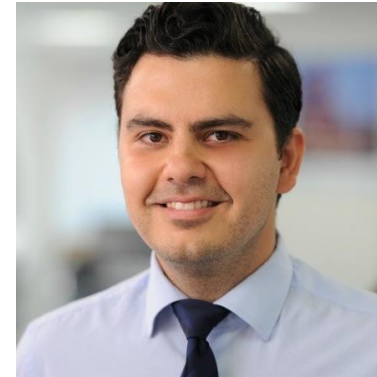
Can CCS deliver on its negative emissions promise?



Chris Gent
Policy Manager
CCSA
Introduction



Sue-Ern Tan
Group Carbon Relations Manager
Royal Dutch Shell
Role of the oil and gas sector in delivering CCS



Emrah Durusut
CCS & Industry Team Leader
Element Energy
What might the first UK CCS projects look like?



Rebecca Heaton
Head of Climate Change
Drax Power
Role of bioenergy with CCS in delivering negative emissions.



**Carbon Capture &
Storage Association**



The Status of CCUS: UK and Globally

Energy Institute
Young Professionals Network
7th May, 2020

Chris Gent
Policy Manager
CCSA

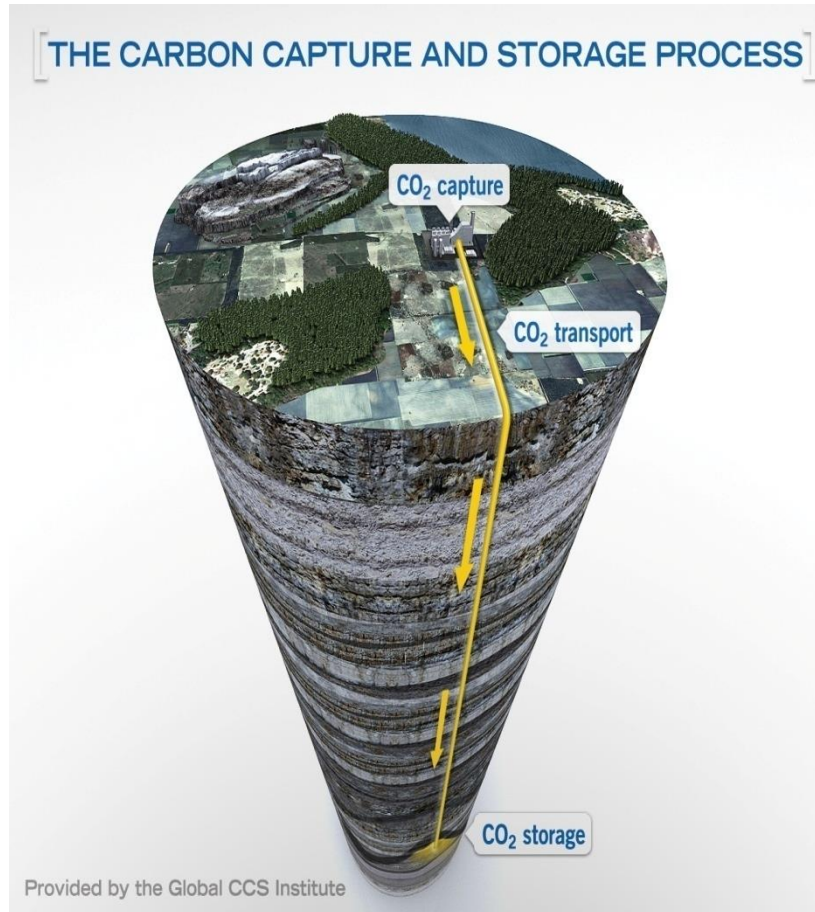
Who are we

Role and objectives

- To assist policy developments in UK, EU and internationally towards a long-term regulatory and incentive framework for CCS
- To raise awareness of CCS as a vital tool in fighting climate change and delivering sustainable long-term clean growth
- To enable the CCS industry to speak with one voice
- Focus on commercial-scale projects
- Technology neutrality (industry, power, hydrogen , BECCS, capture type etc)

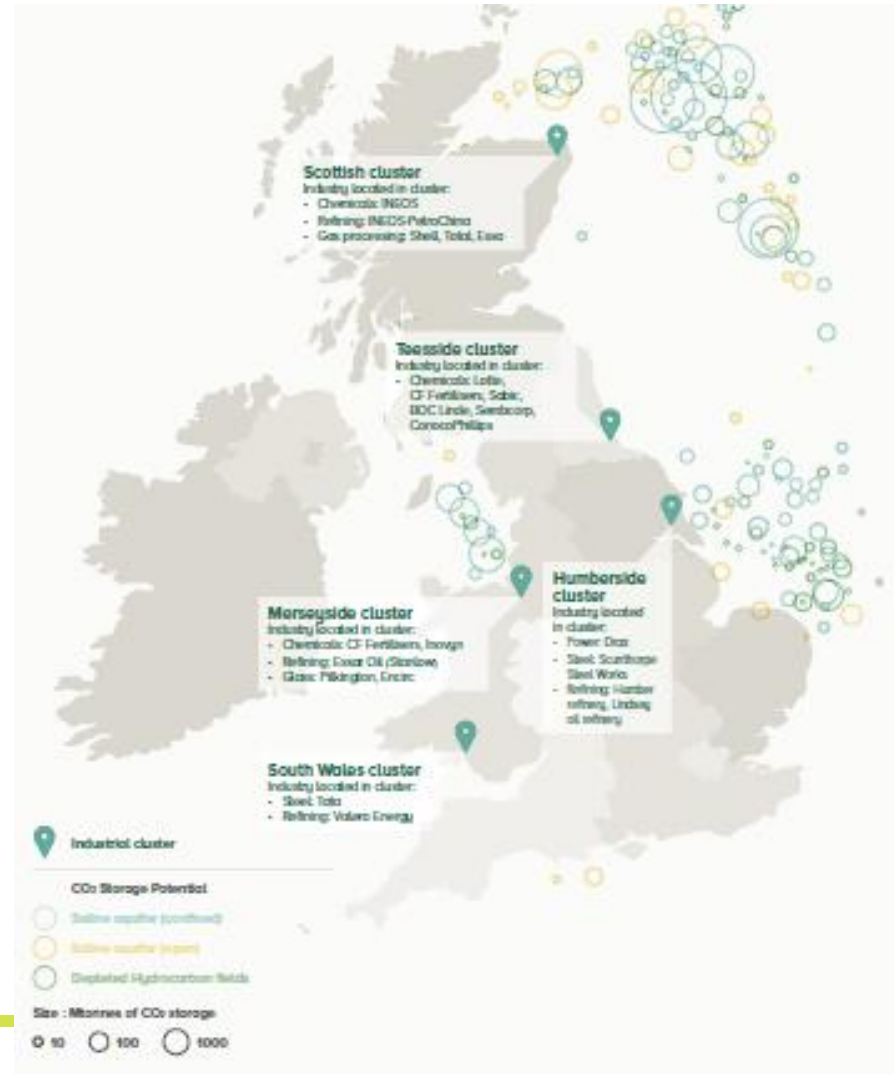


What is CCUS?

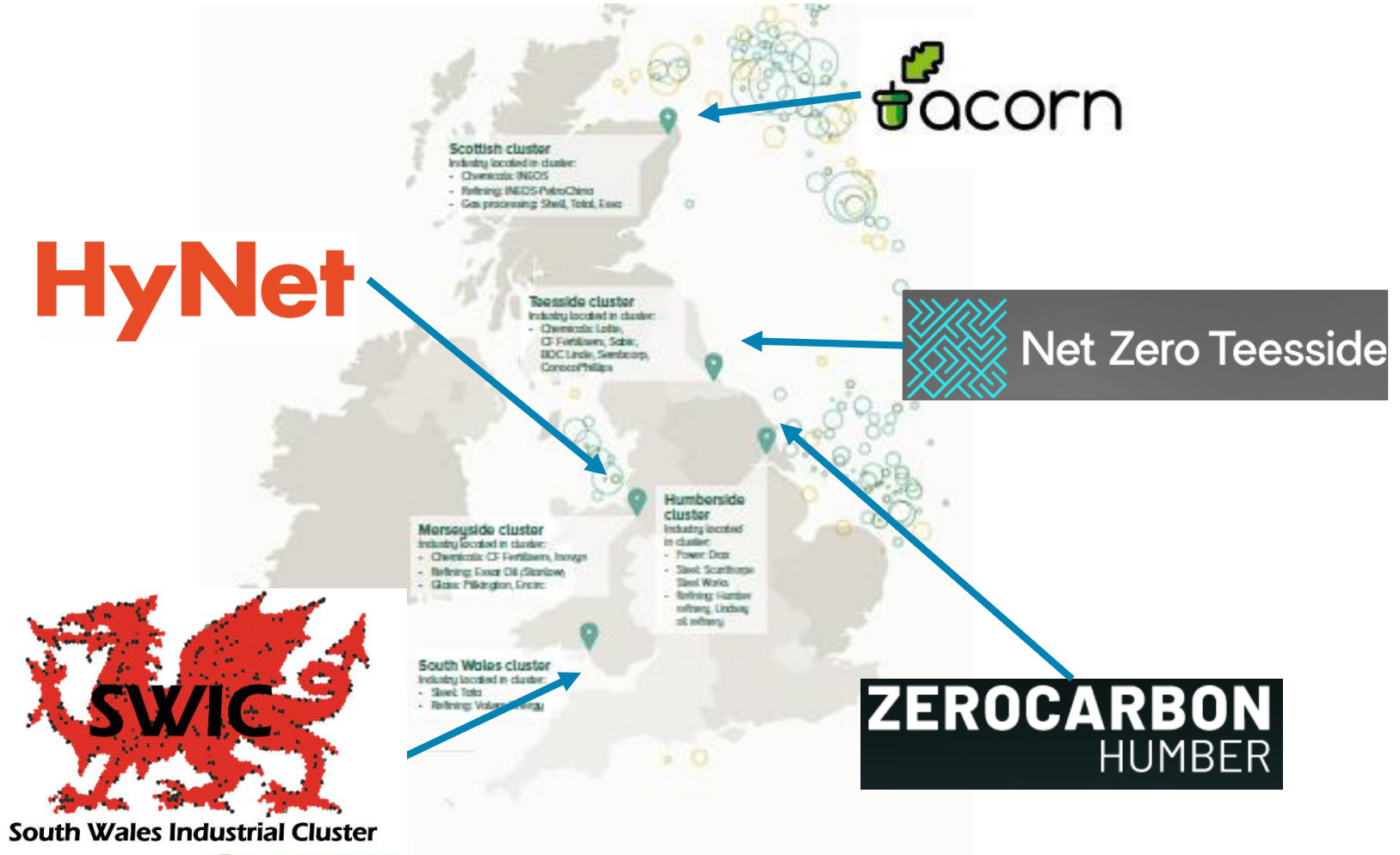


- **Capture** CO₂ from power plants, industrial sites, hydrogen production, negative emissions.
- **Transport** CO₂ via pipeline or ship
- **Store** CO₂ in deep geological formations, e.g. depleted oil & gas fields or deep saline formations.
- **Use** CO₂ in products, albeit for more limited climate benefit.

UK Projects in Industrial Clusters

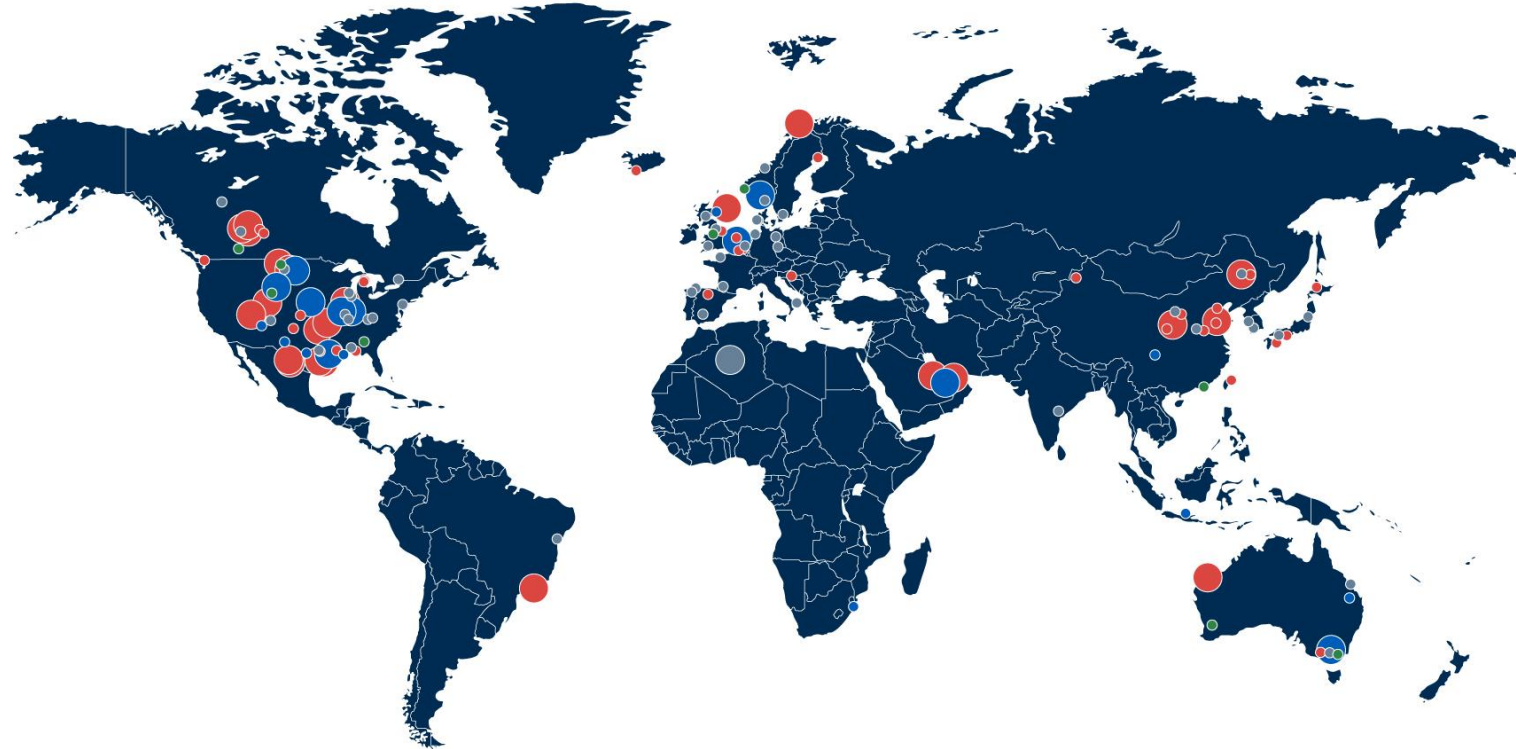


UK Projects in Industrial Clusters



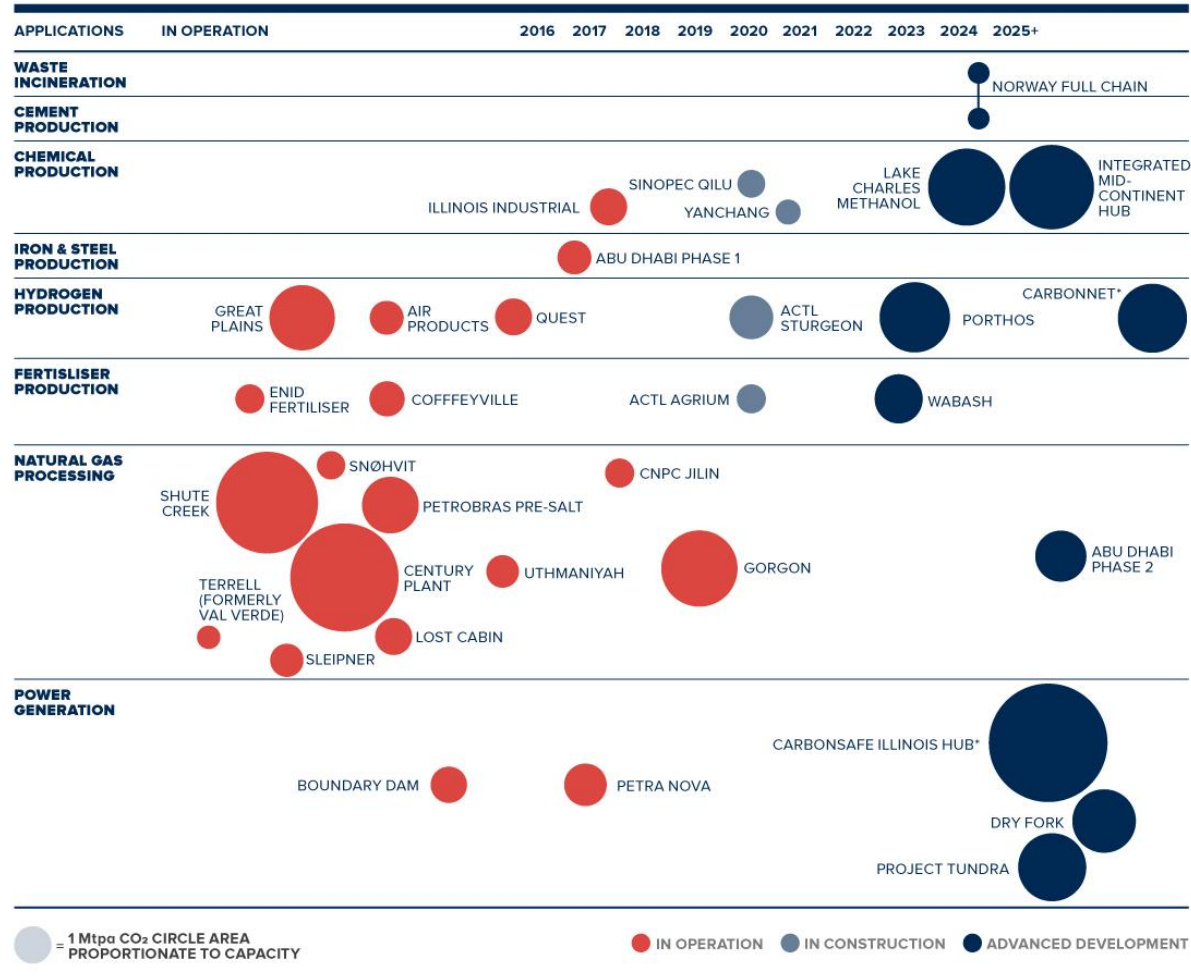
Size: Millions of CO₂ storage
 50 100 1000

Global CCUS Projects



- LARGE SCALE CCS FACILITIES IN OPERATION & CONSTRUCTION
 - LARGE SCALE CCS FACILITIES IN ADVANCED DEVELOPMENT
 - LARGE SCALE CCS FACILITIES COMPLETED
 - PILOT & DEMONSTRATION SCALE FACILITY IN OPERATION & CONSTRUCTION
 - PILOT & DEMONSTRATION SCALE FACILITY IN ADVANCED DEVELOPMENT
 - PILOT & DEMONSTRATION SCALE FACILITY COMPLETED
 - TEST CENTRE
- LARGE SCALE = >400,000 TONNES OF CO₂ CAPTURED PER ANNUM

Global CCUS Projects by sector



Contact us



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Follow us on Twitter: [@The_CCSA](https://twitter.com/The_CCSA)

The Carbon Capture & Storage Association

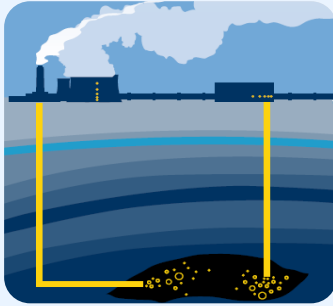
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What might the UK's first CCS projects look like?

Energy Institute YPN

7 May 2020

elementenergy

Emrah Durusut

Emrah.Durusut@element-energy.co.uk

Element Energy, a consultancy focused on the low carbon energy sector

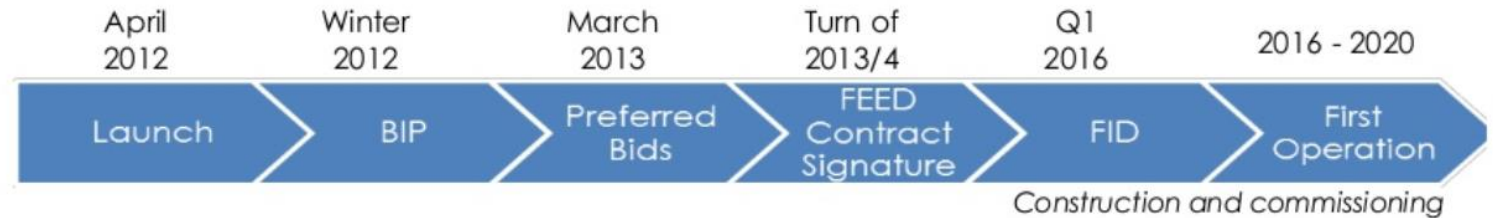
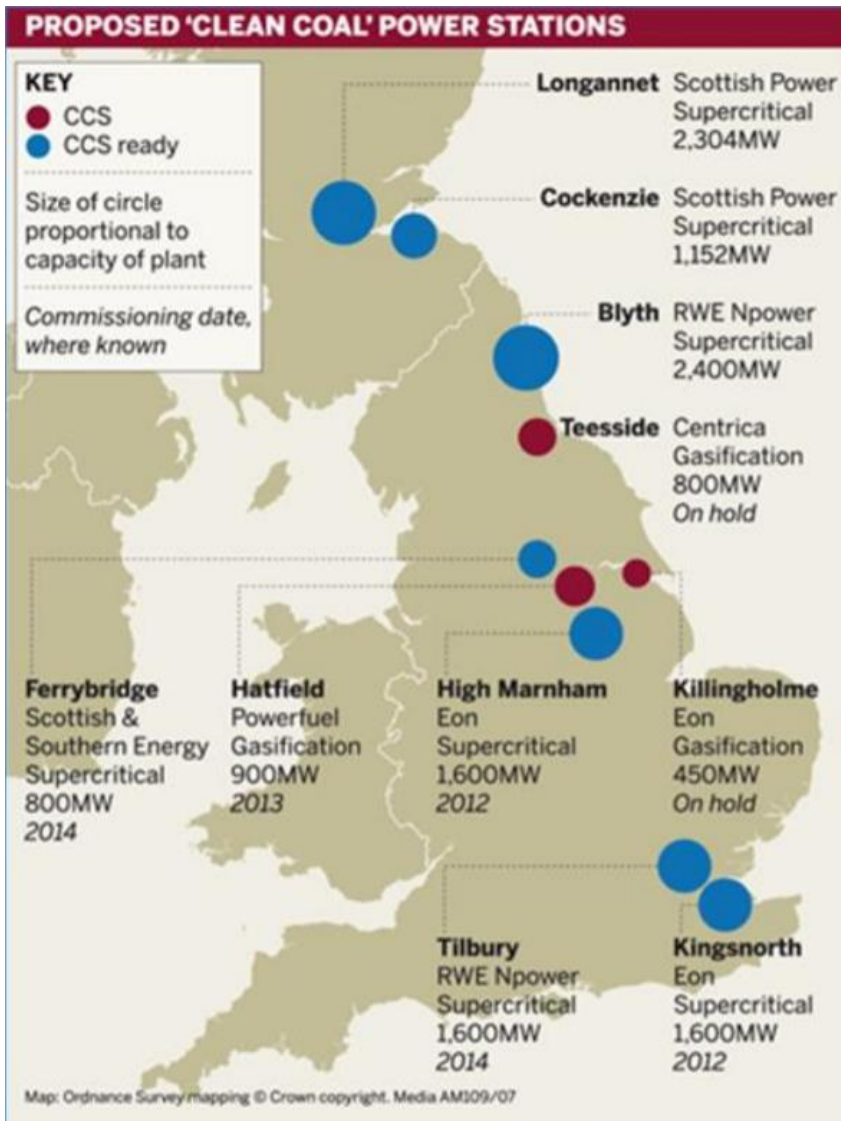
Element Energy covers all major low carbon energy sectors:



Selected clients:

Public sector	Public-Private Partnerships	Private Sector
<p>NGOs</p>		

Old CCS narrative did not work...



White Rose



- An oxyfuel capture project at a proposed new 448MW supercritical coal-fired power station on the Drax site in North Yorkshire, England
- Capturing around 90% of all carbon dioxide emissions, ~ 2 million tonnes of CO₂ per year
- Stored in natural porous rock formations under the North Sea

Peterhead

- A 340MW post-combustion capture retrofitted to part of an existing CCGT at Peterhead, Scotland
- Capturing around 85% of the carbon dioxide emissions, ~ 1 million tonnes of CO₂ per year
- Stored in a depleted gas field under the North Sea





Wed 19 Oct 2011

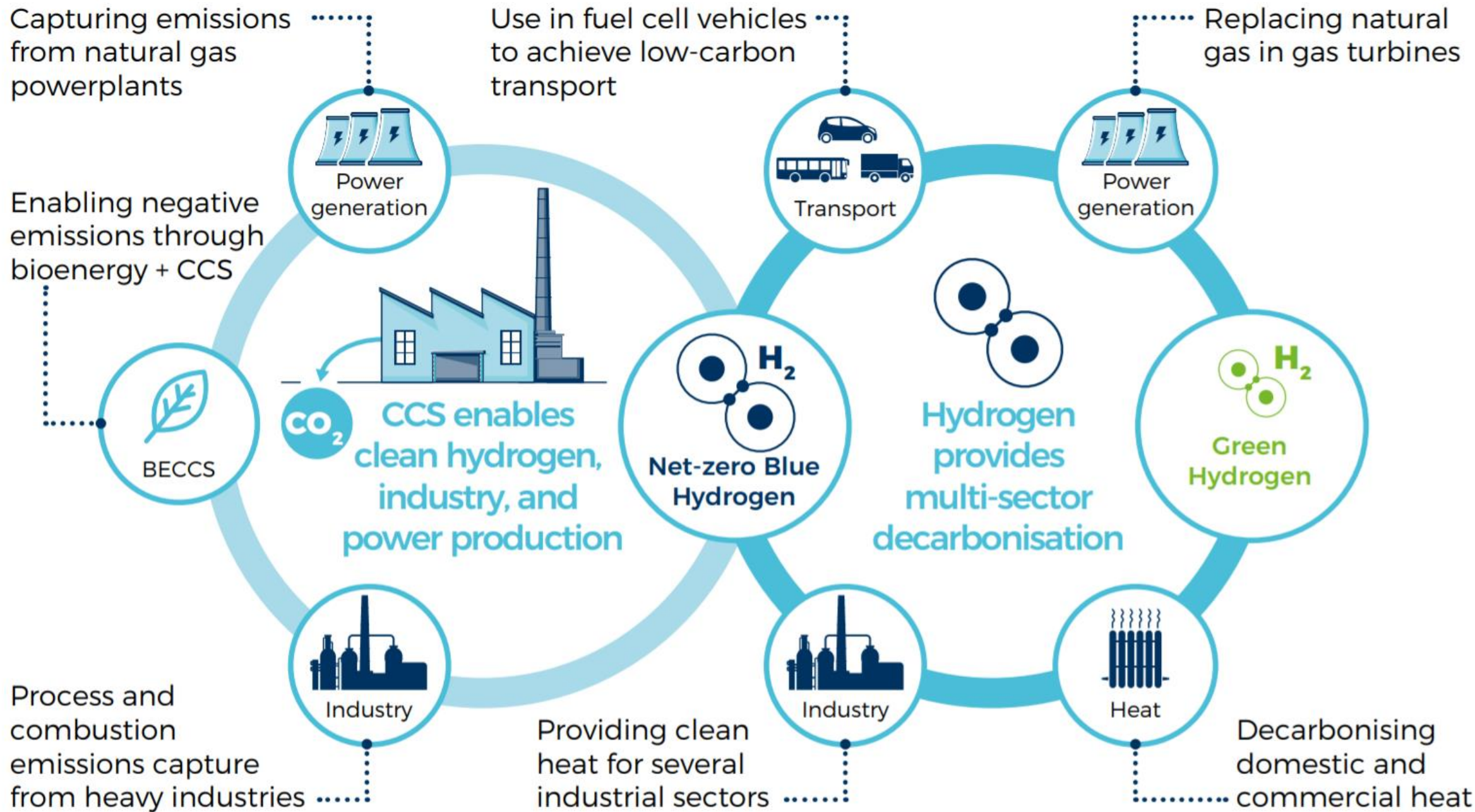
Longannet carbon capture project cancelled

Last remaining project in government competition for CCS funding scrapped as partners fall out over funding

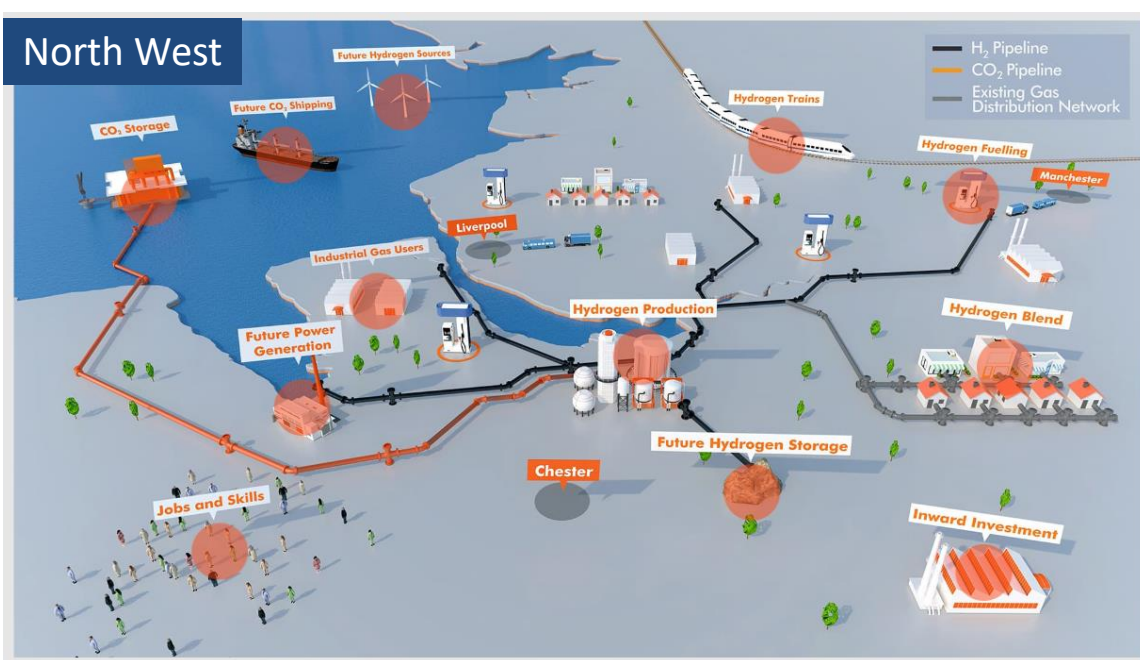
Wed 25 Nov 2015

UK cancels pioneering £1bn carbon capture and storage competition

Conservative government breaks manifesto promise on project to capture emissions from fossil fuel plants, days ahead of UN climate summit in Paris

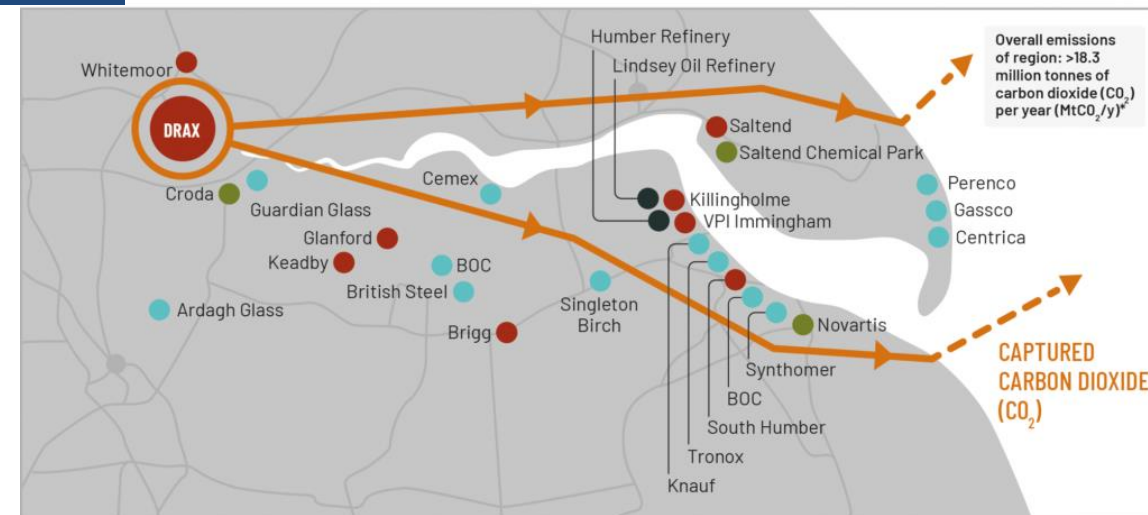


North West



Humber

POWER STATIONS AND INDUSTRIAL PROCESSES IN THE HUMBER REGION

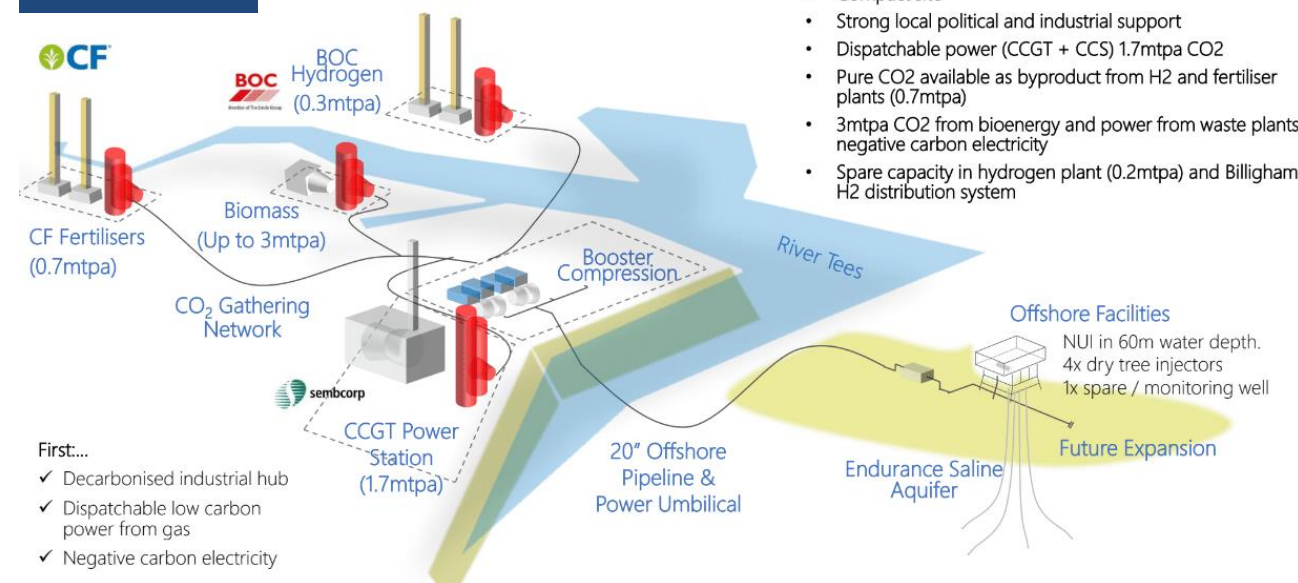


KEY
 ● Illustrative carbon dioxide transport system ● Chemical facility ● Manufacturing
 ● Power station ● Refinery * Industrial emissions figures for the Humber do not include Drax Power Station

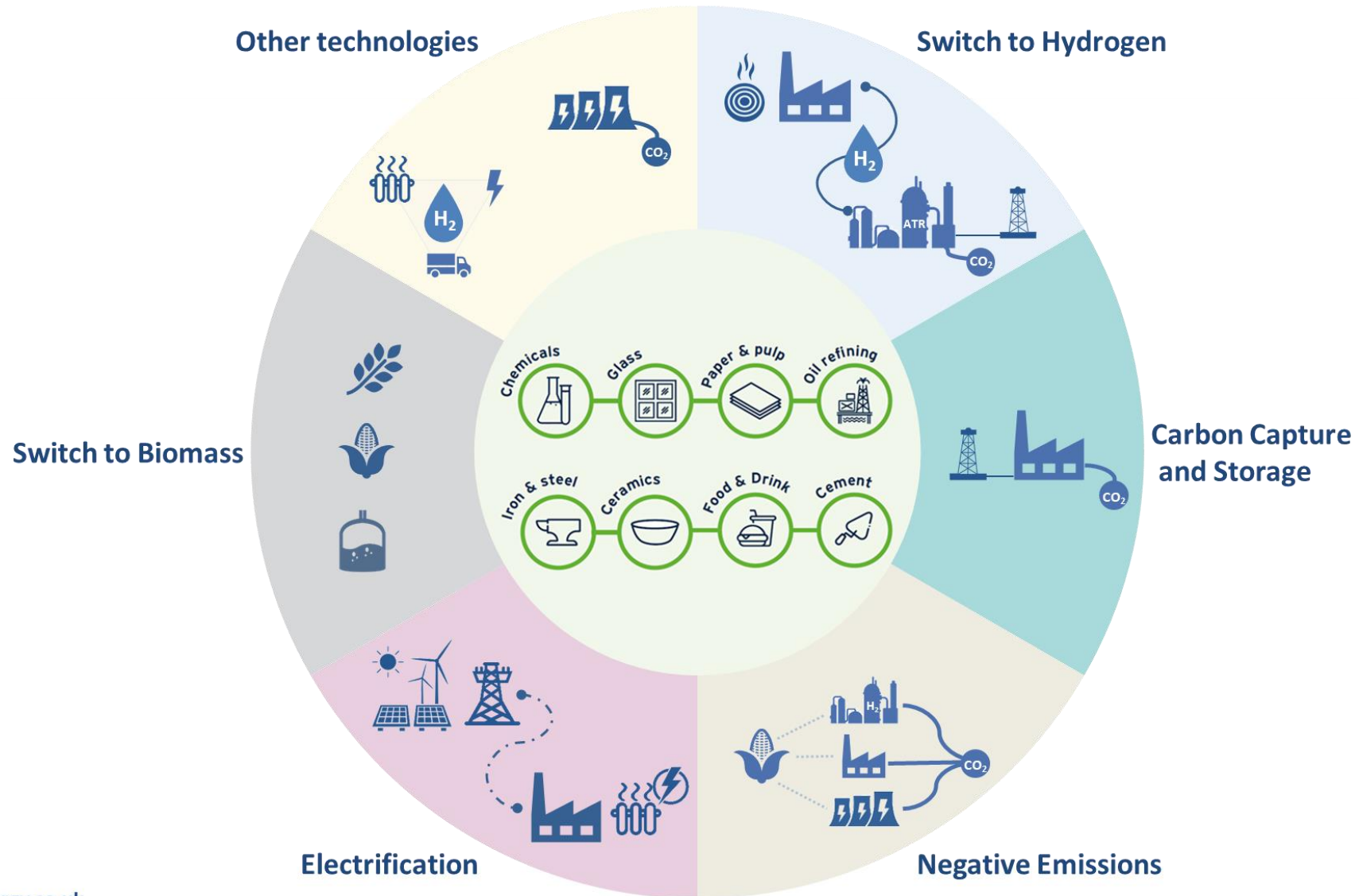
Scotland



Teesside



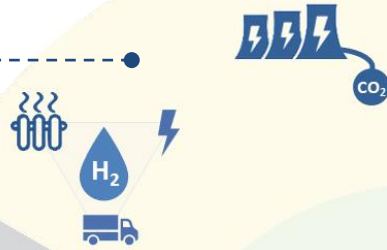
Hydrogen, industrial CCS and BECCS are needed to achieve net-zero industrial clusters...



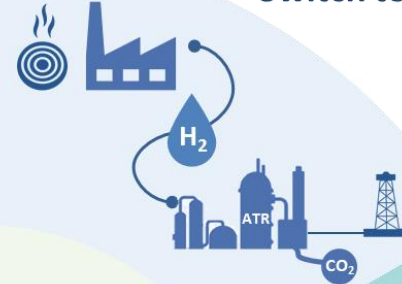
...however, there are still a few(!) policy decisions that need to be made

*Compatibility with other business models and technologies in the cluster – e.g. power CCS, H2GTs, H₂ for heat, H₂ for transport?
Process switching, process substitution?
Other industrial sectors (e.g. engineering, vehicles, etc.) and dispersed industrial sites?*

Other technologies



Switch to Hydrogen



*H₂ production business model?
Hydrogen infrastructure?
Industrial conversion and risks?*

*Biomass availability, supply risks and storage costs?
Biomass for negative emissions only?*

Switch to Biomass



Carbon Capture and Storage



*CO₂ T&S business model? (e.g. RAB, Public ownership)
Carbon capture business model?
CO₂ utilisation?*

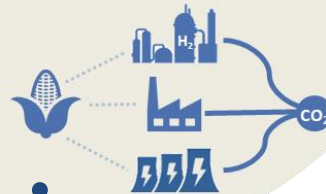
*Grid upgrades and increased demand?
Industrial conversion and supply risks?*

Electrification



*Incentives for negative emissions via H₂ production, industrial CCS or power CCS?
International trading of carbon credits?*

Negative Emissions



Element Energy is a leading low carbon energy consultancy working in a range of sectors including industrial decarbonisation, carbon capture utilisation and storage (CCUS), hydrogen, low carbon transport, low carbon heat, renewable power generation, energy networks, and energy storage. Element Energy works with a broad range of private and public sector clients to address challenges across the low carbon energy sector.

For further information please contact:
emrah.durusut@element-energy.co.uk

The background of the lower half of the slide is a stylized illustration in shades of blue. It depicts an industrial or energy landscape with silhouettes of buildings, a ship, and offshore structures. A prominent yellow line, resembling a pipeline or energy conduit, winds across the scene, connecting various points. The word 'elementenergy' is centered in the middle of this illustration in a white, sans-serif font.

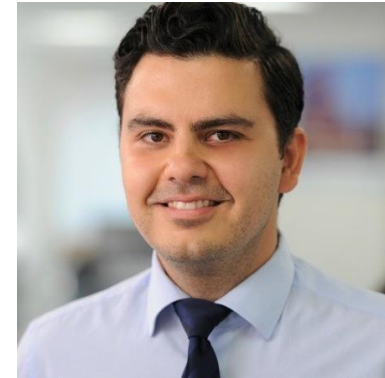
elementenergy

www.element-energy.co.uk

Can CCS deliver on its negative emissions promise?



Q&A



Emrah Durusut
CCS & Industry Team Leader
Element Energy
*What might the first UK CCS
projects look like?*



The role of the oil and gas sector in delivering CCS for net-zero

Energy Institute, Young Persons Network, CCS Webcast

Sue-Ern Tan

Group Carbon Relations Manager

Definitions and cautionary note

This presentation contains data and analysis from Shell's Sky scenario. Unlike Shell's previously published Mountains and Oceans exploratory scenarios, the Sky scenario is based on the assumption that society reaches the Paris Agreement's goal of holding the rise in global average temperatures this century to well below two degrees Celsius (2°C) above pre-industrial levels. Unlike Shell's Mountains and Oceans scenarios, which unfolded in an open-ended way based upon plausible assumptions and quantifications, the Sky scenario was specifically designed to reach the Paris Agreement's goal in a technically possible manner. These scenarios are a part of an ongoing process used in Shell for over 40 years to challenge executives' perspectives on the future business environment. They are designed to stretch management to consider even events that may only be remotely possible. Scenarios, therefore, are not intended to be predictions of likely future events or outcomes.

Additionally, it is important to note that as of April 16, 2020, Shell's operating plans and budgets do not reflect Shell's net-zero emissions ambition. Shell's aim is that, in the future, its operating plans and budgets will change to reflect this movement towards its new net-zero emissions ambition. However, these plans and budgets need to be in step with the movement towards a net-zero emissions economy within society and among Shell's customers.

Also, in this presentation we may refer to "Shell's Net Carbon Footprint", which includes Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions but, to support society in achieving the Paris Agreement goals, we aim to help and influence such suppliers and consumers to likewise lower their emissions. The use of the terminology "Shell's Net Carbon Footprint" is for convenience only and not intended to suggest these emissions are those of Shell or its subsidiaries.

The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this presentation "Shell", "Shell group" and "Royal Dutch Shell" are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to Royal Dutch Shell plc and its subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. "Subsidiaries", "Shell subsidiaries" and "Shell companies" as used in this presentation refer to entities over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as "joint ventures" and "joint operations", respectively. Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

This presentation contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as "aim", "ambition", "anticipate", "believe", "could", "estimate", "expect", "goals", "intend", "may", "objectives", "outlook", "plan", "probably", "project", "risks", "schedule", "seek", "should", "target", "will" and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this presentation, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell's products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including regulatory measures addressing climate change; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; (m) risks associated with the impact of pandemics, such as the COVID-19 (coronavirus) outbreak; and (n) changes in trading conditions. No assurance is provided that future dividend payments will match or exceed previous dividend payments. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional risk factors that may affect future results are contained in Royal Dutch Shell's Form 20-F for the year ended December 31, 2019 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward-looking statements contained in this presentation and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, May 7, 2020. Neither Royal Dutch Shell plc nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation.

We may have used certain terms, such as resources, in this presentation that the United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.

CCS has a key role to play in the energy transition





- CCS is essential for deep decarbonization of heavy industries.
- CCS can provide value to society through creating and retaining jobs.
- Accelerating the pace of CCS deployment requires collaboration between governments, industry and investors, amongst others, to:
 - Help unlock financing capacity.
 - Accelerate technology development.
 - Encourage public support.



Shell's strategic ambitions is to provide a world-class investment case, to thrive in the transition, and to sustain a strong societal license to operate.

CCS is a part of this overall strategy and makes it easier to manage the transition and develop potential new business areas.

CCS is essential for deep decarbonisation of heavy industry

	 Electrification of heat	 Hydrogen as fuel or feedstock	 Biomass as fuel or feedstock ²	 CCS
Cement	✓	✓	✓	✓
Iron and steel		✓	✓	✓
Ammonia		✓	✓	✓
Ethylene	✓	✓	✓	✓
Other industry ¹ (heat)	✓	✓	✓	✓

- ✓ Applied at industrial scale
- ✓ Technology (to be applied)
- ✓ In pilot site (applied) research phase

CCS Applied at Industrial Scale



Iron & Steel, UAE
Emirates Steel Industries
0.8 Mt/a of CO₂ to EOR



Ammonia, USA
Coffeyville Resources Nitrogen Fertilizers
0.8 Mt/a of CO₂ to EOR

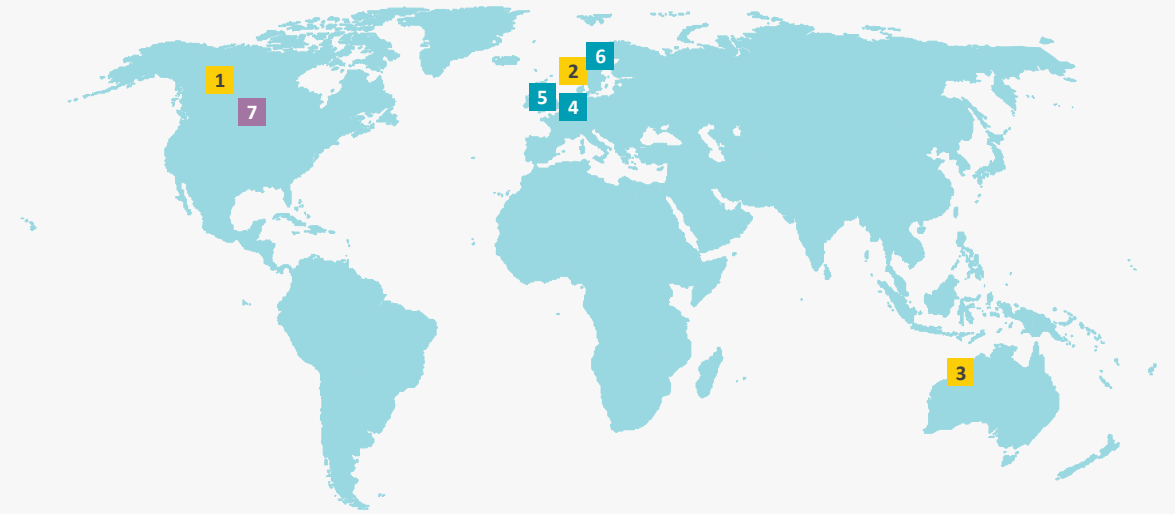
¹ Includes heat demand in other sectors, such as manufacturing, construction, food and tobacco, etc.

² Type of biomass depends on the sector and process: Cement (mostly solid or gaseous biomass), Iron and steel (charcoal or biogas), ammonia (biogas), ethylene (biodiesel, sugar, bioethanol)

Source: data from McKinsey (2018), GCCSI (2018)

Copyright of Shell International B.V.

Shell is involved in a number of CCS projects in different phases of development



Projects in operation

Projects under planning

Involvement through Shell
Cansolv technology
– no Shell equity



1

Quest



2

TCM



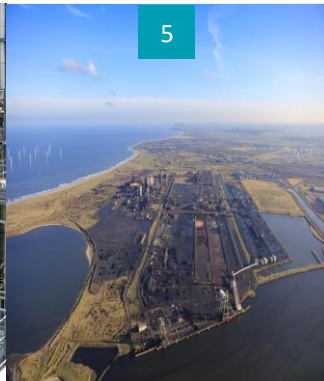
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Gorgon



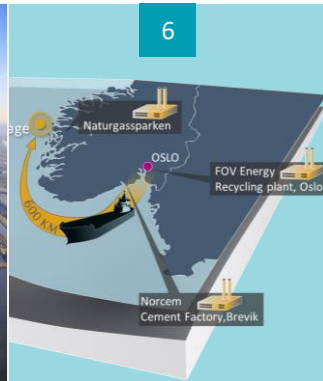
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Pernis CCS



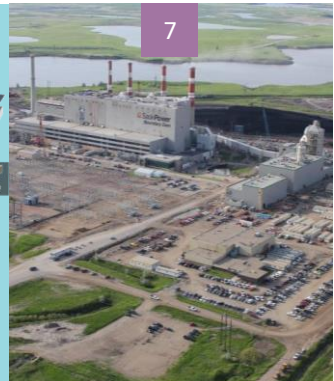
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Net Zero Teesside



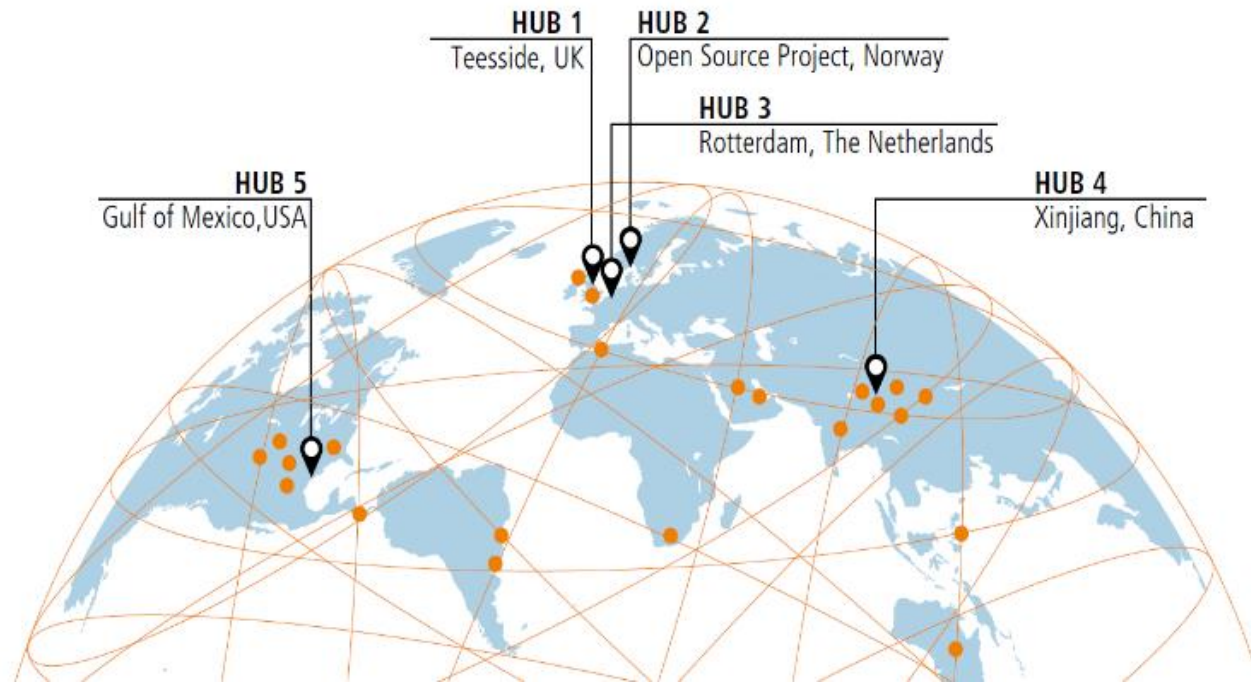
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Northern Lights



7

Boundary Dam



Hubs' Industrial Characteristics

- Biomass power
- Gas power
- Waste incineration
- Fertilizers
- Petrochemicals
- Hydrogen
- Cement
- Steel
- Aluminium
- Refineries
- CO₂ imports

Objective

- Play our part in the emergence of a commercially viable, safe and environmentally responsible CCUS industry
- Help facilitate large scale commercial investment in CCUS
- Bring stakeholders together to enable multiple low carbon industrial hubs

OGCI efforts

- Help 5 emerging hubs to reach operations
- Identification and maturation of future hubs in a number of additional countries
- Clean Energy Ministerial-OGCI joint declaration on accelerating the CCUS industry to explore ways to work together to drive CCUS deployment



**Can CCS deliver on its
negative emissions
promise?**



Q&A



Sue-Ern Tan
Group Carbon Relations Manager
Royal Dutch Shell
*Role of the oil and gas sector in
delivering CCS*

drax

Welcome to Drax

13 May 2020

About Drax

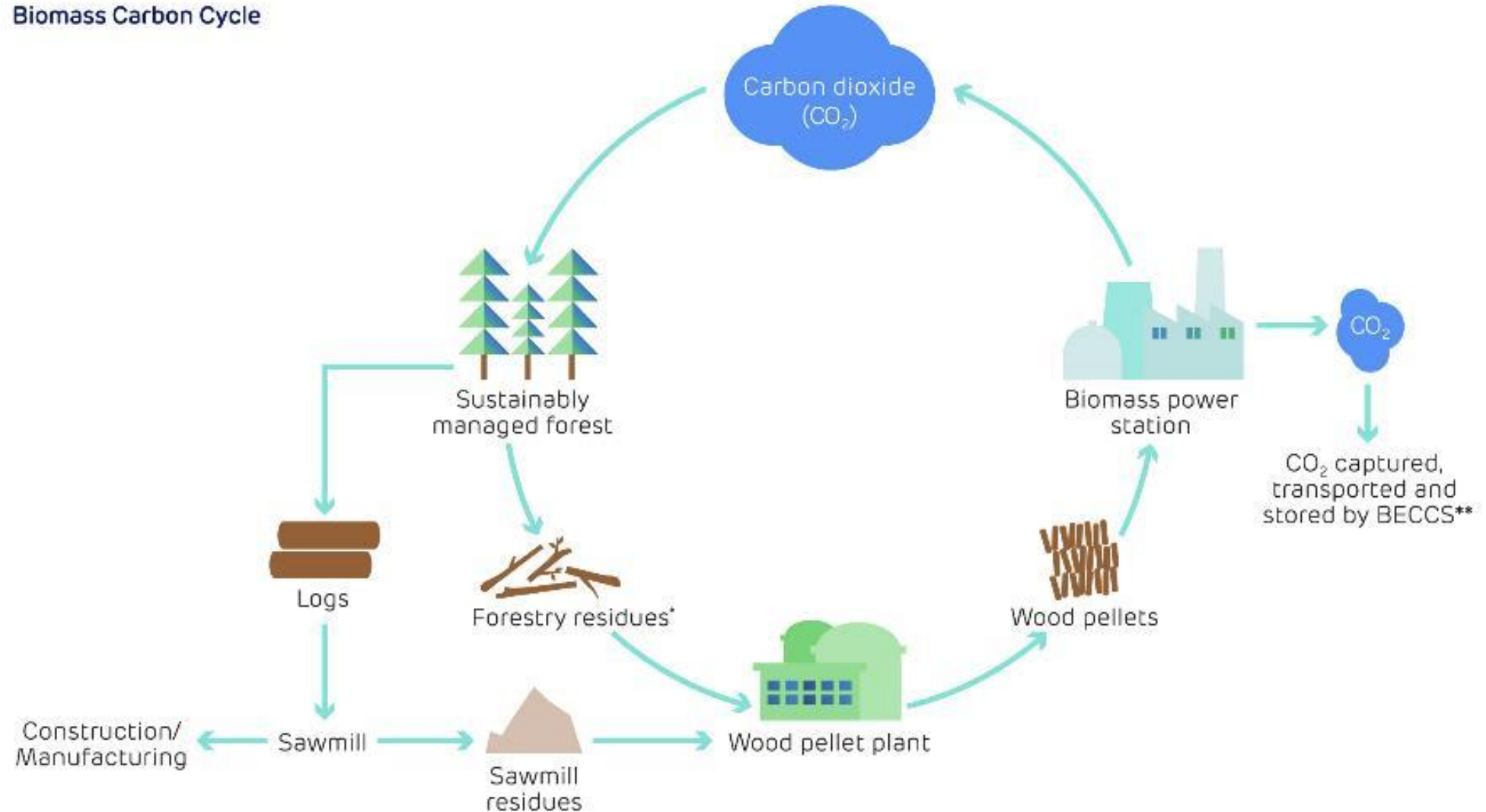


- We've transformed from the UK's largest coal-fired Power Station, into **Europe's largest decarbonization project**
- We're the **largest generator of renewable electricity in the UK (12%)**
- We're the **third largest generator in the UK (8.3m homes)**
- Our operations and supply chain **support 18,000 jobs**
- We're a leading producer of wood pellets from **sustainably managed working forests**
- Our Customers businesses, Haven Power & Opus Energy, are **the UK's largest supplier of renewable energy to businesses (396,000 meter points)**
- Our BECCS pilot project could create **the world's first carbon negative power station**

What is Biomass Energy with Carbon Capture and Storage?

BECCS and its role in removing CO₂ from the atmosphere.

Biomass Carbon Cycle



BECCS & Negative Emissions

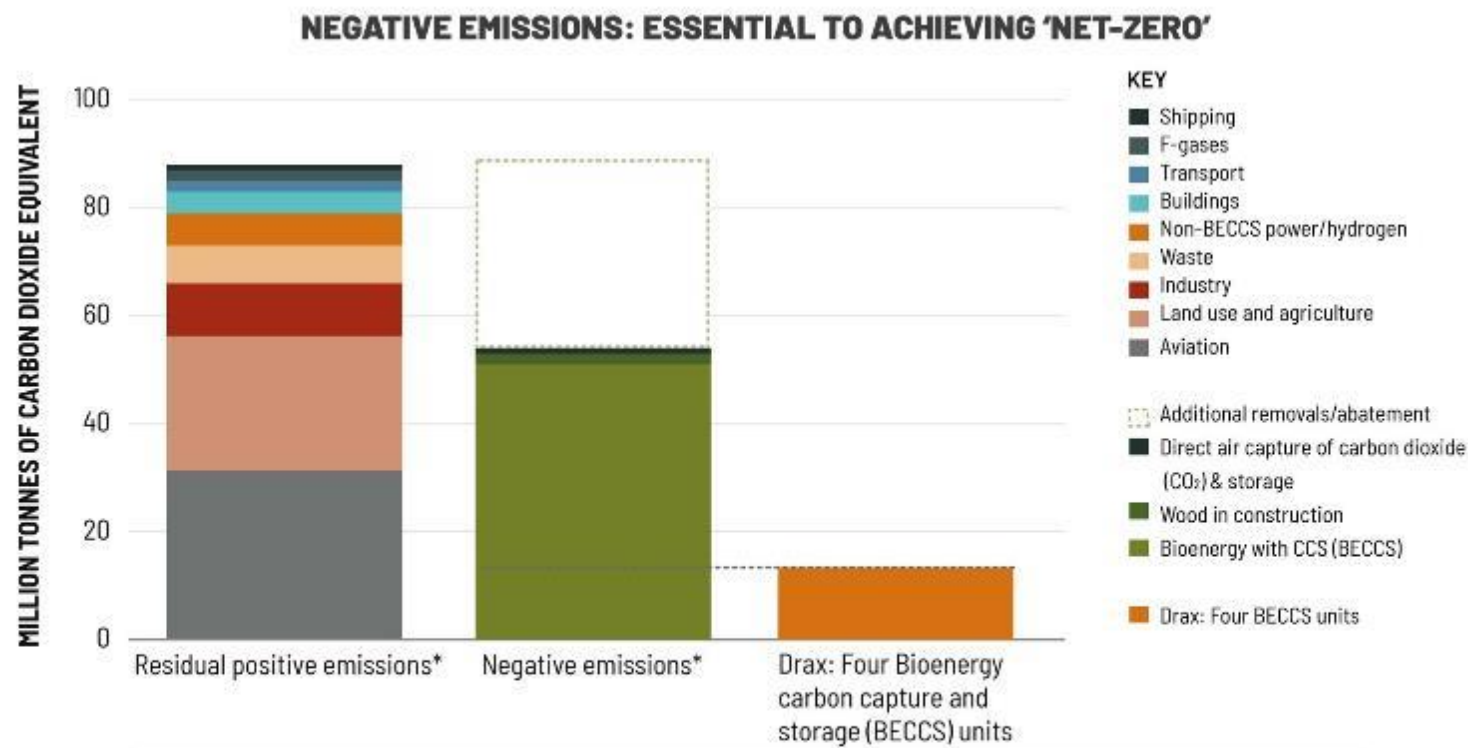
Net Zero by 2050

For the UK to achieve “Net Zero by 2050”, **negative emissions technology must be deployed to counteract the residual positive emissions** left over from sectors such as shipping and aviation;

The Committee on Climate Change (CCC) has recommended that **Bioenergy with CCS at scale should be deployed in at least one industrial cluster by 2030**

We’ve set an ambition to be the **World’s first carbon negative company**. With the right policy framework – we believe **this is achievable within a decade**.

The chart below shows the amount of negative emissions that full BECCS deployment at Drax can contribute to the UK achieving “Net Zero by 2050”



*Source: Committee on Climate Change, 'Net Zero' report (2019)

Notes: Sectoral emissions and contributions from negative emissions presented for the Further Ambition scenario. The contribution from 'additional negative emissions abatement' refers to the options to go beyond the Further Ambition scenario and achieve net-zero emissions, which can be done with additional negative emissions and/or further reductions of positive emissions (see Chapter 5).

BECCS & Negative Emissions

BECCS Pilot Project

Our bioenergy with carbon capture and storage (BECCS) pilot project has proven that **carbon negative power generation is possible.**

- Our joint venture pilot project with C-Capture has been **capturing 1 tonne of CO₂ per day since 2019**
- It's the first carbon capture project from **100% sustainable biomass feedstock in the World**
- Research is being undertaken to explore how BECCS can be achieved to capture CO₂ **on a mass scale**



BECCS & Negative Emissions

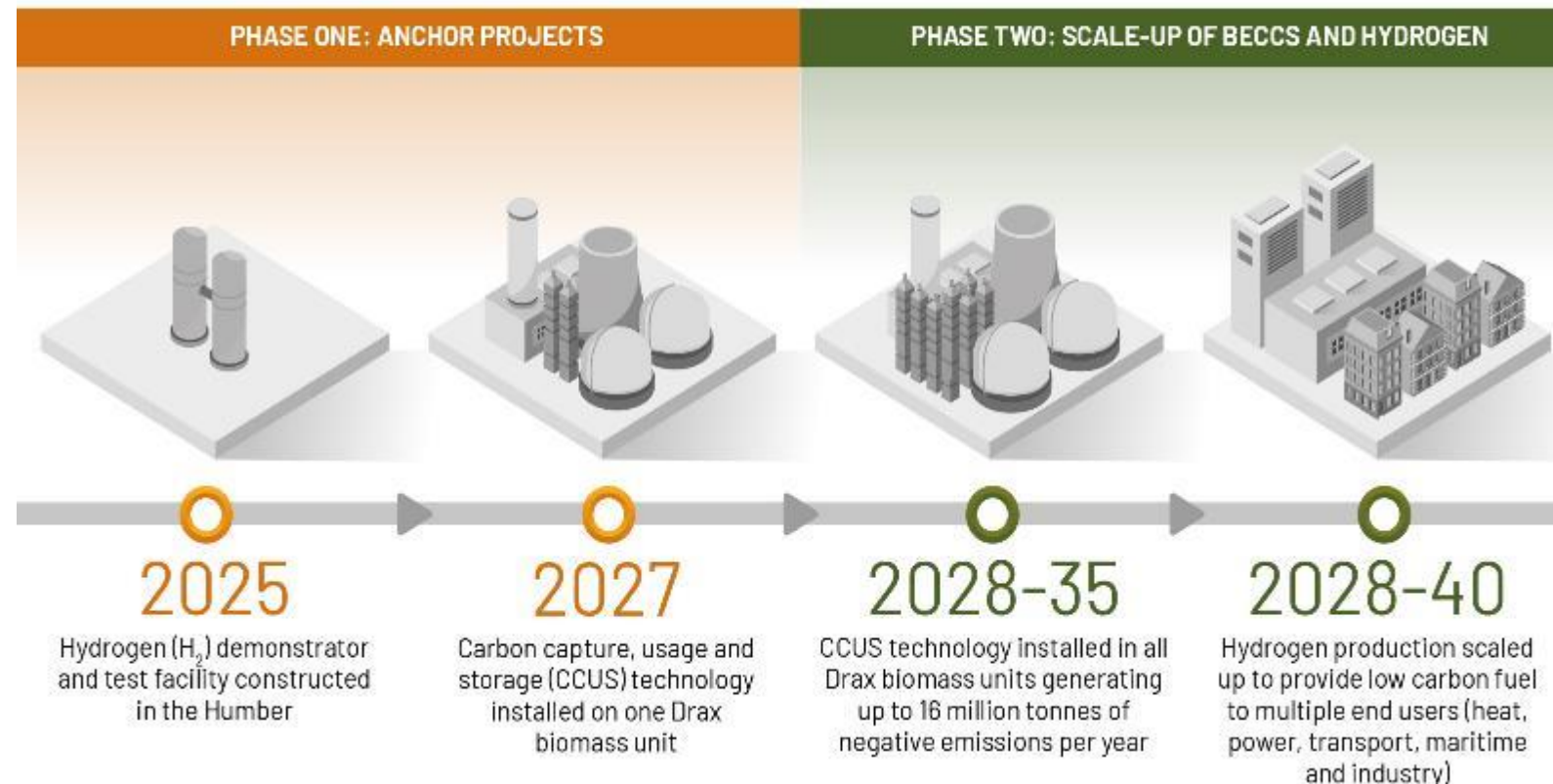
Zero Carbon Humber Campaign

In 2019, Drax, Equinor, and National Grid Ventures created a partnership demonstrating how **they have the potential to decarbonise the Humber**;

- Drax is the anchor project and BECCS technology would be deployed here to **create carbon negative power generation**
- The carbon captured will be transported via **a pipeline through the Humber and stored safely** in the North Sea
- **Heavy emitters** can deploy CCS technology and **join the Humber pipeline**
- **Hydrogen** will be produced in the Humber region to **provide cleaner heating**

The chart below shows the amount of negative emissions that full BECCS deployment at Drax can contribute to the UK achieving “Net Zero by 2050”

ZERO CARBON HUMBER PROJECTS TIMELINE



Investment in BECCS plants could be enabled through multiple policy options



CfD only solution

- **Advantages:** No new scheme needed
- **Disadvantages:** Higher electricity costs, costs not aligned with who benefits, no obvious evolution to long term GGR mechanism



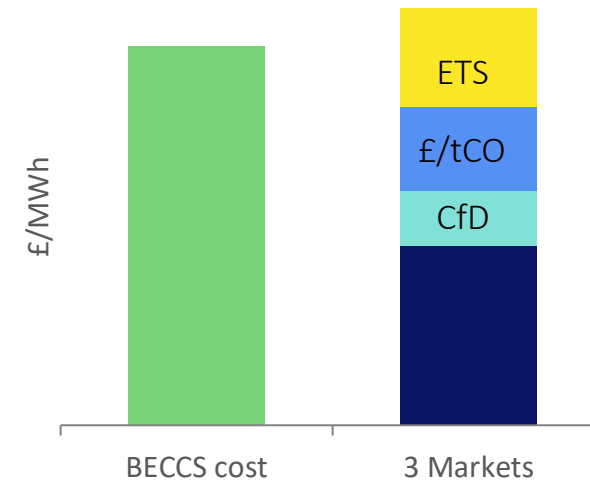
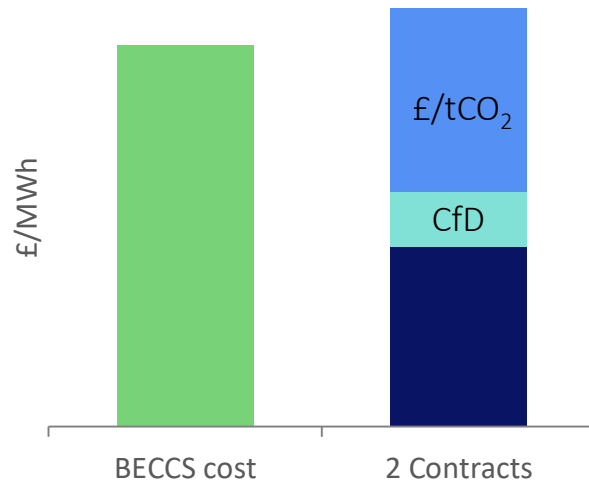
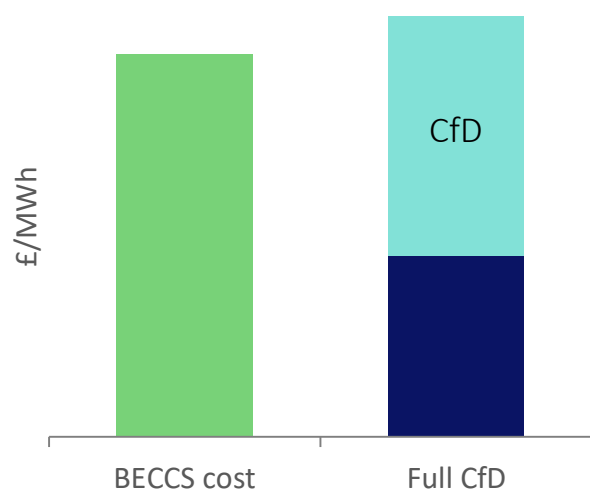
2 contract solution

- **Advantages:** Minimises electricity costs, costs aligned with who benefits, evolution to long term GGR mechanism
- **Disadvantages:** More complex than a simple CfD



3 market solution

- **Advantages:** Low impact on electricity costs, costs aligned with who benefits, stimulates competition amongst GGR technologies
- **Disadvantages:** Non-trivial changes to ETS design, uncertainty in revenue likely not investable





**Can CCS deliver on its
negative emissions
promise?**

Q&A



Rebecca Heaton
Head of Climate Change
Drax Power
*Role of bioenergy with CCS in
delivering negative emissions.*

Generation 2050

Today's YPs will be our energy leaders in 2050. The EI's **Generation 2050** project is a platform for their views and opinions, a 'short circuit' or bridge between today's and tomorrow' energy leaders.

Stay tuned for:

- Kick-off Gen2050 survey
- Invitation to EI podcast "Energy in Conversation"
- Events (aim for COP26)
- Report to industry
- Social media campaign

Climate change is an intergenerational emergency. Young people are by far the most concerned about it and will be most affected by it. Most only have agency over their own behaviours and perhaps an instinct to protest for change.

But professionals under the age of 35 working in energy today will be the industry's leaders in 2050. They will inherit a sector which will be judged on how it has responded; they also have first hand understanding of the complexity and trade-offs involved.

Their voices should be heard more loudly now.

Get Involved with the EI YPN



Young Professionals Network

London & Home Counties

June:

- **Financing Energy Virtual Webinar**
 - How does the energy sector raise finance?
 - How is the wider sector impacted by the recent oil price volatility?

July:

- **Energy Institute AGM**
 - Your chance to step up and get involved with the EI YPN committee
 - Set the agenda for the next 12 months as we help facilitate networking amongst energy young professionals under the 'new normal'

Events announced on LinkedIn & via mailing list:

YPN Connect – postponed



Stay up to date:

- **Twitter:** [@EIYPNLondon](#)
- **LinkedIn:** [Energy Institute – Young Professionals Network \(YPN\)](#)
- **Facebook:** [EI YPN London and Home Counties](#)
- **Join the mailing list**