DEPARTMENT OF ENERGY & CLIMATE CHANGE

CCS Roadmap

Innovation and R&D

April 2012


DEPARTMENT OF
ENERGY
&CLIMATECHANGE

Innovation and R&D

We are:

- **With our partners, delivering a £125m, 4-year, co-ordinated R&D programme**. This includes:
- **Establishing a UK CCS Research Centre**
- **Supporting fundamental research and increased understanding [c£40m]**
  - This includes over £4m recently awarded to university-led projects on gas CCS research
  - A UK CO_2 storage atlas which will be published shortly
- **Supporting component development and innovation [c£30m]**
  - DECC has launched a competition to award over £20m to CCS component development and demonstration
  - ETI will shortly launch a £5m competition specifically focused on developing Monitoring, Measurement and Verification (MMV) tools
- **Pilot scale testing and projects [c£55m]**
  - Ferrybridge, post-combustion coal, 5MWe (operational Nov 2011)
  - Location tbc, Costain capture technology for IGCC, 5-10MW (operational 2014 - 15)
  - Location tbc, capture technology for CCGT, 5-10MW (operational 2014 - 15)

The challenge

1.1. The fundamental barrier facing CCS is cost. A key element of this is the intrinsic cost of the technologies and techniques which make-up CCS. Further development and refinement of existing technologies and innovative breakthroughs that deliver new approaches are vital if we are to reduce the costs of CCS.

1.2. Technology develops following a well documented path. At the birth of a new technology, costs are typically high. As the technology develops through further R&D and by incorporating learning from use of the technology, costs fall as both process and product innovation eliminate inefficiencies and reduce costs. CCS is no different. Currently costs are high. Continuing investment in innovation and R&D will lead to reductions in cost, and

we must make sure that investment is focused in those areas that will deliver the greatest cost reductions.

1.3. Our analysis, which will be published later this year, has shown that deployment costs of CCS could be reduced through learning from research by between £10 - 45 billion through to 2050 depending on the level of deployment.

Progress to date

2.1. The UK is home to world-class CCS innovation, research and development. The Government and its partners have invested significant amounts in CCS R&D. This investment has been, and will continue to be, carried out through the Government's main R&D partners, including:

- **Department of Energy and Climate Change** – Identifies gaps in existing R&D activities to ensure enhanced support is given to key technologies close to market and negotiates within the EU to ensure that EU funds are directed to areas that are a priority for the UK, including CCS;
- **Research Councils** – Support fundamental research, creating new scientific knowledge and training the next generation of researchers;
- **Technology Strategy Board** – Supports new innovation, moving ideas closer to the commercial market; and
- **Energy Technologies Institute** – A unique partnership between the Government and industry, the ETI identifies and accelerates the development of affordable, clean and secure technologies by commissioning large scale system demonstrations.

2.2. This investment is already showing dividends – the UK's academic research is the best in Europe, international companies are choosing to collaborate with UK institutions and innovative smaller companies are emerging with technologies which could further reduce the cost and risk of CCS.

Actions we are taking: Our 4-year, £125m R&D and innovation programme

3.1. The priorities for the R&D and innovation programme have been developed in partnership with representatives from the UK CCS community and the Advanced Power Generation Technology Forum (APGTF) over the past 12 months. A wide range of organisations have contributed to developing a matrix of technology needs. The full version of this was published in September 2011 by the APGTF, and can be found at: http://www.apgtf-uk.com/index.php?option=com_docman&Itemid=137. Figure 1 is a summary of this matrix.

R&D Theme	Short term R&D needs (5 – 10 years)	Medium term R&D needs (7 – 15 years)	Long-term R&D needs (10 – 20+ years)
Whole systems	• Investigate system operability and power plant interaction between CO_2 grid • Test flexibility to cope with change in demand • Develop CO_2 accounting	• Further Investigation of complex interaction of CO_2 from multiple sources (capture technologies, industrial sources)	
Capture	• Learn from demonstration projects • Develop understanding of environmental impact • Identify requirements for retrofitting • Adapt technology for range of fuel types • Specify CO_2 standards • Establish common measures and monitoring	• Provide validation of demonstration capture technologies • Develop and demonstrate 2nd generation capture agents and processes	• Develop commercially available systems with >85% capture rate for all fuel types • Develop capture systems with efficiency >45% including CO_2 capture
Industrial CCS	• Investigate extent to which CCS technologies could apply to industrial applications	• Identify sources with sufficient operational lifetime remaining to make retrofitting feasible	
Transport	• Understand potential hazards and risks to inform decisions on pipeline routes onshore • Develop techniques for leak mitigation and remediation • Develop ship-based transport option	• Gather best practice data • Identify novel pipeline materials and sealing and joining technologies • Develop technologies to reduce power and cost of compression	• Develop performance database for CO_2 transport networks to enable grid optimisation
Storage	• Improve understanding of geological seal integrity and subsurface CO_2 behaviour/ flow • Estimate UK CO_2 storage capacity • Develop and demonstrate low-cost and sensitive CO_2 monitoring technologies • Develop best practice guidelines for well construction, completion and remediation	• Test injection at significant scale at multiple sites • Investigate water production • Develop techniques for rapid, detailed appraisal of formation capacity • Improve monitoring technologies	• Develop techniques for high efficiency use of formation capacity

Figure 1. Overview of future CCS research needs

Case Study: Ferrybridge CC Pilot 100+

A CO_2 post-combustion amine scrubbing pilot plant (100t/d equivalent to 5MWe, 15 MWth) has been designed and installed at SSE's Ferrybridge Power Station to use a slipstream of the flue gases from burning coal and biomass. A test programme will optimise the process and components and develop performance models, including process capability, stability, transient flexibility, amine degradation, and materials performance. University researchers are participating to gain experience and build UK capacity in this field.

The project is a critical bridge between research and commercialisation at a scale chosen strategically between existing pilots (e.g. 160 KWe and 1MWe) accessible to Doosan Babcock and full-size commercial projects. It is currently the largest carbon capture project of any type in the UK.

The primary objectives of the test programme are:

- Prove the technological application of the amine based PCC process under realistic operating conditions;
- Decrease risks connected to near-term scale up and deployment of such a plant by gaining knowledge in key areas;
- Gain information on process operating costs and interaction with the main station;
- Benchmark the Doosan/ HTC Purenergy process against other similar processes;
- Assess the effects of station running schedule/regimes upon PCC performance; and
- Develop and validate process models.

3.2. Our 4-year, £125m co-ordinated R&D programme will be wide ranging, covering:

- Supporting fundamental research and increased understanding [c£40m];
- Supporting component development and innovation [c£30m]; and
- Pilot-scale testing and projects [c£55m].

3.3. To enhance the UK's world leading academic research on CCS, **we are establishing a new UK CCS Research Centre,** to better coordinate and promote this work, and to enhance the already high level of collaboration with industry.

3.4. The UK CCS Research Centre will promote a wide range of activity, in addition to supporting the core research, development and innovation activity. This includes:

- Encouraging the **development of shared R&D facilities** including a **new UK carbon capture testing hub**;

- **Collecting data from our various CCS research projects**; and

- **Development of people** to ensure we have the capability to use the knowledge generated from our R&D programme. The Research Councils doctoral training centres create 20 CCS PhD students each year, and as part of this **we will launch a new DECC CCS Internship Programme** of 2 students a year, to ensure our future CCS R&D leaders understand not only scientific and commercial aspects of CCS but also policy development.

UK CCS Research Centre

The new £13m Centre will bring together over 100 of the UK's top CCS academics, who currently manage an extensive portfolio of CCS projects. The Centre will aim to:

- Improve co-operation between UK researchers and global CCS industries;

- Focus on diverse skills and multiple innovations to accelerate solutions to CCS problems;

- Coordinate participating UK researchers to work on a programme of key strategic CCS priorities; and

- Gain understanding and accelerate the solution of large and complex CCS problems.

£20 million for innovations in CCS technology

3.5. On 13 March 2012 the Energy secretary launched a competition worth up to £20 million to fund CCS innovation.

3.6. The competition is targeted at the development and demonstration of technologies associated with CCS, and on feasibility studies associated with using captured CO_2 from the Ferrybridge CCPilot100+ and Aberthaw capture pilots. The competition follows a similar call in 2011 from the Technology Strategy Board, and both are part of the Government's broader £125 million CCS R&D Programme covering 2011 - 2015.

3.7. The primary objectives of the Innovation Call are to:

- Successfully demonstrate, up to a scale of c10MWe, CCS components and technologies which could be subsequently incorporated into the supply chain of original equipment manufacturers (OEMs) and developers of commercial-scale CCS projects;

- Provide support to tackle the new challenges and innovation required to design and build components that – in terms of scale and/ or complexity – go beyond current understanding and experience;

- Generate learning and practical experience that can improve confidence in innovative CCS components and technologies and so help reduce future costs; and

- Ensure innovation support for CCS complements the existing research, development and deployment (RD&D) programmes being conducted in the UK.

3.8. The Innovation Call complements the Government's CCS Commercialisation Programme. Within approximately the next two years OEMs and project developers who are part of the CCS Commercialisation Programme could be placing orders for parts and therefore it is hoped that some of the components and technologies developed under this Innovation competition may become part of that supply chain and of future supply chains for subsequent CCS projects, both within the UK and beyond.

3.9. The competition will support innovative technologies associated with CCS for large single-point emitters of CO_2, such as fossil-fuelled power plants and energy-intensive industries. The challenge is to reduce the cost of CCS by developing more efficient, lower cost technologies, components and systems; and to develop understanding which reduces uncertainty and risk (and therefore leads to cost reduction) for any aspect of the CCS process.

International collaborations

3.10. Supporting international R&D collaboration is a key part of our approach to delivering CCS globally and in the UK. As with the CCS Commercialisation Programme there are important lessons to learn and knowledge to share which can accelerate the commercial deployment of CCS.

3.11. The vast majority of currently planned large-scale CCS projects are in developed countries, but analysis indicates the need for their demonstration and deployment in the rapidly growing and fossil fuel intensive developing countries. R&D can be a pre-requisite to deployment of large-scale CCS projects, for instance mapping potential CO_2 storage sites and production of other technical reports.

3.12. The Government is supporting a number of collaborative R&D programmes and initiatives. At the multilateral level, DECC supports the work of the International Energy Agency on CCS, including the Greenhouse Gas Programme Implementing Agreement which is based in the UK. Bilaterally, we are supporting collaboration between UK and US universities and R&D work in developing countries such as China.

Department of Energy & Climate Change
3 Whitehall Place
London SW1A 2AW
www.decc.gov.uk

URN 12D/016b