CO_2 Capture Ready Plants

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3rd Oxy-combustion Network Meeting

Yokohama, Japan, 5th-6th March 2008

Overview

- The need for capture ready plants
- Definition of capture ready
- Technical requirements
- Economic considerations
- Which technologies are best for capture ready?

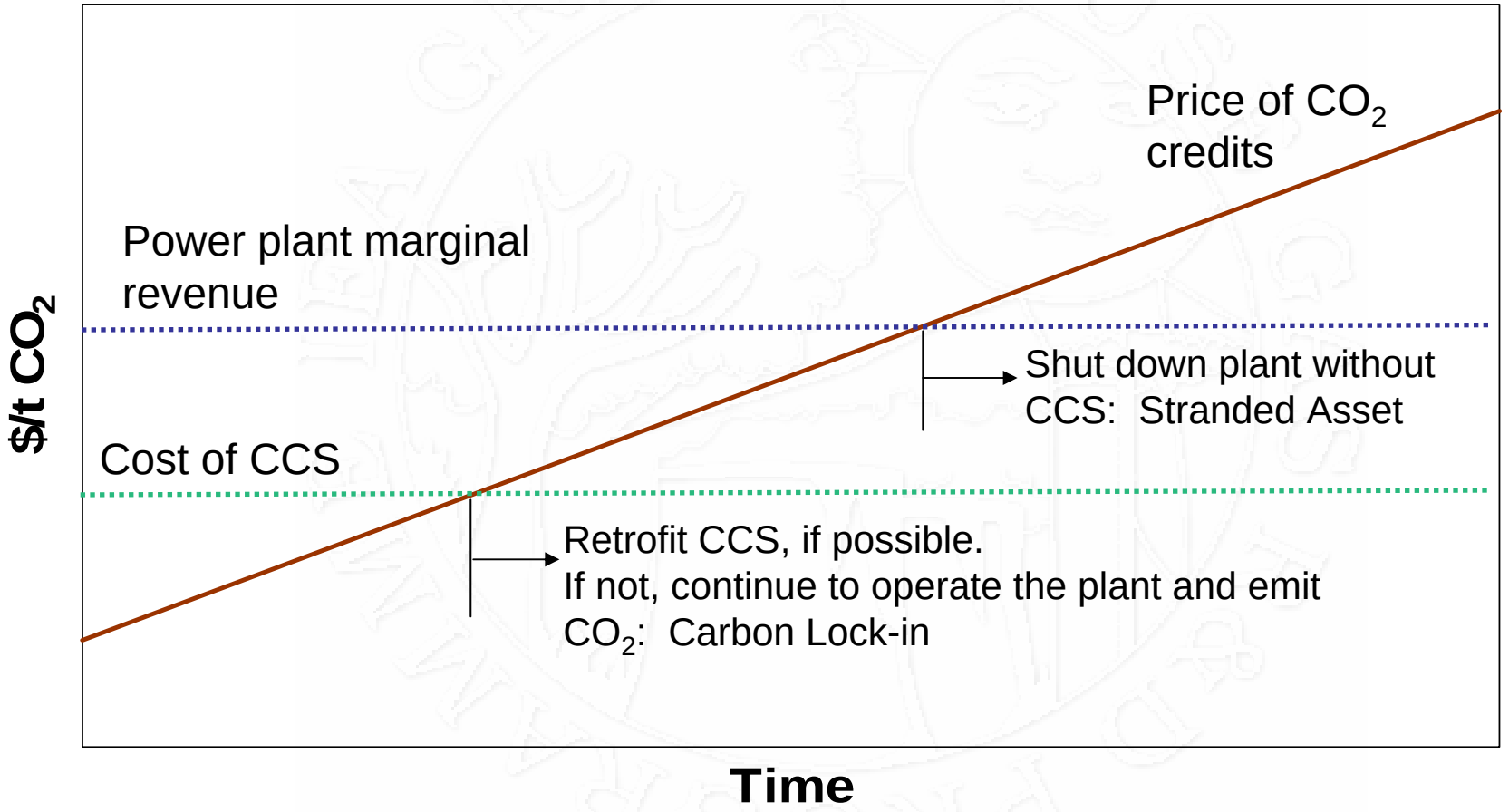
Why are Capture Ready Plants Needed?

- CCS is currently not economic in most cases
  - No economic incentives in many countries
  - Even where there are incentives they are usually too low and uncertain
- CCS is still at the development and demonstration stage
  - Demonstration plants are needed to improve investor confidence
  - Regulatory issues are being addressed
- There is a large demand for new power stations in the near future
  - Developing countries – mainly new capacity
  - Developed countries – mainly replacement capacity
- Power plants have long lives (>50 years)
  - Emission reductions are likely to be necessary during their lifetimes

What is meant by ‘Capture Ready’

- A CO_2 capture-ready power plant is a plant which can include CO_2 capture when the necessary regulatory or economic drivers are in place.
- The aim of building plants that are capture-ready is to reduce the risk of ‘carbon lock-in’ or ‘stranded assets’.

Carbon Lock-in and Stranded Assets



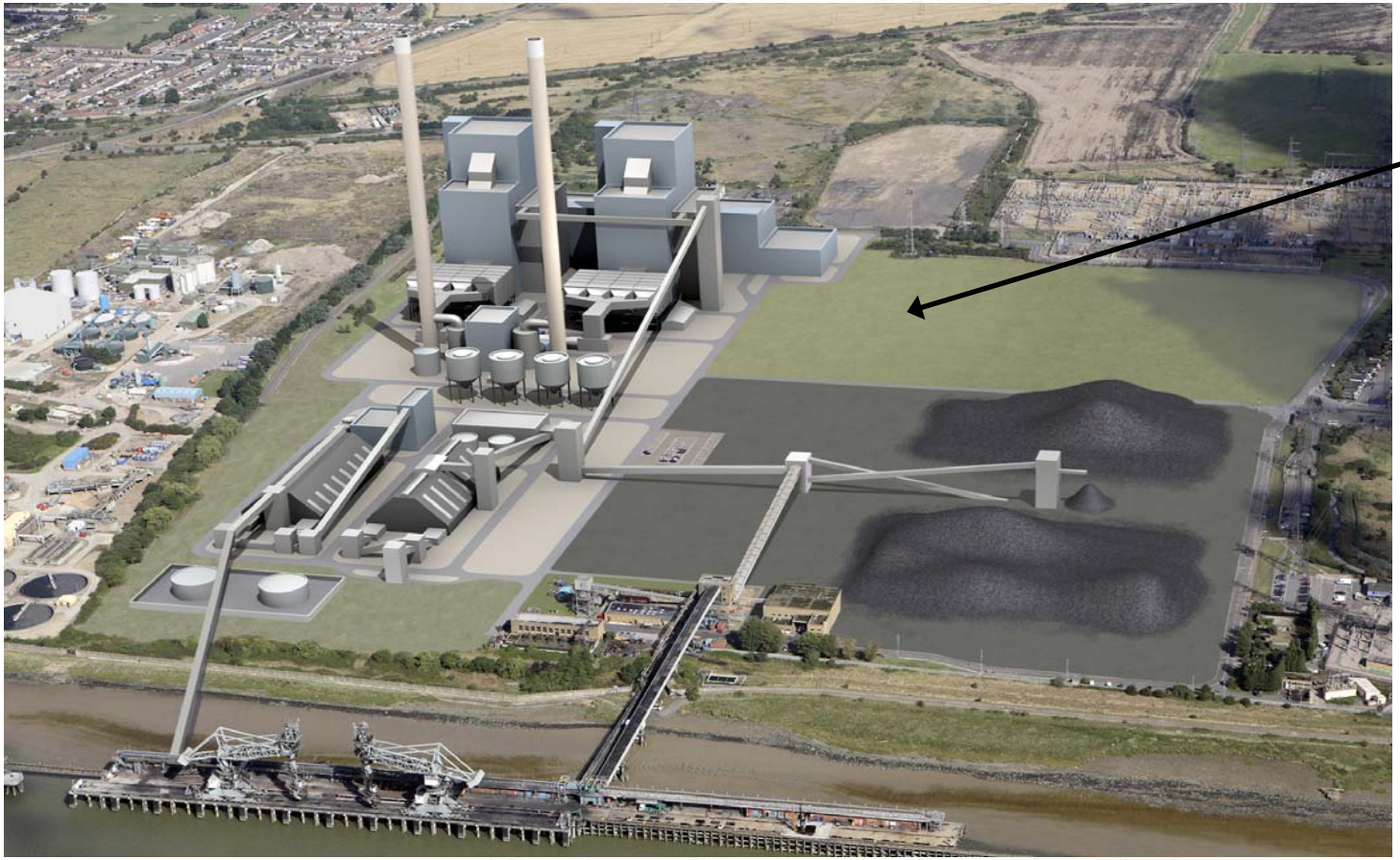
Capture Ready Requirements

- 'Essential' requirements
  - Carry out a design study on retrofit of CO_2 capture
  - Include sufficient space and access for the additional facilities that would be required
  - Identify reasonable route(s) to storage of CO_2
- Optional pre-investments
  - To reduce the downtime and cost of capture retrofit
  - To optimise the plant operation after retrofit

Essential Requirements: Space and Access

- Space for new equipment etc
  - Oxygen plant, flue gas cooler, CO_2 compressor etc
  - Electrical distribution, cooling water, waste water treating etc
  - Safety barrier zones, if required
  - Extra space needed during construction
- Space for access within the existing plant
  - Pipe work and tie-ins with existing equipment
- Additional generating capacity, if required
  - CO_2 capture usually reduces net power output
    - By about 20% for current oxy-combustion technology
  - May need to build new capacity to maintain the site power output

CO_2 Capture Ready Plant



Proposed 'capture ready' power plant at Tilbury
(One of the possible options for this site)

Courtesy of RWE Npower

Essential Requirements: Access to CO_2 Storage

- Where are potential CO_2 stores?
- What are their capacities?
- How to transport CO_2 to the stores?
  - Rights of way for pipelines
  - Safety
  - Public acceptance
  - Proximity to other potential CO_2 sources
    - Large economies of scale for pipelines
- An alternative power plant site may be preferred

How to Establish a Credible CO_2 Store?

- Identify a broad area where a large amount of storage is expected to be available, e.g. the North Sea
- Identify specific reservoir(s)
  - What needs to be done to characterise the reservoir?
    - Seismic surveys
    - Exploratory drilling
  - Costs could be significant
- Purchase a reservoir or a contractual option to use it
  - To avoid someone else using the reservoir

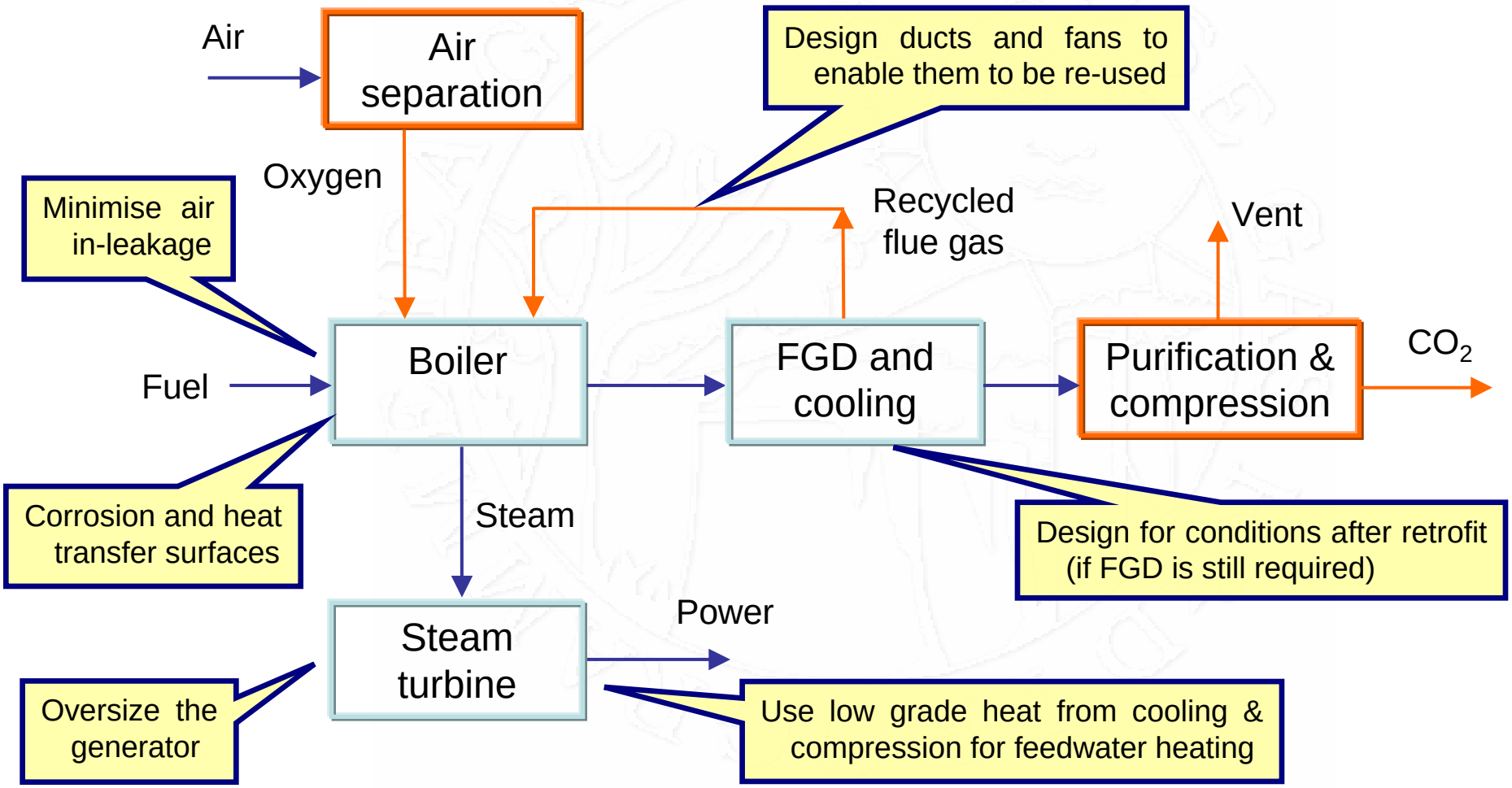
Pre-Investments – Maximising Efficiency

- The efficiency/capital cost trade-off is different for plants with CO_2 capture
  - Thermal efficiency is lower
  - Cost of generation is higher
  - The trade-off favours higher efficiency/higher capital cost designs, e.g. ultra supercritical steam cycles
- Higher efficiency designs reduce emissions even before capture retrofit
  - An important environmental benefit

Pre-Investments - General

- Oversize pipe racks etc
- Include flanges for connecting new plant
- Provision for expansion of the control system, on-site electricity distribution, cooling capacity etc
- Some of these investments are expected to have low costs and high economic returns

Pre-Investments – Oxy-Combustion



Reasons for not Making Pre-investments

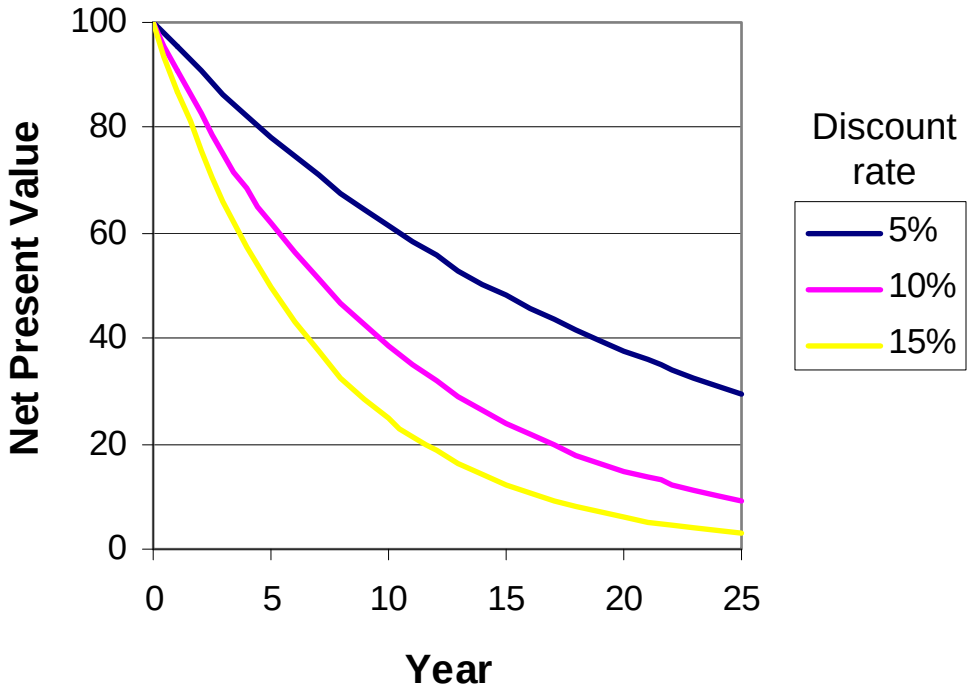
- Uncertainties
- Economic Discounting

Uncertainties

- If or when will capture retrofit be required?
  - Future values of carbon credits
  - Regulatory requirements
- Current uncertainties in large scale plant designs
- How will capture technologies develop in future?
  - Capture ready plants should be designed for current technologies
  - Incremental improvements in future
  - Possibility of substantially better technologies
  - Future technologies should be considered to reduce the risk of obsolescence

Economic Discounting

- Economic resources are worth less in the future than at present
- It may be several years before capture retrofit is required



➢ ***Major pre-investment is unlikely to be worthwhile if there is a long time before capture retrofit***

Which Process is Best for Capture Ready?

- Post-combustion capture
  - Retrofit to capture ready plants is relatively simple
  - Capture ready requirements are relatively well understood but technology developments e.g. ammonia scrubbing could change the requirements
- IGCC pre-combustion capture
  - Potentially attractive option for new-build power plants with capture
  - IGCCs without capture are expected to be more expensive than pulverised coal plants – choosing IGCC is a major pre-investment
  - Capture retrofit impacts on many aspects of the plant, unless significant pre-investment has been made
- Oxy-combustion
  - Some risks for capture ready because oxy-combustion is still at the pilot plant scale
  - Plants could also be made capture ready for post-combustion as a fall-back

A Note of Caution

- Capture Ready does not reduce emissions
  - Unless a higher efficiency plant design is selected
  - In some cases emissions may be slightly higher
- Capture Ready is not a substitute for capture
- Some people may regard Capture Ready as ‘greenwash’
- Plants with capture need to be built to demonstrate technology and increase investor confidence

Conclusions

- Capture Ready can reduce the risk of Stranded Assets and Carbon Lock-in
- Main Capture Ready considerations are:
  - Carry out a study of capture retrofit options
  - Leave space and access for capture plant
  - Identify reasonable route(s) to storage of CO_2
- Major pre-investment is unlikely to be worthwhile unless capture is going to be retrofitted soon after plant start-up
- Capture Ready is not a substitute for capture

Thank you

Any questions?