UNECE Cleaner Electricity Production Workshop and Stakeholder Meeting
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Progressing CCS

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The UKCCSRC is supported by the Engineering and Physical Sciences Research Council as part of the Research Councils UK Energy Programme

Pioneering research and skills

About the UKCCSRC

The UK Carbon Capture and Storage Research Centre (UKCCSRC) **leads and coordinates a programme of underpinning research on all aspects of carbon capture and storage** (CCS) in support of basic science and UK government efforts on energy and climate change.

The Centre brings together around 250 of the UK's world-class CCS academics and provides a **national focal point for CCS research and development**.

Initial core funding for the UKCCSRC is provided by £10M from the Engineering and Physical Sciences Research Council (EPSRC) as part of the RCUK Energy Programme. This is complemented by £3M in additional funding from the Department of Energy and Climate Change (DECC) to help establish new open-access national pilot-scale facilities (www.pact.ac.uk). Partner institutions have contributed £2.5M.

www.ukccsrc.ac.uk

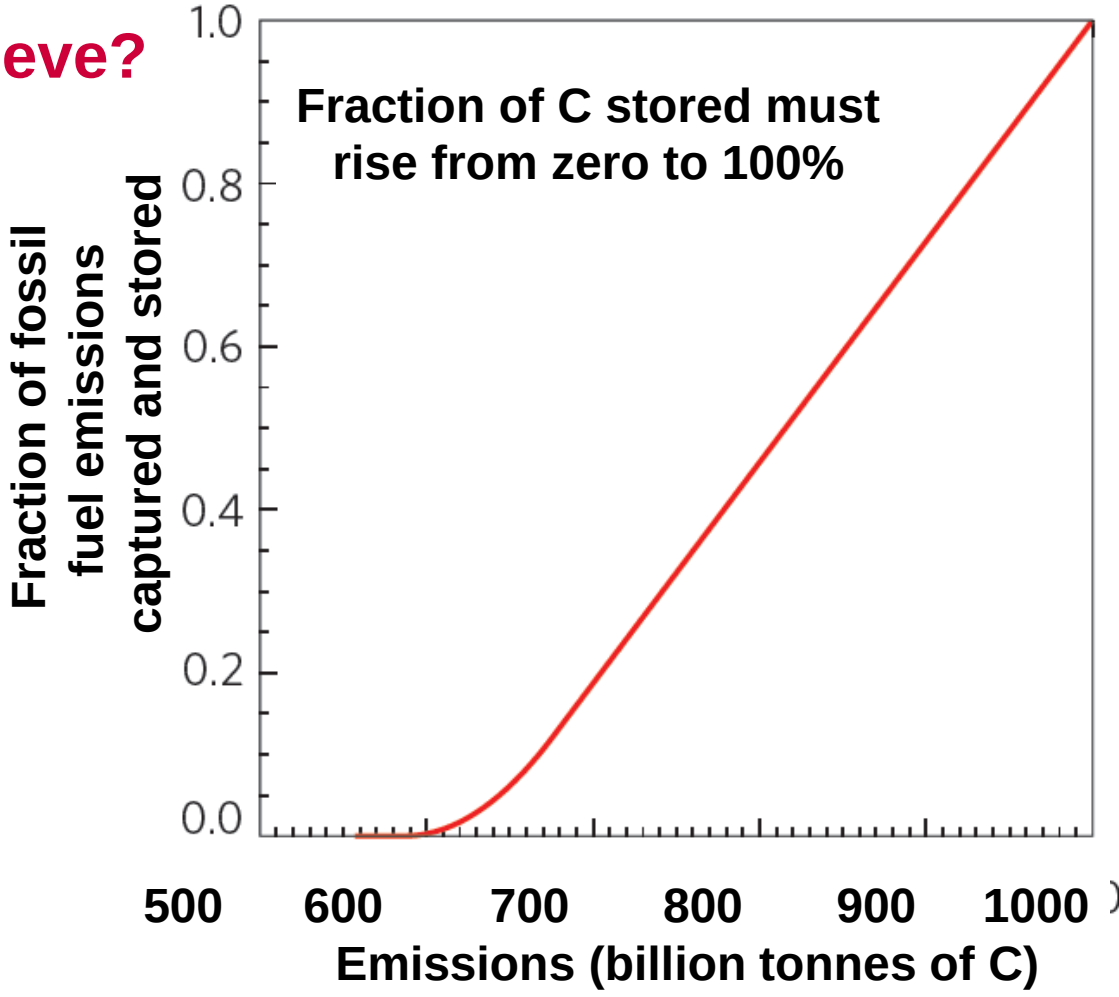
What do we need to achieve?

The prime climate objective is not to end the use of fossil fuels.

The prime objective is to develop and deploy 100% CCS in time to cap cumulative emissions of carbon at a safe level.

CO_2 EOR and other applications with partial overall capture should be seen as a stage in a path from zero CO_2 capture to 100% CCS.

They can be a move in the right direction from where we are now – emitting 100% of fossil carbon to atmosphere.



Myles R. Allen, David J. Frame & Charles F. Mason, The case for mandatory sequestration, Nature Geoscience 2, 813 - 814 (2009), doi:10.1038/ngeo709

The key factor is the extent to which technologies and/or projects can readily be adapted to get higher fractions of CO_2 stored.

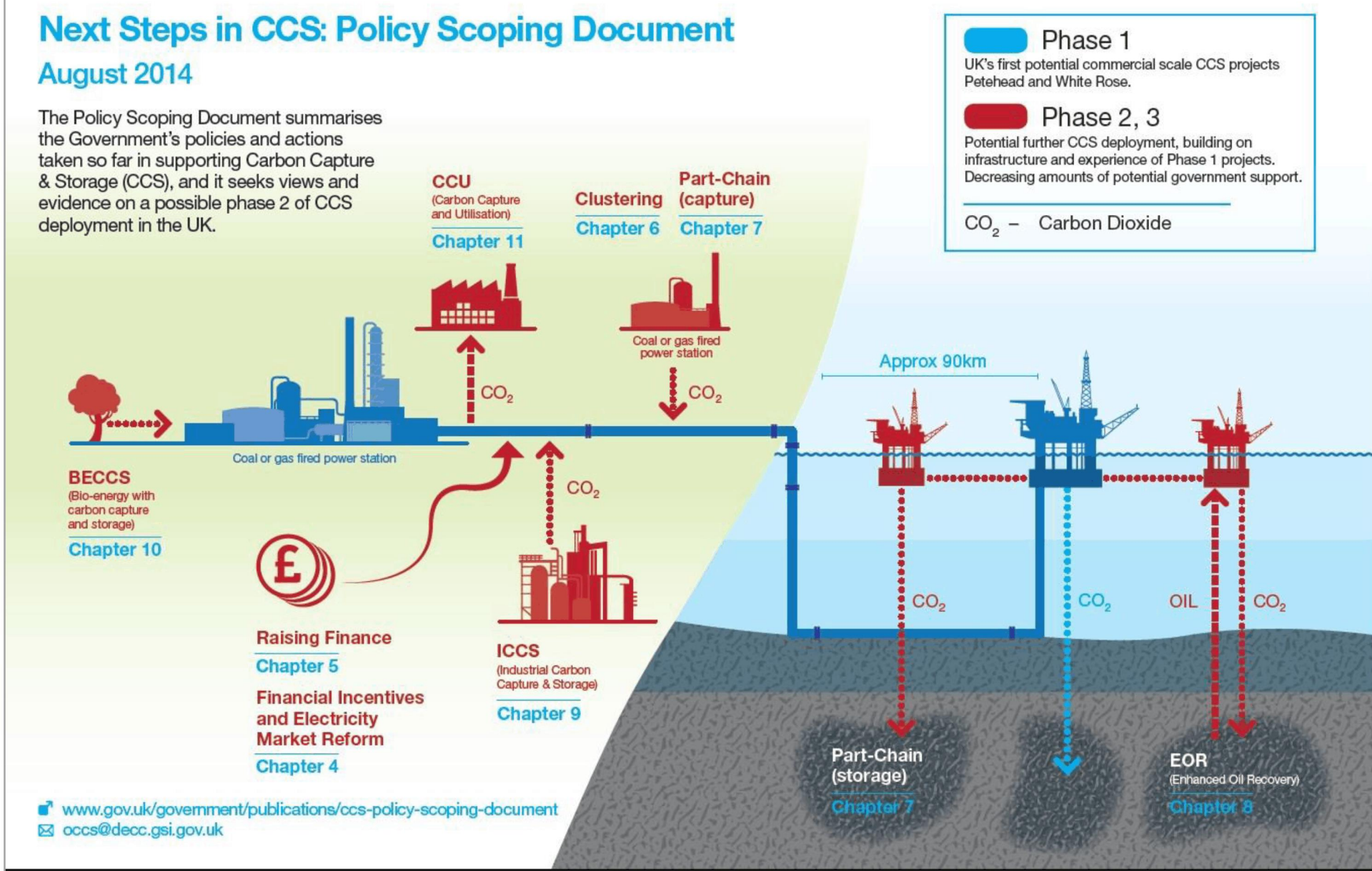
Department of Energy & Climate Change

https://www.gov.uk/government/publications/ccs-policy-scoping-document

Next Steps in CCS: Policy Scoping Document

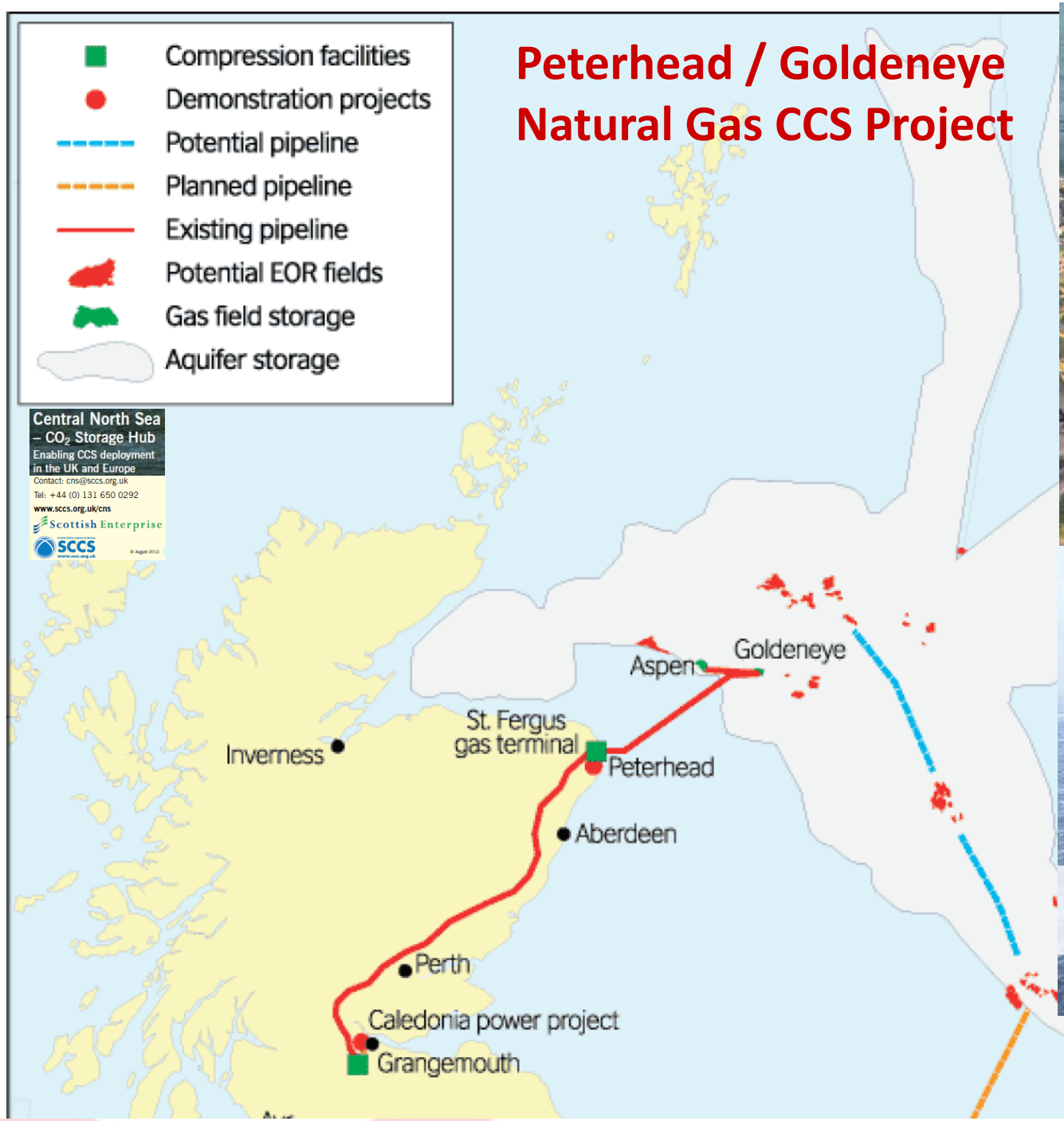
August 2014

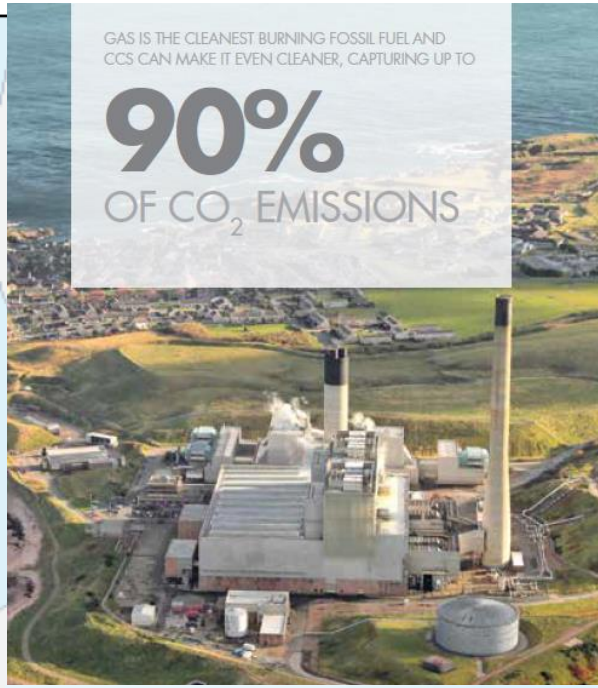
The Policy Scoping Document summarises the Government's policies and actions taken so far in supporting Carbon Capture & Storage (CCS), and it seeks views and evidence on a possible phase 2 of CCS deployment in the UK.



www.gov.uk/government/publications/ccs-policy-scoping-document
occs@decc.gsi.gov.uk

Peterhead / Goldeneye Natural Gas CCS Project





http://s06.static-shell.com/content/dam/shell-new/local/country/gbr/downloads/pdf/peterhead-ccs-brochure.pdf

White Rose Oxyfuel CCS Project

Fuel (http://www.whiteroseccs.co.uk/your-questions-answered/fuel)

What mix of fuels will be used at the plant?
The primary fuel will be coal that is already fired at the existing power station. It is anticipated that the plant will be capable of co-firing biomass with the coal to reduce further the CO2 emissions.

How much fuel will the plant need?
The plant is expected to require approximately 1.2 million tonnes of coal and 300,000 tonnes of biomass per annum (assuming the combustion of 15% biomass).

Where will the fuel come from?
It is likely that the coal and biomass required will come from the same sources as the coal and biomass already delivered to the existing power station. These are a mix of imported coal and coal mined in the UK, as well as biomass sourced from abroad and from over 100 local farmers who have contracts to supply Drax with biomass products.

How will the fuel be stored?
The coal and biomass will be stored onsite within the existing coal stock area and transported to the new power station by a conveyor belt system. There will also be some fuel storage available on the project site.

Will biomass energy crops be grown at the expense of food crops?
Energy crops sourced by Drax are grown on land that is unsuitable for food production in order to comply with the company's robust sustainability criteria. Drax only purchases biomass from sources that are considered sustainable.

What is the apparent global market for CCS?

New projects to suit developing markets may replace some of the long-standing projects on the GCCSI database

How could the global market develop?

1. EOR in North America (and Middle East?)

- Canada and Mexico as well as USA
- Cheap gas but CCS on gas still needs support for EOR
- Time needed to get beyond ‘gas good / coal bad ‘ dogma
- USA - Proposed gas-level EPS may also delay CCS
- Canada – Power EPS + plant life limit = constrained options
- Canada - Oil sands gas for steam generation
- Mexico - Gas for new power, EOR driver plus climate law
- Middle East – Will depend on results from new projects?

How could the global market develop?

UKCCS RESEARCH CENTRE

2. Coal with CCS for developing countries

- World Bank and ADB have stopped funding new coal plants
- Obvious market, but will need OPEX as well as CAPEX support
- Co-benefits from better pollutant control
- But must be cheaper then equivalent energy services from renewables

3. China?

- Sophisticated market with capacity for indigenous supply
- With potentially aggressive export drive - cooperate or compete?
- Large-scale indigenous deployment depends on China's satisfaction with global climate deal and actual EOR prospects

4. Europe

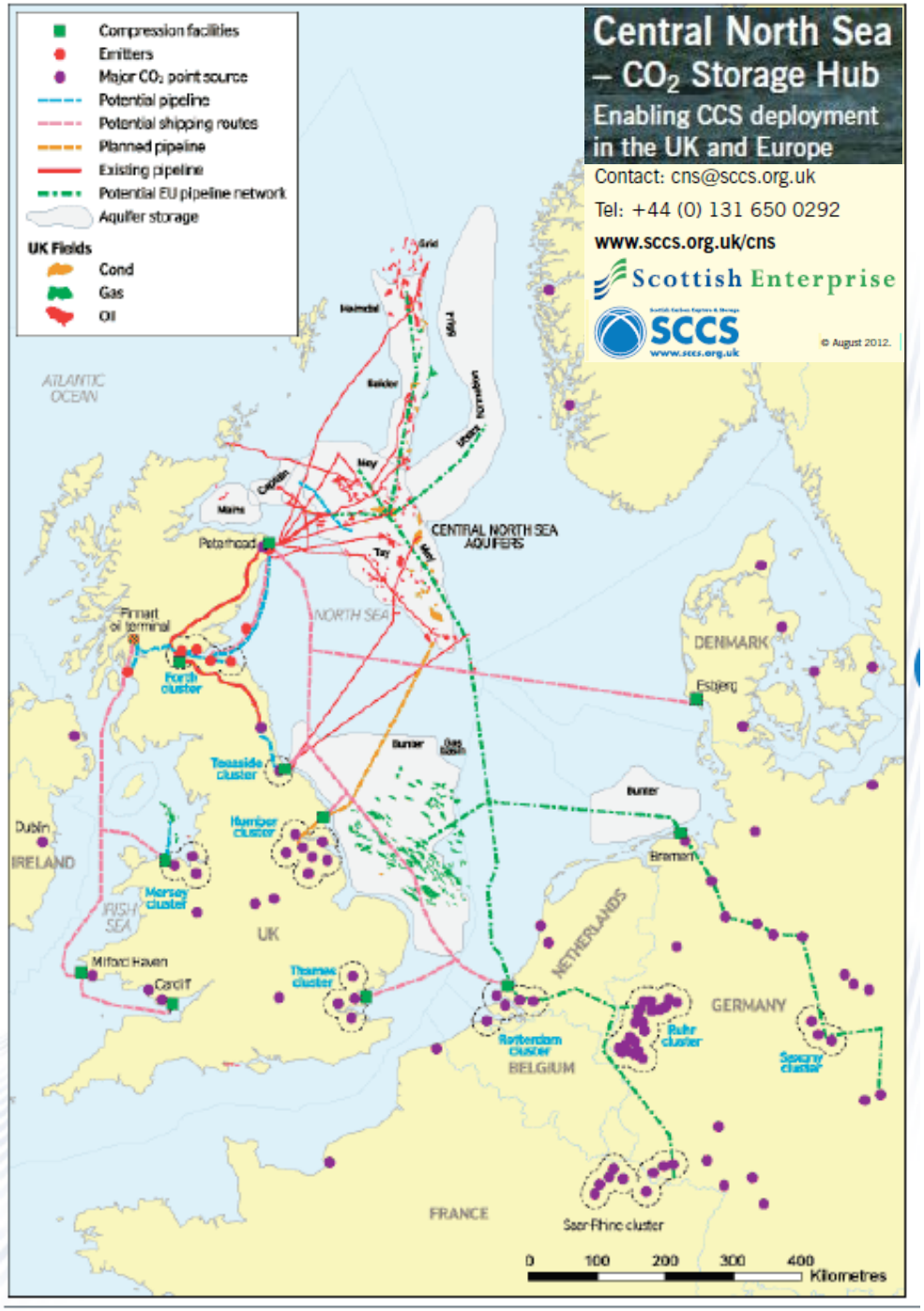
- Keeping coal likely to be a new priority for energy security
- But will this translate in action on CCS - and by when?
- European CCS projects could be a big driver for Markets 1-3

How could the global market develop?

5. Offshore storage

Experience from Norway and UK Commercialisation projects:

- Permitting of transport and storage in the EU
- Validated storage capacity
- New transport infrastructure
- North Sea Basin is major hub for EU CCS, but currently transboundary issues – need to ratify London Protocol
- Offshore storage experience
- Including EOR?
- Offshore pipeline experience
- Re-use of existing pipelines and offshore infrastructure
- Clusters of anthropogenic sources: business models, operation, CO_2 mixing etc.



How could the global market develop?

Offshore storage potential in South China

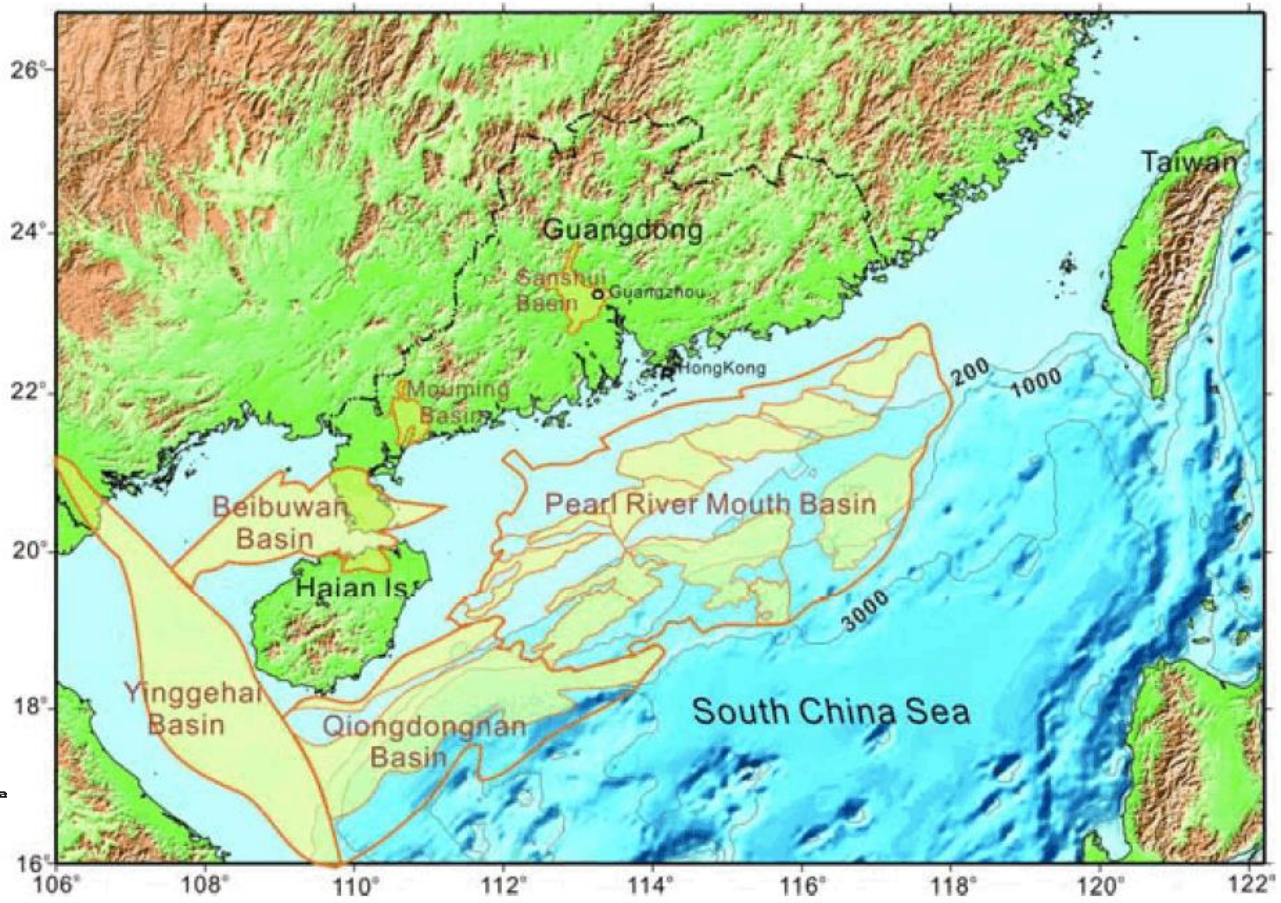
Also prospects in Brazil, Australia, India, US Gulf Coast, Middle East etc.

UK FCO project:

Feasibility Study of CCS-Readiness in Guangdong Province, China (GDCCSR)

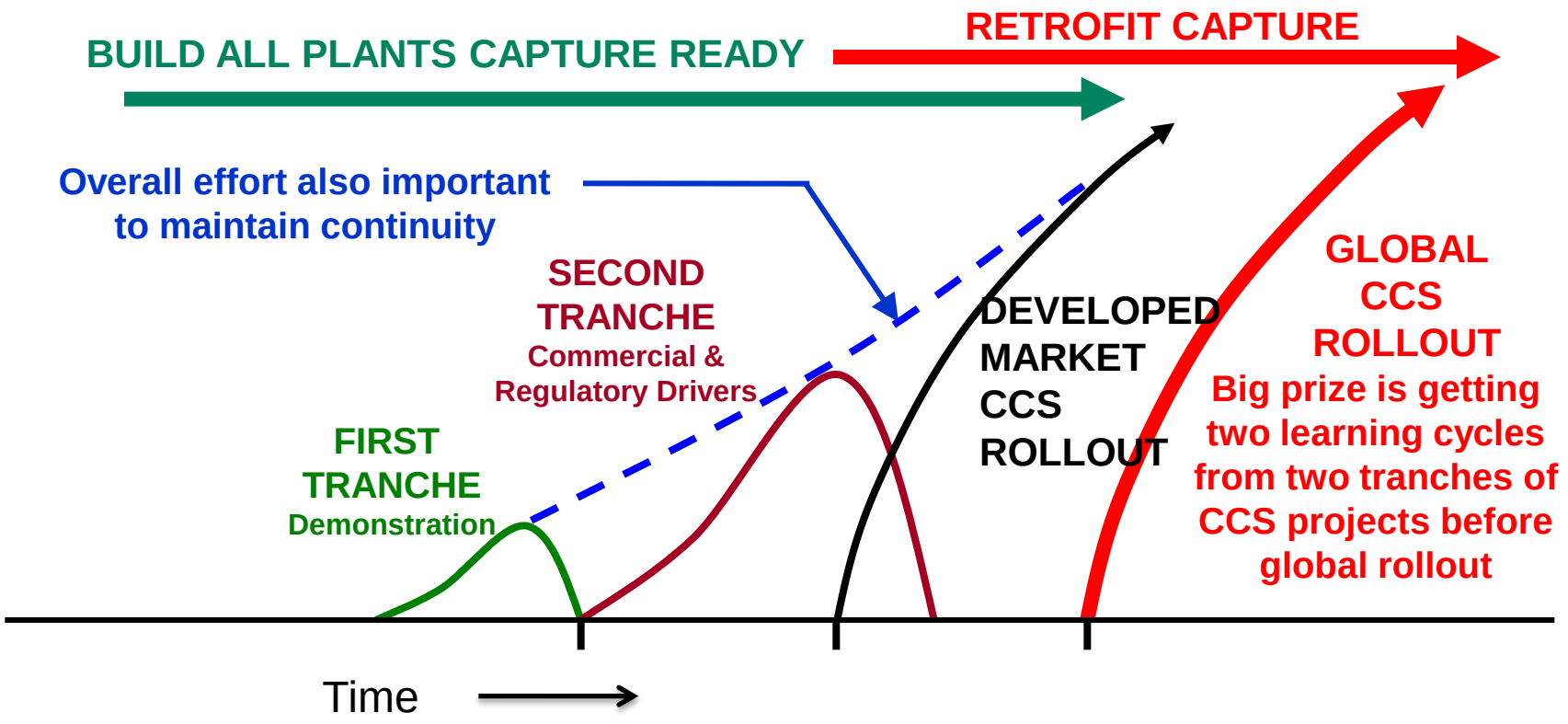
Final Report: Part 2 Assessment of CO2 Storag Potential for Guangdong Province, China

GDCCSR-SCSIO Team
March 2013



http://cdn.globalccsinstitute.com/sites/default/files/publications/118466/assessment-co2-storage-potential-guangdong-province-china-2.pdf

CCS - Sequencing Deployment



Gibbins, J. and Chalmers, H. Preparing for global rollout: A 'developed country first' demonstration programme for rapid CCS deployment. Energy Policy, 2008, 36(2), 501-507.

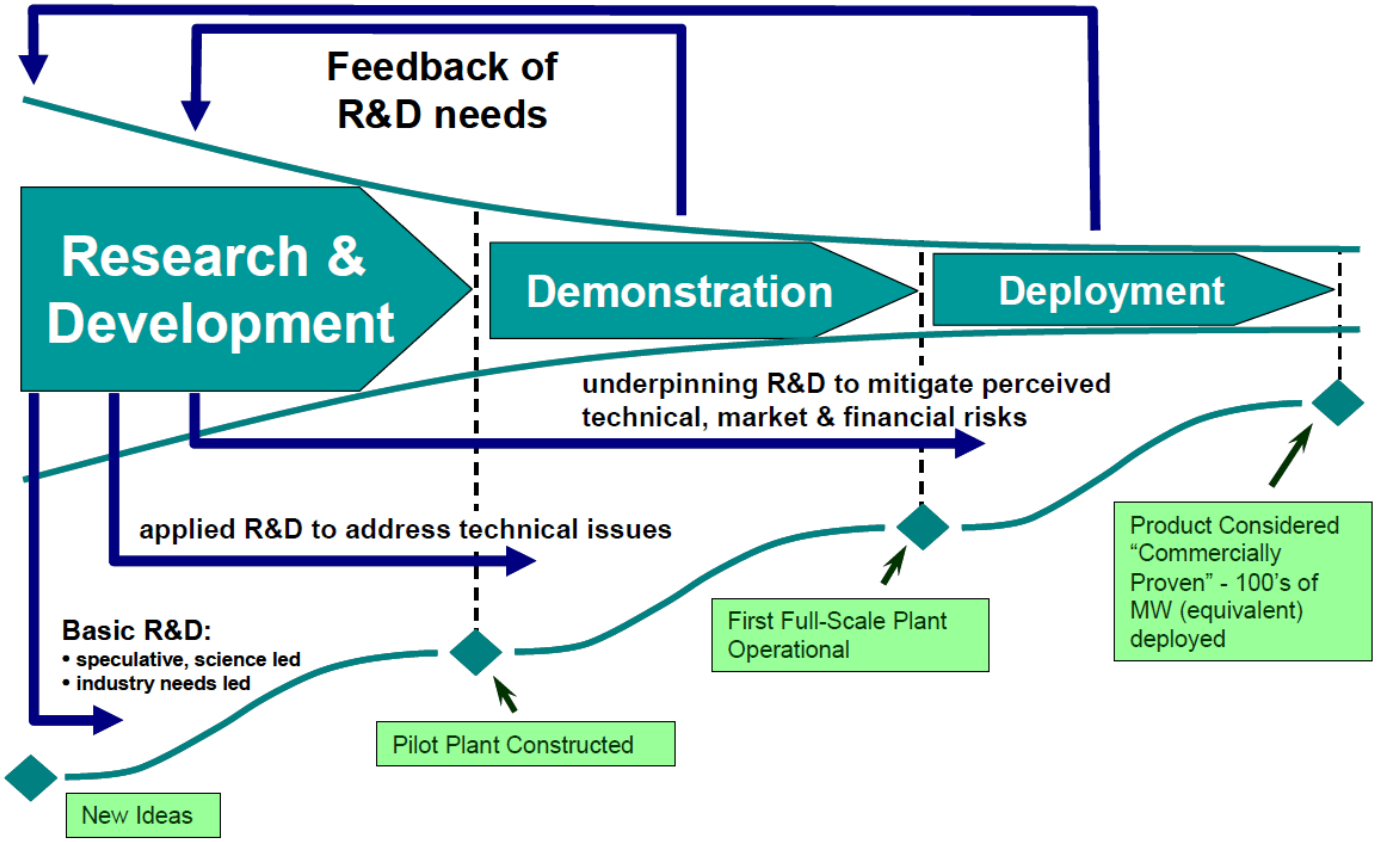
Feedback and Feed-Forward for R&D Essential

Based on Energy Research Partnership, reported in 2006 in http://www.epsrc.ac.uk/newsevents/pubs/second-uk-energy-research-summit/
(and subsequently reproduced in various forms including , www.ukerc.ac.uk/support/tiki-download_file.php?fileId=3619)

UKCCSRC Research and Pathways to Impact Delivery (RAPID)

A. UPDATING CCS KNOWLEDGE REQUIREMENTS

B. CCS KNOWLEDGE GENERATION AND MANAGEMENT



a four-part approach for delivering industry-relevant R&D

C. CCS KNOWLEDGE DELIVERY ACTIVITIES

D. CCS CAPACITY DEVELOPMENT AND CAPACITY DELIVERY

https://ukccsrc.ac.uk/research/research-and-pathways-impact-delivery-rapid

Saskatchewan, Canada, 2 October 2014
SaskPower Boundary Dam Unit 3 official opening

Lignite fuel, ~ 1MtCO_2/yr being sold for EOR
Additional units planned
UKCCSRC R&D collaboration under MOU

- Shell Cansolv amine capture technology,
- Looking for 30% reduction in capital costs

Learning between CCS phases

2nd and 3rd generation technology projects

- **MUST be based on previous projects, just using novel technologies is clearly not a 2nd or 3rd generation**
- Some learning from studies already, e.g. Boundary Dam
- But most proposed projects are still 1st generation
- Need learning by doing from successful projects on:
  - technology (design, procure, construct, commission)
  - markets (business models, contracts, financing)
  - regulation, permitting etc. etc.
- Plus reference plants to reduce risk and financing costs
- **Fully-developed market for supply chains has repeat units**
- **Also need PEOPLE with experience from repeat projects**

Conclusions

Stages in all power plant clean-up technologies:

1. ‘It’s science fiction!’
2. ‘It’s impossibly expensive and complex!’
3. ‘It’s a major investment but necessary.’
4. ‘It’s obviously just a routine part of any power plant.’

CCS is now in early stage 3 and we are working hard to get it to stage 4 as quickly as possible.

- Can expect 2nd generation projects to appear soon that are based on 1st generation projects and that benefit from learning-by-doing ….
- …. and/or from pre-existing transport and storage infrastructure.
- Offshore transport and storage essential for other CCS markets ….
- …. as well as a major European asset.
- RD&D capacity and research-trained industry people also being developed to support CCS deployment.
- **CCS is starting to feel much more ‘practical’**