Energy Security for Australia

Coal

in a Sustainable Future

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Cooperative Research Centre for Coal in Sustainable Development

Australia

www.ccsd.biz

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Brisbane, Australia

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A world view

'If we are serious about tackling climate change, the centre piece of our programme -.. across the world - must be in ensuring we **power our economy** and way of life in a **cleaner, greener and more efficient** way.'

*'… there is no **simple, single solution** to the energy challenges that we and other countries face but that a balanced approach, driven by technology advances and increased efficiency, will be needed.'*

Rt Hon Tony Blair MP - *'The Energy Challenge' DTI Energy Review July 2006.*

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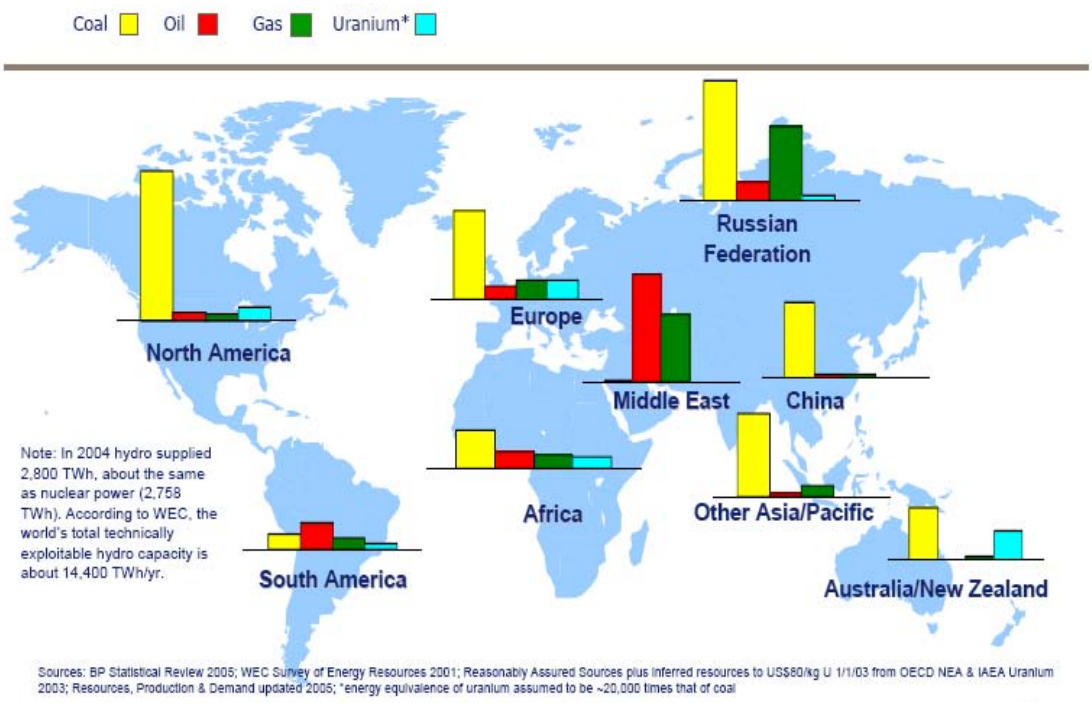
OUTLINE of Presentation

- What are the global trends of clean coal energy?
- What are the opportunities for clean coal energy in Australia in the future?
- What are the key reasons why clean coal energy would be a viable future energy source for Australia (i.e. economic, social, environmental)?
- What are the negative impacts of clean coal energy (i.e. economic, social, environmental) ?
- How does clean coal energy compare with other sources of energy for the future?
- Given the need for immediate greenhouse gas emission reduction (by 2020) how can Clean Coal technology contribute to this?

World energy reserves



Sources: BP Statistical Review 2005; WEC Survey of Energy Resources 2001; Reasonably Assured Sources plus Inferred resources to US$80/kg U 1/1/03 from OECD NEA & IAEA Uranium 2003; Resources, Production & Demand updated 2005; *energy equivalence of uranium assumed to be ~20,000 times that of coal

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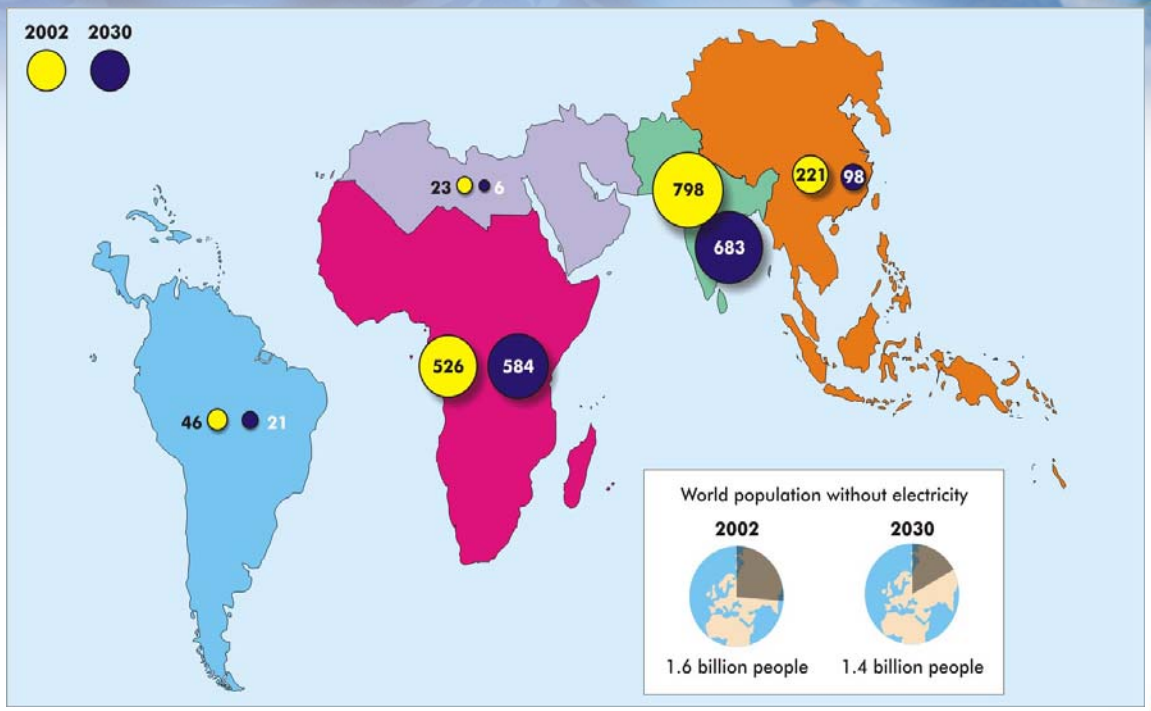
Electricity Deprivation
(Source: IEA – World Energy Outlook 2004)



In 2030 there could still be 1.4 billion people without electricity

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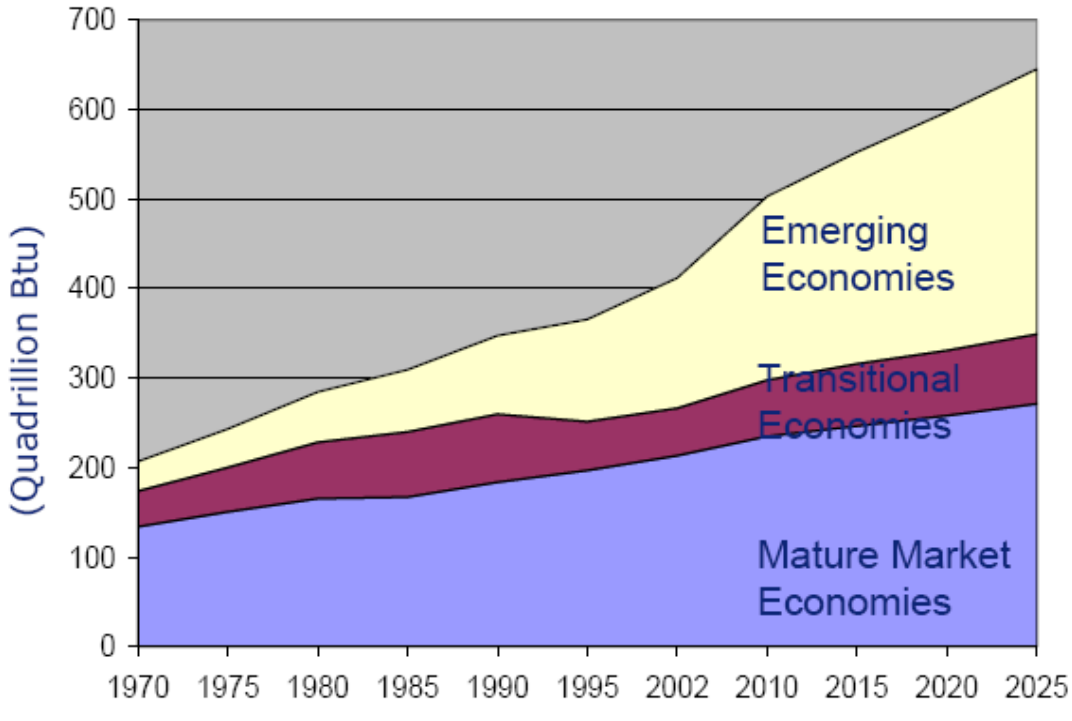
World energy consumption



Source: EIA

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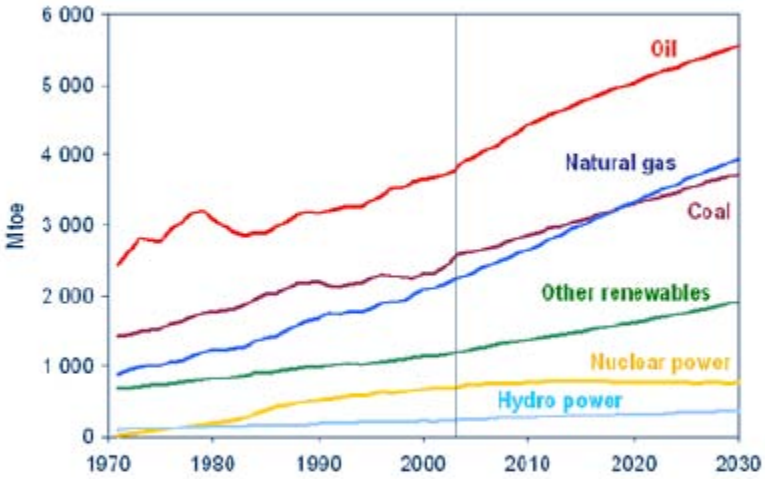
Fossil fuels to remain dominant

World Primary Energy Demand



Oil, gas and coal together account for 83% of the growth in energy demand between now and 2030 in the Reference Scenario

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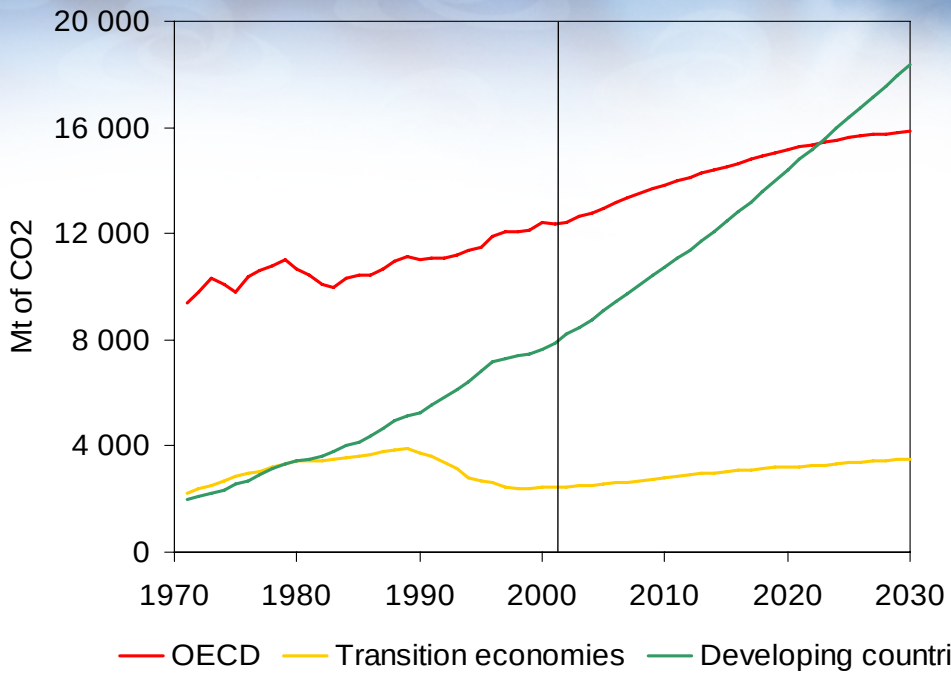
World Energy-Related CO_2 Emissions (Source: IEA – World Energy Outlook 2004)



Global emissions grow 62% between 2002 & 2030, and developing countries' emissions will overtake OECD's in the 2020s

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A premise for a de-carbonised energy future

- Fossil fuels will dominate energy scene for at least the next 50 years
  - Could be as long as 100 to 500 years
  - Would need the longer term supply of renewables
  - A possible intermediate role for nuclear energy
- Retain centralised power generation infrastructure
  - The technology and the energy vectors needed to move to a large scale fully decentralised generation system is not market ready
- De-carbonised electricity and/or hydrogen on a large scale for other sectors of the economy – industry, transport, residential
  - May need to additionally meet a strategic demand for liquid fuels and chemicals from non oil-based resources
- *As a bridge to the future,* de-carbonised energy needs can be supplied and distributed from centralised fossil-fuelled plants with CO2 capture and storage – potentially the cheapest way of seeding a new energy infrastructure based on hydrogen

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Special IPCC Report on Carbon Dioxide Capture and Storage (CCS)

- **In Montreal in November 2005, the IPCC report on CCS was formally approved by 105 countries. Some key observations included:-**
- **CCS is a potentially important part of a mitigation portfolio**
- **By 2050, 30-60% of electricity generation suitable for CCS**
- **Overall ocean storage has major issues to address, such as mortality of ocean organisms, acidification etc**
- **Global geological storage at least 2000G tonnes - enough for next 100 yrs**
- **Including CCS in a mitigation portfolio reduces cost of stabilising CO2 concentrations by 30% or more**
- **Risks for geol storage is low – comparable to accepted industrial activities**
- **For well selected geol storage sites, leakage likely less than 1% per 1000 years**
- **The report supports the approach of including geosequestration in the mix of mitigation options**

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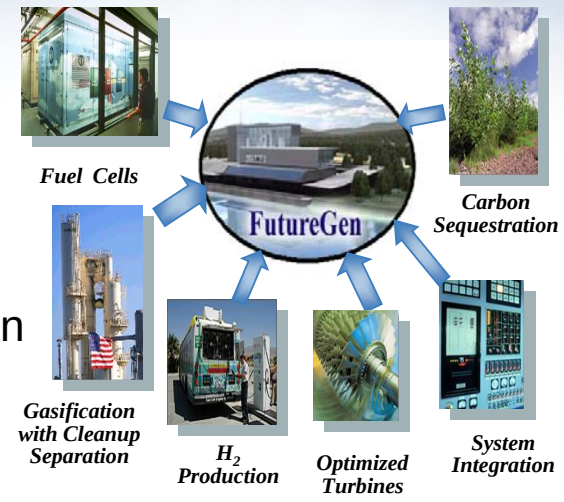
USA: Clean Coal Technologies RD&D address near- and long-range needs

***Short-term**:* keep existing fleet in service; prepare for transition to near-zero emission future

- SO_2, NO_x, Hg
- plant optimization and control
- reduced carbon intensity

***Long-term**:* add near-zero emission energy plants

- IGCCs to market
- advanced materials
- ultra-high efficiency hybrid systems
- CO_2 capture and storage



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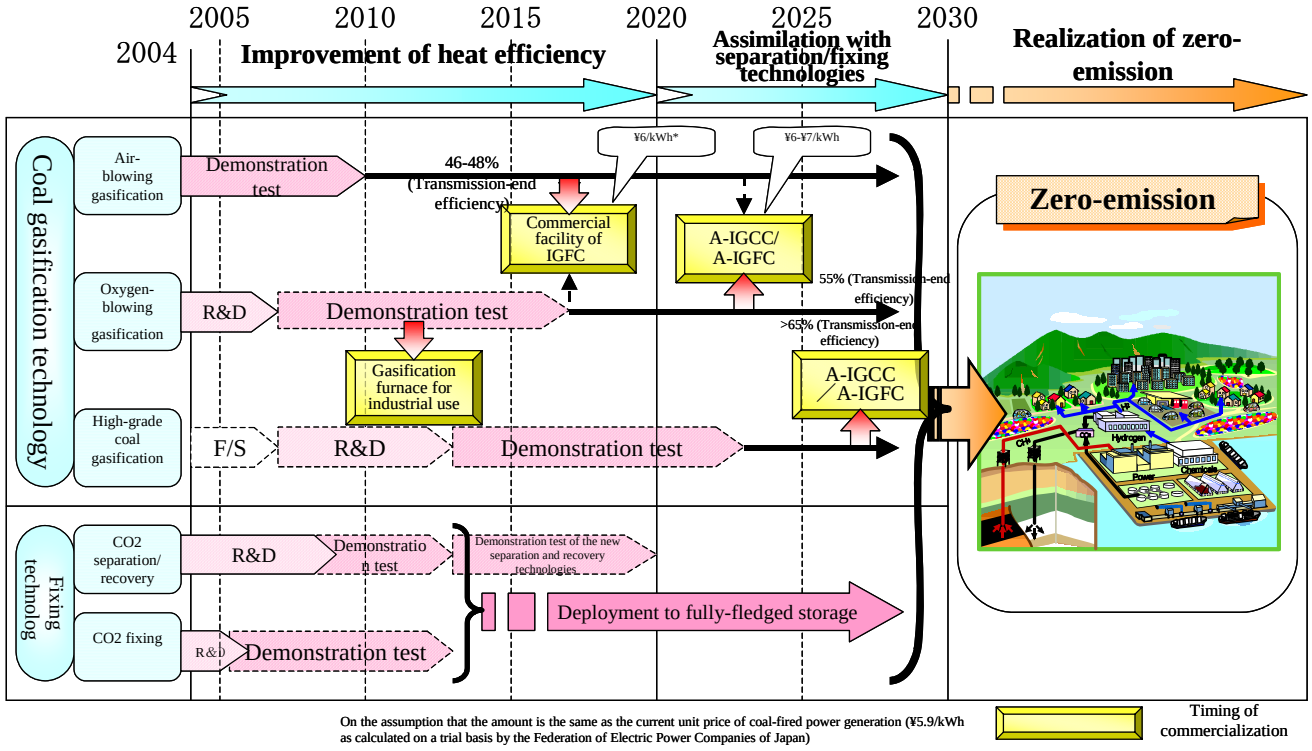
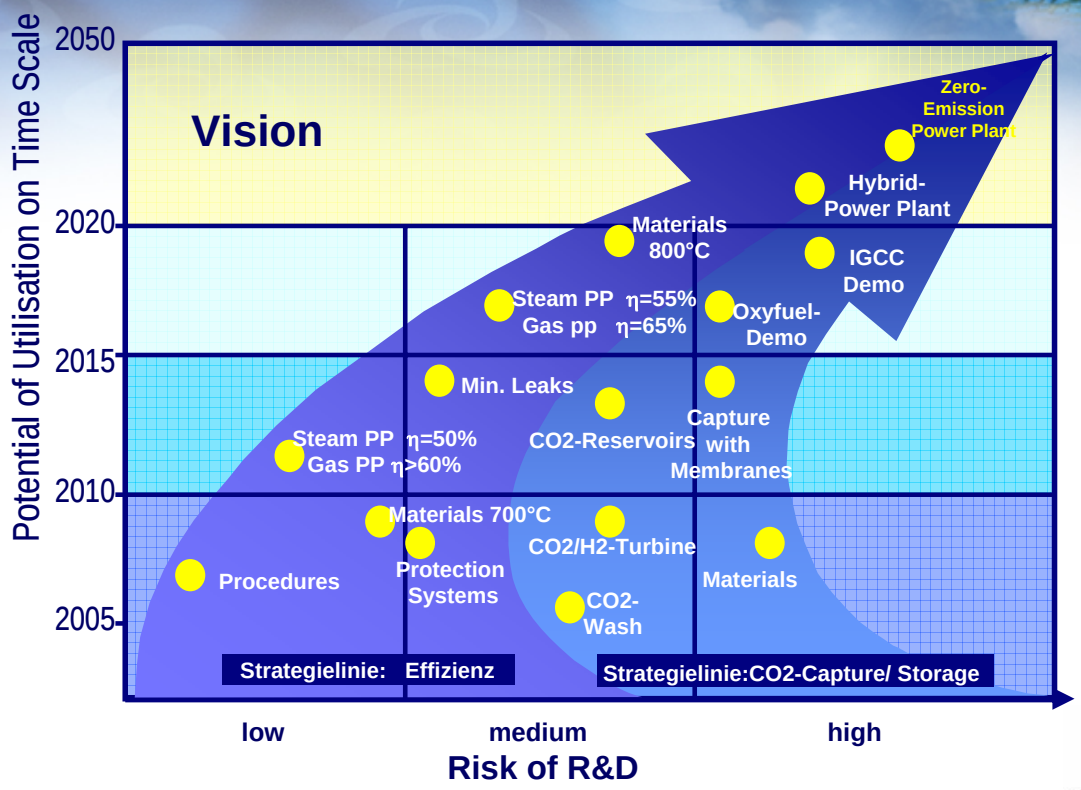
Japan C3 roadmap for realising zero-emission coal utilisation



Germany - C O O R E T E C Roadmap



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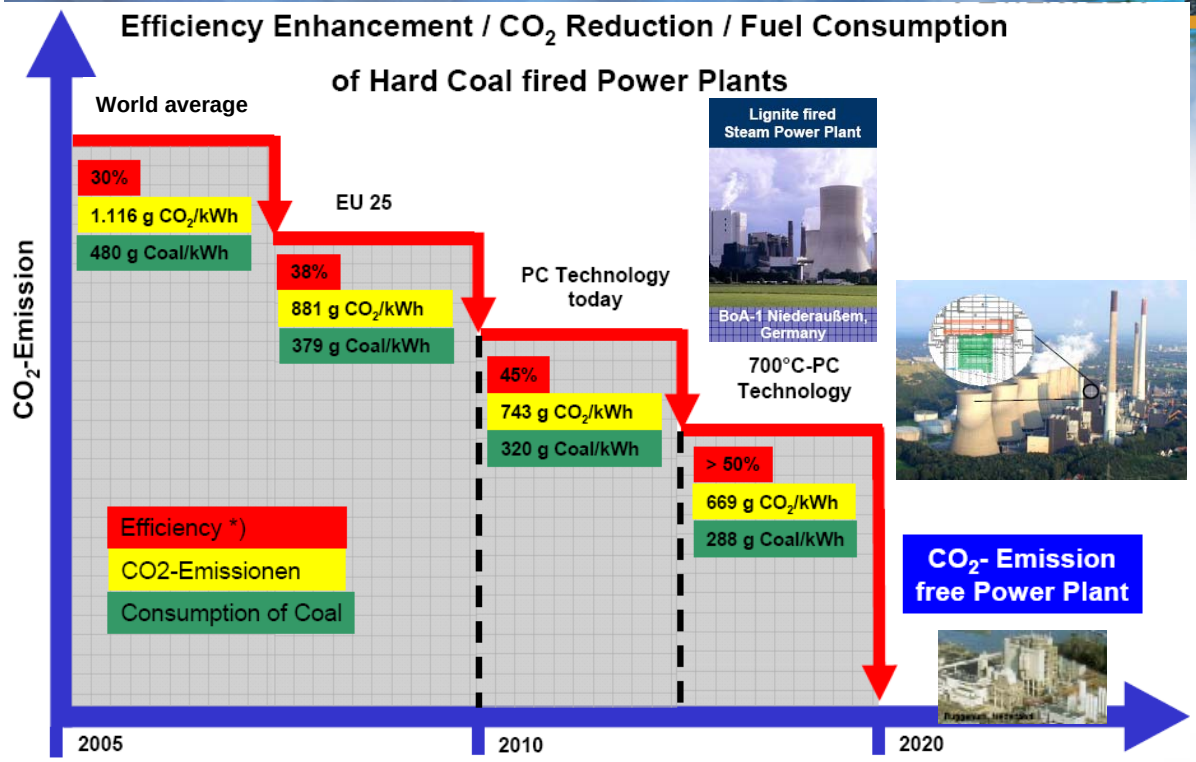
The EU ‘steps’ to zero emissions



VGB PowerTech

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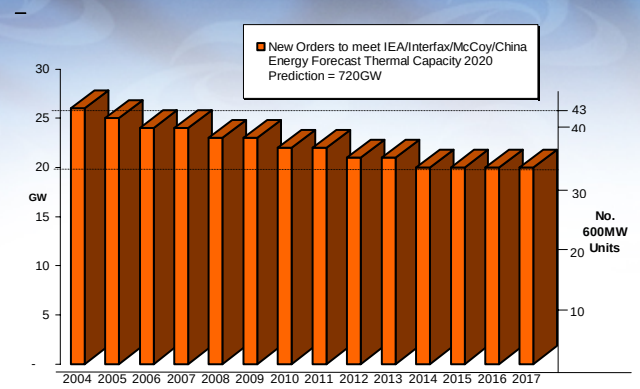
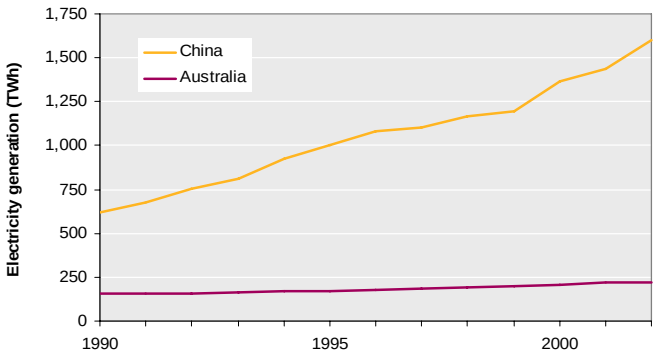
China - Energy Growth





- China is installing Australia’s total capacity each year
- Plans to continue this rate up to 2020
- Likely to greatly influence the learning rate for selected technologies
- China is currently selecting SC pf with IGCC for chemicals production

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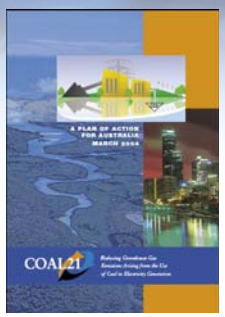
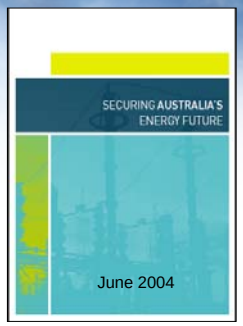
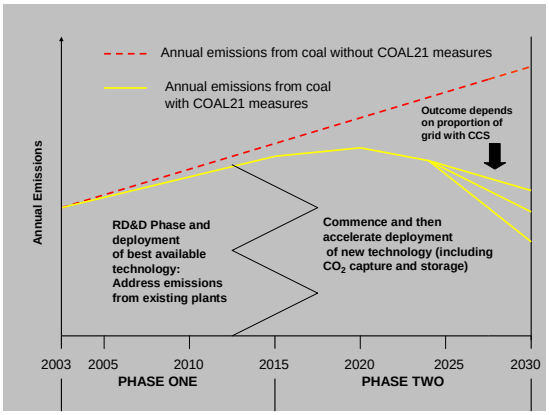
COAL21 National Action Plan & Energy White Paper *'Securing Australia's Energy Future'* - 2004







- **The establishment of a $500 million fund to leverage more than $1 billion in private**
- **Investment to develop and demonstrate low-emission technologies**
- **The provision of $75 million for Solar Cities trials in urban areas to demonstrate a new energy scenario, bringing together the benefits of solar energy, energy efficiency and vibrant energy markets**
- **The provision of $134 million to remove impediments to the commercial development of renewable technologies**

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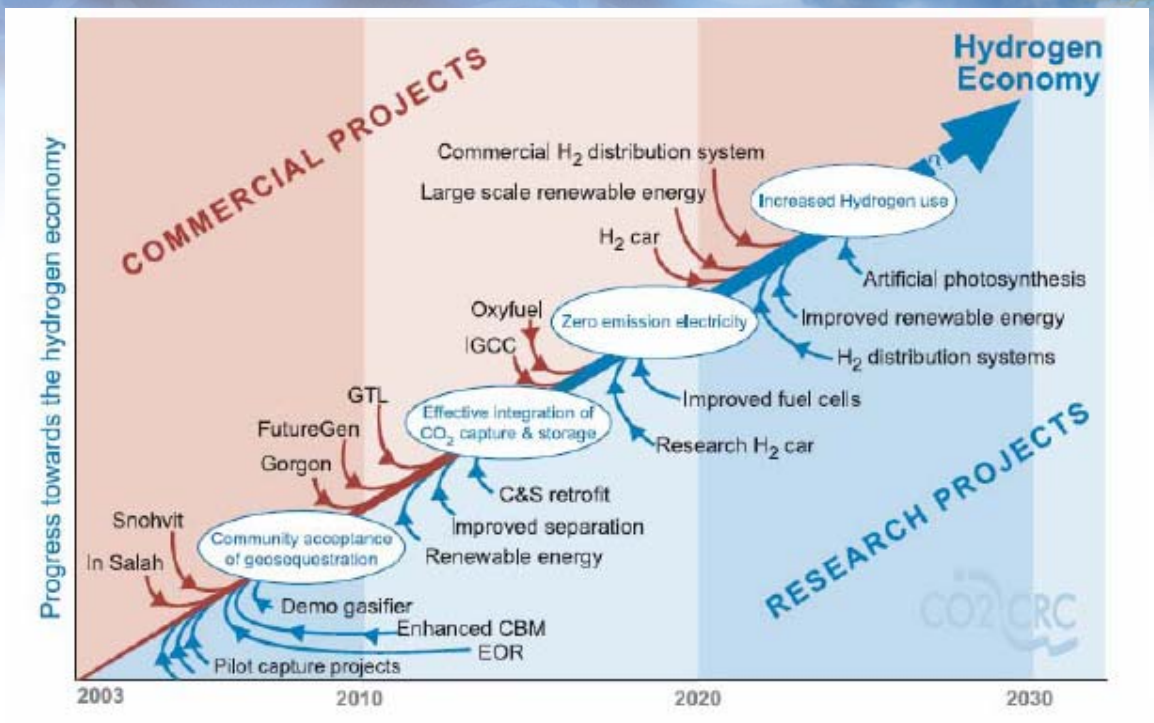
An Australian technology roadmap to the hydrogen economy



Source: IEA – CIAB Roadmapping Coal's Future

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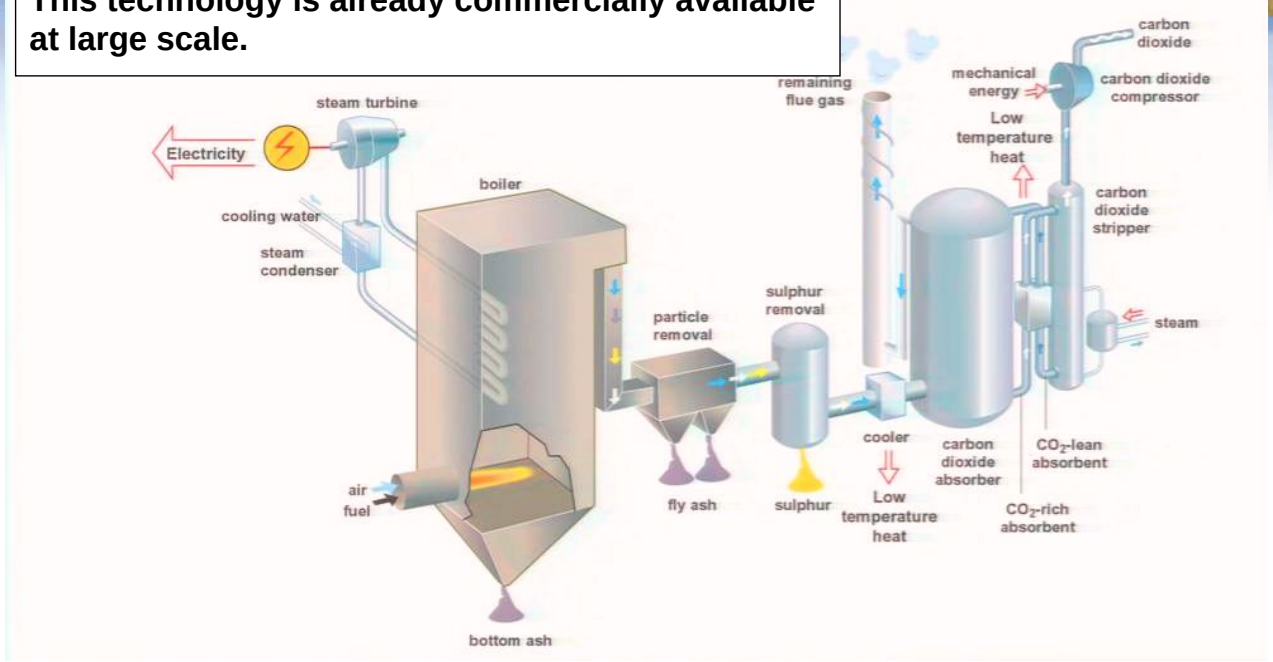
- **What are the opportunities for clean coal energy in Australia in the future?**

Post-combustion capture

This technology is already commercially available at large scale.



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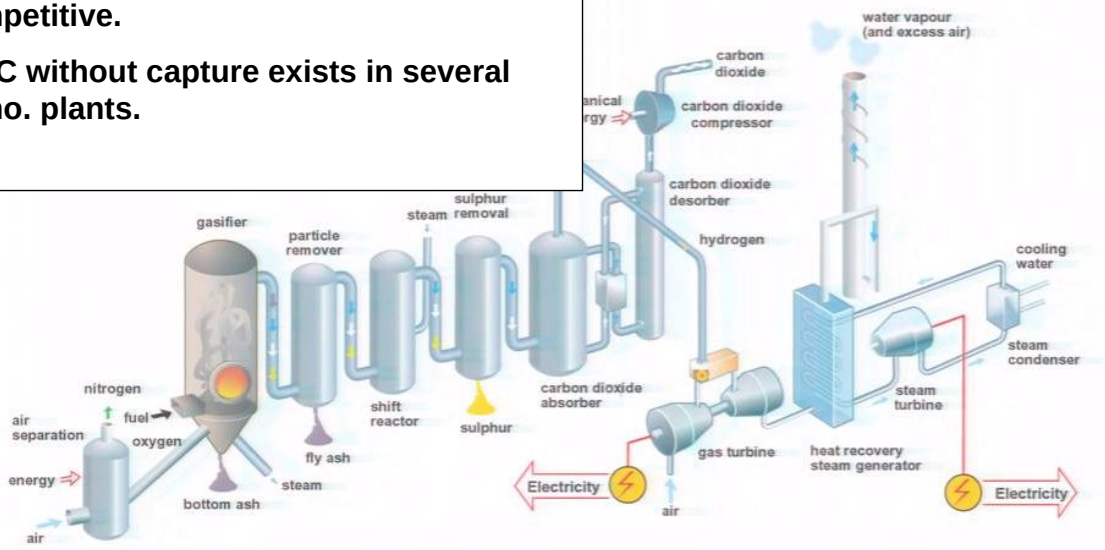
Pre-combustion capture

This technology has the potential to be competitive.

IGCC without capture exists in several demo. plants.



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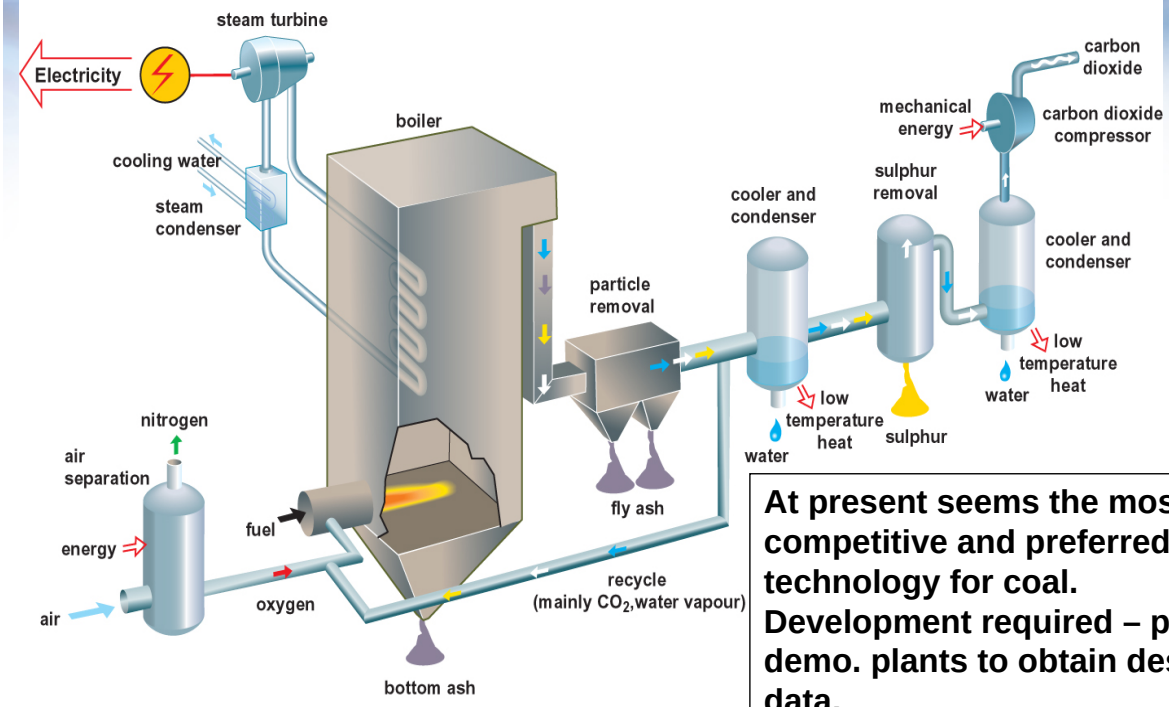
Oxy-fuel (O2/CO2) combustion



At present seems the most competitive and preferred technology for coal. Development required – pilot and demo. plants to obtain design data.

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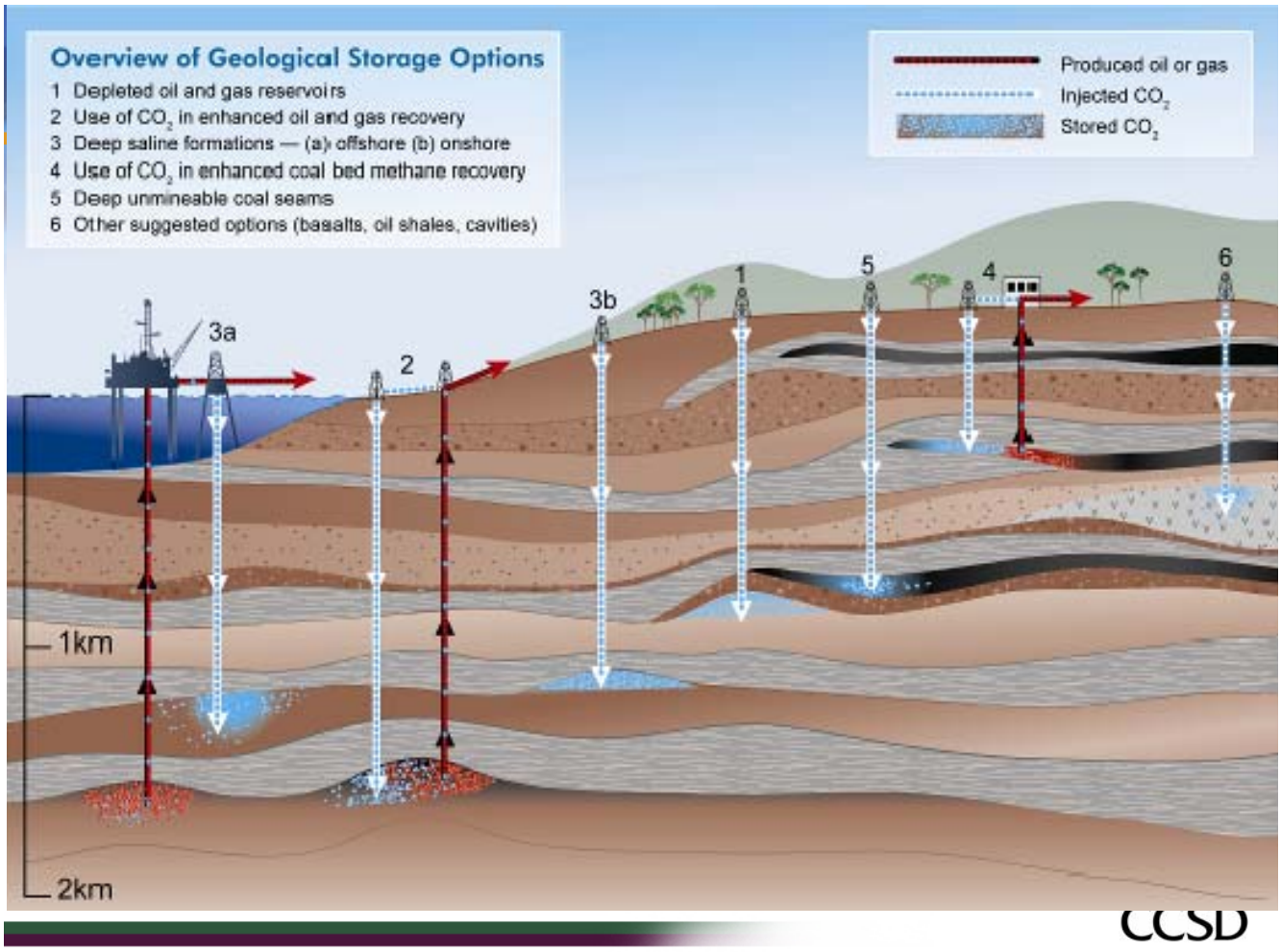
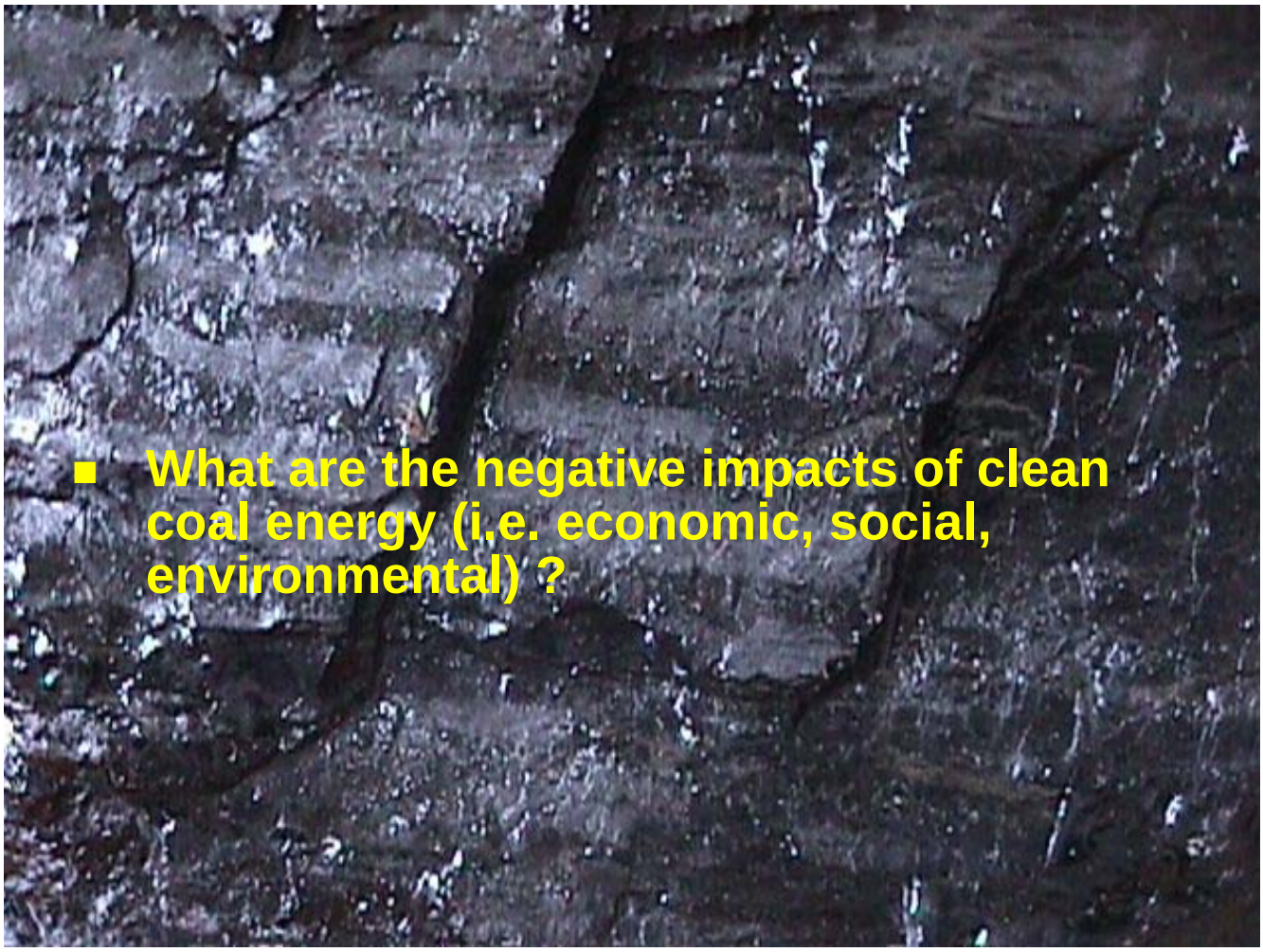
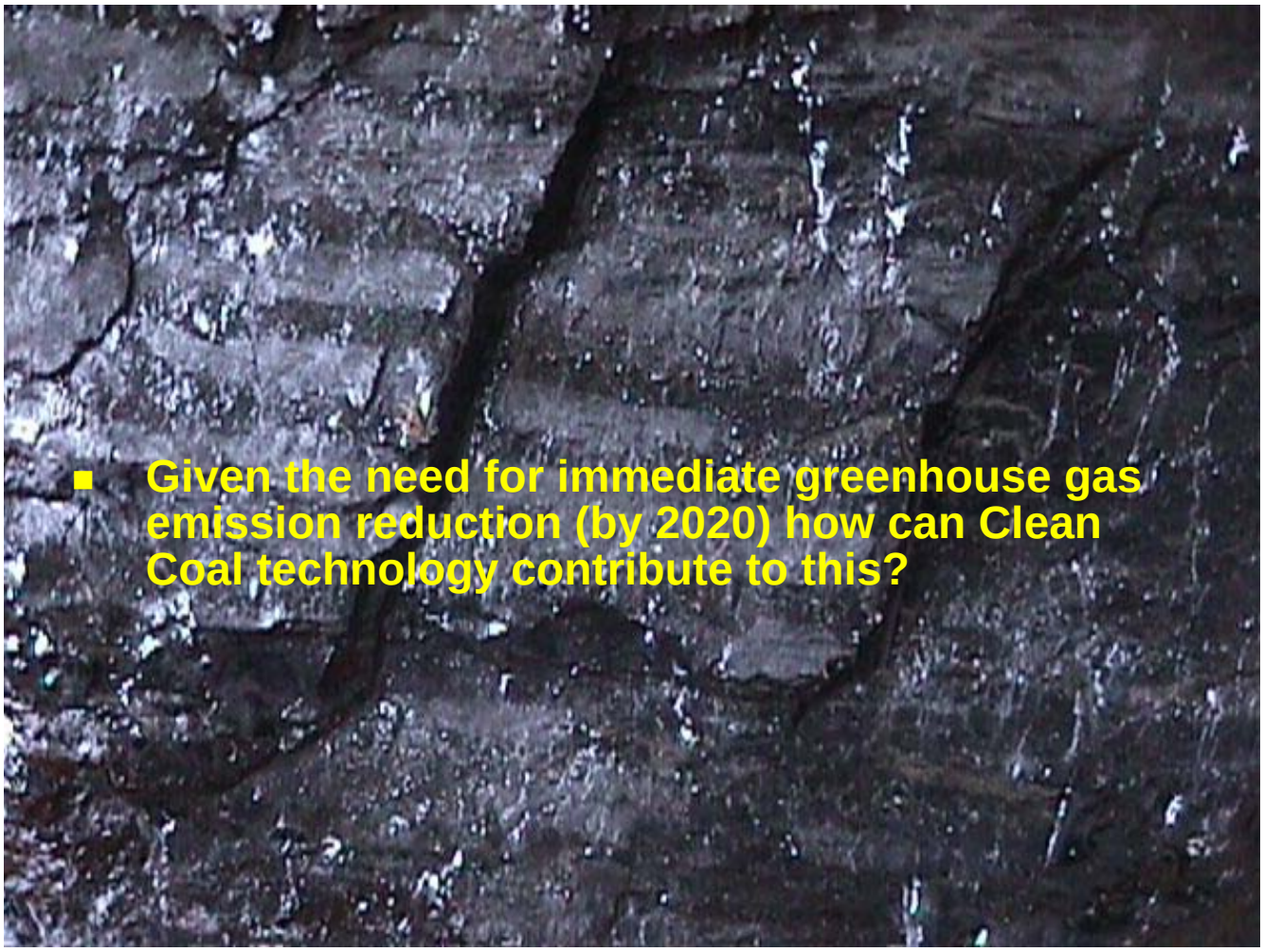


- What are the key reasons why clean coal energy would be a viable future energy source for Australia (i.e. economic, social, environmental)?


What are the negative impacts of clean coal energy (i.e. economic, social, environmental) ?


How does clean coal energy compare with other sources of energy for the future?



The basis for decision making is changing

Expectations are constantly changing

- previously focused on attaining high efficiency, then
- lowest cost capture-hydrogen
- currently low risk and adaptability; optimum combination of efficiency, capture costs, future flexibility
- changing expectations for role of renewables and nuclear

Continual reassessment

- the consensus view is changing on the best technology
- new options for improving existing technologies through re-engineering
- CO2 capture affects the cost of other emission controls

Increased acceptance of the need to back a range of options

- IGCC is no longer the only future option (changing views on the role of hydrogen)
- to reduce risk by providing an adaptive capability

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Future energy scenarios Australia

Options for Electricity Generation in Australia – Supplementary Report **. CCSD Technology Assessment Report 44, 2004: *Paul Graham, Peter Coombes, Tom Beer, Willem Bouma, Doug Vincent***

Analysis steps:

- Identify likely technologies and costs
  - black and brown coal, gas and renewables
- Set GHG emission targets for electricity sector
- Use an economic model to determine the least cost portfolio of technologies which can meet greenhouse targets
- Examine key sensitivities

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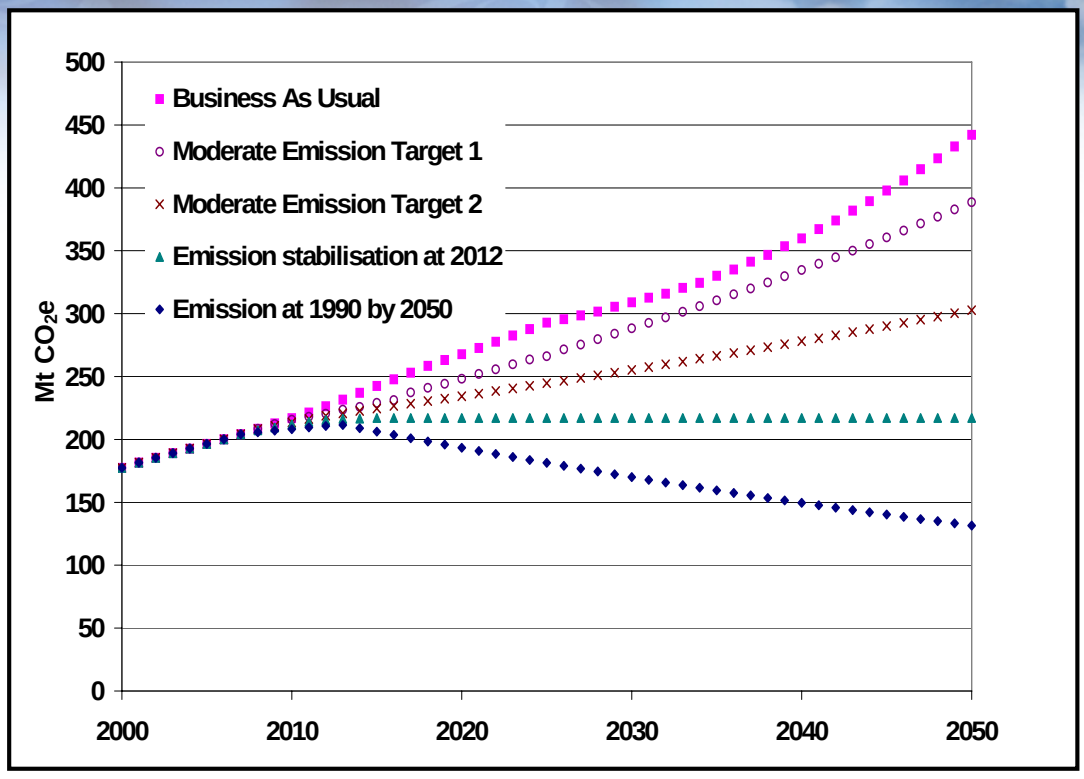
Future energy scenarios Australia - emission outcomes



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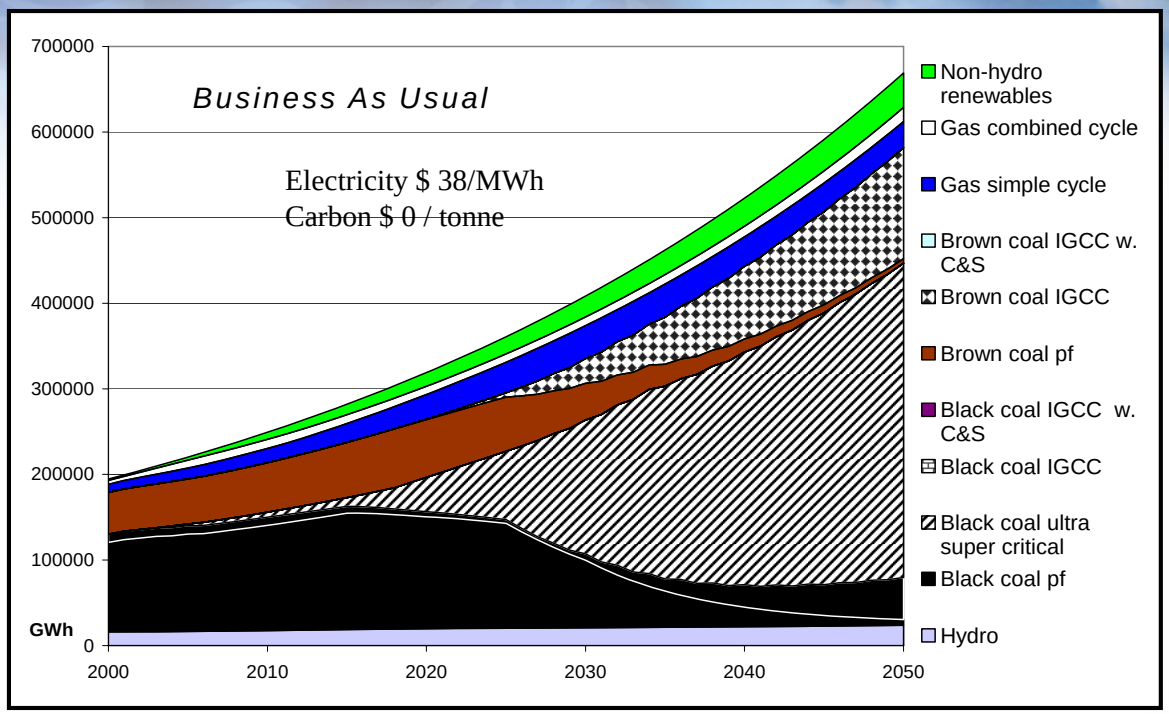
No change to business environment



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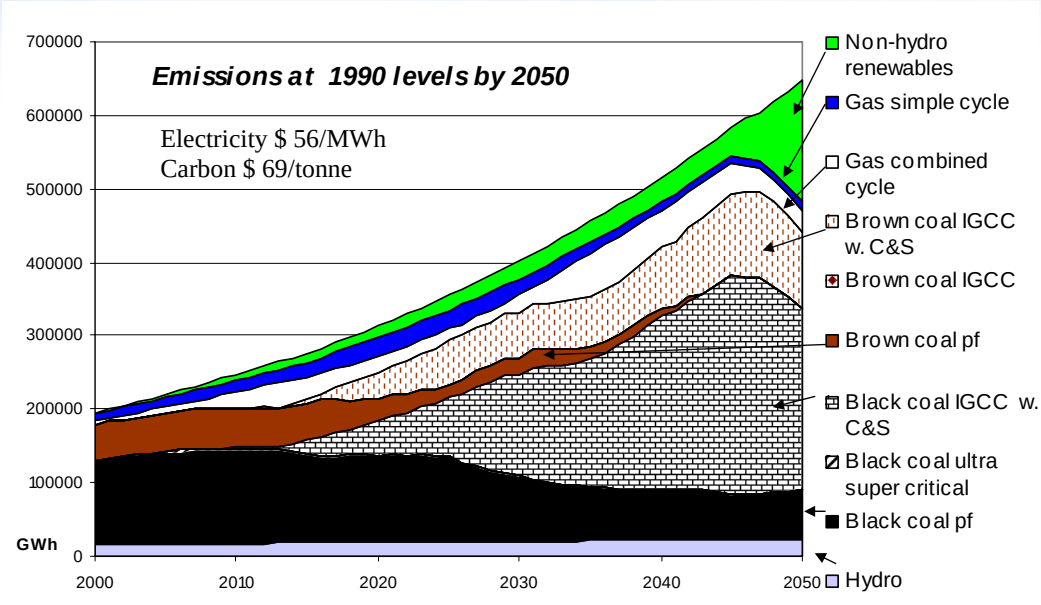
Technology mix for deep cuts in CO_2



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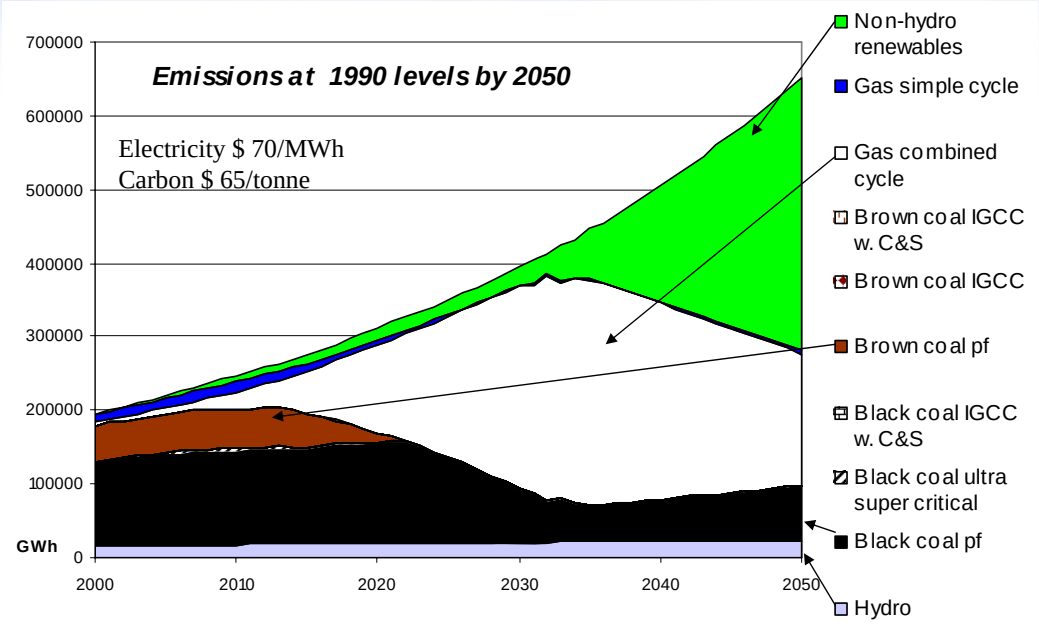
Carbon capture and storage Infeasible



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Technology options for generators

'Techno-economic Assessment of Power Generation Options for Australia'

CCSD Technology Assessment Report 54, 2006: Wibberley L, Cottrell A, Palfreyman D, Scaife P, Brown P

This report summarises technology assessments of low emission electricity generation technologies in an Australian context, with a time horizon of 2015. Technologies reviewed:

- **Advanced super critical pulverised fuel (A/SCPF)**
- **Oxygen fired pulverised fuel (oxy-pf)**
- **Integrated gasification combined cycle (IGCC)**
- **Lignite drying**
- **Post combustion capture (PCC)**
- **In situ gas**
- **Concentrating solar thermal (CST)**
- **Other renewables – PV, wind, biomass**
- **Nuclear**

TAR 54 - Technology comparison key Indicators

Costs and abatement –**Capex** –**Cost of electricity** –**Capture cost** –**Abatement potential**	Retrofit aspects –**Retrofit potential** –**Asset life extension**
Implementation issues –**Staged** –**Unit scale**	**Flexibility-adaptability** –**Operating flexibility** –**Integration with renewables** –**Synergies with renewables** –**Water consumption** –**Future developments** –**R&D requirements**
Coal suitability	

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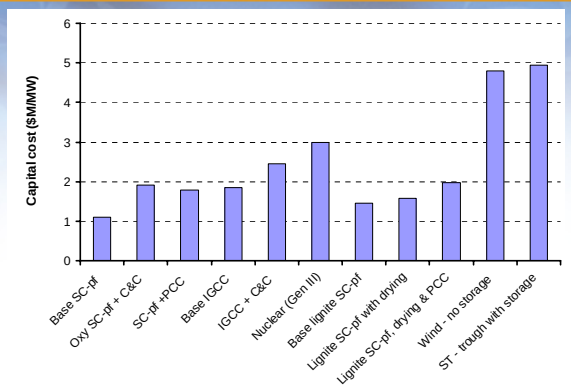
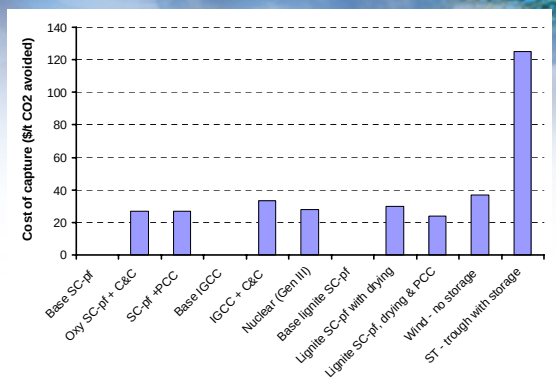
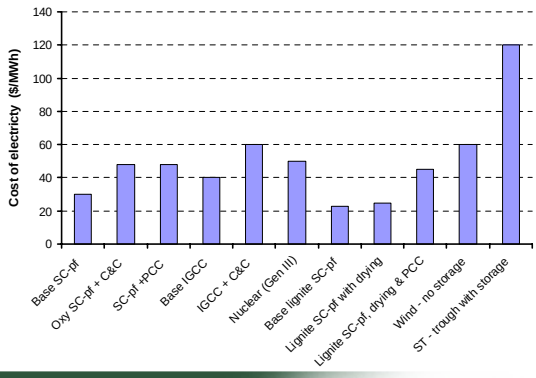
Cost and abatement







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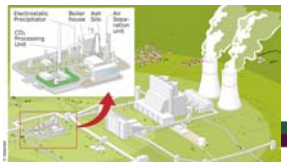
TAR 54 – Some Conclusions

- 3 additional highly relevant areas were identified –
  - conceptual ultra high efficiency processes (to 60%) without capture
  - energy storage
  - transmission of energy (electricity *vs* hydrogen or liquid fuels) and CO_2.

- With on-going research and development (R&D), technology development and reassessment of options continues to change the order of merit of the technologies in terms of overall cost estimates and technology development pathways.



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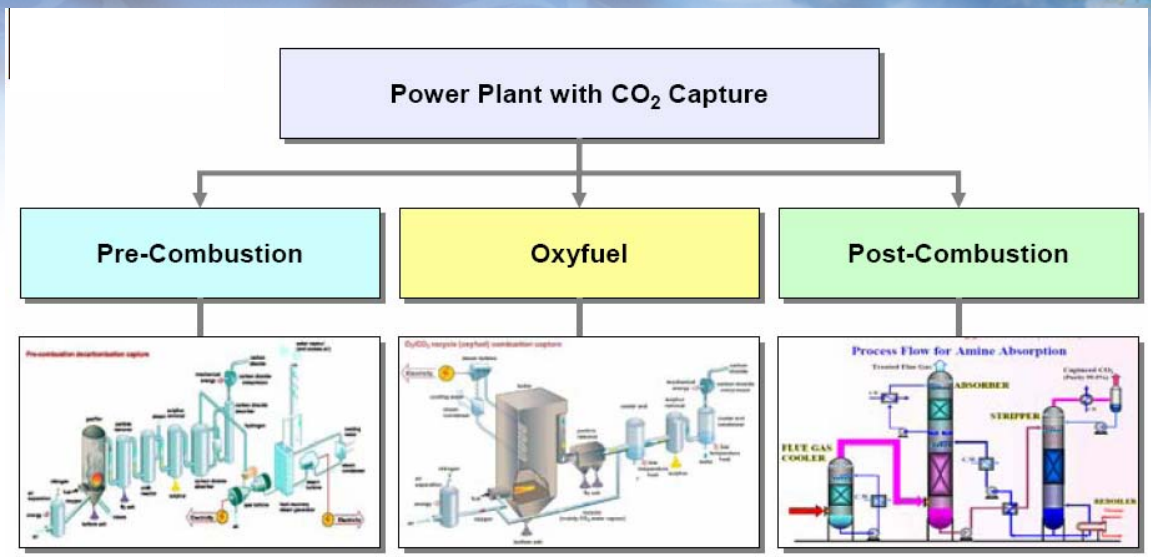
OUTLINE of Presentation

- The global energy outlook – coals role in the supply of primary energy
- Mapping technology pathways to a low emissions future – presentation of international approaches
- The portfolio technology options for Australia
- **A close-up of some promising clean coal technologies**

Power Generation Plant with CCS



Efficiency reduction: 5-15 %-points
Cost of CO_2 avoided: 25- 70 €/t CO_2

VGB PowerTech

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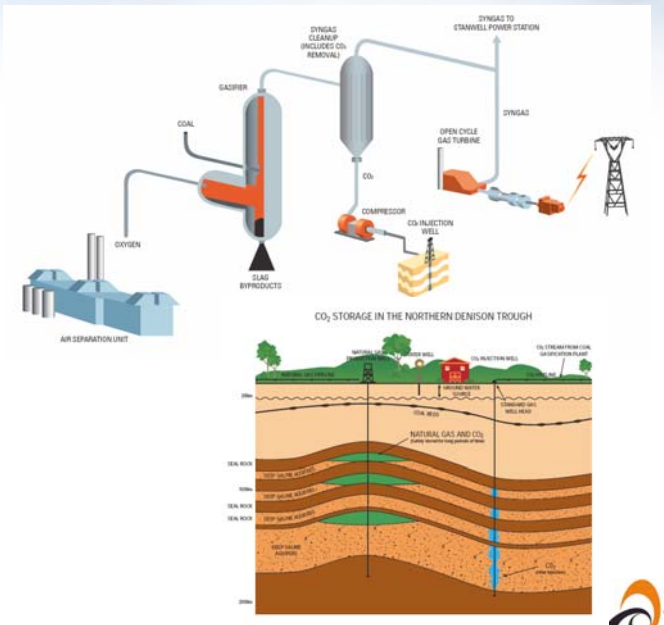
Australian Low emission pilot/demonstration projects

Stanwell Project - Integrated gasification combined cycle (IGCC) with CCS



www.zerogen.com.au

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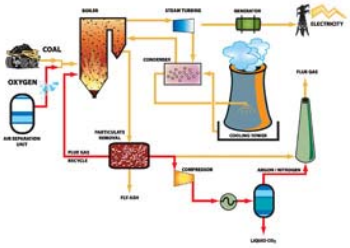
Australian
Low emission pilot/demonstration projects

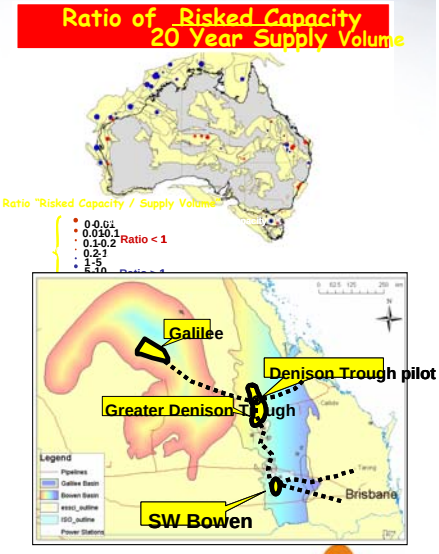
Callide Project - oxy-fuel

The objective is to develop a capability for assessing oxy-fuel technology for retrofits and new plant

Australian and Japanese consortium

- **Phase 1 (2004-06)**
  - Fundamental studies
  - Oxygen production and CO_2 capture
  - Boiler retrofit
  - CO_2 Storage
- **Phase 2 (2007-14)**
  - Demonstration project (LETDF)





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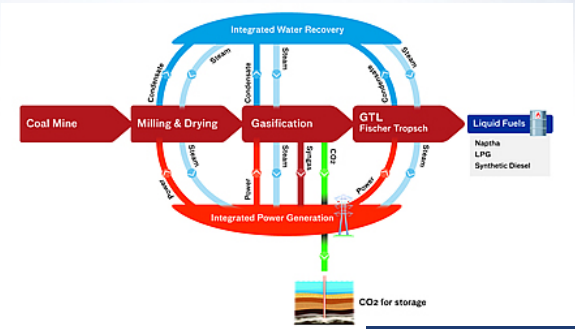
Australian
Low emission pilot/demonstration projects

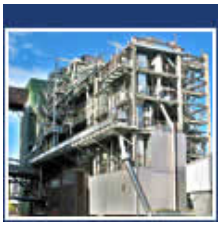
Monash Project

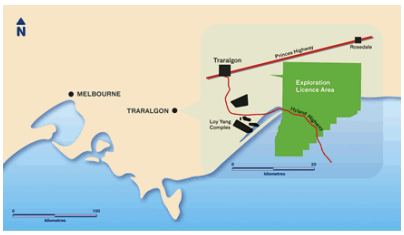
- **The core of the project is a large scale commercial plant in Victoria's Latrobe Valley, with**
  - coal from its own mine
  - drying and gasifying the coal
  - conversion into transport fuels.



and in parallel,

- **Infrastructure for carbon capture and storage.**





www.monashenergy.com.au

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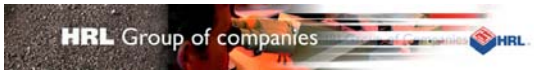
Australian
Low emission pilot/demonstration projects

IDGCC Project – HRL and Harbin (China)

PRESS RELEASE HRL Limited
Date: Tuesday 21 February 2006

'HRL Limited and Harbin Power Engineering Company (HPE), a subsidiary of Harbin Power Equipment Group Corporation, China's largest manufacturer of power generation equipment and power station developer today announced that they had signed a Memorandum of Understanding (MOU), to develop a 400 MW demonstration power station in Victoria's Latrobe Valley using new clean coal technology developed by HRL and to explore future development of other power plants globally.'



www.hrl.com.au

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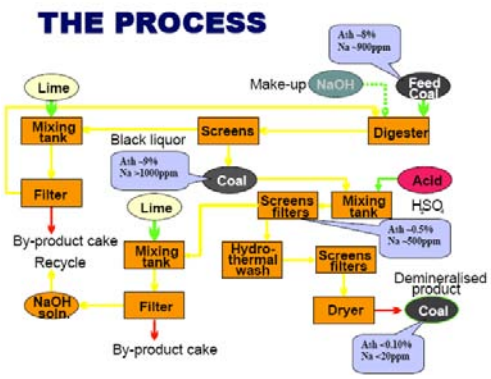
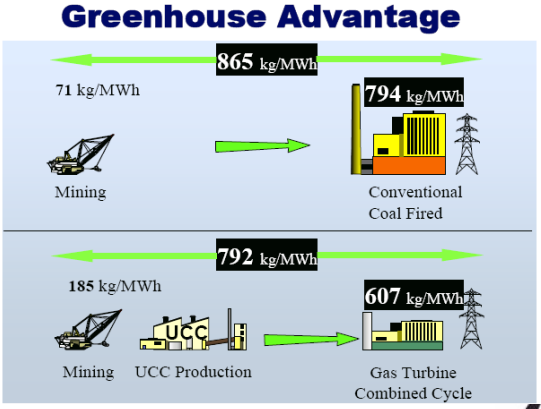
Australian
Low emission pilot/demonstration projects

Ultra Clean Coal

Ultra Clean Coal (UCC) is an ultra high purity coal-based fuel that is capable of being used with more greenhouse friendly power generation technologies.





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- A close-up of some promising clean coal technologies
- **Conclusion**

Conclusions – power form coal and emissions

- **The power sector is the largest single emitter of CO_2 and therefore must take the lead for introducing CO_2 free technology**
- **To be able to make the deep cuts necessary, carbon capture and sequestration (CCS) is necessary**
- **A primary target is to make technology available in 2020, but also to start the development of second generation technology**

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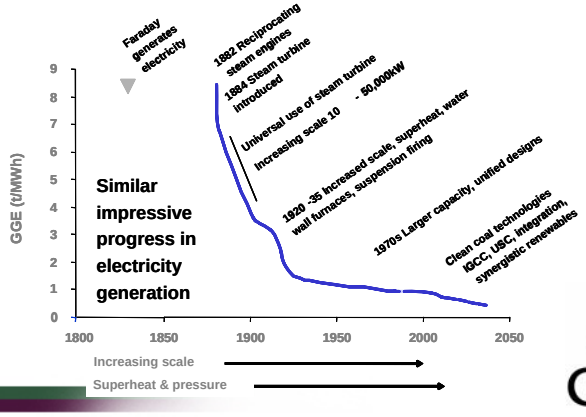
A Final Word on Technology

'The single most frequent failure in the history of forecasting has been grossly underestimating the impact of technologies'

Peter Schwartz from The Art of the Long View



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Thank you for listening

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