

Presentation to AIE 10 March 2008

CCS and the future of Coal-based Power Generation in Australia

**Meeting the challenge of
Climate Change and Growing
Energy Demand**

Bede Boyle

We will cover

- **Global Perspective on CO2 Emissions**
- **Australian Perspective on CO2 Emissions**
- **NEM dispatch scenarios 2020 - 2050**
- **Advances in Coal-fired Technology**
- **Australia *Coal21***
- **Eight CCS Projects in Australia**

“ Most energy supply scenarios project that supply of primary energy will continue to be dominated by fossil fuels until at least the middle of the century.”

**UNEP Report on CO2 Capture and Storage
Intergovernmental Panel on Climate Change**

“ Coal is the low cost mainstay of both the developed and developing world. Carbon capture and storage is the critical enabling technology because it allows significant reduction in carbon dioxide emissions while allowing coal to meet future energy requirements ”

The Future of Coal - March 2007

Massachusetts Institute of Technology

Globally, about 40% of CO2 emissions are from the generation of electricity

- 70% is contributed by coal-fired plants**
- 20% from natural gas- fired plants**
- 10% from oil-fired plants**

A Global Perspective on CO2 Emissions

- **About 81% of energy needs in 2030 will be provided by fossil fuels**
- **70% of growth in CO2 emissions to 2030 will occur in developing countries**
- **Emissions from developing countries will overtake emissions from OECD countries by about 2010**
- **China will account for about 40% of rise in global emissions**

IEA Report 8 November 2006

“ We want Germany’s first CO₂ – free power station to be running in 2015 and CO₂ free power stations to be standard by 2020”

Social Democratic Party

“RWE plans to commission a 450MW IGCC power station in 2014, which will use coal or lignite gasification and carbon capture and storage technology (CCS) to achieve 43% overall efficiency with CCS and 500km CO₂ pipeline.”

Dr Johannes Heithoff – RWE Power AG

- **Coal and natural gas produce about 90% of Australia's electricity and contribute 34% of Australia's greenhouse emissions**
- **Australia's demand for electricity will more than double before 2050**

“ There is no question that, in the absence of commercially successful CCS, some coal-mining and coal-based generating firms in Australia would be negatively affected by the introduction of an ETS, and may struggle to operate profitably in a carbon-constrained economy. On the other hand, commercially successful CCS could turn the coal and coal-based electricity generating areas into regions of strong expansion and prosperity”

Garnaut Interim Report February 2008

**Base Load
(lowest SRMC)**

**– Coal \$1.50/GJ
(\$5/GJ export)**

**Intermediate Load
(medium SRMC - 25% to 30% load)**

- Coal + Gas

**Peaking
(highest SRMC < 5% load)**

**- Gas \$3.50/GJ
(\$7.50/GJ LNG)**

SRMC = short run marginal cost

(export parity)

Base Load (lowest SRMC)	- Coal + CCS	?
	- Gas	?
Intermediate Load (medium SRMC- 25% to 30% load)	- Gas	?
	- Wind	
Peaking (highest SRMC < 5% load)	- Gas	?

However gas price will rise to capture value of emission abatement (CCS) and export parity (LNG)

Base Load

(lowest SRMC)

– Nuclear ?

- IGCC + CCS ?

- Geothermal ?

Intermediate Load

(medium SRMC 25% to 30% load)

- Coal + CCS ?

- Gas + CCS ?

- Wind / Solar ?

- Biomass ?

Peaking

(highest SRMC < 5% load)

- Gas no CCS ?

Growth of Decentralised Power

(Micro DC Grids)

- Wind + Solar

Gas backup

- **Improvements in Thermal Efficiency have reduced CO₂ emissions / tonne of coal**
 - **5% in 1900**
 - **38% with modern pulverised fuel**
 - **45% with supercritical technology**
 - **50% may be achieved in future by ultra supercritical technology and IGCC**
 - **55% R&D**
- **Every 1% increase in efficiency reduces CO₂ emissions by 2-3%**

- **99% of fly ash can be removed by Electrostatic Precipitators and/or fabric filters**
- **90-95% of SO_x can be removed by Flue Gas Desulphurisation**
- **80-90% of NO_x can be removed by selective catalytic reduction**

- **COAL21 National Action Plan**
 - **March 2004**
 - **Identified key emerging technologies**
 - **Identified potential abatement targets for 2030**
- **COAL21 Fund**
 - **Provides A\$1 billion of industry funds to demonstrate promising technologies**

- 1. Coal gasification for either electricity or liquid fuel**
- 2. Oxy – fuel combustion aimed at reducing cost of CO₂ capture**
- 3. Post – combustion capture and storage of CO₂**
- 4. Capture and permanent geological storage of CO₂**
- 5. Advanced clean coal preparation technologies**

Integrated Coal Gasification Combined Cycle (IGCC)

- Target efficiencies greater than 50%**
- Lower SO₂, NO_x and CO₂ emissions**
- 99% of sulphur present in coal can be recovered for sale**
- Best route to produce hydrogen for transport fuel and power-generating fuel cells**

Shell and Anglo American plan to apply advanced drying and proven gasification technologies to brown coal to produce synthetic diesel fuel

Synthetic diesel from gasification of brown coal may eventually replace Australia's dwindling crude oil reserves

- **Oxy – fuel combustion is in the demonstration phase and uses high purity oxygen**
- **Results in higher CO2 concentrations in the gas stream (80% by volume) and, hence, in easier separation of CO2.**

- **Post-combustion capture of CO₂ from flue gasses is technically feasible from a number of existing power plants.**
- **However, CO₂ capture increases cost of electricity 40-85% for a supercritical Pulverised Fuel plant.**

- **Delta and CSIRO propose to jointly develop a \$5million research scale pilot plant to capture (and release) up to 5,000 tonnes per year of CO₂ using an ammonia adsorption process.**
- **The Munmorah pilot plant is a precursor to a larger PCC demonstration project in NSW which would capture 100,000 tonnes of CO₂ per annum, compress and transport the CO₂ into a suitable geosequestration site.**
- **The \$100million plant could be operational by 2013 to demonstrate retrofit technology.**

- **Capture, Compression and Transportation to injection wells in deep underground geological formations for secure storage**
- **Potential to reduce CO₂ emissions by 80-90%**
- ***CCS “Has potential to reduce overall mitigation costs and increase flexibility in achieving greenhouse emission reductions”***

Intergovernmental Panel on Climate Change

- 1. Offshore Sleipner natural gas project in Norway**
- 2. Weburn Enhanced Oil Recovery project in Canada**
- 3. In Salah natural gas project in Algeria**

Most importantly these schemes each capture and store about 1Mtpa CO₂ per year and have not detected CO₂ leakage of any kind.

CCS Project	Lead	Storage
1. Otway	CO2CRC	2008
2. Callide	CS Energy	2010
3. Moomba	Santos	2010?
4. Fairview	GE/Santos/Ergon	2011?
5. Gorgon	Chevron/Shell/Esso	2012?
6. ZeroGen	QLD Gov/Shell	2012?
7. Kwinana	BP / Rio Tinto	No go
8. Monash	Anglo / Shell	2015?

But? – dependent on ETS and carbon price

Demonstration by CO2CRC of geological storage of CO2 and monitoring and verification of the behavior of the stored CO2

The Otway Basin offers the potential to store the very large volumes of CO2 emissions from the nearby Latrobe Valley power stations.

- **Oxy – fuel combustion is in the demonstration phase and uses high purity oxygen and results in higher CO₂ concentrations in the gas stream (80% by volume) and, hence, in easier separation of CO₂.**
- **CS Energy will retrofit 30MW oxyfuel coal-fired power plant for CCS demonstration**

**Stage 1 – demonstrate integrity of
Moomba for CO2 storage**

**Stage 2 – integrate with capture from
large scale CO2 emitters in QLD / NSW**

**Stage 3 – Upscale Moomba as hub to
store large volume CO2 from emission
sources in QLD / NSW / SA**

**Moomba has up to 1,000 million tonnes
of CO2 storage capacity**

GE, Santos, BHP Billiton and Ergon Energy planning 100MW coal seam gas fired power station

Proposed demonstration of CO₂ enhanced coal bed methane production and use of methane in power station

Chevron, Mobile and Shell planning construction of 10Mtpa LNG plant

3Mtpa of CO₂ to be captured from natural gas (+12% CO₂) and injected in Dupuy Formation saline aquifer beneath Barrow Island WA

QLD government demonstration of coal based gasification (100MWe IGCC) to produce low emission base load electricity

Test drilling has indicated that CO₂ can be stored in Dennison Trough

Work is progressing to identify reservoir capacity

BP and Rio Tinto plan to use sub-bituminous coal to produce hydrogen for a 500MW power station with fully integrated CCS

**4Mtpa CO₂ to offshore Perth Basin
Project abandoned due to inability to identify CO₂ storage sites.**

Shell and Anglo American plan to apply advanced drying and proven gasification technologies to brown coal to produce synthetic diesel fuel

- **Shell's proprietary gasification process will be applied to Anglo American's brown coal from Victoria's Latrobe Valley to produce virtually zero sulphur synthetic diesel fuel**
- **Potential sites have been identified for CO₂ storage in deep geological formations**

- Produces UCC with less than 1% ash**
- Alternative fuel to heavy oil and gas**
 - 53% efficiency with direct injection in gas turbine with combined cycle**
 - 58% efficiency with direct injection in diesel engine**

UCC technology is an initiative of White Mining Limited with the CSIRO and has attracted both Federal and State Government support

Advanced Coal Technology Solutions, including CCS, have a vital role in meeting the twin challenges of greenhouse emissions and growing energy demand in Australia through Public / Private Partnerships

- 1 Australia has abundant reserves of economically viable thermal coal**
- 2 Advances in Coal Fired Generation Technology has provided cheap electricity to drive Australia's development whilst responding to changes in environmental legislation and public concerns**
- 3 Major investment is being made by the global coal and power industries to address the twin challenges of greenhouse emissions and growing energy demand**

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Energy Solutions for a
Carbon-constrained World