Low emissions coal technologies in Australia

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Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Australia’s national science agency

One of the largest & most diverse in the world

6500+ staff over 55 locations

Ranked in top 1% in 14 research fields

20+ spin-off companies in six years

160+ active licences of CSIRO innovation

Building national prosperity and wellbeing
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Energy and Coal

- Energy is central to all economies

- Predictions of future world energy use shows continued growth

- This is in part due to increasing world population and also the rapid development of a number of emerging economies

- Heavy reliance on petroleum and coal has raised the issue of anthropogenic global warming

- This talk will discuss coal’s future role in the energy mix with a focus on low emissions technologies, from an Australian perspective
World net electricity generation by fuel, 2007-2035 (trillion kilowatthours)

From US EIA, 2010
Changes in temperature, sea level and Northern Hemisphere snow cover (IPCC, 2007)
Coal and Australia

- Australia has large reserves of black and brown coal

- Australia is the world’s largest exporter of coal and coal is Australia’s highest value export - (black, thermal and metallurgical)

- 76% of Australia’s electricity is derived from coal - (no nuclear power in Australia)

- Coal contributes 40% of net GHG emissions

- Australia has one of the largest GHG emissions per capita in the world (~25 tonne/person)
Australian GHG Emissions (2008)

Total = 551 Mt
Electricity supply by fuel in Australia

Renewables account for ~7% of electricity production

- Hydro 6.4%
- Wind 0.7%
- Biomass 0.4%

Electricity generation contributed 35% of total emissions.

55% - black coal, 21% - brown coal

From DRET, Australian Gov data
Climate Change is a diabolical policy problem

Garnaut (2008)
Garnaut targets and trajectories for GHG reduction

• 450ppm CO$_2$-e stabilisation in the atmosphere requires
  • 25% cut in GHG by 2020, over 2000 levels
  • 90% cut in GHG by 2050, over 2000 levels

• 550 ppm CO$_2$-e stabilisation in the atmosphere requires
  • 10% cut in GHG by 2020, over 2000 levels
  • 80% cut in GHG by 2050, over 2000 levels
Mitigation: where will we reduce emissions (CPRS-5)

Source: Commonwealth of Australia (2008)
Summary of projected electricity & transport sector abatement (CPRS-5)

Source: CSIRO projection (Graham et al 2009)
Electricity generation technology share (CPRS-550ppm)

Source: CSIRO projection (Graham et al 2009)
Australian Government Initiatives

Carbon Pollution Reduction Scheme (emissions trading with implementation in 2013)

Renewable energy target – 20% of electricity supply to come from renewable energy by 2020

Clean Energy Initiative - $4.5B

To be leveraged with State Gov and industry funds

$1.5B for Solar Flagships Program

$2.4B for Carbon Capture and Storage (CCS) Flagships Program

Global CCS Institute ($100m pa)

Australian National Low Emissions Coal R&D ($150m over 7 years from government and industry for R&D to support demonstration projects)
Australian basins and regions considered to have CO2 storage potential

from CO2CRC

KEY
- Basins & regions considered to have storage potential
- Sedimentary basins & regions yet to be assessed for storage potential
- Areas unlikely to have storage potential
- Major emission node
Carbon Pollution Reduction Scheme – Key Features

• Emissions Trading Scheme

• Covers 75% of GHG emissions at inception

• Covers all 6 UNFCCC GHG

• Direct emissions threshold of 25kt of CO₂-e

• Fugitive emissions from coal mining included

• Agriculture included 4 years after commencement of scheme

• Post-Copenhagen, CPRS legislation has been deferred until 2013
Four projects in competition for Gov funds

**Collie Hub Project (Western Australia)**
Capture, transport and storage network for up to 3.3 M tonne CO\(_2\) pa from a variety of sources including:
- coal fired pf power
- alumina
- fertiliser

**CarbonNet (Victoria)**
Capture, transport and storage network for up to 3 M tonne CO\(_2\) pa from a variety of sources including:
- Brown coal fired pf combustion power with Post Combustion Capture
- Gasification
- Other industry
CCS Flagship proposals

Wandoan Power
- 400MW IGCC station with CCS
- GE and Stanwell Corporation

ZeroGen
- 530MW IGCC with capture and CO2 Storage
- Mitsubishi Corporation, Mitsubishi Heavy Industries, ZeroGen Project

Announcement of winner(s) due later this year
Gorgon

- Natural gas to LNG for the export market
- Gas field has 14% CO₂ in the reservoir fluid
- Disposal in unused saline formation at a depth >2000m
- 120 million tonnes will be injected into the Dupuy formation at ~4 million tpa
- Joint Venture Partners Exxon, Chevron and Shell
The Callide Oxyfuel Project

- The Callide Oxyfuel Project is a 30MW centred on Callide A power station.
- CO₂ will be stored in nearby deep saline formation in the Dennison Trough.
- Partners are CS Energy, IHI, JPower, Mitsui, Schlumberger, and Xstrata Coal.
CO2CRC Otway Project Stage 1 and Stage 2

**Stage 1**
- Injection into depleted gas field
- 60,000 tonne CO₂ injected
- CO₂ plume appears well contained, at this stage

**Stage 2**
- Trial injection into Paaratte sandstone formation

**Stage 3**
- Larger injection into Paaratte
Established PCC Pilot Plants - (CSIRO and partners)

- Latrobe Valley Post Combustion Project
  - ETIS support
  - Loy Yang Power Station
  - Lignite
  - Amine based
  - No FGD/DeNox

- CHINA HUANENG
  - APP support
  - Gaobeidian Power Station
  - Black coal
  - Amine based
  - No FGD/DeNox

- Munmorah Power Station
  - Black coal
  - Amine based
  - FGD/DeNox installed

Pilot plants 1-3 kt pa
Fugitive emissions of methane account for 6% of Australia’s GHG emissions.

Emissions arise from both underground and open pit.

Emissions from spontaneous combustion not included as no robust method at present for their quantification.

Included in CPRS.
Fugitive greenhouse gas emissions from spontaneous combustion in spoil piles from open cut coal mines

Three approaches
a) Thermal imaging and chamber measurements
b) Plume traverse
c) Inverse modelling

CSIRO - Coal Technology

Focuses on low emissions coal technologies

- Quantification and mitigation of fugitives
- Gasification of coal and biomass (PEFR)
- Downstream gas processing for IGCC
- Post combustion capture of CO2 (amines, ammonia, adsorbents, ILs, enzymes - black and brown coal - lab and pilot-plants)
- Emissions limits for PCC - amines
- Coal in large scale diesel engines
- Enhanced coal bed methane (ECBM)
- CO2 storage in saline formations
- Mineralisation
- Direct carbon fuel cell
- Coal to Liquids (direct)
- Public attitudes to CCS

We work with many partners – ANLEC, CO2CRC, GCCSI, industry, Universities, other international research organisations etc
Summary

• Coal contributes significantly to global GHG emissions and concerns with climate change are posing significant challenges for coal.

• Coal makes a major contribution to Australia’s economic performance.

• Australia is investing in demonstration scale low emissions coal projects (and coal related R&D) to establish their suitability as part of the technology suite required to reduce GHG emissions.
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GREENHOUSE and ENERGY

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Thank you