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# CSIRO Low Emissions Coal Research

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**Director, CSIRO Advanced Coal Technology**



# CSIRO Advanced Coal Technology

**Goal** - To maximise the benefits from Australia's coal resources in an environmentally and socially responsible manner

**230 scientists and engineers**

**Research Focused in three Themes**

**Theme 1 – Coal Production (Dr Hua Guo)**

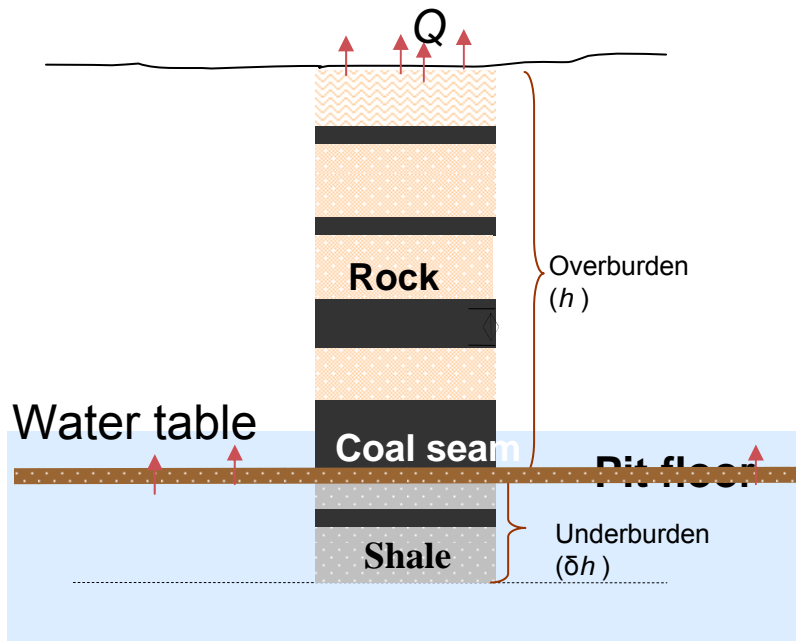
**Theme 2 – Coal Utilisation (Dr David Harris)**

**Theme 3 – CO<sub>2</sub> Capture, Transport, Use and Storage (Dr Lincoln Paterson)**



# Fugitive emissions

- Fugitive emissions of methane account for ~7% of Australia's GHG emissions
- Emissions arise from both **surface and underground mines.**
- CSIRO is investigating **pre-drainage at surface mines** to mitigate methane emissions
- Emissions from spontaneous combustion



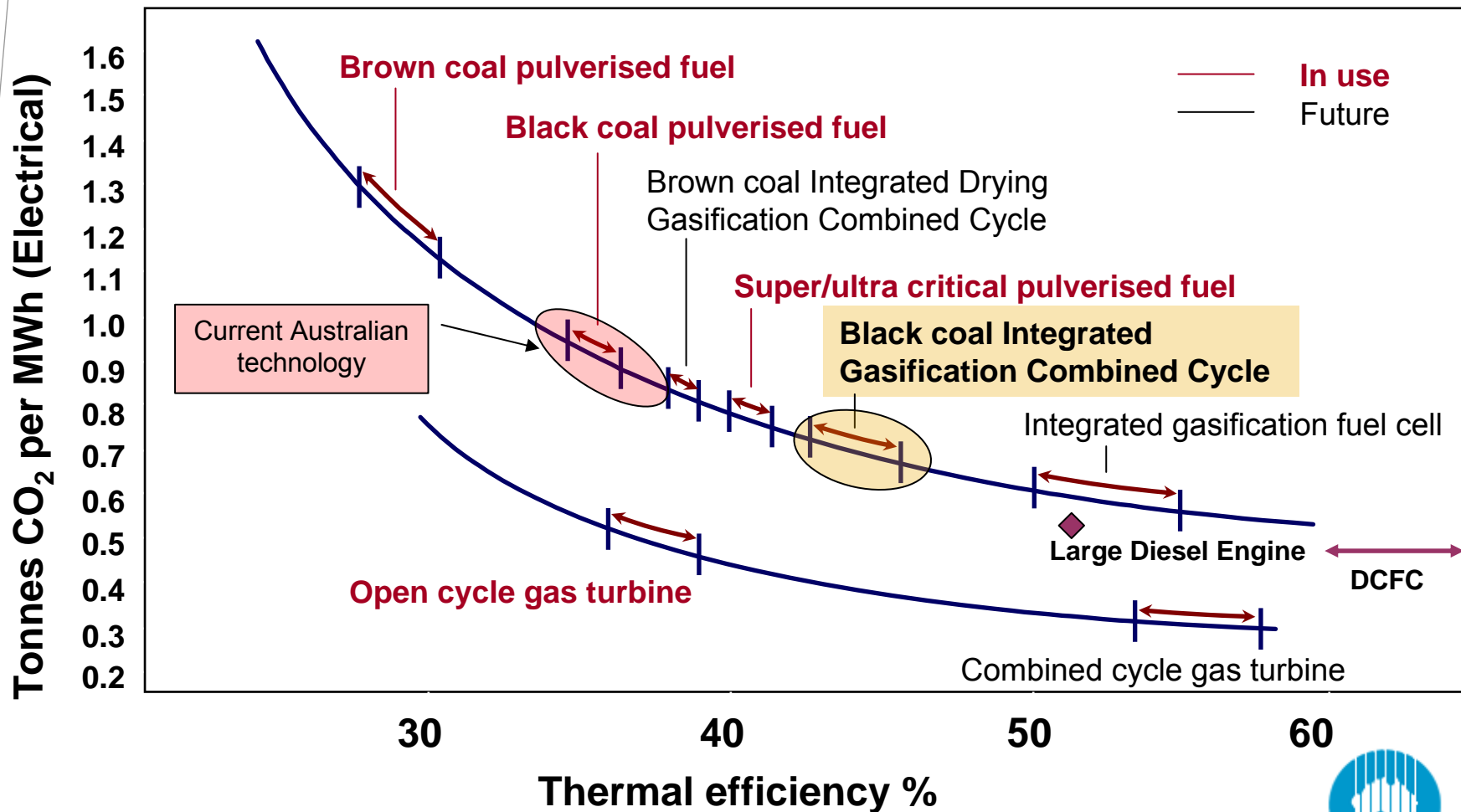
Australia-Japan Coal Workshop - 10 March 2011



Letter of Intent on Coal Mine Methane  
NEDO and CSIRO October 2010



# Technology efficiency impact on CO<sub>2</sub> emissions



# Low emissions coal utilisation

## Gasification of Australian coals

**To improve the understanding of coal performance in gasification technologies, supporting:**

- Use of Australian black and brown coals in new technologies
- Implementation of advanced coal technologies in Australia
- Development of high efficiency IGCC-CCS systems

- High pressure, high temperature coal conversion measurements
- Fundamental investigations of coal gasification reactions
- Slag formation and flow
- Syngas cleaning & processing
- Gas separation ( $H_2/CO_2$ )
- Technology performance models

### **MOUs with**

- AIST – gasification, gas separation, staff exchanges, workshops
- CRIEPI – low emissions technologies, mutual visits, collaboration



# Low emissions coal utilisation

## Direct carbon fuel cell

>70% efficiency possible.

Pure CO<sub>2</sub> stream produced so no need to separate exhaust gases

High efficiency coal use in large diesel engines.

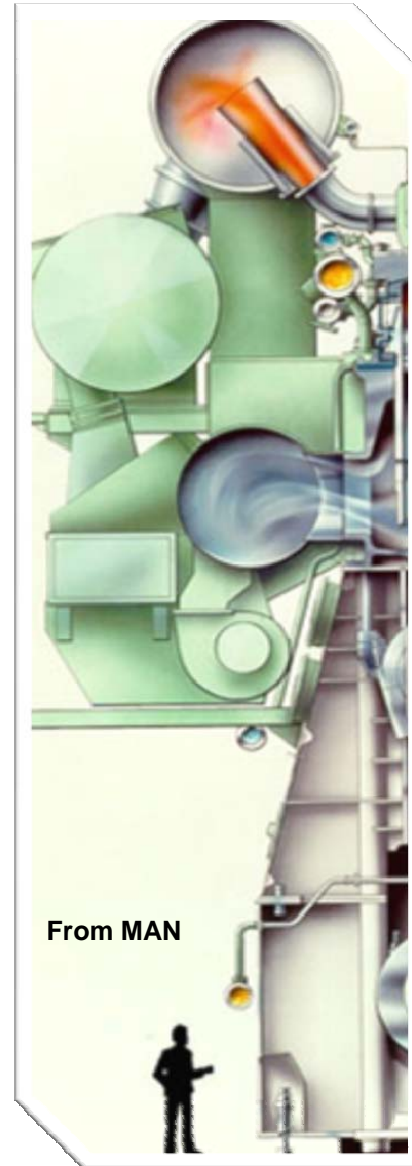
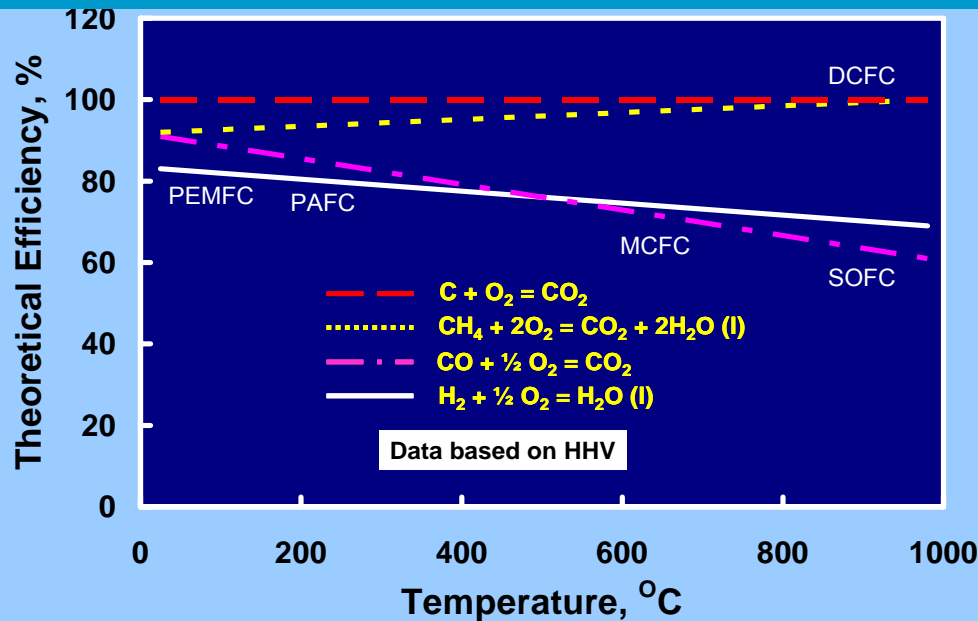
>50% efficiency sought

Corresponding decrease in GHG for storage

Low energy penalty for PCC

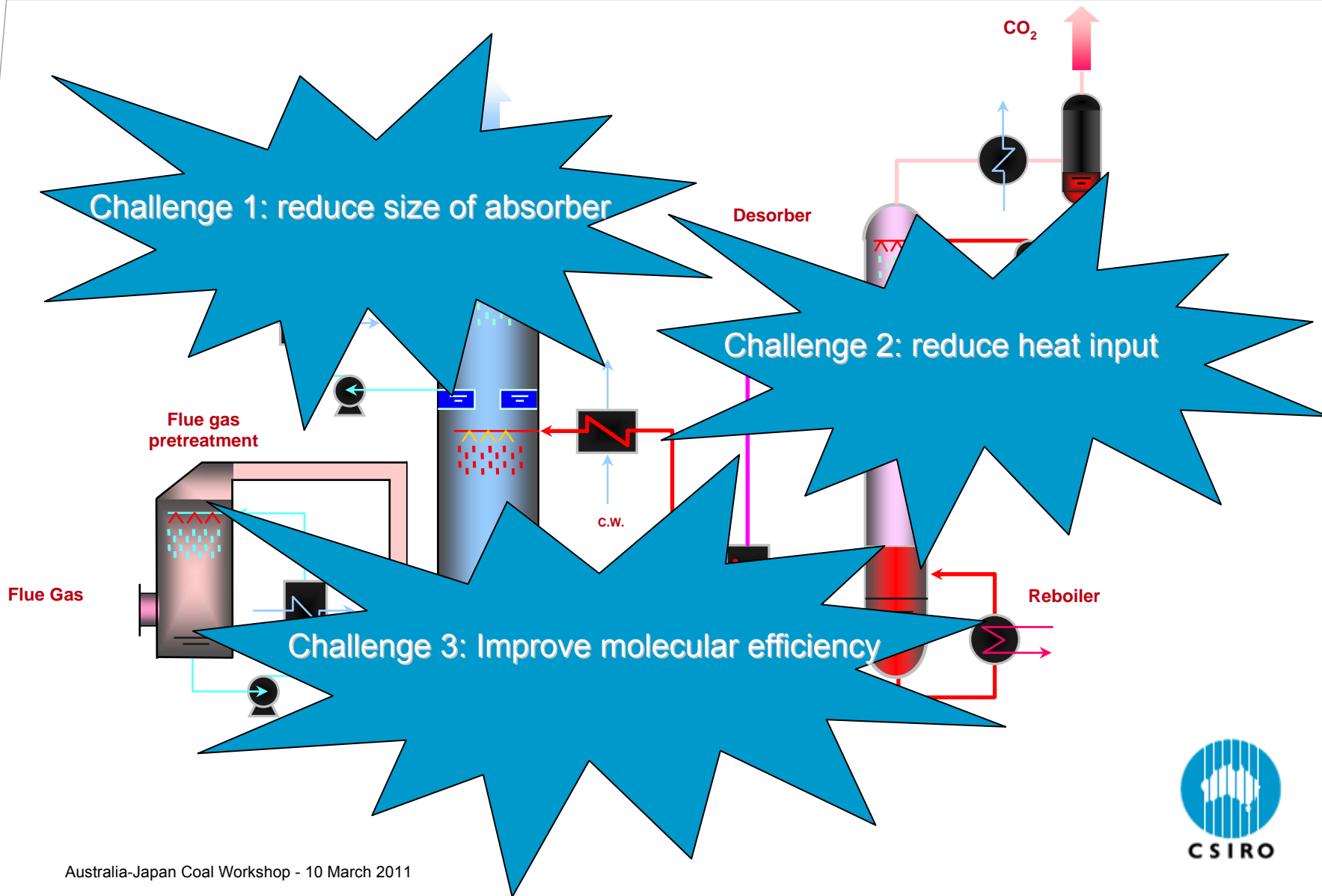
Black and brown coal

The effi. of fuel cells & fuel reactions as a function of operating temperature



# Post combustion capture

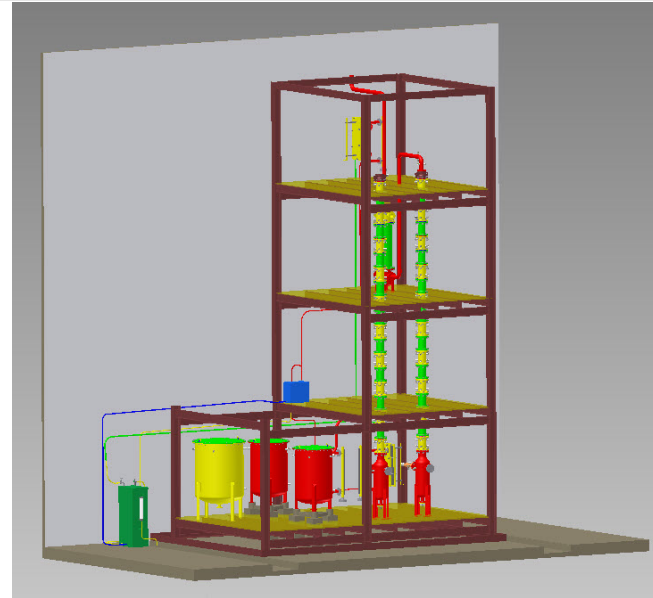
## *Three main challenges in driving down the cost*



# Novel Solvents and Process Development

## Generation I

Traditional capture solvents –  
MEA,  $K_2CO_3$ /promoter, ...



## Generation II

Modern capture solvents –  
MDEA/PZ, AMP/PZ, ...



## Generation III

Novel aqueous solvents –  
novel amines, promoters,  
...

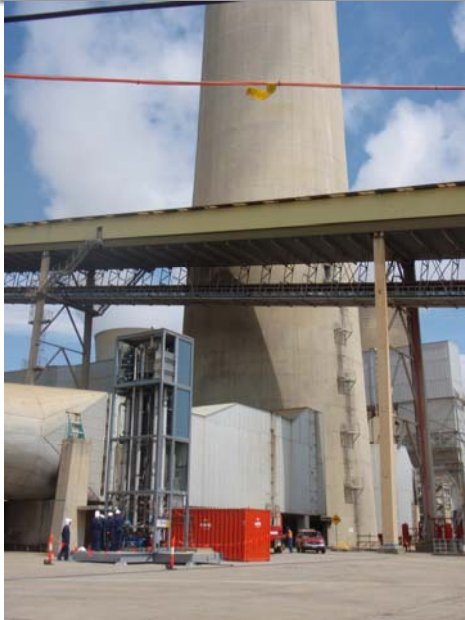
## Generation IV

Novel solvent systems –  
ionic liquids, enzymes, ...



# CO2 Capture, Transport and Geological Storage

## PCC Pilot Plants - CSIRO and partners



### RITE/ CSIRO PCC Workshop

Kyoto May 2009

120 participants

Very successful meeting



### Assessment of RITE Solvent at Loy Yang Power Station

2 x 6 week runs – September 2009,  
January 2010

In partnership with Chiyoda Corporation

Very successful outcomes

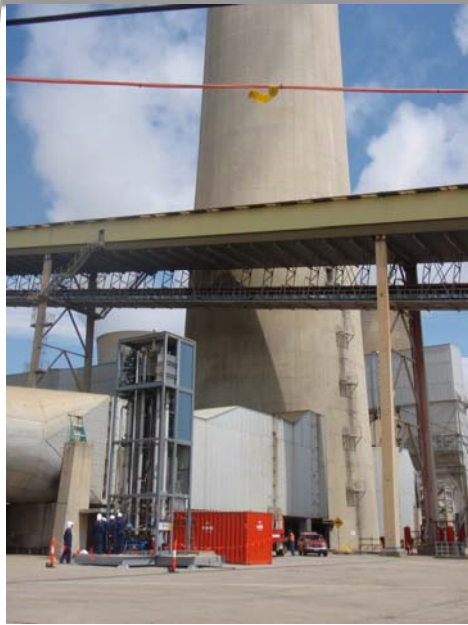


**Pilot plants 1-3 kt pa**  
*Learning by doing*



# CO2 Capture, Transport and Geological Storage

## PCC Pilot Plants - CSIRO and partners



**Pilot plants 1-3 kt pa**  
*Learning by doing*



# PCCS/U towards full scale demonstration

## PCCS/U全流量示范的发展



2008  
3000 t/a pilot  
中试装置  
Beijing  
北京

2010  
120,000 t/a  
commercial  
Shanghai  
小型示范装置  
上海

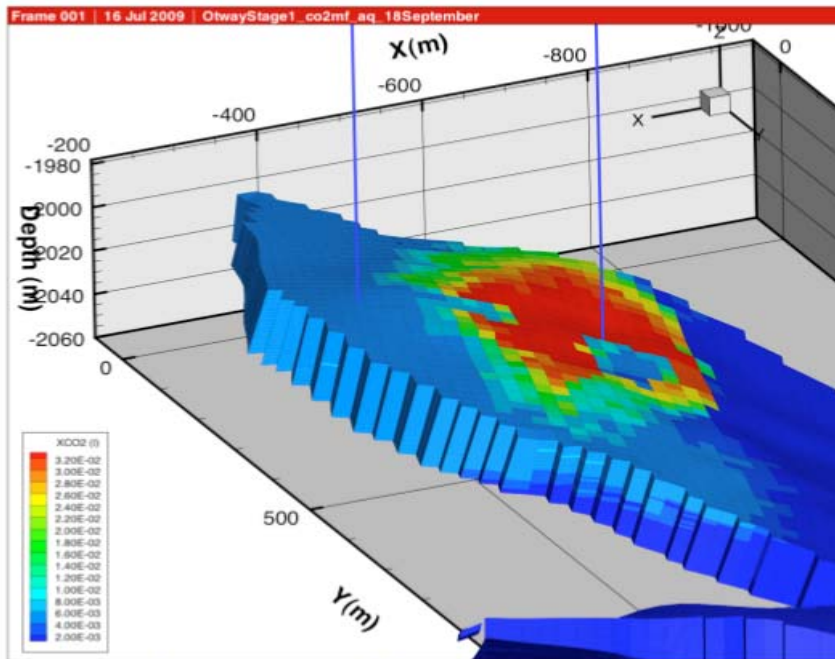
2015-2020 ??  
full scale (600MW)  
demonstration  
Location tbd  
基于600MW全流量示范  
地址待定

**TPRI**

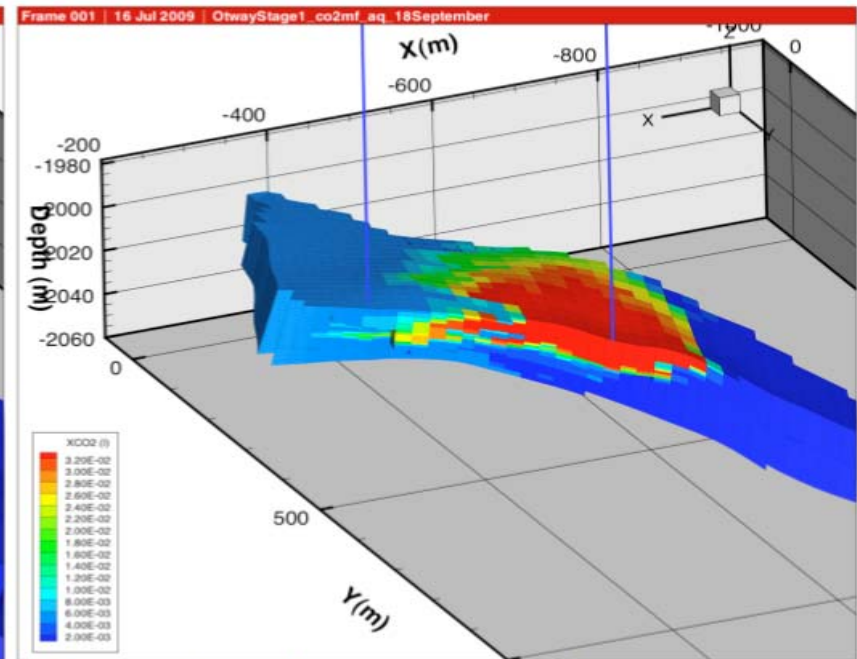
# CO<sub>2</sub> Capture, Transport and Geological Storage

## Transport and fate of sub-surface carbon dioxide

CSIRO is developing computer models to calculate and predict the movement, behaviour and fate of injected CO<sub>2</sub>.



(a) Carbon dioxide mass fraction 18 Sept: no cutaway.



(b) Carbon dioxide mass fraction 18 Sept: cutaway.

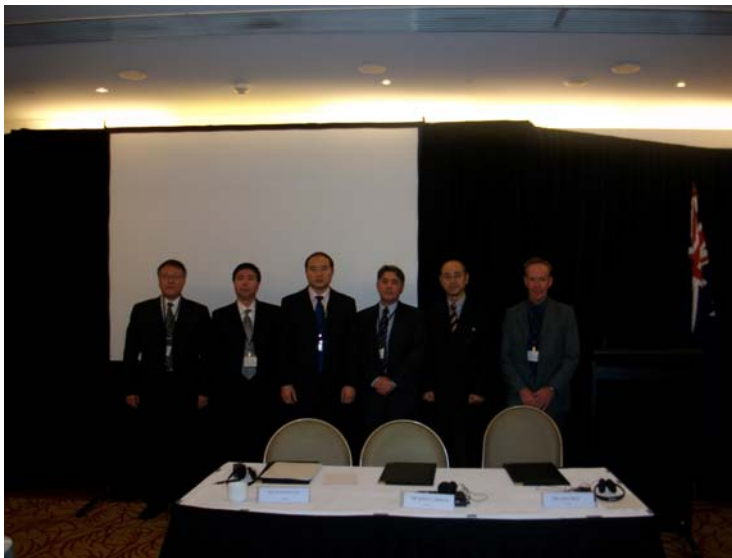
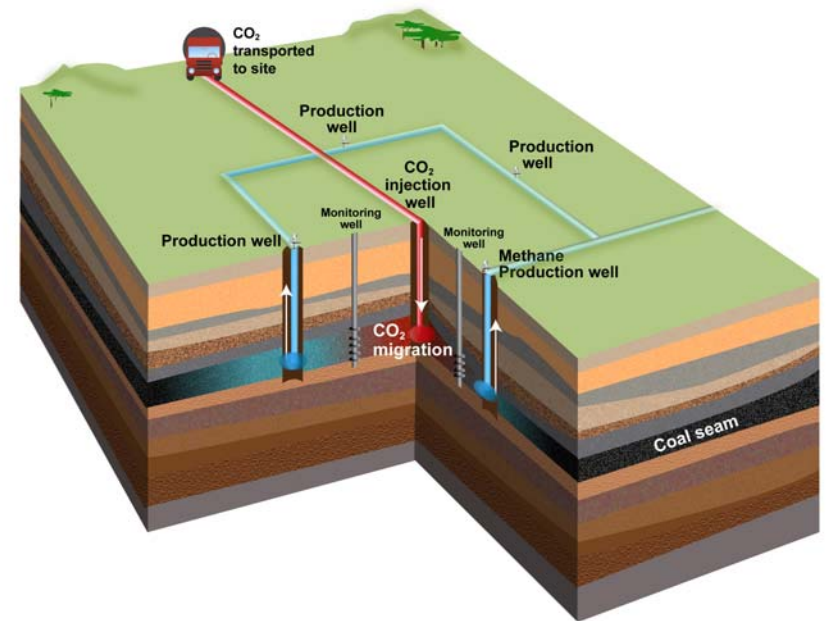
Key partner with CO<sub>2</sub>CRC in the CO<sub>2</sub>CRC Otway project



# CO2 Capture, Transport and Geological Storage

## Developing ECBM as a low emissions technology

- CUCBM (China), CSIRO and JCOAL are carrying out an ECBM field trial in China under Asia Pacific Partnership
- Coal can store approximately twice as much carbon dioxide as methane.
- Horizontal injection well has been drilled with monitoring well almost complete
- ~2000 tonne CO2 injection scheduled for May 2011



Signing at JCG - Dec 2009  
CUCBM, JCOAL and CSIRO

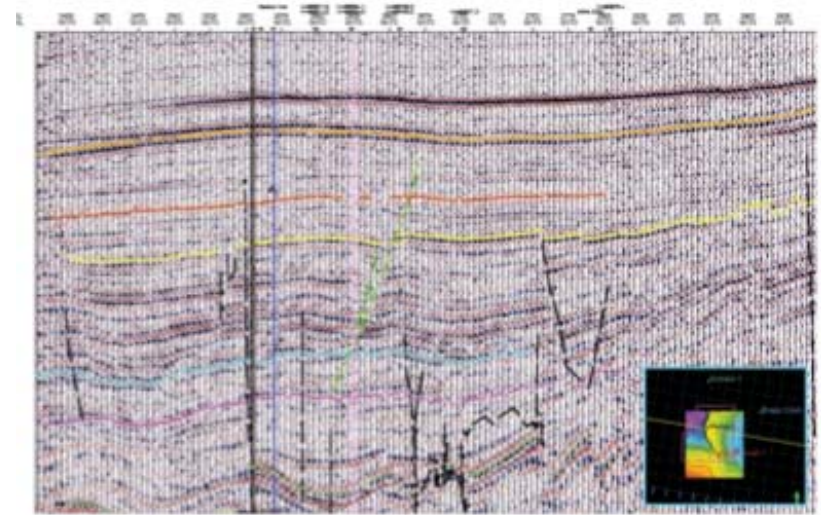


# CO2 Capture, Transport and Geological Storage

## Developing monitoring and verification tools and processes

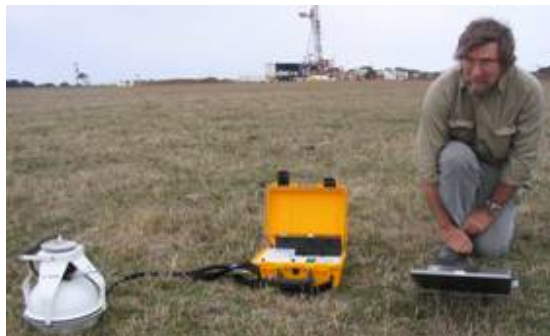
### Developing sub-surface methods utilising

- Tracers
- Surface geophysics
- Downhole geophysics
- Sensors



### Developing surface methods

- Meteorological inverse modelling
- Soil CO2 fluxes



# Advanced Coal Technology

## Partners, Networks, Links

**CSIRO Advanced Coal Technology partners with many organisations both in Australia and internationally. We thank them for their support.**

### **Australia - Government**

DCCEE, DECC(NSW), DPIE (Vic), DRET, NSWCCF, QME

### **Australia - Research Bodies**

ANLEC R&D, BCIA, CO2CRC, SIMTARS

### **CCS Flagships**

CarbonNet(Vic), Collie SW Hub (WA), Wandoan, ZeroGen

### **Industry**

ACARP, Anglo, BHPB, BHP Illawarra, BMA, Bucyrus, Centennial, China Huaneng, CUCBM (China), Delta Electricity, Exergen, General Electric, Huainan Coal, IHI (Japan), Joy, Loy Yang Power, Ludowici, Rio Tinto, Shell, Tarong Energy, TPRI (China), UCCE, Xstrata

### **Universities - Australia**

Curtin, Melbourne, Monash, Newcastle, UNSW, UQ/JKMRC, UWA, Wollongong

### **Universities - International**

Alberta, Canterbury, Delft, ETH, Freiberg, KIGAM(Korea), Leibniz Institute, Munich, Nottingham, Texas, Toronto, Virginia Tech., Wyoming

### **International**

Asia Pacific Partnership, AIST (Japan), CRIEPI (Japan), CUMT (China), GCCSI, IEA Greenhouse Gas Program, IPCC, JCG (China), JCOAL (Japan), iCAP (EU), NEDO (Japan), NIOSH (USA), NIRM (India), Methane to Markets (USA), RITE (Japan), Sasol, Singareni (India), Siemens,



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# Thank you

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