



# Capture Technologies, Transport Infrastructure, & CO2 Storage

Some aspects affecting  
financing

Alastair Rennie, Project Director- Renewables,  
AMEC. 15<sup>th</sup> September 2008

**CARBON CAPTURE AND STORAGE  
FINANCING CHALLENGES AND  
OPPORTUNITIES**  
*World Energy Council Cleaner Fossil Fuels  
Systems Committee  
Carbon Capture and Storage Association  
Hosted by Corporation of London,  
Mansion House*

## AMEC at a glance



Services focused on designing, managing the delivery of, and maintaining strategic and complex assets

- We have annual revenues of over £2.3 billion
- We employ 20,000 employees in over 30 countries
- Our shares are traded on the London Stock Exchange where we are listed in the Oil Equipment and Services sector
- We are a member of the FTSE\* 100
- AMEC is an engineering company doing transportation, flood and dehydration systems, pipeline design services, EOR Conceptual Design Services, PM and Engineering Services for capture processes, new and existing pipelines and storage sites.

\*Financial Times Stock Exchange listing

## Carbon Capture and Storage – Regional

The North American market has been EOR led to increase revenue, with CO<sub>2</sub> as a commodity feedstock. As such it is oil producer led. Re-cycling of the CO<sub>2</sub> from the oil is simply good cost management.

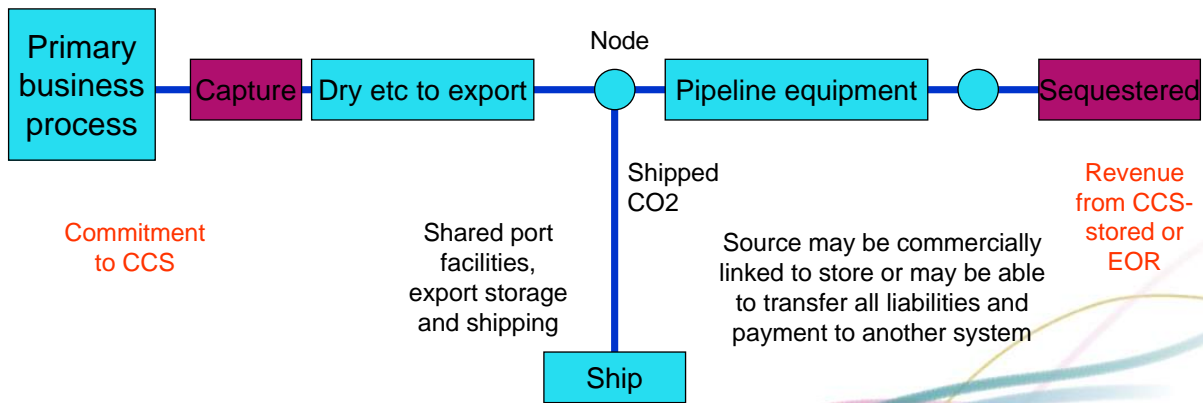
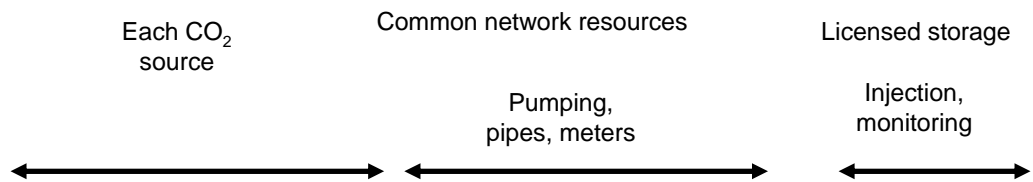
CO<sub>2</sub> in Europe is environmentally led, with the CO<sub>2</sub> as a cost burden and integrity of storage as the goal, with any EOR as a bonus. As such it is emitter led and sensitive to valuing CO<sub>2</sub> externalities with the ETS as the strongest market signal.

Other countries are active, generally with an environmental interest such as China and Australia with their important coal interests.

### **Global focus on coal**

Coal is important because of the relatively high CO<sub>2</sub> per unit energy and its use in power stations which are the largest unit and sector emitters.

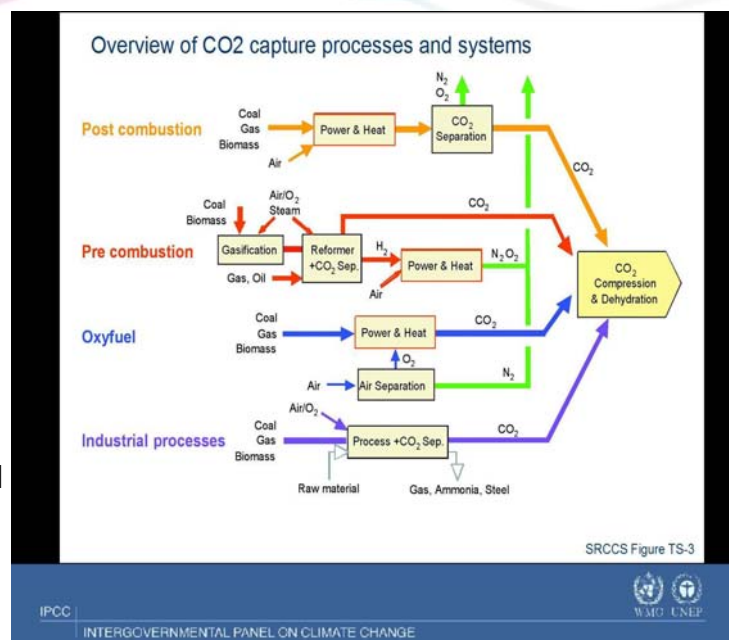
# CCS commercial demarcations



## Capture



- Capture technology and characteristics are driven by site and plant process details. The CO<sub>2</sub> output for high volumes is quite similar in all cases due to multiple downstream considerations
- The main processes, post combustion, oxy fuel and pre combustion, are well understood overall and in most details. R&D may offer important efficiency improvements but are not essential to move forward with CCS.
- The main issue is in proving costs at large power station scales, particularly arising from operating efficiency, availability, and flexibility

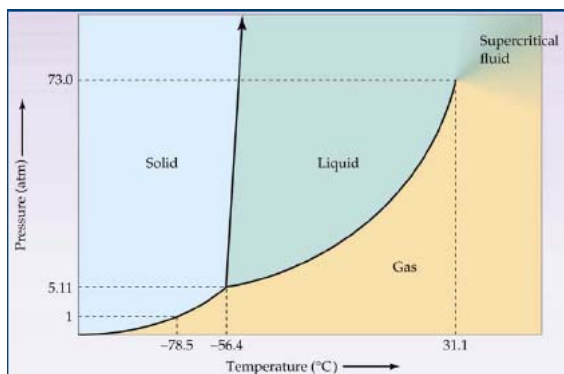


## Transport



Bulk transport has solid, liquid or gaseous options.

- Solid however require energy to cool the CO<sub>2</sub>, insulation during transport, or hydrate formation, and liquefaction for geological injection, so the use of the solid phase is generally discounted. Transport as a gas is good for short distances and smaller volumes.
- For ambient temperatures liquid CO<sub>2</sub> at medium to high pressures is ideal and proven in North America in both volume and distance.
- Besides simple dedicated lines network studies in the UK and US show viable systems once volumes are established.



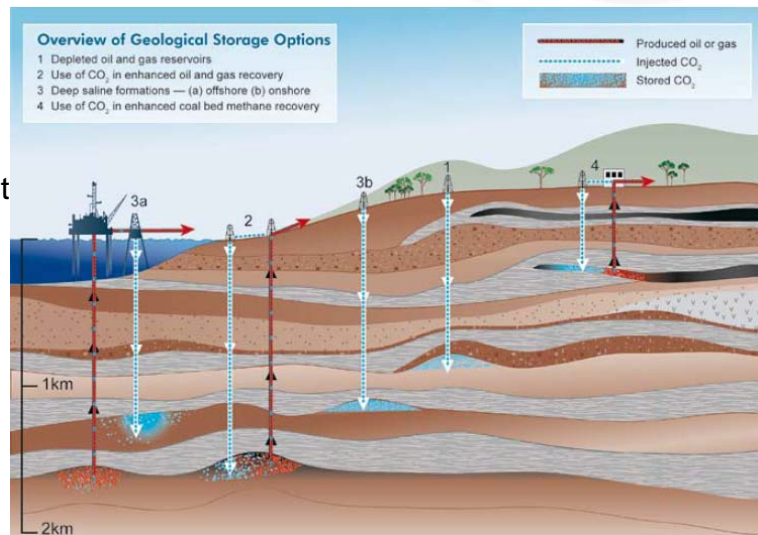
Shipping has specific options of ambient temperature and high pressure, or low temperature and medium pressure.

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## Storage



- Carbonation is useful for smaller quantities in the right circumstances.
- Ocean water storage is ruled out as it is not secure storage without significant environmental risks
- Storage in geological formations requires a seal or cap rock generally at depths greater than say 800m.
- The storing formation, coal, oil& gas bearing rock, or saline aquifer, all require sufficient injectivity
- Various mechanisms will gradually immobilise the CO<sub>2</sub>.



IPCC CCS Figure SPM.4. Overview of geological storage options (based on Figure 5.3)  
(Courtesy CO2CRC)

## Shipping and Pipelines



### Shipping

- Low capital cost to user
- High operating cost
- 3-10 year commitment
- Another commodity to a competitive transport industry
- Practical issues around acquisition dominate consenting
- Interim storage or batch dispatch is a constraint
- Flexible but more disruption risk

### Pipeline

- High capital cost
- Low operating costs
- 10-15 year minimum to plant life commitment
- Bespoke, improved by networking
- Slow approval processes
- Limited capacity variability
- Rigid asset between a source and a store leads to fewer commercial options
- High reliability

## Commercial options for a pipe network



1. Public or Regulated infrastructure- open access, no market exposure
  2. Shared ownership by sources
  3. Ownership by an independent transport company
  4. Shared ownership by investment stakeholders- sources, transporters, store operators. Could include public bodies.
- This ignores single source to single store situations – covered by in-house or linear commercial agreements
  - Covers pipeline networks, including shipped CO<sub>2</sub> inputs and outputs
  - Focus is on earlier configurations of networks - other ownership and commercial arrangements may arise with well established assets and CO<sub>2</sub> flows

## Relative comparisons of main issues



Ownership \ issue	Public/ regulated	Ownership by sources	Independent company	Stakeholder owned
Ownership of the CO <sub>2</sub>	Unlikely to own	Owens the CO <sub>2</sub>	Option to own	Option to own
Commitment by source	Highly risk averse	Potentially well aligned	Mutual commercial risks	Depends on scale & SPV terms
Storage availability	Mainly fixed fee, small rate/tonne	May enable capacity sharing	Back to back investments	Depends on scale & SPV terms
Transport availability	Seek to limit all exposure	Proportional exposure	Seek to limit exposure	Ideally equity proportional to exposure
Discount rate	Lowest	Internal to company	SPV- parent driven	SPV – project finance

## Conclusions on transport

- Public ownership is possible because it is a network rather than a single source solution. However it is not an essential national grid, but there is value in public sector engagement especially in early phases.
- The shared ownership by source interests is, on balance, probably the preferred option.
- We would suggest that this may be enhanced by elements of other stakeholders, not least to engage with the public and to enable increments of investment to reduce the life time costs of moving CO<sub>2</sub> to storage.
- We see the provision of the wider scope of CO<sub>2</sub> services from source to sink as a good way for us to support emitters to minimise costs and for store owners to earn additional income from their oil & gas experience.

## Will it happen?



Requires a number of things to happen before we see CO<sub>2</sub> buried

- Global political agreements
- EU financial and regulatory support
- Government legislation and financial mechanisms
- Agree the regulatory regime, especially H&S of high pressure CO<sub>2</sub> and long term storage characterisation and liability
- For some countries they require enabling the storing of CO<sub>2</sub> from another country (*refer to presentation by Chris Mansfield*)

-just to arrive at a position where Carbon Capture and Storage is a long term commercially viable proposition

Actual financing can then take place to build and operate CCS;

- Capture (*the major commercial cost and risk*)
- Commitment to provide storage or EOR. Some storage has capacity to match sources- mostly a multiple store strategy will be required to match timescales and sizes of sources
- Transport of the CO<sub>2</sub> – secure enough, with (EU) provision for 3<sup>rd</sup> parties

## Factors against implement CCS



- Requires pricing an externality – climate change from CO<sub>2</sub>
- The primary products related to CCS – useful energy such as heat and electricity – are embedded into products and services may have to compete with un-mitigated energy sources.
- For the next rounds of CCS implementations technical and cost risks are serious deterrents to the necessary scale of activity
- Uncertainty of CO<sub>2</sub> value recognition causes financial risk costs which reduces the amount of actual CO<sub>2</sub> captured and stored for the money paid
- Without decent volume from a number of sources then transport and storage become expensive

## Factors helping implement CCS



- It converts coal as the worse/largest pollution source from a problem to an opportunity
- Coal as a resource is internationally a more evenly distributed and matched to energy users
- Good potential for re-use of existing power assets
- Swing production of CO<sub>2</sub> will offset intermittent renewable generation
- Low risk storage in depleted gas reservoirs and very large saline formation storage opportunities
- Governments have accepted that they are best placed to carry long term liabilities for storage.
- Large scale and few players make it easier to view the market and secure climate change improvements such as shared infrastructure with clustering of sources

## Commercial options for CCS



- Capture technology and characteristics are driven by site and plant process details. Source asset owners now need demonstration of the first generation of full scale, fully operational technologies.
- Storage ownership favours exiting owners for EOR, but that needs to be associated with other storage. Proving a saline aquifer resource will take time and money and may be easier for oil & gas reservoir operators in the same block.
- Transport commercialisation needs to focus on earlier configurations of networks - other ownership and commercial arrangements may arise with well established assets and CO<sub>2</sub> flows

If EU initiatives are successful it is feasible to see how good engineering and good commercial design could build CCS systems in Northern Europe.

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