The economic benefits of carbon capture and storage in the UK

Carbon Capture & Storage Association

TUC

'CCS could save 40 per cent of the cost of meeting a 50 per cent global CO2 reduction by 2050'

Contents

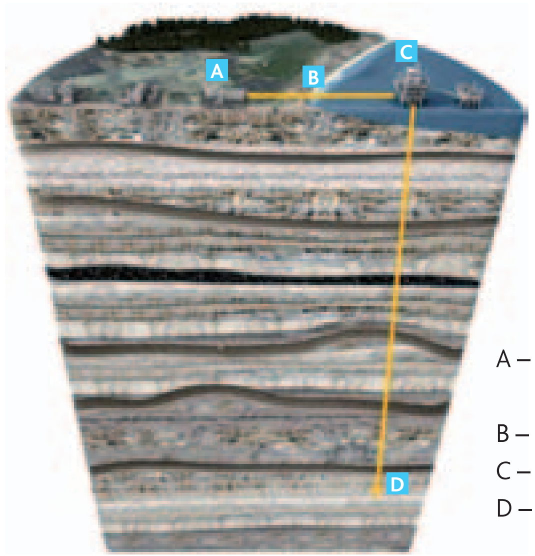
This booklet is a summary report of a joint study by the TUC and the Carbon Capture and Storage Association. See page 4 for details.

> 'CCS could contribute 17 per cent of the necessary global emissions reductions from coal, gas and heavy industry users in 2050'

Introduction

1 WHAT IS CARBON CAPTURE AND STORAGE?

Carbon capture and storage (CCS) is the process of capturing carbon dioxide (CO_2) emissions from large-point sources (such as power stations and industrial facilities) and transporting the gases in pipelines to very deep subsurface rock formations, where it can be safely and permanently stored. CCS prevents the release of large quantities of CO_2 into the atmosphere, which is causing climate change.



A – Power station or industrial facility
B – Pipeline
C – Injection platform
D – Injection of CO_2 into deep geological formation

Figure 1. Carbon capture and storage (CCS)
Source: Image adapted from globalccsinstitute.com

2 CCS COULD BRING VITAL ENVIRONMENTAL BENEFITS

CCS is now seen as a critical part of the world's future low-carbon energy portfolio. Leading energy and climate change institutions agree on the crucial role for CCS in cost effectively realising global emissions reduction targets. International evidence[i] shows CCS contributing 17 per cent of the necessary global emissions reductions in 2050 (from coal, gas and heavy industry users), and delivering 14 per cent of the cumulative emissions reductions needed between 2015 and 2050.

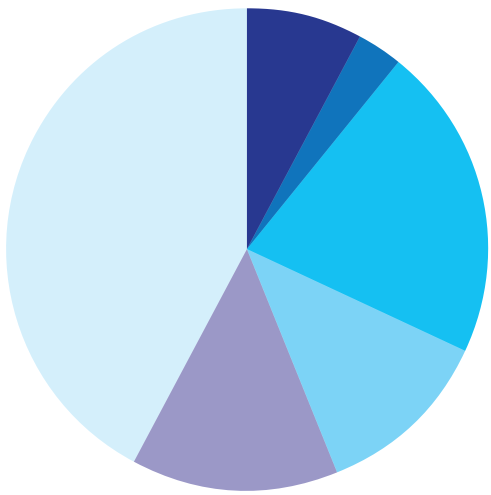


Figure 2. CCS contributes 14% of total emission reductions by 2050 in a 2 Degrees Scenario (2DS)

- Nuclear 8%
- Power generation and fuel switching 3%
- Renewables 21%
- End-use fuel switching 12%
- CCS 14%
- End-use fuel and electricity efficiency 42%

Source: Adapted from IEA 2012

'CCS would bring a 15 per cent reduction in the wholesale price of electricity by 2030'

CCS for power and industry will deliver economic benefits

Inclusion of CCS within a mix of low-carbon technologies is the lowest-cost route to decarbonisation. Evidence from the International Energy Agency (IEA)[ii] shows that without CCS, the cost of meeting a 50 per cent global CO_2 reduction target by 2050 would increase by 40 per cent.

Closer to home, the Energy Technologies Institute[iii] concludes that the cost of delivering a UK low-carbon energy mix in 2050 would increase by one per cent of GDP (or £30bn–40bn per year) if CCS were not included.

3 CCS COULD REDUCE THE COST OF ELECTRICITY AND CONSUMER BILLS

Our new analysis[iv] shows that inclusion of CCS amongst the technologies that will be needed to meet energy demand by 2030 results in a 15 per cent reduction in the wholesale price of electricity (i.e. the market price plus the support for low-carbon generation) compared with alternative scenarios in which CCS is not deployed.

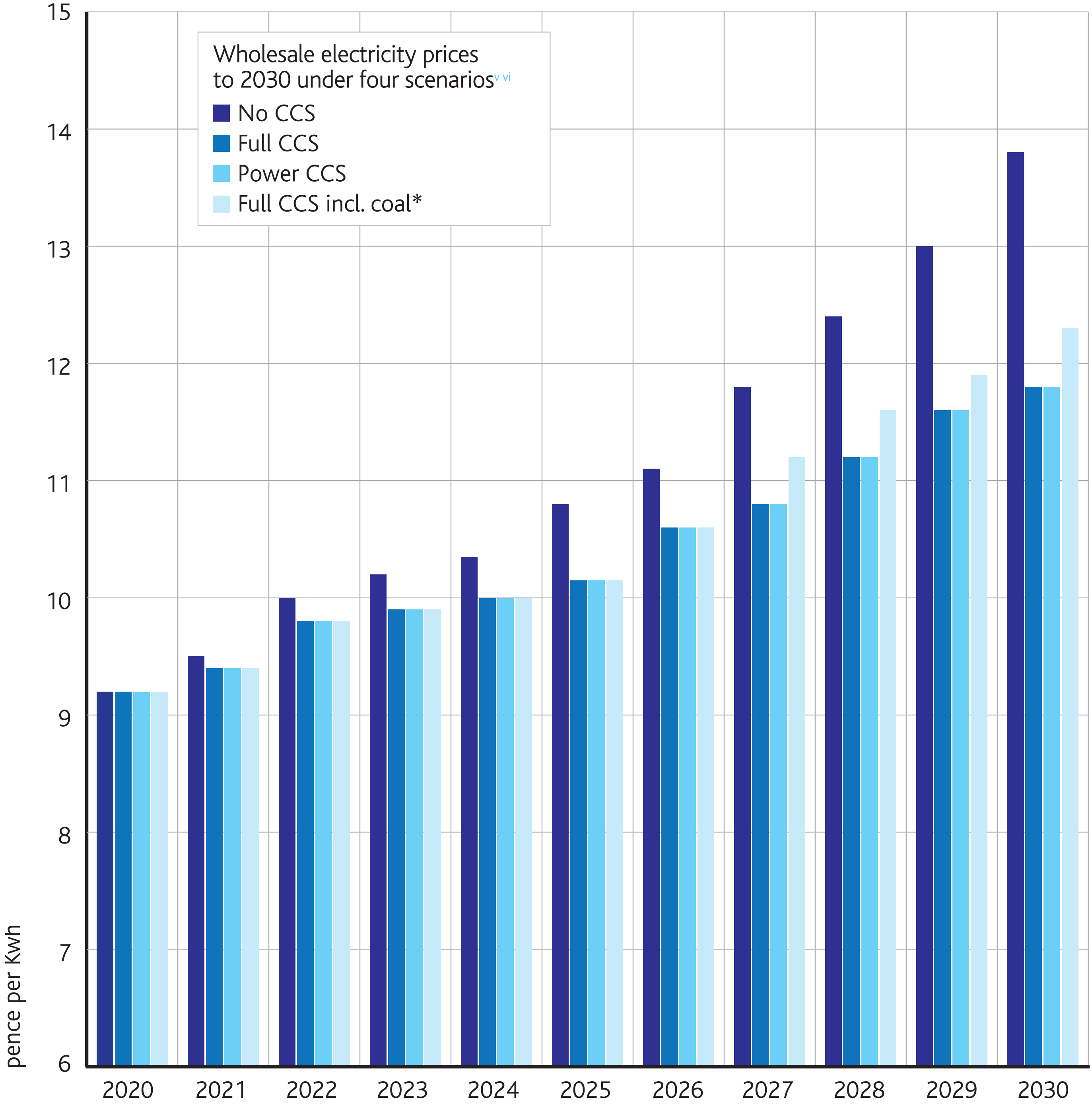
This cost saving is mainly due to the fact that without CCS there is an increase of approximately 20–25 per cent in electricity generation capacity as well as a requirement for additional investment in electricity transmission capacity.

This new analysis is based on four modelled scenarios, detailed in the full CCSA/TUC study, *A UK Vision for Carbon Capture and Storage* (2013), available from www.tuc.org.uk/sites/default/files/UKVisionforCCS.doc and from www.ccsassociation.org/press-centre/reports-and-publications/. The scenarios, ranging from zero CCS by 2030 to ambitious programmes for power and industry, show conclusively that the reduction in the wholesale price of electricity (i.e. the market price plus the support for low-carbon generation) is greatest with the full deployment of CCS for the power and industrial sectors. This approach would bring significant positive impacts for consumers, with household bills estimated to be £82 lower per year by 2030 in the optimal CCS scenarios compared to the baseline[vii].

This would significantly increase the disposable income of householders and reduce the risk of fuel poverty. The lower cost of CCS deployment would also mean that lower subsidies (and therefore lower taxes) would be needed to decarbonise the electricity sector.

'Household energy bills could be £82 lower per year by 2030'

Figure 3. Electricity prices without CCS will increasingly outstrip prices where CCS is allowed to play its part



* for an explanation of these four scenarios please see the full report at www.tuc.org.uk/sites/default/files/UKVisionforCCS.doc or at www.ccsassociation.org/press-centre/reports-and-publications

'15,000–30,000 jobs would be created per year in the CCS industry by 2030'
(range based on the installed capacity of 10 or 20 GW)

4 CCS COULD CREATE NEW JOBS FROM 2015

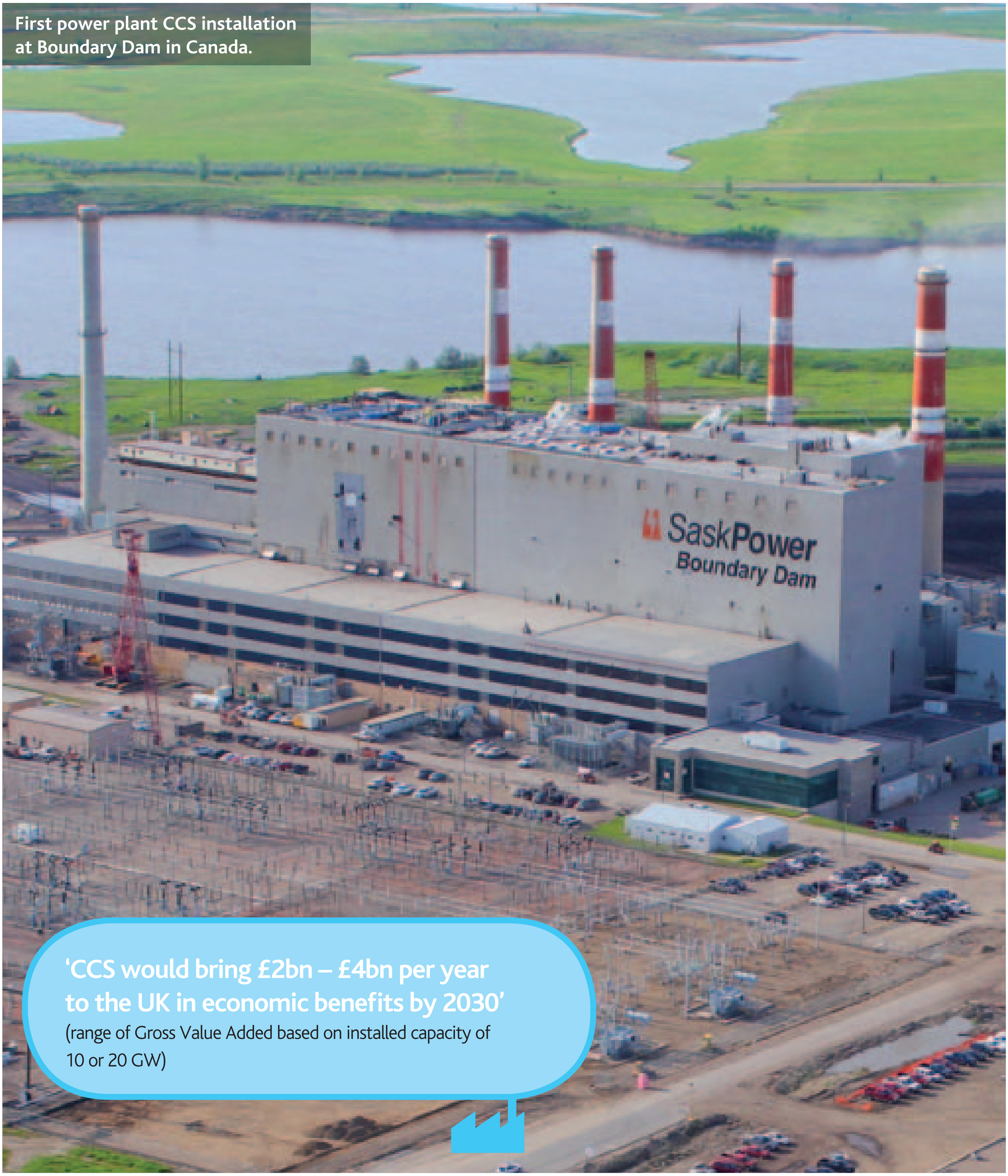
There is a large amount of data and case studies available on potential job creation from CCS in the power sector [viii]. Taken together, these paint an impressive picture with a range of 1000-2,500 jobs created during plant construction (typically four to six years) per power plant CCS installation (it should be noted that these figures relate to new-build CCS power plant only, not retrofit CCS power plant). Once construction is complete, job generation tends to decline, with typical plant estimates of 200–300 jobs in operation and maintenance and the associated supply chain, of which 40–100 jobs are at the plant itself.

These estimates are given credence from the first actual power plant CCS installation at Boundary Dam in Canada[ix] (due to commence operation early 2014), which employed more than 1,500 people during construction, and maintains 41 operational employees at the plant (with more likely to be employed in the supply chain).

Projections of CCS-installed capacity in the UK to 2030 range from 10 GW (conservative) to 20 GW (ambitious but achievable)[x]. This is consistent with the ambition of the CCS industry, as set out in the CCSA document *A Strategy for CCS in the UK and Beyond* (2011), which called for the need to build up to 20 GW of CCS in the UK by 2030[xi]. This translates into between 15 and 25 CCS installations by 2030. Using the previous figures of job generation per installation, we estimate that the total annual number of jobs that could be created in the CCS industry by 2030 ranges from 15,000-30,000 (depending on the installed capacity of 10 or 20 GW respectively).

In addition to job creation, there are significant economic benefits associated with CCS. The Gross Value Added (GVA) to the economy flowing from ambitious investments in power and industry CCS can be calculated using an estimate of the proportion of UK supply chain content in UK CCS projects (UK content). Most economic models[xii] assume 35–75 per cent UK content in the UK CCS market, and 2–10 per cent UK content in the global CCS market. The UK CCS industry has potential to capture a high proportion of the market for engineering design, project management, procurement and commissioning activities, and will benefit from the potential cross-over with the skills currently used in the oil and gas industry. With the achievable aspiration of 75 per cent UK content, our research[xiii] estimates that the GVA benefits from CCS deployment in the UK are in the region of £2bn–£4bn per year by 2030 with a cumulative market value of £15bn–£35bn (depending on whether 10 GW or 20 GW of CCS capacity is installed respectively).

This value would increase if the UK were to take a share in the global CCS market. The International Energy Agency[xiv] has projected that 964 GW of total installed CCS power generation capacity will be needed globally by 2050 to reach required emissions reductions as well as more than three Giga tonnes of CO_2 captured annually from industrial sources – this will create a global market worth over £100bn, much of it in developing countries. With even a modest share of this global market, UK GVA resulting from a share in the global CCS market could increase to between £5bn and £9bn per year by 2030[xv].



First power plant CCS installation at Boundary Dam in Canada.

'CCS would bring £2bn – £4bn per year to the UK in economic benefits by 2030'
(range of Gross Value Added based on installed capacity of 10 or 20 GW)

Image from Saskpower

But CCS won't just bring longer term benefits only – indeed there are currently between five and seven 'shovel ready' power and industry CCS projects in the UK that could deliver jobs and GVA benefits within the next parliamentary term (2015–2020). Each power sector project could deliver approximately £150m per year GVA associated with construction (over a six-year period), and £200m per year from the start of operation[xvi]. It is estimated that 15 to 25 CCS projects are needed in the UK by 2030 and that 964 GW of installed CCS power generation capacity will be needed globally by 2050.

5 CCS COULD HELP RETAIN EXISTING INDUSTRIES AND JOBS IN THE UK

CCS is vital to enable fossil fuels to continue to play an important role in meeting ever-increasing energy demand in an environmentally-sustainable manner.

The government published a *Gas Strategy* in December 2012, in which it is suggested that up to 26 GW of new gas-fired capacity could be required by 2030[xvii]. Gas-fired power has a central role to play in meeting energy demand, and gas-CCS therefore plays a vital part in meeting the UK's statutory target to reduce greenhouse gas emissions by 80 per cent by 2050.

Coal-fired power supplies a significant proportion of the UK's electricity – averaging 38 per cent in 2012. Due to various European environmental regulations, several UK coal stations (8 GW out of the current total of 28 GW) are already due to close before the end of 2015. In addition, many coal-fired power stations are coming to the end of their economic life – which will lead to significant further closures by 2023 without policy intervention. The UK coal mining industry currently employs a highly skilled workforce of more than 6,000. Together with coal power industry and logistics, this reaches a total of 11,000 direct and indirect employees[xviii].

Both gas and coal are also important flexible sources of generation to complement inflexible (nuclear) and intermittent renewable (offshore wind and solar) generation. Fossil fuels with CCS will therefore continue to be important in balancing the electricity generation mix going forward.

However, it is clear that unabated fossil fuels (both coal and gas) cannot continue to operate indefinitely if we are to mitigate climate change. The UK has already implemented a number of policies to prevent the construction of new coal-fired power stations without CCS and the Committee on Climate Change has stated that that "extensive deployment of unabated gas-fired capacity (i.e. without carbon capture and storage technology (CCS)) in 2030 and beyond would be incompatible with meeting legislated carbon budgets"[xix].

The deployment of coal and gas with CCS is therefore associated with the opportunity to prolong the life of important indigenous fossil fuel industries, securing a valuable UK fossil-fuel resource base that will otherwise be lost, and maintaining a significant number of jobs.

> 'There are five to seven 'shovel ready' power and industry CCS projects in the UK that could deliver jobs and GVA benefits from 2015'

Energy–intensive industries

Energy-intensive industries in the UK form the backbone of the UK manufacturing economy, and produce primary inputs for much of what we manufacture and consume in some of the most advanced plants of their kind globally. They also provide essential supply chain products for many low-carbon technologies, such as steel and concrete for wind turbine installations, glass for double glazing and fibres for loft insulation.

CCS could help maintain energy-intensive industries in the UK. The importance of the energy-intensive industries for the UK cannot be understated; together they have a combined turnover of £95bn – equivalent to three per cent of UK GDP. They directly employ 160,000 people in well-paid, highly skilled jobs with a further indirect employment of 800,000 people via supply chains. Their contribution to GVA is significant, reaching £14bn in 2008 or 11 per cent of the UK manufacturing total[xx].

6 ONLY CCS OFFERS THE POSSIBILITY FOR FURTHER SIGNIFICANT DECARBONISATION IN ENERGY-INTENSIVE INDUSTRIES

The sectors that make up the energy-intensive industries range from iron and steel, to chemicals, cement, and refineries. Together, these industries use large amounts of energy and generate just over 10 per cent of the UK's total carbon emissions[xxi]. Most of the options to reduce emissions in these sectors (mainly through energy efficiency) have already been implemented. Due to the fact that the CO_2 is process- as well as fuel-generated, only CCS offers the possibility for further significant decarbonisation in industry. In the UK, many heavy energy users are ideally placed for development of CCS, as they are already located in regional clusters, together with power stations, in close proximity to North and Irish Sea offshore storage locations.

The application of CCS to industry varies between sectors, with some sectors ready to deploy CCS almost immediately if the right policies were in place, whereas others still need to develop and trial a range of capture technologies.

Many of these sectors are facing difficult decisions regarding their continued existence in a carbon- constrained world, and without the development of supportive policies many of these industries are likely to close down in the UK and relocate to other countries (carbon leakage). The consequences for the UK would be very significant and the TUC and the Energy Intensive Users Group (EIUG) have estimated that the economic and fiscal costs associated with the loss of energy intensive employment would amount to a loss of output of more than £77,000 per employee[xxii].

The development of policies that can begin to support the deployment of CCS in these industries is therefore vital to ensure the long-term continued existence of these important industries in the UK, safeguarding a significant number of jobs and generating value to the UK economy.

CCS in the UK

7 THE UK IS ONE OF THE BEST PLACES IN THE WORLD TO DEVELOP CCS

The UK has the opportunity to become a leading global player in the CCS sector. Our abundant offshore CO_2 storage capacity in depleted oil and gas fields, CO_2 storage in combination with Enhanced Oil Recovery (EOR) and storage in deep saline rock formations[xxiii] beneath the North Sea and East Irish Sea give us significant access to the natural resources needed to develop and support this important industry. Experts[xxiv] estimate that geological formations beneath the UK section of the North Sea can store almost 80 billion tonnes of CO_2 – more than enough to meet the needs of UK CCS projects for the next 100 years. This advantage is made even greater when coupled with the fact that many of the UK's largest carbon emitters (power and industrial facilities) are already clustered together around major estuaries such as the Humber, Teesside and Merseyside, close to offshore storage capacity in the North and East Irish Seas.

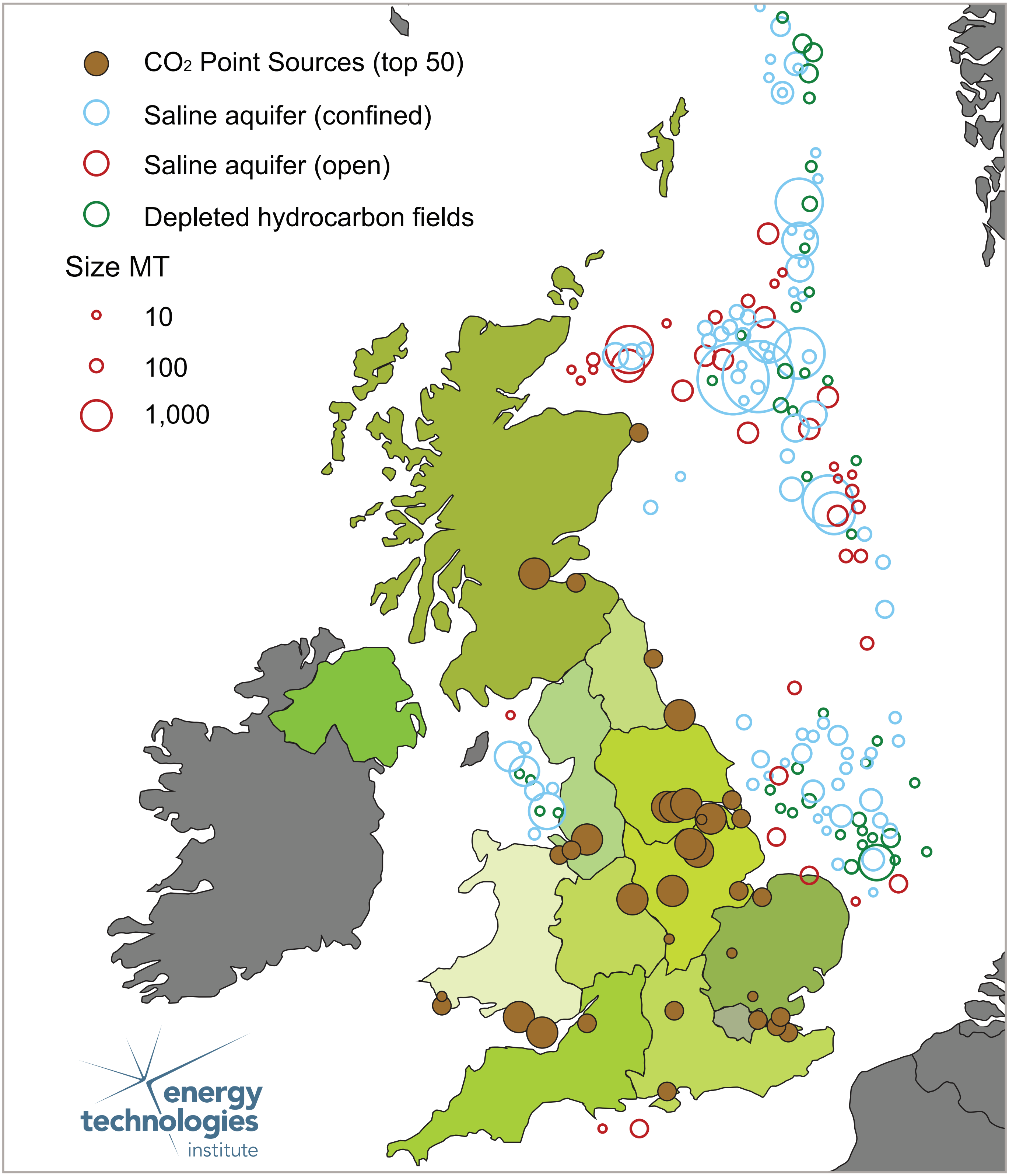
The UK also benefits from existing oil and gas pipelines and offshore platforms that have the potential to be re-commissioned for CCS, thereby prolonging the economic life and value of important offshore assets and deferring their considerable decommissioning costs.

The engineering skills required for CCS are in abundance in the UK, primarily resulting from long-standing experience in the oil and gas, energy supply and process industries. These include power plant and process engineering; the design, build, commissioning of major infrastructure projects; the construction and operation of pipelines; sub-surface analysis; and CO_2 storage, including reservoir operations and field services.

'Softer' skills related to CCS can also be found in the UK, including planning, undertaking environmental impact assessments, managing public perceptions, verification, financing, and insurance and legal services.

Finally, the UK is well established in CCS research and development, with leading research centres in both the public and the private sectors.

Figure 4. Proximity of the UK's largest industrial emitters to CO_2 storage sites in the North and Irish Seas[xxv]



Urgent action is needed to ensure a thriving UK CCS industry

The UK has reached a defining moment with regards to the future of a successful CCS industry. The CCSA/TUC study, *A UK Vision for Carbon Capture and Storage* (2013), argues that decisions taken now, and actions taken over the next 7–10 years, will determine the ability of 'UK plc' to take advantage of its natural assets (physical and human) and capitalise on the investment, employment and export potential of the sector. The TUC and the CCSA believe that the following actions should be urgently prioritised to ensure a thriving CCS industry can be delivered in the UK:

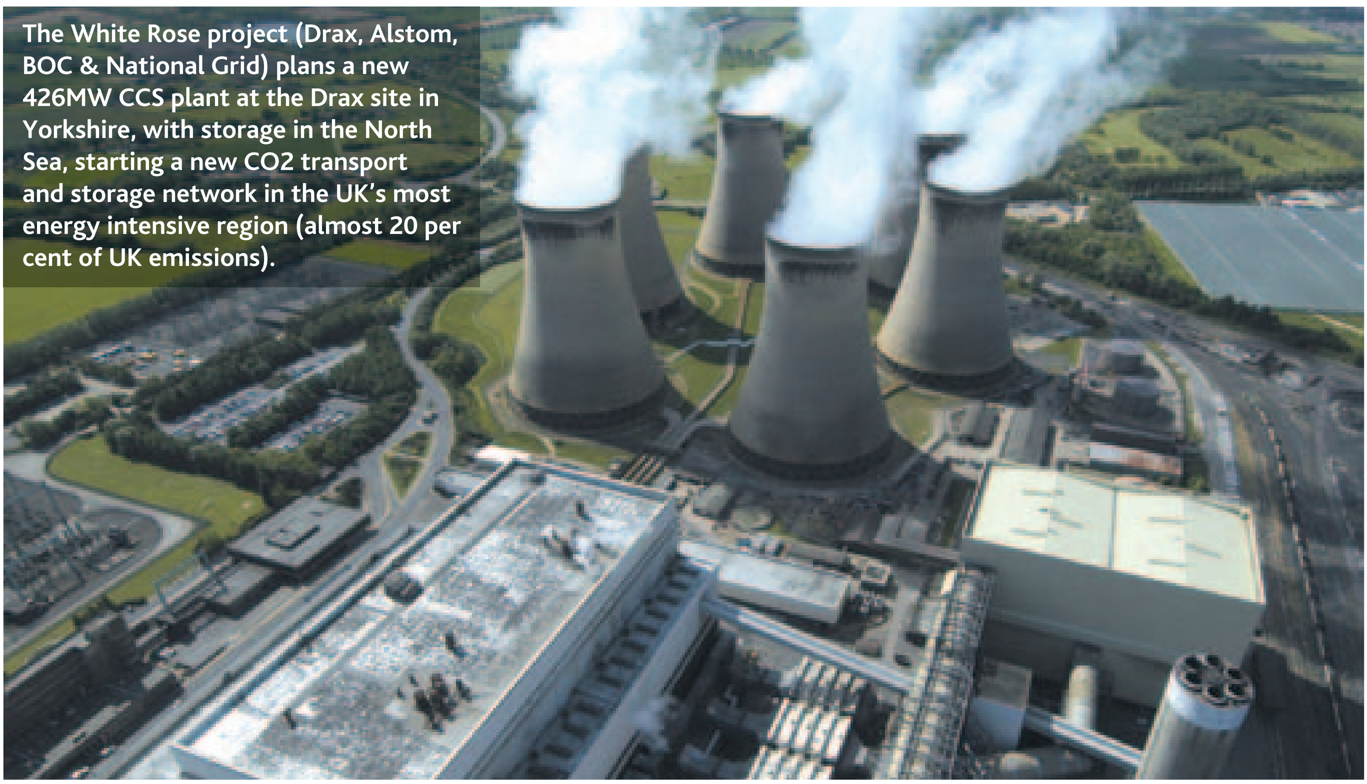
1. **The government should strongly endorse a long-term vision for the sector.**
2. **There should be an immediate and steady rollout of CCS projects including a minimum of two projects from the current CCS competition (ready to begin operating from 2018), and positive final investment decisions on shovel-ready, non-competition projects as early as possible in the lifetime of the next parliament.**
3. **The government's Electricity Market Reform programme should be successfully implemented, particularly through the development of low-carbon support mechanisms such as the Feed-in Tariff with Contracts for Difference that catalyses CCS investment.**
4. **Infrastructure for CO_2 transport and storage should be developed that can cost-efficiently service the needs of not just current emitters but also future power and industrial facilities.**
5. **Support mechanisms for CCS in industrial applications should be developed.**

'Decisions taken now, and actions taken over the next 7–10 years, will determine the ability of 'UK plc' to take advantage of its natural assets'

The full report, *A UK Vision for Carbon Capture and Storage*, was prepared by Orion Innovations (UK) Ltd for the TUC and the Carbon Capture and Storage Association. It is available at www.ccsassociation.org/press-centre/reports-and-publications/ and at www.tuc.org.uk/sites/default/files/UKVisionforCCS.doc

SSE's Peterhead Power Station in Aberdeenshire, from which Shell proposes to capture 10 million tonnes of CO_2, over a ten-year period, and store it in the depleted Goldeneye reservoir some 100km (62 miles) offshore, under the North Sea.

Image copyright SSE



The White Rose project (Drax, Alstom, BOC & National Grid) plans a new 426MW CCS plant at the Drax site in Yorkshire, with storage in the North Sea, starting a new CO_2 transport and storage network in the UK's most energy intensive region (almost 20 per cent of UK emissions).

Image copyright Drax

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i International Energy Agency *Energy Technology Perspectives 2012*

ii International Energy Agency *Technology Roadmap Carbon Capture and Storage* – 2013 edition

iii Energy Technologies Institute *Energy Systems Modelling* (ESME)

iv Cambridge Econometrics, September 2013 – prepared for the Energy Technologies Institute (ETI) as part of the full report *A UK Vision for Carbon Capture and Storage*

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vi Note that mix of technologies in the Full CCS scenario is almost identical to that in the Power CCS scenario, and so electricity prices in these two scenarios follow an almost identical path.

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viii Employment data is a summary of the following reports: CO_2Sense, *The National, Regional and Local Economic Benefits of the Yorkshire and Humber Carbon Capture and Storage Cluster*, October 2012; Scottish Enterprise, *Economic Impact Assessments of the Proposed Carbon Capture and Storage Demonstration Projects in Scotland* – a Summary report, May 2011; information from Teesside and Don Valley projects.

ix http://sequestration.mit.edu/tools/projects/boundary_dam.html and personal communication

x Projections of 10 GW (approximate) installed CCS capacity by 2030 can be found in the DECC *Draft EMR Delivery Plan*, July 2013 with a more ambitious target of 15 GW suggested by the Committee on Climate Change in *Next Steps on Electricity Market Reform – securing the benefits of low-carbon investment*, May 2013. Projections of 20 GW installed CCS capacity can be found in the CCSA *Response to Energy and Climate Change Committee Inquiry into Carbon Capture and Storage*, Sept 2013

xi CCSA, *A Strategy for CCS in the UK and Beyond*, September 2011

xii Data on UK content can be found in: AEA, *Assessing the Domestic Supply Chain Barriers to the Commercial Deployment of Carbon Capture and Storage within the Power Sector*, DECC, September 2012; data contained in Office for National Statistics, *Supply and Use Tables*, 1997–2010; and BIS *Offshore Wind Industrial Strategy, April 2013*

xiii AEA, *Assessing the Domestic Supply Chain Barriers to the Commercial Deployment of Carbon Capture and Storage within the Power Sector*, DECC, September 2012 (GVA calculation is based on AEA figures which assume a relatively high labour input (280,000 man years) for cumulative 10 GW installation)

xiv International Energy Agency *Technology Roadmap Carbon Capture and Storage* – 2013 edition

xv Based on 75 per cent of AEA market value figures: AEA, *Assessing the Domestic Supply Chain Barriers to the Commercial Deployment of Carbon Capture and Storage Within the Power Sector*, DECC, September 2012, and data from IPA, *Carbon Capture and Storage Skills Study*, Alan Young, Richard Catterson and Mike Farley, Sept 2010.

xvi Scottish Enterprise, *Economic Impact Assessments of the Proposed Carbon Capture and Storage Demonstration Projects in Scotland – a summary report*, May 2011

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xviii TUC Clean Coal Task Group, *Roadmap for Coal*, October 2011

xix http://archive.theccc.org.uk/aws/EMR%20letter%20-%20September%2012.pdf

xx TUC, "The Benefits of Securing the Energy-Intensive Industries in the UK" in *Building our Low-Carbon Industries*, June 2012

xxi TUC, "The Benefits of Securing the Energy-Intensive Industries in the UK" in *Building our Low-Carbon Industries*, June 2012

xxii TUC, "The Benefits of Securing the Energy-Intensive Industries in the UK" in *Building our Low-Carbon Industries*, June 2012

xxiii Saline formations are very large, porous rock formations that are typically several kilometres below the surface and contain water that is unusable because of its high salt and/or mineral content.

xxiv Energy Technologies Institute *UK Storage Appraisal Project* (developed into the database CO2stored.co.uk, hosted by The Crown Estate and the British Geological Survey).

xxv Map sourced from DECC CCS Roadmap 2012 and provided by the Energy Technologies Institute.

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