The Evolution of UK Policy on CCS and Air Capture

Dr Tim Fox CEng FIMechE CEnv
Head of Energy and Environment
Institution of Mechanical Engineers

Talk structure

- Presentation overview
  - The global CCS industry
  - Global ambitions and targets
  - Key challenges for CCS
  - Projects, plans, emerging leaders
  - UK & EU ambitions, policy and targets
  - UK demo competition
  - UK deployment model
  - UK mitigation policy
  - Geo-engineering
  - UK policy on Air Capture

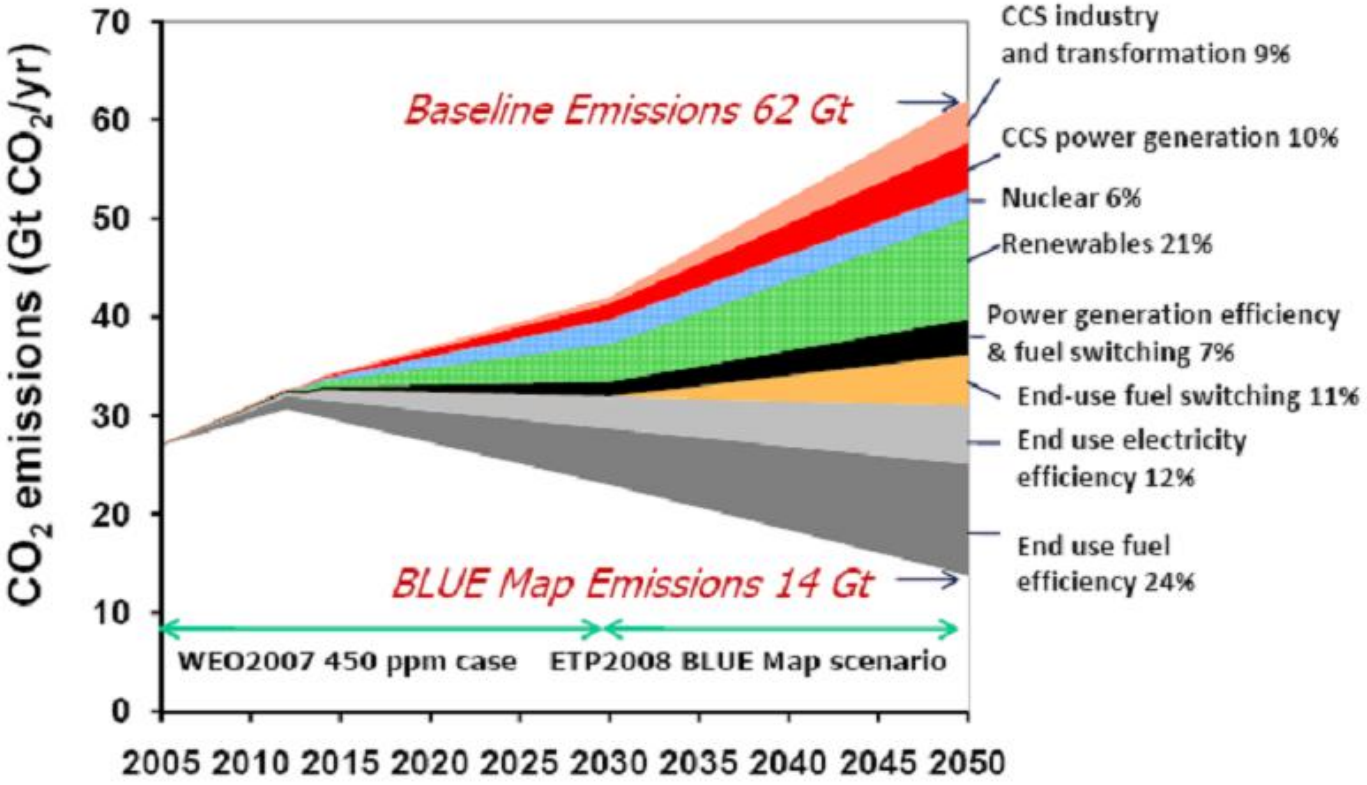
The global CCS industry

- General overview
  - Needed to mitigate global warming and climate change
  - Decarbonise power, oil & gas and industrial sectors
  - Nascent industry in terms of scale and power sector
  - Expected to be deployed between 2020 and 2030
- Overall physical size, globally
  - IEA Roadmap to 2050 states 100 CCS projects required by 2020 and 3400 CCS plants needed by 2050 (35% OECD) to stabilise CO_2 concentration at 450ppm
- Potential fiscal size of sector, globally
  - $3.4 trillion (assuming $1 billion per plant)

(Note: CCS reduces cost of carbon abatement by around 70%)

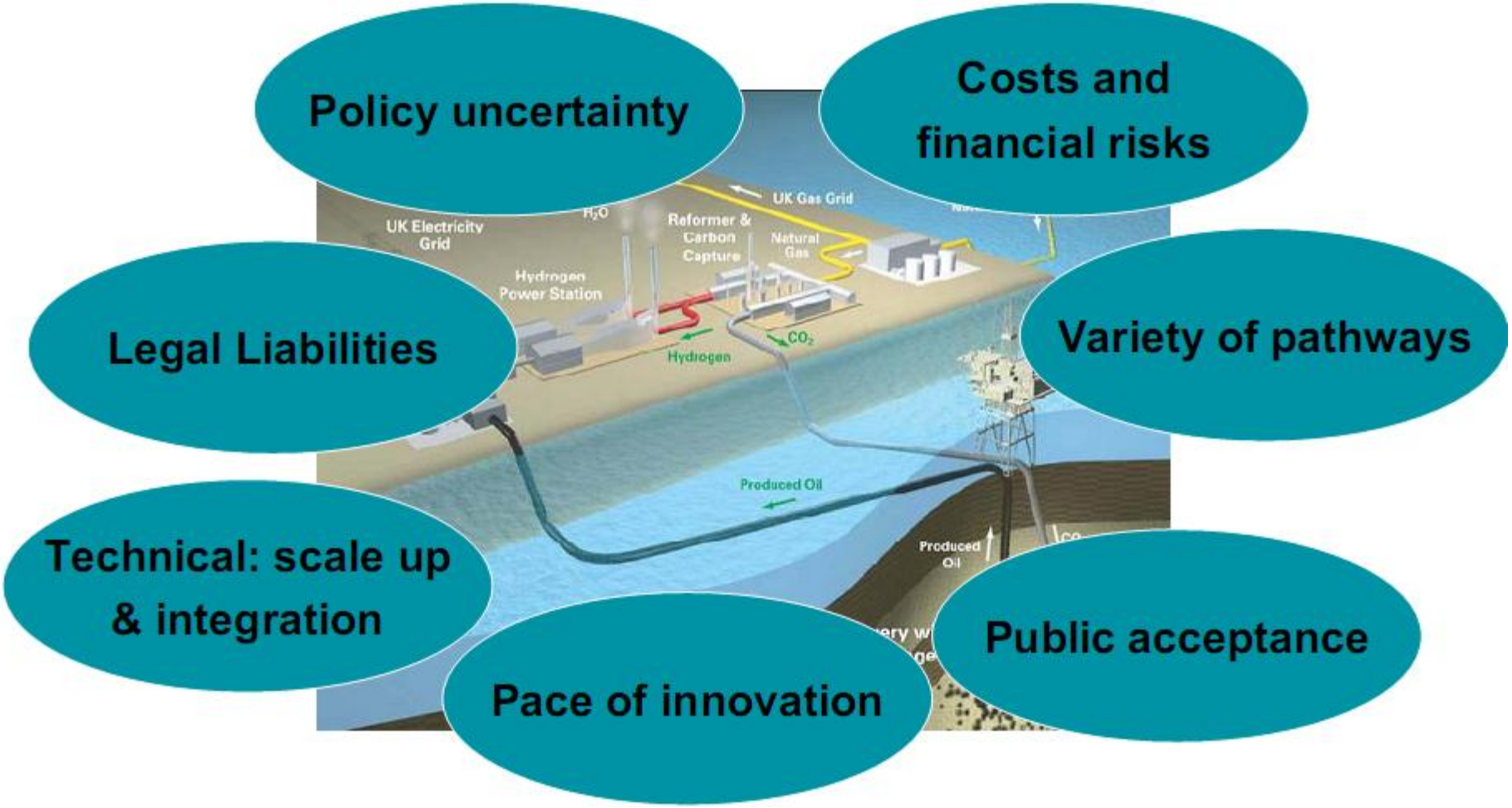
Ambitions and targets

- UNFCCC target is 50% average global reduction in greenhouse gas (GHG) emissions by 2050 relative to 2005
- CCS could provide 19% of the required CO_2 cut ($10GtCO_2$/yr or volume equivalent of 50 million barrels liquid CO_2/day)



Source, IEA

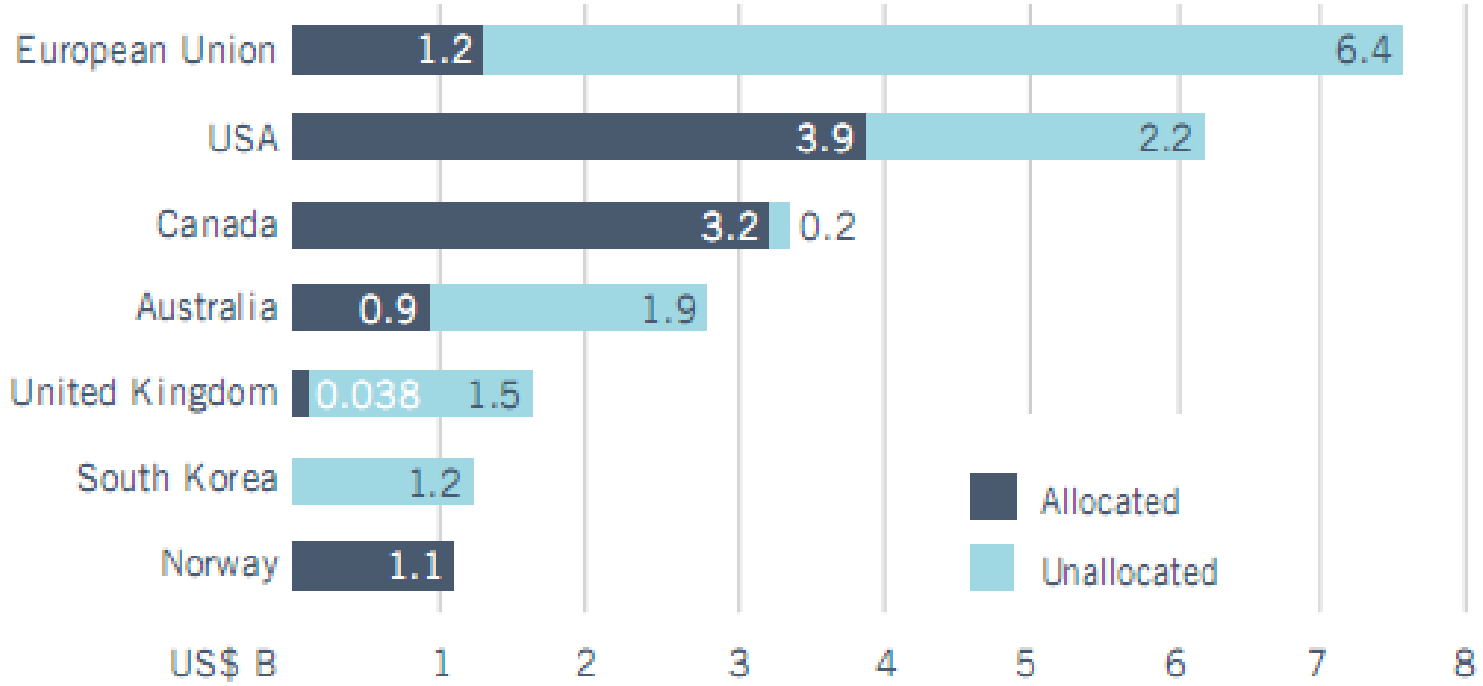
Key challenges for CCS



Source, SPRU

Status and short-term prospects

- Range of current fiscal situations and stimulants
  - Governments continue to increase funding support
  - Since 2005 nearly US$25 billion in support announced
  - EU (inc. UK & Norway) 47% and North America 37%



Source, Global CCS Institute

Projects, plans, emerging leaders

- CCS projects overview
  - 242 projects in planning, construction or operation stages
  - 155 fully integrated with 85 large-scale (800ktCO_2/yr coal)
- Large-scale integrated projects
  - Government funding equally split pre- and post-combustion
  - Oxy-fuel approximately half that of pre- or post-combustion
  - 60% of capacity in planning/construction in power generation
  - 49% of planned/operating is EOR
- Emerging leaders (by capacity in dev/constr/ops)
  - USA, UK, Australia and Canada account for 74% of activity
  - Netherlands, China, UAE and Poland account for 16%
  - USA, Canada, Norway and Algeria have operating plant
  - USA and Australia have plant under construction

CCS contribution in UK by 2050

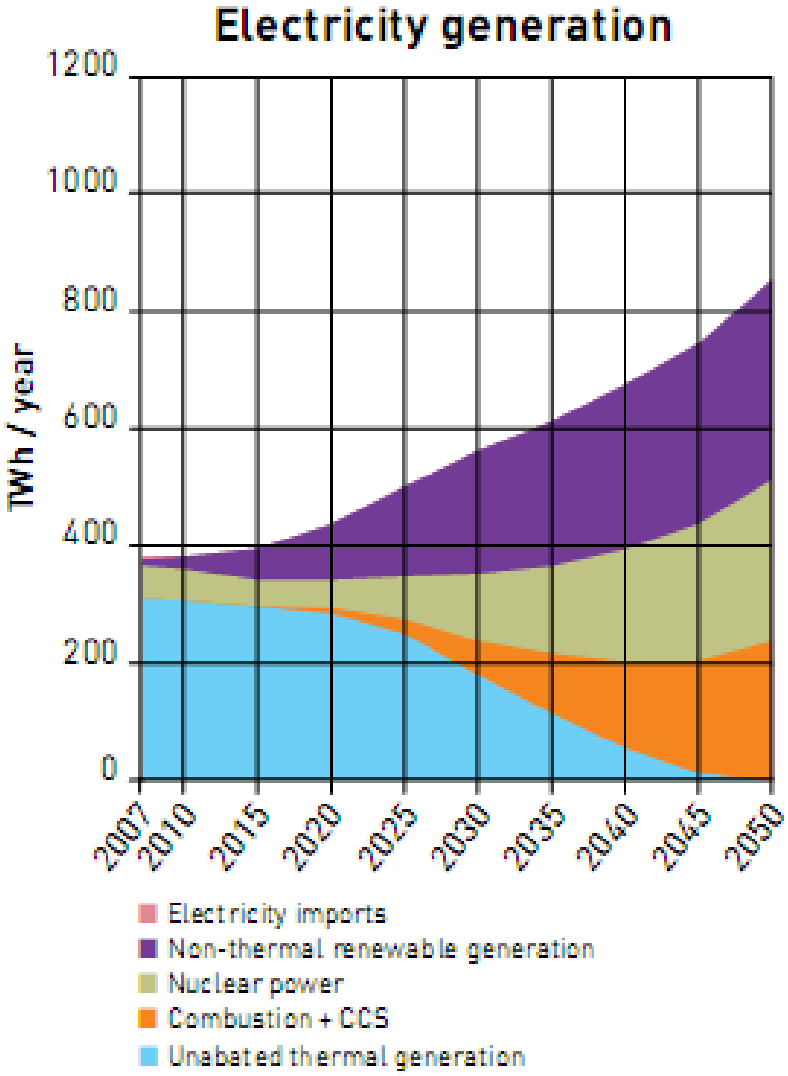
UK DECC 2050 Pathways

- CCS contributes in a trilogy

I. Nuclear
II. Renewables
III. Fossil fuels with CCS

- Climate Change Act 2008 requires 80% reduction in GHG emissions by 2050 relative to 1990 levels
- CCS contributes 20% of GHG cuts needed by 2050 (≈160 $MtCO_{2e}$/yr in 2050)

Source, DECC



UK demo policy and financing

- CCS Demonstration Plant Competition
  - Announced 2007, initially for one post-combustion coal plant project of at least 300 MW
  - Further three projects announced in 2009 with eligibility for pre-combustion added
  - Energy Act 2010 legislates financial mechanism, CCS Levy, to fund demos through levy on electricity supplies and suppliers (expected to raise £9.5 billion over 20 years); recognises lifetime costs of projects not just capital costs.
  - First phase has secured £1bn UK government funding
  - All four projects to be built by 2018 (9MtCO_2/yr by 2020)
- Change (Autumn 2010) to include gas plant eligible
  - UK 2nd dash for gas in 2010s, ≈29GW planned since 2006
  - Gas also needed to balance wind intermittency
  - Gas will need CCS by 2030 if decarbonisation on track

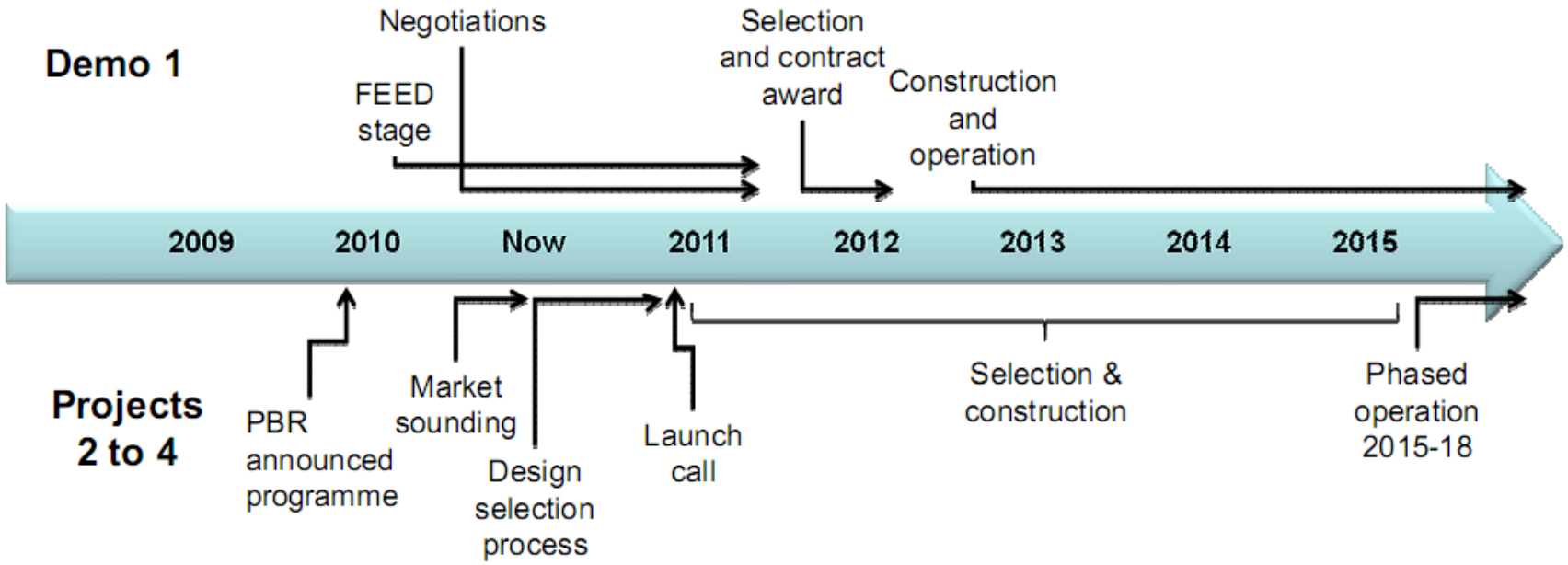
EU demo policy and financing

- Intends to support up to 12 CSS demo projects across Europe by 2015

- Economic Package for Recovery providing €1.05 bn to support six CCS projects across Europe (including €180 million for Powerfuel's 900 MW IGCC at Hatfield)

- NER300 initiative allocates 300 million EU ETS phase 3 New Entrant Reserve allowances to fund CCS and innovative renewables projects
  - €4.5 billion scheme aims to fund at least eight CCS projects (stations of at least 250 MW and at least 85% CO_2 capture)
  - NER funding provides support up to 50% of eligible cost
  - Applications for funding close in February 2011

UK demos current status



Source: DECC

- Demo 1 now has only one contender; a 400 MW retrofit at Scottish Power's 1600 MW Longannet coal station in Scotland

Lessons learnt so far

- Demo competition requires combination of public and private sector skills and significant resources
- CCS has no supply chain business model so need to develop from scratch which takes time and effort
- Clear risk allocation is essential and takes considerable dialogue
- Major barriers to development of CCS are regulation and funding; need long-term political commitment
- Regulatory certainty is crucial but stability difficult because of emerging knowledge and understanding

Potential outcomes

- Aspiration for UK outcome
  - Well placed for CO_2 storage in depleted hydrocarbon fields (7-10Gt, ≈80yrs) and saline aquifers (15-50Gt)
  - Knowledge, skills, experience, cost reduction, first mover advantage and export opportunities
  - 2030 UK CCS industry worth £3-6.5bn/yr and 100,000 jobs
  - Experience of CCS regulation and "best practice" CCS regulatory framework anywhere in the world
- UK outcome aspiration in a global context
  - International collaborative R&D projects, China, USA, RSA
  - International regulatory environment on sub-seabed storage and cross-border transportation
  - Maintains climate change leadership and helps persuade China and USA to take action on emissions

UK deployment policy

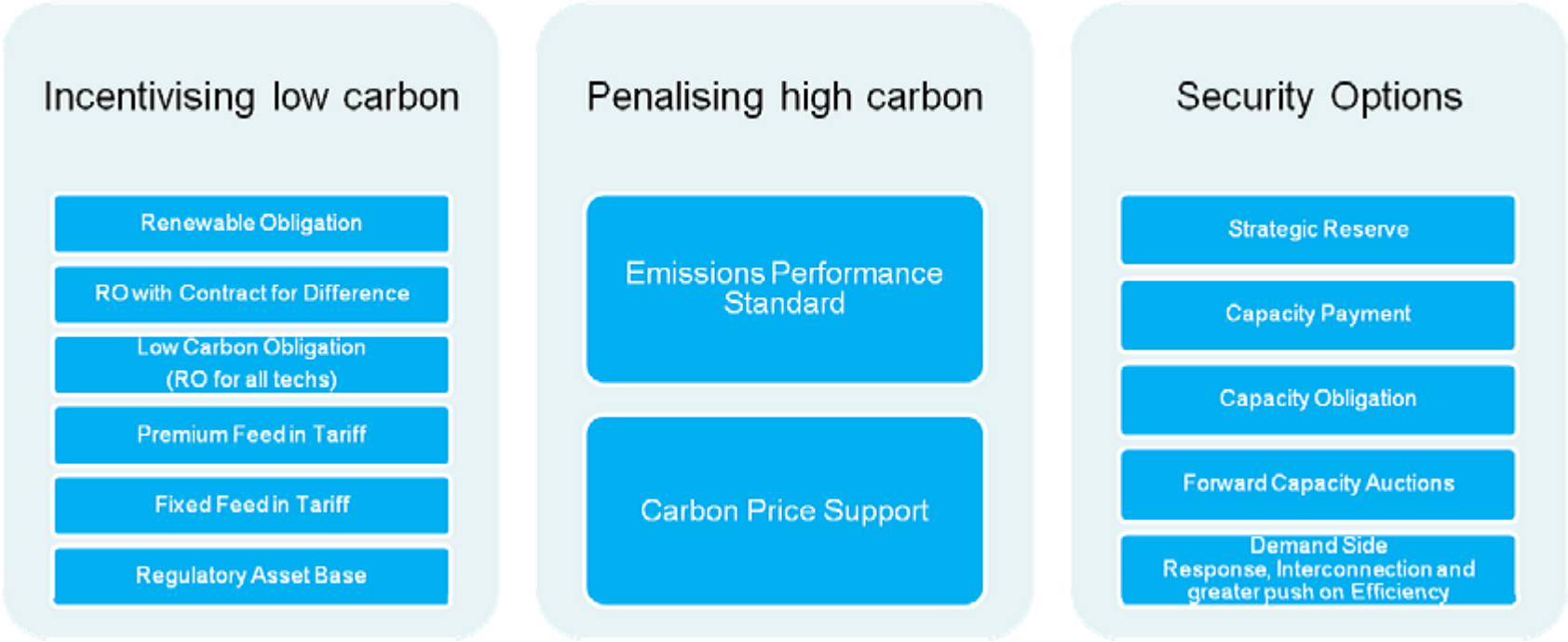
- Creating legislative landscape in a EU context
  - EU Directive on Geological Storage of CO_2
  - No permission for new fossil station above 300 MWe without 'CCS-ready' and in the case of coal at least 300 MWe of capacity CCS installed
  - After 2020 all new coal plant constructed with full CCS
  - All demo plant fully CCS fitted by 2025
  - Emissions Performance Standard (EPS) to set max levels of CO_2 emitted from power stations
- Deployment financing model
  - Electricity Market Review – possible introduction of national floor price for carbon to underpin EU ETS price
- Development of clusters
  - Humberside, Thames, Tyneside, Teesside, Firth of Forth (all to North sea), Merseyside and Clydeside (to Irish Sea)

Commercialisation, legal frames

- EU Directive 2009/31/EC on Geological Storage of Carbon Dioxide (April 2009)
  - Defines type of storage site allowed, framework for issuing exploration and storage permits, sets obligations for operation, closure and post-closure, including transfer of long-term liability from operator to government, and specifies third party access to transportation and site
- EU Environmental Liabilities Directive
  - Defines operator liability for environmental damage, such as groundwater pollution due to CO_2 leakage, irrespective of time elapsed after the facility closes.
- Laws of the Sea
  - London Convention & Protocol and OSPAR Convention amendments to allow trans-boundary CO_2 shipments and storage under seabed

Commercialisation, market model

- UK free market policy – electricity market reform



- Need to identify optimal mix of interventions, when they should be introduced and how to transition from present
- Who pays? Affordability for consumer and fuel poverty
- Essential to fix robust stable long-term market framework

Momentum building – next steps

- Commercial realities
  - EOR is a strong driver for large-scale CCS developments, particularly in North America
  - There is no strong commercial driver for the power sector
  - Integrated technology at scale needs proving and requires public money to incentivise demonstration
  - Costs need driving down to give parity with other low-carbon technologies
- Likely long-term market outcome once proven?
- Need international policy breakthroughs
  - Price on CO_2 emissions
  - Emissions performance regulations
  - Tariff for embedded emissions at borders

UK mitigation policy

- Global leadership
  - UK aspires to lead the world on emissions reduction targets and legislation – sets targets that are groundbreaking in an international context
- Climate Change Act 2008 (26 November)
  - First legislative instrument of type anywhere in the world
  - GHG reduction target of 80% by 2050 relative to 1990, with series of five year carbon budgets along the way
  - UK Committee on Climate Change has recommended budgets for 2008-12, 2013-17, 2018-22 and 2023-2027 leading to at least 60% cut in GHG by 2030

Can we decarbonise fast enough?

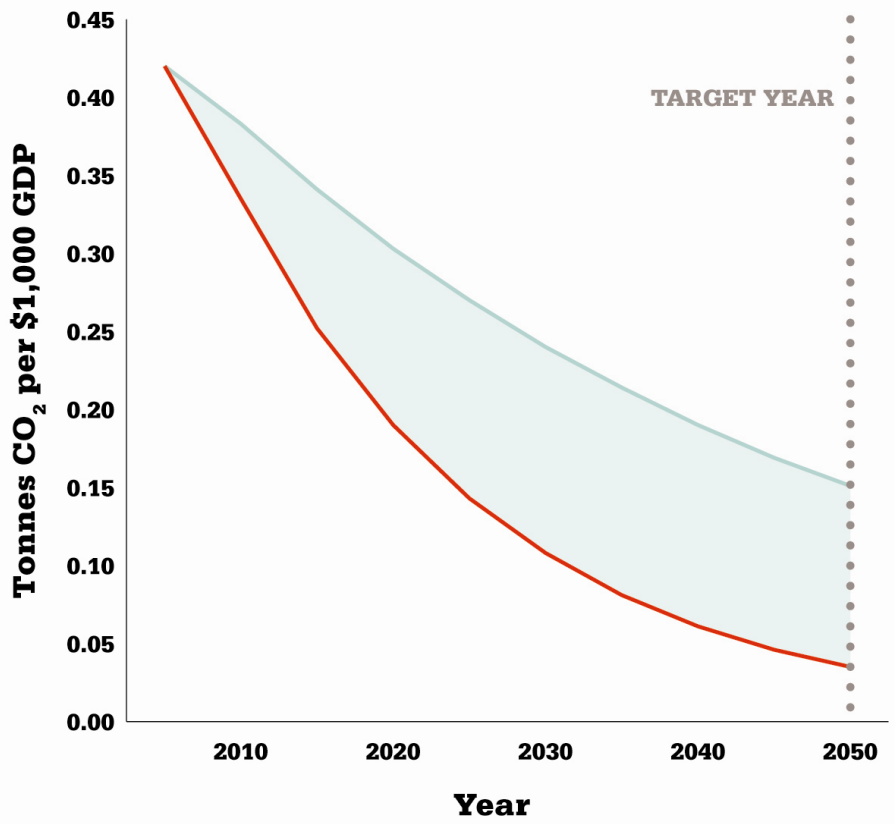
Legend

Blue line: 2.3% per year

Red line: 5.5% per year

Shaded area: shortfall

UK economy needs to decarbonise at 5.5% per annum to meet the 2050 target (assuming a GDP growth rate of 2%)



Historically UK achieved average decarbonisation rate of 2% (at best achieved 2.3% between 1992 and 1998 during the 'dash-for-gas')

Buying time - Geo-engineering?

Technology is used to remove CO_2 from atmosphere, or Earth cooled by reflecting solar radiation back to space

- Marine and Terrestrial Sequestration, Air Capture
- Space Reflectors, Aerosols, Albedo Enhancement

Poor mitigation prospects in near term makes it increasingly likely geo-engineering interventions may need to be deployed within the next 10 to 20 years

HoC IUSS Committee inquiry

- Government position – 2008
- IMechE position – 2008
- IMechE submission – Oct 2008
- Tim Fox oral witness – Nov 2008
- Committee report – March 2009
- Government response – June 2009

House of Commons
Innovation, Universities, Science and Skills Committee

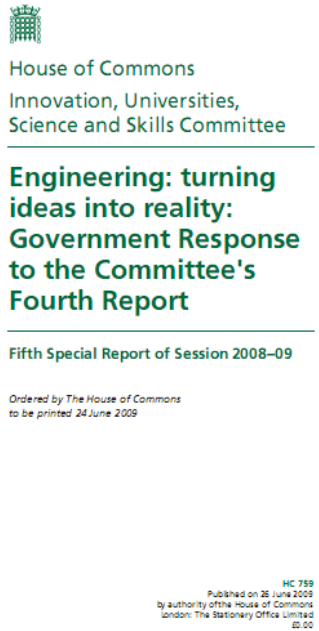
Engineering: turning ideas into reality

Fourth Report of Session 2008–09

Volume I

Report, together with formal minutes

Ordered by the House of Commons to be printed 18 March 2009



House of Commons
Innovation, Universities, Science and Skills Committee

Engineering: turning ideas into reality: Government Response to the Committee's Fourth Report

Fifth Special Report of Session 2008–09

Ordered by The House of Commons to be printed 24 June 2009

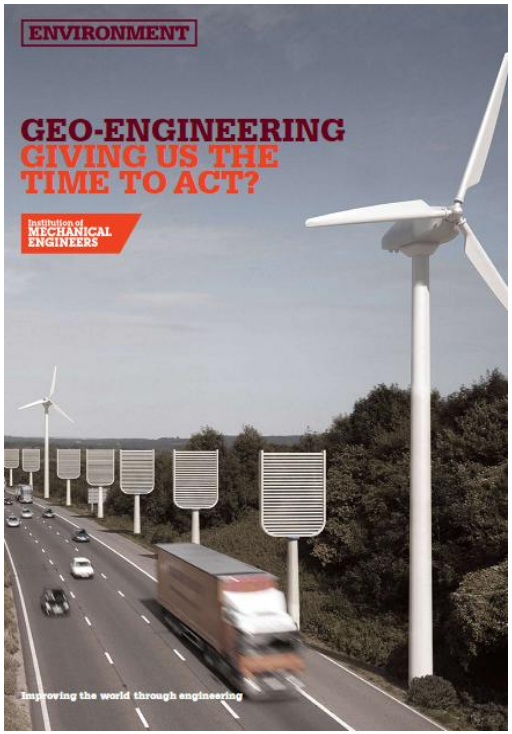
HC 759
Published on 26 June 2009
by authority of the House of Commons
London: The Stationery Office Limited
£0.00

IMechE Cooling the Planet Project

An initial engineering assessment (Nov 2008 – March 2009)

Criteria:

- Low-carbon solutions with low-risk of unintended climate consequences
- Build on existing engineering knowledge and technologies (to avoid significant distraction from mitigation)
- Achievable at relatively low cost within existing national and international policy frameworks



Report published August 2009: three technologies for further work: Artificial Trees, Algae, Reflective Surfaces

Geo-engineering

IMechE recommends that

- UK Government allocates funding to support research (≈ £10m/yr for 10 years) into the feasibility and engineering assessment of geo-engineering approaches and takes a lead on establishing an international research programme

- an international framework is established for governance of geo-engineering R&D

- CO_2 capture from air with sequestration is included in UNFCCC negotiations to enable credits for CO_2 removal from atmosphere ('negative emissions')

Policy influence

- The Climate Change Act was a good first step for the UK but now need strong policy that recognises magnitude of challenge
  - Press and broadcast media
  - Policy influencers / think tanks
  - MPs, Ministers and Whitehall

- IMechE believes climate change policy should take a more realistic approach and include air-capture as an integrated component alongside mitigation and adaptation

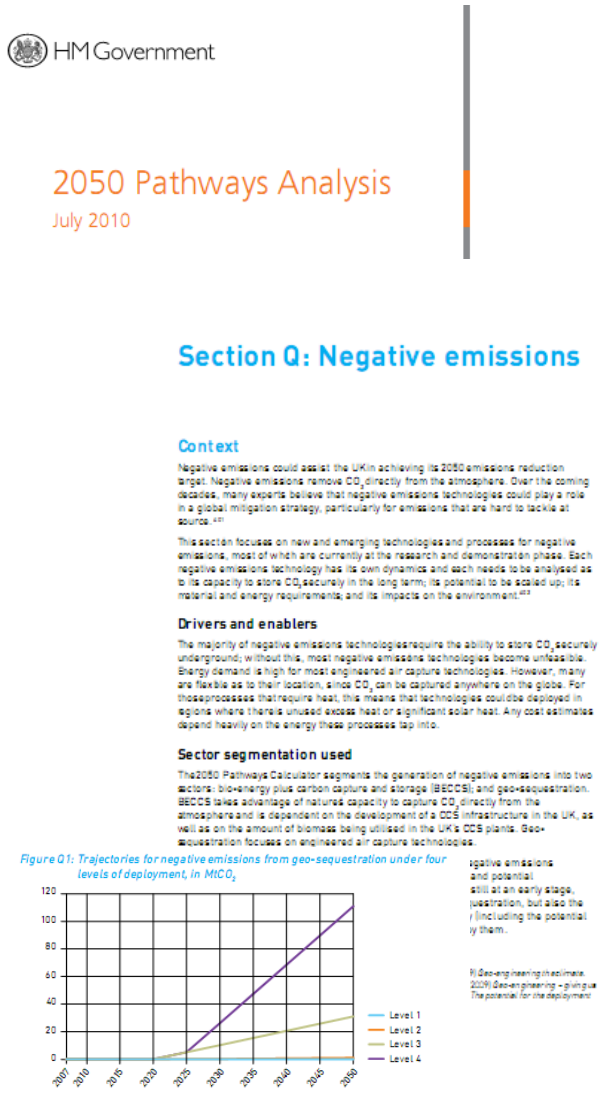
Policy Shift – 2050 Pathways

DECC 2050 Pathways - July 2010

- 'Negative Emissions' defined as removal of CO_2 directly from the atmosphere

I. Bio-energy plus carbon capture and storage (BECCS) – 165 $MtCO_2$/yr by 2050

II. Geo-sequestration (e.g. air capture or enhanced weathering techniques) – 111 $MtCO_2$/yr by 2050.



HM Government

2050 Pathways Analysis

July 2010

Section Q: Negative emissions

Context

Negative emissions could assist the UK in achieving its 2050 emissions reduction target. Negative emissions remove CO_2 directly from the atmosphere. Over the coming decades, many experts believe that negative emissions technologies could play a role in a global mitigation strategy, particularly for emissions that are hard to tackle at source.[421]

This section focuses on new and emerging technologies and processes for negative emissions, most of which are currently at the research and demonstration phase. Each negative emissions technology has its own dynamics and each needs to be analysed as to its capacity to store CO_2 securely in the long term; its potential to be scaled up; its material and energy requirements; and its impacts on the environment.[422]

Drivers and enablers

The majority of negative emissions technologies require the ability to store CO_2 securely underground; without this, most negative emissions technologies become unfeasible. Energy demand is high for most engineered air capture technologies. However, many are flexible as to their location, since CO_2 can be captured anywhere on the globe. For those processes that require heat, this means that technologies could be deployed in regions where there is unused excess heat or significant solar heat. Any cost estimates depend heavily on the energy these processes tap into.

Sector segmentation used

The 2050 Pathways Calculator segments the generation of negative emissions into two sectors: bio-energy plus carbon capture and storage (BECCS); and geo-sequestration. BECCS takes advantage of natures capacity to capture CO_2 directly from the atmosphere and is dependent on the development of a CCS infrastructure in the UK, as well as on the amount of biomass being utilised in the UK's CCS plants. Geo-sequestration focuses on engineered air capture technologies.

Figure Q1: Trajectories for negative emissions from geo-sequestration under four levels of deployment, in $MtCO_2$

egative emissions and potential still at an early stage, uestration, but also the r (including the potential ly them.

9] Geo-engineering is estimate. 2009) Geo-engineering – giving us The potential for the deployment

Next steps - further influence

- Proposition
  - **Negative Emissions** – air capture and sequestration
    - Buys time while transitioning to low carbon economy
    - Account for hard to get at emissions
    - Remove legacy emissions
    - Enables participation by low GHG emitting nations
  - **Carbon recycling** – air capture and processing for onward us in industrial, agricultural, horticultural or fuel applications
    - Helps prevent further accumulation in atmosphere
    - Enables participation of low GHG emitting nations
- Desired outcome
  - UK Government to show leadership in adoption of policy to encourage demonstration/deployment
  - UK Government to champion inclusion in international policy

Thank you

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