

Energy Security: The Real Story

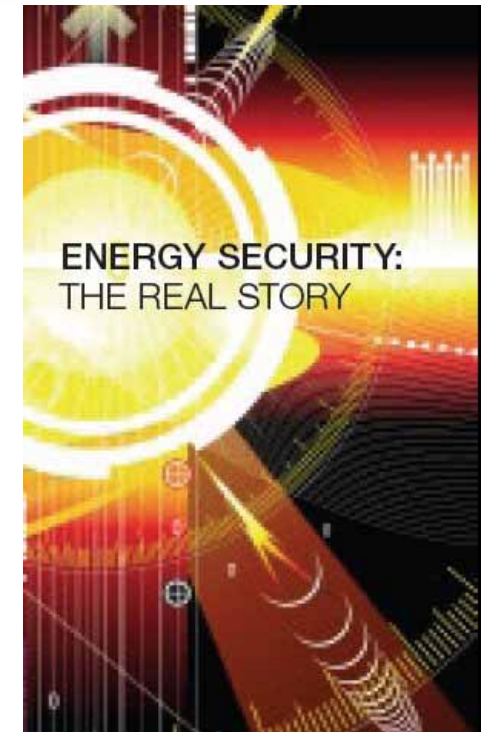
Fossil Fuels

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Energy security – some thoughts

- Civilisation requires energy
Culture = Energy x Technology (White's Law)
- Security requires equity
2.5B people presently using wood & cow dung for cooking and heating
- Society is becoming more globalised
Energy supply and environmental protection are global issues and require global solutions
- Social changes occur over generations
We need to think in terms of +50 year time frames

Global Total Primary Energy Supply

IEA – World Energy Outlook 2006

2005 Current Position

Demand of 11435 Mtoe, CO₂ emissions of 7.3 Gt/a from fuel combustion
81.0% of primary energy from coal + oil + gas
0.5 % from geothermal + solar + wind + heat

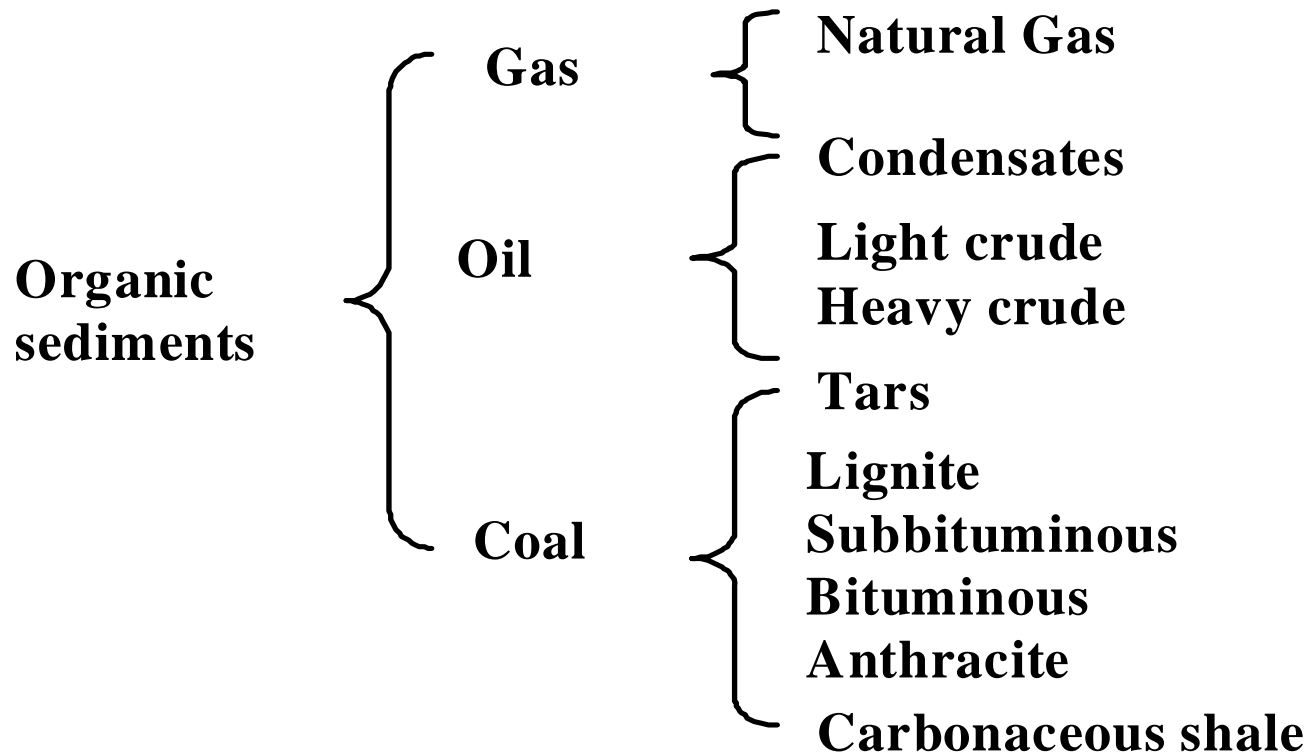
2030 Reference Case projections

Demand to 17095 Mtoe
75% of growth from developing countries
Energy sources remain basically unchanged
+\$US20T supply side investment required

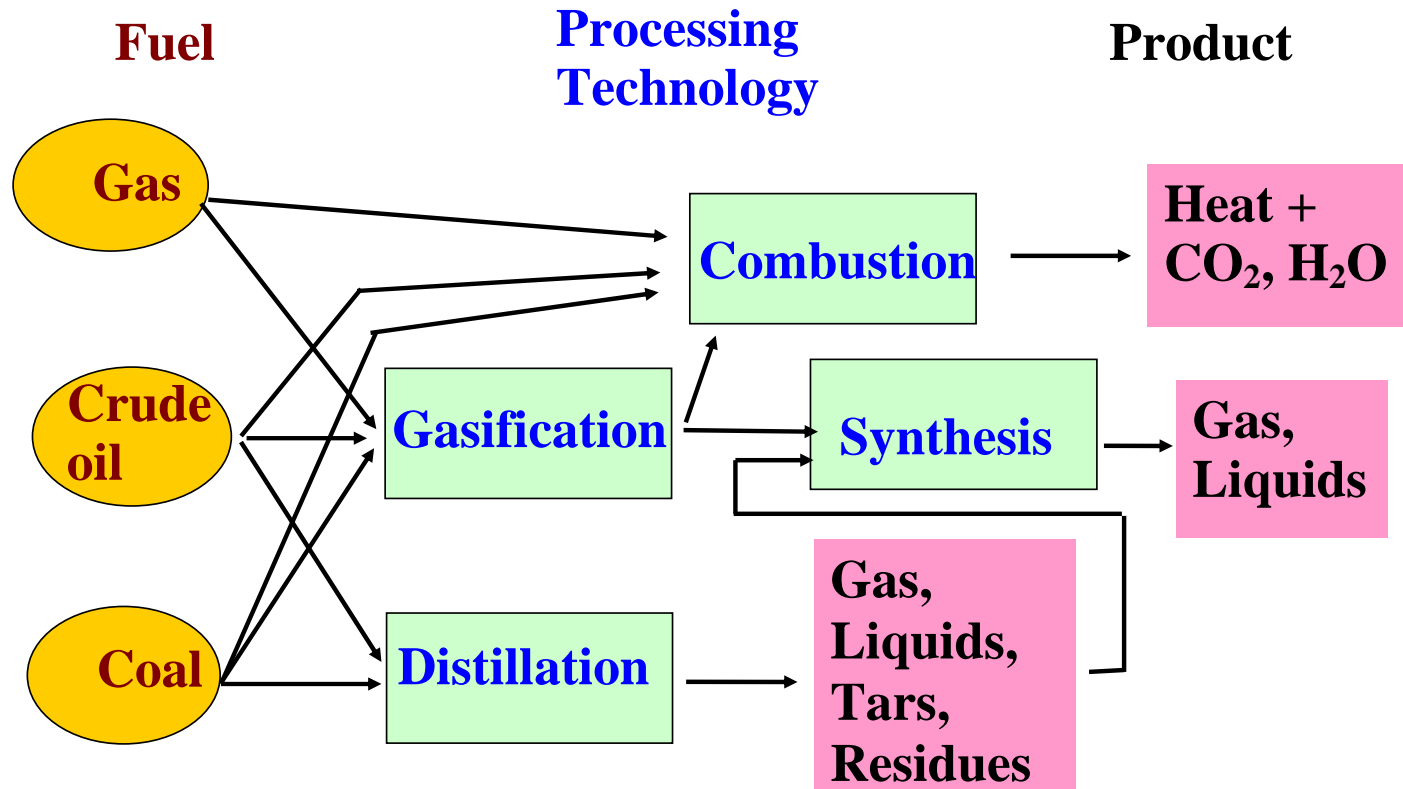
2030 Alternative Energy Policy projections

Demand of 15406 Mtoe
+\$US3T in end use and building expenditure
-\$US3T in supply side equipment

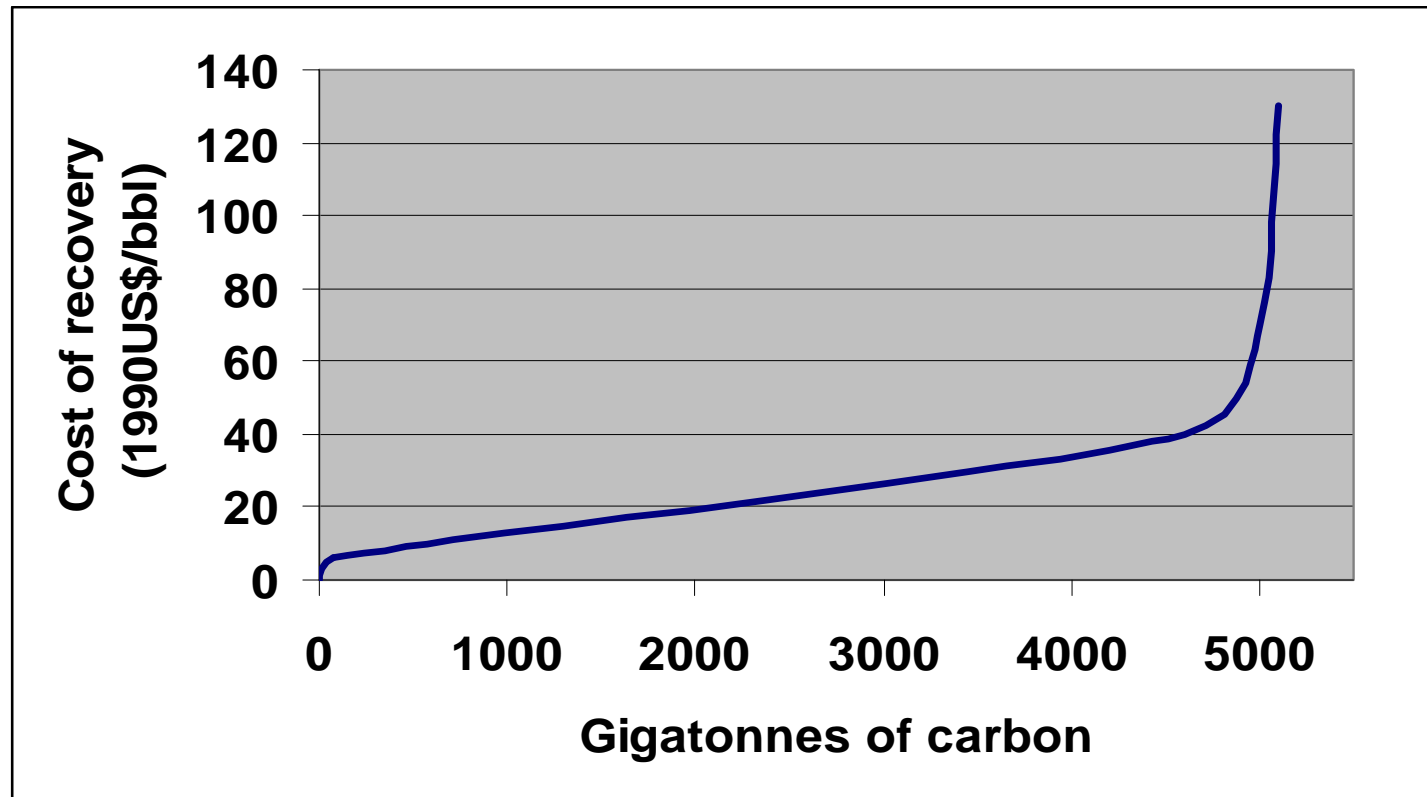
Classification of fossil fuels



Hydrocarbons are interchangeable



Aggregate cost-quantity curve for global fossil fuels



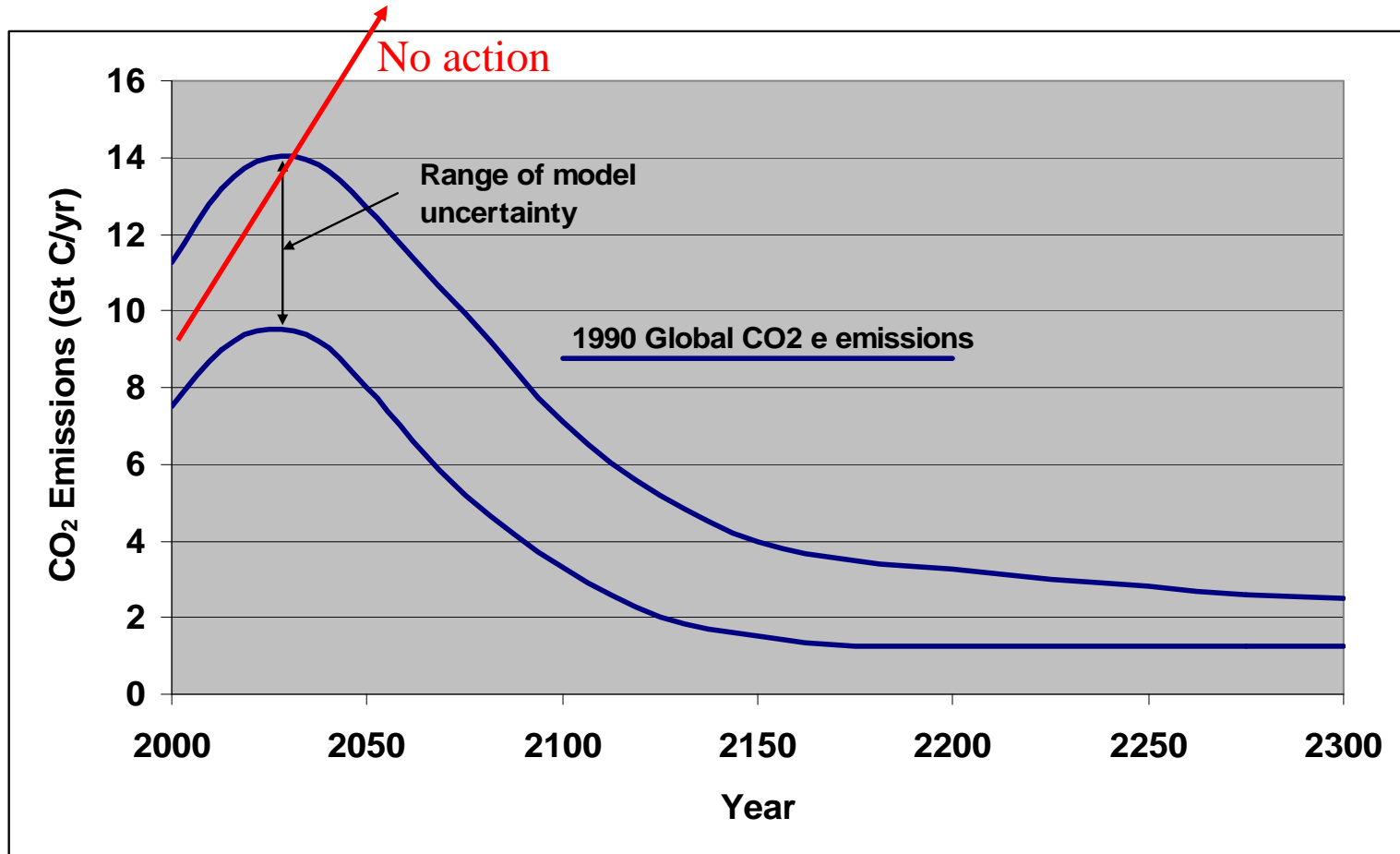
from H.H. Rogner, Annu. Rev. Energy Environ. (1997)

Global carbon reservoirs

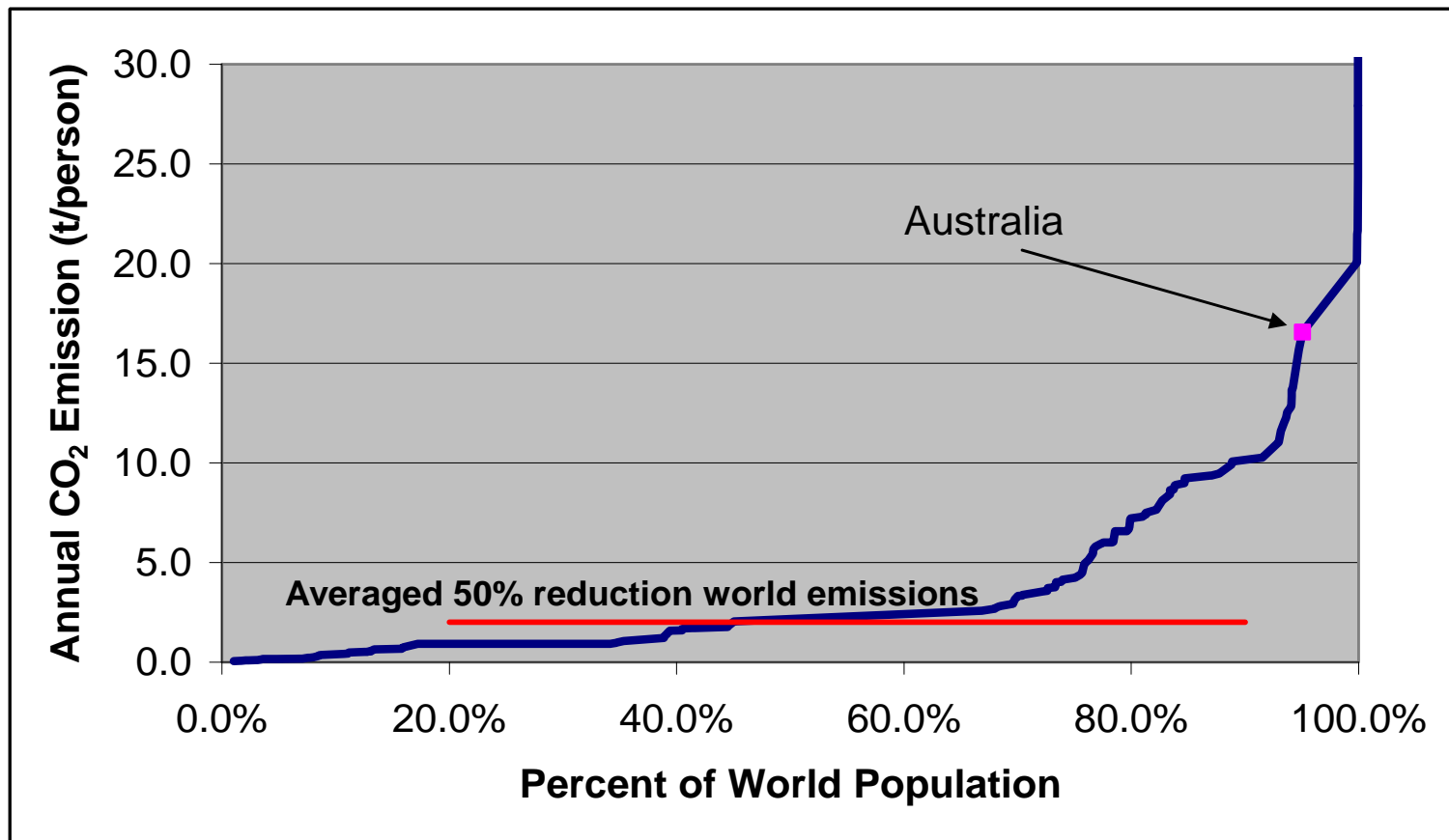
Reservoir	Size (Gt C)
Atmosphere (present)	750
Forests	610
Soils	1580
Surface ocean	1020
Deep ocean	38,100
Fossil fuels	
Coal	4,000
Oil	500
Natural gas	500
Clathrates (methane hydrates)	>10000
Carbonate rocks	1,000,000,000

CO₂ emission trajectories to stabilise at 550 ppm

IPCC – Third Assessment Report (www.ipcc.ch)



Per capita CO₂ emission from energy production (1996 IEA data)



Strategic Options to Reduce CO₂ Emissions

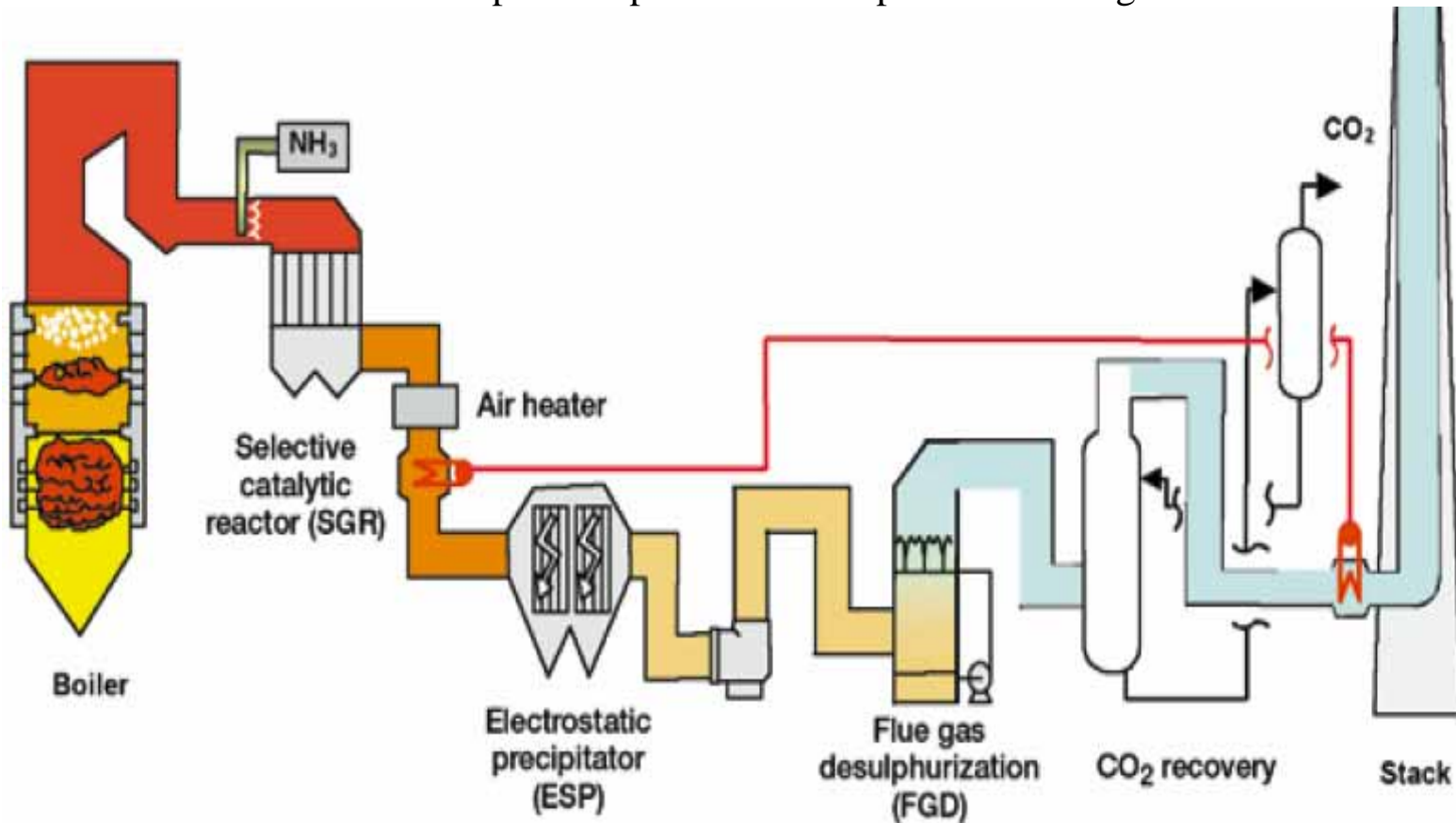
- Reduce energy use
 - Energy efficient technology, lifestyle
- Switch to non carbon based energy
 - Nuclear, solar, geothermal, gravitational
- Remove carbon from fuel cycle
 - Low carbon fuels (coal → gas, oil)
 - **Carbon capture and storage (geosequestration)**

Carbon capture and storage as a transitional strategy

- Builds on 100 years of technology innovation
- Allows use of existing investment in infrastructure, skills and manufacturing capability
- Does not require immediate societal restructure
- Buys time for development of more cost effective renewable technologies
- Applicable in large scale

Pulverised coal boiler with post combustion capture using amine scrubbing

IPCC special report on CO₂ capture and storage



Status of Post Combustion Capture Technology

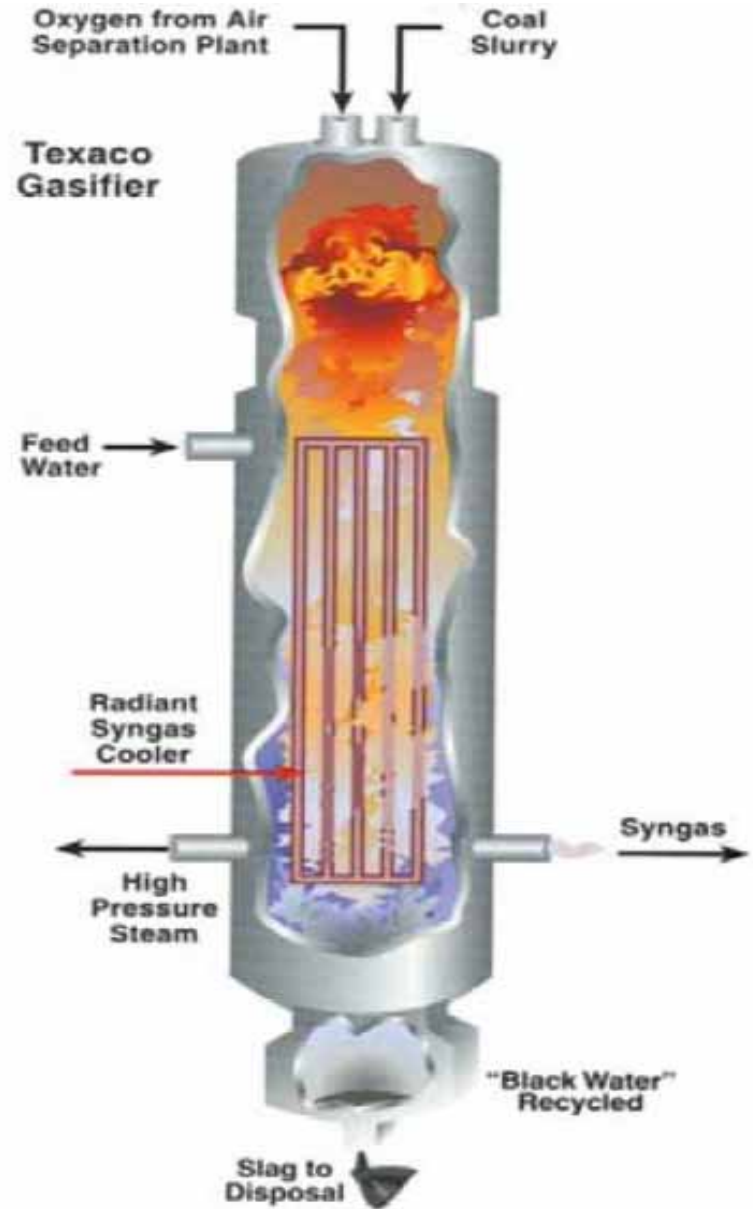
- Amine scrubbing technology is commercially available now
- Presently operating on small number of gas fired plants (to produce CO₂ for commerce)
- Previous (limited) experience with application to commercial scale coal power plant
- Will increase cost of generating power substantially
Cost of generation ~ 30% of retail price of electricity
- Could be implemented now if there is a commercial or political imperative.
- Significant opportunity to reduce cost through research

Coal Gasification

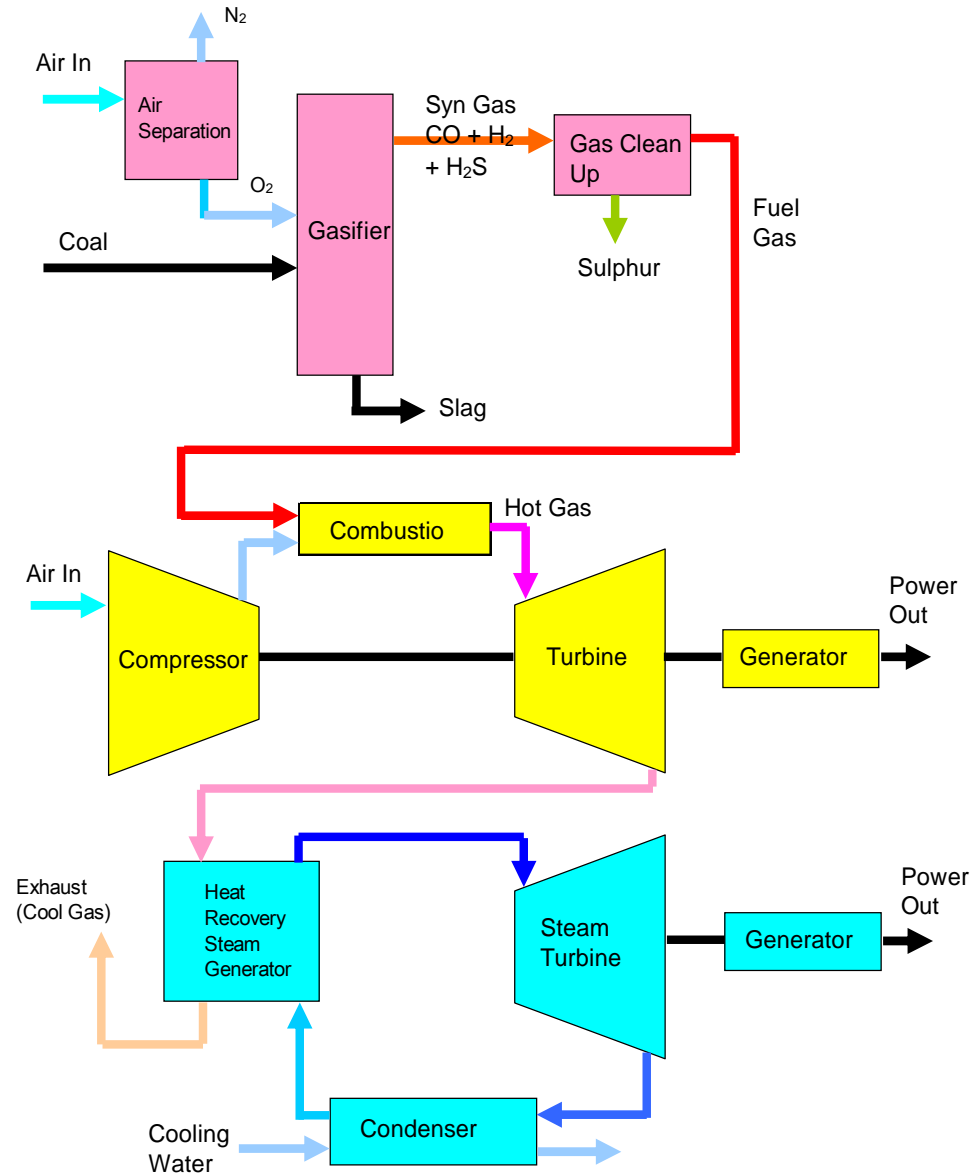
- Reaction of coal with steam to high temperature to produce syngas (CO and H₂)
- Heat for reaction from burning small fraction of coal in oxygen
- Previously widely used to produce Town Gas
- Current technologies use high pressure and temperature to improve efficiency
- Sulphur and ash removed from low volume syngas
- Clean gaseous fuel allows combined cycle power plant with improved efficiency

Texaco Gasifier

- Coal water slurry + O₂ firing
- Reaction 1500 °C, ash melts as slag
- Radiant syngas cooler produces steam
- Syngas fuel value ~ 70 – 80 % of original coal
- Syngas CO + H₂



IGCC Schematic



Progress with Coal Gasification

- Numerous gasification plants constructed
- < 10 IGCC plants presently operating in world, largest ~ 550 MW
- Capital cost higher than pulverised coal
- Efficiency ~ 40%
- Reliability & O&M costs improving
- Will benefit from improvements in gas turbines and O₂ production technologies
- CO₂ removal from syngas is commercial technology

CO₂ Storage Options

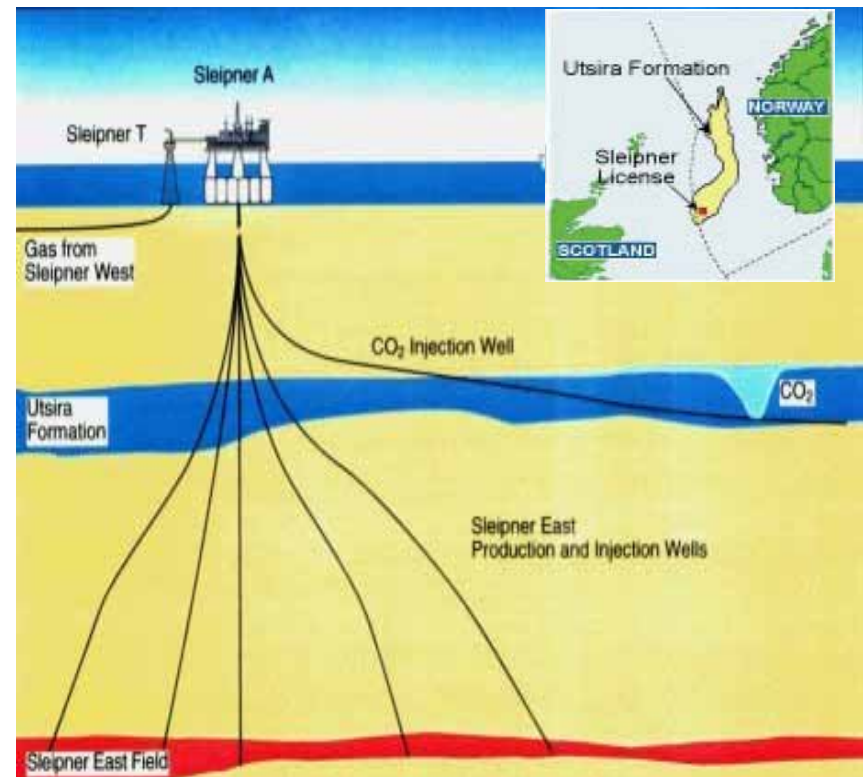
- Ocean disposal
 - Deep Ocean Storage, Surface Dissolution
- Terrestrial Approaches
 - Enhanced Biomass, Mineralisation, Solid Storage
- Geosequestration Approaches
 - Coal Seams, Saline Aquifers, Depleted Gas Reservoirs.

Current underground storage projects

- USA – Enhanced oil recovery
 - 33 Mt/a in over 70 projects
 - CO₂ extracted from earth, transported by pipe & reinjected
- Weyburn (Canada)
 - CO₂ produced by gasification of coal for synthetic natural gas
 - ~ 1Mt/a
- Sleipner (North Sea)
 - CO₂ extracted in process of purifying natural gas
 - ~ 1 Mt/a
- In Salah (Algeria)
 - CO₂ extracted in process of purifying natural gas
 - ~ 1 Mt/a

Injection to Saline Aquifers (Sleipner Norway)

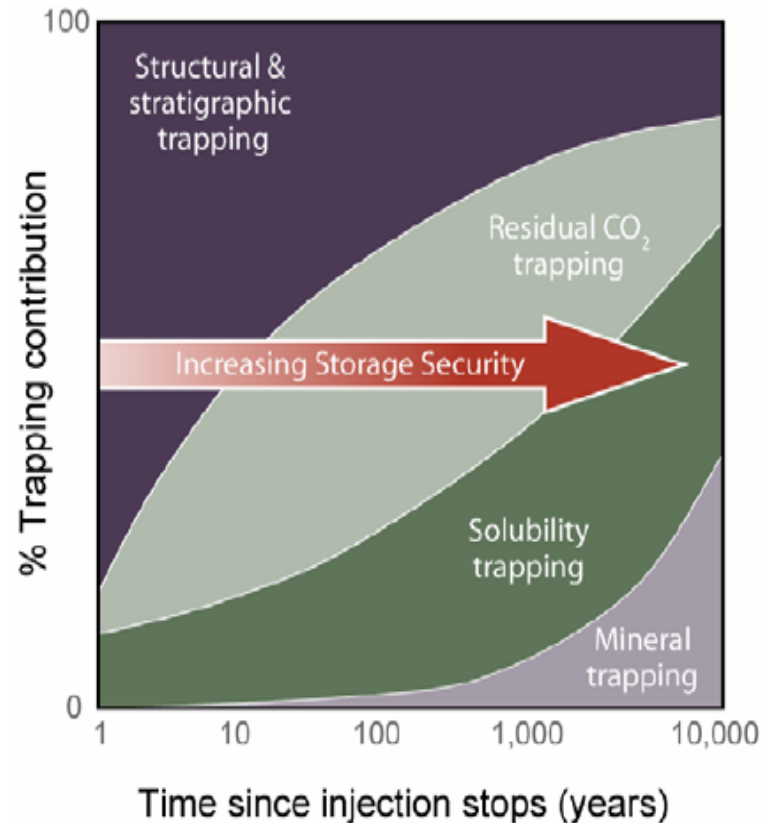
- 1 Mt CO₂ per annum
- CO₂ Tax of \$US55 per tonne (1996)
- CO₂ stripped from Natural Gas (10%)
- Amine Based Solvent
- 1000 metre Depth
- 6 MPa at Well Head



Security of CO₂ Storage

IPCC special report on CCS

- CO₂ denser than air
- Concentrations >15% lead to death
- CO₂ is common gas in coal and gas reservoirs
- Large deposits of CO₂ occur in nature
- CO₂ is reactive, likely to “fix” with time



In conclusion

- Lack of equity across world and large investment requirements contribute to energy security risks
- Emissions, particularly CO₂, more likely to be constraints than are fuel resources
- Numerous technologies could be deployed now
- Political will and economic drivers presently not yet there



www.whitlam.org