BREAKTHROUGH TECHNOLOGIES
Carbon Capture and Storage (CCS)

Dr Peter Cook
Chief Executive
Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC)

The CEDA International Climate Change Conference
Hilton Hotel, Sydney
15 -16 November 2007

CO2CRC

CO2CRC is a leading international CCS R&D program, based in Australia, involving close collaboration between industry , governments and researchers

Australian Government Geoscience Australia | CSIRO | Shell | bp | Chevron | xstrata coal | RIO TINTO

THE UNIVERSITY OF ADELAIDE AUSTRALIA | THE UNIVERSITY OF MELBOURNE | WOODSIDE | Schlumberger | bhpbilliton | NZ RESOURCE CONSORTIUM

MONASH University | UNSW | SOLID ENERGY Coals of New Zealand | ANGLO AMERICAN | Origin energy

Curtin University of Technology | Government of Western Australia Department of Industry and Resources | NSW DEPARTMENT OF PRIMARY INDUSTRIES | State Government Victoria Department of Primary Industries

FOUNDATION FOR RESEARCH SCIENCE & TECHNOLOGY Tūāpapa Rangahau Pūtaiao | ACARP Australian Coal Association Research Program | ConocoPhillips | STANWELL CORPORATION LIMITED

Supporting participants: Australian Greenhouse Office | Australian National University | | CANSYD | Meiji University | The Process Group | University of Queensland | Newcastle University

Lawrence Berkeley National Laboratory | Alberta Research Council

Established & supported under the Australian Government's Cooperative Research Centres Programme

CRC AUSTRALIA

PJC_Forum_June05

CO2CRC

CCS

What is CCS?

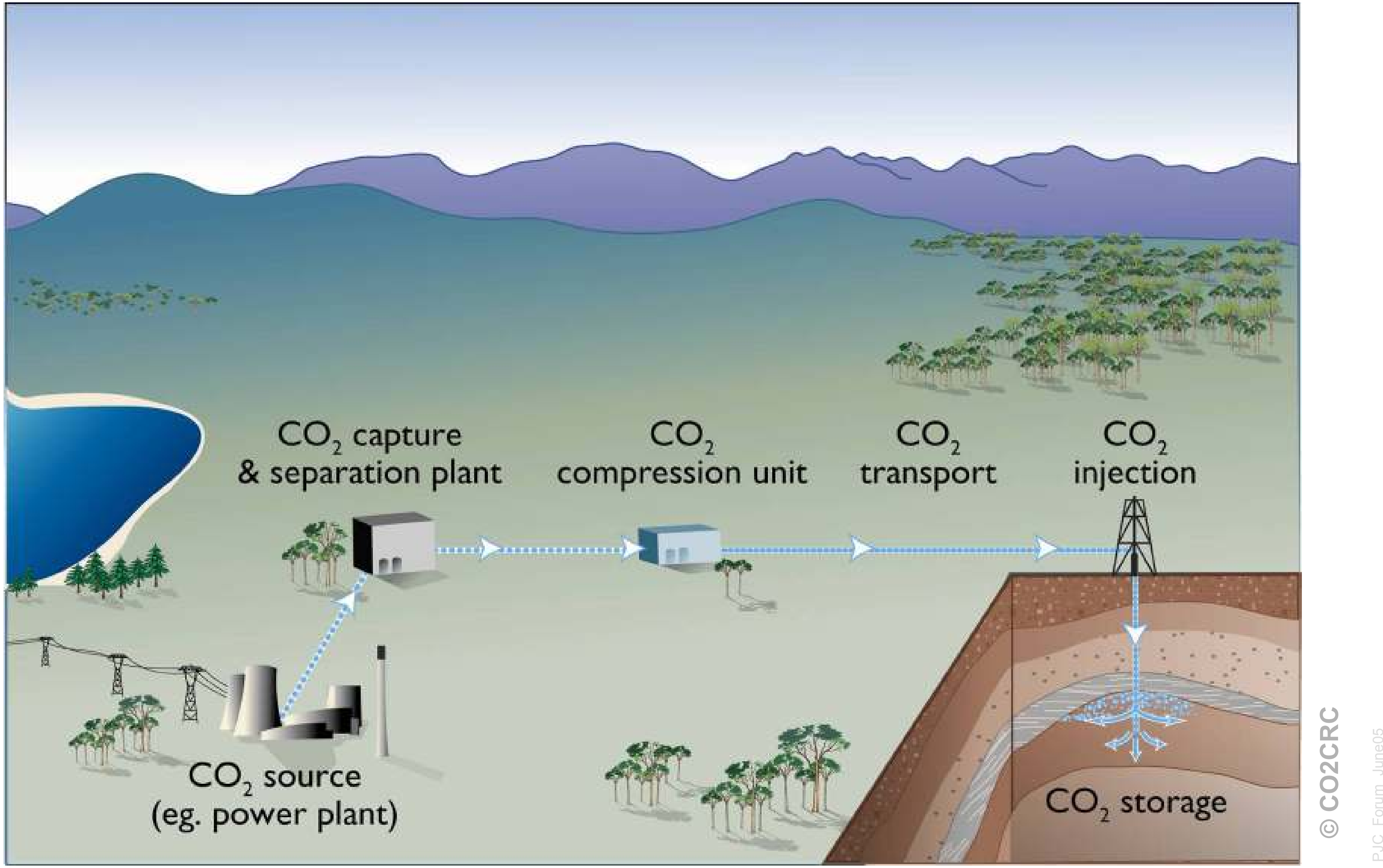
- **Capture**
- **Transport**
- **Storage**

Where is it happening?

- **Demonstration**
- **Commercial**

What is the Future?

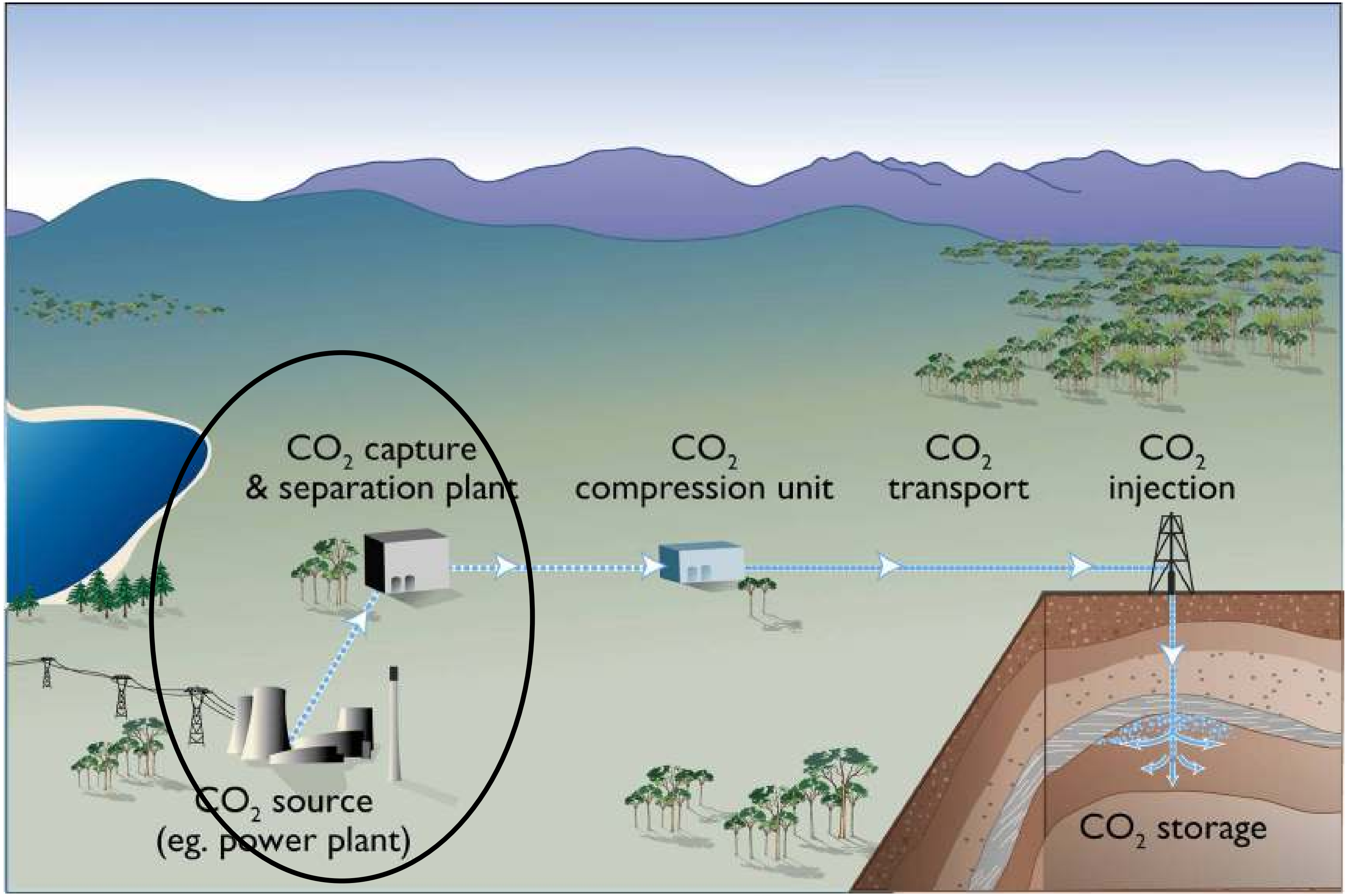
CCS



CO_2 capture
& separation plant
CO_2
compression unit
CO_2
transport
CO_2
injection
CO_2 source
(eg. power plant)
CO_2 storage
© CO2CRC
PJC_Forum_June05

CO2CRC

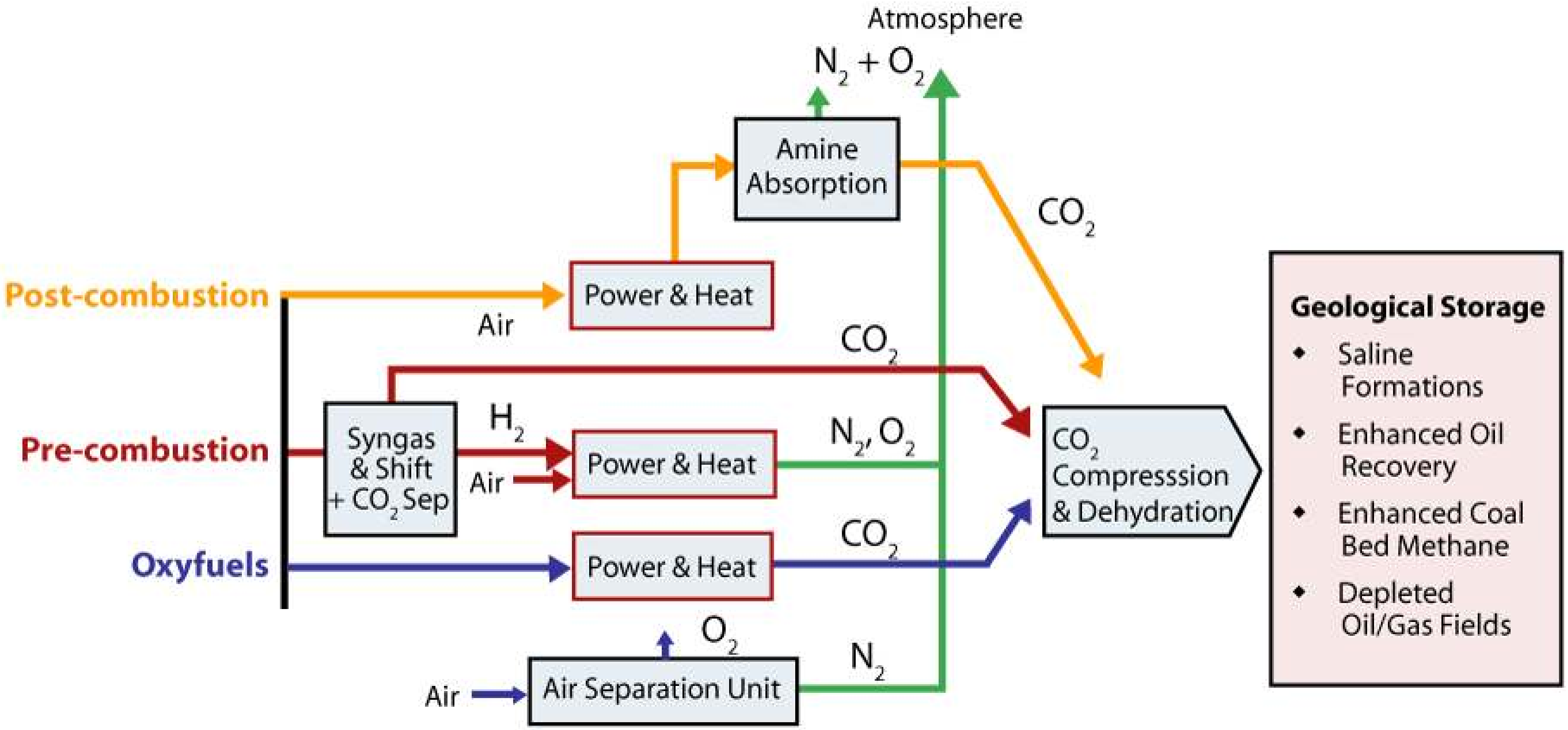
The Carbon Capture Transport and Storage Process



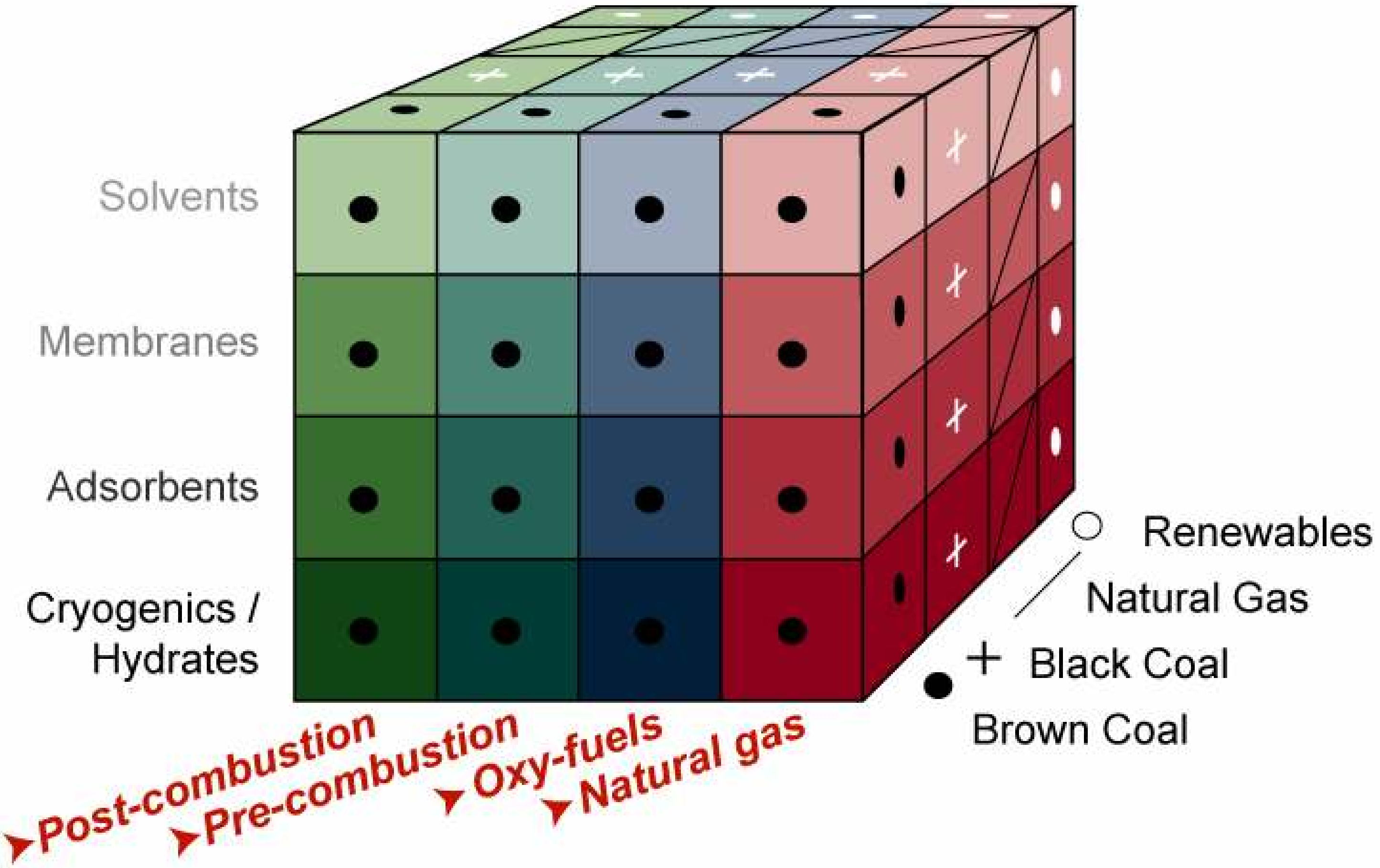
PJC_Forum_June05

CO2CRC

Capture Applications (after CO_2 Capture Project and IEA GHG R&D program)



CO_2 capture and separation is dependant on the combustion system, the fuel and the medium used for separation
This greatly influences cost



Oxyfuels Project, Callide, Queensland

Description – Retrofit 30MW oxyfuel coal-fired power plant for capture and storage demonstration

Capture – Oxy Combustion

- ***Capture Commence*** – 2009

Storage – Saline Aquifier or depleted oil/gas field

- ***Storage Commence*** – 2010
- ***Storage rate* –** up to 50K tpa

Cost – $A 180 million ($A 50 million LETDF)

Partners – CS Energy (+ IHI, ACA, Schlumberger, CCSD, CO2CRC

CO2CRC

Hazelwood PCC Project, Hazelwood, Victoria

Description – Retrofit 200MW boiler in Latrobe Valley. Will demonstrate RWE steam fluidised bed drying and small scale CO_2 capture.

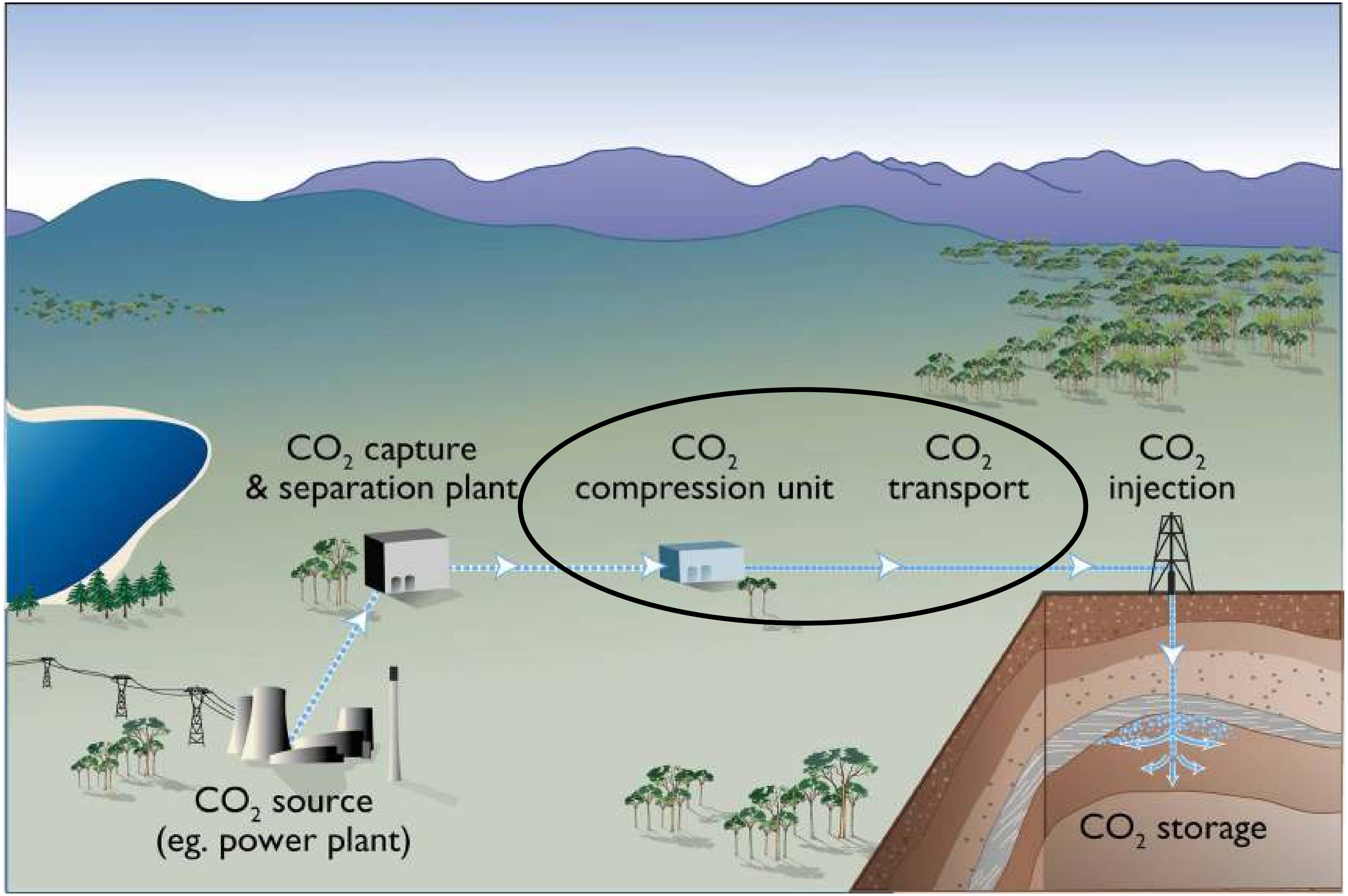
Capture – Post Combustion

- ***Capture Commence*** – late 2008
- ***Capture Capacity* –** 10K tpa

Cost – $A 445 million ($A 50 million LETDF + $A 30M ETIS)

Partners – International Power (+Alstom, RWE, Process Group, CO2CRC)

The Carbon Capture Transport and Storage Process



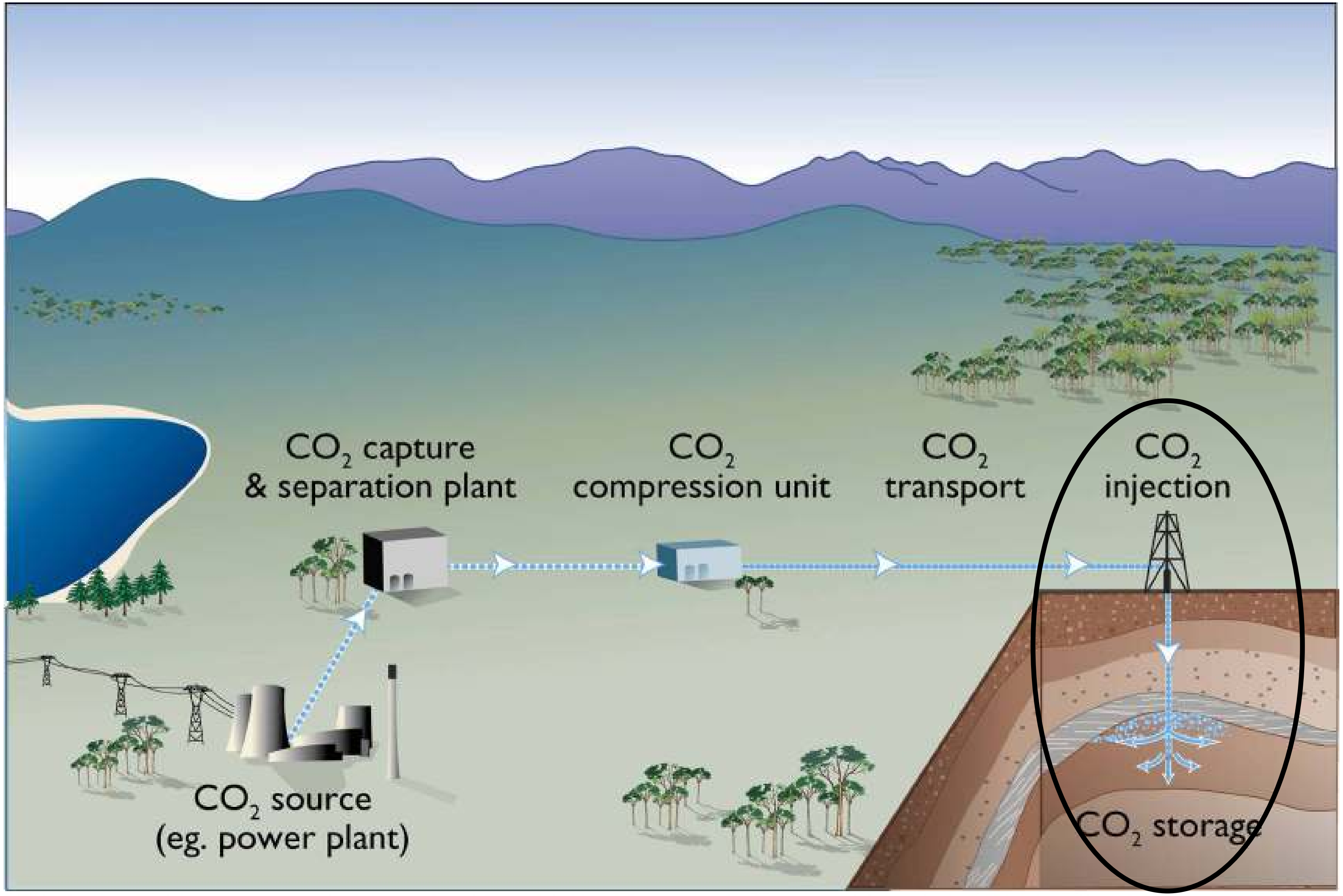
CO2CRC

Weyburn CO_2 Project

- CO_2 Source: Dakota Gasification Company
- 95 mmscfd (5000 tonnes/day) injection rate
- CO_2 purity 95% (primary feed)
- Currently 26% recycle.

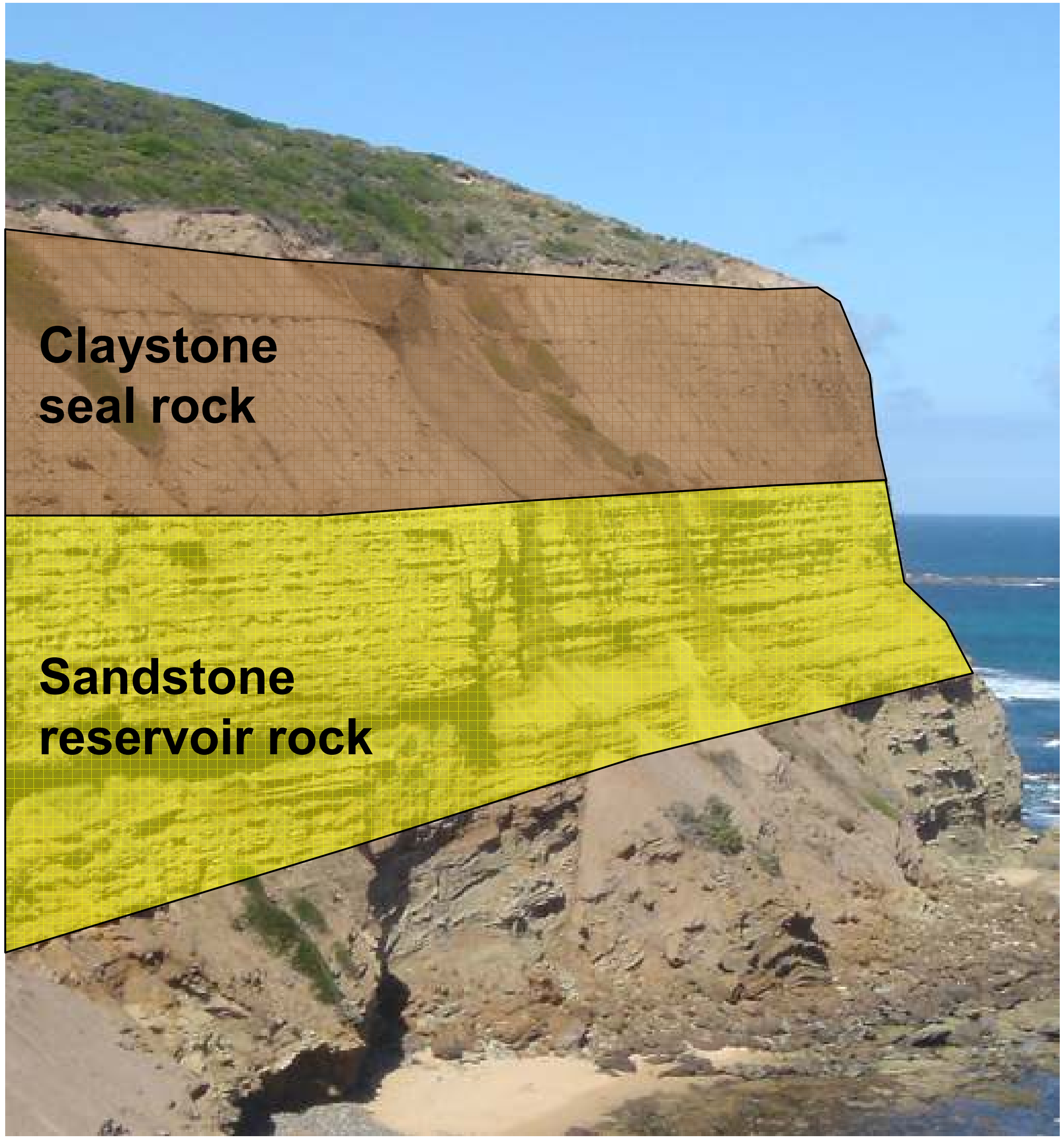
Main CO_2 pipeline enters Weyburn

The Carbon Capture Transport and Storage Process



CO2CRC

Geological Storage of CO_2

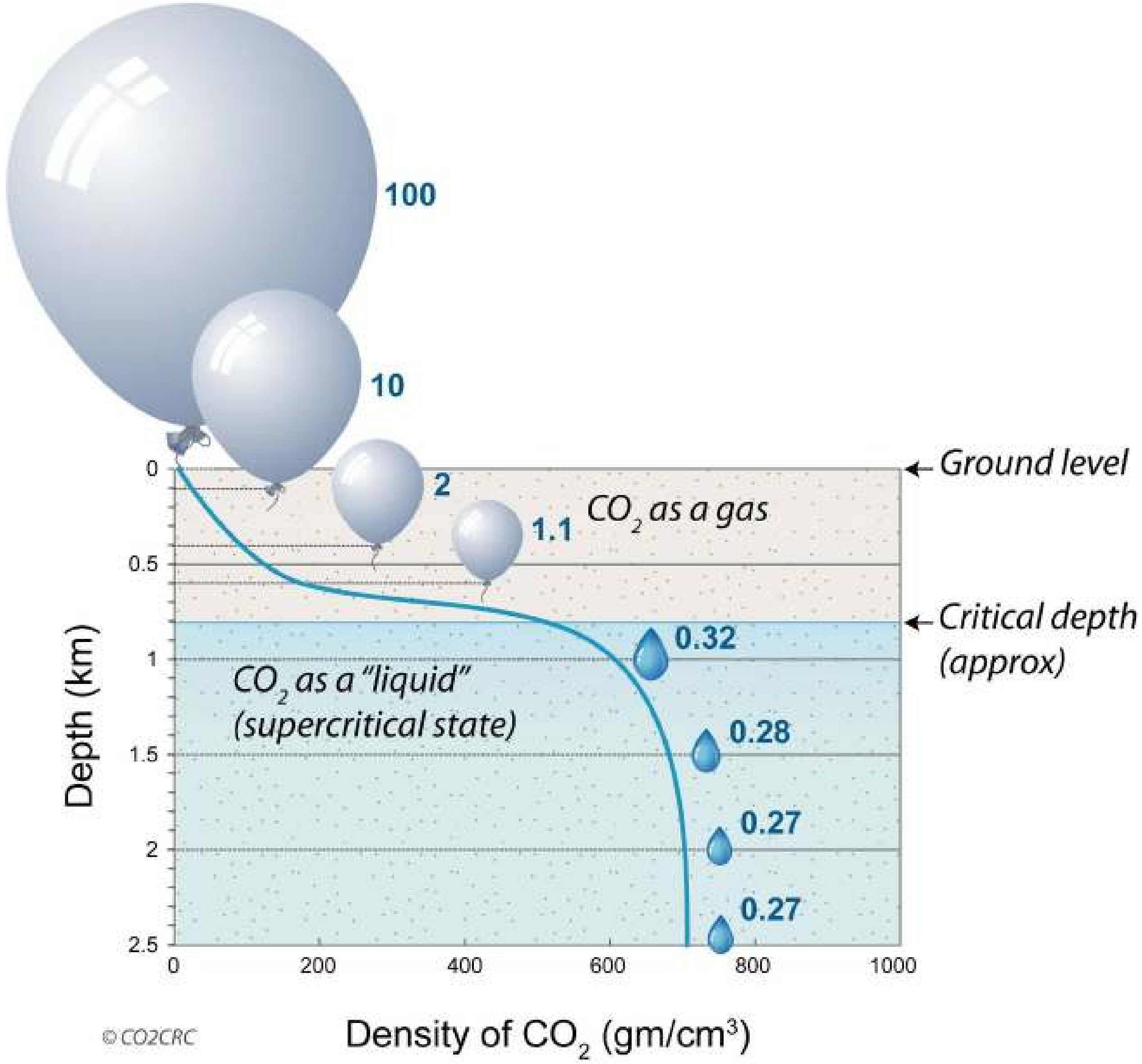


What do we need?

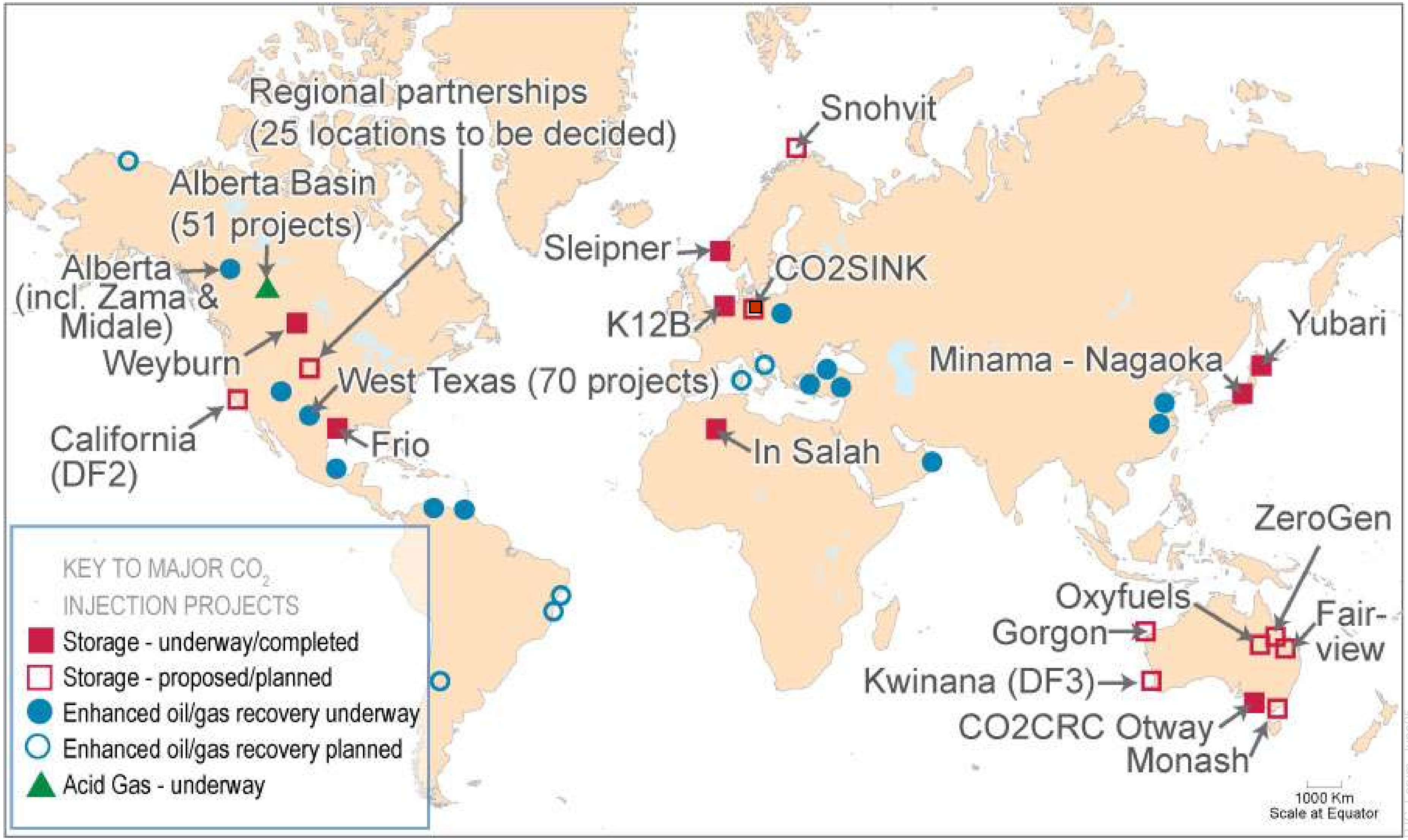
- **RESERVOIR ROCK – porous, e.g. sandstone**
- **SEAL ROCK – non-porous, e.g. claystone**

How does it work?

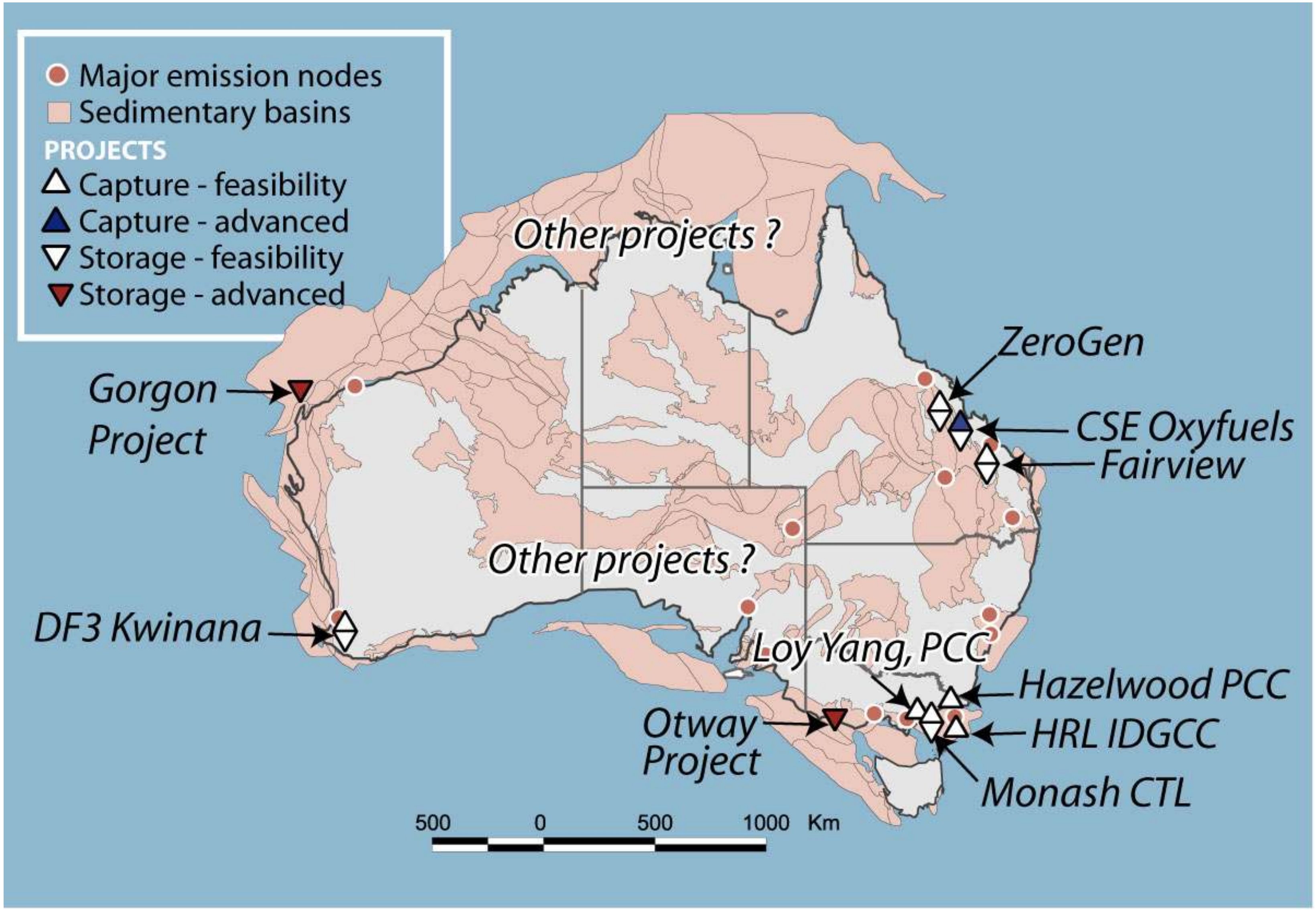
- **CO_2 injected into porous reservoir rock**
- **CO_2 held in place by overlying non-porous seal rock**


100
10
2
1.1
0.32
0.28
0.27
0.27
Ground level
Critical depth
(approx)
CO_2 as a gas
CO_2 as a "liquid"
(supercritical state)
Depth (km)
0
0.5
1
1.5
2
2.5
0
200
400
600
800
1000
© CO2CRC
Density of CO_2 (gm/cm^3)

CO_2 storage-related projects underway or proposed



A number of CCS Projects are currently planned or underway in Australia



Gorgon LNG Project, Barrow Island, W Australia

Description – Construction of 10 million tonne per year LNG plant. CO_2 to be captured from natural gas and injected and into the Dupuy Formation

Capture – CO_2 Separation (part of gas separation for LNG)

- ***Capture Commence*** – 2012?

Storage – Onshore – beneath Barrow Island at a depth of approx 2000m

- ***Storage Commence*** – 2012?
- ***Storage Rate –*** 3 to 4 million tpa

Cost – $A 11 billion plus (total project) (A$ 60M LETDF for storage component)

Partners – Chevron, Esso, Shell

CO2CRC

The Kwinana Hydrogen Project, WA (Proposed)

Description – Use of sub-bituminous coal to produce hydrogen for a 500MW power station, with fully integrated CCS (feasibility study)

Capture – CO_2 separation pre combustion

- ***Capture Commence*** – 2012?

Storage – Offshore Perth Basin

- ***Storage Commence*** – 2012?
- ***Storage Rate* –** 4 million tonnes per year

Cost – $A 2 billion

Partners – BP, Rio Tinto

CO2CRC Otway Project, Victoria

Description – Australia's most advanced storage project, involving demonstration of geological storage of CO_2 and monitoring and verification of the behaviour of the stored CO_2.

Storage – Depleted gas field at 2000m depth

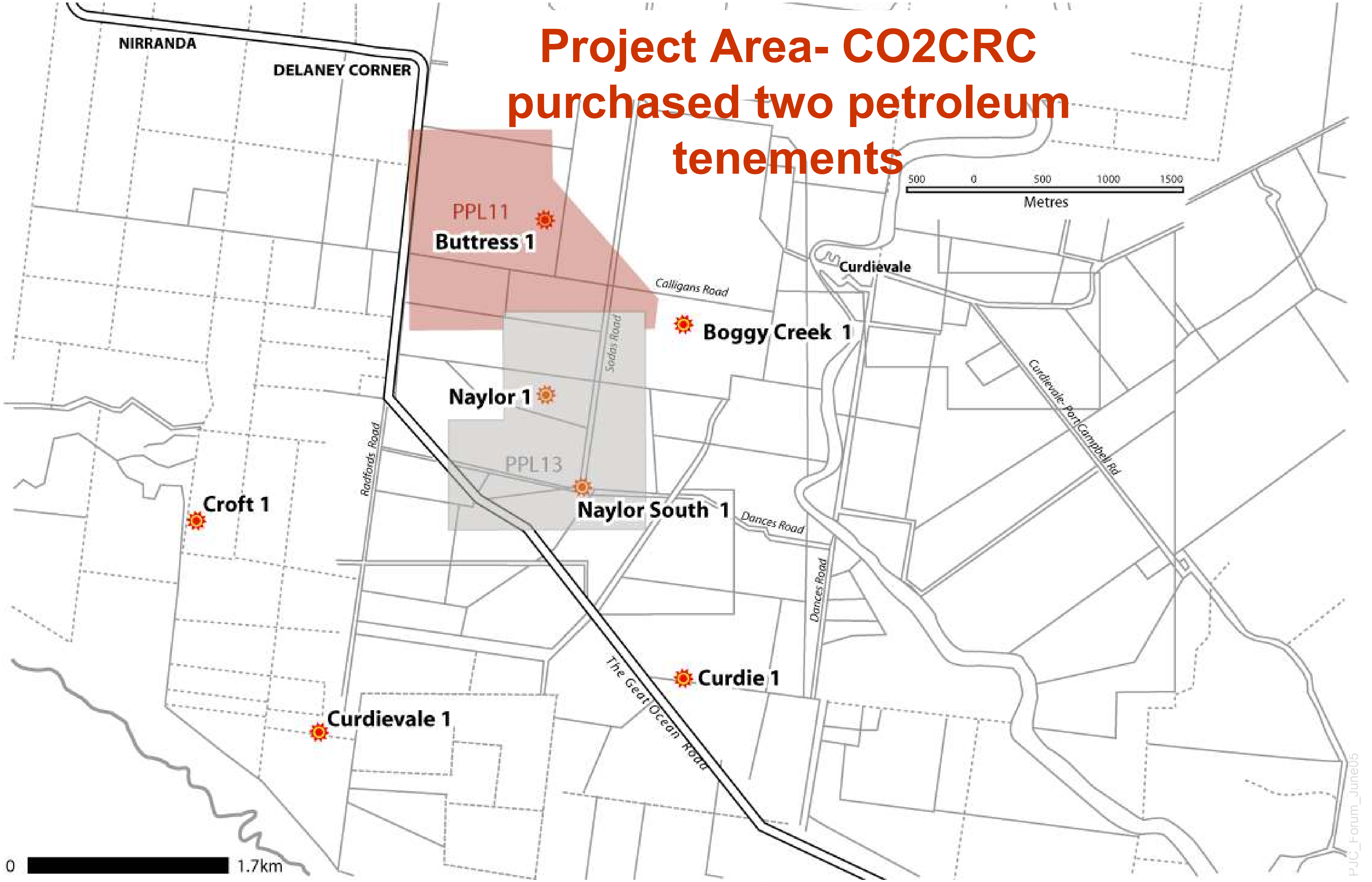
- ***Storage Commence*** – late 2007-early 2008
- ***Storage Rate* –** up to 100,000 tonnes total over approx one year (Stage 1)

Cost – $A 40M plus

Partners – CO2CRC, Industry, Government and Researchers (universities, CSIRO, GA, LBNL, ARC, GNS, KIGAM), DEST,AGO, DoE

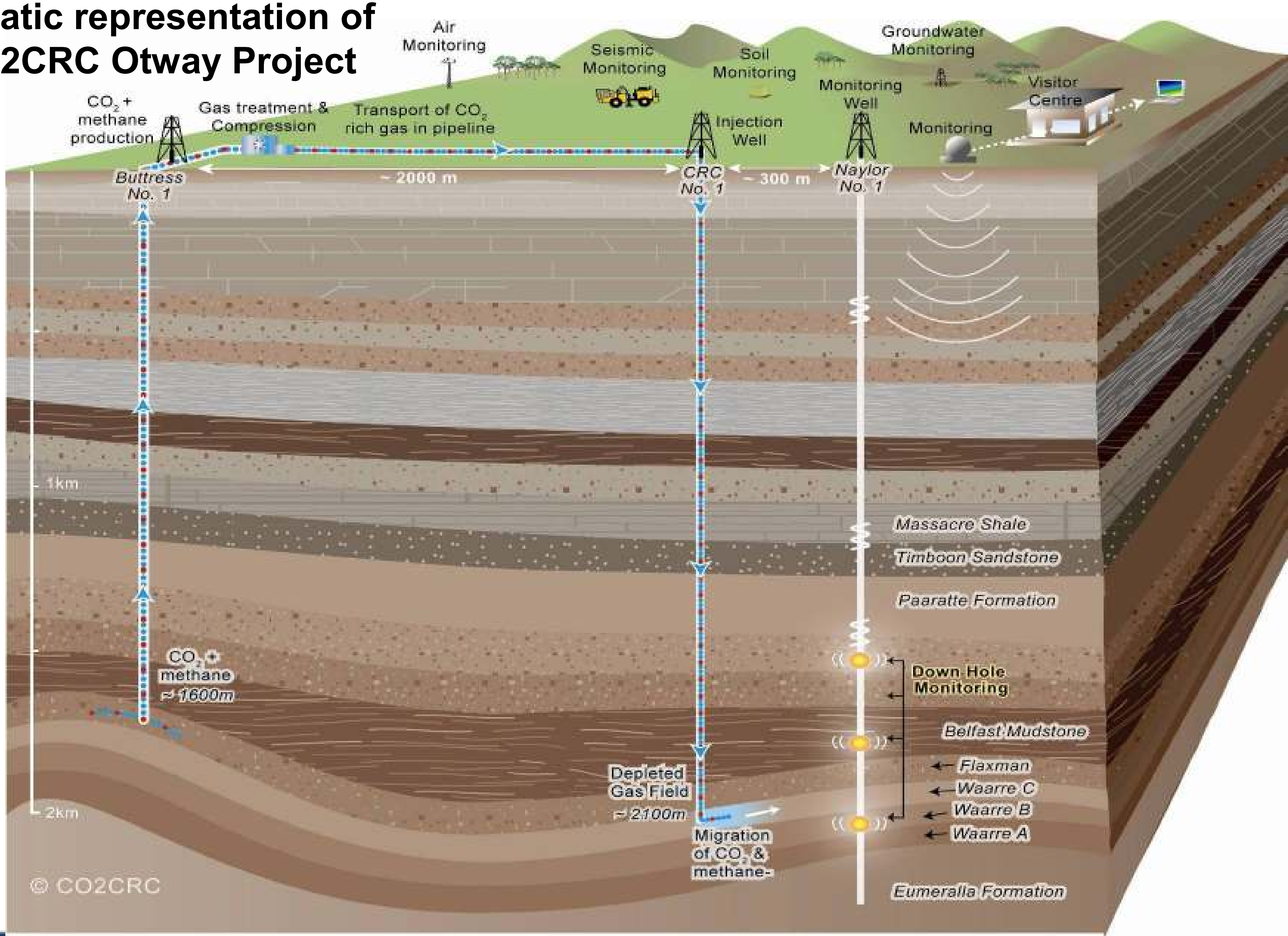
Australia, New Zealand, USA, EU, Korea, Canada

Project Area- CO2CRC purchased two petroleum tenements



CO2CRC

Schematic representation of the CO2CRC Otway Project



CO2CRC

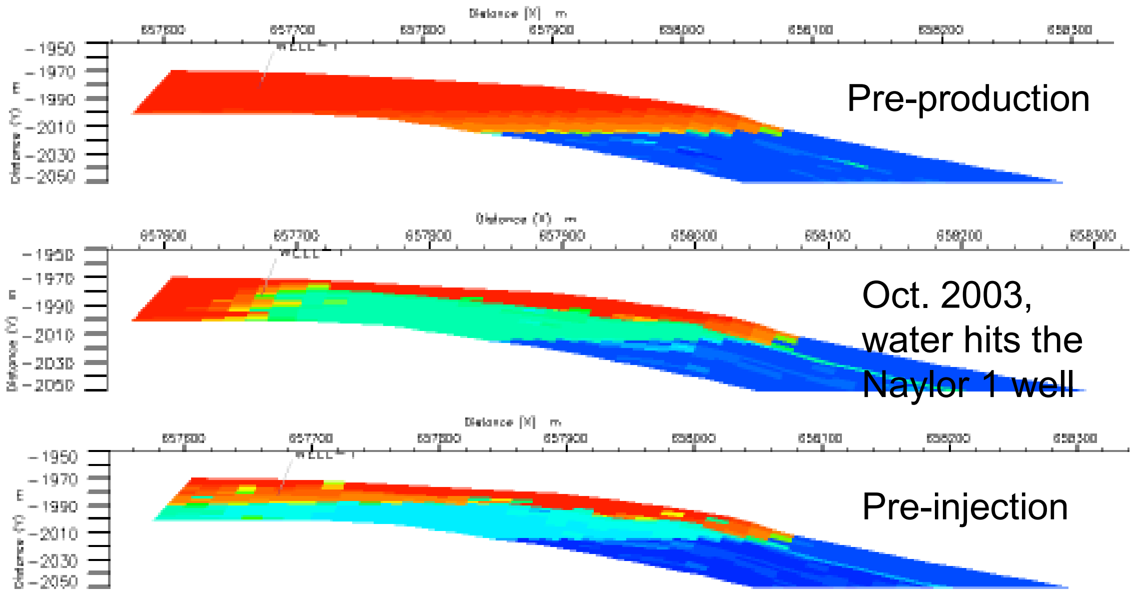
Coring in CRC-1 confirmed an excellent reservoir and seal

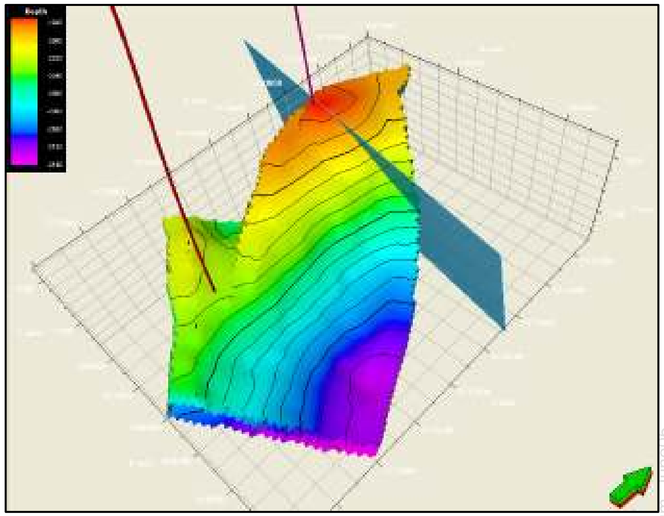
Core sample, CRC-1

CO2CRC

Development of static and dynamic models of the reservoir has been a key part of the project

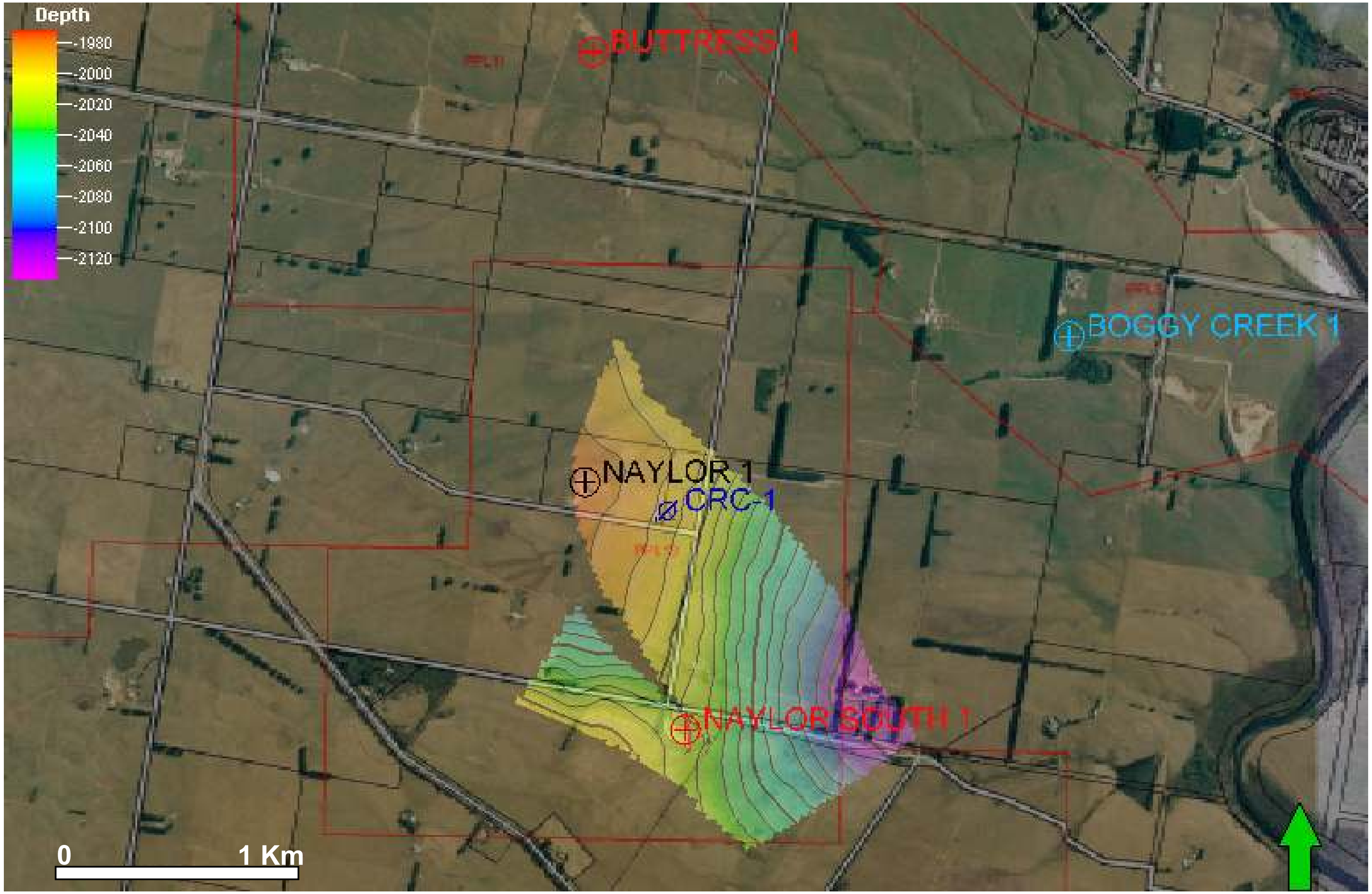
Rigorous multi-disciplinary studies based on established oil field processes validated through peer reviews, were a key component in convincing regulators that the carbon dioxide would stay in the reservoir rocks



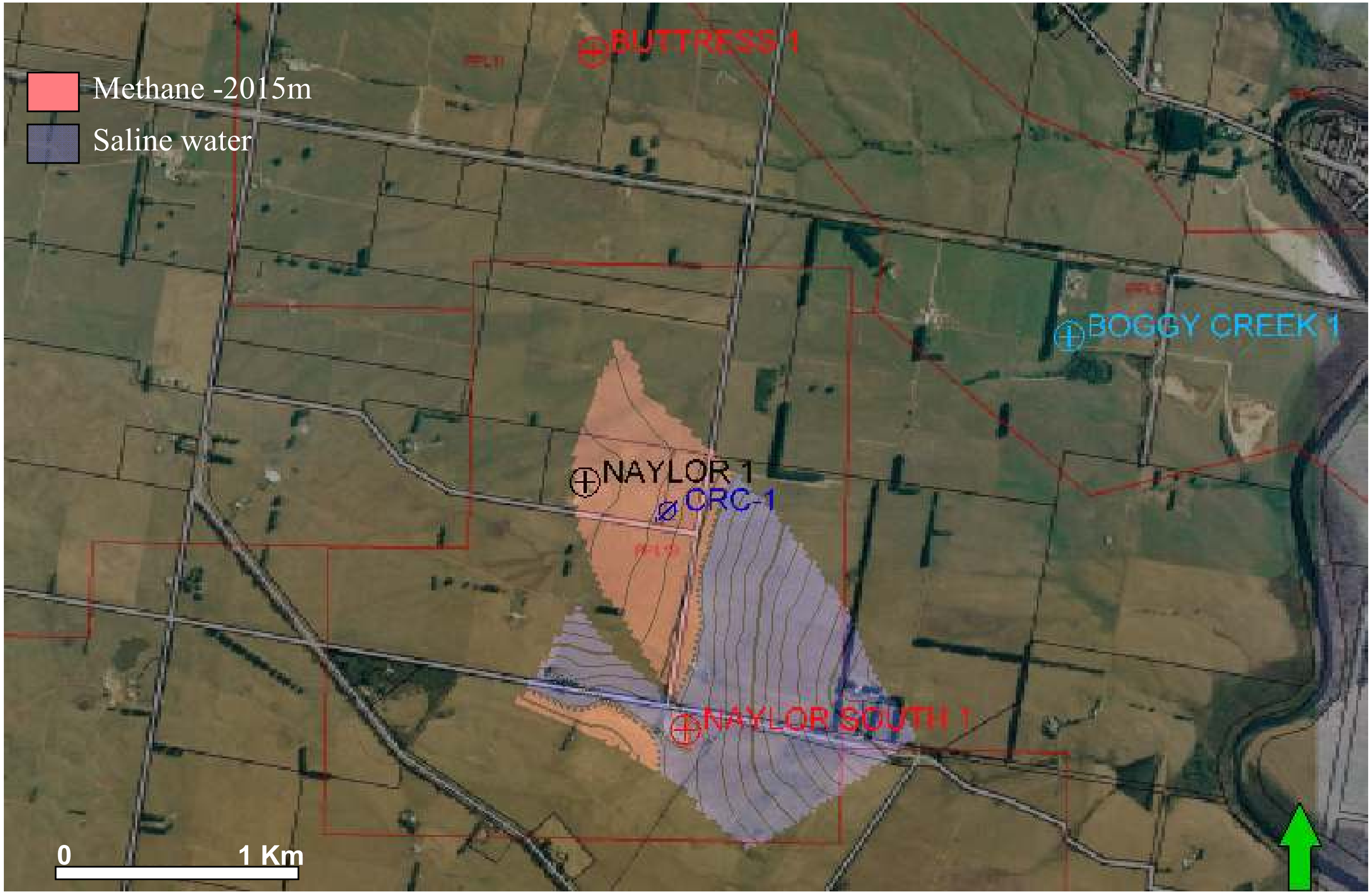


UNSW Australian Government Geoscience Australia CSIRO Schlumberger Curtin University of Technology THE UNIVERSITY OF ADELAIDE AUSTRALIA CO2CRC

The challenge- we currently only have one….

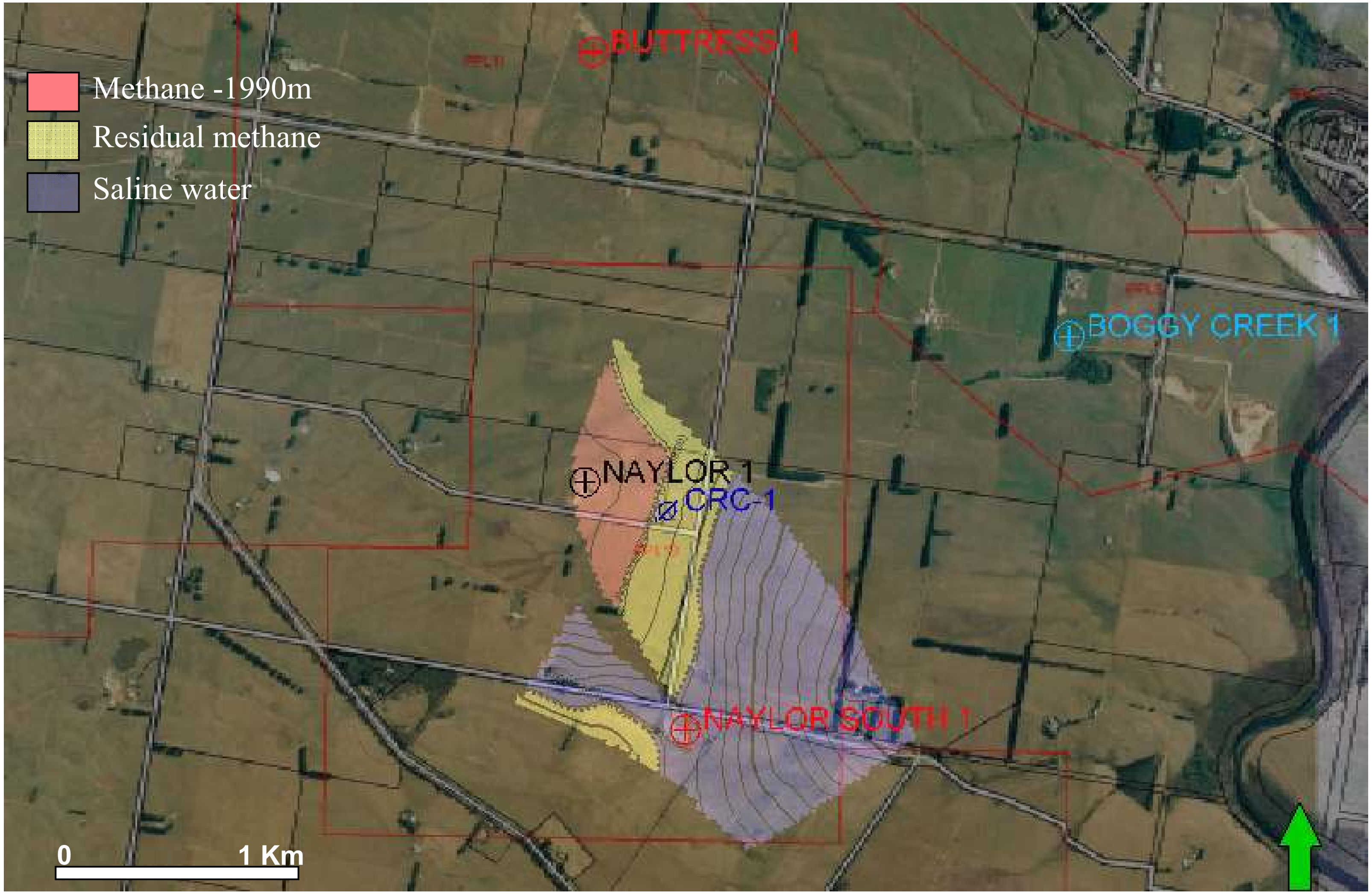


“bankable” storage project…..

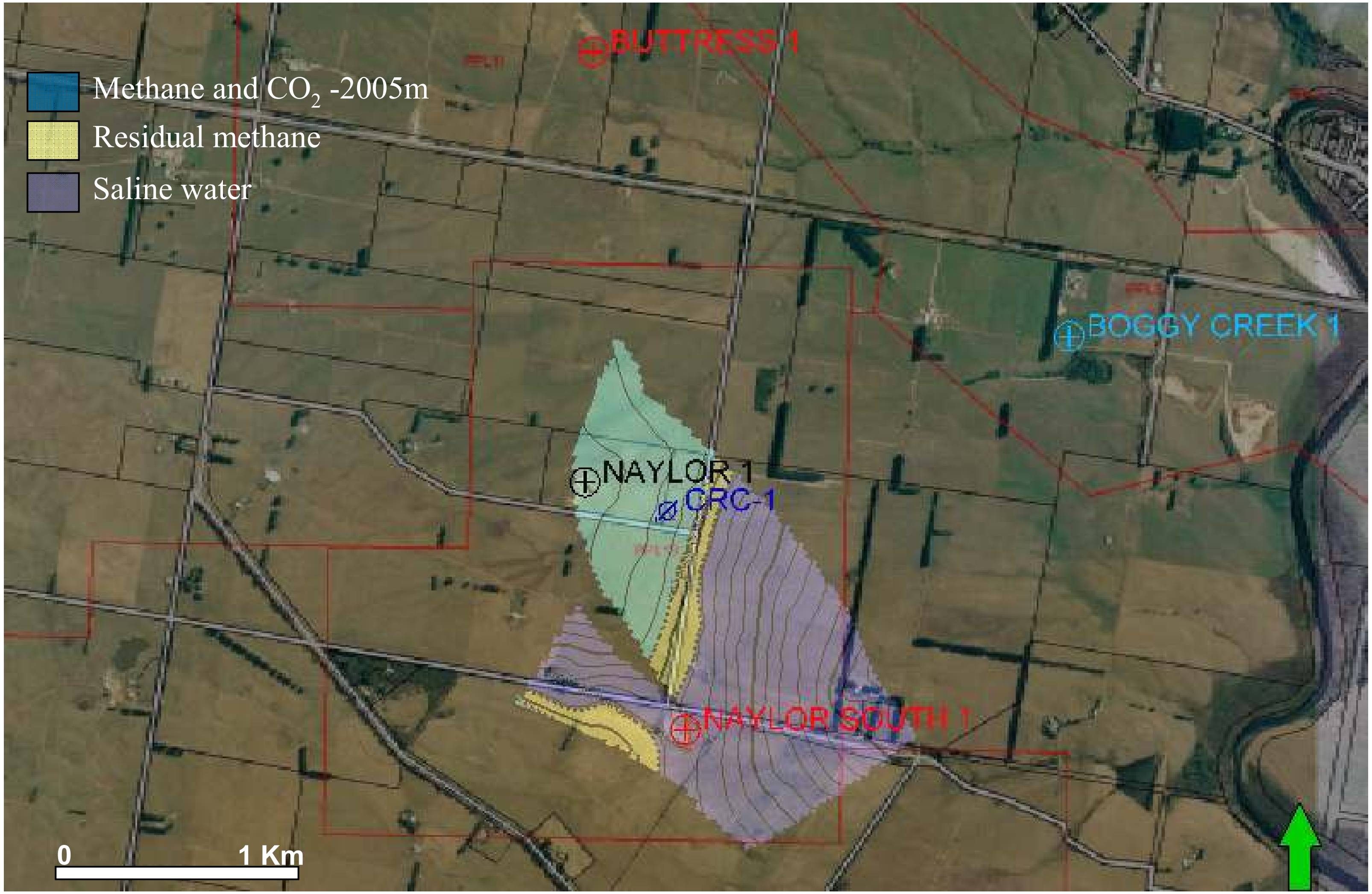


CO2CRC

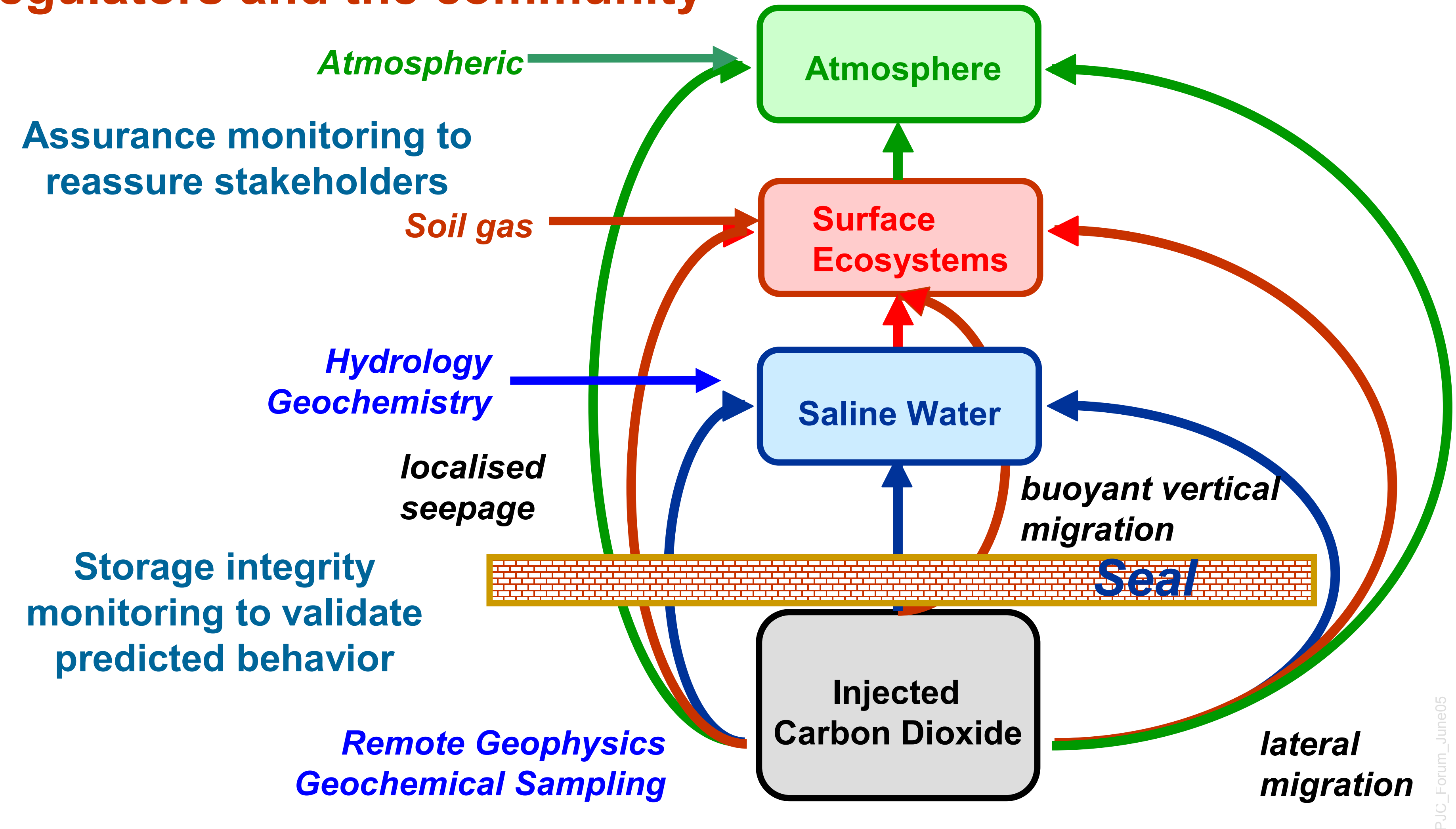
In Australia……



The 100,000 tonne CO2CRC Otway Project!

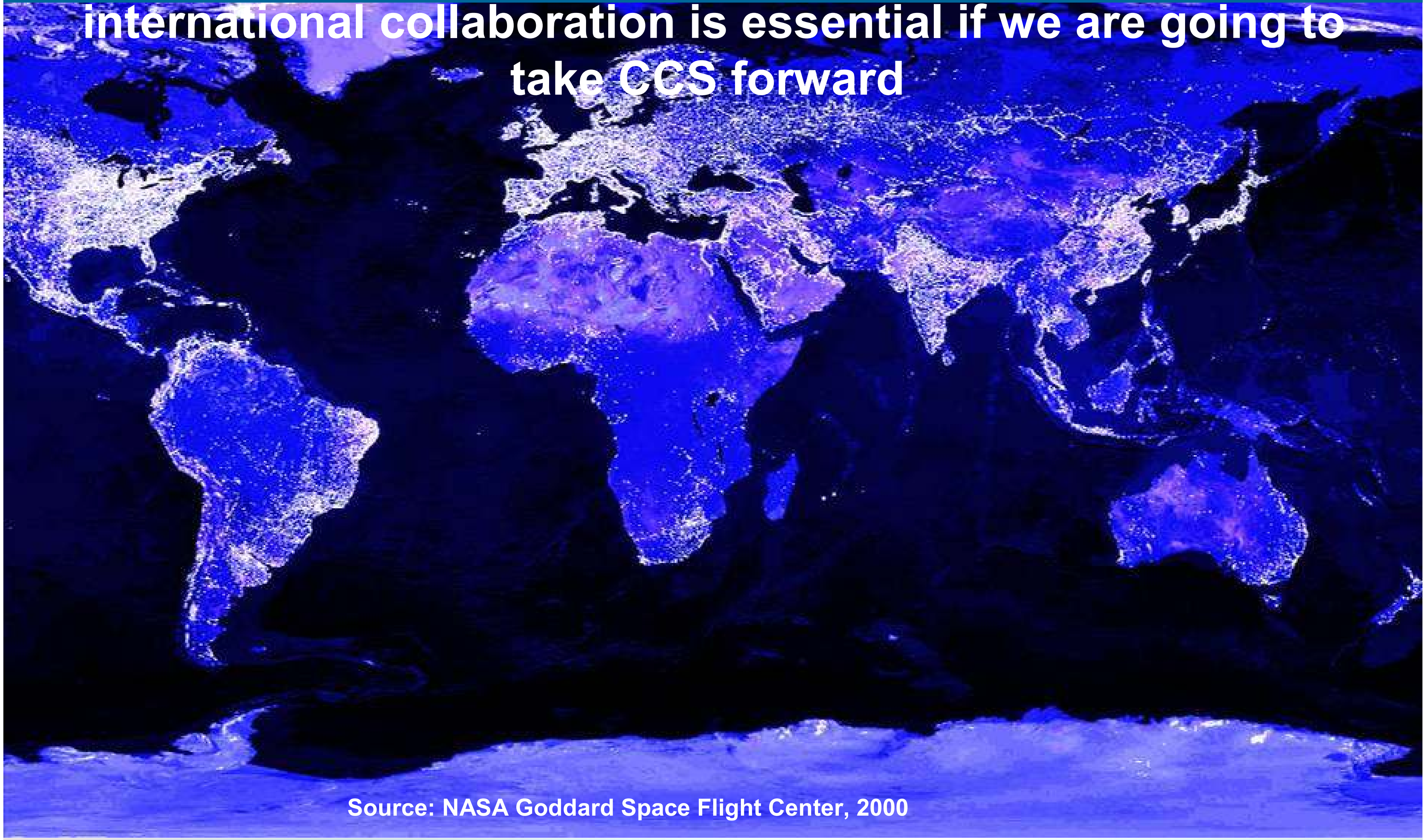


Monitoring & Verification will provide confidence to regulators and the community



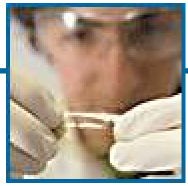
The future of CCS

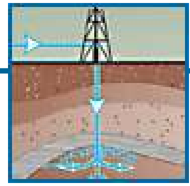
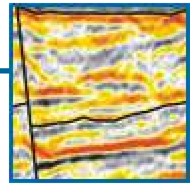
international collaboration is essential if we are going to take CCS forward



Source: NASA Goddard Space Flight Center, 2000

The future of CCS
The commercialisation pathway is not yet defined

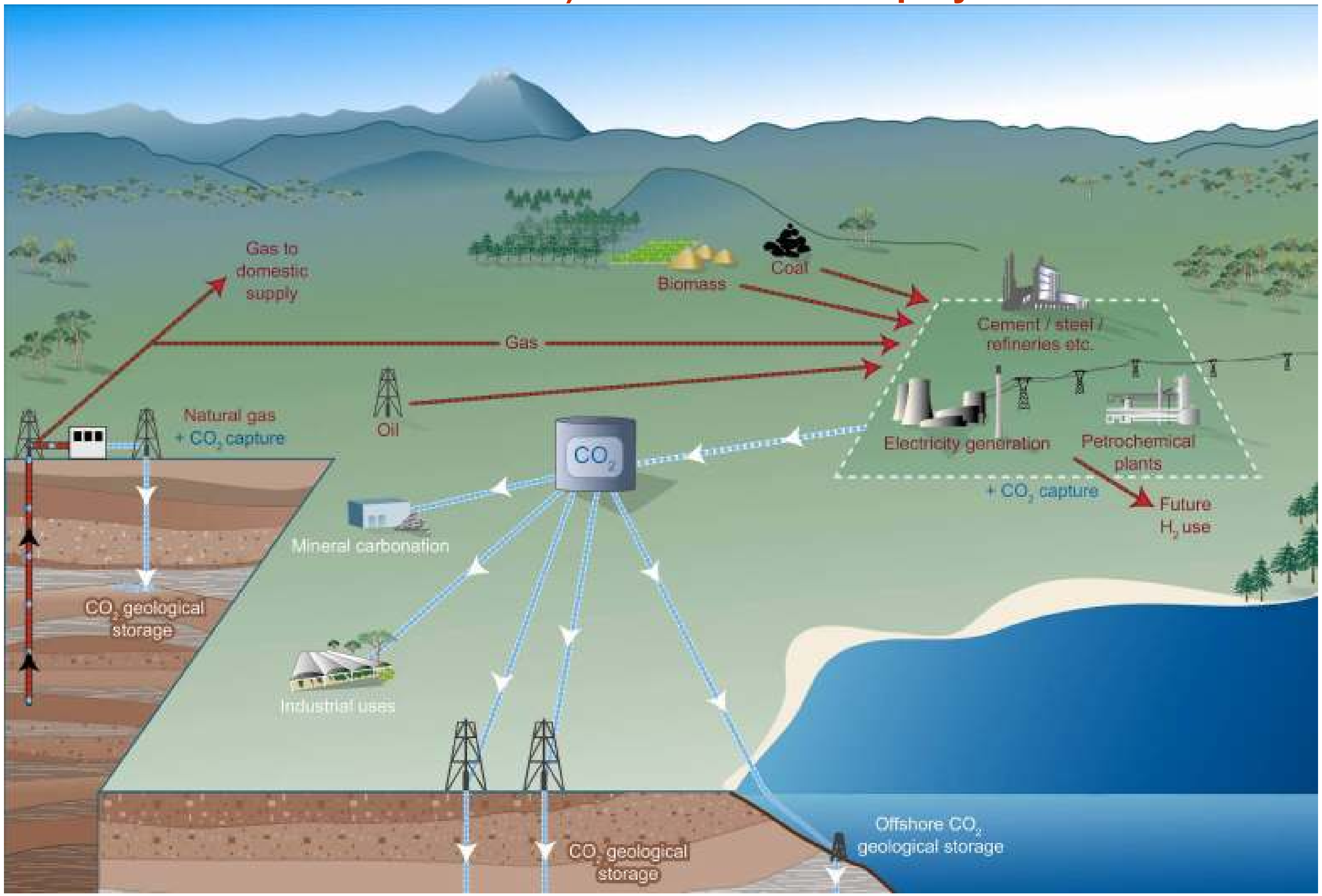



Fuel Supply	Capture	Transport Infrastructure	Storage	M&V	Closure	Long Term Liability
Coal	Generators	E&P(some)	E&P	Govt EPA	Govt EPA-DPI	Govt
Gas	Petrochem	Pipeline	Service Co	Service Co	Insurance	Insurance
E&P	Industrial	Public	New Co	Certification	Service	
R&D	Chem Co	Shipping	R&D	E&P	Certification	
	R&D	Transport	Govt DPI	R&D	E&P	
		Engineering				

Banks, Traders,,CCS Consultants

THE FUTURE OF CCS

Regional approaches, improved technology, learning by doing, public-private partnerships, an appropriate regulatory regime, clarity on long term liability and a price on carbon (or other instruments) will accelerate deployment



PJC_Forum_June05


For as long as we use coal (and increasingly gas) we will need to use CCS to cut emissions
Capture costs will come down and CCS will be economically competitive
Transport is not a major issue
Storage needs confirmation but will be adequate
The CCS business model is immature but it could well become as big as the petroleum business
But we have to start large scale CCS soon!

CO2CRC