Department
of Energy &
Climate Change

Next steps in CCS: Policy Scoping Document

Developing an approach for the next phase of Carbon Capture & Storage projects in the UK

August 2014

URN 14D/281

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www.gov.uk/decc

Foreword

In the 1930s, in the midst of London's pea-soup fog, Battersea Power Station was the first power station in the world[1] to deploy an innovative technology known as "Flue Gas Desulphurisation" (FGD) to clean up sulphur dioxide in its toxic fumes – a key cause of London's air pollution.

The cost of that technology was significant and in the 1930s there were no financial or regulatory incentives to deploy FGD. Battersea was ahead of its time – for a variety of reasons, it took another 70 years before the technology was fully commercialised. But FGD is now installed in over 1700[2] power stations across the world and the energy industry expects to invest around $8bn[3] in the technology in 2015 alone.

Today the problem is not sulphur dioxide, but carbon dioxide. And to solve this problem we need more clean energy from renewable and nuclear sources, alongside cleaner energy from gas. But we also need a new generation of coal and gas power stations equipped with Carbon Capture and Storage (CCS) for the 21st century.

The UK is leading Europe in developing CCS technology, and the world's first power CCS projects in North America will come on stream this year. But we can't wait another 70 years. We need CCS to be commercial in a decade. The prize is a big one - with CCS we can achieve our carbon targets more cheaply and support over 15,000 jobs per year by 2030[4].

It is not just the technology which continues to mature. The regulatory, commercial, legal and financial structures which will allow industry to move forward also need to develop. The Government thinks that the best and quickest way to achieve this is to make available significant support to ensure the UK's first commercial scale CCS projects are established. In addition to working intensively to support those projects, the Government is also thinking ahead to how we can support industry to build on the infrastructure which could be put in place by these projects, in a second phase of CCS development.

The UK is recognised as having the most advanced policy and regulatory framework in the world[5] to encourage CCS. But we need to do more and we need your help. This Coalition Government pioneered open policy making, as set out in the Civil Service Reform Plan. That plan stated that the best way to develop "high quality, creative policy is to open the policy development process to external sources", beyond the Civil Service and Whitehall mandarins.

It is in that spirit, and to continue the excellent work which the CCS industry started under its Cost Reduction Task Force, that I offer this Policy Scoping Document to stimulate discussion and look ahead to further engagement over the coming months on how we can make Phase 2 of CCS deployment in the UK a reality.

Rt Hon Edward Davey MP, Secretary of State

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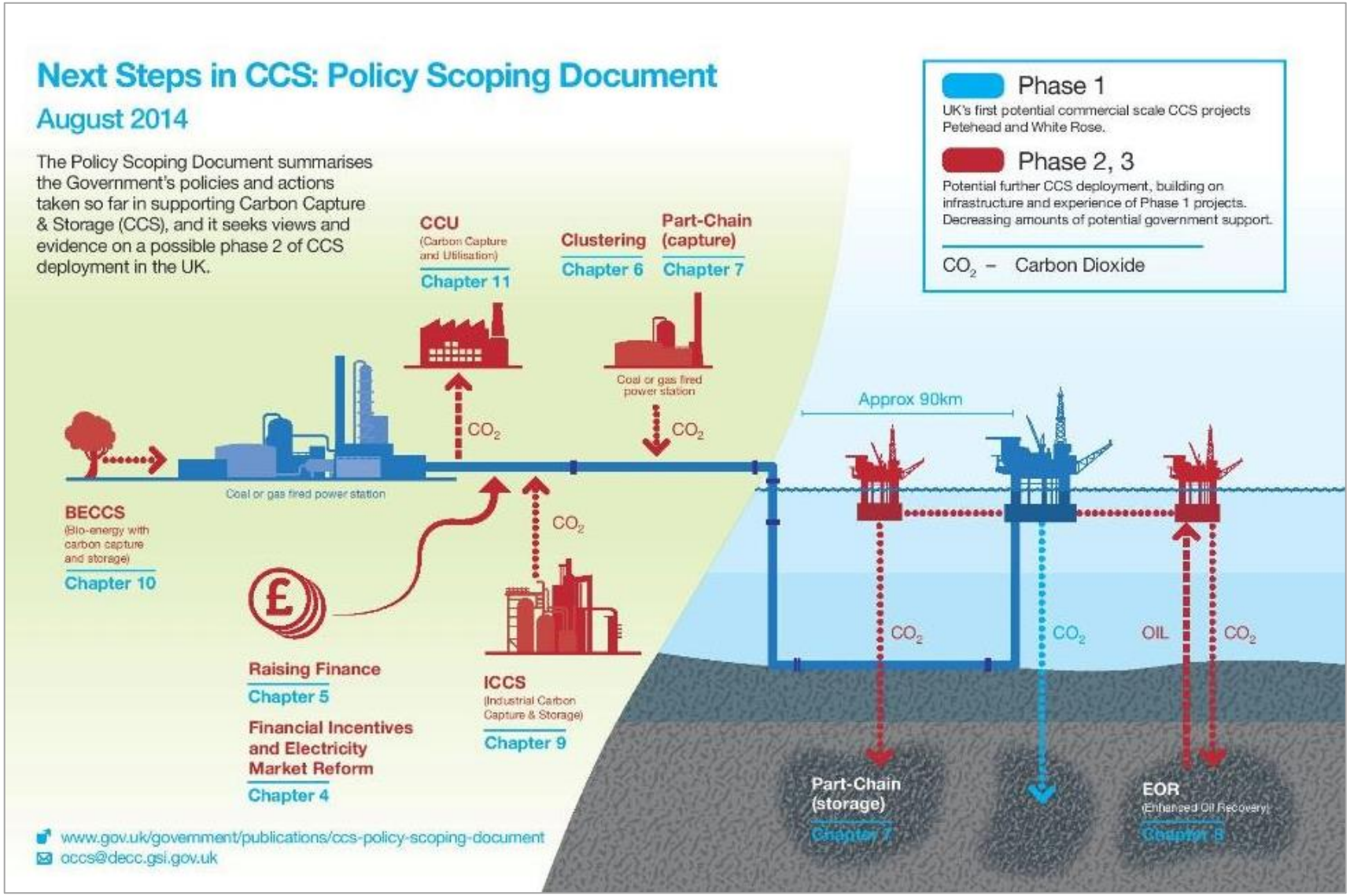
[1] www.ukerc.ac.uk/support/tiki-download_file.php?fileId=2411
[2] Energy Industries Council, http://www.modernpowersystems.com/features/featureflue-gas-desulphurisation-trends-and-opportunities/
[3] http://home.mcilvainecompany.com/index.php/component/content/article/7-news/706-nr1927
[4] http://www.ccsassociation.org/index.php/download_file/view/748/76/
[5] Global Status of CCS 2013, GCCSI http://decarboni.se/publications/global-status-ccs-2013/43-ccs-policy-index


Next Steps in CCS: Policy Scoping Document
August 2014
The Policy Scoping Document summarises the Government's policies and actions taken so far in supporting Carbon Capture & Storage (CCS), and it seeks views and evidence on a possible phase 2 of CCS deployment in the UK.
Phase 1
UK's first potential commercial scale CCS projects Peterhead and White Rose.
Phase 2, 3
Potential further CCS deployment, building on infrastructure and experience of Phase 1 projects. Decreasing amounts of potential government support.
CO_2 – Carbon Dioxide
CCU
(Carbon Capture and Utilisation)
Chapter 11
Clustering
Chapter 6
Part-Chain (capture)
Chapter 7
Coal or gas fired power station
CO_2
Approx 90km
Coal or gas fired power station
BECCS
(Bio-energy with carbon capture and storage)
Chapter 10
Raising Finance
Chapter 5
Financial Incentives and Electricity Market Reform
Chapter 4
ICCS
(Industrial Carbon Capture & Storage)
Chapter 9
OIL
Part-Chain (storage)
Chapter 7
EOR
(Enhanced Oil Recovery)
Chapter 8
www.gov.uk/government/publications/ccs-policy-scoping-document
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General information

Purpose of this document:

The Government aims to deliver a secure, affordable, low carbon energy system. As part of this, the Government's long-term vision for the electricity market, through its Electricity Market Reform programme, is to transition to a point where low carbon technologies can compete fairly on price. Competition between technologies will allow us to meet our objectives in the most cost-effective way. Carbon Capture and Storage is a key technology which will enable this. Therefore, the Government is committed to supporting the commercialisation and cost reduction of CCS alongside the efforts of industry and governments internationally.

This document summarises the Government's policies and actions already taken to support CCS deployment in the UK, and what we believe to be the main challenges to further commercial deployment of CCS in the UK. It invites views, inputs and evidence on addressing those challenges.

The Government committed[6] to engage further with the industry on how mechanisms implemented by the Government's Electricity Market Reform could be applied to early stage CCS projects. This document sets out key aspects of those discussions to date, and key areas which need further development.

The Government anticipates that further policy statements or consultations may be needed as detailed aspects of policy are refined.

CCS terminology

When CCS is referred to in this document, unless stated otherwise it will refer to CCS in its broadest sense:

- capturing carbon from either power generation or industrial processes;
- transporting the CO_2; and
- storing CO_2 in geological formations underneath the seabed, or utilising the CO_2 in products (Carbon Capture and Utilisation - CCU) such as plastic and cement, or as part of the Enhanced Oil Recovery (EOR) technique.

This document is not intended to be a technical guide to CCS, and will not detail the different technologies.

Issued: 7 August 2014

Respond by: 23 October 2014

[6] Para 3.35; EMR: Contract for Difference: Contract and Allocation Overview, Aug 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/233004/EMR__Contract_for_Difference__Contract_and_Allocation_Overview_Final_28_August.pdf

Territorial extent:

This policy scoping document covers Great Britain. The Department for Trade and Industry (DETINI) is responsible for CCS policy in Northern Ireland as energy policy is transferred to the Northern Ireland Assembly.

How to respond:

Your response will most useful if it is framed in direct response to the questions posed, though further comments and evidence are also welcome.

Electronic format is preferred – please send any responses to occs@decc.gsi.gov.uk. However, hard copy responses may also be sent to the Department at the address on page 2.

The Office of Carbon Capture and Storage (OCCS) also sends out updates and bulletins. To register to receive these, please send an e-mail to occs@decc.gsi.gov.uk

Additional copies:

You may make copies of this document without seeking permission. An electronic version can be found at www.gov.uk/decc.

Versions of this document in Braille, large print or audio-cassette are available on request. This includes a Welsh version. Please contact us under the above details to request alternative versions.

Confidentiality and data protection:

Information provided in response to this policy scoping document, including personal information, may be subject to publication or disclosure in accordance with the access to information legislation (primarily the Freedom of Information Act 2000, the Data Protection Act 1998 and the Environmental Information Regulations 2004).

If you want the information that you provide to be treated as confidential please state so clearly in writing when you submit your response. It would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded by us as a confidentiality request.

We will summarise all responses and place this summary on our website at www.gov.uk/decc. This summary will include a list of names or organisations that responded but not personal information such as addresses or other contact details.

1. Executive Summary

CCS – and actions the Coalition Government has taken

1.1. The Government is committed to supporting the commercialisation and cost reduction of Carbon Capture and Storage (CCS) as a key mechanism for delivering a secure, affordable, low carbon energy system.

1.2. CCS is not a single technology, but a suite of different technologies, which in some cases have been used for decades. However, there is limited experience of implementing CCS on power generation worldwide and currently no commercial-scale projects in the UK which are capturing carbon dioxide (CO_2), transporting and then storing it deep beneath the sea-bed.

1.3. The policies made and actions taken by the Coalition Government have meant the UK is leading Europe in the development of CCS – with the best R&D in our universities and two commercial scale projects under active development as part of our world-leading Commercialisation Programme, one of which has secured €300m from the European Commission – the only project in Europe to attract such funding.

1.4. We anticipate that one or both of these projects, White Rose and Peterhead, could form the first phase of CCS deployment in the UK. They would help prove the concept, create important infrastructure that may be used for subsequent projects, create commercial relationships between the different elements of the CCS chain, and begin to build interest from competing businesses and their supply chains. In addition to working intensively to help support these first projects, the Government is also thinking ahead. If the market can demonstrate that costs are falling in line with expectations, the Government will assess how it can support industry to build on the infrastructure put in place through the first projects, to deliver future CCS deployment.

Moving forward - topics covered by this document

1.5. This document invites views, inputs and evidence on our existing policies that could support those projects, and also on future policy development which may be needed. Key aspects are:

- **Financial Incentives & Electricity Market Reform (Chapter 4)**: The Government's long-term vision for the electricity market, through its Electricity Market Reform programme, is to transition to a point where low carbon technologies can compete fairly on price. The Government has already noted its intention[7] that any future Contract for Difference (CfD) allocation for CCS projects would take place through competitive project selection processes, wherever practical and effective, and noted that bilateral negotiation remains an alternative where such processes are not practical; it has also committed[8] to further discussions with CCS developers on these issues.
- In order to continue to make progress in the course of the remainder of 2014 and 2015, DECC will engage with developers on the design of a generic CCS CfD and

[7] Para 3.33, August 2013 publication on EMR Contract and Allocation Overview
[8] Para 3.35, August 2013 publication on EMR Contract and Allocation Overview

options for the criteria which might be applied in any future allocation frameworks. Without prejudice to future decisions on the Levy Control Framework or any future allocation processes under the EMR enduring regime, this work should enable an appropriate suite of enabling architecture to be in place for CCS by 2016.

- **Financing CCS (Chapter 5)**: The Government has recognised that raising finance for low carbon energy and other major infrastructure projects, including CCS, from traditional sources may be challenging, and therefore has a range of mechanisms available to support investors. This chapter provides a brief summary of those mechanisms.
- **Transport and Storage infrastructure (Chapter 6)**: Analysis shows that effective investment in and use of transport and storage infrastructure could deliver significant cost reductions. This chapter sets out the Government's approach to date and seeks views on future direction.
- **Part chain projects (Chapter 7)**: This chapter addresses the possibility that early Phase 2 projects could be "part-chain" CCS projects; clarifies what "part-chain" refers to; and briefly outlines some of the issues affecting such projects.
- **Enhanced Oil Recovery (Chapter 8)**: The Government is exploring with industry the extent to which CO_2-EOR could play a significant role in the UK's CCS deployment and maximise future recovery from the North Sea. This chapter outlines the potential opportunity available, provides an update of recent work and seeks views on how to further encourage activity in this area.
- **Industrial CCS (Chapter 9)**: To meet the UK's longer term ambitions on climate change, carbon dioxide emissions from energy intensive industries will need to be substantially reduced. For some of these industries, CCS is likely to be a key part of the technology mix required to make such reductions. This chapter summarises the Government's activity to date and seeks views on possible next steps.
- **Bio-CCS / Bioenergy with CCS (Chapter 10)**: In the long term, combining bioenergy with CCS (BECCS) to produce negative emissions is predicted to offer a key route by which the UK could meet its 2050 targets. This chapter briefly sets out Government policy development to date.
- **CCU (Chapter 11)**: Carbon Capture and Utilisation (CCU) technologies could offer a route by which to make CO_2 a commodity rather than a waste product. This chapter summarises the Government's current approach.
- **Supply Chain (Chapter 12)**: The CCS supply chain is likely to be similar to those for other major energy infrastructure projects. This chapter outlines how the Government will help companies who wish to exploit the opportunities in this nascent sector.
- **Knowledge Transfer (Chapter 13)**: Knowledge transfer is a key philosophy which underpins the CCS Commercialisation Programme – CCS projects in receipt of Government funding will be expected to share their experience and learning with the wider industry to support development and cost reduction. This chapter summarises the Government's current approach and explores possible approaches under any future projects.
- **Underpinning Research, Development and Innovation (Chapter 14)**: Continued research, development and innovation is a key way in which to further

reduce the costs of CCS by creating better, cheaper components and processes. This chapter summarises the Government's current approach and possible future actions.

Next steps

1.6. We welcome views on the issues identified in this document or more widely. Details of how to respond to questions raised in this document can be found on page 7.

1.7. We will be engaging with the CCS Development Forum[9] on these issues. We will also be discussing with those interested in the development of CCS, both individually and collectively, the issues raised.

1.8. Over the past three years, the Government has issued a series of documents and consultations as policy on Electricity Market Reform and generic CfDs for renewables was refined.

1.9. This document marks a continuation of aspects of that dialogue, and we anticipate further documents and consultations may be issued as detailed aspects of CCS policy are refined.

[9] https://www.gov.uk/government/groups/ccs-development-forum

Section A

2. Introduction

This chapter sets out **why** the Government is encouraging the development and deployment of CCS, and sets out how CCS may be deployed in **three phases** in the UK as the industry matures.

Context

2.1. Supporting the development of Carbon Capture and Storage (CCS) is a priority for the Coalition Government[10]. Cost-competitive CCS has the potential to provide a significant contribution to meeting three of DECC's core objectives:

(i) Promote UK Growth

(ii) Deliver secure energy on the way to a low carbon future

(iii) Drive ambitious action on climate change at home and abroad

2.2. These objectives are set against the backdrop of a legally binding greenhouse gas emission reduction target of at least 80% by 2050 and a need to put the UK on a cost-effective pathway to meeting this target.

Why CCS

2.3. The UK energy system is complex. We use energy in many different ways – to light and heat our homes, to power our industry, and to get to work and go on holiday. Our energy comes from many different sources: renewable, nuclear and fossil fuels to generate electricity; gas to generate heat; oil, in the form of petrol and diesel, in our cars and planes.

2.4. DECC's award winning 2050 Pathways Calculator[11] enables people to explore this system and see how choices in one area have an impact on others. To change the energy system to a secure, affordable, low carbon one, many experts, including the International Energy Agency (IEA) and the Energy Technologies Institute (ETI), agree that CCS will need to be at the heart of it.

2.5. This is because CCS can be used to address different parts of the energy system. First, to achieve the UK's 2050 climate change targets, the UK Government's 2011 Carbon Plan[12] showed that the UK would need to substantially decarbonise its electricity system by 2030. The 2013 Electricity Market Reform Delivery Plan set out several scenarios by which this could be achieved, including a high CCS scenario delivering up to 13GW of decarbonised electricity by 2030. Second, to continue to meet climate ambitions, the UK will then need tackle the carbon emissions which originate from energy intensive industry. For some of these industries, CCS is likely to be a key technology through which to achieve this. Finally, in the long term, when combined with biomass and bioenergy, CCS creates the potential of "negative emissions" – the possibility of removing carbon dioxide from the atmosphere by permanently storing the carbon temporarily locked in plants. The potential of "negative emissions" removes or reduces

[10] The Coalition: our programme for government (2010); The Coalition government mid-term review (2013)
[11] https://www.gov.uk/2050-pathways-analysis
[12] https://www.gov.uk/government/publications/the-carbon-plan-reducing-greenhouse-gas-emissions--2

the need to develop and deploy more expensive carbon mitigation technologies elsewhere in the economy.

2.6. Analysis by the CCS Association (CCSA) showed that deploying CCS in our energy system could reduce energy bills compared with a business as usual approach and support over 15,000 jobs per year by 2030[13].

2.7. CCS provides a means by which fossil fuels, which currently produce around 60% of the UK's electricity and play a vital role in enabling the system to respond flexibly to demand, are able to continue to make a valuable contribution to our energy needs in a low carbon future.

2.8. The Government is therefore committed to work with industry and other governments to help develop CCS as a commercially viable carbon abatement technology. We believe that the immediate priority is to demonstrate the commercial and economic viability of CCS at commercial scale in the power generation sector. The UK Government programme is part of a wider international effort, which should see the first commercial scale power stations equipped with CCS operating from this year in North America.

Cost reduction

2.9. Most new technologies reduce in cost as they develop and mature. Examples of this cost reduction theory include mobile phones, electric vehicles and photo-voltaic solar panels.

2.10. For CCS, like other low carbon energy technologies such as offshore wind, this cost reduction is crucial for it to play a part in the UK's electricity system to 2030 and in the longer term in UK's wider energy system.

2.11. In 2013, the CCS Cost Reduction Task Force (CRTF)[14] undertook a thorough analysis, which concluded that CCS costs could be significantly reduced to a level which is competitive with other forms of low carbon generation in the UK.

2.12. The Government endorsed those conclusions in its response to the Cost Reduction Task Force's report and, through the CCS Development Forum[15], continues to work with industry as it develops, and puts in place, plans for achieving these outcomes.

Three phases of CCS development and deployment

2.13. The maturing of CCS as a commercial technology is unlikely to take place through a linear process. The Government has previously[16] set out a conceptual framework of how CCS could be developed and deployed in three broad phases in the UK:

- The **first phase** of CCS projects is made up of first-of-a-kind (FOAK) projects, taken forward under the Commercialisation Programme. The Government considers that the quickest and most effective way to reduce the cost of CCS is to support the UK's first commercial-scale project(s). A FOAK project is critical in establishing CCS infrastructure in the UK, developing and testing the market-led commercial and legal frameworks for projects of this type, and thereby significantly reducing the risks and barriers faced by subsequent projects.
- The **second phase** of CCS projects: This is a transition phase between heavily state supported Phase 1 and cost-competitive Phase 3 projects. Our discussions

[13] http://www.ccsassociation.org/index.php/download_file/view/748/76/
[14] https://www.gov.uk/government/groups/ccs-cost-reduction-task-force
[15] https://www.gov.uk/government/groups/95
[16] https://www.gov.uk/government/publications/ccs-in-the-uk-government-response-to-the-ccs-cost-reduction-task-force--3

with the industry over the past few months have indicated that project developers may still face some of the challenges of Phase 1 projects – in terms of not being able to absorb all the technical and commercial risks of CCS, and therefore deploying CCS at a cost which is not yet competitive with some other forms of low carbon generation.

As set out in the Government response to the Cost Reduction Task Force, Phase 2 projects might be developed on a similar timeline, as well as subsequent to the Commercialisation Programme projects. It is feasible that early Phase 2 projects may take Final Investment Decisions (FID) later this decade, but before Phase 1 projects have completed construction and commissioning. Later Phase 2 projects may come forward in the early 2020s once Phase 1 projects are operating successfully.

- The **third phase**: By Phase 3 we expect the CCS industry to have developed to a point where projects are fully commercial and are able to compete in the market on the basis of cost with other low carbon technologies, as set out in the EMR Delivery Plan. Our policies are designed to help bring CCS to this third phase as quickly as possible. Our objective is a competitive, low carbon energy market, with different technologies competing on price and providing the best value for money for the consumer.

2.14. The Government remains fuel and capture-technology agnostic. Policies have been designed so as to be equally applicable to CCS on coal or gas power stations, and to projects which utilise any of the three main groupings of carbon capture technology: pre-combustion, post-combustion or oxyfuel.

2.15. As mentioned in the Government Response to the CRTF, the Government anticipates that Phase 2 projects could capture CO_2 emissions from either power stations or energy intensive industry. Project developers may also choose to exploit Enhanced Oil Recovery techniques.

Scoping document

2.16. This document is intended to provide industry with a clearer indication of our plans to support the continued deployment of CCS.

2.17. The document summarises the policies and actions which the Government has already taken to support Phase 1 of CCS deployment in the UK. It then sets out how those policies, including plans to put in place enabling architecture for possible future award of CfDs for CCS projects under Electricity Market Reform, could support Phase 2 CCS Projects and beyond. This is without prejudice to future decisions on the Levy Control Framework or any future allocation processes under the EMR enduring regime.

2.18. It seeks views, evidence and input on this, and on the full spectrum of issues which could impact future policy development on CCS, to enable industry to deliver up to the high CCS scenario from the EMR Delivery Plan.

Open policy making

2.19. The Coalition Government is committed to open policy making, as set out in the Civil Service Reform Plan. That plan states that the best way to develop “high quality, creative policy is to open the policy development process to competition from external sources”.

2.20. This document is designed to provide an opportunity for sources outside the Civil Service to provide their input, views and evidence on the future of CCS in the UK.

3. Interventions to date

The 2012 UK CCS Roadmap[17] set out a comprehensive package of interventions and funding by the Government to support the first commercial scale CCS projects in the UK.

This chapter provides a summary of our interventions to date.

Rationale and Government role

3.1. The Government believes that CCS is one of a number of technologies with the potential to help the UK meet its decarbonisation objectives. We are therefore keen to encourage the development of CCS as a low-cost alternative to other forms of decarbonisation.

3.2. The current market in the UK, and internationally, is not delivering investment in CCS on the scale needed to reduce costs and enable widespread deployment of CCS in the 2020s. Deployment on this timescale is needed if CCS is to fulfil its potential and contribute to the Government's long-term decarbonisation objectives. The Government considers that the quickest and most effective way to reduce the cost of CCS is for the UK to deploy its first commercial-scale projects. In 2012 the Government published its CCS Roadmap. This set out a programme of measures and interventions to support industry in reducing the costs of CCS, to a point where the technology is cost-competitive with other forms of low carbon generation and carbon abatement technology. The five key areas set out in the 2012 Roadmap were:

- £1bn CCS Commercialisation Programme
- Electricity Market Reform
- £125m Research, Development and Innovation Programme
- Addressing key barriers to commercialisation such as regulation
- International engagement and knowledge sharing

Interventions to date

CCS Commercialisation Programme

3.3. The CCS Commercialisation Programme aims to support the deployment of the UK's first commercial scale CCS project(s).

3.4. This will be critical in establishing CCS infrastructure in the UK, developing and testing the market-led commercial and legal frameworks for projects of this type, and thereby significantly reducing the risks and barriers faced by subsequent projects.

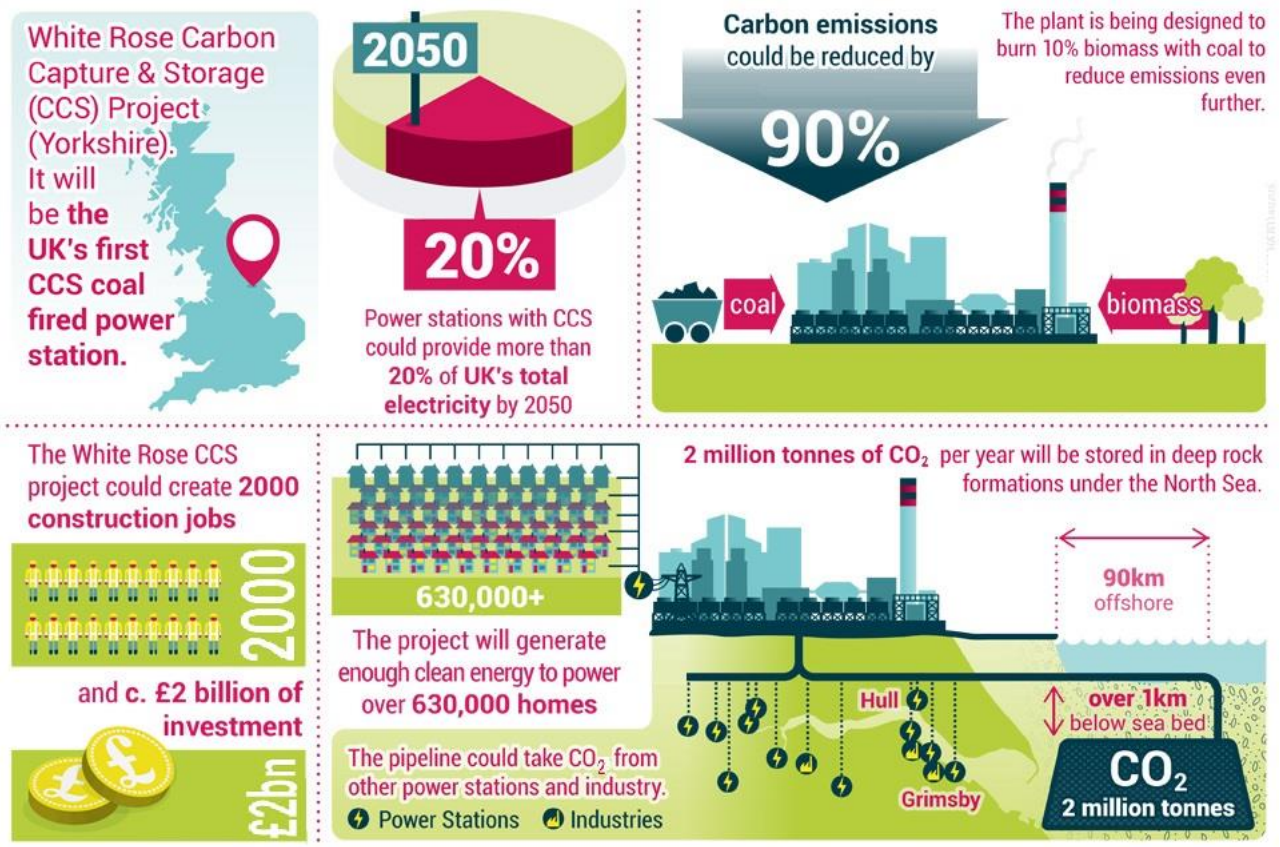
3.5. In recognition of the technical, financial and commercial challenges initial projects face, the Government is providing extensive support. This includes around £100m to support the majority of both development and front end engineering and design (FEED) costs for the two projects in the Commercialisation Programme; making available the remainder of the £1bn capital funding Government has committed to CCS to support the investment required for constructing these projects; providing operational support

[17] https://www.gov.uk/government/publications/the-ccs-roadmap

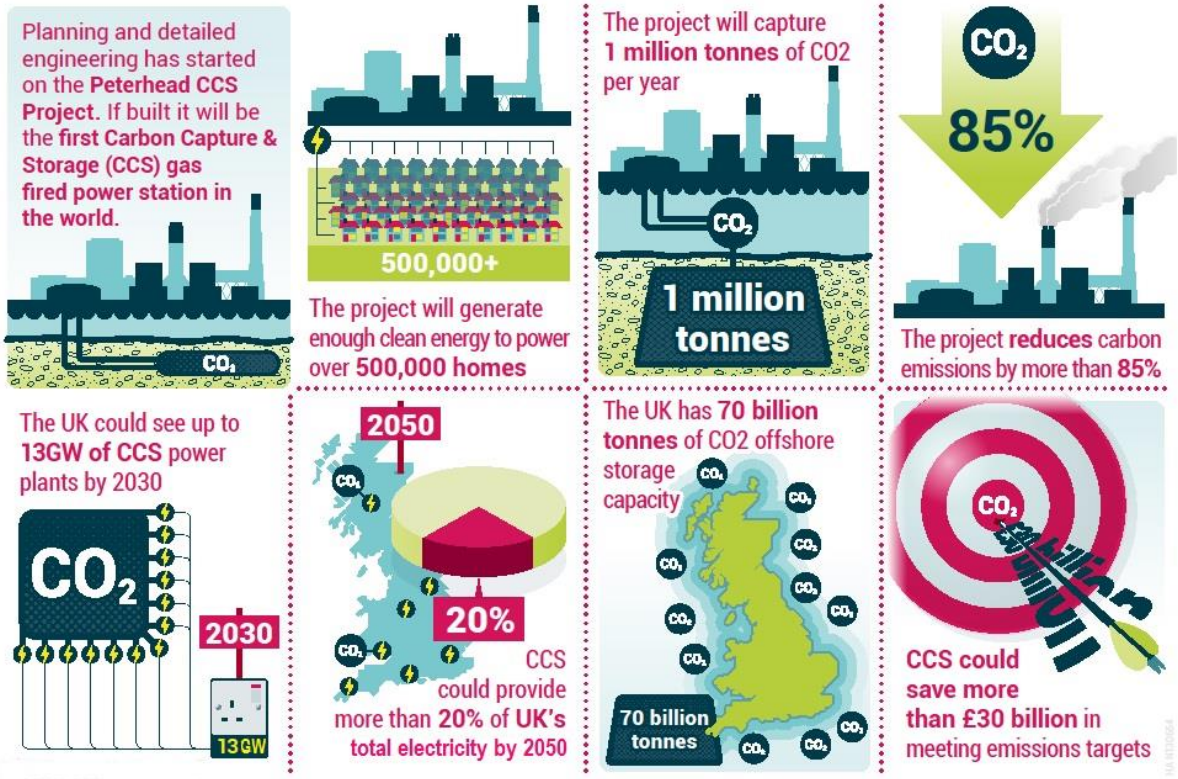
through tailored low carbon Contracts for Difference (CfDs), subject to value for money; and putting in place arrangements, tailored to individual projects, for Government to share CCS specific risks (industry will take on business as usual risks). As a condition of this significant level of public investment, knowledge and know-how developed will be actively disseminated.

3.6. The Competition was launched alongside the Roadmap in April 2012 and attracted significant interest from industry. From an initial eight bids submitted, two projects have been taken forward into FEED:

- White Rose Project in Yorkshire, England – this project proposes to capture about 90% of the CO_2 from a new super-efficient coal fired power station at the Drax site, and to store it in a saline formation deep beneath the Southern North Sea seabed. The project involves Alstom, Drax Power, BOC and National Grid.



- Peterhead Project in Aberdeenshire, Scotland – this project proposes to capture about 85% of the CO_2 from part of the existing gas fired power station before transporting it and storing it in a depleted gas field deep beneath the Central North Sea seabed. The project involves Shell and SSE.



3.7. Both projects are expected to take Final Investment Decisions towards the end of FEED, around the end of 2015, with Government decisions shortly thereafter. Construction, commissioning and operation will follow as soon as possible.

Electricity Market Reform (EMR)

3.8. Electricity Market Reform (EMR) will deliver the low carbon electricity and reliable supplies that the country needs, at the lowest possible cost. It will transform the UK electricity sector to one where low-carbon generation can compete with conventional, unabated fossil-fuel generation – ensuring we build the right mix of generation for the long-term.

3.9. Up to a fifth of generation capacity will close by 2020, whilst UK electricity demand could double by 2050 as our economy grows and heat and transport systems are increasingly electrified. Around £100 billion[18] of investment is required by 2020, and to achieve this investment we need to attract new sources of capital, and do so whilst keeping costs to consumers as low as possible. In order to meet our low carbon objectives and to put us on the right path to 2050, much of our electricity generation will need to be decarbonised by 2030, of which up to 13GW could be from CCS.

3.10. EMR is the Government's response to this challenge and is the biggest reform to the electricity sector since its privatisation. EMR has three goals: to decarbonise electricity generation; to keep the lights on; and to minimise the cost to consumers. The EMR Delivery Plan was published in December 2013.

[18] https://www.gov.uk/government/publications/delivering-uk-energy-investment-2014

3.11. The key mechanism under Electricity Market Reform (EMR) for bringing forward investment in CCS and other low carbon generation are Contracts for Difference (CfDs). CfDs will provide efficient long term support for all forms of low carbon generation – including CCS.

3.12. CfDs provide certainty and stability on prices: generators will receive in effect a fixed price for the low carbon electricity they produce - known as the 'strike price'. When the market reference price is below the strike price generators will receive a top-up payment from suppliers. Conversely if the reference price is above the strike price, the generator must pay back the difference.

3.13. A CfD will be a private law contract between a generator and the newly established Government-owned counterparty body – the Low Carbon Contracts Company. This body will provide a single accountable party for generators to interact with over the lifetime of the CfDs.

3.14. Our long-term vision is for low-carbon generation to compete fairly on cost without financial support, other than that provided indirectly by the carbon price.

3.15. The first CfDs for CCS will be negotiated with the two projects under the Government's CCS Commercialisation Programme. In order to receive CfDs, these projects will need to demonstrate value for money. The design of a generic CCS CfD will take into account progress of these negotiations.

CCS Research, development and innovation

3.16. The 2012 Technology Innovation Needs Assessment (TINA)[19] and the 2013 Cost Reduction Task Force confirmed that further cost reductions in CCS would likely come from continued research, development and innovation.

3.17. The UK has a world-class CCS research base and the Government is committed to supporting this work. We are delivering a 4-year, £125 million CCS Research and Development programme with our funding partners (the Research Councils, Technology Strategy Board and Energy Technologies Institute) to support:

(i) Fundamental research and understanding at our universities and research organisations.

(ii) The development of better, cheaper components and processes.

(iii) Pilot scale projects to bridge the gap between lab-scale research and commercial scale deployment.

3.18. In total, around 100 separate projects are being funded through this programme[20].

3.19. The Government has also supported the establishment of the UK CCS Research Centre (UKCCSRC)[21] – a £13 million investment which brings together the UK's top CCS academics to promote and coordinate UK CCS research capability and increase academic collaboration with industry.

[19] http://www.carbontrust.com/media/168543/tina-ccs-carbon-capture-storage-summary-report.pdf
[20] https://www.gov.uk/government/publications/cross-government-carbon-capture-and-storage-r-d-programme-2011-2015-list-of-projects
[21] https://ukccsrc.ac.uk/

Regulation

3.20. The UK is recognised as one of the most favourable policy and regulatory environments for CCS in the world, according to the Global CCS Institute's (GCCSI) CCS Policy Indicator[22]. The UK has led the world in the development of a regulatory framework to facilitate CCS. The Government undertook a comprehensive review of the regulation necessary to enable CCS in 2007 and has quickly addressed barriers when identified. For example, the Government added powers to the Energy Act 2011 to address a barrier to the reuse of existing capital assets for the purpose of CO_2 storage and transport.

3.21. The Government also recognises the importance of long term regulatory and price signals for investor certainty. For this reason we have brought forward a 'triple lock' of policies which will, among other effects, encourage deployment of CCS. These are (i) the stipulation that there should be no new coal power plants over 300MW built without CCS; (ii) the Carbon Price Floor which gives an economic incentive to reduce emissions from fossil fuelled power stations; and (iii) the Emissions Performance Standard which provides a regulatory backstop to the requirement of no new coal without CCS.

International engagement and knowledge sharing

3.22. Our international engagement is focussed on promoting knowledge sharing between projects and countries to help cost reduction and to support the deployment of CCS.

3.23. The Government is engaging through regional, bilateral and multilateral relationships to collaborate and help overcome the challenges of commercial-scale CCS deployment. We participate in a number of bilateral relationships as well as through international fora such as the Carbon Sequestration Leadership Forum, the North Sea Basin Task Force and the Clean Energy Ministerial; working with countries facing similar challenges to the UK.

3.24. We are also engaging with individual countries and supporting international collaboration on R&D. For example in Canada we have supported the UK CCS Research Centre to establish a research exchange and sign a Memorandum of Understanding (MOU) with Sask Power.

3.25. In April 2012, the Government announced[23] the allocation of up to £60 million to support the development of CCS technology in emerging markets. This pledge is part of the global commitment made by governments in 2011 through the Clean Energy Ministerial Carbon Capture, Use and Storage Action Group to allocate $200 million to accelerate the deployment of CCS in the near term. Working with the Asian Development Bank, £35 million[24] of this funding will be used to support CCS projects in China and Indonesia; and working with the World Bank, the remaining £25 million will support CCS projects in South Africa and Mexico.

[22] Global Status of CCS 2013, GCCSI http://decarboni.se/publications/global-status-ccs-2013/43-ccs-policy-index
[23] https://www.gov.uk/government/news/uk-allocates-up-to-60m-to-support-development-of-ccs-in-emerging-markets
[24] https://www.gov.uk/government/world-location-news/uk-supports-china-and-indonesia-to-develop-carbon-capture-and-storage

Section B

The CCS Commercialisation Programme is designed to bring forward the first commercial scale project(s) in the UK and overcome many barriers.

The purpose of this section is to identify remaining barriers to further deployment, and to seek views, input and evidence on how to address them to inform ongoing policy development.

4. Financial Incentives and Electricity Market Reform

The Government's long-term vision for the electricity market, through its Electricity Market Reform programme, is to transition to a point where low carbon technologies can compete fairly on price.

DECC will continue to make progress towards this goal in the course of the remainder of 2014 and 2015 by broadening its engagement with the industry, on a non-exclusive and no-commitment basis, on the design of a generic CCS Contract for Difference (CfD); on potential future arrangements for awarding CCS CfDs; and on the criteria which it might apply to project selection.

This chapter sets out some of the issues which will be explored over the next 18 months, with a view to putting in place a suite of enabling architecture for future CCS projects by 2016.

Context

4.1. The Government is in the process of reforming the electricity market to bring forward investment in low carbon generation, as part of the transition to a secure, affordable, low carbon energy system.

4.2. The Government's long-term vision for the electricity market, through its Electricity Market Reform programme, is to transition to one in which low carbon technologies can compete fairly on price. Competition between technologies will allow us to meet our objectives in the most cost-effective way.

4.3. Some technology-tailored approaches will be necessary to ensure investment comes forward in the early stages of the transition, while industries are maturing and while cost reductions are being achieved and demonstrated. We set out below our approach to financial support for Phase 1 CCS and initial plans to build on this approach for Phase 2 and beyond.

Approach to supporting Phase One CCS Projects – White Rose and Peterhead

4.4. In recognition of the importance of CCS, and the fact that no commercial scale power projects are operational anywhere in Europe, the Government launched the CCS Commercialisation Programme in 2012. Under this programme, significant levels of Government support have been made available to bring forward these First-Of-A-Kind (FOAK) projects (see table 1). This support includes:

- **Support for FEED development costs.** FEED (Front End Engineering and Design) is the pre-construction stage of engineering and planning necessary to achieve a greater certainty of cost, system design and technical performance. During this stage of work, projects under the Commercialisation Programme are also required to undertake broader work around commercial and financial risk reduction. Through FEED, the developer should become certain enough on the cost of the project to justify further investment which then allows the Government to also take decisions on how much support is justified. The Government is meeting up to 75% of the costs (around £100m in total) supporting the FEED activity of the White Rose and Peterhead CCS projects. The private sector sponsors of both projects are funding the remainder from their own resources.

- **Support for construction costs.** In recognition of the significant capital investment required, and the challenge of raising funds to finance these multi-billion pound FOAK infrastructure projects, the Government will also provide support from the remainder of the £1bn capital funding it has committed to the Programme. In addition to any capital support from Government, both projects would have to raise the majority of capital investment through equity or external finance.
- **Support during operation.** Should one or both of the projects, and Government, take positive Final Investment Decisions, the projects will be eligible for operational support through a CfD. This CfD will pay for the additional operating costs associated with CCS and provide an adequate return on the capital the consortia have invested.

4.5. There remains a significant degree of uncertainty over the costs and operational risks around FOAK projects. We expect FEED to allow for some cost discovery and therefore reduce uncertainty. However, various CCS specific risks may materialise in different phases of the projects during design, build, commissioning, operation and decommissioning. If these risks were to materialise the associated costs could impact on the economic viability of the plant.

4.6. A key aspect of the Government support on offer to the White Rose and Peterhead projects, therefore, is potential risk sharing of CCS-specific risks during construction and operation. As part of the Commercialisation Programme, Government analysed the business-as-usual and CCS specific risks FOAK projects are likely to face in a Baseline Risk Allocation Matrix (BRAM) and set out its high-level approach to risk sharing[25] (see Annex I and II). The Government agreed to share a limited number of CCS specific risks and details of those arrangements will be developed through negotiation with developers. Once agreed, these arrangements will be implemented through specifically tailored project contract terms and a CfD.

Towards Phase 2

4.7. The EMR Delivery Plan set out a range of scenarios for decarbonising the electricity system, including through the deployment of CCS of up to 13GW by 2030 in the high CCS scenario. For the commercialisation objective to be realised, this implies that subsequent projects should involve significant risk transfer from Government and the consumer to the developer, beyond that envisaged for Phase 1 projects.

4.8. Within these parameters, there are a number of considerations that will need to be addressed in the enabling architecture for any Phase 2 CCS projects. Some of these are highlighted below and we welcome preliminary views on these high level issues. We expect to consult on specific issues in greater detail over the course of the next 18 months.

Pre-Capital investment

4.9. A CfD requires a developer to be sufficiently confident of the capital and operational costs of its project to estimate, with reasonable certainty, the strike price it will need over the lifetime of the project. Reliable estimates of these costs are usually only available once FEED is complete.

[25] Tender documents are available at: https://online.contractsfinder.businesslink.gov.uk/Common/View%20Notice.aspx?site=1000&lang=en&noticeid=560937&fs=true

4.10. However, developing a project through FEED to a point where the developer can take an investment decision in itself involves significant costs. Investors in more established low carbon generation technologies are prepared to make similar investment without the certainty of a CfD. On the other hand, during initial discussions, CCS developers have noted the high risks created by the uncertainty, complexity and interdependencies of the CCS chain. They were therefore not prepared to fund such FEED investment entirely at their own risk without the offer of a CfD.

4.11. Whilst this is understandable given the currently nascent state of CCS in the UK, in the longer term CCS developers will need to develop projects at their own risk, as is the case for other low carbon technologies, up to the point where they can attract sufficient interest from investors.

Q1. To what extent would developers be prepared to invest in FEED costs ahead of allocation of a CfD? What measures could be adopted so that the developers have sufficient certainty of their costs and a Strike Price to form the basis of an investment decision?

Capital Investment

4.12. The Commercialisation Programme combines revenue support through Contracts for Difference with an element of capital support. Follow-on projects will be eligible to apply for infrastructure guarantees and other finance mechanisms such as through UK Green Investment Bank and European Investment Bank (see chapter 5), to support them in raising finance from non-public sources.

4.13. The Commercial Development Group, established under the Cost Reduction Task Force, and which reports to CCS Development Forum is working to support project developers in engaging with finance markets.

Q2. How best should the industry-led CCS Commercial Development Group work to support project developers in engaging with finance markets?

Operational support via Contracts for Difference

4.14. CfDs are long-term, private law contracts where Generators sell their electricity into the market in the usual way and where variable payments are made to ensure the generator receives the agreed “strike price”. CfDs stabilise returns for generators at a fixed level over the duration of the contract. This removes the generator’s long term exposure to electricity price volatility, substantially reducing the commercial risks faced by these projects. CfDs are not intended to provide protection against project development, technical or operational performance risks. The Government does not believe that they should fulfil this role for CCS.

4.15. However, initial feedback from developers is that the generic CfD may require some adaptation to be investible for CCS projects, including early stage Phase 2 projects, for example enabling flexibility to be able to adjust the Strike Price to take account of:

- movement in capital estimates; and
- changes to some operational costs once the Strike Price is agreed.

4.16. This is because there are a number of uncertainties which have the potential to impact the overall cost and return on investment of CCS projects along its full chain. Examples include:

- Uncertainties in future fuel price assumptions, as CCS has significant fuel costs unlike some other low carbon generation.
- Availability of cost effective infrastructure which can over time lead to cost reduction.
- Availability of valuable alternatives for the disposal of carbon dioxide (e.g. the use of carbon dioxide in enhanced oil recovery).
- The performance of the storage sites.

Q3. To what extent should Government reflect long-term risks of full chain CCS projects in the design of a CCS CfD? In particular, we will want to explore the extent to which similar risks also arise in other sectors and the changes that may be needed in CfD design to put CCS on an equivalent basis to other low carbon technologies.

4.17. In the 2013 EMR Contract and Allocation Overview[26] the Government noted its intention that any future CfD allocation for CCS projects would take place through competitive project selection processes, wherever practical and effective. This is in line with Government policy of increasing competition within and between low carbon technologies, which will assist with meeting Government's goals for least-cost decarbonisation of the power sector over the longer term. It also noted that bilateral negotiation remains an alternative for CCS CfD allocation where competitive processes are not practical. Any final allocation decision would still be subject to strict value for money considerations and an assessment of overall budget constraints.

4.18. The Government committed[27] to engage further with CCS developers, assessing the applicability of the generic CfD to early stage CCS projects and whether this needs to be tailored to provide appropriate support for this technology.

4.19. In order to continue to make progress towards achieving cost competition within and between low carbon technologies, DECC will therefore, in the course of the remainder of 2014 and 2015, broaden its engagement with the industry on a non-exclusive and no-commitment basis on the design of a generic CCS CfD and options for how these may be allocated in future. The design of a generic CCS CfD will also take into account progress in the CCS competition, where relevant, for other early stage CCS projects. Without prejudice to future decisions on the Levy Control Framework or any future allocation processes under the EMR enduring regime, this work should enable an appropriate suite of enabling architecture to be in place for CCS by 2016.

4.20. The current approach for the Phase 1 projects, and potential future approach for Phases 2 and 3 is summarised in table 1 below.

[26] EMR: Contract for Difference – Contract and Allocation Overview August 2013. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/233004/EMR__Contract_for_Difference__Contract_and_Allocation_Overview_Final_28_August.pdf

[27] Ibid

TABLE 1			
High-level principles for HMG intervention to support CCS – reducing levels of support through phases to full commercialisation			
	Phase 1 Peterhead White Rose	Phase 2 Transition phase	Phase 3 Full commercialisation
HMG Contribution to FEED costs	Yes	Subject to decision†	**No**
HMG contribution to construction costs	Yes*		**No**
HMG risk sharing during construction	Yes*		**No**
HMG risk sharing during operation	Yes*		**No**
CfD	Yes*	In principle, subject to decision†	In principle - all low carbon technologies compete on price†

Notes:

* Subject to negotiations, Final Investment Decisions by consortia and Government, an assessment of affordability and value for money; and state aid approval

† Without prejudice to future allocations from the current Levy Control Framework; or future decisions on the next Levy Control Framework period

Next steps

4.21. In order to put in place by 2016 the enabling architecture to bring forward a second phase of CCS in the UK, the Government will work to broaden its consultation with industry over the next 18 months on:

- The design principles of a generic CCS CfD.
- Options for how such a CfD may be allocated in future, including criteria that may apply.

4.22. These consultations will be without prejudice to future decisions on the Levy Control Framework or any future allocation processes under the EMR enduring regime.

4.23. We welcome views at this stage on whether the challenges outlined above on pre-capital investment, capital investment and operational support are appropriate issues on which to focus further consultations, and any further issues we will need to consider.

Questions:

Q1.	To what extent would developers be prepared to invest in FEED costs ahead of allocation of a CfD? What measures could be adopted so that the developers have sufficient certainty of their costs and a Strike Price to form the basis of an investment decision?
Q2.	How best should the industry-led CCS Commercial Development Group work to support project developers in engaging with finance markets?
Q3.	To what extent should Government reflect long-term risks of full chain CCS projects in the design of a CCS CfD? In particular, we will want to explore the extent to which similar risks also arise in other sectors and the changes that may be needed in CfD design to put CCS on an equivalent basis to other low carbon technologies.

5. Financing CCS projects

The Government has recognised that raising finance for low carbon energy and other major infrastructure projects, including CCS, from traditional sources may be challenging, and therefore has a range of mechanisms available to support investors.

This chapter provides a brief summary of those mechanisms.

Context

5.1. As evidenced by White Rose and Peterhead, full-chain CCS projects are major, multi-billion pound infrastructure projects. These projects are part of the Government's Top 40 priority investments, as set out in the National Infrastructure Plan[28].

5.2. Up to 2020 alone, the UK needs to attract a further £100bn investment[29] in its energy infrastructure. The changes to the Electricity Market and the creation of Contracts for Difference (CfDs) are designed to provide project developers with revenue certainty. However, project developers still need to raise capital funding to finance the construction of their projects.

5.3. As for other infrastructure projects, that finance will need to come from market. However, the Government has recognised that raising such finance for these low carbon energy projects from traditional sources may be challenging, and therefore has a range of mechanisms available to support investors in raising sufficient capital from non-public sources to take forward their projects. The key mechanisms are provided by the Green Investment Bank and Infrastructure UK.

Green Investment Bank

5.4. The Green Investment Bank (GIB) was established to accelerate investment in the UK's transition to a green economy. The UK Government is the sole shareholder and provided an initial £3.8bn of capital to be invested with the aim of helping to lower the cost of capital for green projects.

5.5. The GIB has a key role to play given the restricted availability of long-term debt to low-carbon infrastructure projects. Investments are made in demonstrably green projects and programmes with the aim of mobilising private capital. To date, the GIB has committed £1.3bn of capital and in doing so has mobilised a further £4.6bn. Products available through the GIB include debt, mezzanine, equity and guarantees, offered on terms equivalent to others in the market, but not low cost finance or grants.

Infrastructure UK

5.6. Infrastructure UK (IUK)[30] is a unit within the Treasury that works on the UK's long-term infrastructure priorities, of which CCS is one, and helps secure private sector investment. IUK manages the UK Guarantee Scheme, a mechanism through which the Government is seeking to kick-start crucial infrastructure projects.

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[28] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263159/national_infrastructure_plan_2013.pdf
[29] https://www.gov.uk/government/publications/delivering-uk-energy-investment-2014
[30] https://www.gov.uk/government/organisations/infrastructure-uk

5.7. The Treasury has made available £40bn of financial guarantees for such infrastructure projects. This support is offered as a financial guarantee of scheduled principal and interest to a lender or investor in a UK infrastructure project and on behalf of the relevant borrower or issuer of debt.

European Investment Bank

5.8. The European Investment Bank (EIB) is the bank of the European Union and is one of the largest multilateral borrowers and lenders by volume in the world. The bank provides finance and expertise for sound and sustainable investment projects which contribute to furthering EU policy objectives.

5.9. The vast majority of the EIB's financing is through loans, but they also offer guarantees, equity investment, intermediary project loans through local banks, project bonds, venture capital and microfinance among their range of products. Support from the EIB can be used to assist in unlocking financing from other sources.

Q4. Are these existing products sufficient to support CCS projects in raising finance from non-public sources? If not, please explain why, with supporting evidence, and what kind of additional financing or products would be needed?

Experiences from White Rose and Peterhead projects

5.10. As part of the FEED contracts signed with the Government, White Rose and Peterhead will share key aspects of their experience and learning with the wider industry (this approach is set out in more detail in chapter 13). This learning will include how the projects are financed (within the terms of commercial confidentiality), what viable financial structures look like and financial model templates for the use of prospective CCS developers.

Question:

Q4.	Are the existing products offered by the Green Investment Bank (GIB), Infrastructure UK (IUK) and the European Investment Bank (EIB) sufficient to support CCS projects in raising necessary finance from non-public sources? If not, please explain why, with supporting evidence, and what kind of additional financing or products would be needed?

6. Transport and storage infrastructure

Analysis[31] shows that effective investment in, and use of, transport and storage infrastructure could deliver significant cost reductions.

This chapter sets out the Government's approach to date, and seeks views on future direction.

Context

6.1. Regulatory arrangements for transport and storage are in place in the UK and will need to be tested in practice as projects get underway. The Government has also introduced measures to ensure that we are able to make most effective use of CCS specific infrastructure at a national level as it is constructed. The challenge is to promote investment in transport and storage to enable deployment while there remains significant uncertainty about the timing, location and scale of CCS deployment.

6.2. Transport and storage are fundamental to the effective commercialisation of CCS. Investment at scale, and ahead of demonstrable demand, is key to unlocking the cost reductions the Cost Reduction Task Force (CRTF) has identified as essential if CCS is to be cost effective compared with low carbon alternatives. Transport and storage also requires substantial investment and poses performance risk to a CCS project which must be managed.

Expected requirement

6.3. Permanent, environmentally secure storage is fundamental to successful CCS. There is good evidence to suggest that the UK's geology is well suited to the permanent containment of carbon dioxide. This capacity has been comprehensively mapped[32], but developing potential sites into operational storage capacity will require significant investment. That investment requires a high level of confidence that the store will be used and will perform as expected.

Clustering - shared transport and storage infrastructure

6.4. Work done by the UK CCS Cost Reduction Task Force[33] suggests that investment in, and effective use of, shared transport and storage infrastructure could deliver about half of the cost savings necessary for CCS to be cost competitive with other low carbon forms of generation. This is greater than any other contributory factor analysed in their report. This analysis suggests that, subject to technical limits on capacity, sharing of infrastructure could be key if CCS is to compete with other low carbon generation. A key challenge is therefore the extent to which this investment in shared infrastructure can be justified.

6.5. The Government has sought to facilitate investment in CO_2 transport and storage in recent years. These efforts have focussed on:

- **Establishing a system for permitting and leasing of offshore CO_2 storage sites**. Comprehensive arrangements were set out in legislation in 2008 and detail subsequently added on the permitting conditions and processes, as well as the

[31] https://www.gov.uk/government/groups/ccs-cost-reduction-task-force
[32] http://www.co2stored.co.uk/
[33] https://www.gov.uk/government/groups/ccs-cost-reduction-task-force

terms of the lease necessary from The Crown Estate, to progressively develop specific storage sites. These arrangements provide for the prospect of storing carbon dioxide in tandem with the recovery of hydrocarbons, through CO_2 EOR.

- **Understanding the Storage Potential of the UK Offshore Area**. The UK Government has funded or part-funded a number of assessments of the UK offshore area. These confirm the enormous potential capacity (at least 100 years at current levels of CO_2 emissions) but also recognise the uncertainty attached to the practical and economic development of those estimates, particularly for less characterised features such as saline aquifers. The most recent and detailed assessment appraised around 600 potential storage sites, with a total of up to 78 gigatonnes of capacity. The CO_2 Stored[34] database is one of the most complete storage atlases anywhere in the world and is being further developed and made available through The Crown Estate and the British Geological Survey.
- **A regulatory backstop to encourage the shared development and use of CCS infrastructure**. Regulations[35] were implemented in 2011 to facilitate third party access to, or modification of, CCS infrastructure. These are based on a process of negotiated access, with the ability for the Government to adjudicate in the national interest in the event the parties are unable to reach agreement.
- Current regulation does not make provision or comment on technical aspects of shared CCS infrastructure, such as operating parameters including pipeline pressures for wider networks, or specifications for the CO_2 to be transported.

Q5. We would welcome views on whether this is a priority from an industry perspective.

- The **projects under the Commercialisation Programme**, i.e. White Rose and Peterhead, both have transport and storage infrastructure capacity in excess of their own needs.

Future development of transport and storage infrastructure

6.6. One of the actions identified by the Cost Reduction Task Force was to put in place arrangements to ensure optimal transport and network configuration. As a result the Storage Development Group was established, reporting into the CCS Development Forum. The Government is keen for this Group to have strong industry participation and leadership, and to come forward with practical actions needed to help reduce the risks of investing in storage site exploration, development and operation identified by the Cost Reduction Task Force. We will continue to work with the Group with this objective in mind.

6.7. A number of commentators have pointed to the longer lead times for storage site development compared with other parts of the CCS chain. This is unlikely to be a problem for integrated full-chain projects, where the project plan will factor in the different duration of each part of the chain. However, there are currently few market incentives to invest in exploring and developing storage sites outside of these circumstances. If this is the case then future CCS projects will need either to develop their project on a timetable consistent with the time needed to explore for and develop

[34] http://www.co2stored.co.uk/
[35] http://www.legislation.gov.uk/uksi/2011/2305/made

new CCS transport and storage infrastructure, or make use of existing infrastructure if that is practical and available.

6.8. The Government introduced legislation to facilitate effective utilisation of existing infrastructure in 2011, and we are keen to better understand what further steps may be necessary to stimulate private investment in infrastructure deployment. This is already an area that the Storage Development Group is considering, but we would also welcome views of other interested parties on this point.

Q6. What further steps may be necessary to stimulate private investment in infrastructure deployment?

6.9. We have also considered previously how far the current market led approach to CCS infrastructure is capable of delivering the investment needed if CCS is to be widely deployed. The essence of this approach is that investment is private sector led and stimulated by demand, but with a regulatory backstop (2011 CO_2 Infrastructure legislation) to enable projects and facilities to be modified where it is in the wider interest to do so, and to enable third parties to access existing infrastructure. In developing the Commercialisation Programme, the Government believed that this approach is more likely to result in cost-effective investment in CCS infrastructure than would a programme of public investment in transport and storage.

6.10. In 2010 Government consulted on whether a national or regional monopoly (either in the private or public sectors) supplier of transport and storage services should be created as an alternative to this market based approach. Based on the responses received, it concluded[36] that this was unnecessary given the current state of development of CCS, but said it would keep the option under review. It is not apparent that circumstances have changed significantly since then. In particular uncertainty about the timing, location and scale of CCS deployment, which is essential for CCS infrastructure to be effectively planned, does not appear to have reduced significantly since 2010.

CO_2 storage site permits and provision for liabilities under the CCS Directive

6.11. Carbon dioxide storage can only take place in the UK under the terms of a permit issued by the appropriate regulatory body. The terms of the permit are set out in European legislation, and the permit controls the process of storage as well as placing obligations on the permit holder to manage the storage site in an environmentally acceptable manner. It also imposes obligations on the storage site permit holder to take remedial action where necessary and to bear the cost of any environmental damage caused by the storage site, including climate damage in the event that carbon dioxide leaks into the atmosphere. The permit holder is relieved of long-term liability for the site once injection comes to an end, the associated infrastructure has been decommissioned and the evidence points toward complete and permanent containment of the CO_2.

6.12. A number of prospective developers of CO_2 sites have identified these regulatory requirements as a disincentive to invest in storage site development. In particular they are concerned about the potential climate change contingent liability that could crystallise during the period the permit is in place and - whilst very unlikely - could be significantly greater than the revenue earned during the operation of the store if it did materialise. Concern tends to be focussed on the financial implications of the

[36] https://www.gov.uk/government/consultations/developing-our-carbon-capture-and-storage-ccs-industry

obligations, should the most extreme circumstances arise, rather than the obligations themselves.

6.13. There is little scope within current European legislation for Member States to modify the obligations on a storage permit holder. The Government's approach is therefore to work with the industry to help better understand the financial implications of storage liabilities that might arise. We recently published an assessment of the potential financial consequences from the theoretical leakage of carbon dioxide[37]. In virtually all circumstances these consequences are likely to be finite, and remedial measures would be available to mitigate the cause of the damage. The European Commission is currently reviewing the CCS Directive (as set out below), but it is too early to know whether these provisions will be adjusted as a result. We want to work with industry to understand what further work we could do collectively that would help build confidence in the financial implications of storage site integrity.

Q7. We would welcome views on the current arrangements for permitting the operation of storage sites, whether these are proving to be a barrier to investment, and if so how these barriers might be overcome.

CCS Directive

6.14. The European Commission is currently reviewing the CCS Directive. The Commission will submit a review report to the European Parliament and to the Council by March 2015. An external evaluation study consisting of an on-line survey, follow-up interviews and stakeholders meetings is underway.

6.15. The Commission has signalled that the review will also be a broad based policy review and therefore an opportunity to consider wider European CCS policy – particularly in the light of the forthcoming agreement on the 2030 climate and energy package.

Q8. Are there elements of the way the CCS Directive has been implemented in the UK that ought to be revisited? What should the UK be asking for during the Directive review process?

Projects of Common Interest (PCI) / Connecting Europe Facility (CEF) funding

6.16. In October 2013, the European Commission adopted a list of 248 key energy infrastructure projects. These projects had been selected by twelve regional groups established by the new guidelines for trans-European energy infrastructure (TEN-E). Carrying the label "projects of common interest" (PCI) they will benefit from faster and more efficient permit granting procedures and improved regulatory treatment.

6.17. This list will be updated in October 2015 and could potentially include CO_2 transport projects. In order to progress any potential inclusion on such a list, and to consider any CO_2 transport proposals if included, the European Commission requires a "thematic group" to be established. The North Sea Basin Task Force is currently exploring whether it can take on the role of such a thematic group.

6.18. The European Commission documentation[38] sets out the eligibility criteria for CO_2 transport projects.

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[37] https://www.gov.uk/government/publications/co2-storage-liabilities-in-the-north-sea-an-assessment-of-risks-and-financial-consequences-summary-report-for-decc-may-2012

[38] http://ec.europa.eu/energy/infrastructure/pci/pci_en.htm

6.19. For a project to be included in the list, it has to have significant benefits for at least two Member States (or at least one Member State and one State from the European Economic Area); contribute to market integration and further competition; enhance security of supply, and reduce CO_2 emissions. CO_2 transport projects should also enable the connection of multiple CO_2 sources and storage sites via common infrastructure and minimise environmental burden and risks.

6.20. PCIs may be able to access financial support from the Connecting Europe Facility (CEF), under which a €5.85 billion budget has been allocated to trans-European energy infrastructure for the period 2014-20. Projects can receive co-funding up to 50%. This rate can be exceptionally increased to 75% if the project proves through its cost-benefit analysis that it contributes to significantly increased regional or Union-wide security of supply, that it strengthens the solidarity of the Union or that it comprises highly innovative solutions. CEF can provide financial instruments (project or corporate financing) and grants for studies (which minimise risk factors) or works (filling the funding gap for non-commercial projects).

6.21. Given the potential funding opportunity, the Government would encourage the CCS industry to consider how potential project proposals should be identified and developed.

London Protocol

6.22. Geological formations underneath the North Sea could act as a storage hub for Europe. However, current international regulation, referred to as the London Protocol[39], could in some circumstances prevent this. The London Protocol has been interpreted by contracting parties as prohibiting the export of CO_2 from a contracting party to other countries for injection into sub-seabed geological formations.

6.23. The protocol was amended by contracting parties in 2009 to allow for cross-border transportation of CO_2 for sub-seabed storage, but the amendment must be ratified by two-thirds of contracting parties to enter into force. To date, only a handful of contracting parties have ratified.

6.24. The UK will continue to raise awareness among relevant Governments of the importance to global CCS deployment of ratifying international marine treaty amendments, including the London Protocol Article 6 amendment.

Questions:

Q5.	To what extent is it a priority from an industry perspective for regulation to cover technical aspects of shared CCS infrastructure, such as operating parameters including pipeline pressures for wider networks, or specifications for the CO_2 to be transported?
Q6.	What further steps may be necessary to stimulate private investment in CO_2 transport and storage infrastructure deployment?

[39] 1996 Protocol to the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter

Q7.	What are your views on the current arrangements for permitting the operation of storage sites? Are these arrangements proving to be a barrier to investment, and if so how might these barriers be overcome?
Q8.	Are there elements of the way the CCS Directive has been implemented in the UK that ought to be revisited? What should the UK be asking for during the Directive review process?

7. Part Chain and Full Chain projects

This chapter looks at the interaction between full-chain and part-chain CCS projects in developing UK CCS infrastructure.

Context

7.1. The Government considers that the best, quickest way to reduce the costs of CCS is to support the deployment of the UK's first commercial scale CCS projects which incorporate the full-chain of CCS activity – capture, transport and safe, permanent geological storage.

7.2. The criteria for the Commercialisation Programme therefore prioritised such full-chain projects. Part-chain projects were not excluded, but needed to demonstrate potential to ultimately form a full-chain project.

7.3. The full-chain projects under the Commercialisation Programme, i.e. White Rose and Peterhead, both have transport and storage infrastructure capacity in excess of their own needs. Cost Reduction Task Force analysis showed that shared use of infrastructure could deliver the biggest cost reduction as compared to other cost reductions from cheaper financing, technology learning and engineering improvements, and potentially EOR.

7.4. The Government has not taken any decision on whether potential future support might be directed at full-chain projects, part-chain projects or both, and all projects will need to demonstrate that they can deliver value for money. Notwithstanding this, the full-chain infrastructure developed through Phase 1 creates the possibility of future part-chain projects, and we set out below some of the issues that might need to be addressed in such projects.

Commercial structures of part-chain projects

7.5. Part-chain projects, utilising the infrastructure laid down for example by the Phase 1 project(s) or any subsequent infrastructure providers, could be formed at either end of the pipeline:

- **Part-chain capture projects**: Power stations or heavy industry installing carbon capture technology, and plugging into any existing infrastructure in order to dispose of their CO_2.
- **Part-chain storage projects**: Project developers wishing to make use of Enhanced Oil Recovery (EOR) techniques in particular may wish to enter some form of commercial arrangements to buy captured and transported CO_2.

7.6. It is also possible that infrastructure providers may choose to invest in additional transport infrastructure to link-in with any existing transport and storage infrastructure.

7.7. A major area where the market still appears immature is the commercial structures which would be needed for part-chain projects to exploit the infrastructure created by Phase 1 project(s) or other infrastructure providers.

7.8. As set out in chapter 6, the regulatory framework[40] has been established, by which CCS projects, including Phase 1 project(s), will be expected to allow access to their infrastructure on fair and reasonable terms.

7.9. One key aspect of any commercial structures will be the payment flow of possible CfDs. The core rationale of the CfD under Electricity Market Reform is a strike price to incentivise the generation of clean electricity.

7.10. Conceptually, if a part-chain capture project entered into commercial agreements with Phase 1 projects or any subsequent infrastructure providers on access to their infrastructure, the part-chain project could demonstrate that its electricity was clean and thereby qualify for a CfD.

7.11. The part-chain capture project could then use CfD revenue to meet the cost of any tariff agreed with the provider or operator of the existing transport and storage infrastructure.

Q9. The Government does not consider it currently has a role, beyond existing third party regulations, in establishing the terms and conditions of any such agreements. What steps do you think industry should take to further develop the commercial models for any such agreements?

Question:

Q9.	The Government does not consider it currently has a role, beyond existing third party regulations, in establishing the terms and conditions of any agreements between part-chain projects and full-chain / CO2 infrastructure providers. What steps do you think industry should take to further develop the commercial models for any such agreements?

[40] http://www.legislation.gov.uk/uksi/2011/2305/made

8. Enhanced oil recovery (EOR)

The Government is exploring with industry the extent to which CO_2-EOR could play a significant role in the UK's CCS deployment and maximise future recovery from the North Sea.

This chapter outlines the potential opportunity available, provides an update of recent work and seeks views on how to further encourage activity in this area.

Context

8.1. The UK's offshore oil and gas reserves, and the industry which has grown to exploit those reserves, has made a significant contribution to the economy and job creation. Achieving optimal recovery from the UK's reserves is demanding, but with the average UK Continental Shelf (UKCS) recovery factor from oil fields projected to be approximately 47% at end of field life, there is still a significant prize to be gained by maximising recovery from the existing oil fields.

8.2. Enhanced oil recovery (EOR) refers to a range of techniques used to recover incremental oil beyond that which can be extracted from the more conventional depletion and waterflood recovery mechanisms. CO_2-based EOR, part of the miscible gas injection technique, is one such method.

8.3. CO_2-EOR is sometimes referred to under the umbrella term of "Carbon Capture and Utilisation" (CCU), particularly in the US and China. Broader CCU issues are explored in chapter 11.

8.4. The CO_2-EOR industry has been long established in North America, with over 150 fields in operation generating c250,000 barrels of oil a day[41].

8.5. The Cost Reduction Task Force recognised the potential contribution of CO_2-EOR to the UK's CCS industry, and calculated that the technique, and revenue generated, could reduce the cost of CCS by between £5-£26/MWh (depending on assumptions around the underlying power station). However, as set out in the Government's Response, it is not yet clear to what extent the North American experience can be replicated in the UK offshore. Of 300 fields currently in operation on the UK Continental Shelf, only two are EOR schemes, although additional projects are now either in execution, such as the world's first offshore Low Salinity scheme (BP's Clair Ridge development), or are at pre-sanction stages of evaluation. The principal barriers to implementing EOR projects include:

- Higher risk for EOR offshore compared to onshore. The well spacing is much higher offshore, which increases reservoir uncertainty, and is more difficult to carry out small scale pilot projects before committing to full-field development.
- Supply of secure, low cost EOR injectants, in particular for miscible gas (including CO_2) EOR.
- Weight and space limitations on offshore oil platform which make retrofitting major new equipment for EOR projects challenging.

[41] http://www.adv-res.com/pdf/v4ARI%20CCS-CO2-EOR%20whitepaper%20FINAL%204-2-10.pdf

The Wood Review; and PILOT EOR Work Group

8.6. The Wood Review, commissioned by the Government to examine how to maximise recovery from the UK's oil and gas reserves also recognised the potential of CO_2-EOR, and stated that "industry should be encouraged more in EOR schemes to avoid leaving significant value behind". The Review also endorsed the work of the PILOT group[42] - a partnership between the UK oil and gas industry and DECC, which established an EOR Work Group in 2013.

8.7. The PILOT EOR Work Group is undertaking a three phase programme to:

- Screen the UKCS fields for EOR potential.
- Engage industry and look for synergies by geography/geology/EOR type and collaborative opportunities to progress EOR understanding.
- Where possible, initiate EOR projects with operators and / or suppliers.

8.8. Within this programme of work, PILOT is keen to identify a candidate field for an independent pre-FEED study to assess economic feasibility of CO_2 EOR. However, such work is dependent on an operator bringing forward a proposal for detailed review.

8.9. This programme of work commenced in earnest in October 2013, with a workshop of over 40 experts. Using an advanced screening tool, all the major oil fields were screened for both hydrocarbon miscible gas injection and for CO_2 injection. That screening also took into account the distance from the potential CO_2 storage hubs that may be developed under the CCS Programme, as PILOT believes that CO_2 EOR projects are more likely to develop by exploiting existing CO_2 storage hubs than by developing stand-alone CO_2 infrastructure.

8.10. The data from this screening led PILOT to conclude that the top 15 fields could produce an additional 0.6 billion barrels of oil equivalent (boe) with 0.1-0.2 billion boe as a result of CO_2-EOR. At an assumed market price of $100 per barrel, that would indicate a possible gross revenue of $10bn - $20bn.

8.11. DECC, as regulator for the offshore oil and gas industry, has recently contacted UKCS field operators to begin a series of "EOR Reviews" to look in more detail at what is holding back EOR project investment and what industry and government can do to increase EOR activity. This programme of reviews, responsibility for which will pass to the Oil and Gas Authority once it is established, will start in autumn 2014 and is expected to take 1-2 years. These planned reviews will include CO_2-EOR proposals. Since field development projects are confidential during the planning stage, no further details are expected to be released at this stage.

8.12. These reviews will help inform DECC's future approach to offshore EOR, including CO_2 EOR.

Incentives

8.13. There is no consensus within industry as to how CO_2-EOR could or should develop in the UK. It has been suggested that Government should take further measures to encourage such development. The Government is aware of the significant potential for enhanced oil recovery on the UK Continental Shelf. It will consider evidence from industry on the possible need to support gas and oil companies on EOR projects

[42] https://www.gov.uk/government/groups/105

through its review of the oil and gas tax regime, which was announced at Budget 2014. HM Treasury published a call for evidence[43] on 14 July, marking the start of 12 weeks of discussions with industry and other stakeholders on the long-term future of oil and gas tax.

Q10. On issues of incentives for CO2-EOR, respondents are encouraged to input to the HM Treasury call for evidence on the Review of the Oil and Gas Fiscal Regime, which closes on 3 October 2014.

CO_2 supply and demand

8.14. The potential availability of CO_2 and the fields in which it can be used may not match up in a timely manner.

Q11. How should industry collaborate to best match the needs of CO_2 supply and demand for any future CO_2-EOR industry and how should this be managed?

8.15. Some industry stakeholders have speculated that additional infrastructure may be needed over and above that proposed under Phase 1 project(s), in order to realise the potential of EOR - for example a pipeline from the Southern North Sea to the Central North Sea.

Q12. How should the industry collaborate to take forward any such requirements?

Questions:

Q10.	On issues of incentives for CO_2-EOR, respondents are encouraged to input to the HM Treasury call for evidence on the Review of the Oil and Gas Fiscal Regime, which closes on 3 October 2014
Q11.	How should industry collaborate to best match the needs of CO_2 supply and demand for any future CO_2-EOR industry and how should this be managed?
Q12.	How should the industry collaborate to take forward any additional transportation infrastructure requirements of any future CO_2-EOR industry?

[43] https://www.gov.uk/government/consultations/review-of-the-oil-and-gas-fiscal-regime-a-call-for-evidence

9. Industrial CCS

To meet the UK's longer term ambitions on climate change, carbon dioxide emissions will need to be substantially reduced. For some energy intensive industries, CCS is likely to be a key part of the technology mix required to make such reductions.

This chapter summarises the Government's activity to date and seeks views on possible next steps.

Terminology

9.1. Industrial CCS refers to capturing and storing carbon emissions from energy intensive industries such as iron and steel, cement, refineries and chemicals. This includes emissions from industrial processes, and from equipment used to generate heat and electricity on industrial sites.

Context

9.2. The Government expects Industrial CCS (ICCS) to be a key option for delivering the significant carbon abatement required in energy intensive industries.

9.3. Analysis by the International Energy Agency (IEA) shows that industrial sectors such as iron and steel, cement, refineries and chemicals account for 20% of total global CO_2 emissions. Furthermore, emissions from each of these sectors are expected to grow until at least 2050 under current policies. The IEA estimate that industrial applications could comprise half of the emission reductions achieved through CCS globally by 2050[44].

9.4. Without CCS it may not be possible to substantially decarbonise these sectors in the medium or even long term as many industrial processes unavoidably generate CO_2 as a result of chemical reactions that are integral to the formation of the final product. Whilst energy efficiency and fuel switching will reduce emissions they will become increasingly expensive. Hence economies with energy intensive industries will find their decarbonisation efforts becoming both more difficult and costly without large scale industrial CCS.

9.5. Whilst considerable knowledge and experience can be transferred from the power generation sector's development of carbon capture technologies to energy intensive industries, there are also unique challenges in relation to suitable capture technologies, sector specific commercial considerations, and impact on end products' cost and quality.

9.6. Recent government modelling[45] suggests that ICCS could be an important means of carbon reduction for industry from the mid-2020s in the UK. However, there are currently just a handful of ICCS projects around the world.

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[44] http://www.iea.org/publications/freepublications/publication/CCS_Annex.pdf

[45] Modelling to support *The future of heating: meeting the challenge* - report by Redpoint https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/197562/baringa_heat_paper_analytical_support.pdf

Work to date

9.7. Work in early 2013 by BIS and by the UK CCS Research Centre on technological aspects of CCS, found a complex picture with different technology needs in each sector and highly uncertain and variable costs.

9.8. In order to provide more evidence, BIS and DECC commissioned further analysis which was undertaken collaboratively with industry, and published in May 2014. The results are summarised below:

Industrial CCS: Techno-economic study

BIS and DECC funded a techno-economic study of carbon capture and carbon utilisation technologies in four key energy intensive industry sectors – iron and steel, cement, chemicals and refineries. Companies in these sectors, along with academia, provided input and oversight throughout the study.

The study focused on understanding possible technologies which could lead to deployment by 2025, an ambition expressed in the Committee on Climate Change's 4th Carbon Budget, as well as related costs.

Key findings included:

- *Some (first generation) technologies such as amine solvents can be rolled out by 2025 in most sectors if demonstrated by 2020. Exceptions include cement, where site conditions may favour calcium looping technology. Calcium looping is at an earlier stage of development but published cost estimates suggest it is of lower cost than some first generation technologies.*
- *Industrial carbon capture is expected to cost over £50 per tonne of CO2 captured for all technologies, with the exception of capture from high purity streams associated with some chemicals processes, notably ammonia and hydrogen manufacture. The range of costs is comparable to expected costs of capture in the power sector.*
- *'First generation' amine technologies are likely to be most cost-effective for all industries in the mid-2020s, though more cost effective technologies may become available shortly thereafter.*
- *'Second generation' technologies, including those more optimised for each sector, could be available around 2025 if development and deployment are accelerated (and are more likely to be cost effective in the 2030s)*

- *The report identifies site level barriers, the most pertinent of which detailed engineering studies, pilots and demonstrations could reduce are:*
    - *Increased operational complexity and risks (unavailability, process dependencies)*
    - *New applications of existing technologies which are not yet proven at scale*
    - *Plant integration risks (hidden costs of additional downtime, alternative product supplies, technology lock-in)*
    - *High levels of uncertainty regarding costs*
- *Carbon Capture and Utilisation (CCU) for industrial emissions is unlikely to be commercial by the mid-2020s (see chapter 11 for further discussion of CCU).*

9.9. This techno-economic study shows CCS in industrial sectors is still at an early stage compared to the power sector and may require government intervention for the technologies to become commercial.

Current evidence gathering and policy development

9.10. The Government is undertaking or supporting a number of key pieces of work to further understand and support the development of industrial CCS. These include work as part of the Tees Valley City Deal, and the Industrial 2050 Decarbonisation and Energy Efficiency Roadmaps project.

Tees Valley City Deal

9.11. Some of the above barriers, such as uncertain costs and commercial requirements, are being explored in Teesside through work funded under the Tees Valley City Deal[46]. The Local Enterprise Partnership, Tees Valley Unlimited, has been awarded £1m, alongside industry contributions, to carry out:

- pre-FEED (Front-End Engineering and Design) analysis on capture, transport and storage from multiple industrial sources in Teesside; and
- development of possible business and investment models for industrial CCS in Teesside

9.12. The project is expected to conclude towards the end of 2015.

Industrial 2050 Decarbonisation and Energy Efficiency Roadmaps

9.13. The recent techno-economic study evidence is contributing to analysis by BIS and DECC on Industrial 2050 Decarbonisation and Energy Efficiency Roadmaps, which will inform medium to long term decarbonisation policies for energy intensive industries and will report in 2015.

9.14. The project involves collaborative work with eight energy intensive industries to identify potential emissions reduction pathways, and to agree immediate next steps to help enable progress. Work is already underway with all eight sectors, with iron and steel, and paper and pulp most advanced.

[46] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/321751/Tees_Valley_City_Deal_Document.pdf

On-site generation / Private Networks

9.15. The Government consulted extensively in designing the generic CfD and allocation methodology, and published the draft CfD Agreement and terms and conditions (April 2014). Furthermore, the Final CfD Operational Framework (published in November 2012) stated that eligible low-carbon electricity generation operating on a 'private wire' network could participate within the CfD regime. The Government has since published the CfD for Private Network Generation: policy overview (June 2014)[47]. The policy overview sets out how license-exempt, renewable generators operating on a private network (and with an onsite customer) will be able to participate in the CfD regime.

9.16. As part of the Government's approach to developing CfDs and an allocation framework for CCS projects outside the CCS Competition, we would welcome views on:

Q13. What changes to the CfD design would developers need in order to bring forward projects involving industrial emitters installing CCS on their onsite power generation? Respondents should note that the Government intends to publish further guidance on Private Network Generation in early Autumn 2014.

Future policy work

9.17. Policy for industrial CCS will continue to be developed, using the outputs from the techno-economic study, Tees Valley project and the Industrial 2050 Decarbonisation and Energy Efficiency Roadmaps.

9.18. We would welcome thoughts on what should be considered as part of this work. Key issues to be explored include:

Q14. Which of the barriers are the most important and how should they be overcome?

Q15. What is the best next step for each sector? For example, should first generation technologies be brought forward in all sectors, or would it be better to consider bespoke actions per sector?

Q16. How should any Government activity best support R&D and innovation for ICCS?

9.19. We intend to hold a workshop in autumn 2014 to exchange views and seek further inputs from industry about how best to make progress on innovation in industrial CCS.

Questions:

Q13.	What changes to the CfD design would developers need in order to bring forward projects involving industrial emitters installing CCS on their onsite power generation? Respondents should note that the Government intends to publish further guidance on Private Network Generation in early Autumn 2014.
Q14.	Which of the barriers to industrial CCS are the most important and how should they be overcome?

[47] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/320667/policy_overview.pdf

Q15.	What is the best next step for each sector? For example, should first generation technologies be brought forward in all sectors, or would it be better to consider bespoke actions per sector?
Q16.	How should any Government activity best support R&D and innovation for ICCS?

10. Bio-CCS / BECCS

In the long term, combining bioenergy with CCS (BECCS) to produce negative emissions[48] is predicted to offer a key route by which the UK could meet its 2050 targets.

This chapter briefly sets out Government policy development to date.

Context

10.1. The 2014 Intergovernmental Panel on Climate Change (IPCC) report highlighted the importance of Bioenergy and CCS, sometimes referred to as BECCS or BioCCS:

> *"Combining bioenergy with CCS (BECCS) offers the prospect of energy supply with large-scale net negative emissions"*[49]

10.2. Energy system models, such as that developed by the Energy Technologies Institute (ETI)[50], also highlight the importance of BECCS and "negative emissions".

10.3. Biomass can be used as the single fuel source for power generation (dedicated use) or in combination with conventional coal sources (co-fired generation).

10.4. When combined with CCS, it offers the potential of "negative emissions" by taking atmospheric CO_2 temporarily locked in plants and storing them permanently in geological formations[51].

10.5. The Government is committed to ensuring that bioenergy used in the UK energy system is from sustainable sources. DECC has developed a scientific calculator[52] to investigate the impact on carbon emissions of biomass sourced from North America to produce electricity.

Policy development to date

10.6. In 2012, the ETI[53] undertook a study on the technical aspects of combining bioenergy and CCS.

10.7. The FEED programme for White Rose, under the UK CCS Commercialisation Programme, includes a design option of co-firing biomass with coal.

10.8. To date, through the EU Emissions Trading System (EU ETS) mechanism and Electricity Market Reform, there are incentives to deploy biomass combustion and CCS respectively. However, there are no specific incentives to deploy bio-CCS / BECCS.

10.9. The Government, as set out in the Bioenergy Strategy (2012)[54], recognises that full exploitation of the potential from BECCS will require further work to understand how trading in negative emissions may be incorporated into carbon trading mechanisms in the long term, either globally or at regional level, such as within the EU ETS.

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[48] https://workspace.imperial.ac.uk/climatechange/Public/pdfs/Briefing%20Papers/Briefing%20Paper%208.pdf
[49] Pg25, Section 4.2.2, IPCC, 2014: Summary for Policymakers, In: Climate Change 2014, Mitigation of Climate Change. http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf
[50] http://www.eti.co.uk/modelling-low-carbon-energy-system-designs-with-the-eti-esme-model/
[51] Definition taken from Grantham Institute briefing paper: https://workspace.imperial.ac.uk/climatechange/Public/pdfs/Briefing%20Papers/Briefing%20Paper%208.pdf
[52] https://www.gov.uk/government/publications/life-cycle-impacts-of-biomass-electricity-in-2020
[53] http://www.eti.co.uk/project/biomass-to-power-with-carbon-capture-and-storage/
[54] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48337/5142-bioenergy-strategy-.pdf

10.10. The Committee on Climate Change's 2014 Progress Report to Parliament[55] recommended that:

"[The EU ETS Reform and] regulatory regime should also allow for negative emissions (e.g. from use of bioenergy with CCS) to count towards required emissions reduction."

Q17. We would welcome views as to what issues the UK Government may want to urge the European Commission to consider regarding BECCS before they propose the detailed architecture of EU climate and energy policy for the period post-2020, including revisions to the EU ETS Directive for phase IV of the EU ETS (2021-2030).

Question:

Q17.	We would welcome views as to what issues the UK Government may want to urge the European Commission to consider regarding BECCS before they propose the detailed architecture of EU climate and energy policy for the period post-2020, including revisions to the EU ETS Directive for phase IV of the EU ETS (2021-2030).

[55] http://www.theccc.org.uk/wp-content/uploads/2014/07/CCC-Progress-Report-2014_web_2.pdf

11. Carbon Capture and Utilisation (CCU)

Carbon Capture and Utilisation (CCU) technologies could offer a route to making CO_2 a commodity rather than a waste product.

This chapter summarises the Government's current approach.

Context

11.1. CCU refers to technologies which can capture and then convert CO_2 into viable commercial products such as construction materials, biofuels, fertilisers and polymers.

11.2. Particularly in the US and China, the term "CCU" also includes Enhanced Oil Recovery (EOR) (see chapter 8).

Current activity

11.3. As part of the 4-year, £125m CCS R&D Programme, the Government and its partners are investing around £10m in CCU. The Government, through the Research Councils, also supports the CO_2-Chem network[56], one of the largest networking groups for academia and industry to share ideas on CCU.

11.4. Recent expert reports suggest that most CCU technologies remain at the R&D level[57] and are unlikely to be commercial by the mid-2020s, although some are advancing and already attracting private sector investment[58;59].

Q18. The Government and its R&D partners will continue to monitor the progress of CCU technologies, as part of wider efforts on CCS. Do you wish to offer any evidence of such progress?

Question:

Q18.	The Government and its R&D partners will continue to monitor the progress of CCU technologies, as part of its wider efforts on CCS. Do you wish to offer any evidence of such progress?

[56] http://co2chem.co.uk/
[57] CCU in the Green Economy, 2011
[58] http://www.econic-technologies.com/wp-content/uploads/2013/12/Econic-Press-Release1.pdf
[59] http://www.c8s.co.uk/index.php

12. Supply chain

The CCS supply chain is likely to share many characteristics with the supply chain for other major energy infrastructure projects.

This chapter outlines how the Government will support companies to exploit the opportunities in this nascent sector.

Context

12.1. A thriving CCS supply chain is beneficial for the UK economy and will be essential as CCS develops. The deployment of CCS, starting with the White Rose and Peterhead CCS projects, represents multi-billion pound opportunities for companies at all levels in the supply chain.

Current approach

12.2. As with other infrastructure projects of similar scale, the supply chain for developing, constructing and operating a commercial CCS project will be complex, involving a range of businesses and contractual relationships. The Government has no role in dictating these arrangements, other than to ensure that public funding does not distort these normal commercial processes.

12.3. It is expected that the Phase 1 CCS projects will help stimulate the supply chain, providing opportunities across the different stages:

- at the design and planning stage;
- at the construction stage, the opportunity to supply equipment and services;
- through on-going services during operation; and
- at the decommissioning stage.

12.4. The Government has set out that projects wishing to apply for a CfD must have a supply chain plan before they can apply. Similar requirements will be made to projects under the Commercialisation Programme. The aim of the supply chain plan assessment process is to encourage the effective development of low carbon electricity generation supply chains by encouraging open and competitive tenders and the promotion of innovation and skills which will in turn drive down the cost of low carbon generation over the long term and result in lower energy costs to consumers. By delivering low carbon generation as efficiently as possible and at least cost to consumers, more generation will be supported which will ensure that consumers have access to the secure energy they need at affordable prices.

Supporting companies wishing to exploit opportunities in the CCS sector

12.5. The Energy Industries Council (EIC), supported by DECC, facilitated a Ministerial Supply Chain Event in May 2014. Both CCS Competition projects set out their plans and future procurement intentions, which are likely to emerge from late 2015 onwards. DECC intends to work with partners to facilitate further CCS supply chain engagement during 2015 to raise awareness of these opportunities.

12.6. A number of routes are available to support companies that may wish to supply goods and services to CCS projects. For example, the Department for Business, Innovation and Skills' Advanced Manufacturing Supply Chain Initiative (AMSCI)[60] provides grant funding to organisations.

International projects

12.7. With the UK seen as leaders in the development of CCS, increasingly there are opportunities to supply goods and services to international CCS projects. DECC will continue to engage with UKTI regarding possibilities for both inward and outward investment as the CCS industry develops.

Q19. Is any further action needed to support supply chain companies wishing to supply good and services to CCS projects in the UK or abroad?

Longer term CCS supply chain capacity

12.8. In 2012, the Government commissioned analysis[61] which concluded that the capacity in the UK supply chain would not act as a constraint on future deployment of CCS out to 2030. Any potential barriers, outlined below, were expected to resolve themselves as the UK CCS market grows.

Q20. Do you agree that currently there does not appear to be significant supply chain barriers to the commercial deployment of CCS up to 2030? If your answer is no, please set out why, with supporting evidence.

Questions:

Q19.	Is any further action needed to support supply chain companies wishing to supply good and services to CCS projects in the UK, or abroad?
Q20.	Do you agree that currently there does not appear to be significant supply chain barriers to the commercial deployment of CCS up to 2030? If your answer is no, please set out why, with supporting evidence.

[60] https://www.financebirmingham.com/amsci/ (the scheme is run by Finance Birmingham for BIS)
[61] AEA's 2012 Report "Assessing the Domestic Supply Chain Barriers to the Commercial Deployment of Carbon Capture and Storage within the Power Sector"; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/140108/AEA_Technology_reprort_-_Assessing_the_Domestic_Supply_Chain_Barriers_to_the_Commercial_Deployment_of_Carbon_Capture_and_Storage_within_the_Power_Sector_-_FINAL.pdf

13. Knowledge transfer (KT)

Knowledge transfer is a key philosophy which underpins the CCS Commercialisation Programme. CCS projects in receipt of Government support will be expected to share their experience and learning with the wider industry to support development and cost reduction.

This chapter summarises the Government's current approach, and explores possible approaches under any future phases of CCS deployment.

Context

13.1. Knowledge Transfer (KT) refers to the principle of sharing learning and experience gained by projects under the CCS Commercialisation Programme. In broader terms, KT is the process of collating and disseminating information, know-how (how to do and deliver), skills and experience (tacit knowledge) on all aspects of delivering a large scale full chain CCS project through FEED, construction, commissioning, operation, decommissioning and post-closure monitoring.

Current approach

13.2. Amongst other benefits, Phase 1 projects are intended to support commercial scale CCS by sharing knowledge to help mature and de-risk CCS deployment. This knowledge includes programme and risk management; commercial arrangements and financial options; technical design and integration of all the sub-systems within the CCS chain; operating and maintenance philosophy; understanding the supply chain; and compliance with statutory and regulatory regimes. To protect commercial and proprietary information, KT will not include commercially sensitive information.

13.3. Knowledge will be disseminated through reports made freely available to all on the Government's website. In addition, there will be mechanisms to share know-how and experience, such as participation at seminars and workshops and the hosting of secondments from the UK academic community.

Knowledge transfer for phase two projects

13.4. Phase 1 projects will be contracted to provide KT as part of the capital expenditure grant award.

13.5. It is intended that this KT will cover the whole-life project cycle, from FEED through to decommissioning and monitoring.

Q21. Should similar arrangements be made for the provision of KT from any Government supported future CCS projects? If so, what kind of aspects of KT does industry find most useful?

13.6. We identified the target audience for the KT from Phase 1 projects as those integral to the future deployment of CCS, including: prospective CCS developers, owners and operators; the CCS supply chain; policy makers in the UK and other governments, and regulators; CCS financiers and insurers; industry bodies; and the research community, though they can be accessed freely by all.

Q22. How can KT from projects under the Commercialisation Programme and any future projects be most usefully disseminated, e.g. via report, workshops, seminars etc.?

Questions:

Q21.	Should similar arrangements be made for the provision of KT from any future CCS? If so, what kind of aspects of KT does industry find most useful?
Q22.	How can KT from projects under the Commercialisation Programme and any future projects be most usefully disseminated, e.g. via report, workshops, seminars etc.?

14. Research, development and innovation

Continued research, development and innovation is expected to further reduce the costs of CCS by creating better, cheaper components and processes.

This chapter summarises the Government's current approach, and possible future actions.

Context

14.1. Further development and refinement of existing technologies and innovative breakthroughs are vital if the costs of CCS are to be reduced.

Current programme

14.2. The UK has a 4-year (2011-2015) £125 million cross-government CCS research, development and innovation programme. Funding comes from the Department of Energy and Climate Change (DECC), the Technology Strategy Board (TSB), the Energy Technologies Institute (ETI) and the Research Councils and covers:

- £62 million to support fundamental research and understanding, including £13 million to establish the UK CCS Research Centre to bring together the UK's top CCS academics to promote and coordinate UK CCS research capability and increase academic collaboration with industry.
- £28 million to support the development and demonstration of CCS components and next generation technologies, such as new solvents and capture technologies, turbines and CO_2 metering and monitoring technologies.
- £35 million for pilot scale projects to bridge the gap between research and commercial scale deployment.

14.3. The Advanced Power Generation Technology Forum (APGTF), with input from the UK CCS Research Centre, has undertaken a prioritisation of R&D needs for CCS.[62]

Future funding & project selection

14.4. As part of the £125m programme, DECC launched a £20m CCS Innovation competition. Based on feedback from our academic and industrial stakeholders, that competition was open to all aspects of CCS, provided projects could demonstrate cost reduction potential. As a result, funded projects included: capture technologies, transportation and metering, storage, CCU and industrial CCS.

14.5. The Government and partners intend to make available further funding for CCS R&D for Financial Year (FY) 15/16, to be announced in autumn 2014.

Question:

Q23.	For any future funding calls, should R&D funding be targeted at specific aspects of the CCS chain, or level of technology maturity?

[62] Ch4, Cleaner Fossil Power Generation in the 21st Century – Moving Forward 2014 http://apgtf-uk.com/index.php/publications/publications-2014/doc_download/15-cleaner-fossil-power-generation-in-the-21st-century-moving-forward-2014

Section C

15. Catalogue of questions

Ch 4: Financial Incentives and Electricity Market Reform	
Q1.	To what extent would developers be prepared to invest in FEED costs ahead of allocation of a CfD, and if they are not able to do so what measures could be adopted so that the developers have sufficient certainty of their costs and a Strike Price to form the basis of an investment decision?
Q2.	How best should the industry-led CCS Commercial Development Group work to support project developers in engaging with finance markets?
Q3.	To what extent should Government reflect long-term risks of full chain CCS projects in the design of a CCS CfD? In particular, we will want to explore the extent to which similar risks also arise in other sectors and the changes that may be needed in CfD design to put CCS on an equivalent basis to other low carbon technologies.
Ch 5: Financing CCS projects	
Q4.	Are the existing products offered by the Green Investment Bank (GIB), Infrastructure UK (IUK) and the European Investment Bank (EIB) sufficient to support CCS projects in raising necessary finance from non-public sources? If not, please explain why, with supporting evidence, and what kind of additional financing or products would be needed?
Ch 6: Transport and Storage Infrastructure	
Q5.	To what extent is it a priority from an industry perspective for regulation to cover technical aspects of shared CCS infrastructure, such as operating parameters including pipeline pressures for wider networks, or specifications for the CO_2 to be transported?
Q6.	What further steps may be necessary to stimulate private investment in infrastructure deployment
Q7.	What are your views on the current arrangements for permitting the operation of storage sites? Are these proving to be a barrier to investment, and if so how might these barriers be overcome?
Q8.	Are there elements of the way the CCS Directive has been implemented in the UK that ought to be revisited? What should the UK be asking for during the Directive review process?

Ch 7: Part and Full Chain projects	
Q9.	The Government does not consider it currently has a role, beyond existing third party regulations, in establishing the terms and conditions of any agreements between part-chain projects and full-chain / CO_2 infrastructure providers. What steps do you think industry should take to further develop the commercial models for any such agreements?
Ch 8: Enhanced Oil Recovery (EOR)	
Q10.	On issues of incentives for CO_2-EOR, respondents are encouraged to input to the HM Treasury call for evidence on the Review of the Oil and Gas Fiscal Regime, which closes on 3 October 2014
Q11.	How should industry collaborate to best match the needs of CO_2 supply and demand for any future CO_2-EOR industry and how should this be managed?
Q12.	How should the industry collaborate to take forward any additional transportation infrastructure requirements of any future CO_2-EOR industry?
Ch 9: Industrial CCS	
Q13.	What changes to the CfD design would developers need in order to bring forward projects involving industrial emitters installing CCS on their onsite power generation? Respondents should note that the Government intends to publish further guidance on Private Network Generation in early Autumn 2014.
Q14.	Which of the barriers to industrial CCS are the most important and how should they be overcome?
Q15.	What is the best next step for each sector? For example, should first generation technologies be brought forward in all sectors, or would it be better to consider bespoke actions per sector?
Q16.	How should any Government activity best support R&D and innovation for ICCS?
Ch 10: Bio-CCS / BECCS	
Q17.	We would welcome views as to what issues the UK Government may want to urge the European Commission to consider regarding BECCS before they propose the detailed architecture of EU climate and energy policy for the period post-2020, including revisions to the EU ETS Directive for phase IV of the EU ETS (2021-2030).

Ch 11: CCU	
Q18.	The Government and its R&D partners will continue to monitor the progress of CCU technologies, as part of its wider efforts on CCS. Do you wish to offer any evidence of such progress?
Ch 12: Supply Chain	
Q19.	Is any further action needed to support supply chain companies wishing to supply good and services to CCS projects in the UK, or abroad?
Q20.	Do you agree that currently there does not appear to be significant supply chain barriers to the commercial deployment of CCS up to 2030? If your answer is no, please set out why, with supporting evidence.
Ch 13: Knowledge Transfer (KT)	
Q21.	Should similar arrangements as those under the Commercialisation Programme, be made for the provision of KT from any future CCS projects? If so, what kind of aspects of KT does industry find most useful?
Q22.	How can KT from projects under the Commercialisation Programme and any future projects be most usefully disseminated, e.g. via report, workshops, seminars etc.?
Ch 14: Research, Development and Innovation	
Q23.	For any future funding calls, should R&D funding be targeted at specific aspects of the CCS chain, or level of technology maturity?

Annex I - Government's approach to Risk Allocation under Phase 1 of the Commercialisation Programme [i]

[Full documentation can be found at: https://online.contractsfinder.businesslink.gov.uk/Common/View%20Notice.aspx?site=1000&lang=en&noticeid=560937&fs=true]

Chapter 5 of Invitation to Participate in Discussions (ITPD), April 2012

5. Risk allocation

5.1. Introduction

5.1.1. Importance of risk

(a) Risk identification, risk ownership and risk management are critical components to the successful delivery of the CCS Commercialisation Programme and to the development of a commercial CCS industry. They will be an important element of any commercial arrangements the Authority enters into with a Bidder, and the successful management of risk will be key to any Payment Mechanism and incentive regime.

(b) The Authority has undertaken considerable analysis of the Demonstrator 1 and of information obtained from market soundings. It recognises that each potential Project will have a particular risk profile and each Bidder a particular risk appetite.

5.1.2 Bidder risk assessment requirements

Bidders are expected to demonstrate in their Bids that they have a clear understanding of the full range of risks that are associated with their Bids (see instructions to Bidders later in this section). They are expected to have completed and to evidence in Bids a comprehensive risk assessment, including assessment of the consequence of particular risks maturing and of the mitigation actions that need to be in place both to reduce the likelihood of risks crystallising and the impact (financial, technical and temporal) if they do.

5.1.3 This section of ITPD

This section of the ITPD describes the Authority's approach and underpinning concepts for the assessment and allocation of risks. It sets out the Government's position on risk allocation. It should be read alongside Part 4 of this ITPD which describes how risk allocation will be contractualised.

5.2 **Authority's approach to risk**

5.2.1 General principle of risk allocation

(a) Risks will primarily be allocated to the party with the best ability to influence and manage such risks. The Authority therefore expects industry to be responsible for managing the many risks inherent in the development and operation of CCS Projects which are within their natural sphere of competence – risks such as ensuring that timely construction conforms with design, that private capital is available when contracted to be available and that systems are properly operated once constructed. These have been categorised as "Business As Usual "risks.

(b) Industry's expert ability to manage these risks, and to apply this expertise to finding solutions to the novel problems posed by CCS, is at the heart of the CCS Commercialisation Programme.

5.2.2 CCS-specific risks

Before solutions for complex risks

(a) It is recognised that the nature of some particular risks unique to CCS are such that they are not yet well understood and/or readily insured against or easily managed. The Authority considers that a pragmatic solution will need to be established between industry and Government for the management of, and liability for, those risks.

(b) However, the Authority will not contract:

(i) for Government to manage risks which, despite their novelty and emerging nature, industry has better expertise to manage; or

(ii) for industry to manage risks which are wholly outside its control and which Government or other stakeholders are better placed to manage.

Shared risks migrates to industry over time

(c) Some risks may be shared and the Authority expects that there may be a distinction to be drawn between the management of some risks (often best placed with industry) and the financial consequences of risks maturing.

(d) The Authority's analysis suggests that risk allocation and management in some areas should change over time as risks become better understood and Projects become better defined and developed. The contractual arrangements described in Part 4 of this ITPD will include a mechanism for change that allows this to occur at an affordable price, and with value-for-money and Deliverability as the key drivers.

Some Projects may not succeed

(e) Ultimately, it is possible that a Project may, despite the best efforts of all parties, prove that CCS, or a particular CCS technology, is not economically viable at Commercial Scale. If this happens, this is not a risk that the Authority expects Bidders to take exclusively.

5.3 **Overview of Authority's required risk allocation**

5.3.1 General

(a) The Authority seeks to achieve a process for the allocation and management of risk which maximises the delivery of the CCS Commercialisation Outcome at best value for taxpayers and electricity consumers and within affordability constraints.

(b) The Authority recognises that to deliver the CCS Commercialisation Outcome at best value-for-money within affordability constraints it needs to balance the exposure of participants (Government and industry) to risk in a manner which makes Projects fundable, from both public and private sources.

(c) At a high level, it is expected that risks will be allocated and managed by one or more parties and managed through the agreed contractual mechanisms. To achieve this it is necessary to identify and characterise all material risk, including its likelihood and impact to time, cost and performance and agree appropriate mitigation action and identify the party best able to manage it.

5.3.2 FEED work

(a) A key risk mitigant will be work that industry has done or does to explore and develop its understanding and reduction of risk during FEED work. The Authority is willing to consider part-funding of this work on the basis described in the draft FEED Contract.

(b) FEED will be commissioned where Bids, selected through Evaluation, are insufficiently mature in terms of cost uncertainty, risk understanding or other factors to justify the immediate award of a Project Contract.

5.3.3 Project Contract, CfD and PCG

The primary risk allocation arrangements will be contained in the suite of contracts that may be awarded to Bidders. These are described in Part 4 of this ITPD and comprise primarily:

(a) **The Project Contract**. This will be the principal contract for the injection of Capital Grant for construction funding by the Authority and addressing design and construction risks and others that apply during the period before the CCS systems have all completed commissioning. Certain other, longer term risks will also be addressed in this contract. A summary of this contract is set out in Section 4 of Part 4 of this ITPD.

(b) **The Contract for Difference** that is intended to be agreed at the time that the Project Contract is executed, subject to modification at key project Milestones to reflect agreed risk allocation. A summary of the main terms that the Authority envisages this will contain is set out in Section 5 of Part 4 of this ITPD. This is intended to be a vehicle for funding operating period costs and (potentially) further contributions towards capital costs. It is intended to address the risks associated with electricity market price volatility; and

(c) **The Parent Company Guarantee** described in Section 6 of Part 4 of this ITPD and set out in Appendix 8.

5.3.4 Risk proposition

The Authority has established and reflected in this ITPD what it considers to be a balanced proposition on risk allocation which reflects the approach described above. The Authority accepts that, in Projects as novel as those which will participate in the CCS Commercialisation Programme, negotiation of risk allocation will be required to strike the optimum balance; however, during these negotiations it does not expect a wholesale departure from the proposition set out in this ITPD.

5.3.5 Baseline Risk Allocation Matrix

Purpose

(a) The Baseline Risk Allocation Matrix is set out in Appendix 11 of this ITPD. It has been developed as a means through which to present the principal risks that arise in a potential CCS Project. It does so assuming an integrated CCS Full Chain Project. It is intended as a mechanism to show how the Authority expects risks to be allocated between industry and the Government and provide a reasoned justification for the allocation.

Instructions to Bidders

(b) Bidders are accordingly urged to accept and price the risk allocation proposed in the Baseline Risk Allocation and the Contracts Principles set out in Part 4 of this ITPD. Departures from the Authority's Baseline Risk Allocation proposition must be itemised and fully detailed. Each must be priced, to allow the Authority to assess the improved value for money afforded by the proposed change.

Evaluation of Bid risk profile

(c) The extent to which a Bid departs from the Authority's Baseline Risk Allocation, any enhanced value for money offered will be Evaluated. Significant detrimental departures will attract concomitantly negative Evaluation. Bids which depart from the Authority's risk proposition to such an extent as to call into question the likelihood that the Authority would be able to conclude a negotiation successfully will be Evaluated accordingly. The Authority reserves the right to reject any Bid which leads it to conclude that a negotiation is unlikely to be successful.

(d) It follows that the Authority considers that any Bid in which Bidders propose to accept and manage additional risk to that already allocated to industry in the Authority's proposed allocation will be Evaluated more favourably, provided it is demonstrated that the risks concerned can be managed effectively.

Bidder discussion of risk

(e) Bidders are urged to use the discussion process described in Section 3 of Part 1 of this ITPD to test proposed deviations from the Authority's risk proposition.

Preference for integrated Bidders

(f) Bids which are made on a fully integrated basis – where a single contract can be placed with a single Bid Vehicle, which is responsible for managing the entire Project and all risks that are allocated to industry, supported by Parent Company Guarantees in the form set out in Appendix 8 – will be Evaluated as being significantly more attractive than those which are not made on that basis. In short, the Authority does not want to own or fund Consortium integration risks.

Part Chain Projects

(g) The risks posed by Part Chain Projects will need to be managed effectively. Part Chain Projects will only be supported by a FEED Contract where the Bidder can clearly identify the potential to connect and become part of a CCS Full Chain Project in the foreseeable future. In such cases, definition and allocation of risks across the CCS Chain will need to be demonstrated in a manner consistent with the overall risk allocation put forward by the Authority. Part Chain Projects will not be funded beyond FEED Contracts unless they have joined other Part Chain Projects or a CCS Full Chain Project to become a CCS Full Chain Project or a Cluster Project.

Annex II - Government's approach to Risk Allocation under Phase 1 of the Commercialisation Programme [ii]

[Full documentation can be found at: https://online.contractsfinder.businesslink.gov.uk/Common/View%20Notice.aspx?site=1000&lang=en&noticeid=560937&fs=true]

Appendix 11 from ITPD – Baseline Risk Allocation Matrix

1.1 Baseline Risk Allocation Matrix

General

1.1.1 The Baseline Risk Allocation Matrix prepared by the Authority has been presented in this Appendix 11 of this ITPD. The Baseline Risk Allocation Matrix sets out the CCS Specific Risks and the Business As Usual risks.

1.1.2 Any risks/and or impacts to the Project which are considered to be a result of Developer default is a BAU risk.

1.1.3 At the point at which risks are considered closed (i.e. at the point in time beyond which the probability of the risk materialising is close to zero) then, the majority of such risks will pass entirely to the Bidder/Developer.

Structure of Baseline Risk Allocation Matrix

1.1.4 The structure and headings of the Baseline Risk Allocation Matrix are as follows running from left to right:

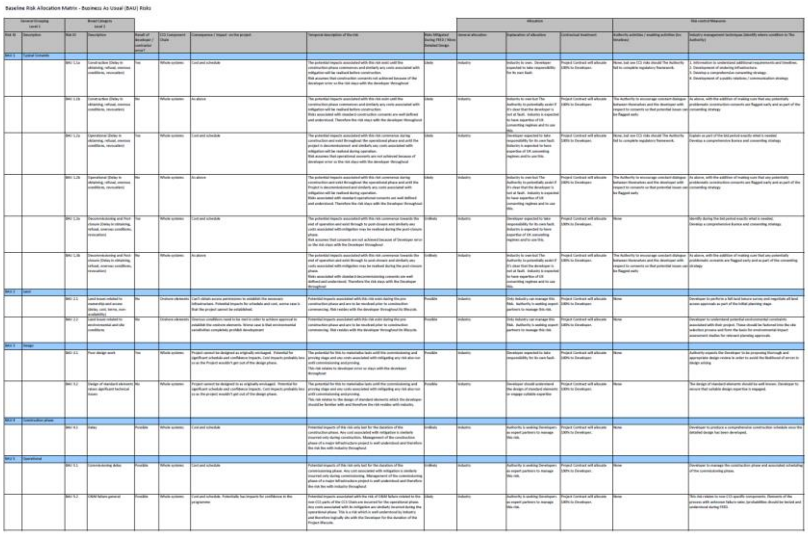
- Level 1 and Level 2 risk categorisation: high level broad risk categories are identified (Level 1) with subsequent detailed breakdown into Level 2. Risks are profiled at their lowest defined level. The Level 1 and Level 2 risks have been given unique identification numbers.
- Component chain: where applicable, the risk is subsequently defined according to the CCS Chain Link to which it relates.
- Consequence / impact: provides a description of the likely impact which will be result should the risk materialise.
- Temporal description of the risk: the relevant part of the Project lifecycle which is potentially affected by each risk is described in this column. A statement about when in the Project lifecycle the Baseline Risk Allocation and subsequent responsibility for its management changes is also provided, where relevant.
- Risks mitigated during FEED: a statement as to the likelihood of the risk level reducing as a result of conducting FEED, is provided.
- General Baseline Risk Allocation and explanation of Baseline Risk Allocation: a statement about who is responsible for which risk, along with an explanation, is provided.
- Contractual treatment: a high-level explanation of how the risk will be addressed in the relevant contracts is provided.
- Risk control measures: potential risk control measures are provided and are split according to the Authority enabling activities and industry management techniques. The former category demonstrates the actions which the Authority believes that the it needs to take in order to mitigate the risk in question; the latter category demonstrates the type of risk mitigation response that it

- would expect from industry. This is not intended to be comprehensive but provides an initial proposed risk allocation for Bidders. The Authority does not expect that the
- relevant contracts will necessarily oblige it to undertake these activities; in some cases it would be unlawful to fetter its public law discretion by doing so.

1.1.5 Any risks and/or impacts to the project which are considered to be a result of Developer fault is a BAU risk.

1.1.6 At the point at which risks are considered closed (i.e. at the point in time beyond which the probability of the risk materialising is close to zero) then, in the main, they pass entirely to Bidder/Developer.

[NB. Appendix 11 contains six pages of detailed tables, a sample of which is below. These can be found in the electronic version]


Baseline Risk Allocation Matrix - Business As Usual (BAU) Risks

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URN 14D/281