

Drivers for CCS in a Low Carbon Economy

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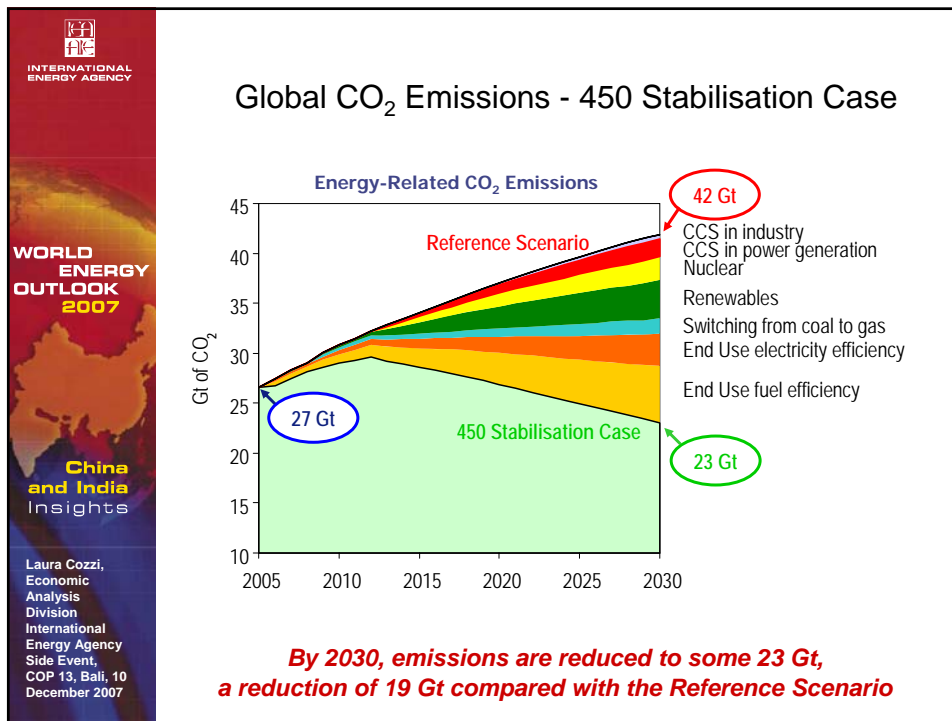
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Outline

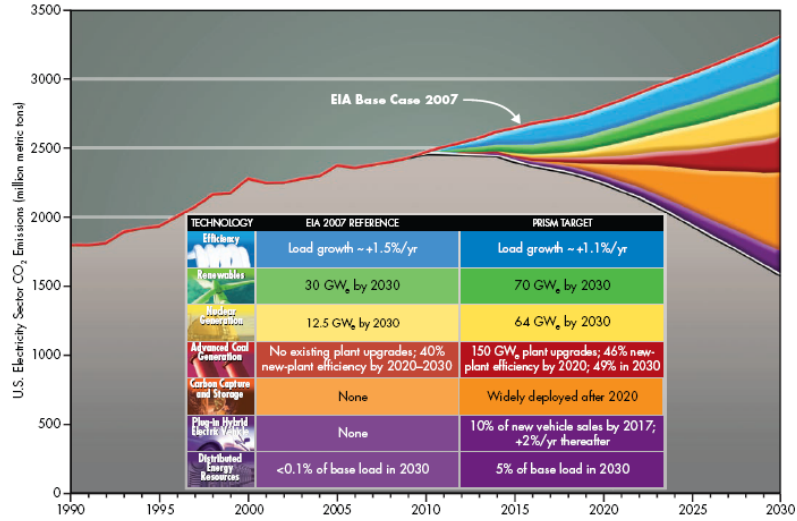
- Drivers for CCS deployment in the long term
- Drivers for CCS demonstration in the short term
- Implications for design (technology and policy)
 - Capture ready
 - Flexibility
- Conclusions

Independent experts say CCS is needed

- Stern Review, 2006
“[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.”
- Statement by Lord Martin Rees, President of the Royal Society, 10 June 2008
“If coal burning power plants and industries continue to pump out carbon dioxide unabated we face a growing risk of triggering a dangerous and irreversible change in the climate. Techniques for carbon capture and storage must therefore be developed urgently. So much is at stake that current efforts are quite inadequate.”



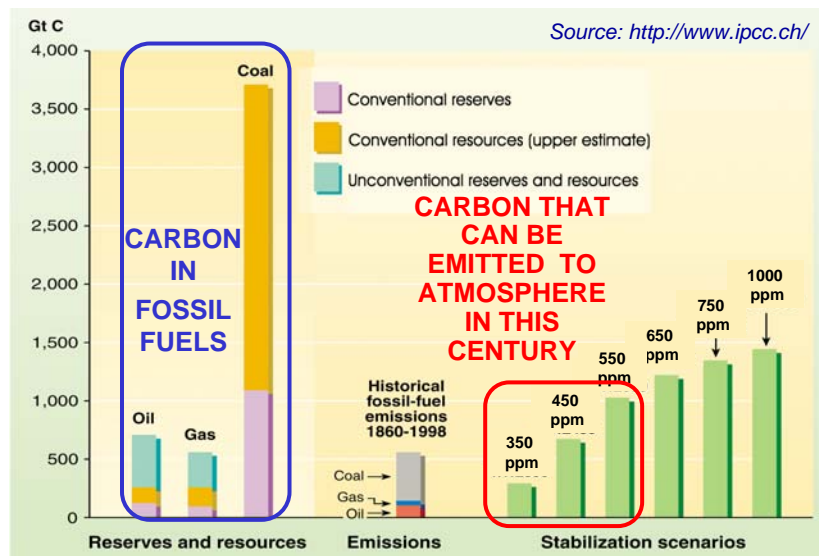
EPRI PRISM Analysis for USA



http://mydocs.epri.com/docs/CorporateDocuments/EPRI_Journal/2007-Fall/1016127_ModelingtheTechMix.pdf

CCS is the only way that fossil fuels can be used safely

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



Class 1 – Class 2 – Class 3 CCS projects

Class 1 CCS projects stop things getting worse

Class 2 CCS projects make things get better

Class 3 CCS projects remove CO₂ from the air

Class 1: Usually producing hydrocarbons, get carbon footprint down to conventional hydrocarbon levels e.g. coal-to-liquids, oil sands

Class 2: Carbon free energy vectors – electricity, H₂, heat

Class 3B: Biomass plus CCS (takes CO₂ from the air)

Class 3A: Technology to process air directly to capture CO₂

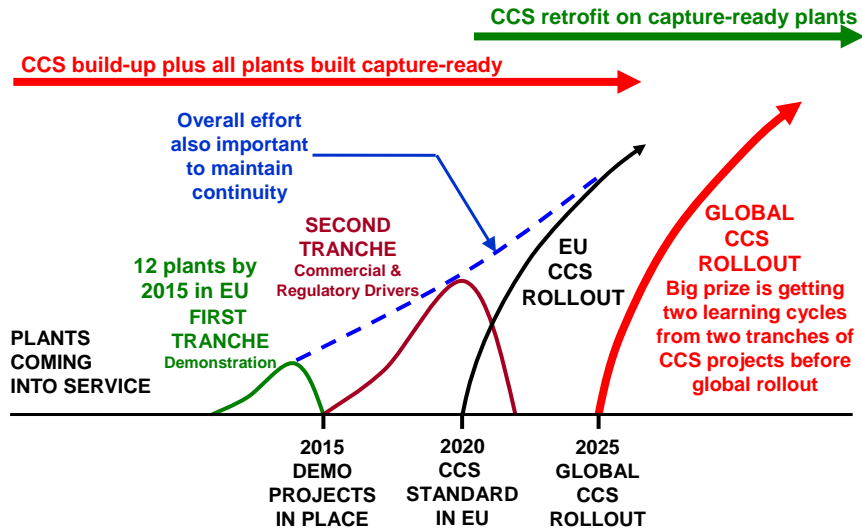
Enhanced oil recovery (EOR) a grey area

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Demonstration programme to get ready for capture (1)

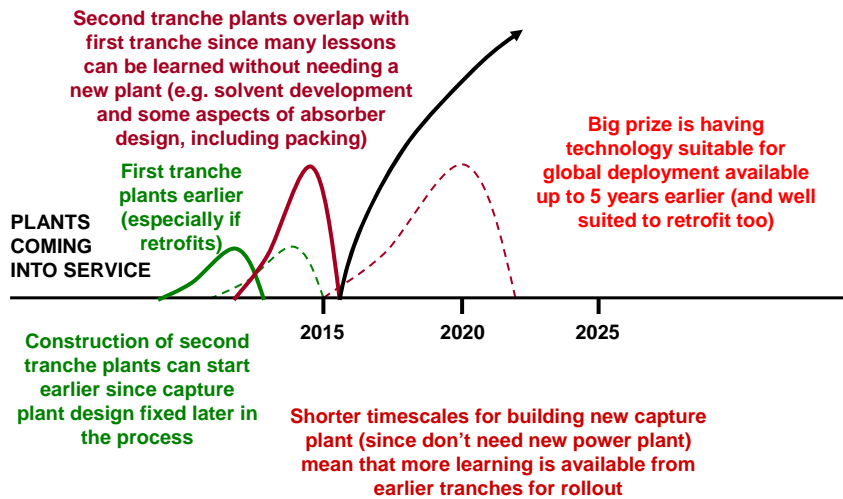
Critical path for IGCC and oxyfuel demo and deployment?...



Gibbins and Chalmers (2008), Energy Policy

Demonstration programme to get ready for capture (2)

Critical path for post-combustion capture demo and deployment?...



Gibbins and Chalmers (2008), Energy Policy

UK CCS Competition

- One project – post-combustion capture on commercial-scale (at least 300MW) coal power plant
- Post combustion – tackle global emissions, retrofitting can reduce emissions already locked-in
- Carbon dioxide stored offshore
- Operational by 2014

Objectives of UK demonstration

Two key objectives:

- Deliver successful demonstration of full chain of CCS technologies on a power plant at commercial scale
- Demonstrate technology that is relevant and transferable to key global markets

<http://www.berr.gov.uk/energy/sources/sustainable/carbon-abatement-tech/ccs-demo/page40961.html>

http://energy.senate.gov/public/_files/RCrisp.ppt

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Capture ready design and policy: Whys map on to hows

Must:

- Have access to geological storage
 - Have space and access for capture equipment
 - Have reasonable confidence it will work
- e.g. Have to re-permit for CO₂ after ten years?**

Society

Reasonably-justified plan for the future

Also consider:

- Up-front expenditure with savings later, e.g.
Bigger, better equipment?
Cheaper/better CO₂ storage?
- Flexibility – initial retrofit and later technology upgrades

Regulator

but different interests?

Owner

**& auditors,
bank's
engineers etc.**

Detailed studies for immediate action, protect investment value

Tilbury - 2x 800MW Capture ready- photo montage (some details omitted)

npower



Richard Hotchkiss, RWE npower R&D, RECENT DEVELOPMENTS IN CARBON CAPTURE AND STORAGE
COMBUSTION DIVISION OF THE COAL RESEARCH FORUM . 17 April 2007, <http://www.coalresearchforum.org/pastmeetings.html>

RWE Group

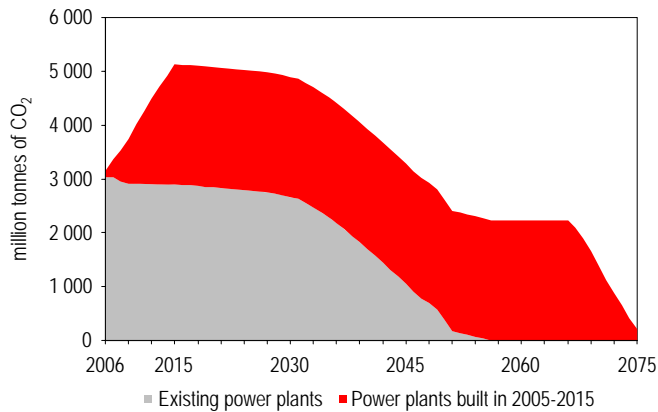
**Tilbury - 2x 800MW
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**CO₂ Emissions from Coal-Fired Power Stations
built prior to 2015 in China & India**



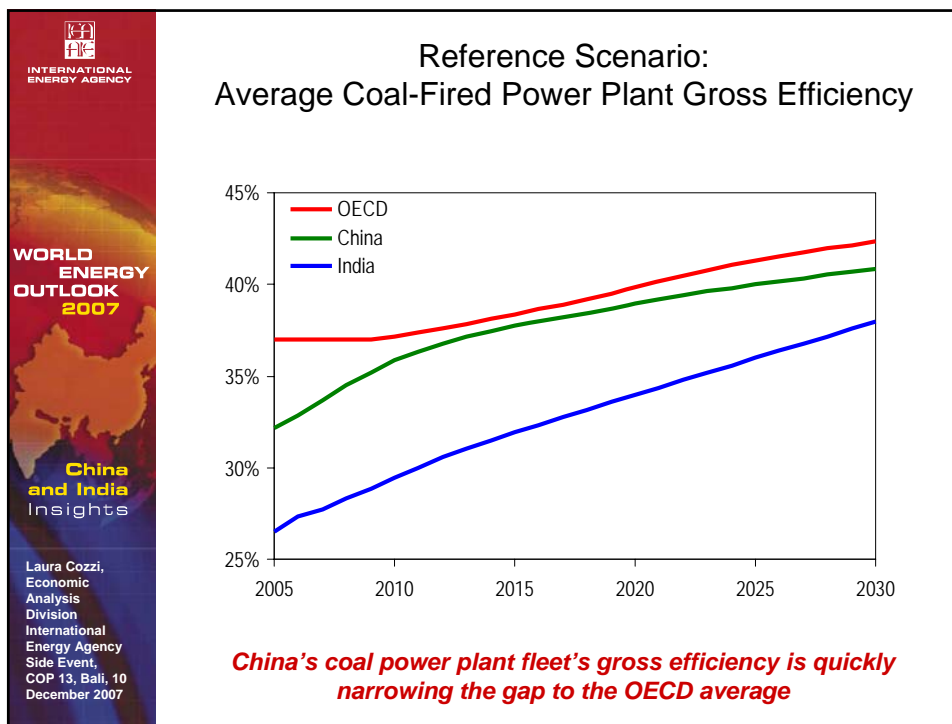
***Capacity additions in the next decade will lock-in technology
& largely determine emissions through 2050 & beyond***

INTERNATIONAL ENERGY AGENCY

WORLD ENERGY OUTLOOK 2007

China and India Insights

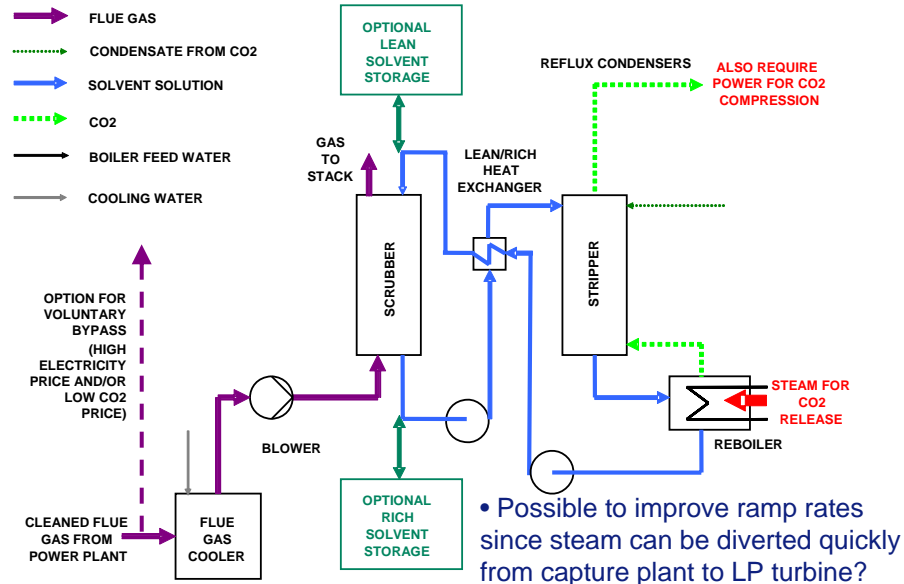
Laura Cozzi,
Economic Analysis Division
International Energy Agency
Side Event, COP 13, Bali, 10 December 2007



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Some examples of flexible operation



More detail in Chalmers and Gibbins (2007) Initial evaluation of the impact of post combustion capture of carbon dioxide on supercritical pulverised coal power plant part load performance, Fuel 86, 2109-2123

Sources of value for flexible operation?

- Potential synergies with renewables
 - Avoid energy penalty during peak hours
 - Avoid excessive use of high energy cost plant
 - Ancillary service revenue stream
 - Deferral of new build
 - Risk mitigation
 - Policy risk, including climate change
 - Commodity prices
 - Benefiting from technology advances
- ...but analysis difficult since many have system-specific values

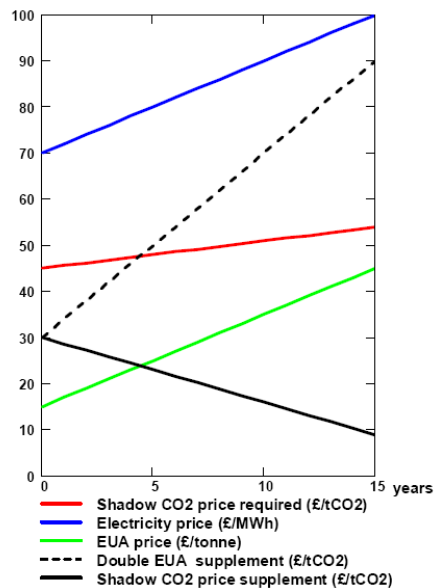
CCS incentives: potential for flexibility?

- Almost certainly want different incentives for different tranches
- Mechanisms to consider include
 - Capital grants (State Aid rules issue in Europe)
 - Feed in tariffs for CCS plants
 - CCS electricity obligation certificates (similar to ROCs)
 - Give extra EA's for stored/abated CO₂ – ZEP say x 3
 - Floor price for abated CO₂/contract for differences
 - Government offers 'sewage system' for CO₂ – location?
 - Performance standards – some flexibility important
 - 'No new coal without CCS' & 'natural gas standard'
 - Carbon Storage Certificates

CCS incentives: remembering the future

Purely illustrative example comparing shadow carbon price supplement value probably decreasing with time and 'double EUA' supplement increasing with time.

Estimates based on 45% LHV power plant with 9 percentage points capture penalty. Initial shadow carbon price required £45/tCO₂ as shown.



Conclusions

- CCS is being highlighted as an important option by a number of independent experts
- Getting ready for 2020 deployment of CCS is already urgent for 2 demonstration tranches
- Capture ready is likely to be important, at least in China (and India)
- Flexible operation can make a big difference to power plant profits
- Need to identify policy measures that allow flexibility but maintain environmental integrity

Acknowledgements

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 - UK Carbon Capture and Storage Consortium, part of the TSEC programme
 - British Coal Utilisation Research Association (BCURA)
 - IEA Greenhouse Gas R&D Programme
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- The opinions and interpretations expressed in this paper are, however, entirely the responsibility of the authors.

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