CO2 Capture and Sequestration

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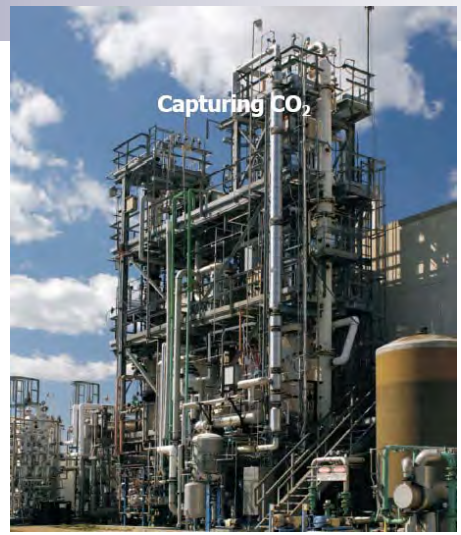
Gaffney, Cline & Associates (GCA) Overview

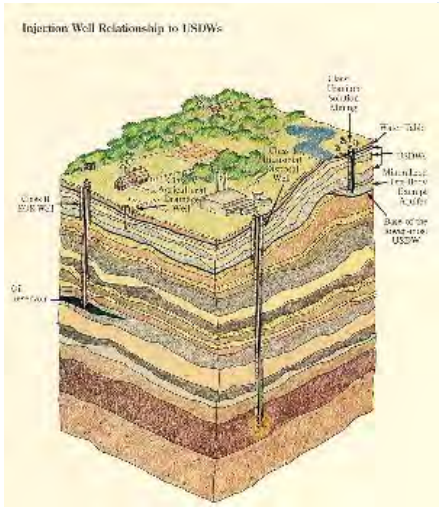
- **GCA, founded in 1962, is an international technical and managerial consultancy focusing on the full gamut of the oil and gas business from exploration to market development**
  - Technical
  - Strategic
  - Commercial
- **GCA clients include a broad cross section of the industry from national oil companies and governments to major integrated oil companies and investment banks**

CO_2 Capture and Sequestration Process

- **Capture of CO_2 Emissions**
  - Separation and processing of CO_2
- **Transfer**
- **Sequestration**



Source:IEA Greenhouse Gas R&D programme, 2007



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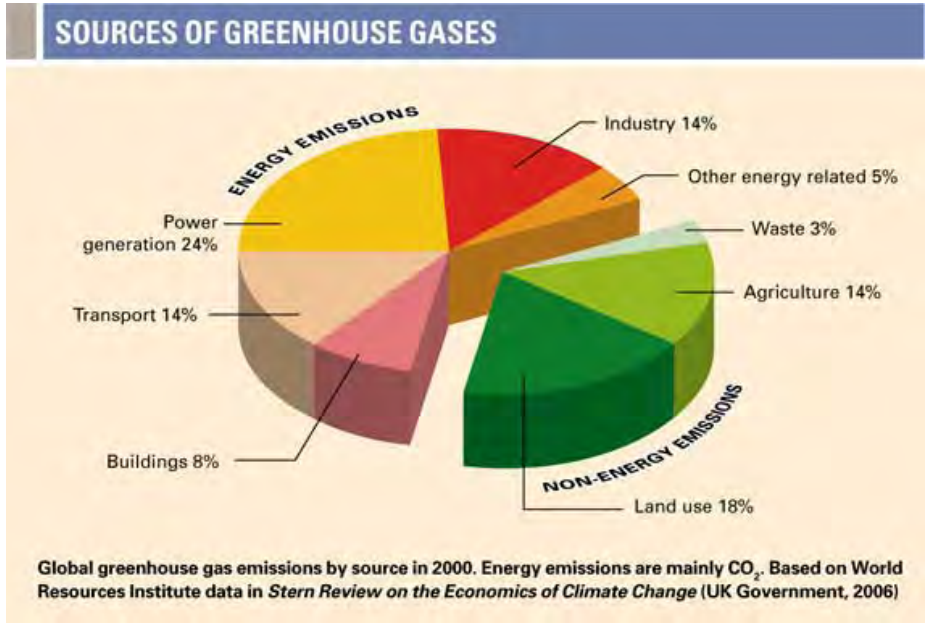
Overview of CO_2 Capture and Sequestration

- **CO_2 capture and sequestration is a means of reducing greenhouse gases by diverting CO_2 emitted from industrial sources into storage facilities instead of releasing them into the atmosphere**
- **While the technology to capture CO_2 is commercially viable and well developed, storage technology is much less well developed**
- **The costs for capture and sequestration are a major issue in commercial development**
  - For example, the costs are estimated to raise the price of electricity by 20-80% by some power plant operators
- **Despite cost hurdles, the number and range of CO_2 projects is expanding around the world due to the pressure to reduce greenhouse gases. (BP, Statoil, etc.)**

Capture of CO_2 Emissions

- **Opportunities to Capture CO_2 Emissions**
  - Gas processing
  - Industrial processes (cement, alcohol, etc)
  - Coal gasification
  - Coal fired and gas fired plants
  - Oil extraction from oil shales
- **Not practical to capture CO_2 from**
  - Transportation
  - Construction
  - Agriculture/farming
  - Natural emissions

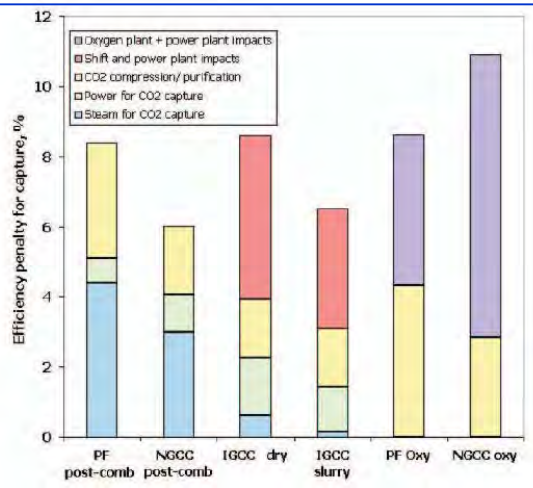
- ***Less than 50% of CO_2 emissions related to human activities can be captured (about 20 GT out of 41 GT est. for 2007)***



Source: BP p.l.c., 2008

Capture Technology

- **Direct capture from industrial processes**
- **Separation of CO_2 from combustion products**
  - Separation of CO_2 from flue gases
  - Separation of N_2 before combustion, processing of CO_2-rich flue gases
- **Dehydration and removal of corrosive agents**



Source:IEA Greenhouse Gas R&D programme, 2007

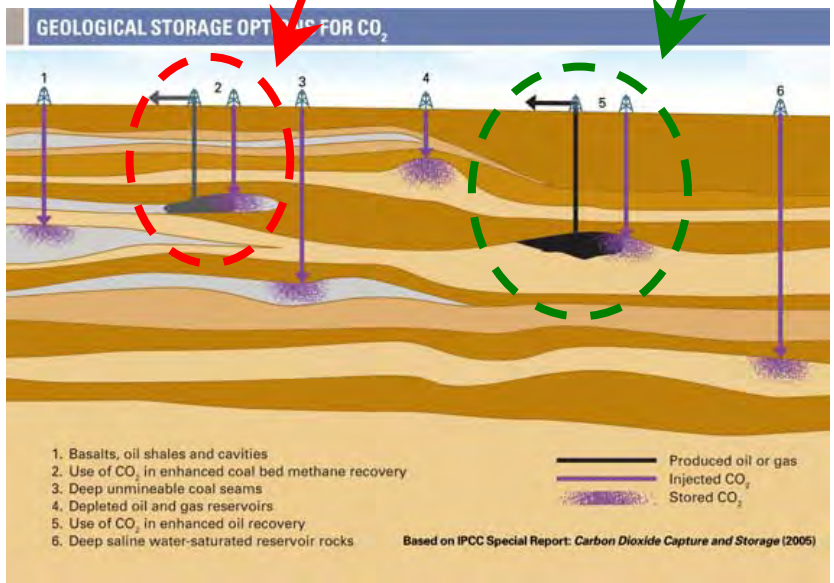
- ***CO_2 capture translates to about 10% decrease of thermal efficiency in Power generation plants***
- ***The increase of power generation costs will be at least 10% with a CO_2 capture implementation***

Transfer of CO_2

- Over-land pipelines (longest ~1600 Km)
- Subsea pipelines ?
- Liquefied gas tankers ?

CO_2 Sequestration

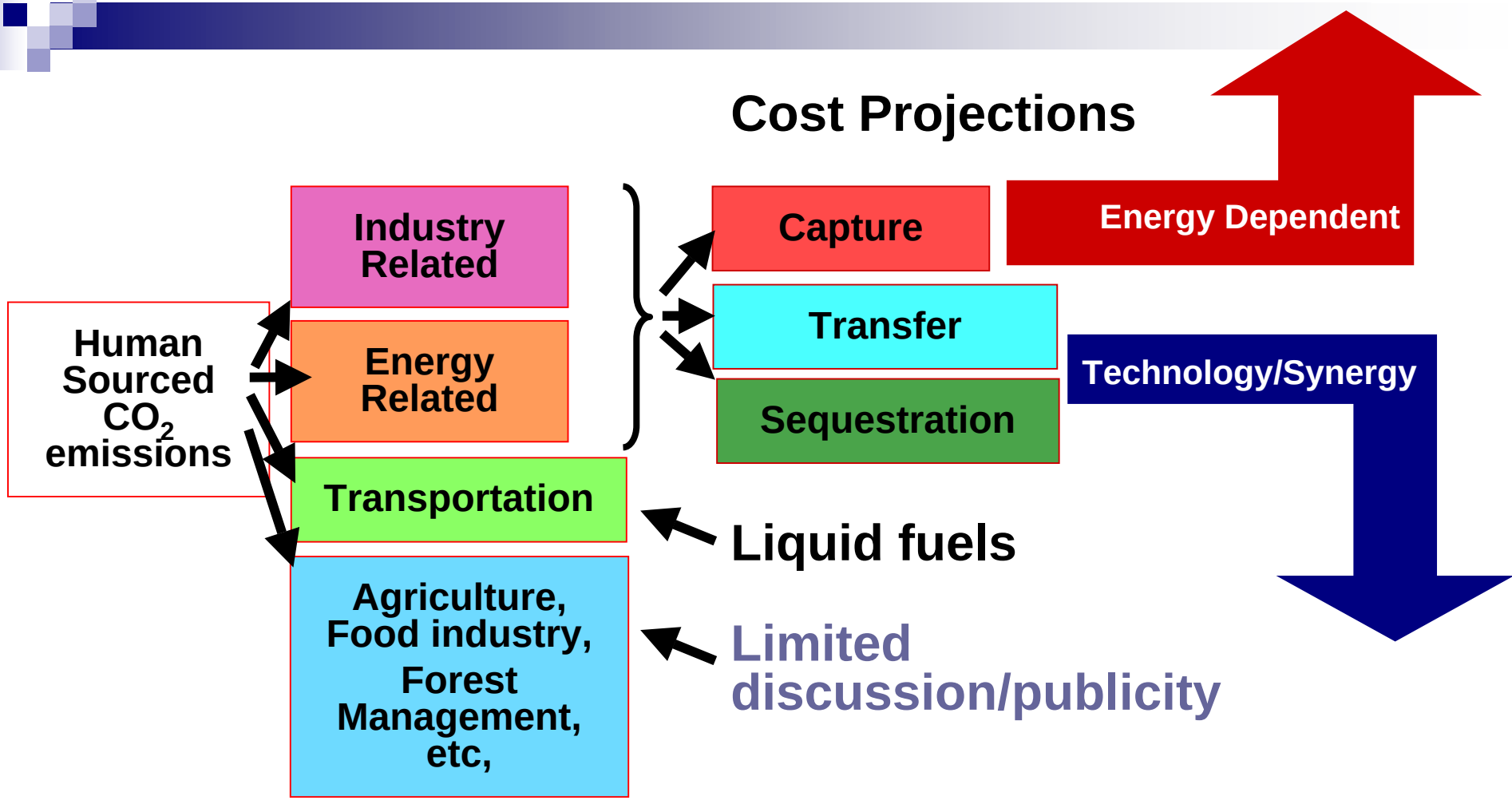
- **Agent for enhanced oil recovery**
  - CO_2 injection in oil fields can almost double oil recovery
- **Enhanced gas recovery**
  - Displaces methane from coal-beds
  - Used as fracture agent in tight gas reservoirs
- **Deep aquifer injection**
- **Ocean floor ???**



Source: BP p.l.c., 2008

- ***10,000 GT potential for undeground storage***
- ***About 10% of the underground storage potential relates to depleted oil and gas reservoirs***

What might be more important?



Pragmatic approach/synergy

- **Challenges posed by increased energy costs will impact CO_2 reduction implementation**
- **Expand existing EOR projects**
  - Existing economic incentives
  - Synergies in surface facility and transfer networks
- **Improve methods of transfer**
  - Increase practical distance between capture/sequestration locations
- **Offer long term incentives that can justify private sector investments**
- **Integrate energy production – CO_2 capture markets and policies**