

CCS

network
to the
future

CO₂sense yorkshire

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Executive summary

Meeting the challenge of combating climate change presents opportunities as well as risks. While we have to move to renewable forms of energy, fossil fuels will continue to be our main source of energy over the next few decades. This gives us the opportunity to explore processes and technologies that reduce the emissions of carbon dioxide (CO₂) when fossil fuels are used.

Developing carbon capture and storage (CCS) at large scale is one of those opportunities. Capturing CO₂ emitted at source, and then storing it safely deep in depleted gas fields and other geological locations offshore, provides a means of managing our carbon emissions.

The Yorkshire and Humber region, for a long time, has been successful in attracting businesses of all types including a large number of power stations, heavy industry and other large single point emitters of CO₂. Many of these single point sources are located in a tight geographic cluster, along a corridor that runs roughly parallel to the M62 motorway. The southern North Sea coast at the end of this corridor is close to several depleting gas fields and saline aquifers – layers of porous rock saturated in salt water, which can be used as safe and permanent storage sites for CO₂.

The government and industry have already shown interest in developing and deploying CCS. Yorkshire and Humber is ideally placed to be at the forefront of national and international efforts to show how CCS can make a substantial contribution to the global effort to reduce greenhouse gas emissions.

This document informs decision makers in industry and government and potential investors of the extent of the opportunity for CCS in Yorkshire and Humber. It shows how a CO₂ transport network could be constructed in the region. It explores the risks that would be involved and suggests some commercial structures that are well-placed to manage these risks. It also examines the costs and the likely benefits arising from such a scheme.

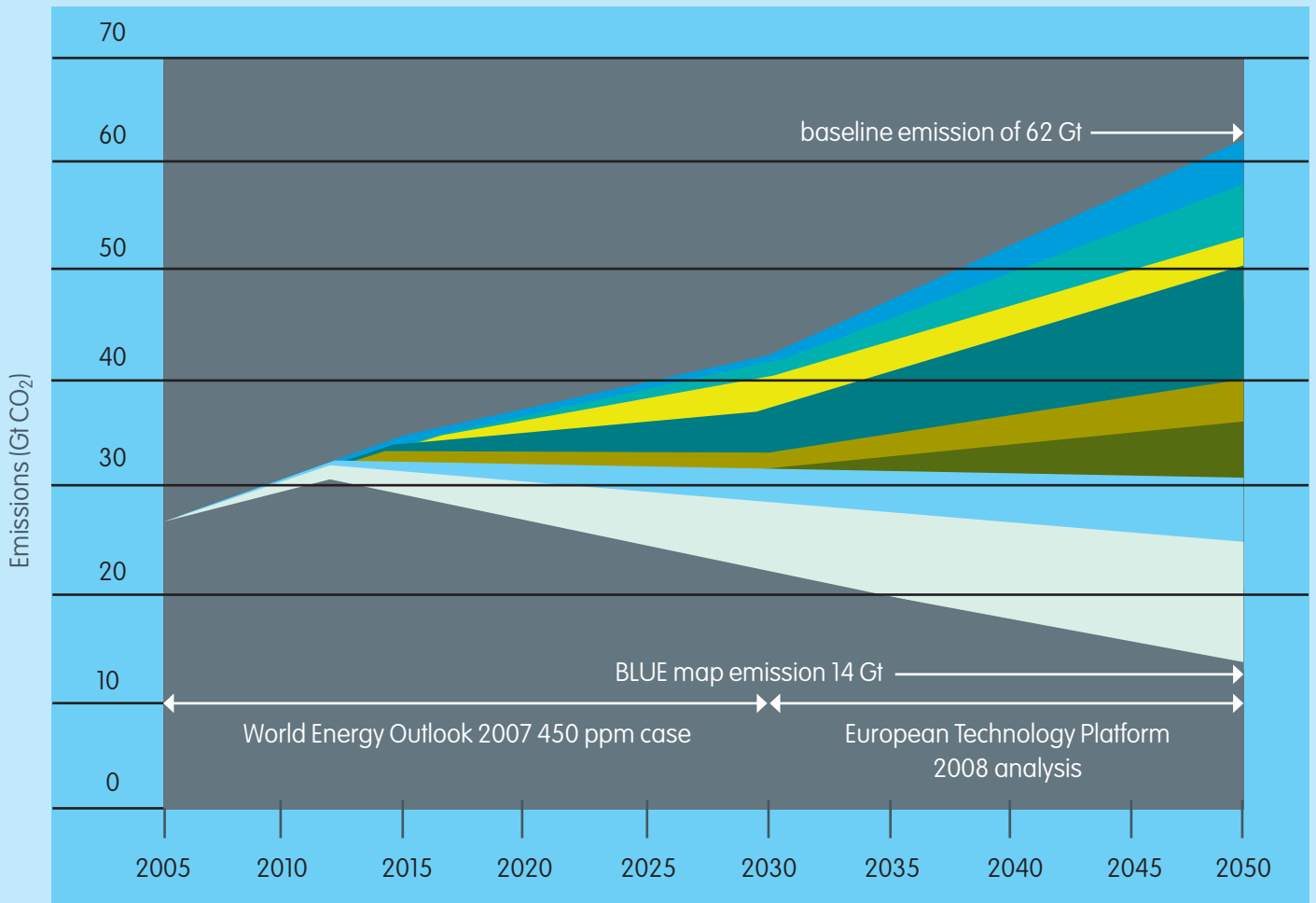
This work has been carried out by a consortium chaired by CO2Sense Yorkshire. CO2Sense Yorkshire is Yorkshire Forward's business development programme dedicated to helping businesses and other major regional organisations cut their carbon emissions and help achieve sustainable development in the region.

Carbon capture and storage: what and why?

CO₂ capture, transport and storage is a bridging technology that will allow us to continue to use fossil fuels, until replacement processes based on renewable energy can come to fruition. The UK Committee on Climate Change has described CCS as an 'essential technology for reducing global emissions' and one that will help the UK to achieve its climate change obligations, such as the decarbonising of electricity production by 2030 and the reduction of CO₂ emission levels by 80% by 2050 from 1990 levels.

Globally, CCS is an essential contributor to the need to reduce CO₂ emissions.

- CCS industry and transformation (9%)
- CCS power generation (10%)
- Nuclear (6%)
- Renewables (21%)
- Power generation efficiency and fuel switching (7%)
- End use fuel switching (11%)
- End use electricity efficiency (12%)
- End use fuel efficiency (24%)



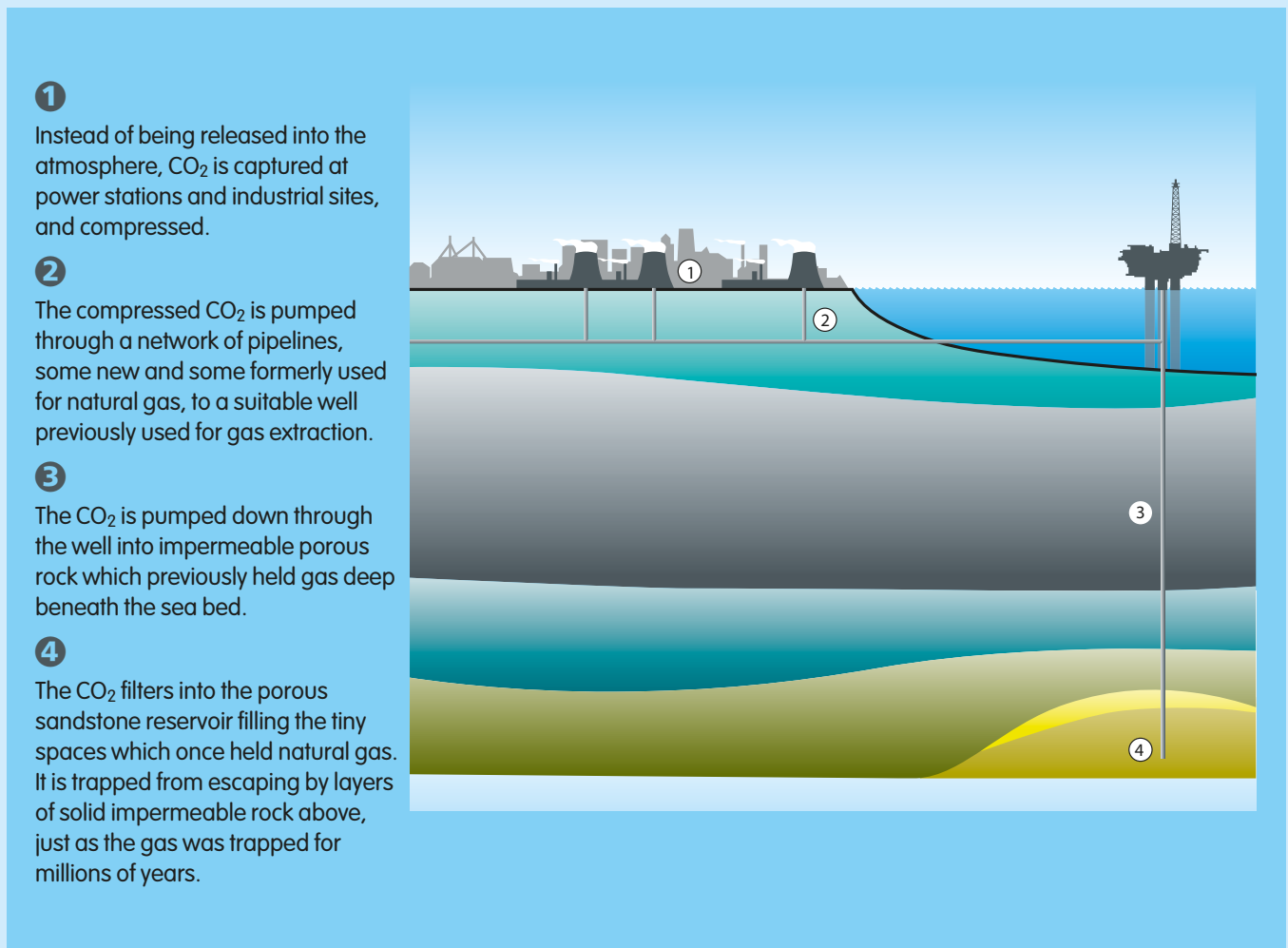
Potential emission reduction by technology required to meet IEA target

Source: IEA, 2007

“CCS technology has the potential to capture around 90% of the CO₂ produced by using fossil fuels from large single point sources, which is then stored safely and permanently instead of being released into the atmosphere.”

CCS involves three stages, each of which is proven technology:

- **Capturing** the CO₂ produced by using fossil fuels in industrial processes such as power generation and other industrial activity such as steelmaking, oil refining and cement production.
- **Transporting** CO₂, by pipelines or ships, to suitable storage. The pipeline system typically comprises compressors and pumps both onshore and offshore to deliver the CO₂ from the source to the store. Transporting CO₂ over long distances is already done at scale elsewhere in the world including North America and Norway.
- **Storing** the CO₂ safely in sites such as depleted oil and gas fields or large deep saline aquifers, where it can remain indefinitely.



Source: National Grid



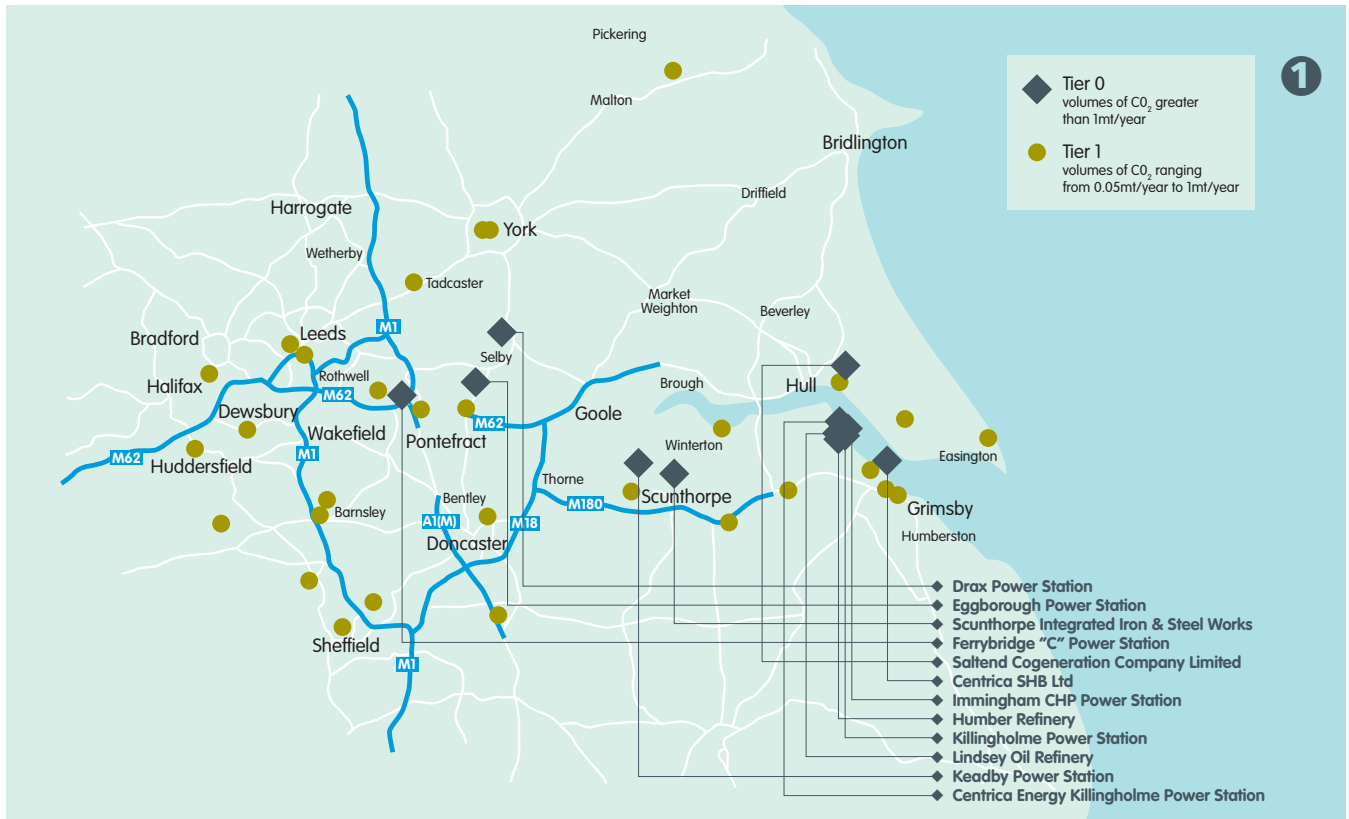
Why Yorkshire and Humber?

There are two compelling reasons for developing a CCS network in Yorkshire and Humber:

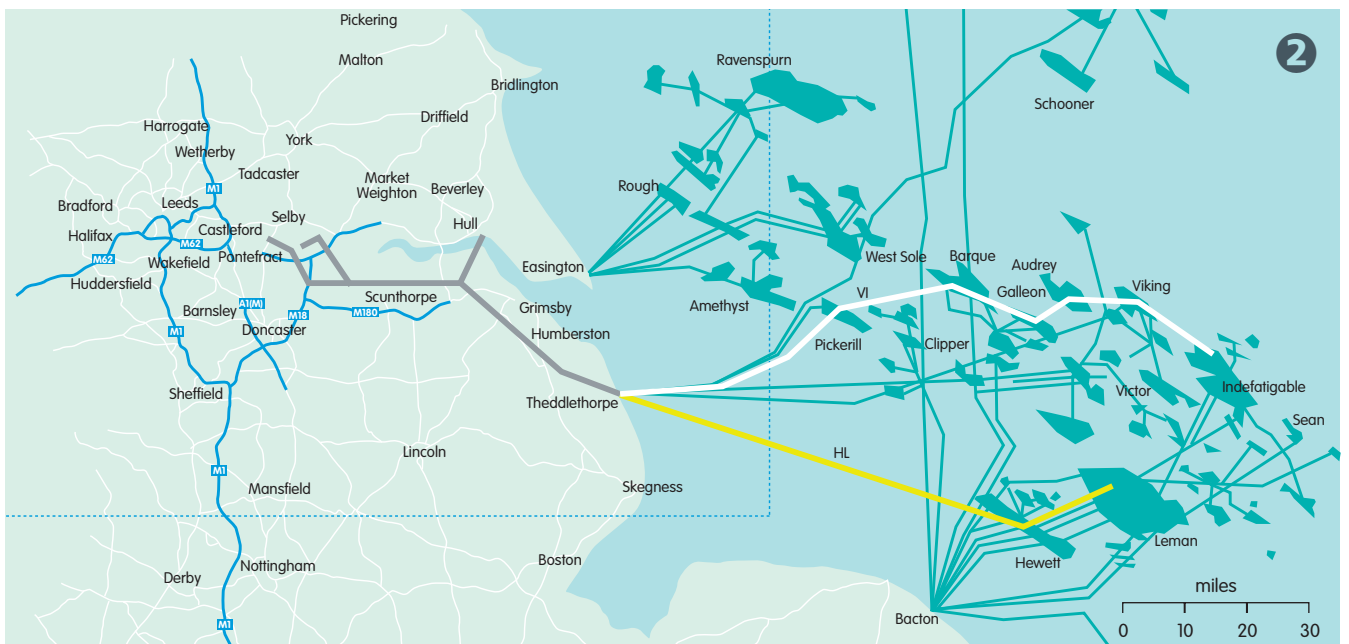
- **Clustering:** The region has a large number of single-source CO₂ emitters, with the potential to adopt CCS, which are clustered around a corridor, which runs roughly parallel to the M62. These sites currently emit around 60m tonnes of CO₂ per year, which is equivalent to almost half of all the emissions from UK households. This means that a single pipeline could be constructed to which each of these emitters could link. This would be more efficient and likely to be more environmentally acceptable than each emitter developing its own 'source to sink' pipeline.
- **Storage:** The Yorkshire and Humber coastline is close to several large potential offshore storage sites. The viability of any CCS system increases with its proximity to suitable storage facilities and the Yorkshire and Humber region is ideally situated to take advantage of the many depleting gas fields and saline aquifers in the southern North Sea. The region is also well located to use existing coastal gas terminals to access the southern North Sea storage sites. This will reduce the environmental impact of CO₂ transport and complement existing industrial activity.

Yorkshire and Humber emits more CO₂ than any other region in the UK, and in the whole of Europe, is second only to the Ruhr Valley in Germany. This is due to the large number of power stations and the heavy industry that is situated in the region. A CCS network in the region would therefore have a significant effect on UK and global emissions and is the natural choice for the development of such a network.

“A CCS network in Yorkshire and Humber would have a significant effect on UK and global emissions and is the natural choice for the development of such a network.”



Map of the region to illustrate that CO₂ comes from a small number of large emitters



General network route showing alternative offshore routes to gas fields

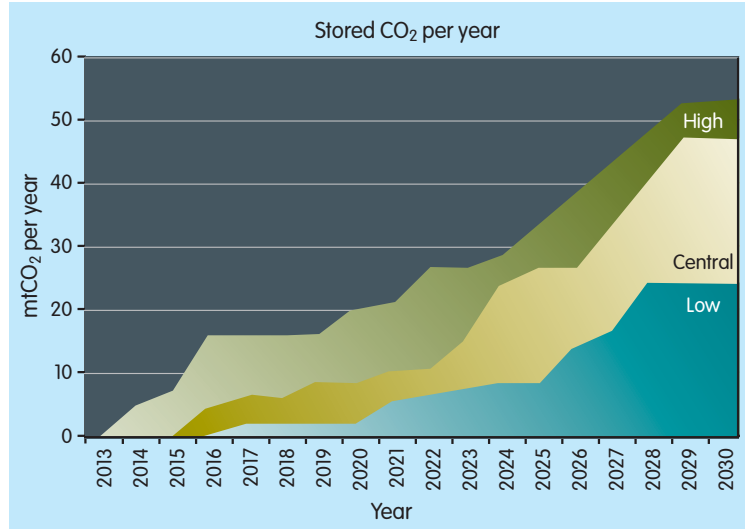
“Constructing the network over 15 years could generate approximately £1.8 billion in gross value added (GVA) and support up to 55,000 jobs in the region.”



The costs

Developing a CO₂ transport pipeline stretching from Ferrybridge power station – situated at the junction of the M62 and the A1 – to the south Humber Bank, would cost at least £2 billion. This is about the same as the cost of developing a high-speed rail link between Leeds and Sheffield.

The transport costs could be as low as £1.50 – £2 per tonne of CO₂. A network could be constructed with the capacity to transport 60 million tonnes of carbon dioxide (mtCO₂) per year to suitable storage locations by 2030. The potential to increase volumes of stored CO₂ from 2014 to 2050 is illustrated to the right.



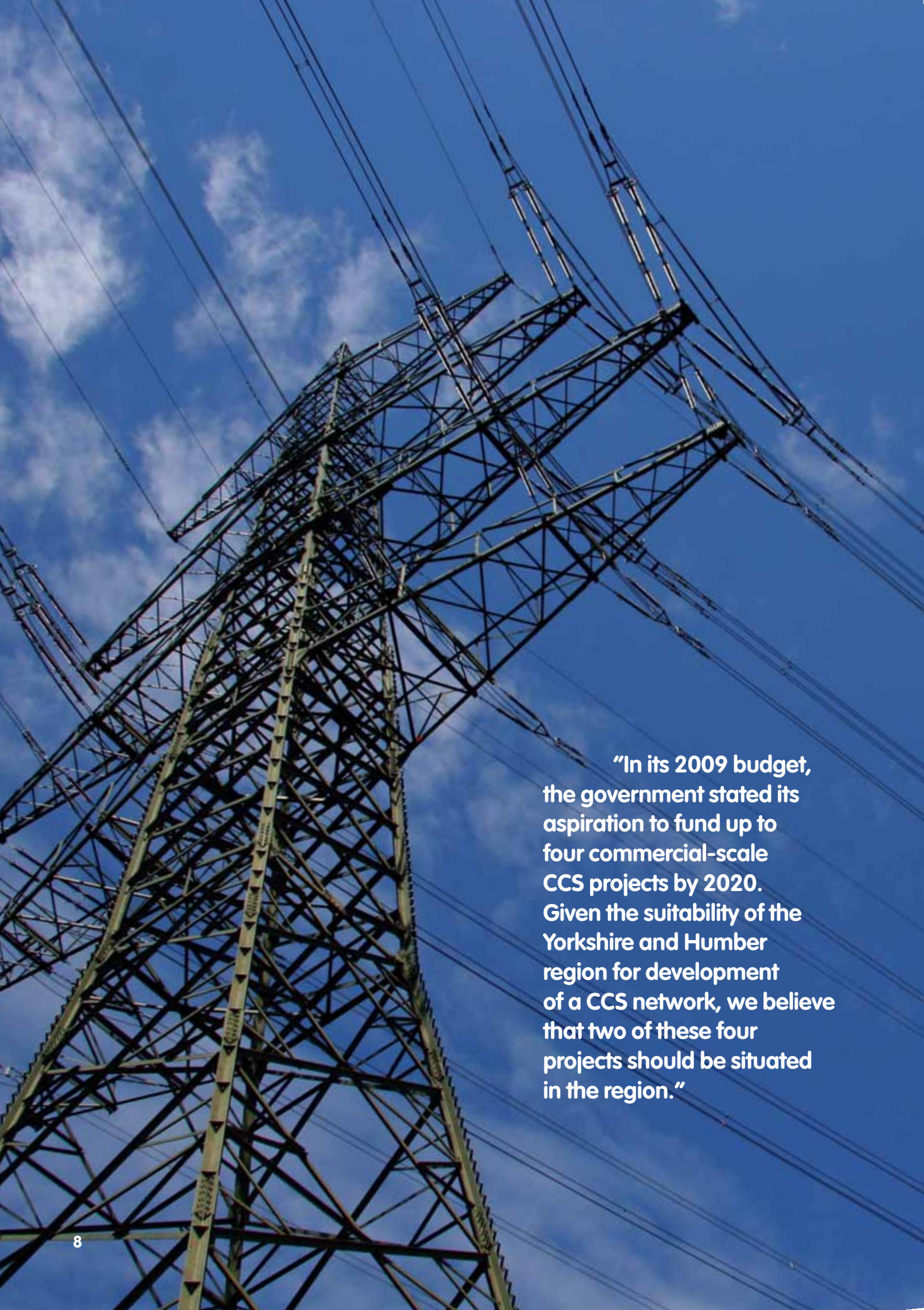
Three scenarios for CO₂ storage in the Yorkshire and Humber region

The benefits

- Constructing the network over 15 years could generate approximately £1.8 billion in gross value added (GVA) and support up to 55,000 jobs in the region.
- The operations phase could produce £126 million of additional GVA and support up to 2,400 jobs per year in the region.
- The net benefits to the region from the first 25 years of network operation could be £31 billion, modelled on a carbon price in the European Union Emissions Trading Scheme of €35 per tonne.
- Companies from the engineering and chemicals sectors in the region will have the opportunity to develop the skills, products and services required to construct, operate and maintain the network, and export this know-how to an emerging global CCS market ultimately worth many billions per year.

Making it happen

- Yorkshire and Humber is potentially best placed in Europe to develop a large-scale CCS cluster. However, it will require strategic leadership across the public and private sectors to realise the opportunity.
- National government has to ensure the appropriate financial and regulatory framework is in place to bring forward sufficient levels of commercial scale CCS demonstration that can then lead to rapid deployment of the technology by industry.
 - Regional bodies and local authorities should work with national government, industry and regulatory authorities (such as the Health and Safety Executive) to ensure that the strategic framework, business case and consenting process is in place to allow collaborative development of a CCS cluster and communication of the wider economic and social benefits.
 - Industry has to undertake CCS demonstration and deployment in a manner that is safe, cost effective, will add value to the economy, significantly contribute to emissions reduction targets and help promote international adoption of the technology.
 - Locally, public support for the demonstration and deployment of CCS will be crucial to ensure projects can be developed to acceptable costs and timescales.



“In its 2009 budget, the government stated its aspiration to fund up to four commercial-scale CCS projects by 2020. Given the suitability of the Yorkshire and Humber region for development of a CCS network, we believe that two of these four projects should be situated in the region.”

Funding the network

The development of a CCS cluster will require a mix of private and public investment. This is partly to manage the business and financial risks associated with this type of project. Current carbon prices in the EU Emissions Trading Scheme are significantly lower than required to commercialise CCS, although they are projected to increase in the next decade. Until the financial value of abated CO₂ emissions reaches this higher level, public funding will be required to share the commercial risks. This is currently provided to renewable energy sources such as wind farms, and the support costs of CCS are likely to be comparable to those of renewables.

Currently, there are three potential sources of initial public funding:

- **European Energy Programme for Recovery (EEPR)** funding, from the European Union. This could provide support for the costs of constructing capture-ready plant and transport facilities. Yorkshire Forward was among those supporting Powerfuel Power Ltd at Hatfield, Doncaster in their successful bid for up to €180m funding from the EEPR, which will provide a valuable part of the finance they require for a project to establish a clean coal power station with the necessary carbon capture, transport and storage by 2015.
- **New Entrant Reserve** funding, available from revenues generated by the EU Emissions Trading Scheme. Up to 45 million European Union Allowances (carbon credits) per project will be available to support up to 50% of costs for CCS and innovative renewable energy projects.
- **The UK CCS demonstration programme.** In its 2009 budget, the government stated its aspiration to fund up to four commercial-scale CCS projects by 2020. Given the suitability of the Yorkshire and Humber region for development of a CCS network, we believe that at least two of these four projects should be situated in the region. However, the cluster benefits could be achieved in a shorter timescale and in a more efficient manner if more projects were located in the Yorkshire and Humber region.

It would be possible to use a combination of these funding sources to support the development of CCS projects in the region.

How to make it happen: the commercial approach

Any commercial structure needs to be capable of addressing the risks involved in a CCS project. These risks include the following:

- Design and cost overruns
- Technical failure risk
- Risk of changes to legislation and regulation
- Customer counterparty credit risk

The private sector is arguably best-placed to manage the risks of the network's development and operation, but public sector risk underwriting and support for investment would be needed. Levels of risk will be greater at the early stages of the project but many risks will become less significant as experience grows.

The two commercial structures that are most capable of managing these risks are:

- **Government-led Design, Build, Finance and Operate (DBFO) concession.** In this structure, the government procures a network by competitive tender on behalf of industrial emitters, financed through payment for services over the period of the concession. The delivery risk would lie with the private sector.
- **Third-party regulated.** In this structure, an industry group or third-party arbitrator procures a network, which is developed under self-regulation. Private regulation of this type is already working in other similar projects in the UK. For example, the UK Oil and Gas Infrastructure code of practice sets out the principles and procedures to allow third-party access to offshore oil and gas infrastructure. In case of dispute, the Secretary of State has power to determine that access be provided and on what terms.

This combination of funding to limit risk and clear options for commercial structures could enable an early demonstration of a pipeline capable of transporting and storing larger volumes of CO₂ than would be required for a single demonstration project. This could give other emitters the confidence to invest early in carbon capture plant.



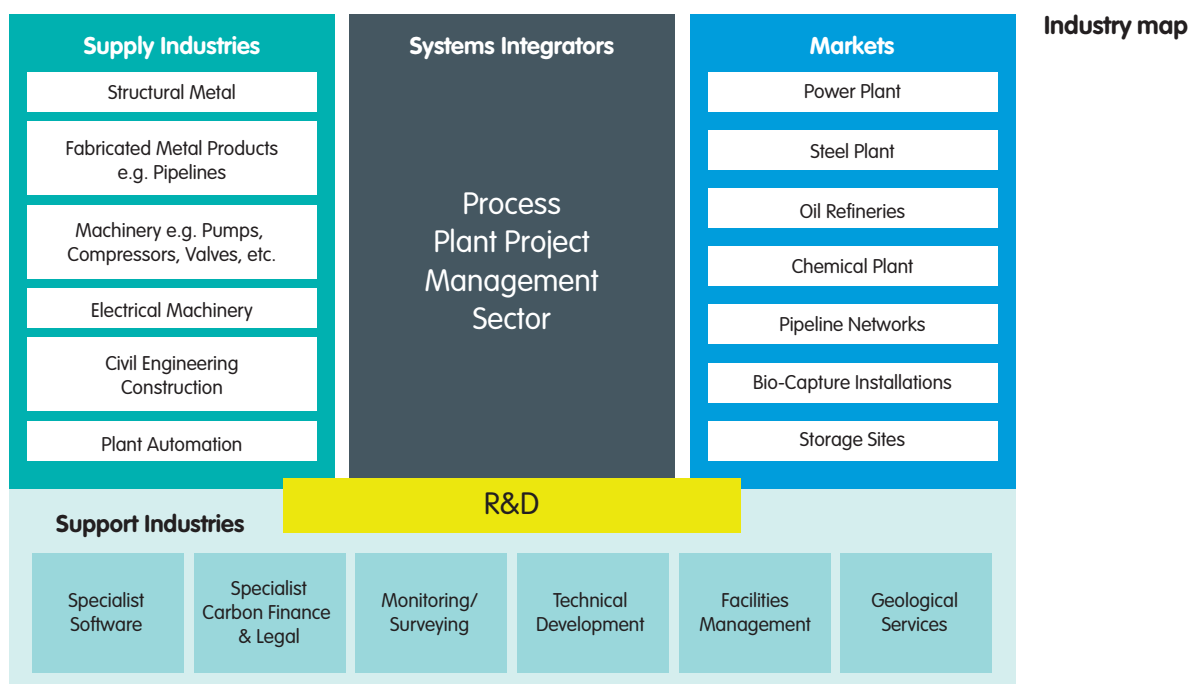
“A range of opportunities arise across the CCS value chain, which the region, with its existing industrial heritage and expertise, is well-placed to exploit.”

Building on the opportunity

Developing and deploying CCS is one of the main objectives of the UK government's Low Carbon Transition Plan and Low Carbon Industrial Strategy. Realising a CCS network in Yorkshire and Humber could foster research and development in CCS process technology, lead businesses in the region to develop products and services for a global CCS market, see innovation in other forms of low carbon energy and make this a preferred location for industry seeking a safe and low-cost solution for their CO₂ emissions.

A range of opportunities arise across the CCS value chain, which the region, with its existing industrial heritage and expertise, is well-placed to exploit. These opportunities include technology development and research work being carried out in universities in the region. Areas of potential development include:

- **The development of a parallel hydrogen network from IGCC (integrated gasification combined cycle) syngas:**
Early investments in CO₂ capture plant in the region are likely to be based on IGCC technology. This involves converting coal into combustible gases such as hydrogen. Much of the hydrogen would be used on-site for power generation, with some made available for other uses such as partially decarbonising existing gas-fired power plants or powering fuel-cell vehicles. It may also be cost effective to include a low-pressure hydrogen pipeline in parallel with a CO₂ pipeline to enable the low-cost, bulk transport of hydrogen in the region.
- **The import and export of CO₂:**
The CCS network is focused on transport to safe storage in depleted gas reservoirs in the southern North Sea. As an additional opportunity an import/export terminal on the Humber could serve other European users and sources of CO₂.
- Opportunities exist throughout the CCS value chain, in the research, development and application of technologies in each phase of the CCS process, from capture through transport to storage. Universities in the region are well placed to bring forward innovations in the efficiency of power generation plant, new technology for CO₂ capture and better understanding of the geological storage of CO₂. Businesses in the region that already supply products and services to energy intensive industries and the offshore sector could gain the confidence to enter the global CCS market that could be worth many billions per year.



Find out more

For more information about how your organisation could take advantage of the opportunities presented by CCS, or how CCS in Yorkshire and Humber could benefit the UK, please contact Dr. Stephen Brown, Programme Director, CCS at CO2Sense Yorkshire, on 0113 237 8409 or at stephen.brown@co2sense.org.uk.

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What's next?

CO2Sense Yorkshire is working with a range of industry partners to develop the strategic case, and collaborative engineering design work. This will support future submissions for development funding to sources including New Entrant Reserve funding and any future UK government support programme.

We are also considering alternative funding models to identify how an oversized transport infrastructure can be constructed, in order to encourage early private-sector investment.

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This publication informs decision makers in industry and government and potential investors of the extent of the opportunity for Carbon Capture and Storage in Yorkshire and Humber. It shows how a CO₂ transport network could be constructed in the region. It explores the risks that would be involved and suggests some commercial structures that are well-placed to manage these risks. It also examines the costs and the likely benefits arising from such a scheme.