

Revising the UK CCS RD&D Roadmaps

UKCCSRC Bi-annual Meeting
Nottingham, 4-5th September 2013

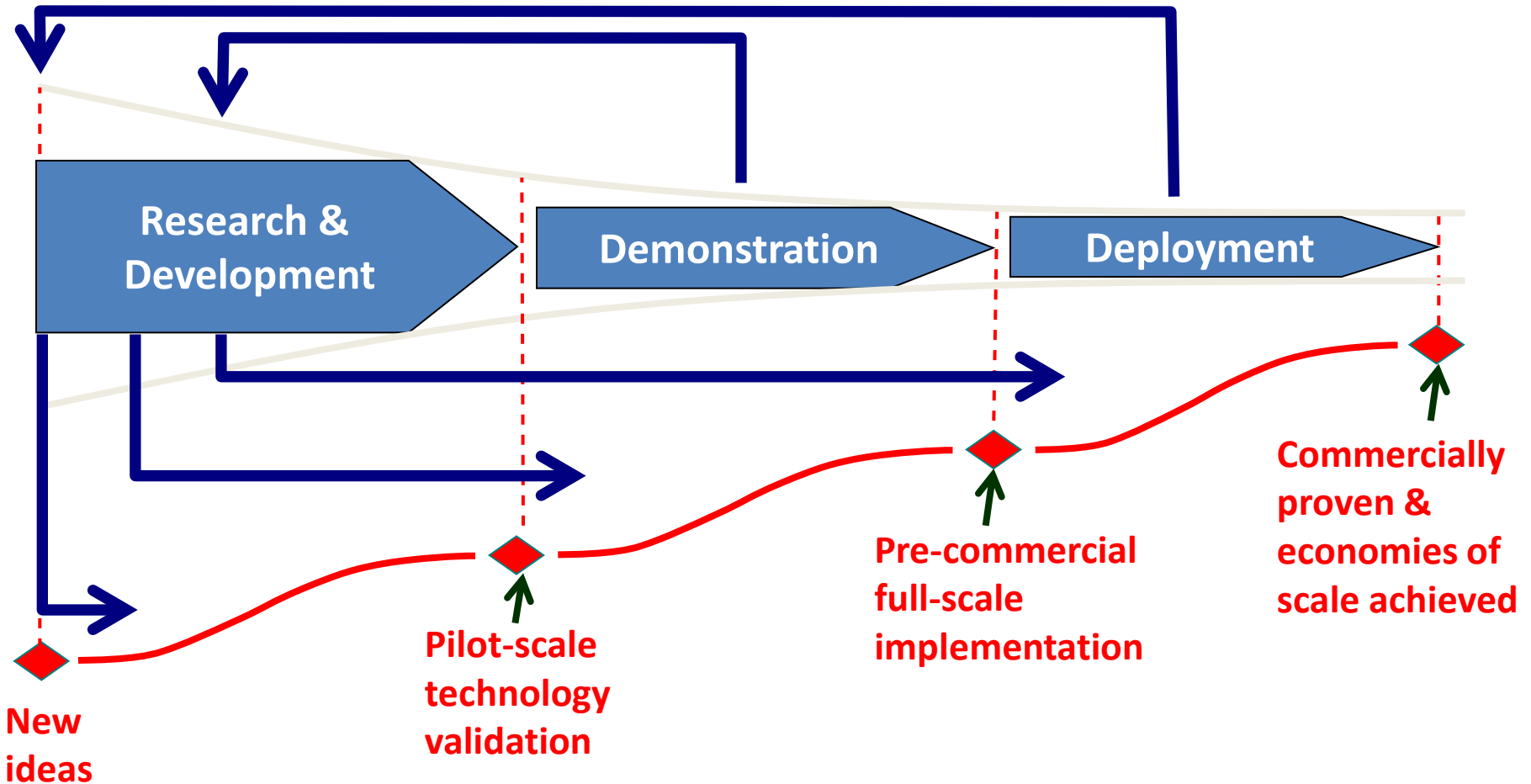
Philip Sharman

CCS grand challenges

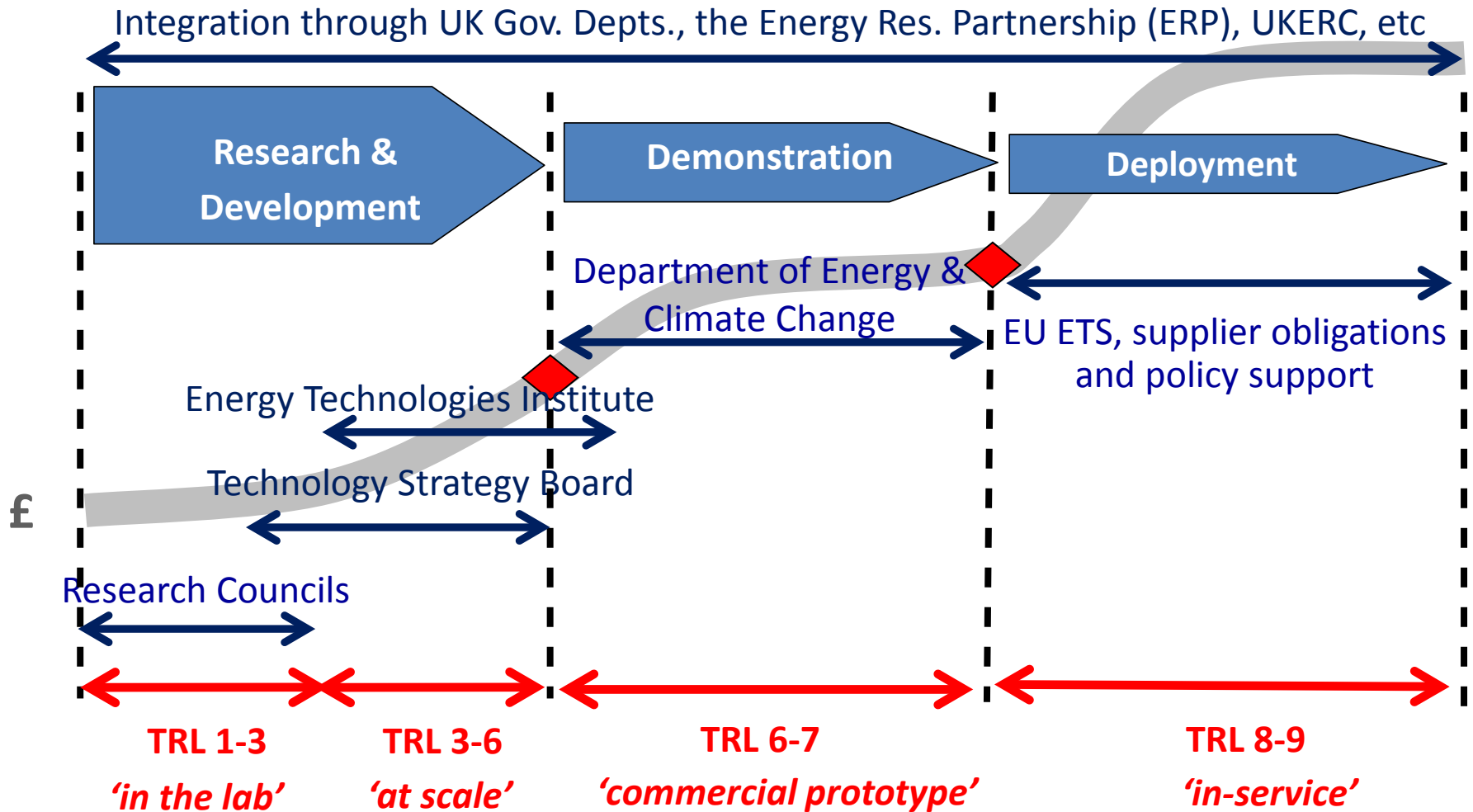


- Timescales – Speed of development and deployment
- Technology diversity
- Integration – CCS components to CCS systems
- Scale-up issues – Pilots to demos
- Roll-out to meet targets – ‘MW to GW’
- CCS economics and financing
- Cost reduction of capture
- Secure, long-term storage
- Public perception and acceptance
- Policy, politics and regulation

The innovation chain



Public sector funding



Roadmap and priorities



International roadmaps



IEA, 2013



CSLF, 2011
(rev. due November)



GCCSI, 2012
(rev. due October)



ZEP, 2010
(rev. due imminently)

UK roadmaps

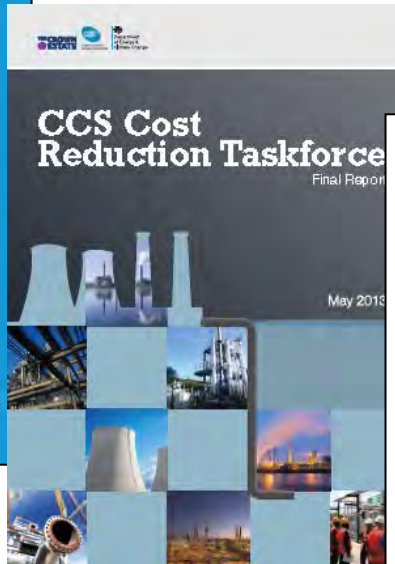


CCS Roadmap

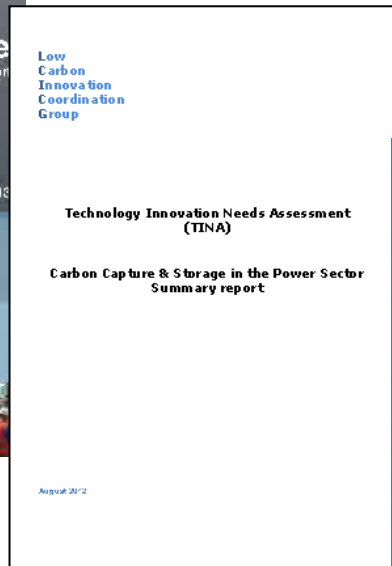
Supporting deployment of Carbon Capture and Storage in the UK

April 2012

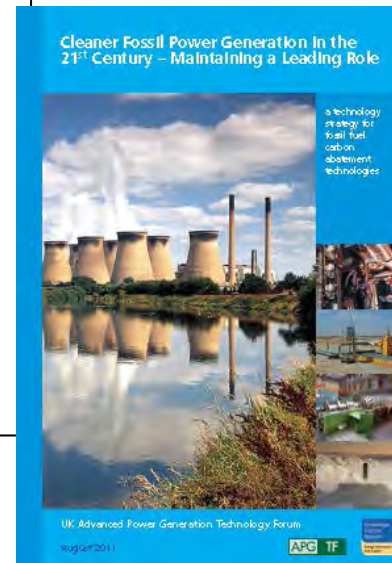
DECC, 2012



TCE/CCSA/DECC,
2013



LCICG, 2012



APGTF, 2011
(rev. due December)



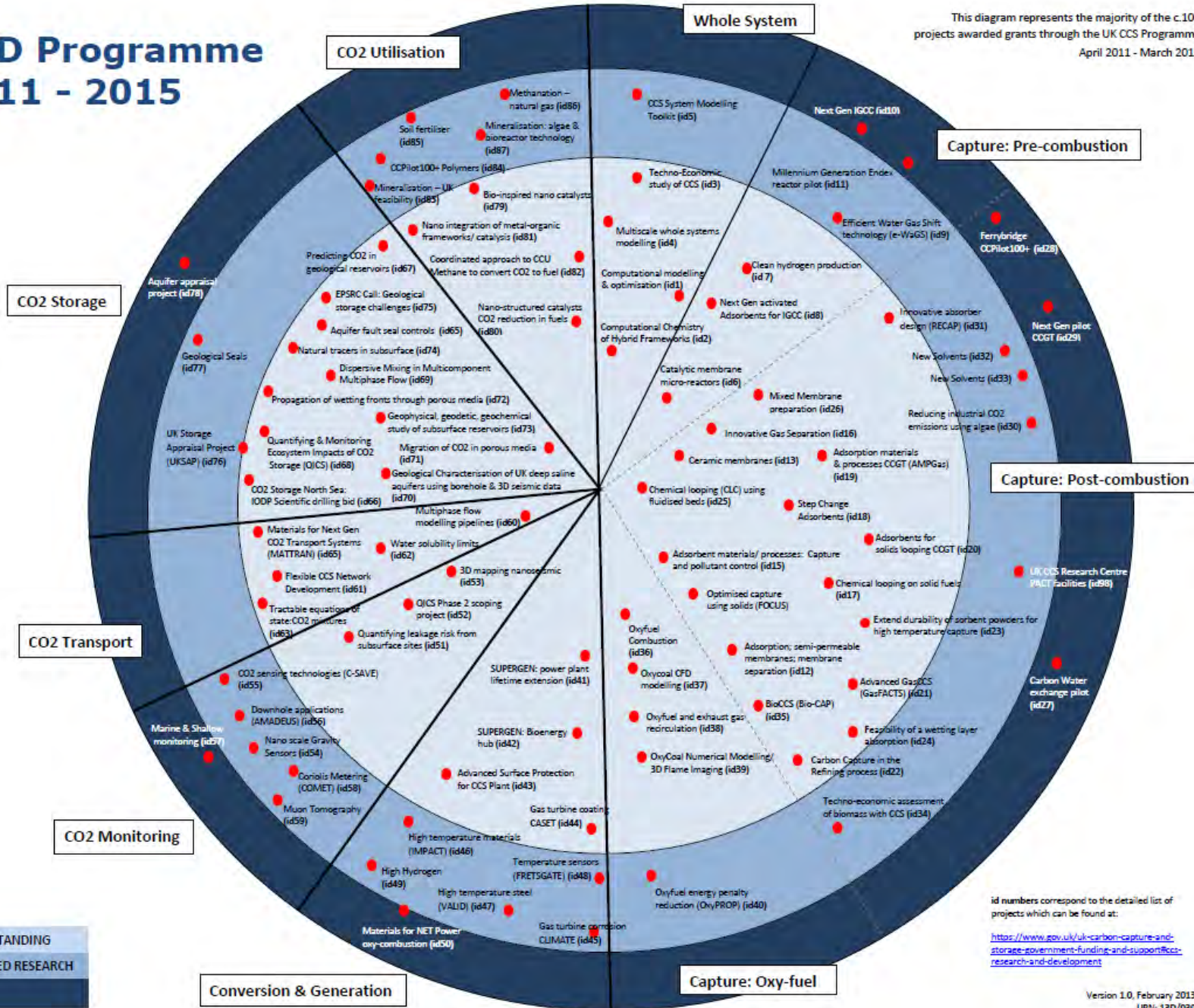
UKCCSRC, 2012
(rev. due 2014)

UK CCS R&D Programme £125m, 2011 - 2015

This diagram represents the majority of the c.100 projects awarded grants through the UK CCS Programme
April 2011 - March 2015



FUNDAMENTAL RESEARCH & UNDERSTANDING
COMPONENT DEVELOPMENT & APPLIED RESEARCH
PILOT SCALE



id numbers correspond to the detailed list of projects which can be found at:

<https://www.gov.uk/uk-carbon-capture-and-storage-government-funding-and-support-ccs-research-and-development>

Revising UK roadmaps



- **Step 1:** Preliminary revision of ‘headline’ priorities in DECC CCS Roadmap (i.e. old ‘fig 6’)
 - Consultation between APGTF (lead), UKCCSRC Research Groups, CCSA, selected others
 - **Completed** early August
 - Submitted to DECC as ‘work-in-progress’

UK 'headline' priorities: whole-systems/x-cutting issues



R&D needs to meet short-term objectives (applicable in 0-10 yrs)	R&D needs to meet med.-term objectives (7-15 yrs)	R&D needs to meet long-term objectives (10-20+ yrs)
<ul style="list-style-type: none"> ❖ Methods to improve public, financial community & institutions' understanding (policy/reg./incentive frameworks, C accounting – inc. BECCS) ❖ System-level modelling to understand operability in response to increased need for fossil fuels in decarbonised system with intermittent renewables ❖ Improved understanding of impacts/benefits of clustering of sources, optimum location of power plants & strategic dev. of UK storage resource ❖ Assess optimum levels of CCS for low-C electricity, heat & ind. CO₂ abatement ❖ Develop CO₂ accounting, monitoring & measurement techniques & influence development of standards 	<ul style="list-style-type: none"> ❖ Maximise economically realistic potential for CO₂ utilisation (inc. EOR) ❖ Further optimisation of system-level modelling & cluster development ❖ Further development of optimised flexible CCS 	<ul style="list-style-type: none"> ❖ Strategic development of UK storage resource for UK & EU emissions

UK 'headline' priorities: CO₂ capture



R&D needs to meet short-term objectives (applicable in 0-10 yrs)

- ❖ Learn from pilot, demo & FOAK commercialisation projects (UK/abroad), improving confidence on long-term effects – degradation, corrosion, emissions
- ❖ Develop understanding of environmental impact (to air/water)
- ❖ Identify requirements for retrofitting/capture-readiness/future-proofing
- ❖ Solvent , process & equipment improvements for cost reduction

R&D needs to meet med.-term objectives (7-15 yrs)

- ❖ Develop & validate at appropriate pilot-scale 2nd gen. capture agents & processes for new plant & retrofit to earlier plant (including novel low-temp. solid absorbents & new oxy-fuel cycles)
- ❖ Develop CCS technologies for GT plant (including EGR & optimised GTs)

R&D needs to meet long-term objectives (10-20+ yrs)

- ❖ Develop commercially available systems to meet CRTF targets & CO₂ purity standards for all fuel types
- ❖ Develop novel cycles or capture systems with energy penalty significantly below 10%points for coal & 8%points for gas

UK 'headline' priorities: industrial CCS



R&D needs to meet short-term objectives (applicable in 0-10 yrs)

- ❖ Studies to develop early opportunities where CO₂ streams are available
- ❖ Adapt 1st/2nd generation capture technologies for industrial use to meet CO₂ storage standards & initiate projects
- ❖ Investigate scope for cost reduction and scalability of carbon capture & utilisation (CCU) solutions & identify R&D priorities

R&D needs to meet med.-term objectives (7-15 yrs)

- ❖ Develop additional CCU technologies for other high-emission industries

R&D needs to meet long-term objectives (10-20+ yrs)

UK 'headline' priorities: CO₂ transport

R&D needs to meet short-term objectives (applicable in 0-10 yrs)

- ❖ Understand potential hazards & risks to inform decisions on pipeline safety
- ❖ Gather best practice data
- ❖ Develop techniques for leak mitigation & remediation
- ❖ Develop transportation with ships

R&D needs to meet med.-term objectives (7-15 yrs)

- ❖ Develop technologies to reduce power & cost of CO₂ compression
- ❖ Extended testing on pipeline test loops with realistic CCS CO₂ mixtures to push frontiers for materials, components & operating strategies

R&D needs to meet long-term objectives (10-20+ yrs)

- ❖ Develop performance database for CO₂ transport networks to enable grid optimisation

UK 'headline' priorities: CO₂ storage

R&D needs to meet short-term objectives (applicable in 0-10 yrs)

- ❖ Improve understanding of dynamic behaviour of CO₂ storage systems over range of spatial & temporal scales
- ❖ Further increase understanding of practical capacity for selected sites
- ❖ Develop & demonstrate improved CO₂ monitoring technologies (inc. tracers) to meet requirements of reg. regime
- ❖ Develop operational procedures to significantly improve long-term integrity of existing/new wellbores in contact with CO₂
- ❖ Improve understanding & communication of storage risk
- ❖ Develop well operations for frequently varying rates of CO₂ injection

R&D needs to meet med.-term objectives (7-15 yrs)

- ❖ Test injection at significant scale at multiple sites
- ❖ Investigate pressure relief, inc. by water production
- ❖ Qualify capacity forecasts against data from actual CO₂ injection once demo site(s) are operational
- ❖ Improve understanding of geological seal behaviour, inc. impact of faulting on store integrity
- ❖ Model validation to understand uncertainty envelope associated with performance predictions

R&D needs to meet long-term objectives (10-20+ yrs)

- ❖ Develop techniques for high-efficiency use of formation capacity

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**

Revising UK roadmaps



- **Step 3:** Updating of R&D ‘target diagram’:
 - UKCCSRC lead
 - In parallel to ‘technology matrix’ (**continuous**)
- **Step 4:** Iterate ‘headline’ priorities with DECC:
 - **Complete end Sept**
- **Step 5:** RAPID 2 Handbook, in conjunction with RAPID Call #2:
 - **TBC, 2014**

References

- IEA CCS Roadmap 2013: <http://www.iea.org/publications/freepublications/>
- CSLF Technology Roadmap 2011: <http://www.cslforum.org/technologyroadmap.html>
- GCCSI Status Report 2012: <http://www.globalccsinstitute.com/get-involved/in-focus/2012/10/global-status-ccs-2012>
- ZEP Long-Term CCS R&D 2010: <http://www.zeroemissionsplatform.eu/library/publication/95-zep-report-on-long-term-ccs-rad.html>
- DECC CCS Roadmap 2012:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48317/4899-the-ccs-roadmap.pdf
- CRTF Final Report 2013: <https://www.gov.uk/government/publications/ccs-cost-reduction-task-force-final-report>
- LCICG CCS Technology Innovation Needs Assessment 2013:
http://www.lowcarboninnovation.co.uk/working_together/technology_focus_areas/carbon_capture_and_storage/
- APGTF CCS RD&D Strategy 2011: http://www.apgtf-uk.com/index.php?option=com_docman&task=cat_view&gid=918
- UKCCSRC RAPID Phase 1 Handbook 2012: <http://www.ukccsrc.ac.uk/carbon-capture-storage-research-centre/rapid-process>
- UK CCS R&D Prog. 'Target Diagram' and Spreadsheet 2013: <https://www.gov.uk/uk-carbon-capture-and-storage-government-funding-and-support#ccs-research-and-development>