2007 International Workshop on IGCC & Co-Production
and CO2 Capture and Storage
May 23-24, Beijing, China

Overview of UK CCS activities

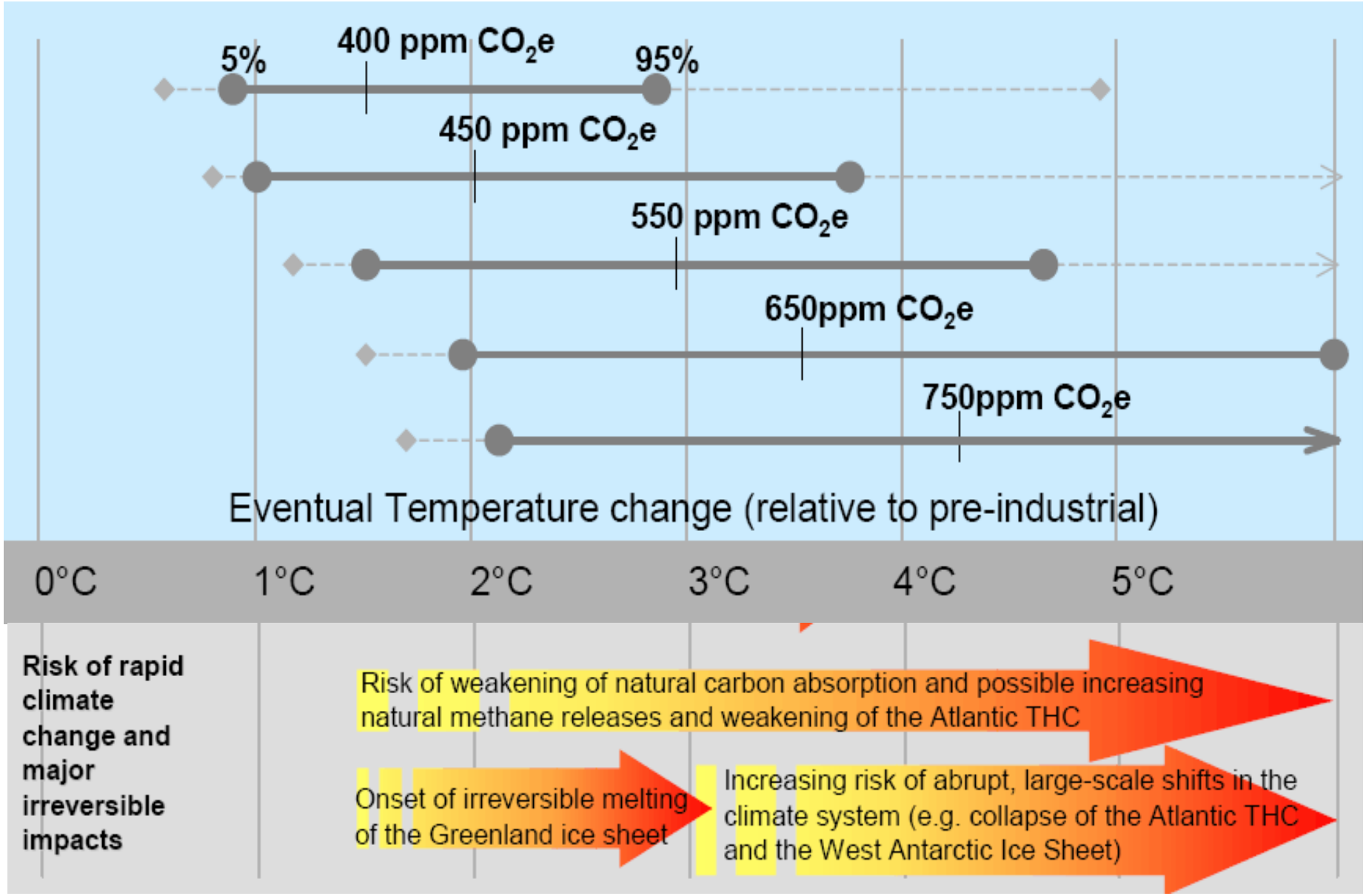
Dr Jon Gibbins

Energy Technology for Sustainable Development Group
Mechanical Engineering Department
Imperial College London

UK Carbon Capture & Storage Consortium
www.ukccsc.co.uk

j.gibbins@imperial.ac.uk

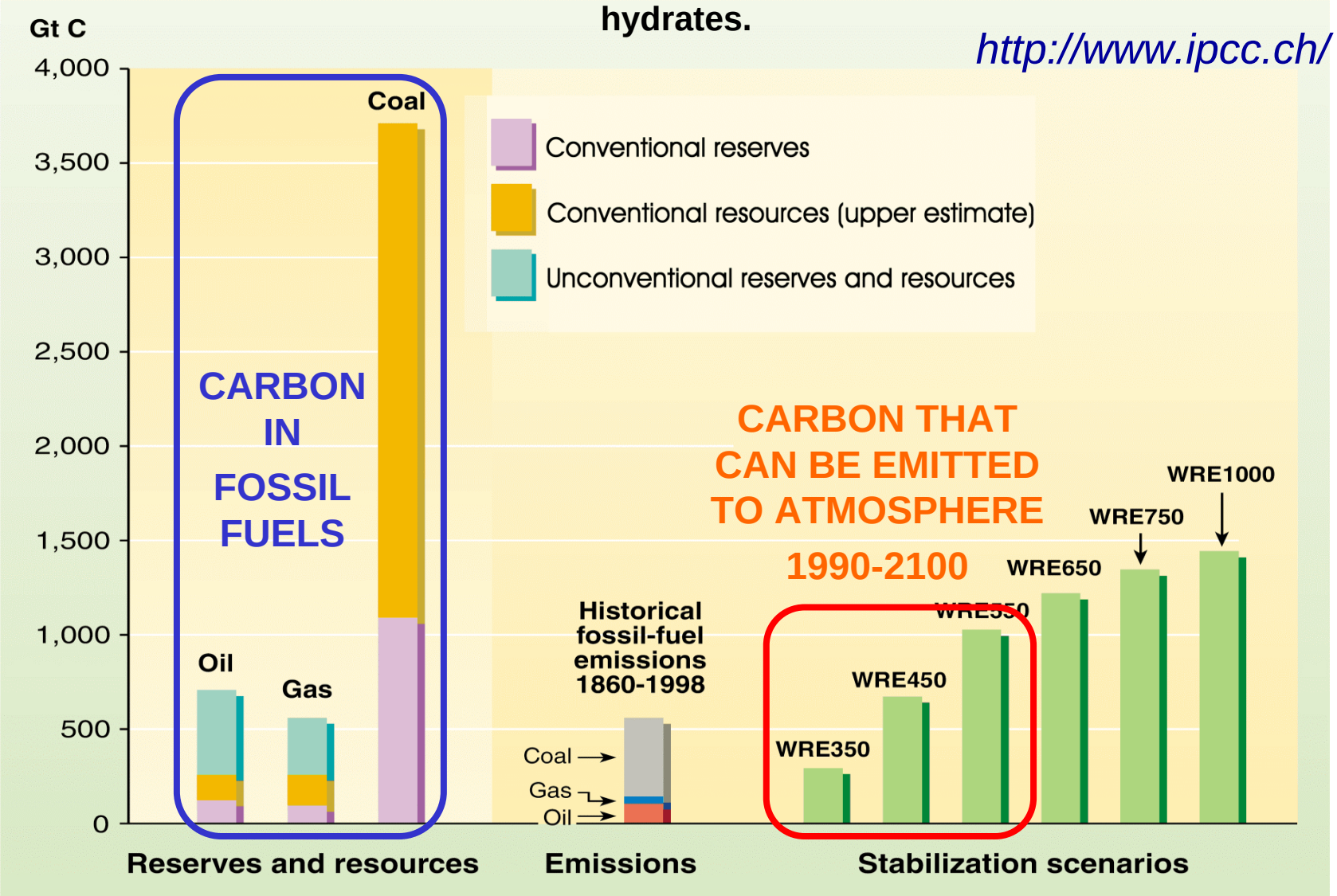
STERN REVIEW: The Economics of Climate Change



CRITICAL ROLE FOR CCS

'Unconventional oil' includes oil sands and oil shales. Unconventional gas' includes coal bed methane, deep geopressured gas etc. but not a possible 12,000 GtC from gas hydrates.

http://www.ipcc.ch/



The Gleneagles Communiqué

14. We will work to accelerate the development and commercialization of Carbon Capture and Storage technology by:

(a) endorsing the objectives and activities of the Carbon Sequestration Leadership Forum (CSLF), and encouraging the Forum to work with broader civil society and to address the barriers to the public acceptability of CCS technology;

(b) inviting the IEA to work with the CSLF to hold a workshop on short-term opportunities for CCS in the fossil fuel sector, including from Enhanced Oil Recovery and CO_2 removal from natural gas production;

(c) inviting the IEA to work with the CSLF to study definitions, costs, and scope for 'capture ready' plant and consider economic incentives;

(d) collaborating with key developing countries to research options for geological CO_2 storage; and

(e) working with industry and with national and international research programmes and partnerships to explore the potential of CCS technologies, including with developing countries.

How to make plants capture-ready

Must:

- Have access to suitable geological storage
- Have space and access for capture equipment
- Have reasonable confidence it will work (feasibility study)

Also consider:

- Up-front expenditure with savings later, e.g.

  IGCC instead of PC?

  Bigger/better equipment?

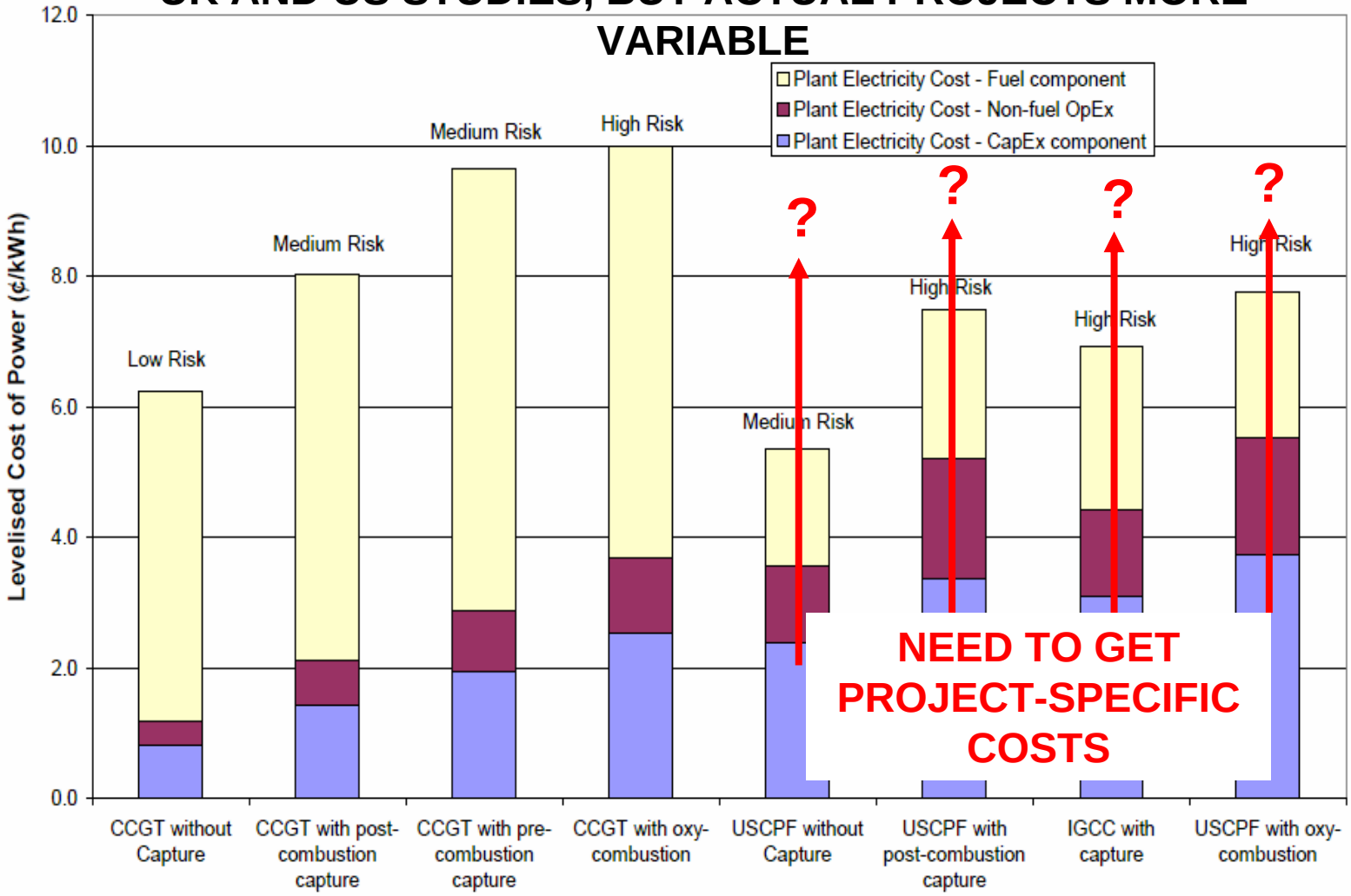
  Move near cheaper/better CO_2 storage?

But only pre-investments with very good returns justified

See IEA GHG report on capture-ready out soon

IGCC or PC?

SIMILAR COST TRENDS FROM A NUMBER OF GENERIC UK AND US STUDIES, BUT ACTUAL PROJECTS MORE VARIABLE



Natural gas plants — **Coal/solid fuel plants**

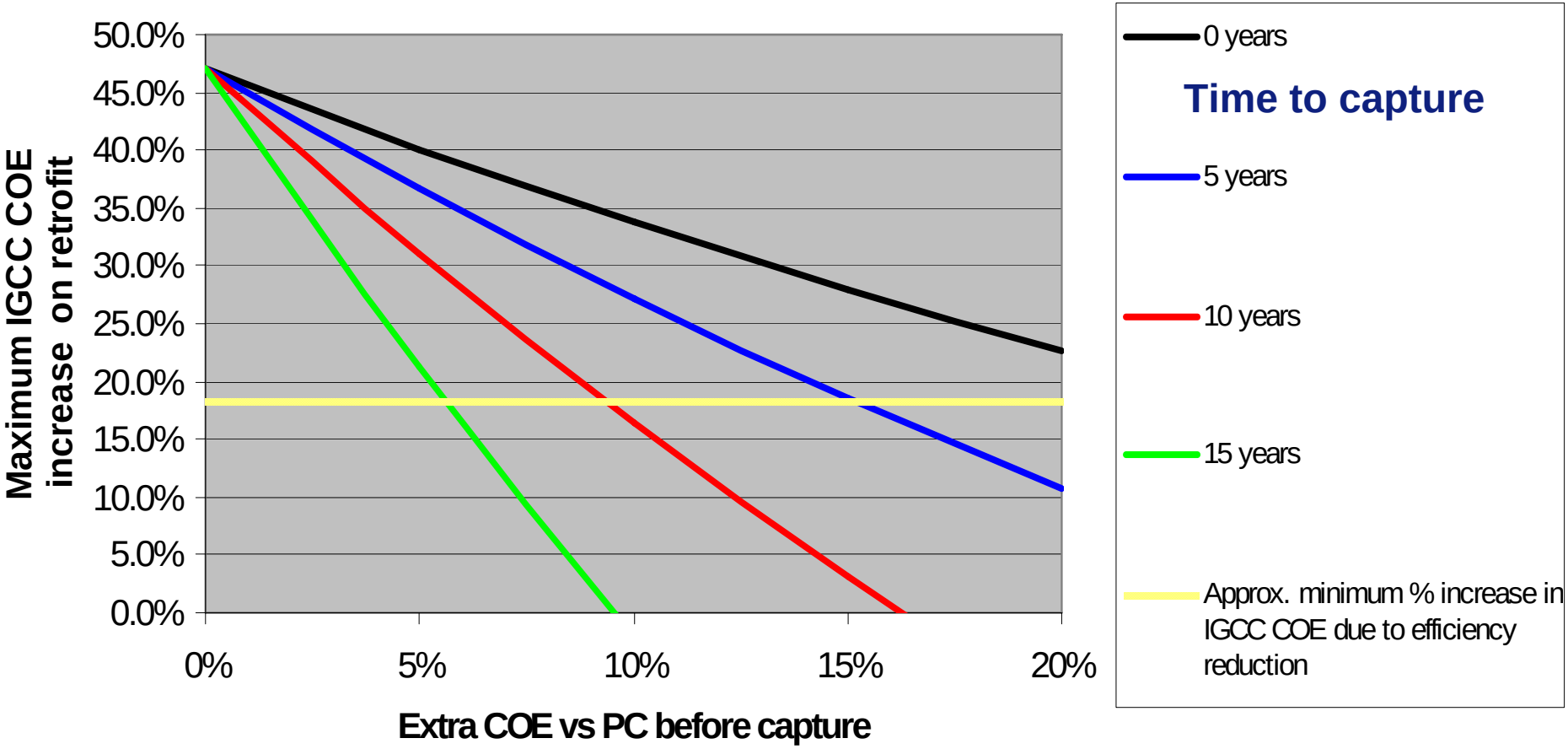
IEA GHG (2006), CO2 capture as a factor in power station investment decisions, Report No. 2006/8, May 2006

Costs include compression to 110 bar but not storage and transport costs. These are very site-specific, but indicative aquifer storage costs of $10/tonne CO2 would increase electricity costs for natural gas plants by about 0.4 c/kWh and for coal plants by

BALANCING HIGHER INITIAL COSTS WITH LOWER CAPTURE COSTS FOR IGCC

Cost increase for CR PC 50%
Cost increase for new capacity vs PC 25%
CR PC Capture penalty 44% to 34.5% LHV
CR IGCC capture penalty 42% to 35.5% LHV

Interest rate 10%
Plant life 40 years



CCS in Stern Review – Role of CCS

- “There is still time to avoid the worst impacts of climate change, if we take strong action now.”
- “Carbon capture and storage is essential to maintain the role of coal in providing secure and reliable energy for many economies.”
- “[CCS] is a technology expected to deliver a significant portion of the emission reductions. The forecast growth in emissions from coal, especially in China and India, means CCS technology has particular importance.”

AN ENERGY POLICY FOR EUROPE

10 January 2007 http://ec.europa.eu/energy/energy_policy/index_en.htm

To provide global leadership, the EU must provide a clear vision for the introduction of CCS:

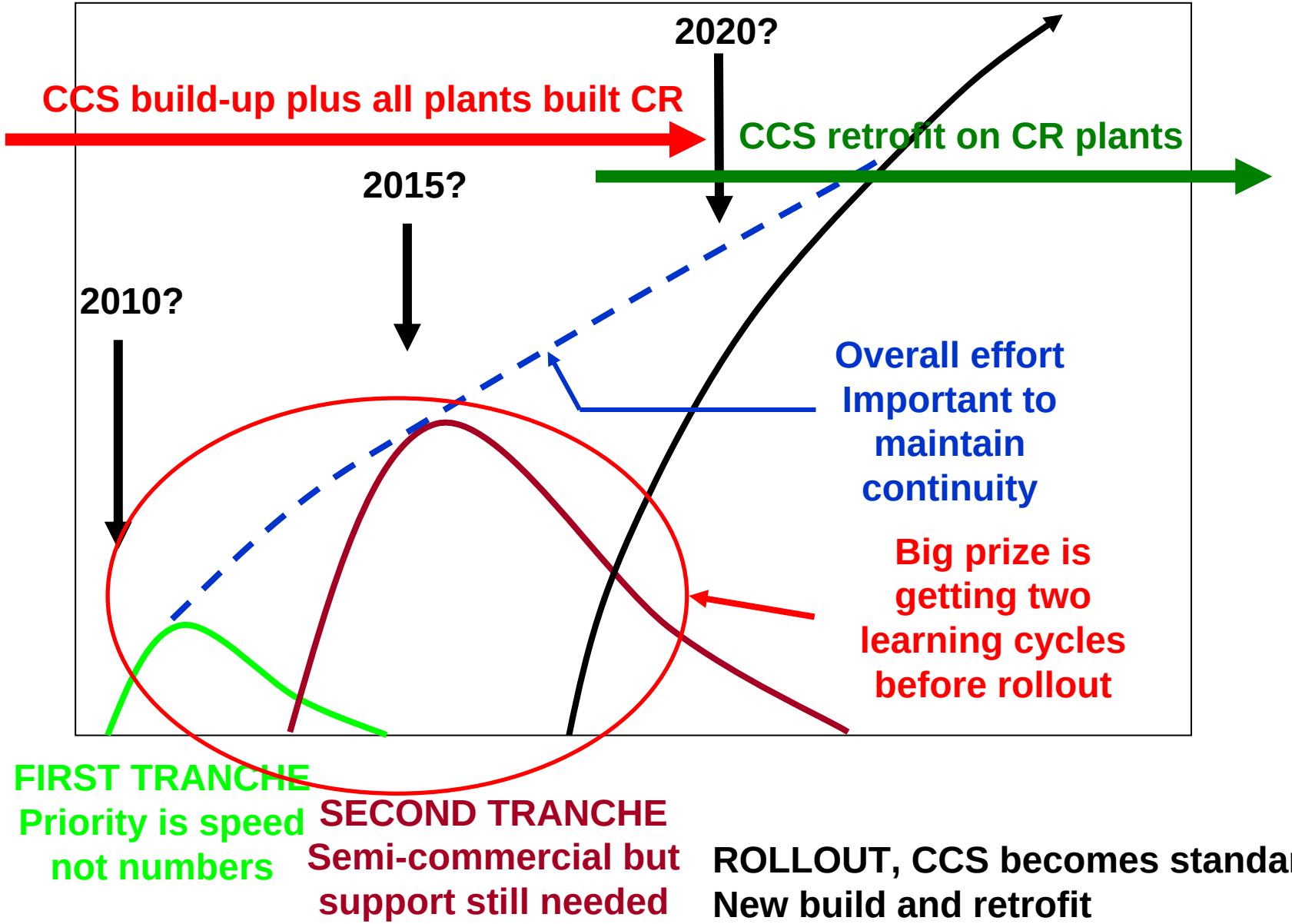
- **Regulatory framework (including EU ETS)**
- **More and effective research**
- **International action**
- **By 2020 all new coal-fired plants should to be fitted with CCS**
- **Existing plants should then progressively follow the same approach**

The Commission will in 2007 start work to stimulate construction and operation by 2015 of up to 12 large scale demonstrations of sustainable fossil fuels technologies in commercial power generation in the EU25.

The Commission will assess .. whether, if not equipped with CCS, new coal- and gas-fired installations are prepared for later addition of CCS technologies ('capture ready'). If this turns out not to be the case, the Commission will consider proposing legally binding instruments as soon as possible, after a proper impact assessment.

BUILD-UP TO ZERO EMISSIONS FROM COAL

http://ec.europa.eu/energy/energy_policy/annexes_en.htm



CCS Proposals – UK

Proposed full-scale (~300 MWe and above) CCS projects - indicative only

Project	Fuel	Plant output	Capture technology
Progressive Energy /Centrica, Teeside	Coal (petcoke)	800 MW	IGCC + shift + precombustion
Powerfuel/ Kuzbassrazrezugol Hatfield Colliery	Coal	~900 MW	IGCC + shift + precombustion Shell gasifier
Conoco-Phillips, Immingham	Coal (+petcoke?)	450 MW (or more, with retrofit)	IGCC+CCS addition to planned NGCC CHP plant
E.ON, Killingholme, Lincolnshire coast	Coal (+petcoke?)	450 MW	IGCC + shift + precombustion
RWE, Tilbury	Coal	2 x 800 MW	PC, CR, new supercritical, post-com
SSE, Ferrybridge	Coal	1 or 2 x 500MW	PC, CR, supercritical retrofit, oxyfuel
E.ON, Kingsnorth	Coal	2 x 800MW	PC, CR, new supercritical, post-com
RWE, Blyth	Coal	3 x 800MW	PC, CR, new supercritical
Scottish Power, Longannet	Coal	~ 2400 MW	PC, CR, supercritical retrofit, (oxyfuel?)
Scottish Power, Cockenzie	Coal	~ 1200 MW	PC, CR, supercritical retrofit, (oxyfuel?)

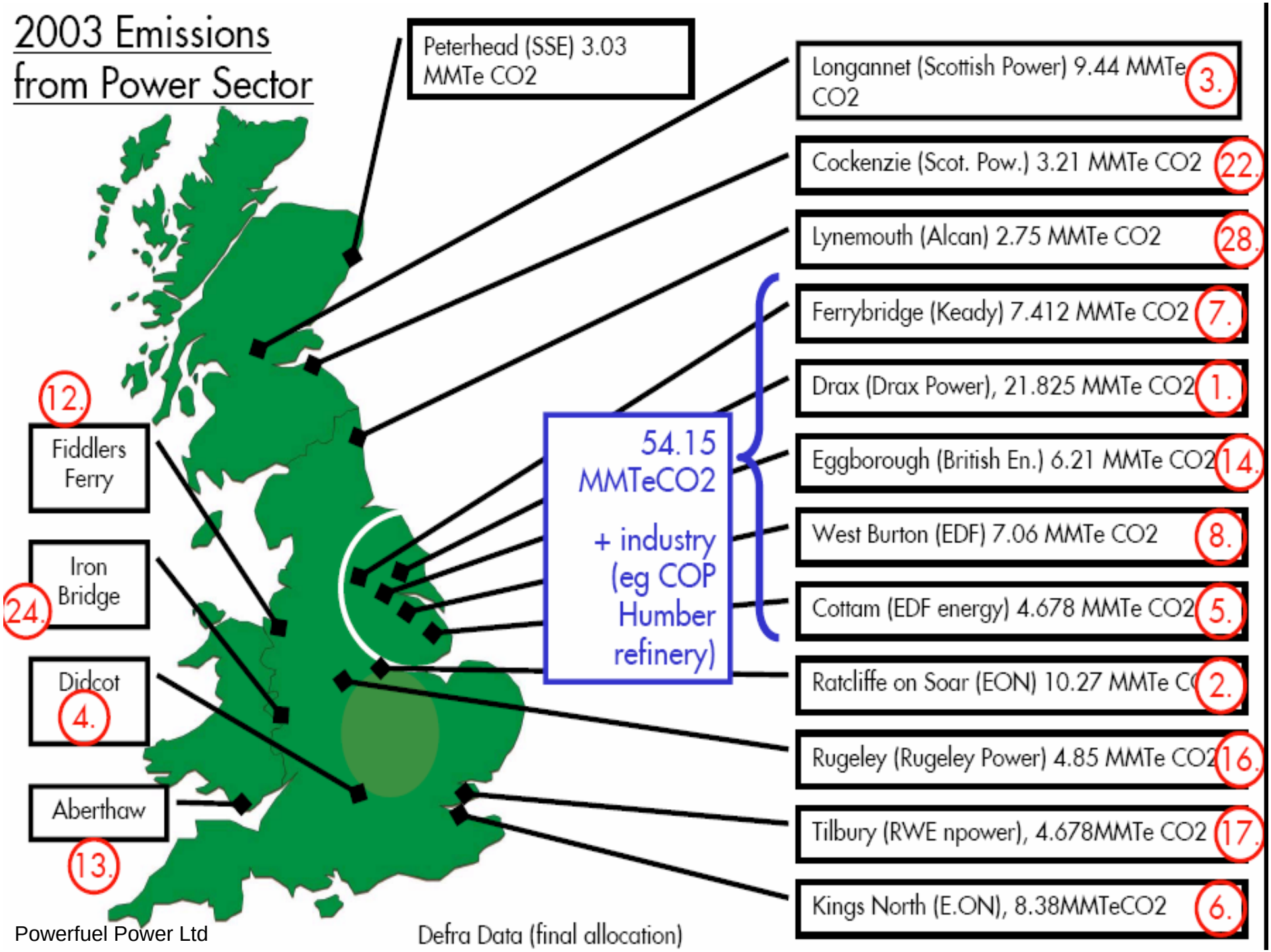
Tilbury.
Capture ready- photo montage

(some details omitted)

Tilbury.
Capture ready- photo montage

(some details omitted)

2003 Emissions from Power Sector

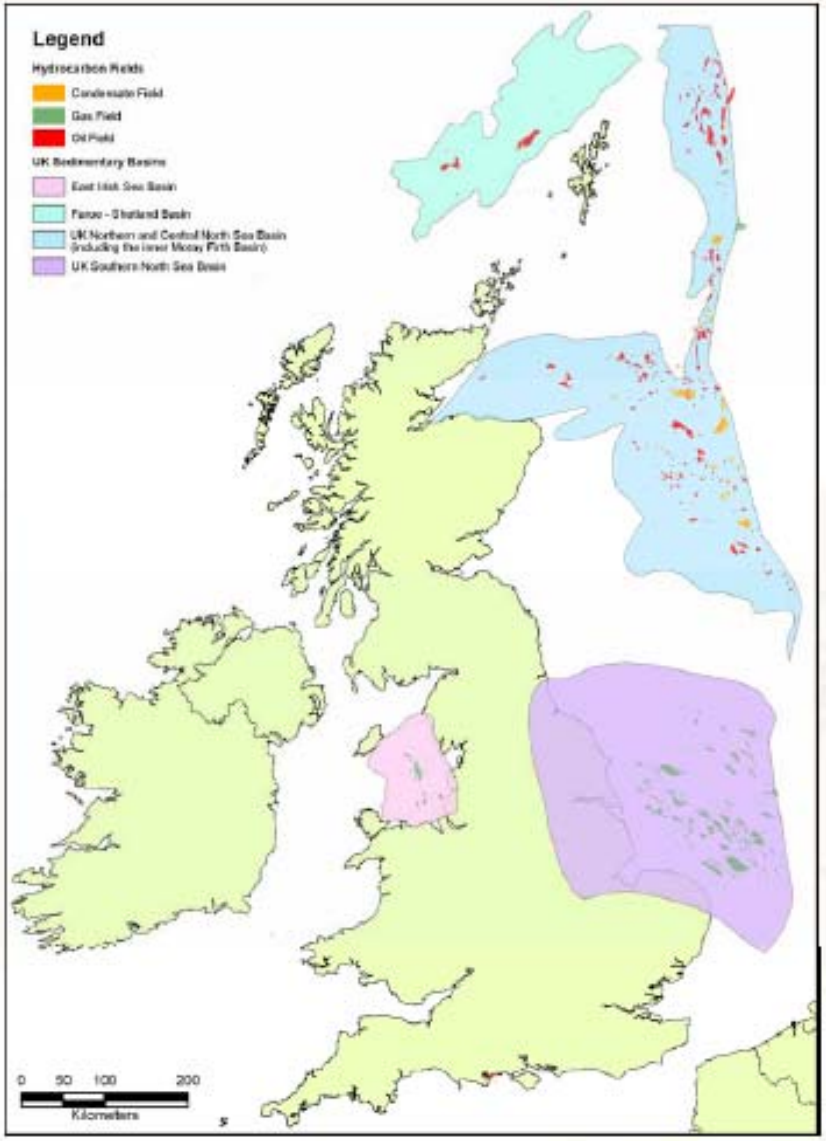


Defra Data (final allocation)

Powerfuel Power Ltd

UK Geological Storage

- Oil fields
- Gas fields
- Gas/condensate fields
- Saline-water-bearing reservoir rocks (saline aquifers)
- Coal seams



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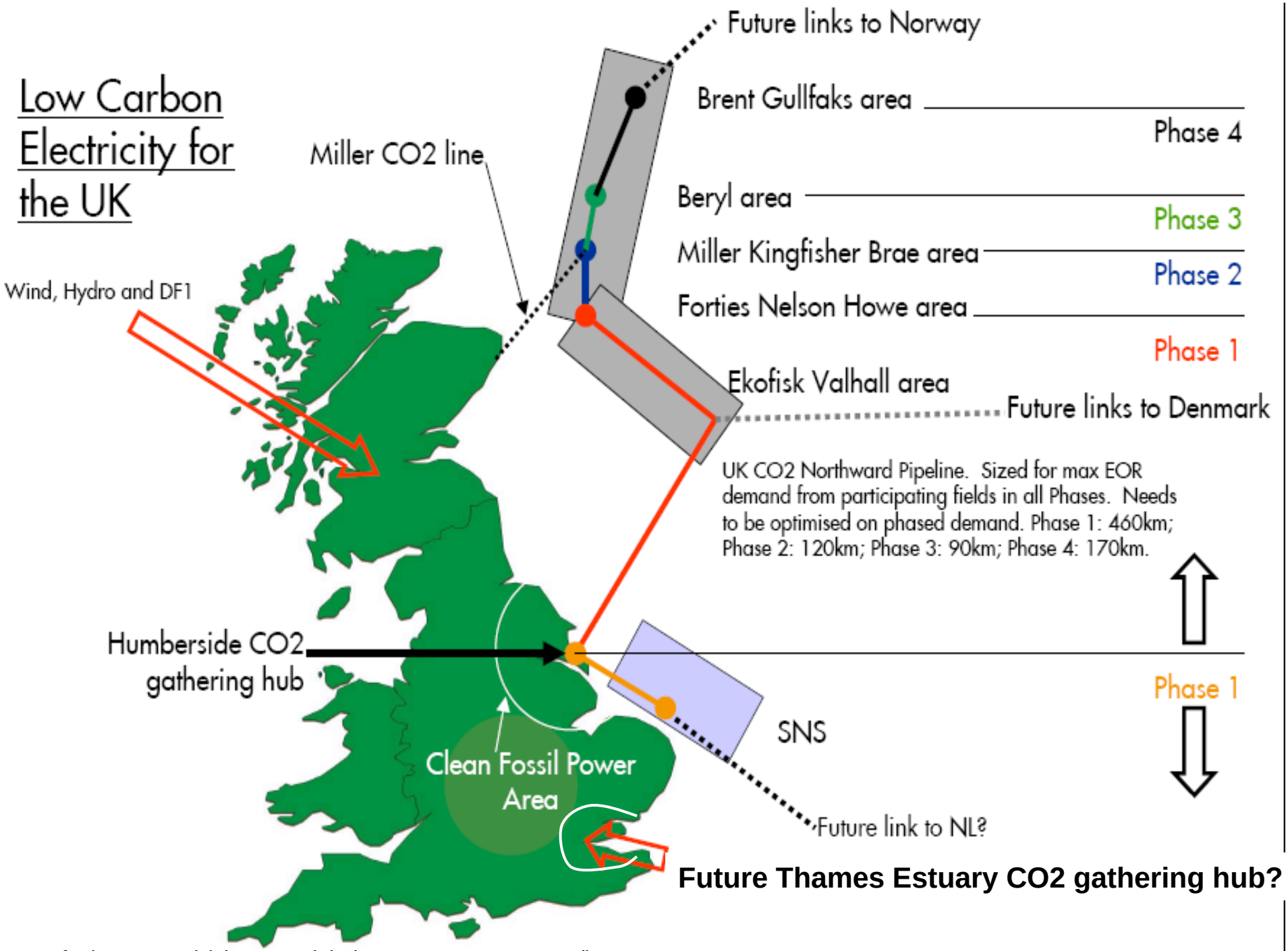

Future Thames Estuary CO2 gathering hub?

Powerfuel Power Ltd (plus Imperial Thames Estuary proposal)

Meeting the Energy Challenge
A White Paper on Energy
May 2007

Department of Trade and Industry

Presented to Parliament by the Secretary of State for Trade and Industry

By Command of Her Majesty

May 2007

http://www.dtistats.net/ewp/

CCS DEMONSTRATION PROJECT COMPETITION

Following the 2007 Budget announcement, the Government is engaged in designing a competition framework for the UK CCS demonstration. Our intention is to launch the competition in November 2007. The criteria against which proposals will be assessed are likely to include the need for any project proposal to:

– be located in the UK;

– cover the full chain of CCS technology on a commercial scale power station (capture, transport and storage);

– be based on sound engineering design (reliable and safe) underpinned by a full front-end engineering and design study;

– set out the quantum of financial support requested;

– be at least 300MW, and capture and store around 90% of the carbon dioxide and thereby contribute at least an additional 0.25 Mt/yr of carbon savings to the UK's domestic abatement targets (relative to a gas-fired power station of equivalent size without CCS);

– start demonstrating the full chain of CCS at some point between 2011 and 2014;

– address its contribution to the longer term potential of CCS in the UK, (for example, through the potential of shared infrastructure) and to the international development of CCS; and

– be supported by a creditworthy developer entity.

UK Carbon Capture and Storage Consortium

started June 2005

to promote an understanding of how options for decoupling fossil fuel use from carbon emissions through the use of carbon capture and storage could be used to assist the UK in achieving an energy system which is environmentally sustainable, socially acceptable and meets energy needs securely and affordably

Part of the Research Councils TSEC Programme

www.ukccsc.co.uk

Tyndall Centre

University of Aberdeen

BGS 1835

The University of Reading

CAMBRIDGE

PLYMOUTH MARINE LABORATORIES

CRANFIELD

NOTTINGHAM

The University of Edinburgh

University of Newcastle

University of Glasgow

Manchester 1824

University of Leeds

Imperial College London

HERIOT-WATT

UK CSC

UKCCSC PROJECT SCOPE, STRUCTURE AND COORDINATORS

E. GIS (Sam Holloway, BGS)

F. Dissemination (Stuart Haszeldine, Edinburgh)

G. High Level Energy Modelling
(David Reiner, Cambridge)

H. Dynamic Pathways
(Clair Gough, Manchester)

Other activities required to integrate information from all project themes (will occur directly between any themes and tasks where appropriate although these are not all shown schematically)

A. Fossil Energy Systems and CO2 Capture and Transport (John Oakey, Cranfield)

A1. Fossil fuel supply

A2. CCS synergies with other low emissions technologies

A3. Fossil fuels and CCS as bridge to H2 economy

A4. Fossil fuel utilisation with CO2 capture

A5. UK real time electricity supply and CCS plant

A6. UK CO2 transport infrastructure

A7. Long Term Utilisation

B. Geological Storage (Jonathan Pearce, BGS)

B1. CO2 integrity: pre-assessment
- Caprocks and seals
- Geochemical responses
- Geophysical monitoring

B2. UK hydrocarbon fields and added value from CO2
- Near-field and reservoir characterisation
- Subsurface flow modelling
- Phase behaviour and injectivity
- Economic analysis

B3. UK offshore and onshore aquifers: injectivity and storage volumes

C. CCS and the Environment (Carol Turley, PML)

C1. Marine ecosystems models

C2. Laboratory mesocosms

C3. Natural analogues

C4. Scientific literature

C5. Field experiments

C6. Socio-economics

C7. Networking

D. Social Processes in relation to CCS (Simon Shackley, Manchester)

D1. Media and NGOs

D2. Stakeholder analysis and business models

D3. Responsiveness to events

Note: Simon Shackley is planning to go on sabbatical in late 2005. During that time David Reiner (Cambridge) will be responsible for overseeing this theme and Sarah Mander (Manchester) will lead work on the media (G1).

Notes:
1) Names in brackets are theme leaders. Theme leaders in bold plus Jon Gibbins (Imperial) form the Management Committee.
2) Themes E to H are integrating activities

Carbon Capture & Storage Association

http://www.ccsassociation.org.uk/

started March, 2006

The Carbon Capture & Storage Association

The Carbon Capture & Storage Association (CCSA) exists to represent the interests of its members in the business of capture and geological storage of carbon dioxide as a means of abating atmospheric emissions of carbon dioxide

and, potentially, as a means of enhancing the production of fossil hydrocarbons. From its base in London the Carbon Capture & Storage Association brings together specialist companies in manufacturing & processing, power generation, engineering & contracting, oil, gas & minerals as well as a wide range of support services to the energy sector such as law, banking, consultancy and project management. The Association is a model for sectoral cooperation in business development and its existence is welcomed by government.

Various ongoing CCS activities

DTI internal studies and funded research projects

http://www.dti.gov.uk/energy/sources/sustainable/carbon-abatement-tech/page19502.html
http://www.dti.gov.uk/energy/sources/sustainable/carbon-abatement-tech/publications/page19482.html

DTI Project 407: Coal-Fired Advanced Supercritical Boiler & Turbine Retrofit with CO_2 Capture

DTI Project 366 : Future CO_2 Capture Technology Options for the Canadian Market

New DTI and industry projects: Oxyfuel, IGCC, post-combustion, includes:

- E.ON oxyfuel test rig
- Doosan Babcock 30-40 MW oxufuel burner rig
- RWE test rig – post-combustion

Energy Technologies Institute starting later in 2007, £600M+ over ten years

BP-Rio Tinto Hydrogen Energy: headquartered in Weybridge in the south-east of England

IEA Greenhouse Gas Programme: Cheltenham, south-west England
http://www.ieagreen.org.uk/

WHAT ADVANCES ARE NEEDED?

- Start on first tranche plants – will immediately trigger R&D
- Get new technologies working:

  IGCC - mainly engineering

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- Get the best out of existing PC technology

  post-combustion capture options

  capture-ready and retrofit strategies

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- Start on first tranche plants – will immediately trigger R&D
- Get new technologies working:
  - IGCC - mainly engineering
  - oxyfuel - basic research and engineering in parallel
- Get the best out of existing PC technology
  - post-combustion capture options
  - capture-ready and retrofit strategies
- Storage issues: ETS, capacity optimisation, safety, monitoring, long term liability – rapid progress needed
- Transport and storage systems – pipeline routing issues
- Political, regulatory, fiscal backup – post-Kyoto process
- Build capacity: people, expertise, manufacturing capacity

Incremental development and innovation

CCS systems will operate in new ways in new markets

CCS OR THE END!