

## Latest developments of CCS in Australia

**Presenter: Rick Causebrook** – General Manager Research  
Australian Low Emissions Coal Research & Development

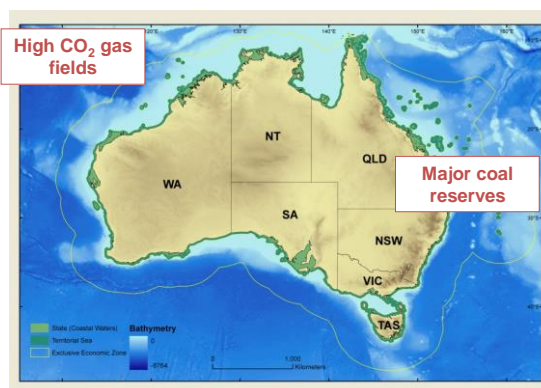
CHINA-AUSTRALIA GEOLOGICAL STORAGE

CAGS II Workshop 2  
11<sup>th</sup> – 13<sup>th</sup> May 2014- Shanghai



## The drivers for CCS in Australia

- Australian Government commitment to reducing GHG emissions to atmosphere
- Australian coal reserves on the east coast-
- Australia's leading export worth A\$ 55 billion in 2009
- High CO<sub>2</sub> gas fields on the North West Shelf
- Australia's high per capita emissions



CAGS II Workshop 2  
Shanghai 11-13 May 2014



## Government Initiatives To Support CCS

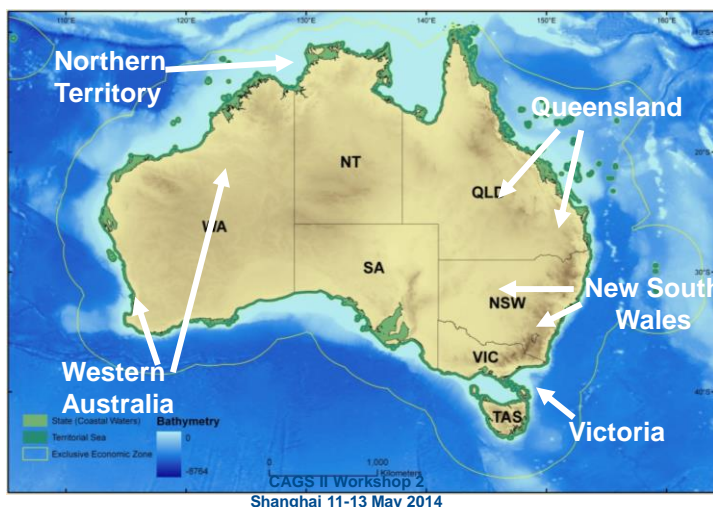
- The previous Australian Government introduced a number of initiatives over a number of years to encourage CCS. These include:
  - National Low Emissions Coal Initiative
  - National Carbon Storage
  - National Carbon Mapping and Infrastructure Plan
    - Carbon Storage Task Force
  - National CCS Council
  - NCIP data acquisition program
  - State Government Initiatives
  - CCS Flagships Programme

CAGS II Workshop 2  
Shanghai 11-13 May 2014



## Government Data Acquisition Programmes

Joint State and Federal Government geological exploration programmes to improve understanding of nation's storage potential and encourage exploration



5

## CCUS and CCS in Australia

- Australia currently has no CCUS programmes.
- Some commercial production of CO<sub>2</sub> from natural sources.
- Most major Australian oil provinces not suitable for miscible CO<sub>2</sub> EOR.



Some potential for some future CO<sub>2</sub> EOR in the Cooper Basin in Central Australia.

CO<sub>2</sub> removed from natural gas streams is currently vented.

CAGS II Workshop 2  
Shanghai 11-13 May 2014



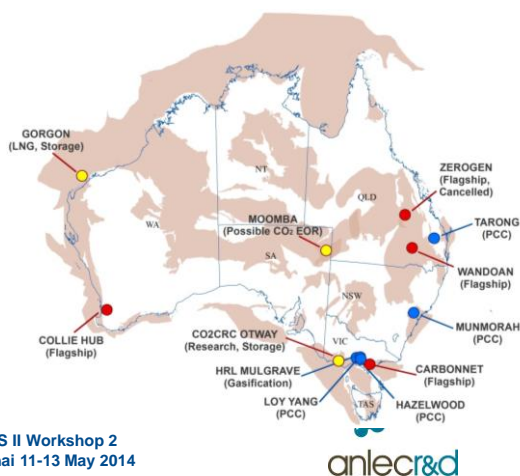
6

## CCS in Australia

- Seven experimental /demonstration capture projects underway or completed.
- One demonstration storage programme in progress (OBPP).
- One major LNG / CO<sub>2</sub> storage project under construction (Gorgon).

➤ Three integrated capture / storage projects in planning or early exploration stages under joint Industry/Government funded projects.

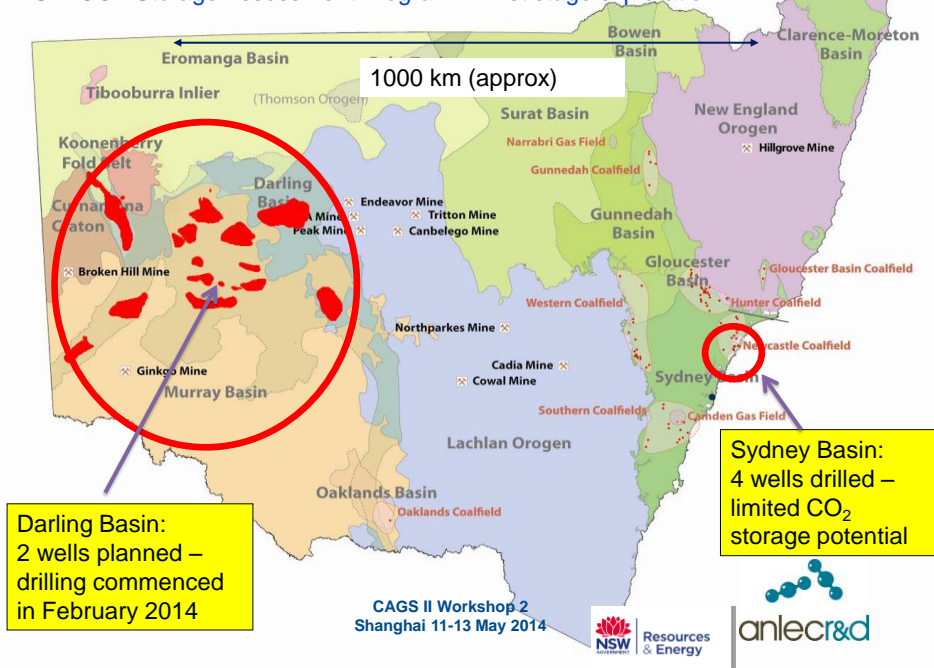
➤ One advanced exploration stage project cancelled due to difficulties in establishing storage capacity in chosen location (ZeroGen).



CAGS II Workshop 2  
Shanghai 11-13 May 2014

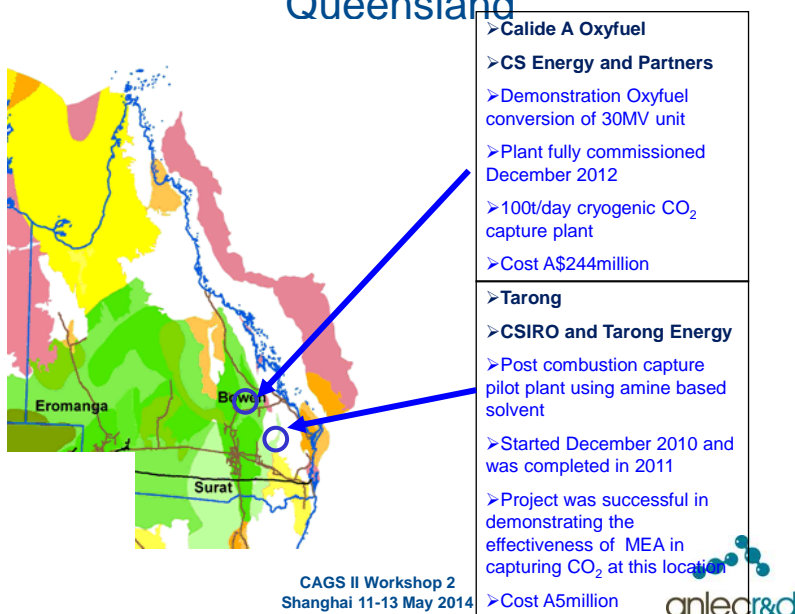


## NSW CO<sub>2</sub> Storage Assessment Program – First stage exploration



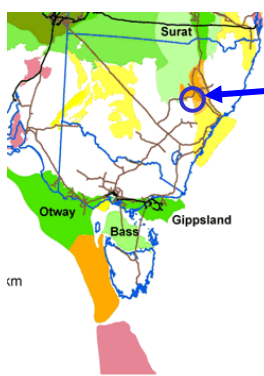
## CO<sub>2</sub> capture projects in Australia - Queensland

8



9

# CO<sub>2</sub> capture projects in Australia – New South Wales



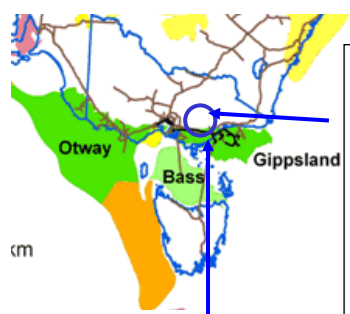
- >Munmorah PCC (Completed)
- >Vales Point PCC in progress
- >Delta electricity and CSIRO
- >Research Scale Project Investigating post combustion capture using the ammonia adsorption process
- >Tests to capture up to 3000 tonnes of CO<sub>2</sub> successfully completed at Munmorah
- >Plant moved to nearby Vales Point Power Station
- >Plant being prepared for broader set of liquid absorbent technologies.

CAGS II Workshop 2  
Shanghai 11-13 May 2014



10

# CO<sub>2</sub> capture projects in Australia Lalrobe Valley Projects - Victoria



- >Loy Yang Power Station
- >Loy Yang power and CSIRO
- >Mobile PCC Facility capturing 1000tpa CO<sub>2</sub>

- >Hazel wood Power Station
- >International Power and CO<sub>2</sub>CRC
- >2 Projects
  - >H3 Capture Project
    - Solvent PCC
    - Completed in 2011
  - >Uno Mk 3 Project
    - >K<sub>2</sub>CO<sub>3</sub> PCC

- >Mulgrave Capture Project
- >HRL and CO<sub>2</sub>CRC
- >Research gasifier used in pilot scale capture project – now completed

CAGS II Workshop 2  
Shanghai 11-13 May 2014



## Storage Research Project- the CO<sub>2</sub>CRC Otway Basin Test

- A major project involving research teams from Australia and overseas and both industry and research institutions
- Stage 1: 65kt CO<sub>2</sub> injected into a depleted gas field
- Stage 2: researching CO<sub>2</sub> storage in saline aquifers
- Nine major research streams
- Two large field experiments
- 79 researchers across 11 institutions
- 2011-2012 budget of A\$11.9 million



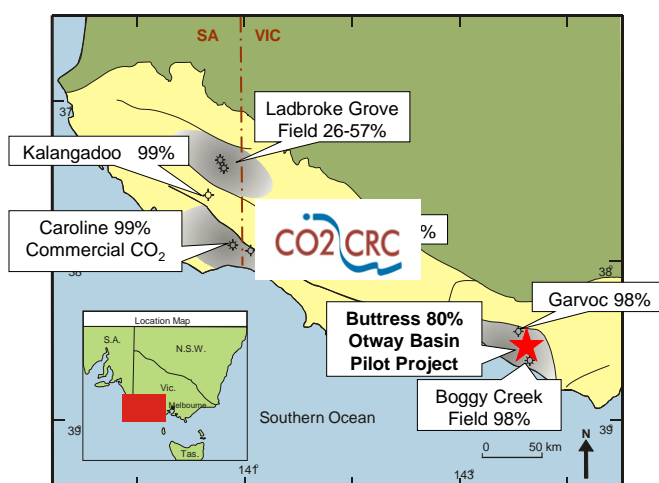
CAGS II Workshop 2  
Shanghai 11-13 May 2014



Pictures: ©CO<sub>2</sub>CRC



Located in an area where naturally occurring CO<sub>2</sub> is available

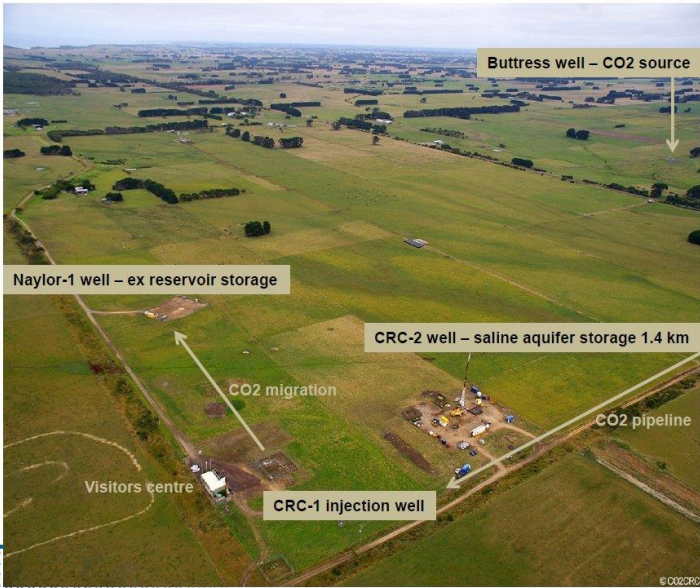


CAGS II Workshop 2  
Shanghai 11-13 May 2014

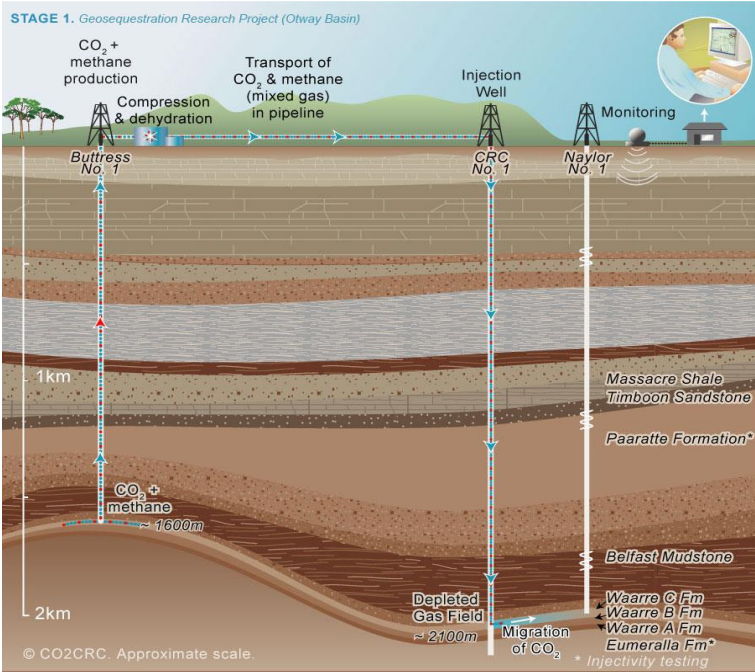




The Otway Project from the Air



CAGS II Workshop 2  
Shanghai 11-13 May 2014



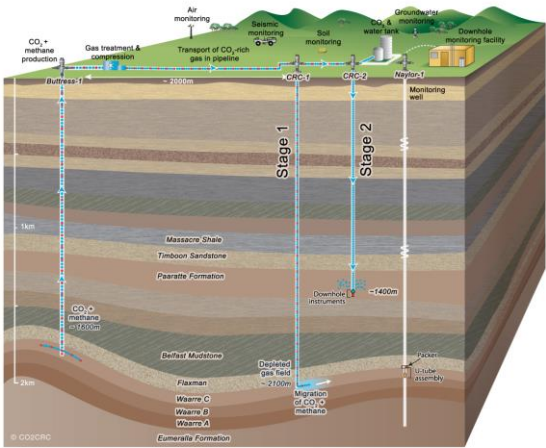
# The CO2CRC Otway Project

- Stage 1:
- Production of CO<sub>2</sub> rich gas
  - Injection into Waarre Fm depleted gas field
  - Monitoring and verification
  - >65,000t injected
  - Completed in 2009



# The CO2CRC Otway Basin Pilot Project

- Stage 2:**
- “Huff and puff” test to evaluate residual trapping
  - Using natural CO<sub>2</sub> rich gas
  - Paaratte Fm (~1400m), saline aquifer
  - New well CRC-2

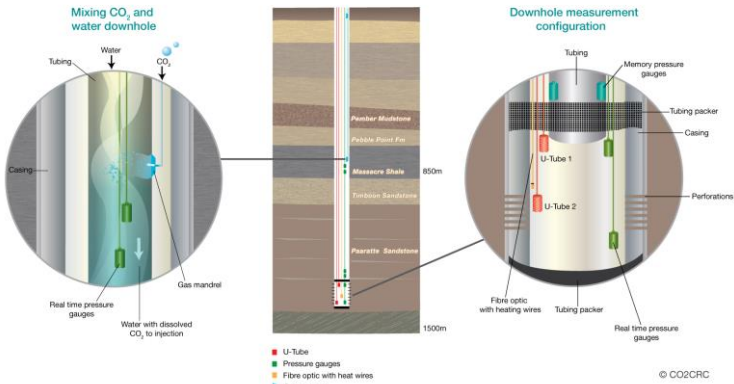


CAGS II Workshop 2  
Shanghai 11-13 May 2014



## Saline Aquifer storage Test in Otway Stage 2

Residual gas saturation test (Otway Stage 2B)  
CRC-2 Well



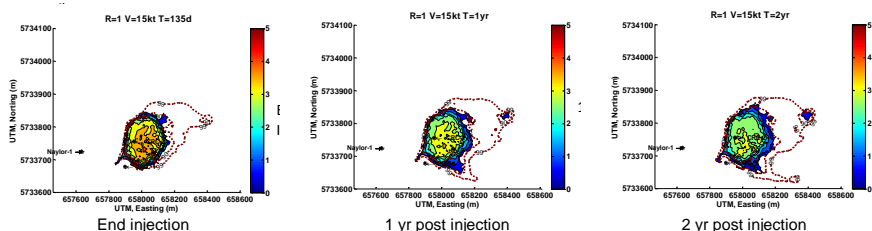
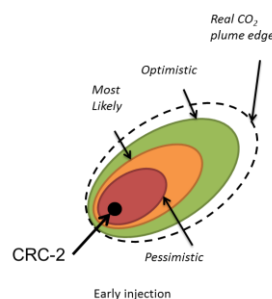
CAGS II Workshop 2  
Shanghai 11-13 May 2014





## Otway Stage 2C: Plume Stabilisation and 4D Seismic Monitoring

- Detect injected Buttress gas in the subsurface using seismic; ascertain minimum detection limit.
- Observe the gas plume develop using time lapse seismic.
- Verify stabilisation of the plume in a saline formation using time lapse seismic.



CAGS II Workshop 2  
Shanghai 11-13 May 2014

18

## Australian Government Supported Initiatives

### The Flagship Projects

The \$1.68 billion CCS Flagships programme offers commonwealth Government support to help develop “first of a kind” large scale, integrated, industrial CCS projects in Australia.

These projects are intended to contribute to reaching the G8 goal of “20 by 2020”

Projects have to satisfy strict guidelines

CAGS II Workshop 2  
Shanghai 11-13 May 2014



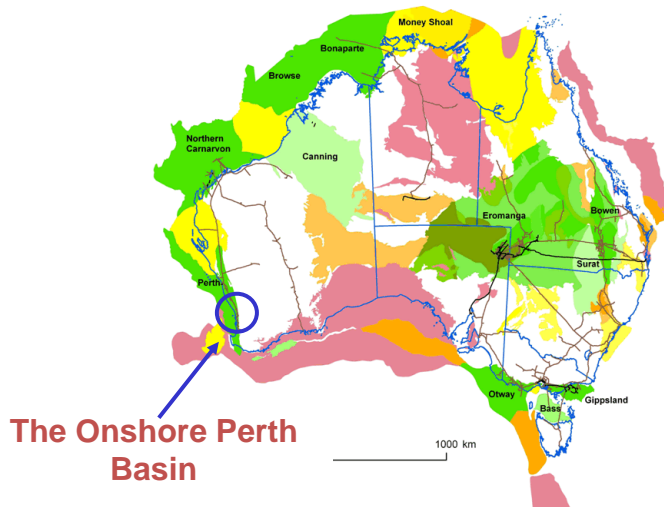
## Government Supported Initiatives The Flagship Projects

- 1) The Southwest Hub Carbon storage Project-  
Western Australia
  - A\$53 Million in support for detailed feasibility study  
announced in June 2011
- Slides courtesy of the Southwest Hub Project

CAGS II Workshop 2  
Shanghai 11-13 May 2014



## The South West Hub Project in Western Australia

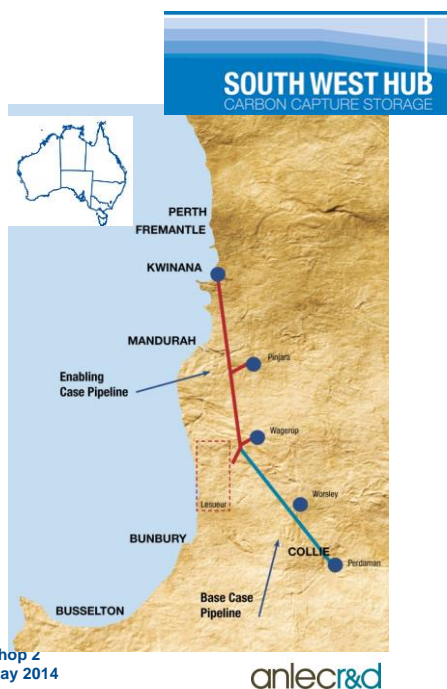


CAGS II Workshop 2  
Shanghai 11-13 May 2014

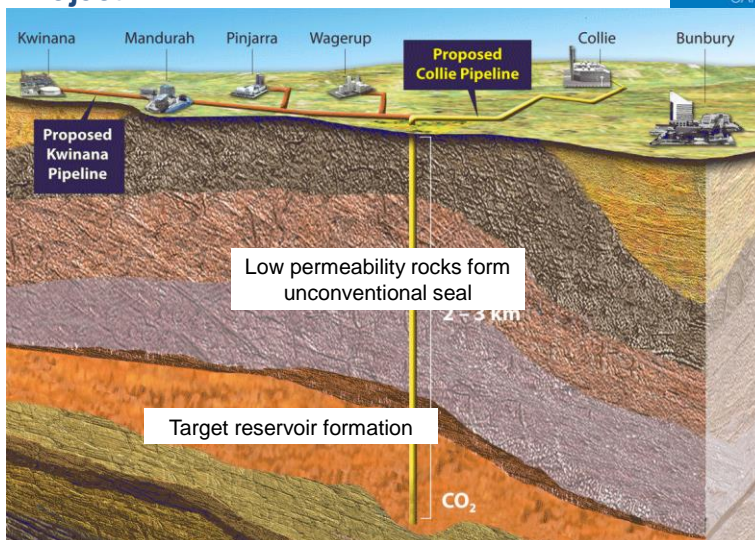


## South West Hub Carbon Storage Project

- Integrated industrial CO<sub>2</sub> geosequestration system
- Storage within an identified area
- 2.4 mtpa from fertilizer plant CO<sub>2</sub>
- Red mud sequestration 300,000+ tpa (Alcoa)
- Potential for up to 7 mtpa for future power generation



## South West Hub Carbon Storage Project



## South West Hub Carbon Storage Project



- Development plan:
- Target injection (40 yrs): 6 injectors
- Completion consideration to optimize injection volume and manage containment risk
- Two potential injection zones identified from seismic and modeling



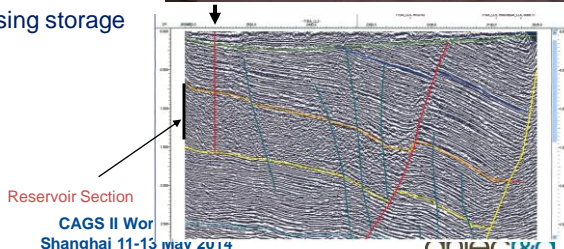
CAGSii Workshop 2  
Shanghai 11-13 May 2014

anlect&d

24

## Harvey -1 Exploration well

- Drilled during February and March 2012 to a total depth of 2945m.
- Target Lesueur Formation (Permian) extensively cored.
- Drilling identified several thick shale/paleosol bands within the target formation to act as seals to the underlying reservoir
- Core tests indicate that the reservoir has promising storage potential



CAGS II Wor  
Shanghai 11-13 May 2014

anlect&d





27

## Government Supported Initiatives The Flagship Projects

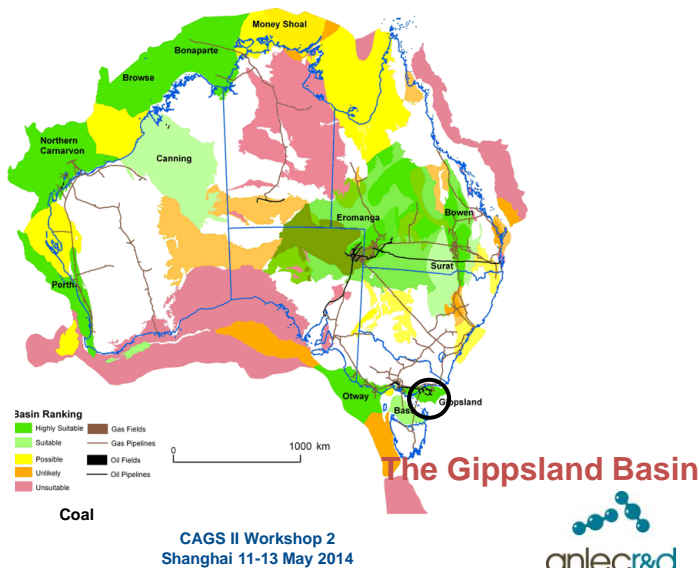
- 2) The CarbonNet Project – Victoria
- A\$100 Million for detailed feasibility study announced in February 2012
- Slides courtesy of CarbonNet

CAGS II Workshop 2  
Shanghai 11-13 May 2014



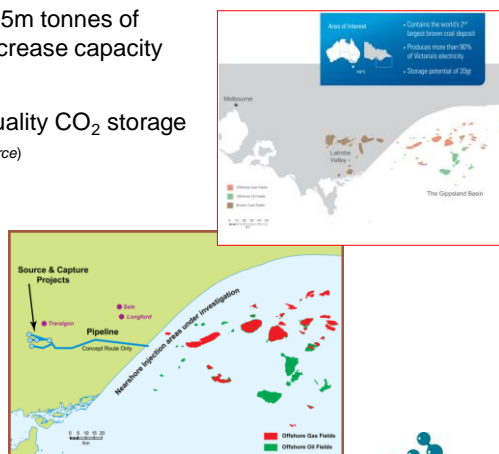
28

## CarbonNet - A Victorian Project



## The CarbonNet Project

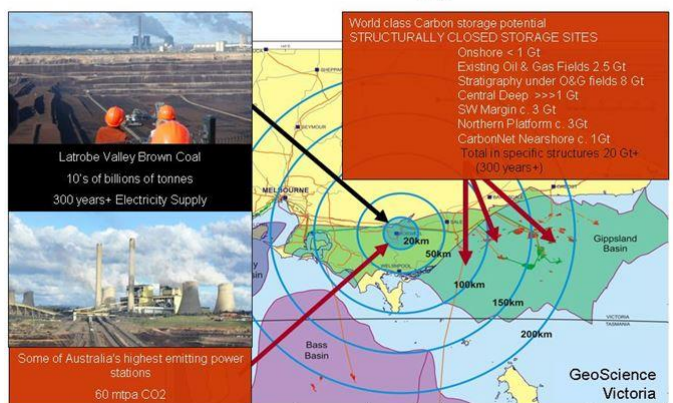
- Investigating feasibility of commercial scale multi user network
- Aiming to capture and store 1-5m tonnes of CO<sub>2</sub> pa with the potential to increase capacity over time
- Gippsland Basin is highest quality CO<sub>2</sub> storage site in Australia (2009 Carbon Taskforce)
- Funded by the Australian Government & the State of Victoria
- Awarded further A\$100m for feasibility



CAGS II Workshop 2  
Shanghai 11-13 May 2014



## CarbonNet – The Gippsland Basin



CAGS II Workshop 2  
Shanghai 11-13 May 2014



## CarbonNet - Scope

### Storage Objectives

- **Confirm** the presence of sites with 20-100 Mt of accessible CO<sub>2</sub> storage within the Latrobe Group in the near shore Gippsland basin
- **Demonstrate** the injectivity properties of the Latrobe Group at the preferred injection sites are adequate
- Establish that the injection of **1 to 5 Mt** of CO<sub>2</sub> per annum can be undertaken in a **sustainable and secure** manner
- Determine that injected CO<sub>2</sub> will have a **minimal and acceptable impact** on other users and resources within the basin
- **Commence monitoring programs** to establish baseline data base(s) for future developments and to provide surveillance procedures to demonstrate that the CO<sub>2</sub> is behaving as modeled and will be constrained over anthropogenic and geological timeframes

CAGS II Workshop 2  
Shanghai 11-13 May 2014



32

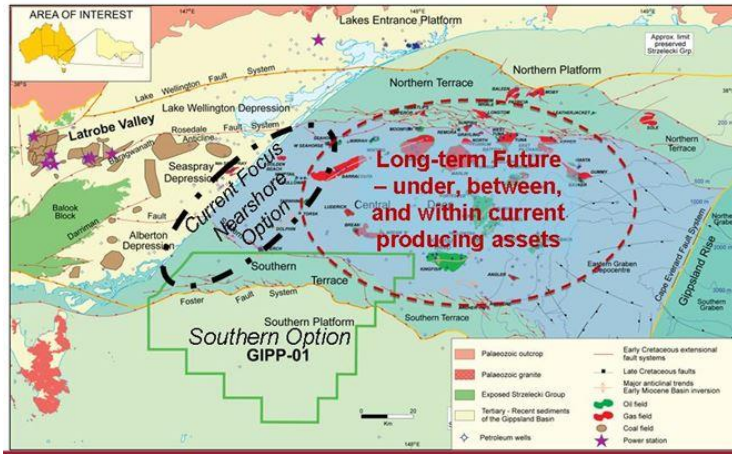
## What makes CarbonNet unique?

- Potential to extend the life of the Victoria's brown coal assets
- Awarded the first offshore GHG Assessment Permit in Australia
- Deployed Regulatory Test Toolkit
- Det Norske Veritas certification process underway
- Lead research organisation received \$51.6m funding from Australian Government's Education Investment Fund to support CarbonNet
- Funding from the Global CCS Institute
- Inhouse team of international experts

CAGS II Workshop 2  
Shanghai 11-13 May 2014



## CarbonNet - Focus



CAGS II Workshop 2  
Shanghai 11-13 May 2014



34

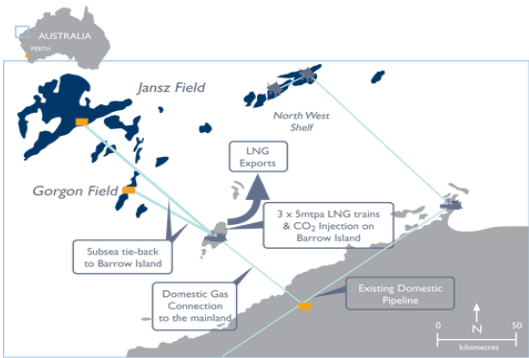
## The Gorgon Project – a Major Industrial Project

CAGS II Workshop 2  
Shanghai 11-13 May 2014



# The Gorgon Project

- Greater Gorgon Gas Fields lie 130-200km offshore and contain about 40 trillion cubic feet of gas
- Water depths, Gorgon 270m Janz 1300m
- CO<sub>2</sub> content Gorgon 14%, Janz 0% , overall ~7%
- Processing Facility onshore Barrow Island 3x5Mtpa trains.



<http://www.gorgon.com.au/index.html>

CAG SII Workshop 2  
Shanghai 11-13 May 2014

## Project Joint venture Partners

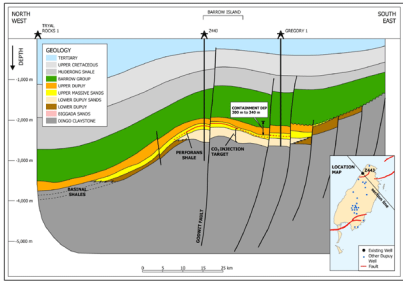
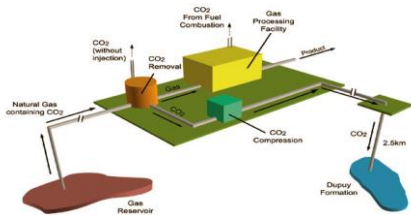
- Chevron (47.333%)
- Shell (25%)
- ExxonMobil (25%)
- Osaka Gas (1.25%)
- Tokyo Gas (1%)
- Chubu Electric Power (0.417%)



36

# The Gorgon Project

- Gas piped and separated on Barrow Island
- CO<sub>2</sub> removed for sales gas
- CO<sub>2</sub> compression attached to gas facility
- Up to 3.4Mtpa of CO<sub>2</sub> will be captured, piped and stored in deep formations below Barrow Island



CAGS II Workshop 2  
Shanghai 11-13 May 2014





37

## The Gorgon Project

- **Status:**
- **Project construction in progress**
- **Project on shedule for first LNG in 2015**
- **First CO<sub>2</sub> injection some months later**



CAGS II Workshop 2  
Shanghai 11-13 May 2014

anlecr&d

## 5. ZeroGen Project

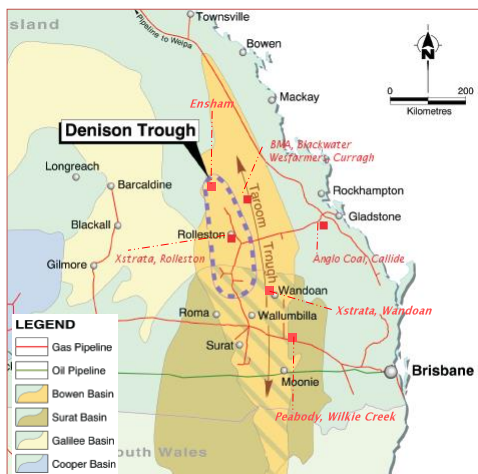


Source: ZeroGen

CAGS II Workshop 2  
Shanghai 11-13 May 2014

anlecr&d

## 5. ZeroGen Project



- Planned for 530MW coal-fired IGCC plant with 90% CO<sub>2</sub> storage in northern Queensland
- After 5 years of exploration and 12 exploration wells it was recognised that the injectivity of the formation was **too low** to allow the injection of the target volumes of 60 million tonnes of CO<sub>2</sub> at 2 MMTPA at an economic cost
- The project has produced many valuable learnings on the difficulties of assessing low permeability reservoirs.

Sources: ZeroGen; Marsh & Scott, 2005

CAGS II Workshop 2  
Shanghai 11-13 May 2014



40

Critical lesson: Without a defined storage reservoir there is no CCS Project

Geologists need to get this message over to Government and Industry, until the reservoir has been characterised properly there is no certainty of storage.

Low permeability fluvial basins will be the biggest challenge to evaluate.

CAGS II Workshop 2  
Shanghai 11-13 May 2014



- **Questions?**

CAGS II Workshop 2  
Shanghai 11-13 May 2014

