PCC Pilot Plant Research at CSIRO in support of Demonstrations

CCS Week – AIE at Powerworks

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Advanced Coal Technology Portfolio

www.csiro.au

Overview

PCC at CSIRO in support of demonstration stage

- Research at Newcastle
- Research at Sydney, Canberra, Clayton
- PCC pilot plants in VIC, NSW and QLD.

CCS at CSIRO in addition to CO2CRC contribution

- Luke Donnell, Lincoln Paterson

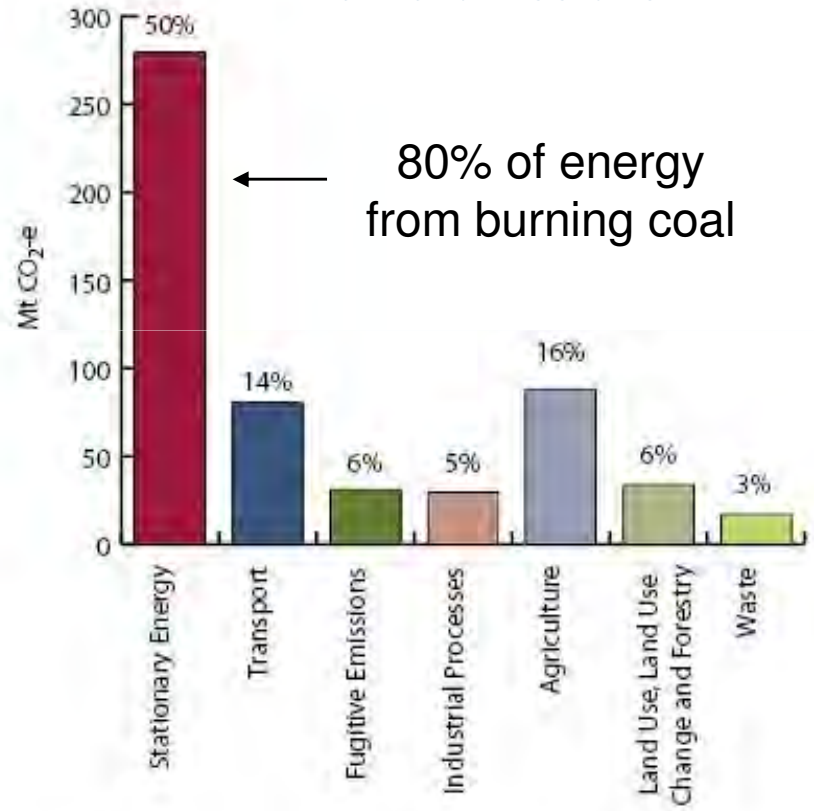
Why are we interested in PCC?

Coal is important to Australia

Most of Australia's electricity is produced from pulverised coal fired boilers (60% black coal, 20% brown coal)

- Generation capacity ~ 28 GW
- Electricity production ~ 170 TWh/a
- Average generation efficiency
  - Black coal: 35.6% - 0.9 tonne CO_2/MWh
  - Brown coal: 25.7% - 1.3 tonne CO_2/MWh
- CO_2-emissions ~ 170 Mtonne CO_2/a from ~ 60 flue gas streams

Breakdown of Australian GHG emissions



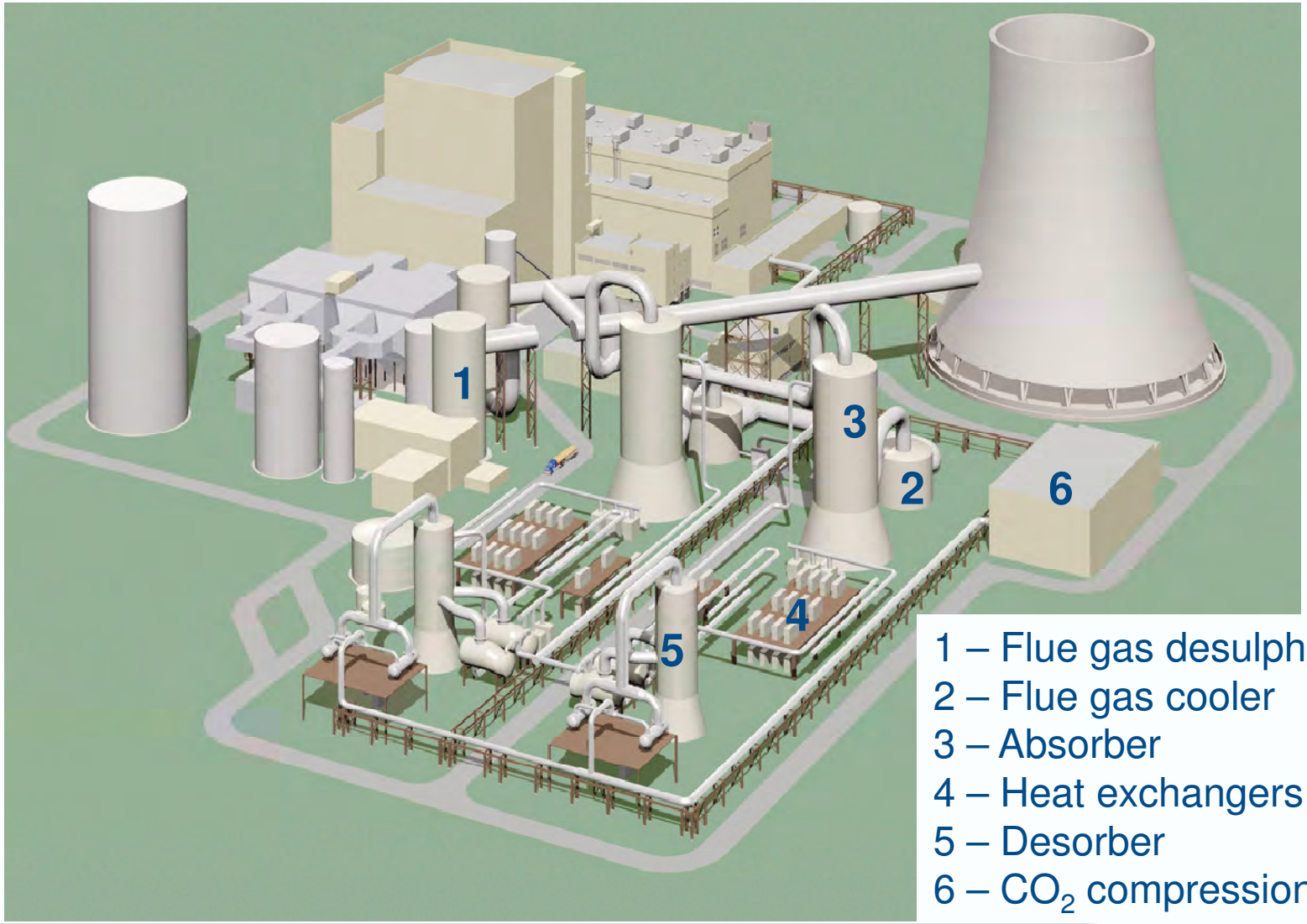
Benefits of PCC

- Low technology risk
- **End of pipe** technology readily integrated into existing power stations
- Allows for **retention of existing corporate knowledge** in the safe and efficient operation of coal fired power stations. Avoids stranded assets
- **Modular** design allows for **staged implementation** in line with emission reduction targets
- Allows for **variable** CO_2 removal thus enabling the power stations output to be varied to accommodate network demand and **market conditions**

Known issues with PCC

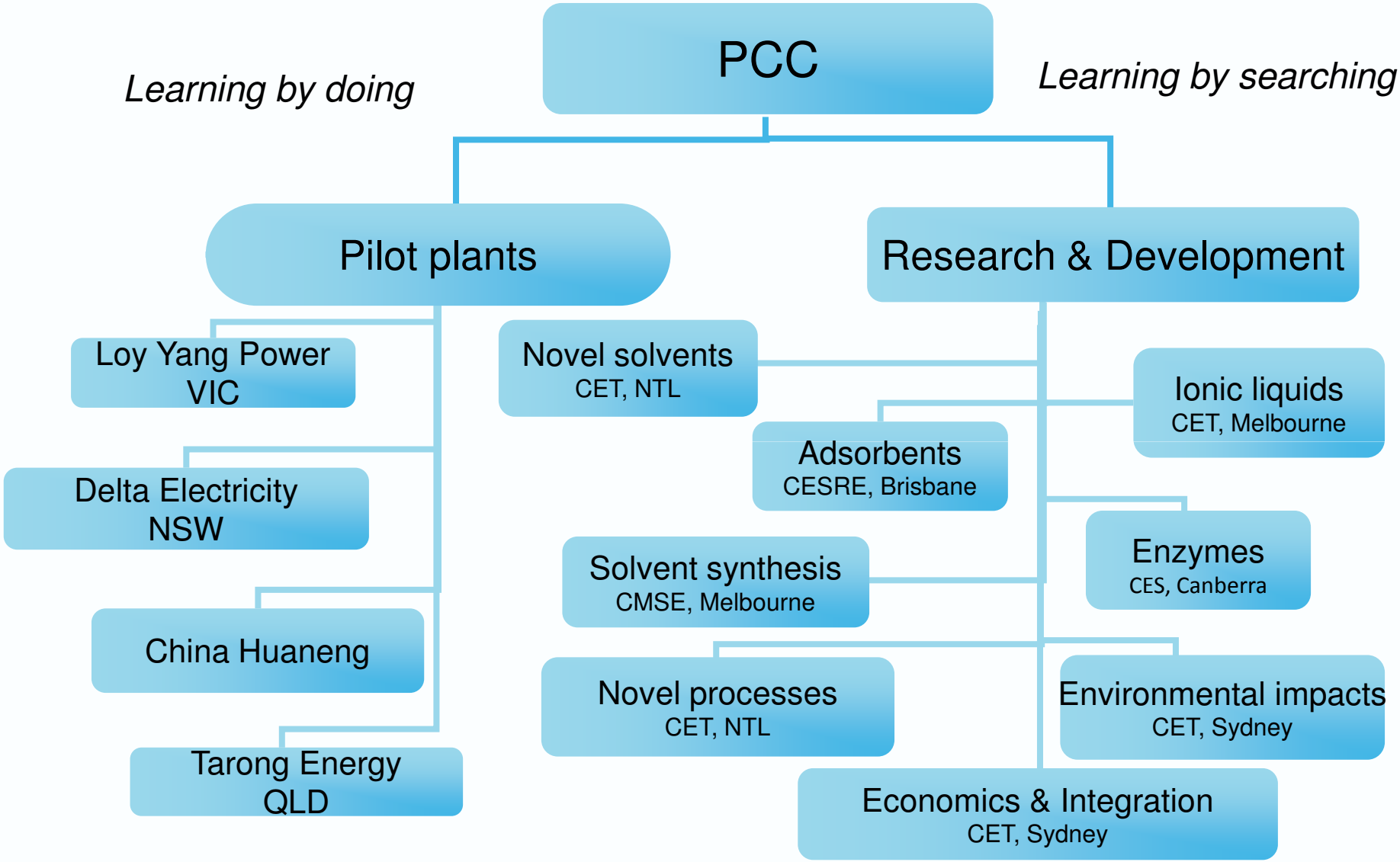
- High capture cost
- Electricity cost increase
- Loss of generation efficiency
- Conventional process sensitive to O_2, SO_x and other flue gas constituents
- Large increase in cooling water requirement
- Not demonstrated in integrated power plants scale – size of installations

Known issues with PCC – size of installations

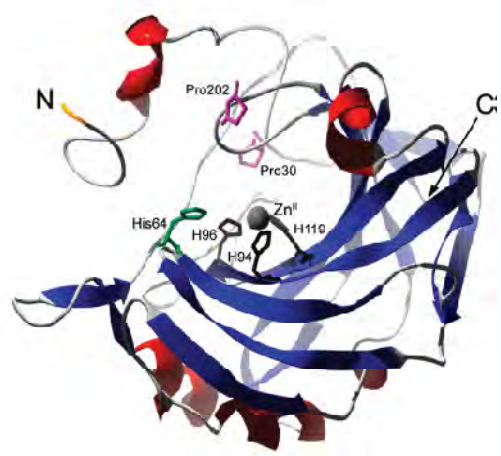


1 – Flue gas desulphurisation
2 – Flue gas cooler
3 – Absorber
4 – Heat exchangers
5 – Desorber
6 – CO_2 compression

Integrated PCC R&D Programme - overview



Novel capture technologies

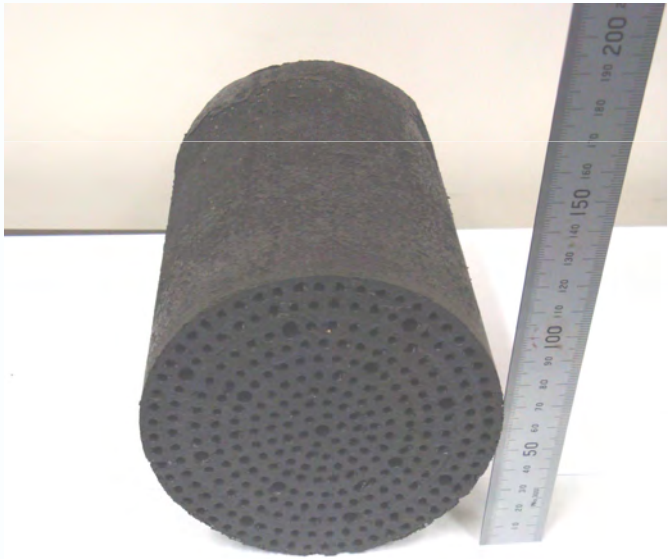


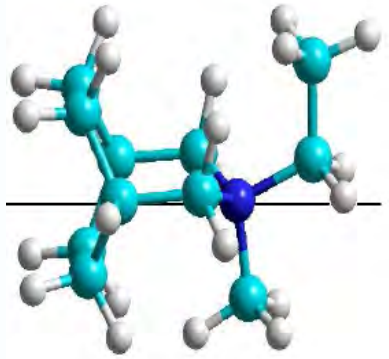
Enzymes:

- Promotion of CO_2 capture using enzymes
- Low energy regeneration of CO_2 from amine carbamates using enzymes

Solid Adsorbents:

Monolithic carbon fibre composite adsorbents

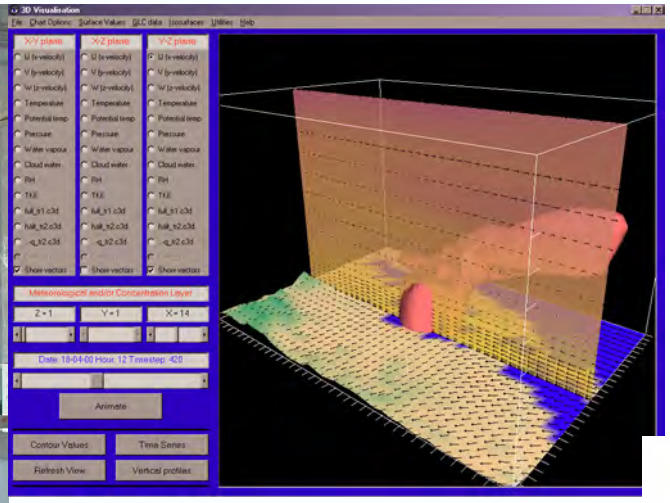




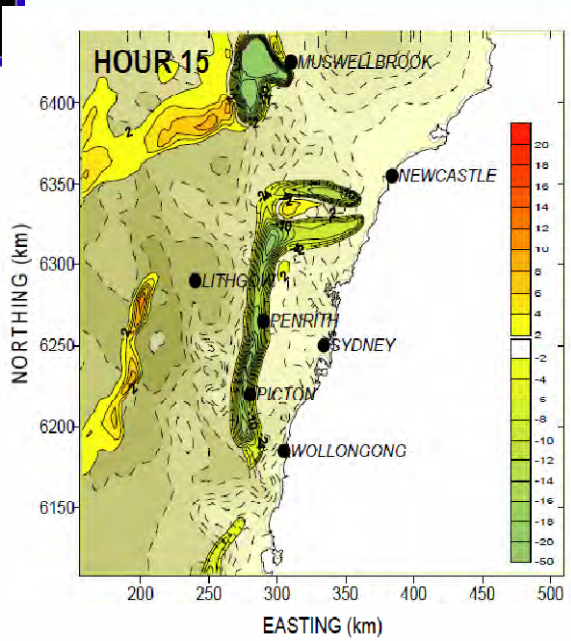
Ionic Liquids

Environmental impacts

Smog chamber facility at Lucas Heights

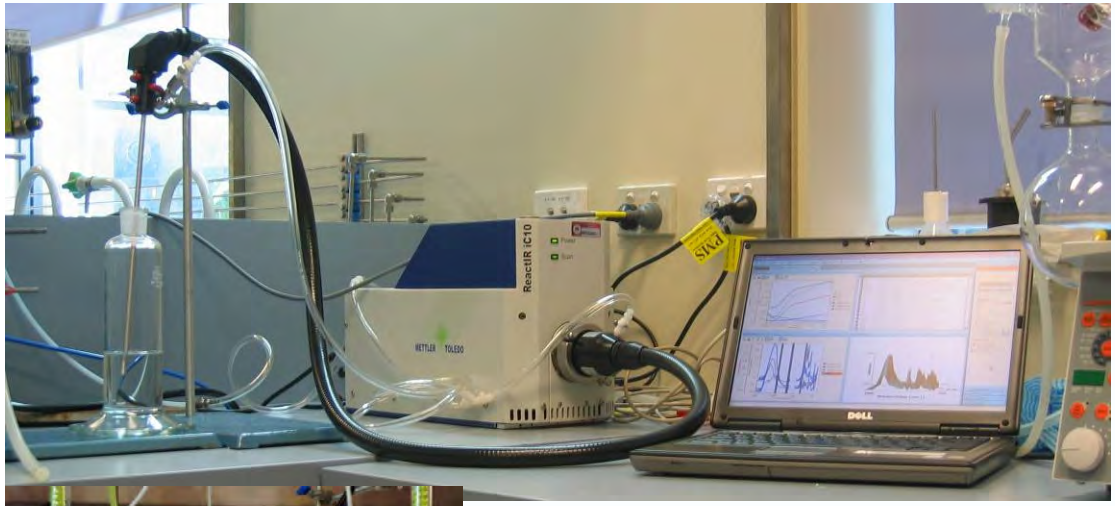


Emission modelling



Transport of pollutants

Liquid absorbent R&D capability

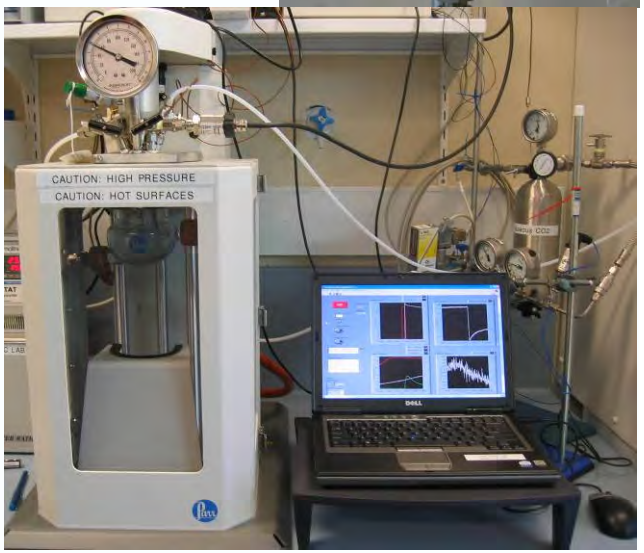


Speciation in liquid

Absorption rates

Absorbent degradation

Vapour liquid equilibrium

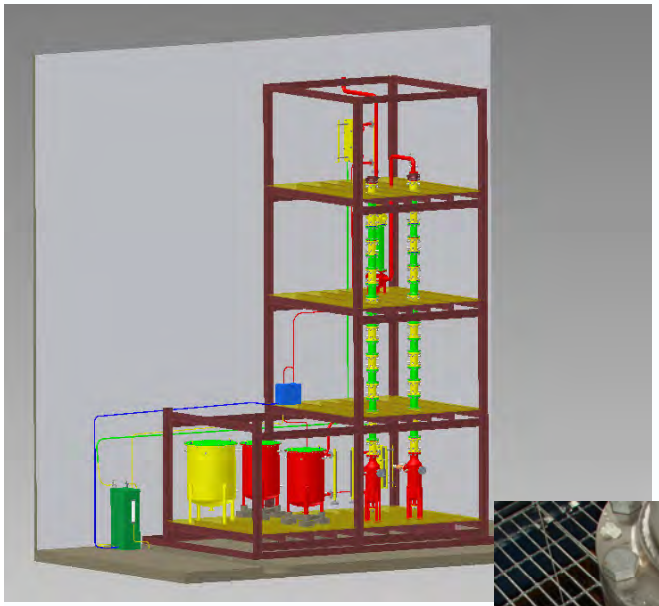


Economics and modelling

Efficiency or Cost	Range	Comments
Generation efficiency without PCC	35 – 41 %	Efficiency range determined by type of steam cycle and type of cooling
Generation efficiency with PCC	25 – 29 %	
Capital costs without PCC	$ 2300 – 3000/kW	Cost range determined by type of steam cycle and type of cooling
Capital costs with PCC	$ 4900 – 5900/kW	
Cost of generation without PCC	$ 21 – 66/MWh	Lower costs refer to the fully amortised power plant; higher costs refer to newly built power plant
Cost of generation with PCC	$ 75 – 129/MWh	
Avoided CO_2 emissions cost	$ 68 – 92/t CO_2	

Source: Feron and Paterson (2011)

Process development



Flexible absorber/desorber rig

Segmented columns

Controlled compositions

PCC pilot plant locations

CHINA HUANENG

Gaobeidian Power Station, Beijing

stanwell

Tarong Power Station, QLD

Delta electricity

Vales Point Power Station, NSW (nee Munmorah)

LOY YANG power

Loy Yang Power Station, VIC

CSIRO

Pilot plant summary – matrix model

Plant	Loy Yang	Munmorah -> Vales Point	Tarong	Newcastle PDF
Solvent	Amine	Ammonia/ Amine	Amine	Both
Flue gas source	Brown coal	Black coal	Black coal	Synthetic
Scale	50 kg/hr	300 kg/hr	100 kg/hr	20 kg/hr
Focus	Solvent benchmarking	Ammonia operation	Process optimisation	Process development
Other activities	Emission study Ageing amine	Pressurised absorption	Concentrated piperazine	Cutting edge processes

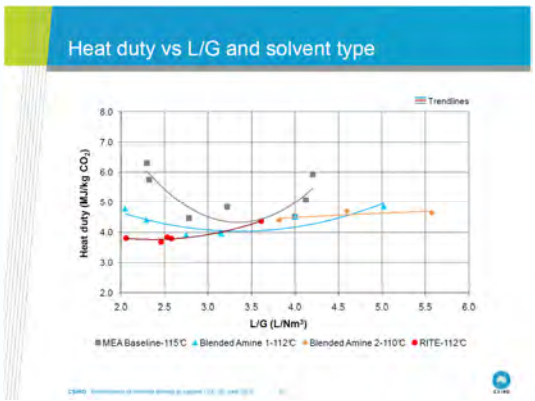
Matrix approach helps cover many aspects of PCC as well as providing quicker delivery of information

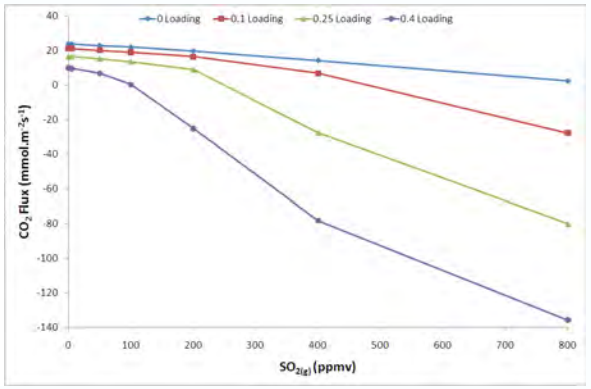
Suite of results in VIC

iCap CO2.org	*coCAPco*
8 Research providers	2 Research providers
6 Power companies	2 Power companies
€6.3M (€4.3M EC-contribution)	$3.7M ($1.5 BCIA contribution)

Objective:
Develop, test and demonstrate integrated SO_2 and CO_2 capture with stepwise regeneration.

Milestone:
Demonstrate *iCap* process design with real flue gas at Loy Yang Power within *coCAPco* project.





The Post-combustion CO_2 Capture group:

Thank you

Commonwealth, State (VIC, NSW, QLD), AGL LY, TRUenergy, Delta Electricity, Stanwell Power, MHI, Chiyoda, CERI, GCCSI, ANLECR&D, BCIA, Monash University, Newcastle University, TNO, ETH, SINTEF, Tsinghua University, RITE, and others.