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CCS R&D priorities in UK

Opportunity for UKCCSRC to input to UK policy

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- 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

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- 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

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DECC Roadmap Fig 6

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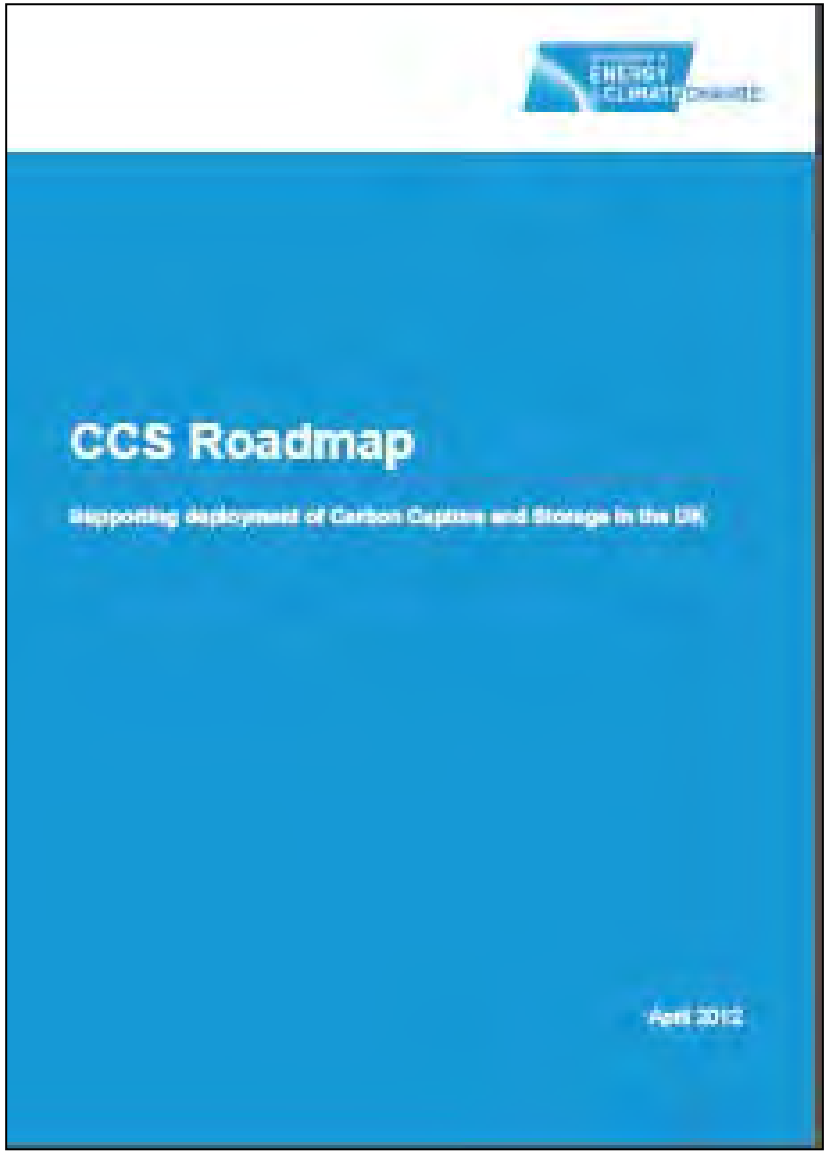
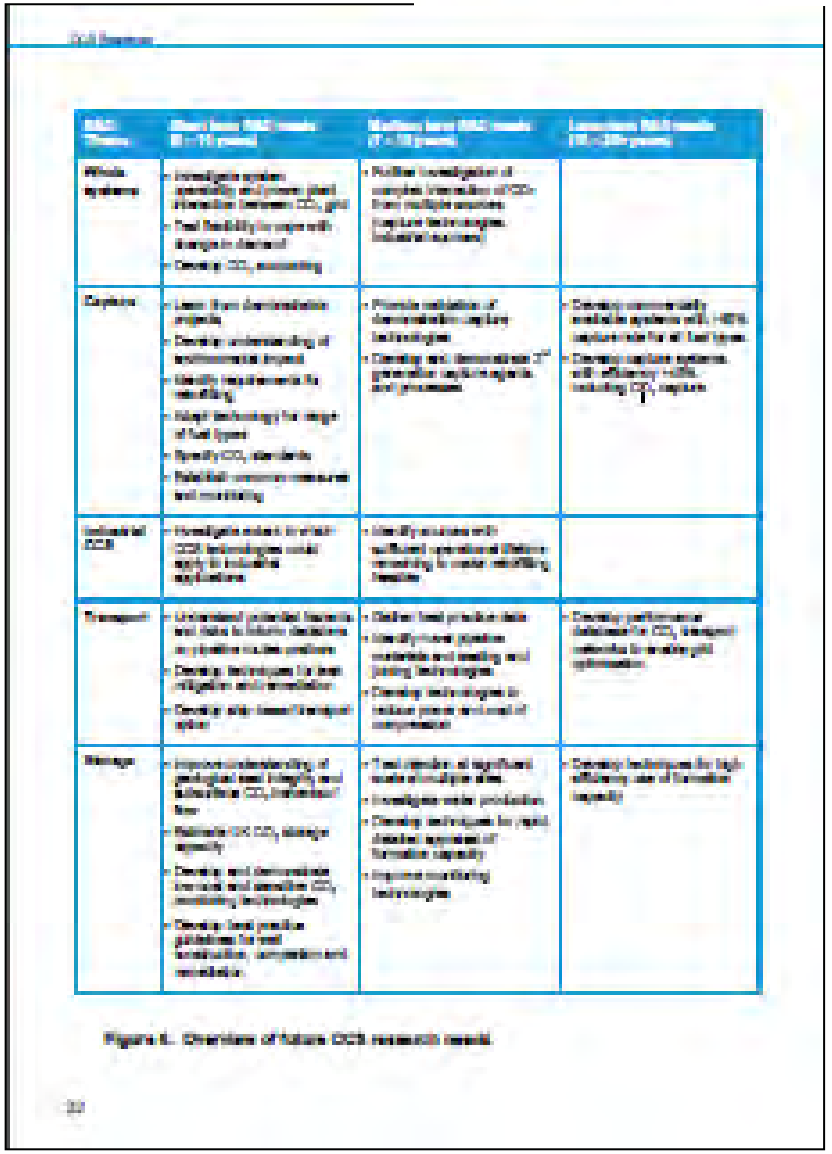




Whole-systems and Cross-cutting Issues

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)
• 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 CO_2 abatement. • Develop CO_2 accounting, monitoring and measurement techniques (CO_2 & impurities) and influence development of CO_2 standards taking account of different sources and applications	• Maximize economically realistic potential for utilisation of captured CO_2 (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	• 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)
• 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	• 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)	• Develop commercially available systems to meet Cost Reduction Task Force targets and CO_2 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

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)
• Studies to develop early opportunities where CO_2 streams are available • Adapt 1st/2nd generation capture technologies for industrial use to meet CO_2 storage standards and initiate projects • Investigate scope for cost-reduction and scalability of carbon capture and utilisation (CCU) solutions and identify R+D priorities	• Develop additional CO_2 capture and utilisation technologies for other high-emission industries	

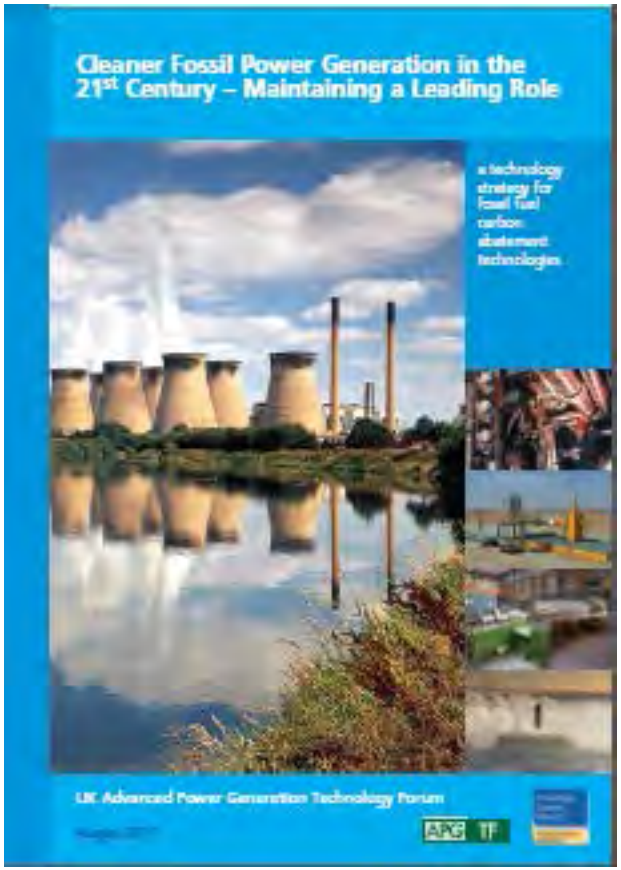
CO_2 Transport

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)
• 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	• Develop technologies to reduce power and cost of CO_2 compression • Extended testing on pipeline test loops with realistic CCS CO_2 mixtures to push frontiers for materials, components and operating strategies	• Develop performance database for CO2 transport networks to enable grid optimisation

CO_2 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)
• 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 CO_2 • Improve understanding and communication of risk around storage • Develop well operations for frequently varying rates of CO_2 injection.	• Test injection at significant scale at multiple sites • Investigate storage pressure relief, including by water production • Qualify storage capacity forecasts against data from actual CO_2 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	• Develop techniques for high-efficiency use of formation capacity

APGTF Strategy update



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

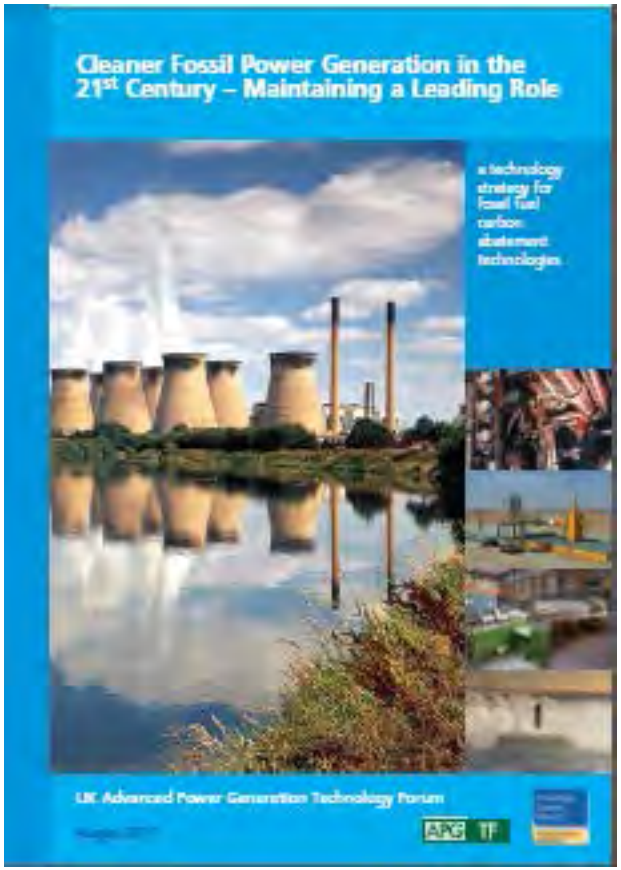
Chapter 2: Objectivities of the Strategy, including review of progress against the 2011 Technology targets and other general progress

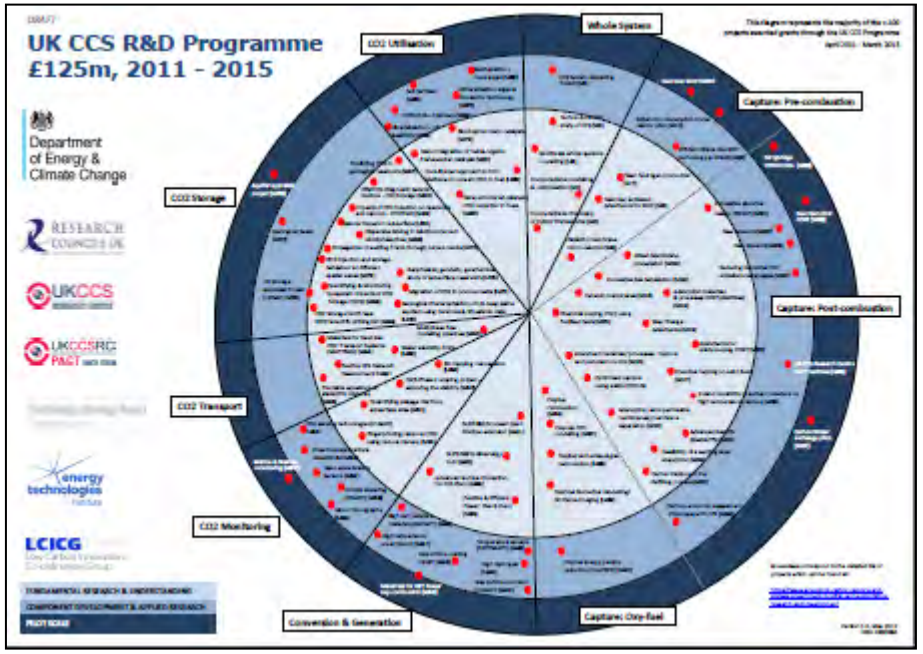
Chapter 3: R+D complete and in progress
- DECC Dartboard diagram
- Other relevant projects

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

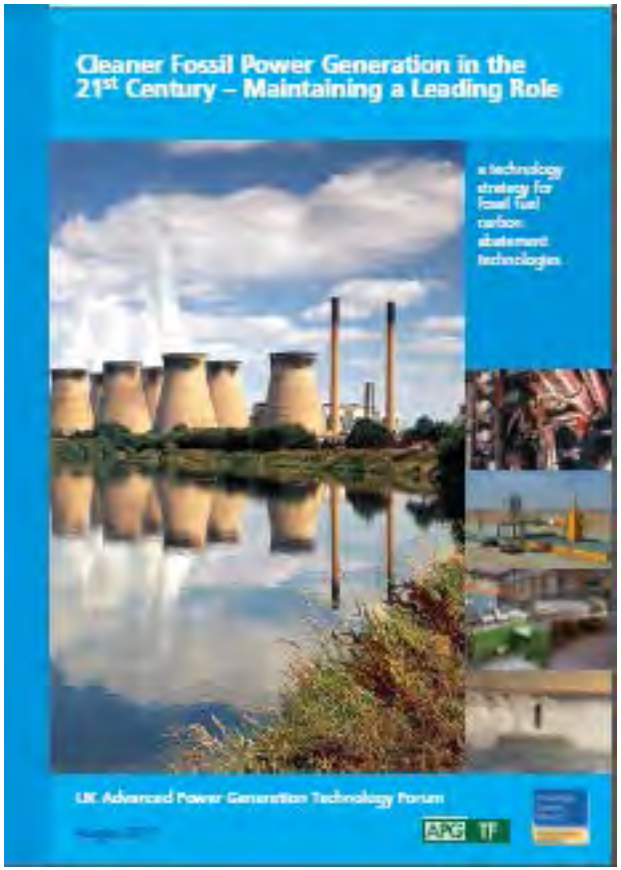




Chapter 3: dartboard diagram backed up by full listing on an XL spreadsheet on the APGTF website

Need to add other *relevant* projects

APGTF Strategy update



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- **Other *relevant* projects**

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- consistent with headline recommendations to DECC

Chapter 5: Complementary actions needed
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- Supply chain development
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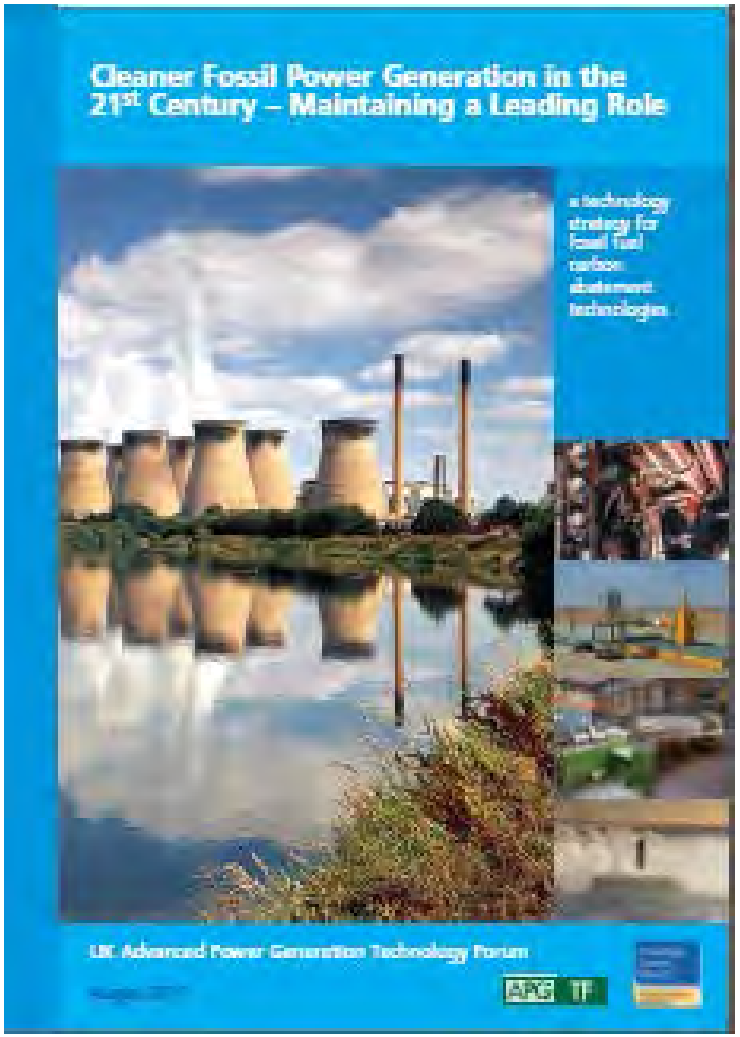
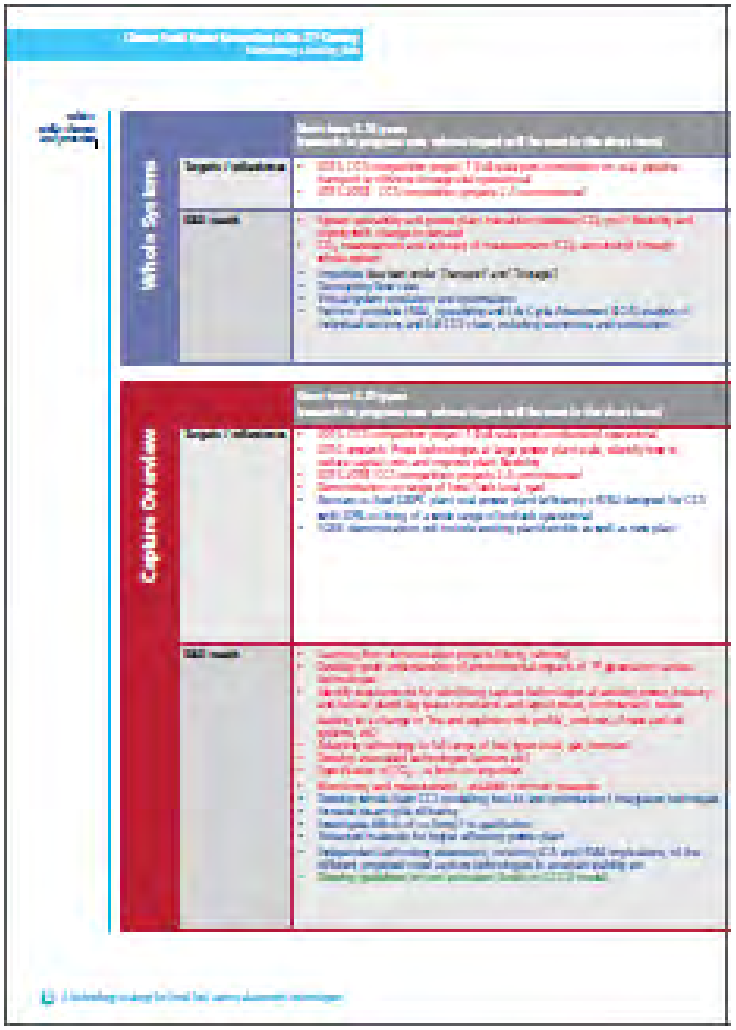
Topics currently under consultation in blue

APGTF Table 4





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- 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

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cleaner fuels for power and industry

- **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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• Learn from pilot-scale, demonstration and 'first-of-a-kind' commercialisation projects (UK and abroad), improving confidence on long term effects - degradation, corrosion, emissions
  • Xxxxxx
  • Yyyyyy
  • zzzzzzz
• Develop understanding of environmental impact (to air and water)
  • Aaaaa
  • bbbbb
• Identify requirements for retrofitting/capture-readiness/future-proofing
  • cccccc
• Solvent , process and equipment improvements for cost reduction
  • ddddd
	• 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)
	  • Ggggg
	  • hhhhh
	• Develop CCS technologies for gas turbine plant (including EGR and optimized gas turbines)
	  • Jjjjjjj
	  • kkkkk
		• Develop commercially available systems to meet Cost Reduction Task Force targets and CO_2 purity standards for all fuel types
		  • Mmmmm
		  • nnnnnnn
		• Develop novel cycles or capture systems with energy penalty significantly below 10% points for coal and 8% points for gas
		  • Pppp
		  • qqqq

Industrial CCS

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• Studies to develop early opportunities where CO_2 streams are available
  • Aaaa
  • bbbb
• Adapt 1st/2nd generation capture technologies for industrial use to meet CO_2 storage standards and initiate projects
  • Ccccc
  • dddd
• Investigate scope for cost-reduction and scalability of carbon capture and utilisation (CCU) solutions and identify R+D priorities
  • eeeee
	• Develop additional CO_2 capture and utilisation technologies for other high-emission industries
	  • Fffff
	  • gggg	