

CCS R&D priorities in UK

Opportunity for UKCCSRC to input to
UK policy

- UKCCSRC is supporting APGTF in updating R&D priority recommendations for DECC
- Agreed action on APGTF from the Cost Reduction Task Force
- UKCCSRC is one of the key consultees, (alongside APGTF members, Competition entrants, and CCSA)
- Results will feed into updates of the relevant tables in DECC CCS Roadmap and APGTF Strategy

- APGTF has appointed industry leads for
 - Generation and Capture
 - Bryony Livesey
 - Robin Irons
 - Transport
 - Rosemary Whitbread
 - James Watt
 - Storage
 - Tony Espie
 - Tony Boor
 - And appointed Mike Farley as project manager
- UKCCSRC have asked Mike to assist on organising input from Centre members

DECC Roadmap Fig 6



CCS Roadmap

Supporting deployment of Carbon Capture and Storage in the UK

April 2012

CCS Research

CCS Theme	Short term R&D needs (0-10 years)	Medium term R&D needs (11-20 years)	Long-term R&D needs (21-30+ years)
Whole systems	<ul style="list-style-type: none"> Investigate system operability and system start/shutdown between CO₂ gas Test feasibility to cope with change in demand Develop CO₂ accounting 	<ul style="list-style-type: none"> Further investigation of complex interaction of CO₂ from multiple sources (capture technologies, industrial processes) 	
Capture	<ul style="list-style-type: none"> Learn from demonstration projects Develop understanding of environmental impact Identify requirements for retrofitting Develop technology for range of fuel types Specify CO₂ standards Establish common research terminology 	<ul style="list-style-type: none"> Provide validation of demonstration capture technologies Develop and demonstrate 2nd generation capture projects and processes 	<ul style="list-style-type: none"> Develop commercially available systems with >80% capture rate for all fuel types Develop capture systems with efficiency >80%, including O₂ capture
Industrial CO ₂	<ul style="list-style-type: none"> Investigate extent to which CO₂ technologies could apply to industrial applications 	<ul style="list-style-type: none"> Identify routes and sufficient operational status (ensuring it meets retrofitting needs) 	
Transport	<ul style="list-style-type: none"> Understand potential benefits and risks to future decisions on pipeline route and route Develop techniques for leak mitigation and remediation Develop site-based transport options 	<ul style="list-style-type: none"> Define test protocols and standards and testing and joining technologies Develop techniques to reduce peak demand of compression 	<ul style="list-style-type: none"> Develop performance indicators for CO₂ transport networks to enable cost optimisation
Storage	<ul style="list-style-type: none"> Improve understanding of geological seal integrity and subsurface CO₂ behaviour/flow Validate CO₂ storage capacity Develop and demonstrate licensed and operated CO₂ monitoring technologies Develop test practice guidelines for seal characterisation, compression and remediation 	<ul style="list-style-type: none"> Test operation of significant scale storage pilot sites Investigate water production Develop techniques to verify detailed assessment of formation capacity Improve monitoring technologies 	<ul style="list-style-type: none"> Develop techniques for high efficiency use of formation capacity

Figure 6. Overview of future CCS research needs.

Whole-systems and Cross-cutting Issues

R&D needs to meet short -term objectives (applicable in 0 – 10 years)	R&D needs to meet medium-term objectives (applicable in 7 – 15 years)	R&D needs to meet long-term objectives (applicable in 10 – 20+ years)
<ul style="list-style-type: none"> • Effective methods to improve understanding of CCS by the public, financial community and institutions, including the wider context of CCS, policy/ regulatory/incentive/ frameworks and carbon accounting (including bioenergy with CCS and industrial emissions) • System level modeling to understand the operability of a full CCS system in response to an increased need for fossil fuels to provide security and flexibility in a decarbonized energy system with intermittent renewables. • Improved understanding of the impact and benefits of clustering of sources , optimum location of power plants (gas and coal) and strategic development of UK storage resources. • Assess the optimum levels of CCS for low carbon electricity and heat and industrial CO₂ abatement. • Develop CO₂ accounting, monitoring and measurement techniques (CO₂ & impurities) and influence development of CO₂ standards taking account of different sources and applications 	<ul style="list-style-type: none"> • Maximize economically realistic potential for utilisation of captured CO₂ (including EOR) • Further optimization of system level modeling and cluster development (sources and stores) recognizing the different lead times of the several parts of the CCS chain • Further development of optimised flexible CCS 	<ul style="list-style-type: none"> • Strategic development of UK storage resource for UK and European emissions

CO2 Capture

R&D needs to meet short -term objectives (applicable in 0 – 10 years)	R&D needs to meet medium-term objectives (applicable in 7 – 15 years)	R&D needs to meet long-term objectives (applicable in 10 – 20+ years)
<ul style="list-style-type: none"> • Learn from pilot-scale, demonstration and 'first-of-a-kind' commercialisation projects (UK and abroad), improving confidence on long term effects - degradation, corrosion, emissions • Develop understanding of environmental impact (to air and water) • Identify requirements for retrofitting/capture-readiness/future-proofing • Solvent , process and equipment improvements for cost reduction 	<ul style="list-style-type: none"> • Develop and demonstrate at appropriate pilot scale 2nd generation capture agents and processes both for new plant and for retrofit to earlier plants (including novel low temperature solid absorbents and new oxyfuel cycles) • Develop CCS technologies for gas turbine plant (including EGR and optimized gas turbines) 	<ul style="list-style-type: none"> • Develop commercially available systems to meet Cost Reduction Task Force targets and CO₂ purity standards for all fuel types • Develop novel cycles or capture systems with energy penalty significantly below 10% points for coal and 8% points for gas

Industrial CCS

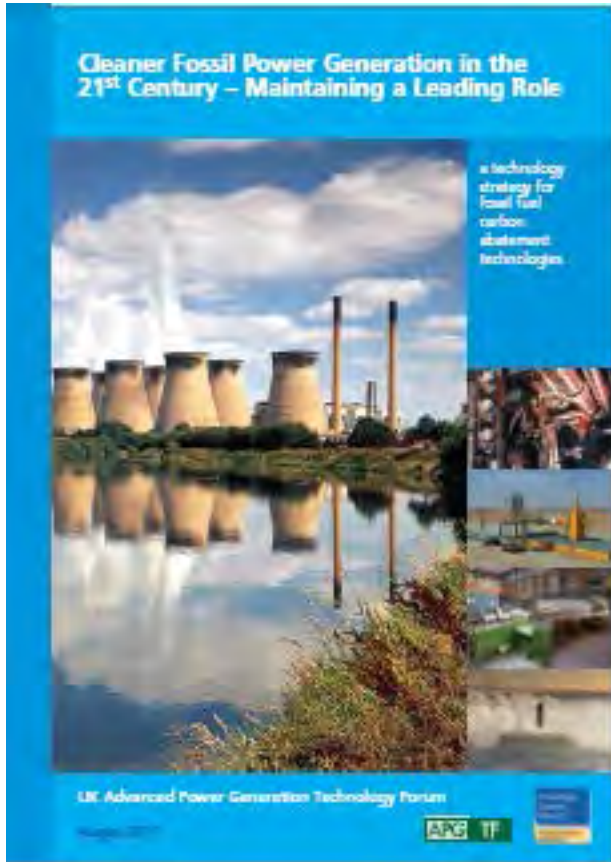
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<ul style="list-style-type: none">• Studies to develop early opportunities where CO₂ streams are available• Adapt 1st/2nd generation capture technologies for industrial use to meet CO₂ storage standards and initiate projects• Investigate scope for cost-reduction and scalability of carbon capture and utilisation (CCU) solutions and identify R+D priorities	<ul style="list-style-type: none">• Develop additional CO₂ capture and utilisation technologies for other high-emission industries	

CO₂ Transport

R&D needs to meet short -term objectives (applicable in 0 – 10 years)	R&D needs to meet medium-term objectives (applicable in 7 – 15 years)	R&D needs to meet long-term objectives (applicable in 10 – 20+ years)
<ul style="list-style-type: none">• Understand potential hazards and risks to inform decisions on pipeline safety• Gather best practice data• Develop techniques for leak mitigation and remediation• Develop transportation with ships	<ul style="list-style-type: none">• Develop technologies to reduce power and cost of CO₂ compression• Extended testing on pipeline test loops with realistic CCS CO₂ mixtures to push frontiers for materials, components and operating strategies	<ul style="list-style-type: none">• Develop performance database for CO₂ transport networks to enable grid optimisation

CO₂ Storage

R&D needs to meet short -term objectives (applicable in 0 – 10 years)	R&D needs to meet medium-term objectives (applicable in 7 – 15 years)	R&D needs to meet long-term objectives (applicable in 10 – 20+ years)
<ul style="list-style-type: none"> • Improve understanding of dynamic behaviour of CO₂ storage systems over a range of spatial and temporal scales (within and beyond the store) • Further increase understanding of practical UK storage capacity for selected sites • Develop and demonstrate improved CO₂ monitoring technologies (including tracers) to meet the requirements of the CCS regulatory regime • Develop the operational procedures (and improve materials where necessary) to significantly improve the long-term integrity of existing/new wellbores in contact with CO₂ • Improve understanding and communication of risk around storage • Develop well operations for frequently varying rates of CO₂ injection. 	<ul style="list-style-type: none"> • Test injection at significant scale at multiple sites • Investigate storage pressure relief, including by water production • Qualify storage capacity forecasts against data from actual CO₂ injection once demonstration site(s) are operational • Improve understanding of geological seal behaviour, including impact of faulting on store integrity • Model validation to understand the uncertainty envelope associated with performance predictions 	<ul style="list-style-type: none"> • Develop techniques for high-efficiency use of formation capacity



Chapter 1 : Introduction (summarises the current scene wrt to CCS in UK and internationally)

Chapter 2: Objectivities of the Strategy, including review of progress against the 2011 Technology targets and other general progress

Chapter 3: R+D complete and in progress

- DECC Dartboard diagram
- Other relevant projects

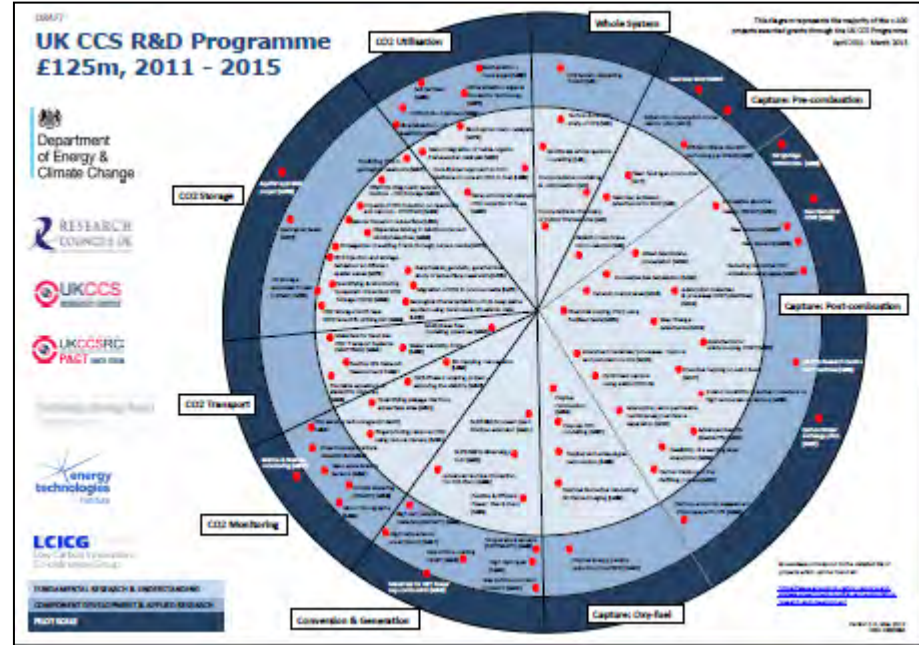
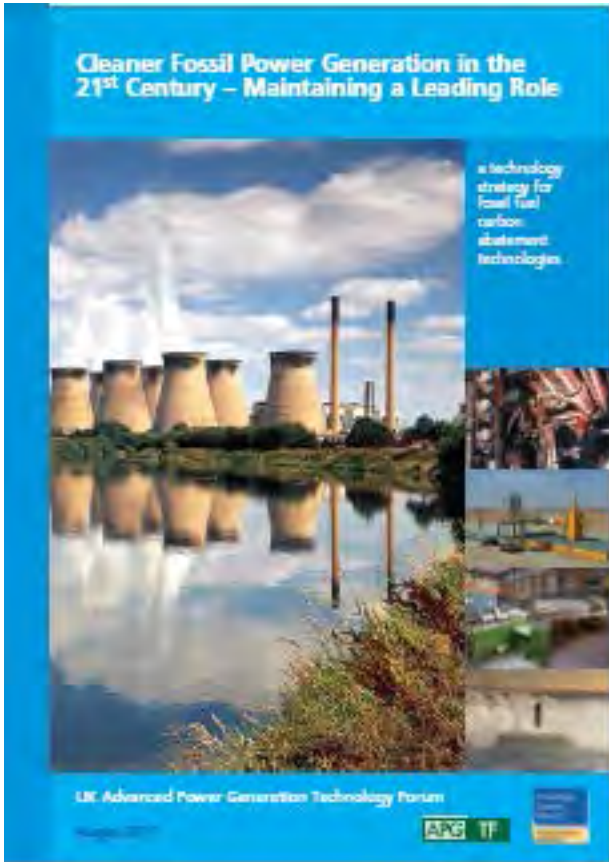
Chapter 4: Priorities for future R+D

- consistent with headline recommendations to DECC

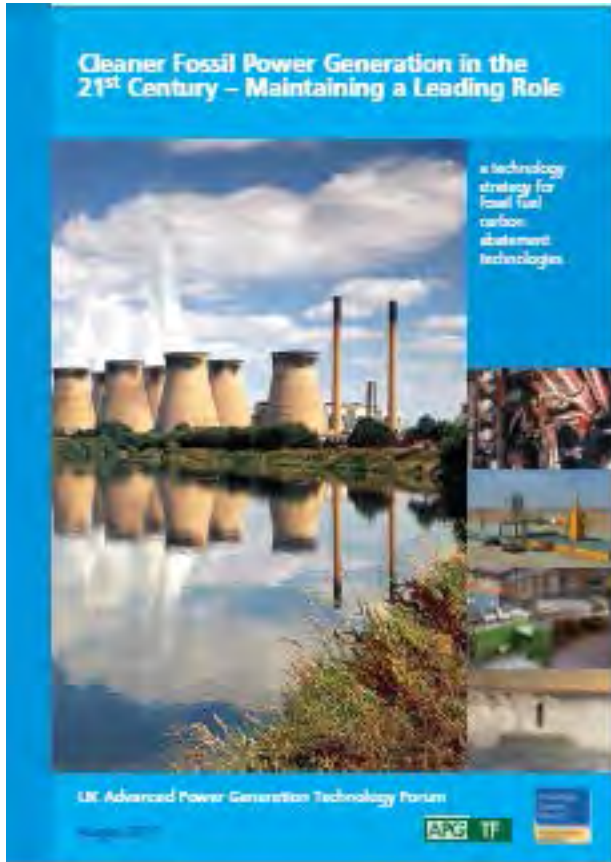
Chapter 5: Complementary actions needed

- Knowledge exchange,
- Supply chain development
- Skills development, and capacity building
- International collaboration
- Public outreach/education

APGTF Strategy update



Chapter 3: dartboard diagram backed up by full listing on an XL spreadsheet on the APGTF website
 Need to add other *relevant* projects



Topics currently under consultation in blue

Chapter 1 : Introduction (summarises the current scene wrt to CCS in UK and internationally)

Chapter 2: Objectivities of the Strategy, including review of progress against the 2011 Technology targets and other general progress

Chapter 3: R+D complete and in progress

- DECC Dartboard diagram
- **Other relevant projects**

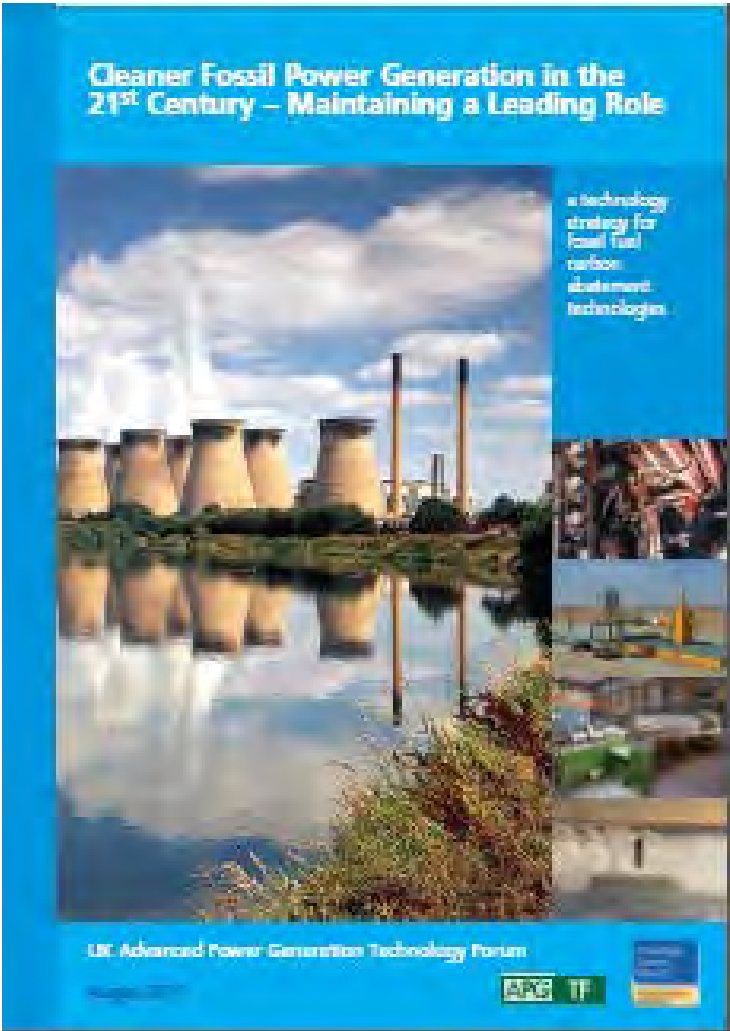
Chapter 4: **Priorities for future R+D**

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Chapter 5: Complementary actions needed

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APGTF Table 4



Cleaner Fossil Power Generation in the 21st Century
Technology & Policy (2011)

Table 4: Technology strategy for fossil fuel carbon abatement technologies

2015-2020	
Whole System	<p>Short term (2-5 years) Research in progress now, advanced staged and to be used in the short term</p> <p>Targets / Milestones</p> <ul style="list-style-type: none"> CC1, CC2 demonstration projects: 1 full scale post-combustion on coal, possibly transport or offshore (strategical operational) CC1, CC2B: CC1 demonstration projects (2.3 demonstration) <p>Key issues</p> <ul style="list-style-type: none"> Greater availability and power plant based demonstration (CC1) post flexibility and capacity will change industrial CC1, demonstration and advanced of measurement (CC2) demonstrated through pilots/industrial Investment in new plant (demonstration and transport) Technology demonstration Policy/regulatory incentives and requirements Technical feasibility (R&D, operational) & Life Cycle Assessment (LCA) support of industrial settings and full life cycle, including water use and emissions
Captain Overview	<p>Short term (2-5 years) Research in progress now, advanced staged and to be used in the short term</p> <p>Targets / Milestones</p> <ul style="list-style-type: none"> CC1, CC2 demonstration projects: 1 full scale post-combustion operational CC1B projects: Pre-ss technologies at large power plant scale, likely to be in coal or gasification, steel and refinery plant. Feasibility CC1, CC2B: CC1 demonstration projects (2.3 demonstration) Demonstration range of fossil fuel based, gas Research and development (R&D) plant and power plant technology (R&D) designed for CC1 with CC1B and long of a wide range of industrial operational CC1B demonstration and include existing plant/industrial as well as new plant <p>Key issues</p> <ul style="list-style-type: none"> Learning from demonstration projects (flexible, scaling) Quality and consistency of industrial feed stocks of 10-15% conversion carbon abatement Identify requirements for enabling support technologies at utility scale, industry and industrial (steel, gas, refinery and steel, cement, methanol) based facility by change in the and capital cost profile, and industrial scale cost of systems, etc. Identify technology for full range of fuel types (coal, gas, biomass) Develop advanced technologies (demonstration) Support of CC1, as demonstration Identify and maintain - available - relevant resources Technology demonstration (CC1) enabling full life cycle demonstration (pre-pilot technologies) Technical feasibility (R&D, operational) & Life Cycle Assessment (LCA) support of industrial settings and full life cycle, including water use and emissions Policy/regulatory incentives and requirements Technical feasibility (R&D, operational) & Life Cycle Assessment (LCA) support of industrial settings and full life cycle, including water use and emissions

© Technology strategy for fossil fuel carbon abatement technologies

- Plan for today
 - Listen to your views and reflect these as we prepare APGTF Chapter 3 and 4.
 - Explain process of consultation
- Invite UKCCS members comments input via website.

Revising UK roadmaps



- **Step 2:** Updating detailed ‘technology matrix’ as part of new APGTF CCS RD&D strategy
 - APGTF theme leaders to produce draft using ‘headline’ priorities as headings (**completing now**)
 - Consultation between APGTF (lead), UKCCSRC RGs, CCSA, project developers, IPA, CRF, EG&S KTN, learned bodies, selected others
 - **Aim to complete by end Sept**
 - Prepare rest of strategy and **publish by end Dec**

CO2 Capture

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