

Depth:
-1.96 km

Source: BP, Rio Tinto

Australian CCS Commercial and R&D Projects

CCS Workshop, Tokyo 2007

John Wright

National Research
FLAGSHIPS



Australian Situation 2007

- High level of CCS activity in Australia
 - early stage development in pilot, demonstration and commercial planning
 - over 15 major projects covering CCS from coal (black and brown) and gas (LNG and CSM)
 - also a high level of activity in Research Centres, Universities and CSIRO

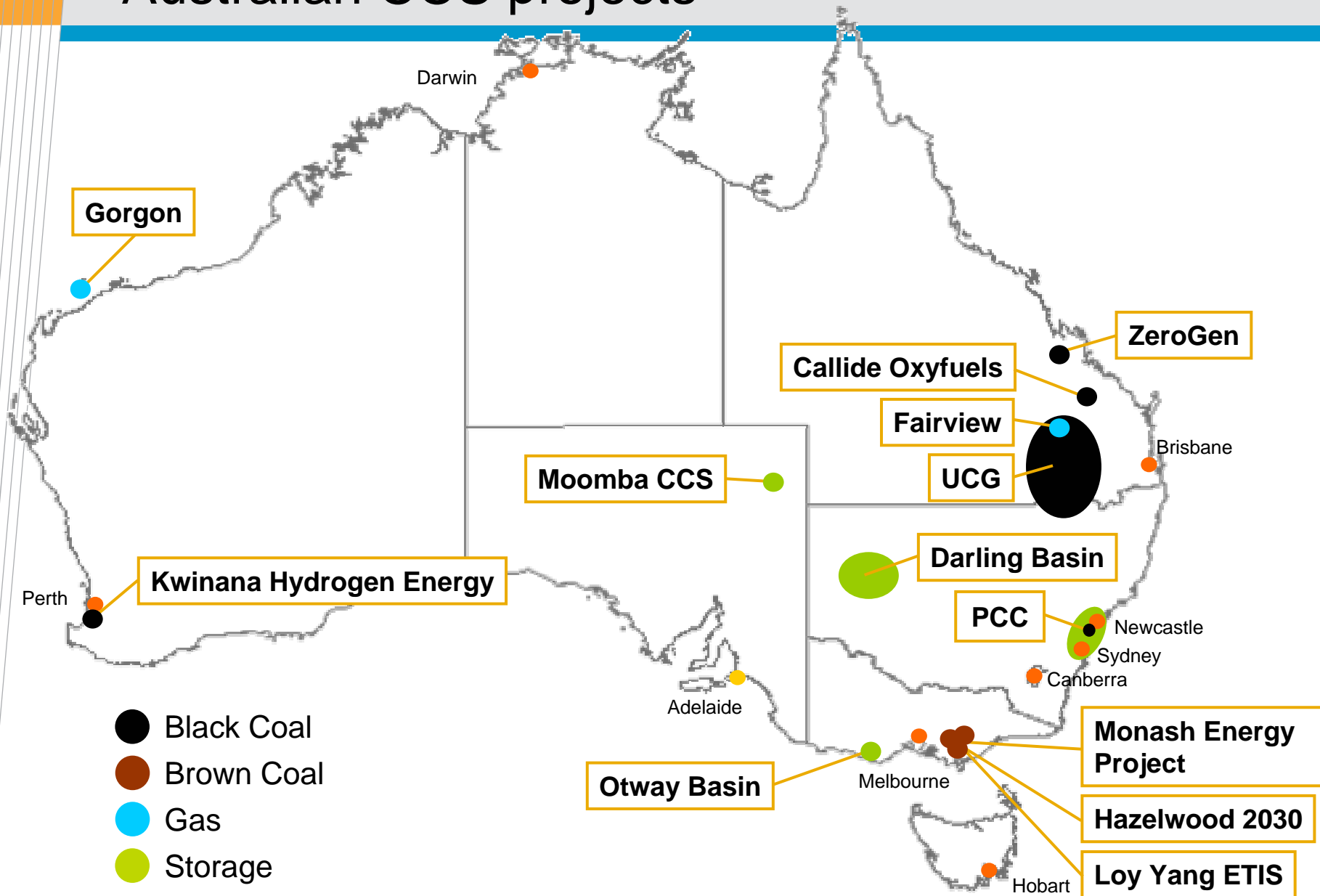


Drivers for CCS in Australia

- There are basically 3 main drivers for CCS in Australia
 - reduction of GHG emissions
 - preparation for introduction of emissions trading and a clean energy target (CET)
 - government and industry financial support (eg LETDF, COAL21 fund, various state support)



Geographic distribution of major, announced Australian CCS projects



Brown Coal – Hazelwood 2030

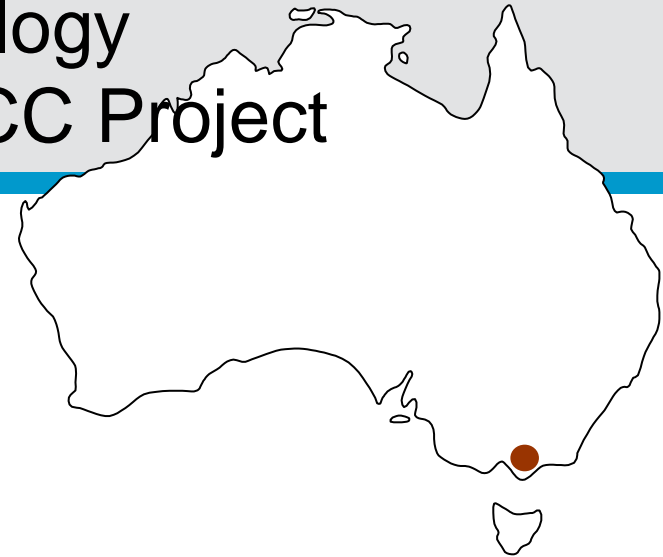


- Lignite drying and CO₂ capture demonstration
- 200MW boiler re-fit
- CO₂ amino acid-based solvent capture (25-50 TPD)
- CO₂ used to neutralise alkaline mine water
- International Power, Alstom, RWE, Process Group, CO₂CRC
- Cost, \$360 million
- Coal drying/CO₂ capture commencing 2008



Source: International Power

Brown Coal – Energy Technology Innovation Strategy (ETIS) PCC Project

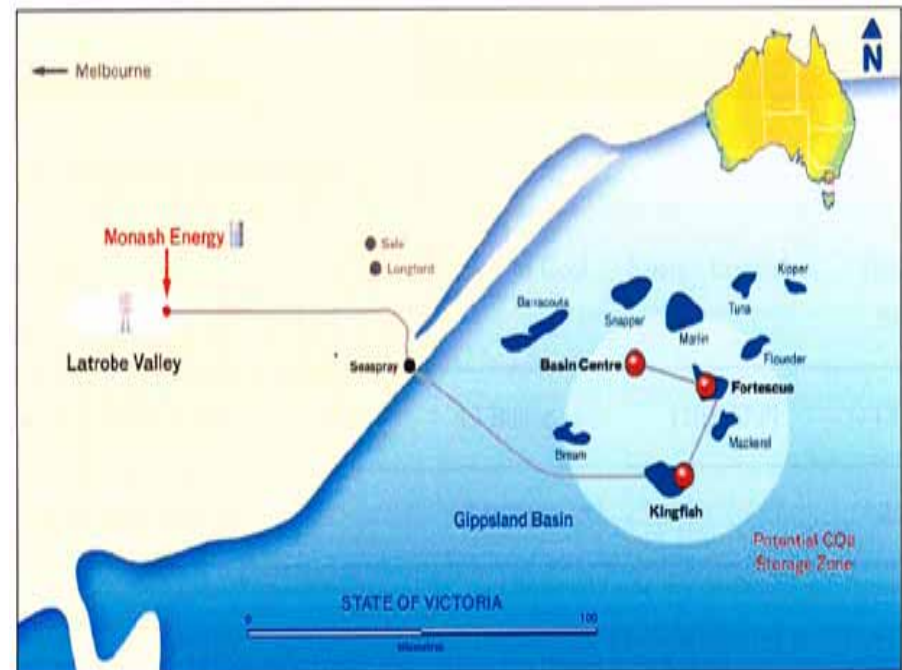
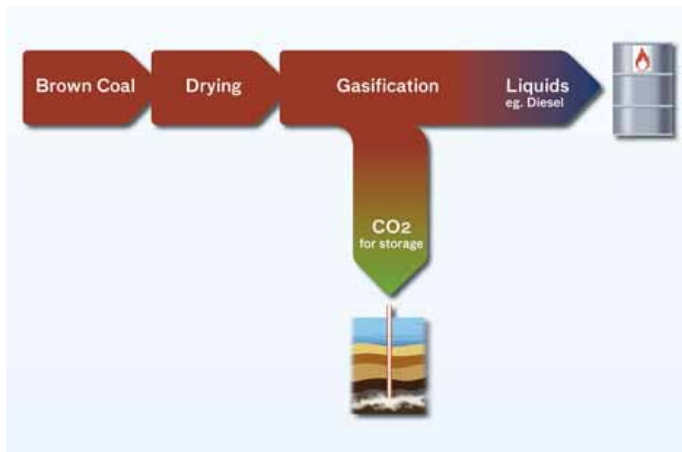


- Assessment of PCC and process options for Loy Yang A power station
- Pilot CO₂ capture (3 TPD) from Loy Yang A
- Testing of commercially available and new solvents
- Loy Yang, CSIRO, International Power, CO2CRC
- Government, CSIRO, Loy Yang Power
- Cost \$5 million

Source: International Power

Brown Coal – Monash Energy Project

- Coal-to-liquids project
- 60-70k barrels per day
- 40 year life
- Coal drying, gasification and F-T
GTL conversion
- CO₂ liquified and stored in
depleted oil/gas field (15mtpa)
- Storage potential up to 6 billion
tonnes
- Anglo Coal, Shell



Source: Monash Energy

Brown Coal – IDGCC Technology, HRL Limited



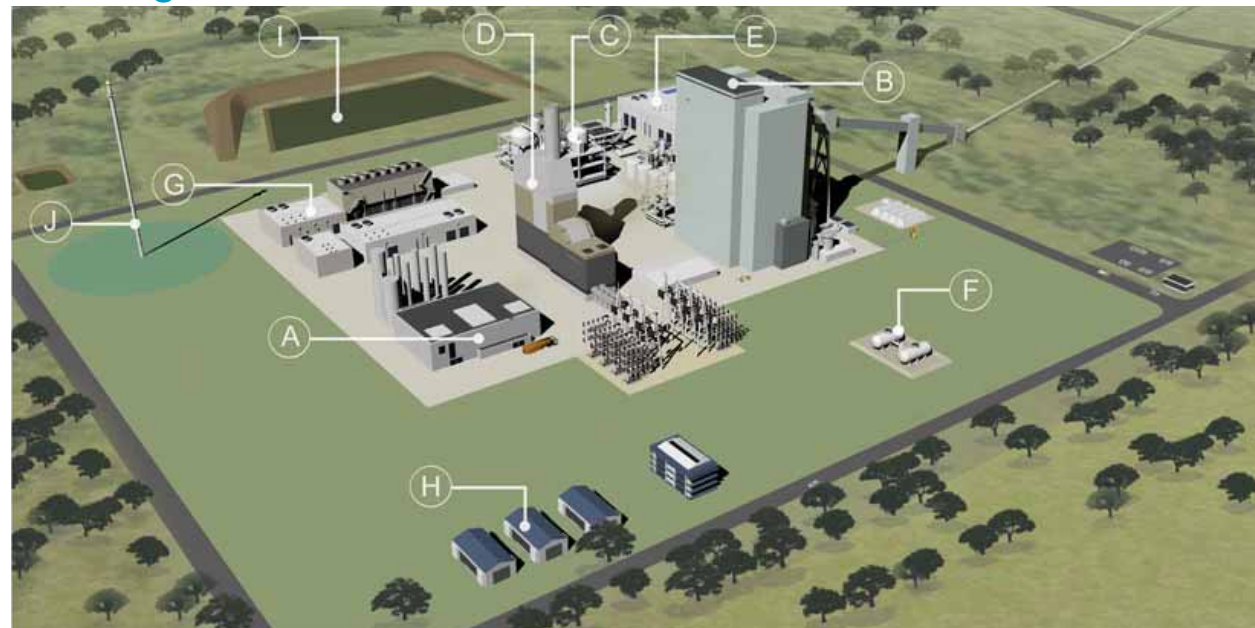
- 400 MW IDGCC plant development
- Efficiency increase from 33% - 40%
- CO₂ emission reduction up to 30%
- Suitable for pre-combustion CO₂ capture
- HRL Limited, Harbin Group
- Cost \$750M
- Operation, late 2009

Source: HRL

Black Coal – ZeroGen Project



- 100MW demonstration IGCC plant
- Reduction of CO₂ emissions by 75% compared to conventional pf plant
- Captured CO₂ piped 220 km for storage in the Denison trough (saline aquifer)
- CO₂ storage of 420 ktpa
- Queensland Government, Shell, Stanwell
- Cost \$445 million
- Operation 2011



Source: ZeroGen

Black Coal – Callide Oxyfuel Demonstration Project



- Retrofit a 30MW pf boiler for oxygen firing
- Capture the CO₂ and truck 50-75 tpa liquid 200-250 km for storage (Denison Trough – depleted gas wells)
- CS Energy, Xstrata Coal, JCoal, IHI, JPower, Schlumberger, CO2CRC, CCSD, ACA
- Cost \$180m
- Startup, 2011



Source: Callide

Black Coal – Kwinana Hydrogen Energy Project

- 500MW IGCC power plant with CCS
- Sequestration of CO₂ up to 4 mtpa off shore in the South Perth Basin
- Rio Tinto, BP
- Project cost \$2 billion
- Feasibility studies under way (start up 2011 – 2014)



Source: CO2CRC

Black Coal – PCC Projects

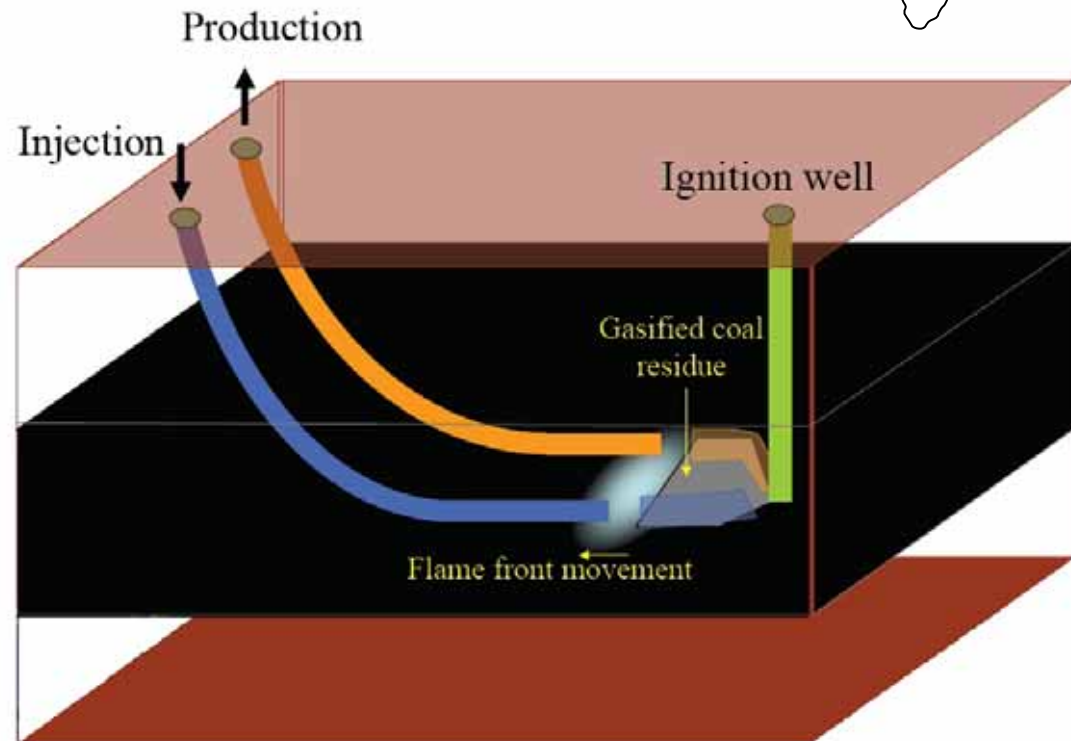


- Laboratory research, evaluation of sorbents, membranes and energy integration
- Pilot plant research and development – Australia and China (Mobile Pilot Plant)
- CSIRO, Delta, Huanong Group

Source: CSIRO

Black Coal – Underground Coal Gasification

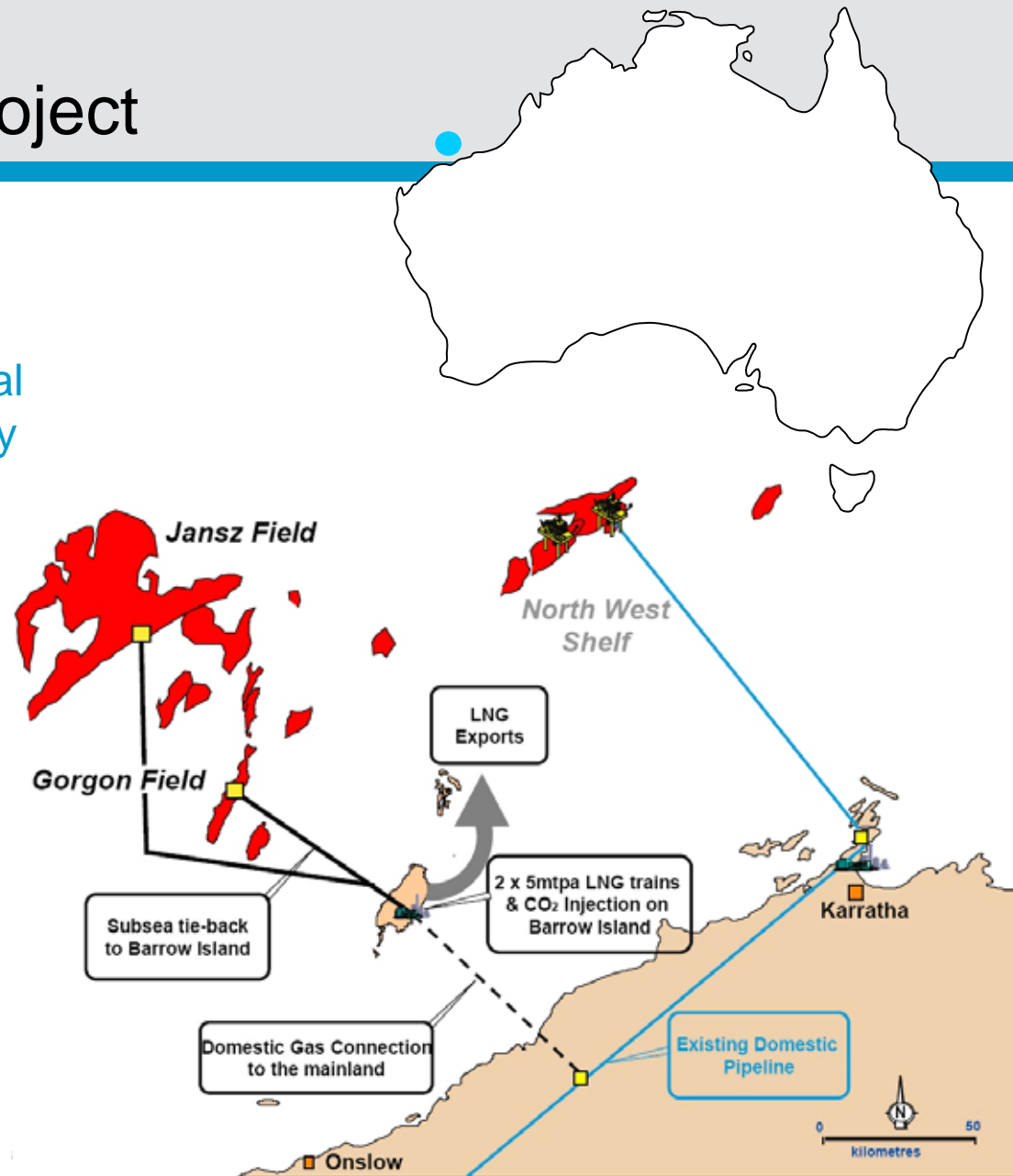
- Studies of underground coal gasification by at least two groups in Australia
- Include Carbon Energy and Linc Energy
- Carbon Energy proposal to demonstrate oxygen-blown UCG with CO₂ removal and 40MWe gas turbine
- Cost \$80 million
- Carbon Energy, CSIRO Metex Resources



Source: Carbon Energy

Gas – Gorgon Project

- CO₂-containing natural gas brought to Barrow Island
- CO₂ captured from the natural gas and injected in the Dupuy Formation (2500m)
- 3 – 4 mtpa CO₂ sequestered
- Chevron, Esso, Shell, Mobil
- Cost \$11 billion
- Feasibility studies continuing

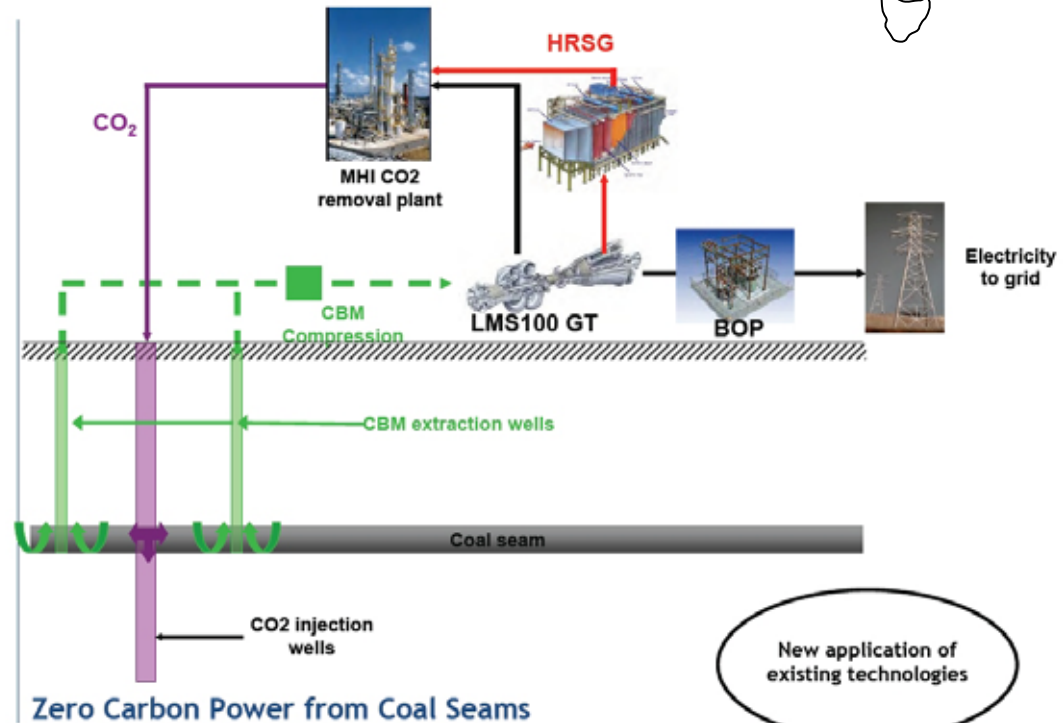


Source: Chevron

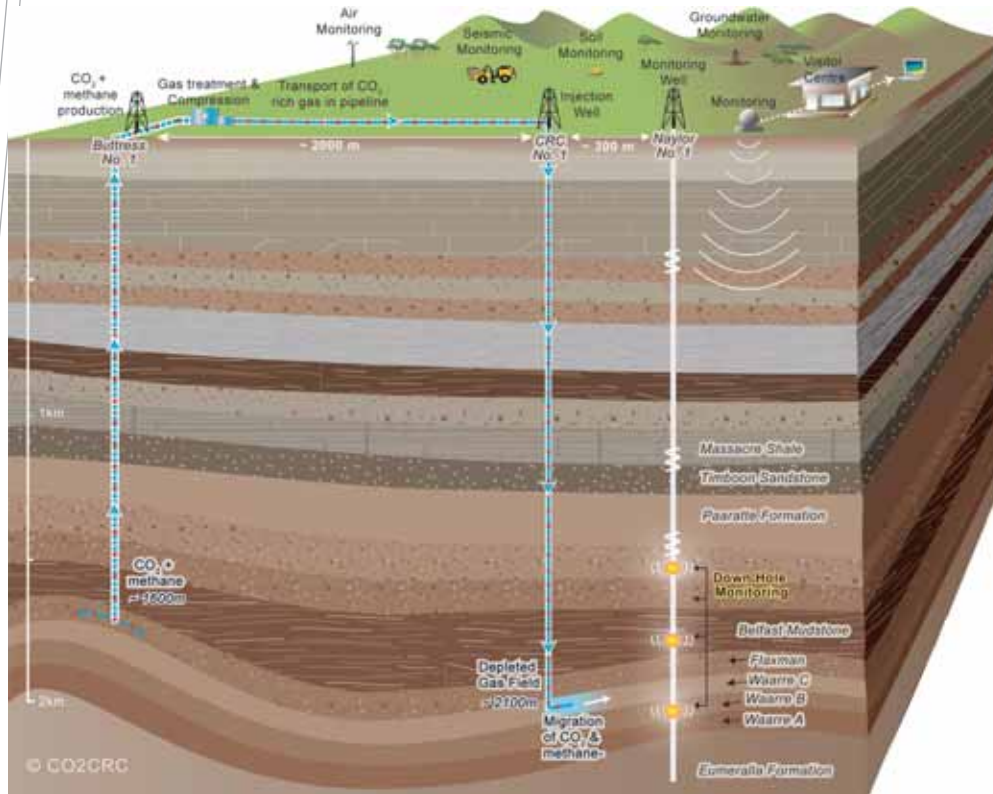
Gas – Fairview Project



- Extraction of CSM
- Gas turbine power generation (100MW)
- CO₂ solvent capture (340 tpd)
- Injection of CO₂ to enhance CSM extraction
- Gas from an existing Santos operation
- Santos, BHP-B, Lucas, GE, ICTPL, CSIRO
- Cost \$445 million
- Startup 2009



Storage – Otway Basin Project



Source: CO2CRC

- Extraction of CO₂/CH₄ gas from existing gas well
- CH₄ removal, compression and injection into a depleted gas field
- Detailed modelling and monitoring of site
- Injection of 100kt CO₂
- Partners – CO2CRC participants
- Project cost \$40 million
- Commencing late 2007

Storage – Moomba Carbon Storage

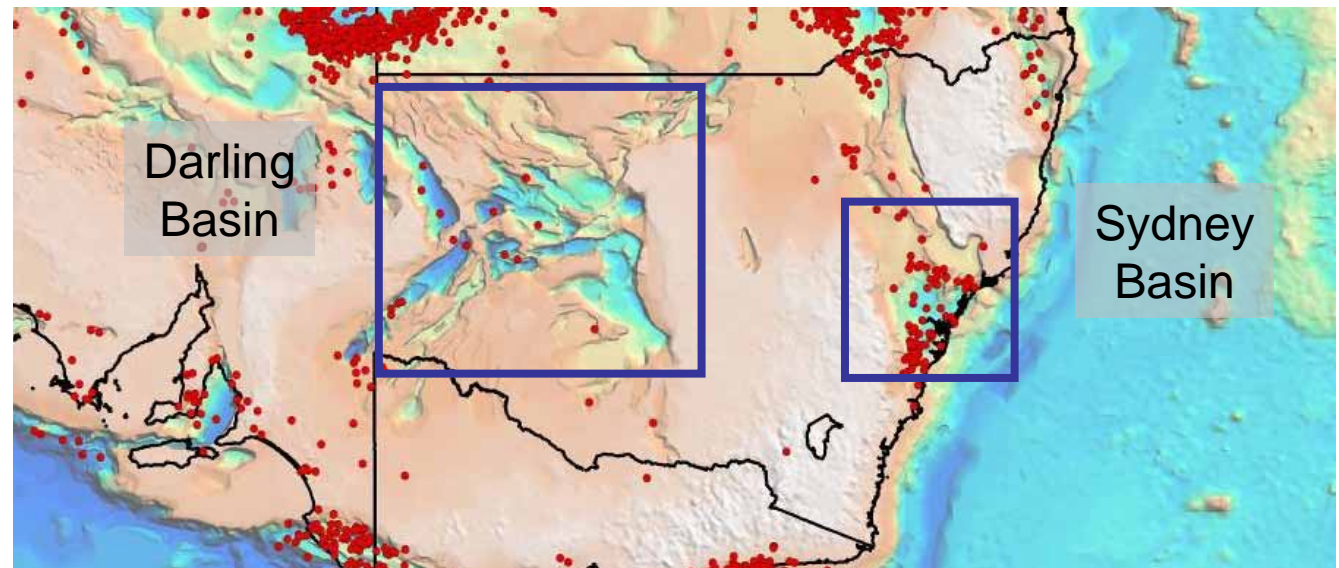
- The Cooper oil and gas fields with the Moomba processing plant are Australia's largest onshore resource investment
- The depleted field is capable of storing up to 20 Mt of CO₂ pa for up to 50 years
- Most gas handling infrastructure is in place
- Propositions to take CO₂ from NSW, SA and QLD CCS projects for sequestration



Source: Santos

Storage – Reservoir Studies of the Sydney and Darling Basins

- Survey of sequestration potential of NSW by FrOG Tech Pty Ltd
- Concentrated in the Sydney and Darling Basins
- Many areas shown not to be suitable – identified two areas for closer examination



Source: FrOG Tech Pty Ltd

Major Projects Summary

- Many CCS projects covering capture and storage from coal and gas power generation
- Wide spread of technologies involving CCS
- All are at an early stage and will take 10 – 15 years to be developed into full commercial projects

➡ And there is an equally active R&D activity



Main CCS R&D Centres



CCSD

Coal gasification



cLET

Coal gas processing



CO2CRC

CO₂ capture and sequestration



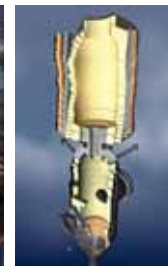
CSIRO

Works with all centres and
conducts independent CCS
R&D

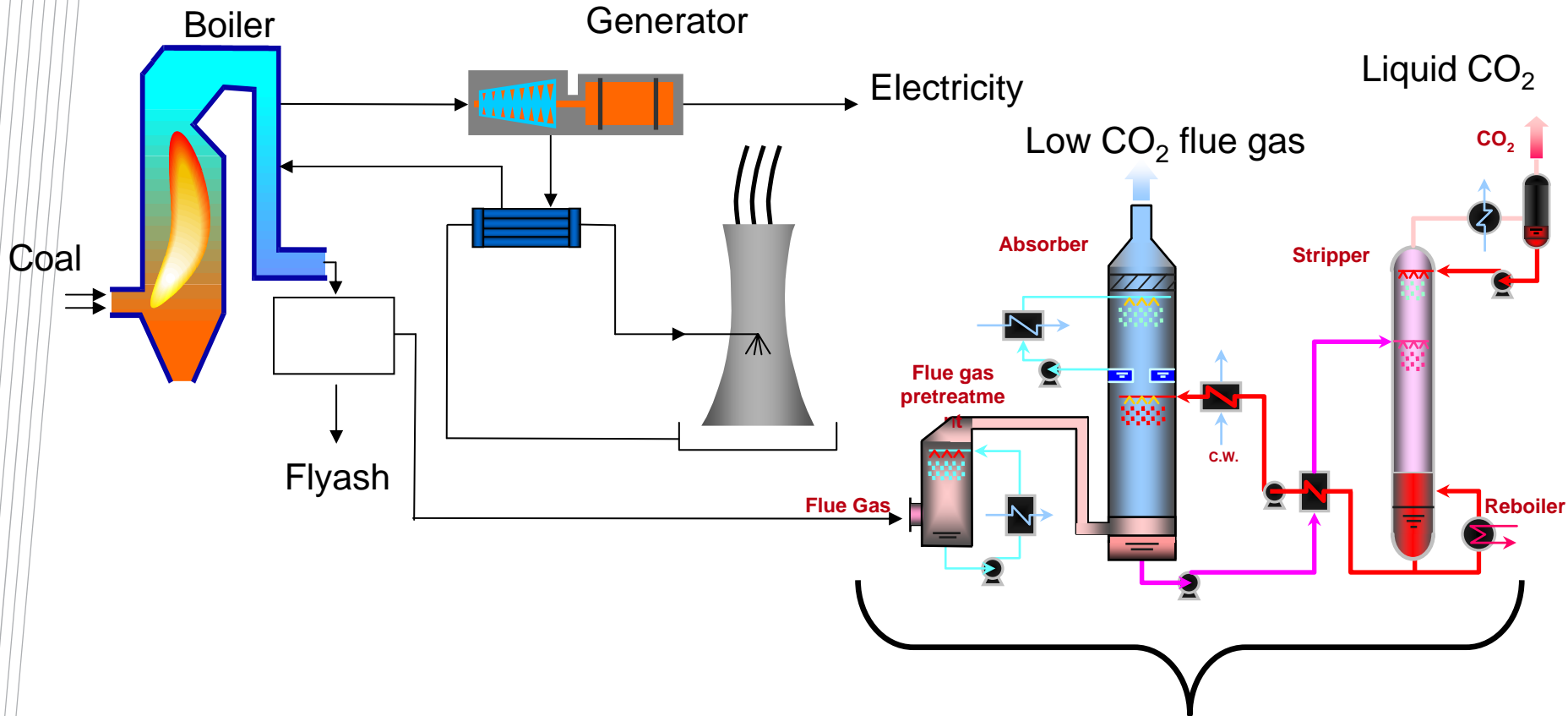
PCC R&D in CSIRO

Why PCC?

- Low technology risk
- Flexible operation, in tune with market requirements
- Ability to adopt technology improvements, providing pathway toward zero-emissions
- For new and retrofit applications, preventing stranded assets

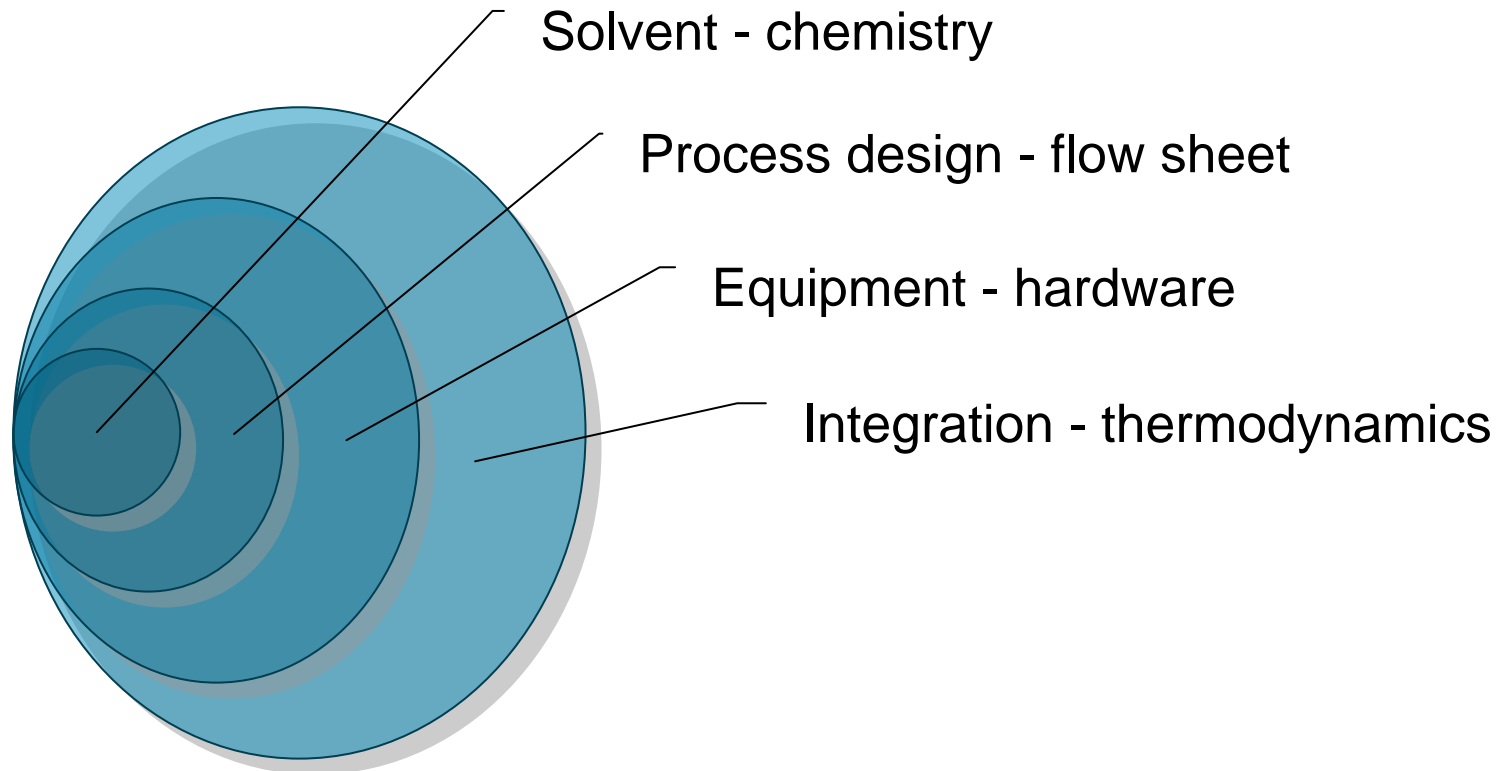


PF Power Plant with PCC



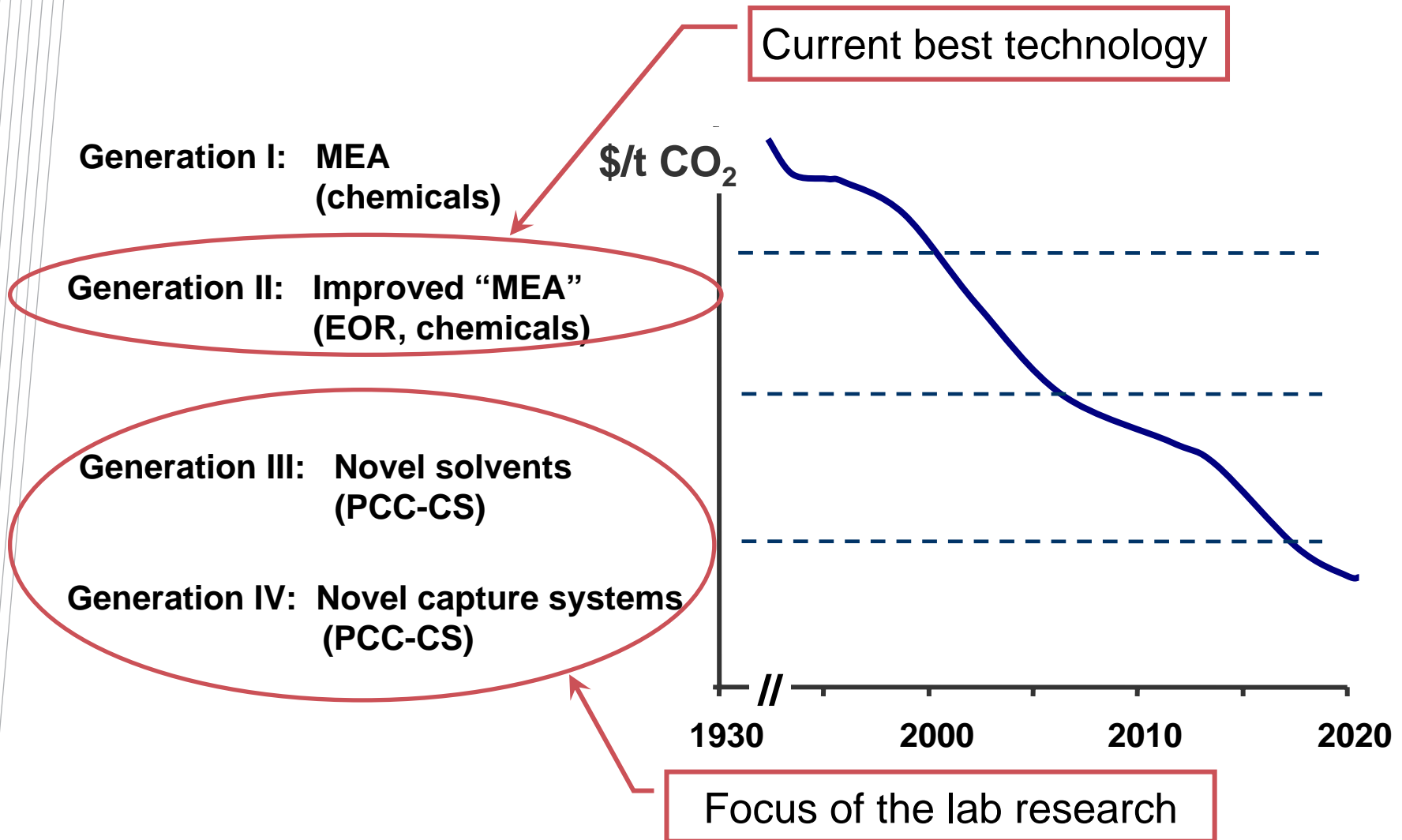
Leading option is a solvent process

Solvent System Development

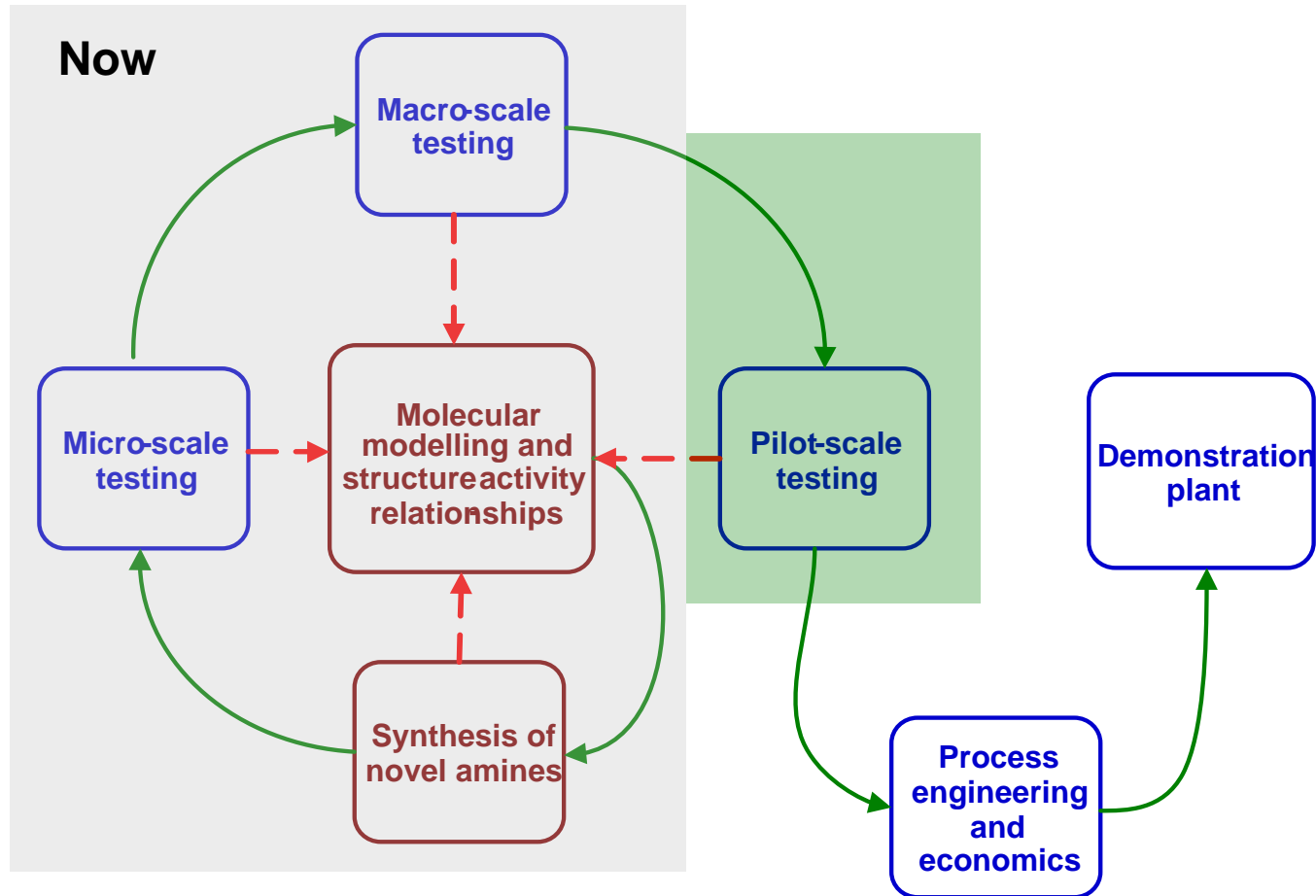


A holistic approach is essential!

The Development Path for PCC



Development / Testing Path



Laboratory – Micro Scale TGA

- Micro-scale TGA measurements of solvents
 - Microgram quantities required so appropriate for screening newly synthesised molecules
 - CO₂ uptake measured as a mass increase



Laboratory – Macro Scale

- Macro-scale absorption apparatus

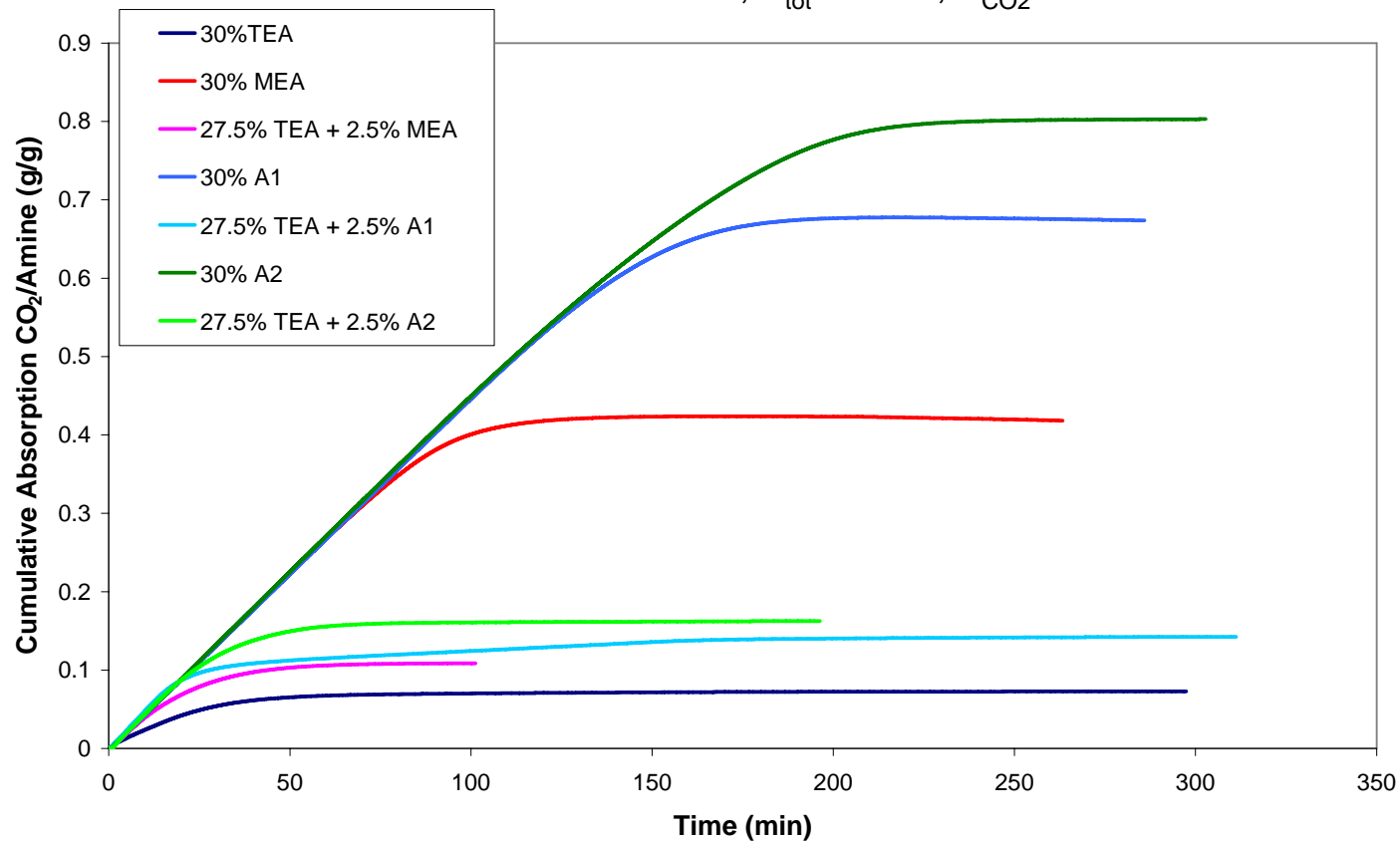
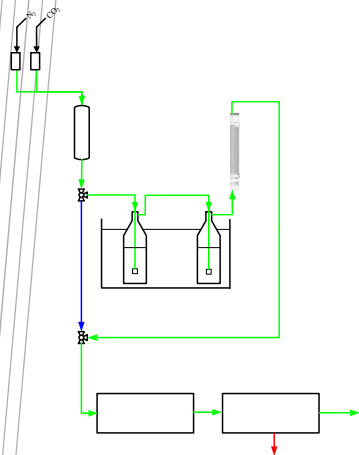


Macro Scale Results

300 mL of 30% Amine Solutions w/w

13% CO₂, 87% N₂ @ 1.7 Lmin⁻¹

T = 40°C, P_{tot} = 1atm, P_{CO₂} = 0.13 atm



Transportable PCC Pilot Plant

- **Multiple transportable pilot plants**
 - 1,000 tpa
 - Pre-wash column for optional SO_x / NO_x scrubbing
 - Dual 200 mm absorbers
 - Single stripper column
- **Relocatable for slip stream operation**
 - Several power stations in program burning black and brown coal
- **Modular construction**
 - Plans for testing different packing types and novel membrane contactors
 - Testing of alternative solvents (e.g. chiller being added to test chilled ammonia as a solvent)
- **Sophisticated gas analysis**
 - Providing data on solvent stability
 - Crucial information for environmental impact assessments



Finally

- Activity on CCS in Australia is at a high level
- Most activities are still at an early stage
- Activities cover a very broad range and involve black and brown coal, natural gas and coal seam methane
- Activities also cover exploration for sequestration sites and the feasibility of integrated CO₂ pipelines



There is also a healthy R&D activity backing up the pilot and demonstration projects

