

The challenge and the opportunity of clean coal technology for the coal industry



ENERGY EDGE

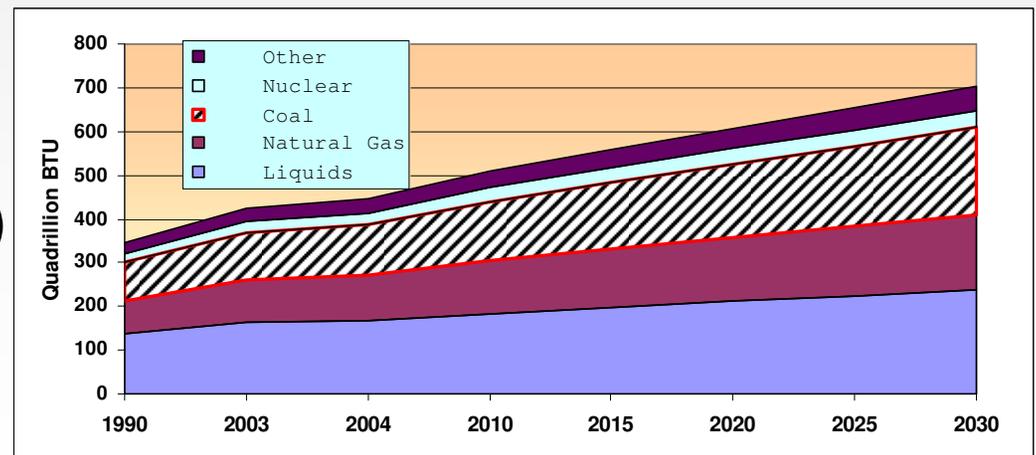
Presentation Summary

- Who is driving clean coal?
- What really is clean coal?
- Will coal producers miss the bus?
- What strategic options exist for coal producers?
- How can coal producers take advantage of the opportunities?
- How could coal be used in the future?

Who is driving Clean Coal?

- Several interested parties:
 - Coal producers (so they can sell more)
 - Coal users (to minimise electricity production costs)
 - Environmentalists (because they should)
 - Politicians (because they shouldn't)
 - Oil and gas producers (because they have to)

Conflict?
Economics v Idealism



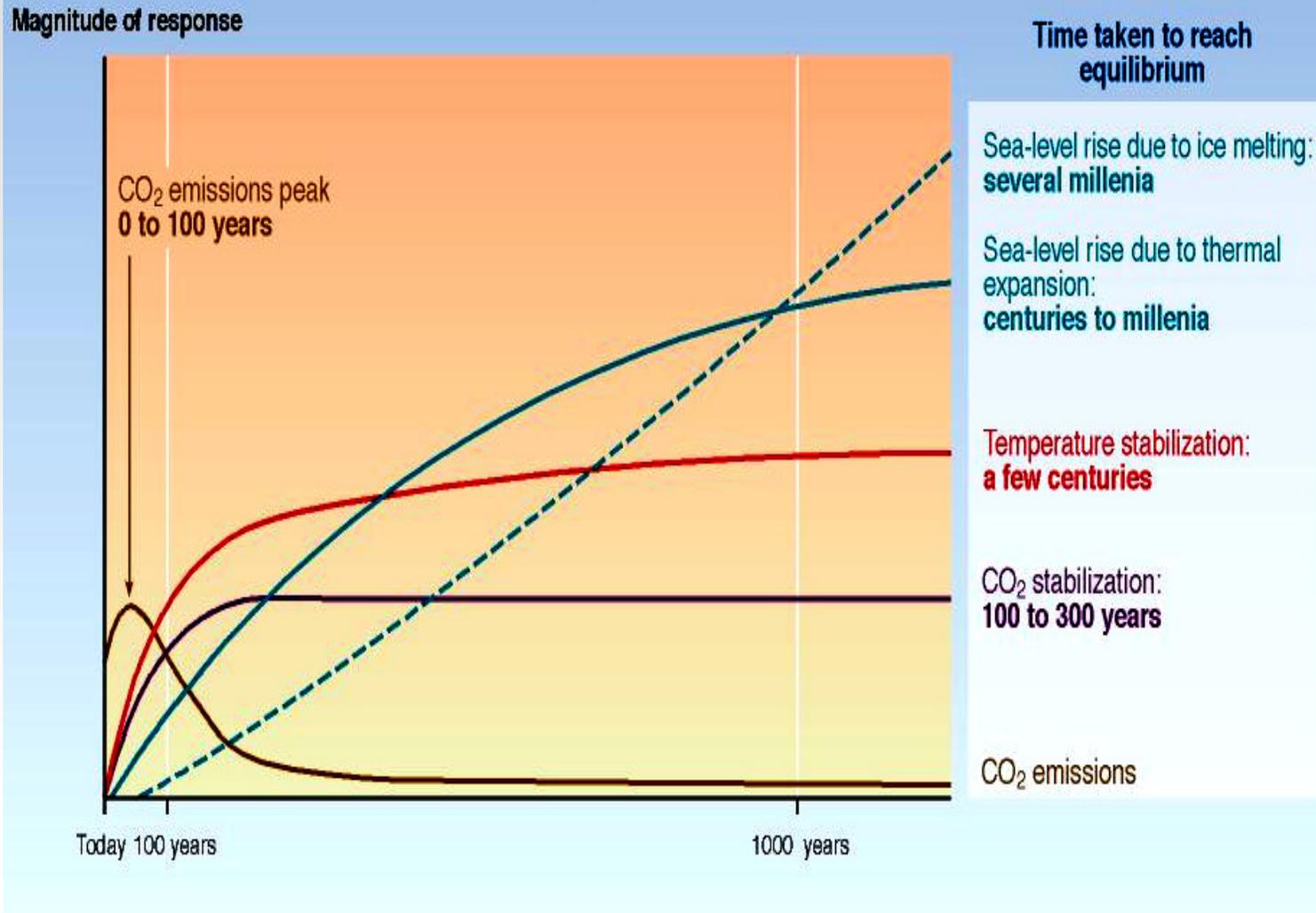
What are clean coal technologies?

- Higher temperature boilers
- Scrubbing systems
- Integrated combined gasification cycles
- Carbon capture and storage
- Coal gasification
- Coal liquefaction
- Underground coal gasification

Are these all really CCT's?

- The term 'clean coal technology' implies that coal is used in a way that is clean
- Is that true of the so-called CCT?
- Or, are we actually pretending that using coal in a way that is cleaner than it has been in the past is actually clean
- Even so, from a coal producers perspective, which technologies are the best to back that will fundamentally improve the company's long term business prospects?

What is the problem?



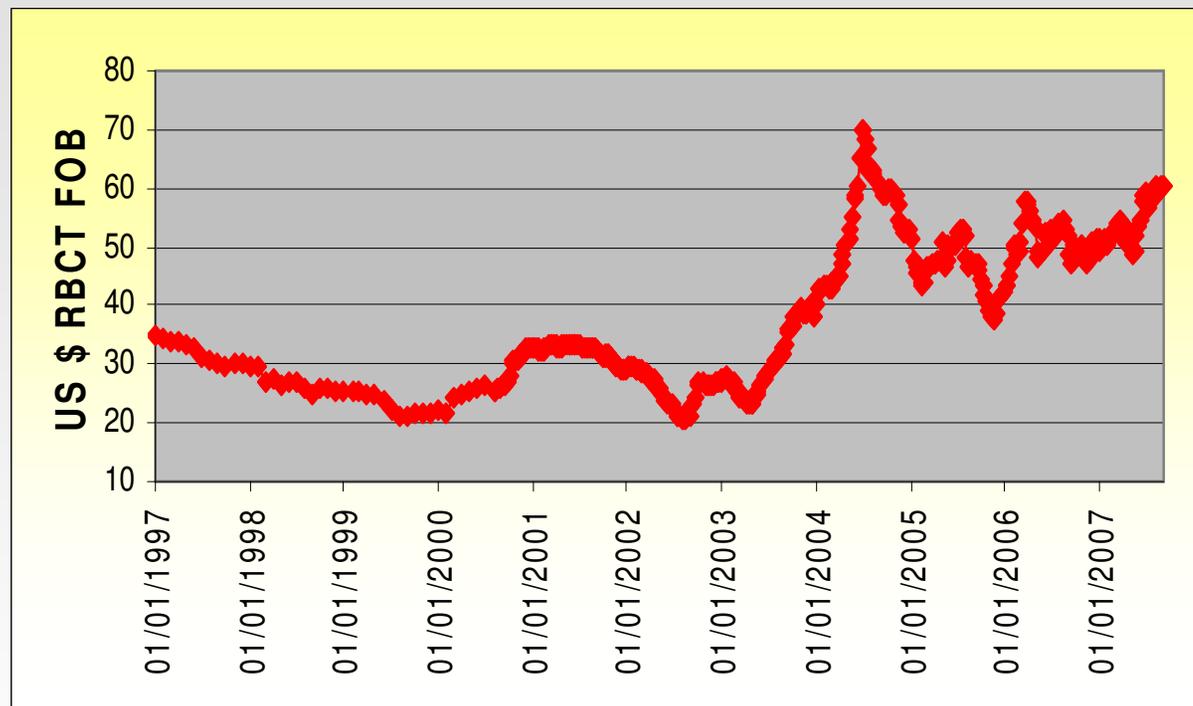
What is the problem?

- Are coal users and producers actually faced with a business problem or a social responsibility problem
- Or is it a social responsibility problem that has been turned into business problem through legislation?
- Does it matter so long as there is a problem that requires a solution?
- Yes, because a business problem can be solved by 'normal' business means – engineer it away
- But a social issue may mean that the problem must be fixed whether it provides a financial return or not – just like mine rehabilitation and environmental controls, for example
- The difference is that the level of resources needed to fix the issue in the business case is determined by the reward, whereas the minimum input usually governs the latter case

The Strategic Decision

- For coal producers and users, the big issue is which option to back
- Or, actually, whether to back one at all or let someone else take the risk and keep your money in your pocket
- For most businesses that are risk-averse (like coal producers) you try to gamble on certainties (or at least near certainties)
- But what do you back and why?
- Will the chosen course of action protect the existing competitive advantage, reducing the risk of other coal producers or other energy players that fancy a piece of your action
- But can coal producers play a role in developing new technologies?

Maybe?



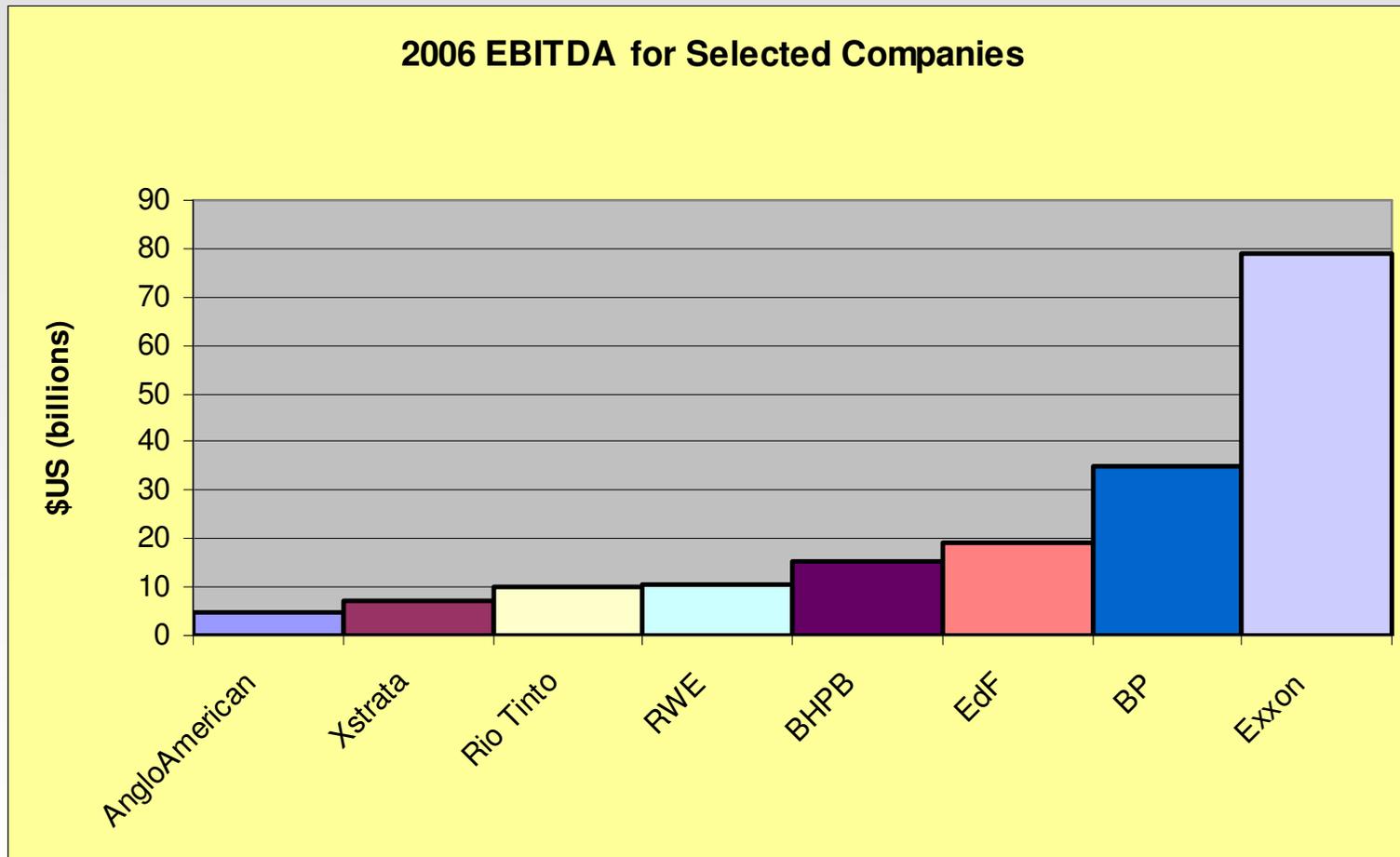
Source: McCloskey

- For the first time, coal producers are actually making real money – or are they?

Coal producer profitability

Producer	2007 producers (US\$)				
	Period	Criteria	Revenue	Gross profit	Profit (US\$/t)
BHP Billiton	Yr to June	Thermal	3769	675	7.76
		Coking	3769	1509	39.29
Rio Tinto	Half year	Australia	1127	306	19.13
		US	727	139	2.28
Anglo Coal	Half year	S Africa	676	207	22.97
		Australia	653	111	9.51
		Colombia	298	135	25.69
Xstrata	Half year	Aust Coking	255	85	36.95
		Aust Thermal	900	195	9.71
		S Africa	378	108	9.81
		S America	251	121	25.74

But, there is a big brother there (and an uncle)



Coal producer profitability

- Historically poor – under 10% return on investment in the past
- Getting better, but significant division between exporting operations and domestic focus
- Some exporters (Russia, Poland) still not making major returns
- Production costs typically increased 30%-50% in the last three years
- Can coal producers commit to substantial funding to participate in major development of CCT's?

So, what do the coal producers do?

- It is in their interests to help develop technology that will enhance their businesses – i.e. increase coal demand
- But what are they?
- What threats are faced from non-coal competitors?
- Given the limited resources of many coal companies, what technologies are the best investments?

CCT's

- Determine which technologies will help reduce emission reductions without making a real step change?
- Surely, the real prize is to locate a a technology that fundamentally changes the way coal is used and its impact on the environment
- This allows the enormous coal resources in the world to be exploited
- Of the technologies, higher pressure boilers are an evolution of the existing use and do not represent a fundamental way coal is used – emissions are less but still an issue
- Will such technologies actually increase coal use, or just maintain it?

Boiler Technology

Technology	Unit Size	Efficiency	Fuel Flexibility	Environmental Performance
PC - Sub critical	All sizes	Up to 40%	Wide	High CO ₂ , low NO _x and SO _x if designed
PC - Super critical	All sizes	Up to 45%	Wide	Lower NO _x , SO _x and CO ₂
Fluidised Bed	Up to 600MW, Lagsiza Poland 400MWe	Up to 45%	Low ash best	By-products can be an issue. Cyclone and ash heat loss reduces efficiency
IGCC	About 400MW	Up to 45%	Low grade fine	Excellent. Inert slag, low NO _x , Sox and CO ₂

CCT's

**Increasing efficiency
of coal use**

Boiler technology

**Electricity producers,
coal producers?**

**Treating the by-
products**

CCS, SOx and NOx control

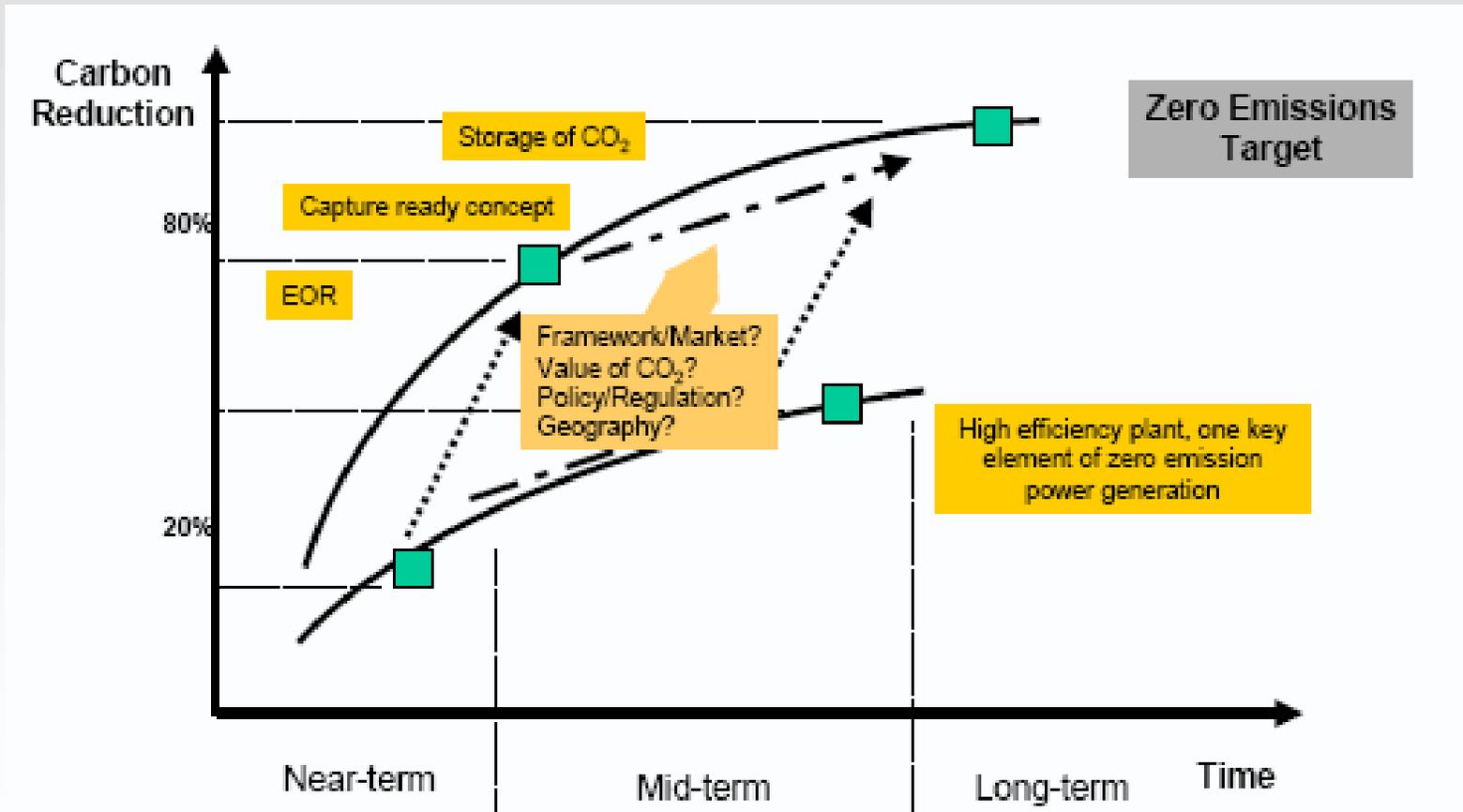
**Electricity producers,
coal producers?**

**Fundamental
change**

**Gasification, hydrogen
technology**

Oil and gas companies

Really, only a few technologies are clean



Source, Otter, Alstom

For coal producers

- The questions are therefore:
- Are there technologies that can both meet the need for substantial (and possible total) reductions in emissions?
- Is it worth coal producers being involved in improving technologies or better to consider any techniques that may result in fundamental improvements in emissions?
- If the latter is a suitable strategy, what types of technologies may be the best bets?

Coal gasification and liquefaction

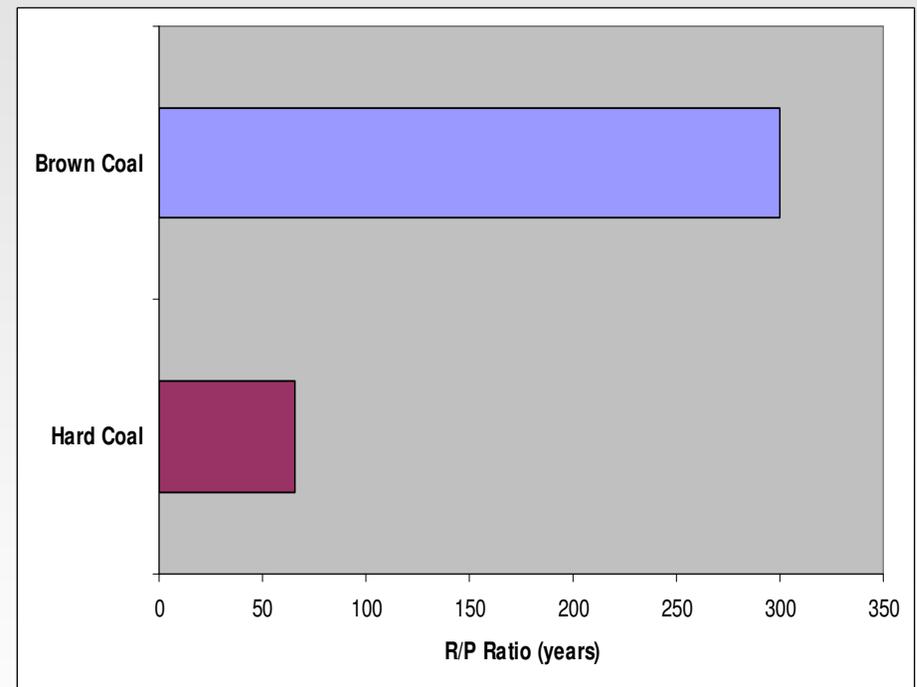
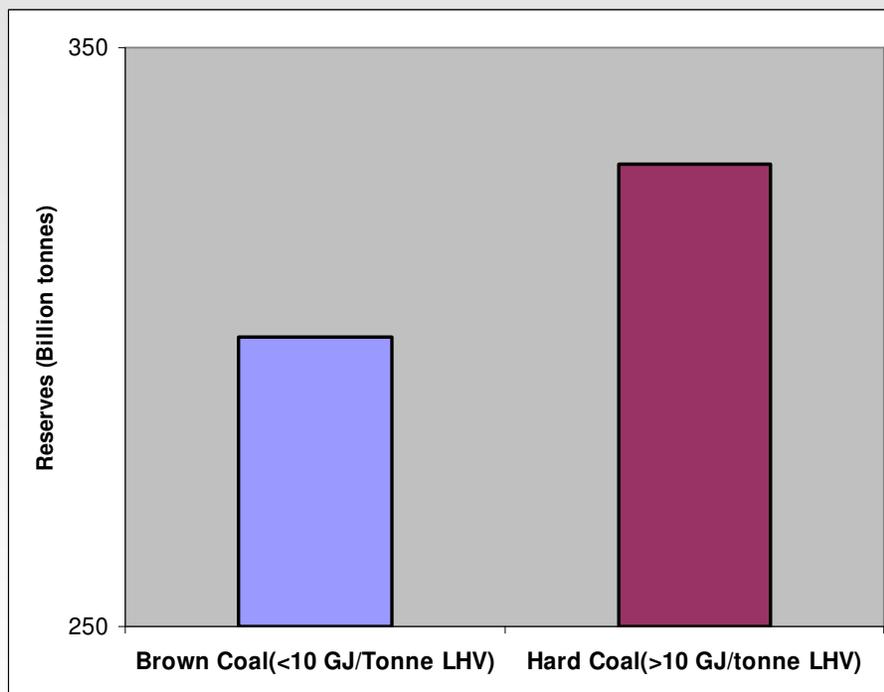
- Techniques have merit and provide an opportunity for coal to provide energy to a wider audience
- SASOL most experienced born out of adversity in South Africa
- Surface gasification still requires the coal to be mined
- Typically uses coarse coal, relatively low quality not suitable for traditional export products
- Ash (which may be 25% - 30% of the coal content) can be used in cement, road fill and concrete
- For long term success, key element will be the low cost supply of coal, typically under \$10 per tonne
- So unless the producers becomes vertically integrated, will it be a significant opportunity if coal revenues are low?

But, hang on....

- Backing this technology as a key strategy from a coal producer perspective needs to ensure we actually have enough coal
- Generally, it is estimated there are 200 years of supply of coal at current rates of usage
- Usual to think there is almost a trillion tonnes of proven coal in the world, roughly split 50-50 between hard coal and lower quality resources
- We disagree.....

Global Coal Reserves

Global Reserves Assessment



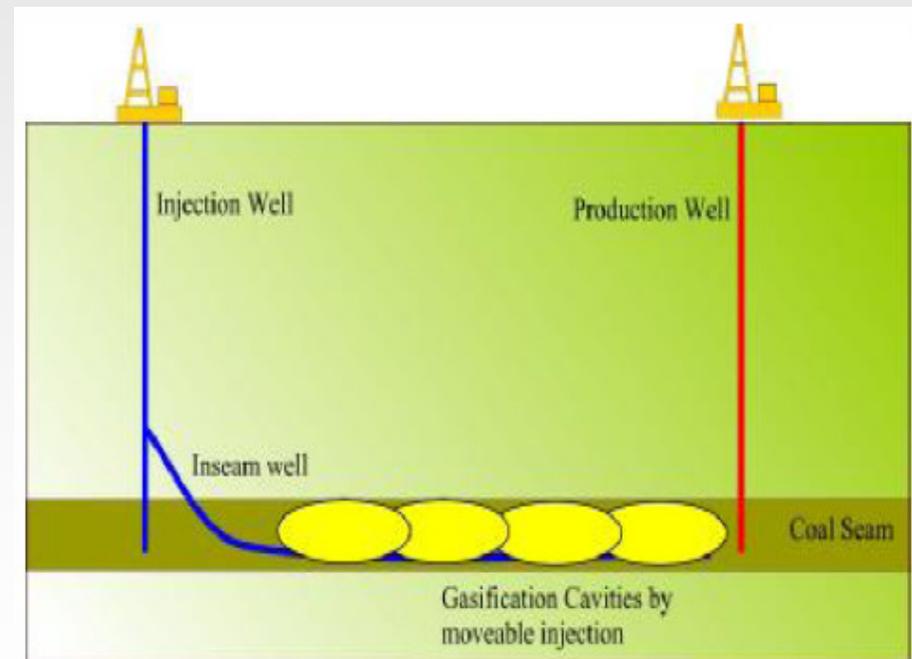
- Brown (lignite and subbituminous) and hard (bituminous and anthracite) reserves exist in roughly equal proportions (300 Bt to 330 Bt, respectively)
- However, comparing current coal production rate (5 Bt/PA) to Lignite (<1 Bt/PA) means Lignite has more than 5 times as many years availability at current R/P ratios

So where does that leave us

- Surface treatment is exciting but needs careful long term reserve assessment – especially in China with only 30 years ‘proven’ thermal coal reserve life
- One technology appears to fit most of the strategic boxes:
 - It involves coal
 - It involves utilising coal resources, which may or may not be mineable
 - It offers access to new and old energy markets
 - If allied to CCS it offers significant emission reductions
- That is Underground Coal Gasification (UCG)
- The important issue is that although coal producers need some new skills are needed, the coal producers have the best knowledge of the reserve base

Underground coal gasification

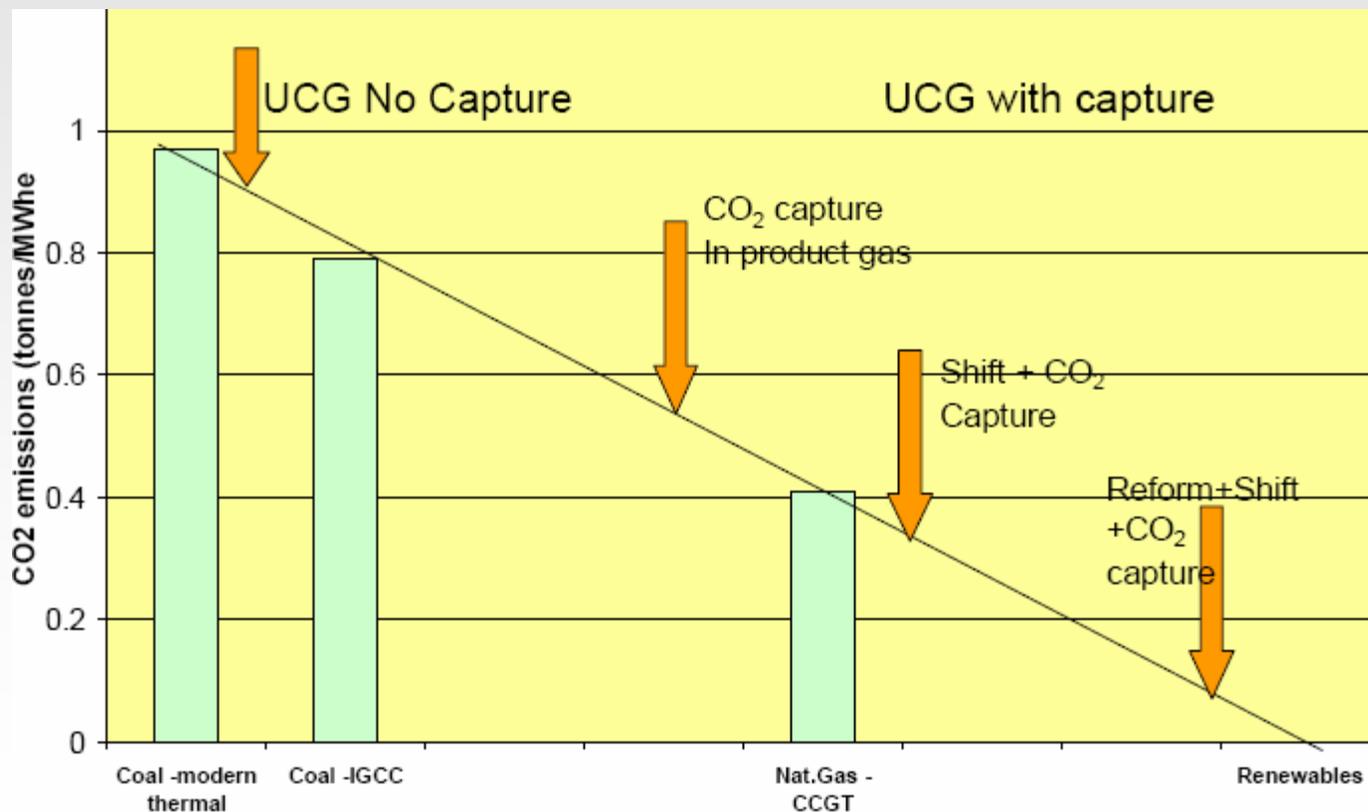
- Steam and air/oxygen injected into seam from surface well
- Through a series of reactions, coal is gasified into 4 product gases, including CH_4 , H_2 , CO and CO_2 and released to production well
- Doesn't reduce emissions on its own



Controlled Reaction Injection Point UCG

Underground coal gasification

Combined with effective CCS, UCG promises to be among the most effective technologies in reducing GHG emissions



Source: UCG Eng., Energy Edge

ENERGY EDGE

Advantages of UCG

- Exploits coal resources that are not conventionally mineable
- Coal producers hold this data
- Has a stronger practical potential to store CO₂ underground
- The combination offers a potential fundamental shift in emission controls
- Will not increase coal use per se but offers coal producers new opportunities to develop with mining and extend the life of conventional mining
- Current budgets are low and do not reflect the potential of the opportunity

What steps should coal companies take?

- Goal for coal producers is to remain a significant player in coal and energy industry
- Identify the technology that has the best chance of aligning with corporate goals and long term growth
 - Can you be a market leader?
 - Do you have the right skills?
 - Can you JV to acquire them?
 - Can the partnership be differentiated from others?
 - Mitigate risk through partnering
- UCG offers the option to exploit a wide range of coal resources, participate in a growing market area and meet environmental constraints
- Don't neglect other technologies but assess the suitability carefully to match the business and make best use of the company's resource base