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# The Path to Deployable CCS Technologies



Produced by the Steering Group of the Scottish  
Carbon Capture Transport and Storage Study

Available at [www.erp.ac.uk/sccs](http://www.erp.ac.uk/sccs)

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1

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## Role of CCS in Climate Change Mitigation

- It is accepted that:-
  - CO<sub>2</sub> from fossil fuel power generation accounts for approx. 35% of total UK CO<sub>2</sub> emissions.
  - Fossil fuels will continue to be used for power generation for foreseeable future.
  - CCS on fossil fuel power generation is essential to achieve the CO<sub>2</sub> emissions reductions required by the 2050 targets, alongside renewables and other emissions reduction strategies.

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2

## UK and EU CCS Ambitions

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- CCS to be available as a low carbon deployment option for power generation and major industrial plants by 2020

via

- A programme of commercial scale demonstration projects, to be operational by 2015

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3

## Ambitions for CCS in Scotland

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There is strong synergy between the ambitions of government and industry (electricity companies, oil and gas companies, CCS and power plant suppliers):

- **Government and its agencies**
  - Meet climate change emissions reduction targets with secure and affordable energy prices
  - Establish strong energy and CCS industry to maximise economic benefit and employment
- **Industry**
  - Electricity companies need reliable technologies and strong industrial support capable of delivering CCS to meet ambitious programmes
  - Oil & gas companies need the business environment to ensure Scottish offshore storage potential is tapped timely, successfully and efficiently
  - Power plant and CCS suppliers and consultancies need references for their goods and services
  - All industrial participants need an adequate supply of skilled workers to allow them to achieve their ambitions across the power plant, capture, transport and storage chain
- **Academia / Research base**
  - Universities need clear targets and funding support

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4

## Key Dates

- **EU demo programme** – 10-12 EU commercial scale demo projects operational by 2015.
- **G8** – 20 projects committed by 2010, operational by 2020.
- **Scottish Parliament** - recently set target of 42% reduction in GHG emissions by 2020
- **Committee for Climate Change**
  - 34% cut in GHG emissions by 2020 relative to 1990.
  - 80% cut in GHG emissions by 2050 relative to 1990.
- CCS ready for wide scale deployment by 2020

**FIRM DATES**  
**FIRM COMMITMENTS**  
**BUT HOW CAN WE ENSURE CCS IS PART**  
**OF THE CLIMATE CHANGE SOLUTION?**

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5

## Objective - CCS ready for wide scale deployment by 2020

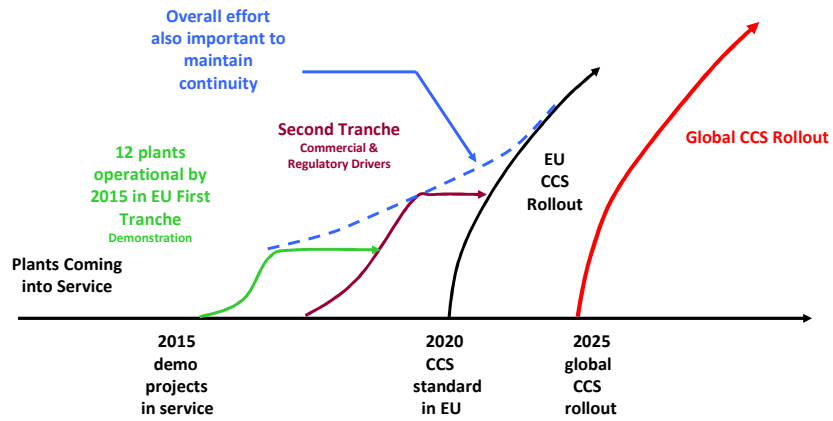
### REQUIRES ALL OF THE FOLLOWING

- Proven technology via initial commercial scale demonstration projects operational by 2015 and a second tranche soon after
- Transport infrastructure
- Proven large scale storage capacity by 2020, including methodology/guidelines for storage site assessment
- R+D to improve technologies – capture, transport + storage
- Stakeholder engagement
- Industry capacity and skills development built up
- Establishment of the CCS business environment
- Appropriate regulatory regime

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6

# Commercial Scale Demonstration Units By 2015



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7

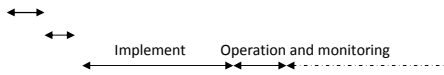
# Commercial Scale Demonstration Units By 2015



## 1<sup>st</sup> Phase – EU Demo Process (Capture, transport and storage)

- funding commitment by Govts ◇ Necessary for developer confidence to commitment of resource and funds
- o EU EERP
- o EU 300M EUAs
- o UK post competition
- o UK further demo projects

- Funding process, long term and sustained ◇ Necessary for developer confidence to commitment of resource and funds
- select projects
- sanction projects
- implement



## Other International Activity

## 2<sup>nd</sup> Phase –Process

- design
- sanction projects
- commence operation

Notes: All technologies require demonstration and/or development – post, pre and oxy.  
 EERP – European Economic Recovery Package  
 EUA – Emissions Unit Allowance

Learning transfer

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8

## Required rate of growth of CCS

2009	2015 - 2020	2020		2020 - 2030	2030
Fledgling industry	<ul style="list-style-type: none"> <li>• EU – 10 to 12 demo projects</li> <li>• UK – up to 4 demo projects</li> <li>• Scotland – 1 or more demo project</li> <li>• EU – 30 Mtes/year CO2 stored</li> </ul>	<ul style="list-style-type: none"> <li>• EU - 150 Mtes CO2 cumulatively stored</li> <li>• EU and UK – CCS deployment commencing</li> </ul>	<ul style="list-style-type: none"> <li>• Need large scale proven aquifer storage capacity</li> <li>• Need financial funding method for CCS deployment established</li> </ul>	<ul style="list-style-type: none"> <li>• CCS rollout</li> </ul>	<ul style="list-style-type: none"> <li>• CCS norm</li> <li>• EU - ?? GW capacity</li> <li>• UK - ?? GW capacity</li> </ul>

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9

## Transport Infrastructure

### Issues for the development of a transport infrastructure

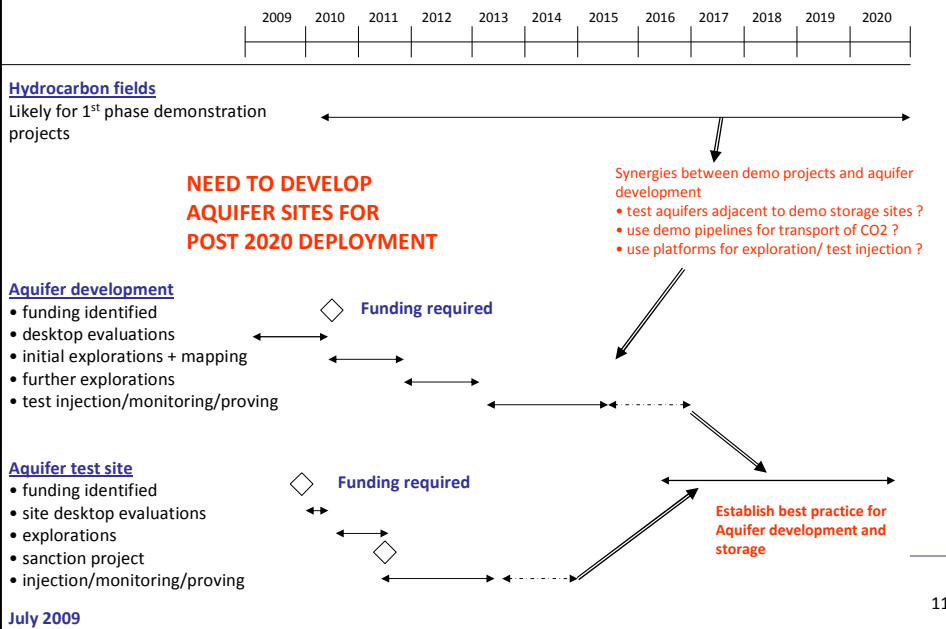
- Efficiency of transport infrastructure
    - individual source to sink projects inefficient
    - cluster a more efficient approach
    - what will/should 1st phase demonstration projects be ?
    - how to develop early projects to allow growth potential ?
- NEED TO DEVELOP THINKING NOW**
- Networks
    - how to evolve initial infrastructure into efficient networks ?
    - will private industry develop or is regulatory intervention required ?
    - are current competitions for project funding conducive to future networks ? Would collaboration better encourage the right thinking ?
    - network design dependent upon emitters' future CCS plans. How to encourage sharing of this information ? When will this information be available ?

**NEED METHODOLOGY FOR CCS ROLL-OUT FOR 2020**

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10

## Proven Large Scale Storage Capacity by 2020



## Proven Large Scale Storage Capacity by 2020 - Aquifers

### Issues for aquifer development

- High cost of proving aquifer storage capacity
  - What is the cost ??
  - Who pays ?
  - Where is the incentive for risk money ?
  - Probability of failure ?
  - Parallels with oil/gas exploration activity ?
  - Role for Government ?
- Which comes first – development of aquifer storage capacity or CCS projects ?
  - no incentive to develop proven aquifer stores without knowing there is a requirement for storage.
  - no incentive to develop a capture project without knowing there is a store available.

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12

## R+D Requirements



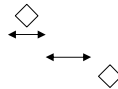
### R+D – Technology Improvement and Development

← Ongoing – Public Sector (Research Councils and EU) + Private Sector →

Capture, treatment, transport and storage  
Health and Safety  
Power generation, cement, petrochemical, steel + other

### Post combustion capture large pilot

- funding identified
- design
- construct
- operate



- Why UK need for large pilot project ?**
- direct UK learning instead of indirect
  - skills development
  - informed user development

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13

## Stakeholder Engagement

- Stakeholder engagement to be continued via existing activities and progress
- Reviewed periodically.
- Stakeholders include
  - Public (local and wider)
  - NGOs
  - Governments
  - Policymakers
  - Politicians
  - Research funders
  - Academics
  - Industry
  - +

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14

# Industry Capacity and Skills Development



## Skills (professional and craft)

- Skill gap analysis
- Identify requirements
- identify funding
- implement



Similar skills issue was faced by the UK oil and gas industry in the 1970s and successfully addressed.  
Ref 1973 report by Dept Of Employment – “Education and Training for Offshore Development”.

Examples - Engineering Doctorate training centres, funded MScs

## Industry capacity

Size of task identified by

- CCS industry potential to be same size as current oil/gas industry
- CCS transport and storage component will use the same skills as the oil and gas industry
- Exponential growth
  - o 2009 – fledgling industry
  - o 2015 - 1<sup>st</sup> demos
  - o 2020 – commencing deployment
  - o 2030 – CCS the norm on fossil power generation

## Industry opportunities

CCS is a diversification opportunity for Scotland’s established oil and gas industry

CCS is vital and a major opportunity for existing power plant equipment suppliers

Development of storage capacity for UK and EU

Development of new products and businesses to serve Scottish, UK and global markets

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15

# Establishment of the CCS Business Environment

- Enduring policy mechanisms for CCS required for wide-scale deployment of CCS post 2020.
- Development of business models for the CCS chain
  - Who will be the players in the transportation and storage components ?
  - Will transport and storage be regulated or free market activities ?
  - Interactions across chain require to be developed and proven.
  - Interaction between two essential industries with differing business models
    - power industry – low risk, low return
    - oil/gas industry – high risk, high return
  - New transport industry required to connect the capture and storage sectors

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16



## Appropriate Regulatory Regime

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- REGULATION IS AN ENABLER TO ALLOW 2020 AND 2050 TARGETS TO BE ACHIEVED
  - Already complete
    - EU CCS Directive – 2008
  - Work in progress
    - OSPAR and London Convention amendments
    - UK Energy Bill
    - Licensing Arrangements for storage sites
  - HSE requirements require to be developed
- TIMESCALE FOR REGULATION NEEDS TO MATCH DEMONSTRATION AND DEPLOYMENT REQUIREMENTS

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17

## Implementation – Near Term Year 1

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- commitment to long term funding for commercial scale demonstration projects
- commence development of aquifer test site
- commence proving large scale aquifer capacity
- continue R+D
- commence development of post combustion capture pilot project
- commence skills and industry gap analysis
- continue regulatory regime
- continue stakeholder engagement

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18

## Implementation – Medium Term Years 2 to 3

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- sanction commercial scale demonstration projects
- sanction aquifer test site
- commence explorations of large scale aquifer capacity
- continue R+D
- operate post combustion capture pilot unit
- complete skills gap analysis and commence implementation of actions
- regulatory regime complete
- enduring policy regime under development
- continue stakeholder engagement – argument for CCS won

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19

## Implementation – Long Term Years 4 to 10

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- 1st phase commercial scale demonstration projects in operation
- 2nd phase commercial scale demonstration projects under construction
- aquifer test site in operation
- proving large scale aquifer capacity in process
- aquifer site methodology/guidelines in place
- continue R+D
- skills gap being addressed
- business environment established
- regulatory regime in place

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20

## Post 2020

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**CCS AVAILABLE AS A LOW CARBON OPTION FOR INDUSTRY**