CO₂ Capture Ready Plants

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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

- Retrofit CCS, if possible.
- If not, continue to operate the plant and emit CO₂: Carbon Lock-in
- Shut down plant without CCS: Stranded Asset

Price of CO₂ credits

Power plant marginal revenue

Cost of CCS

Time

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Capture Ready Requirements

- ‘Essential’ requirements
  - Carry out a design study on retrofit of CO₂ capture
  - Include sufficient space and access for the additional facilities that would be required
  - Identify reasonable route(s) to storage of CO₂

- 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
Proposed ‘capture ready’ power plant at Tilbury

(One of the possible options for this site)

Courtesy of RWE Npower
Essential Requirements: Access to CO₂ Storage

• Where are potential CO₂ stores?
• What are their capacities?
• How to transport CO₂ to the stores?
  • Rights of way for pipelines
  • Safety
  • Public acceptance
  • Proximity to other potential CO₂ 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

- **Air separation**
  - Minimise air in-leakage

- **Boiler**
  - Corrosion and heat transfer surfaces
  - Fuel
  - Steam

- **FGD and cooling**
  - Use low grade heat from cooling & compression for feedwater heating
  - Design ducts and fans to enable them to be re-used

- **Purification & compression**
  - Vent
  - Recycled flue gas
  - CO₂

- **Steam turbine**
  - Power
  - Design for conditions after retrofit (if FGD is still required)

- **Oxygen**
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 CO₂
• 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?