

# **Geosequestration of CO<sub>2</sub>: The View from ‘Down Under’\***

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## **Abstract**

The reduction of emissions of carbon dioxide is a high priority for governments and industry reflected in commitments and agreements by the international community through institutions such as the United Nations, the G8, and the International Energy Agency. Geosequestration of CO<sub>2</sub> (also known as carbon capture and storage, or CCS) provides the greatest opportunity for mitigation of carbon dioxide resulting from the use of fossil fuels. CCS involves the long-term storage of captured CO<sub>2</sub> emissions in subsurface geological formations. In Australia, stationary energy-generating plants account for approximately half of all greenhouse gas emissions and constitute point sources from which carbon dioxide can potentially be captured and geologically stored. This has led to a number of recent Government and industry initiatives to support the development and deployment of large-scale integrated CCS projects. The Australian Government is introducing a Carbon Pollution Reduction Scheme (CPRS) to provide the legal framework for reducing the carbon intensity of the Australian economy. The National Low Emissions Coal Council (NLECC) was established with joint funding from the Australian Coal Association and support from the States with the primary focus of supporting large-scale demonstration projects in Australia. Building on a G8 initiative, the Federal Government recently established the Global Carbon Capture and Storage Institute (GCCSI) to facilitate the deployment of 20 large-scale CCS projects. It is anticipated that some of these will be in Australia.

Australia's first demonstration of geological storage of CO<sub>2</sub> (the CO<sub>2</sub>CRC Otway Project) is already underway in the state of Victoria. This innovative project, which is the largest R&D project of its type in the world, is in the process of injecting up to 100,000 tonnes of CO<sub>2</sub> into a depleted gas field to demonstrate CCS storage technologies. The project involves leading Australian and international researchers working to develop and implement a rigorous program of CO<sub>2</sub> treatment, transport, injection, storage, monitoring and verification. Monitoring and verification is crucial to long-term public acceptability and to the requirements of regulators and financial markets.

# Geosequestration of $\text{CO}_2$



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## The View from 'Down Under'

**The Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC)**  
 – a leading international collaborative R & D program, focused on GHG  
 technologies, based in Australia



Supporting participants: Australian Gov Departments | Australian National University | LBNL | ARC  
 | CANSYD | Meiji University | The Process Group | University of Queensland | Newcastle University | USDoE

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



## World CO<sub>2</sub> Emissions

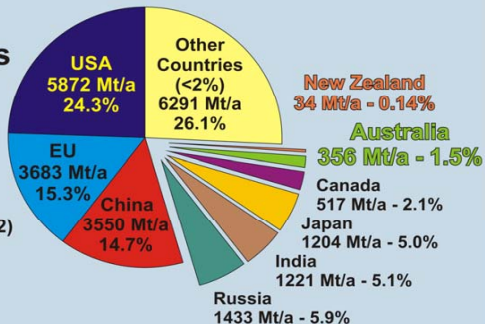
### CO<sub>2</sub> Emissions

World total:

**24126 Mt/a**

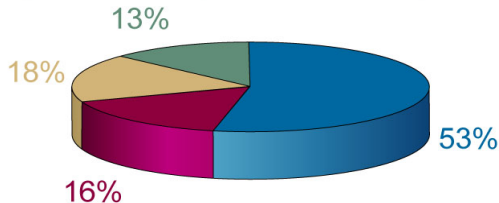
(United Nations

Statistics Division, 2002)



## Australia's carbon dioxide emissions total 356 MT, of which 69% is sequesterable

Sequesterable v non-sequesterable sources of CO<sub>2</sub>

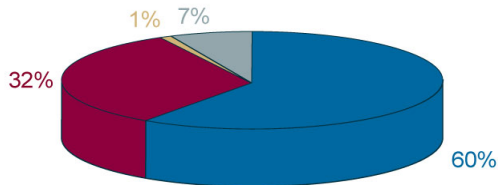


- Energy sector (sequesterable)
- Industrial processes (potentially sequesterable)
- Transport (non-sequesterable)
- Other non-sequesterable

Source: AGO (2006), National Greenhouse Gas Inventory - 2004

## Australia's carbon dioxide emissions from the electricity sector are mainly produced from black and brown coal

CO<sub>2</sub> emissions from power stations - by fuel type



| Fuel       | Emissions Mt CO <sub>2</sub> -e |
|------------|---------------------------------|
| Black Coal | 116                             |
| Brown Coal | 63                              |
| Coal Total | 179                             |
| Petroleum  | 2                               |
| Gas        | 14                              |
| TOTAL      | 194                             |

■ Black Coal ■ Brown Coal  
■ Petroleum ■ Gas

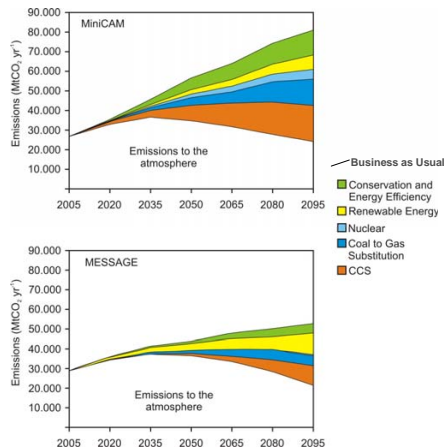
Source: AGO(2006), National Greenhouse Gas Inventory - 2004

# Australian Public Perception

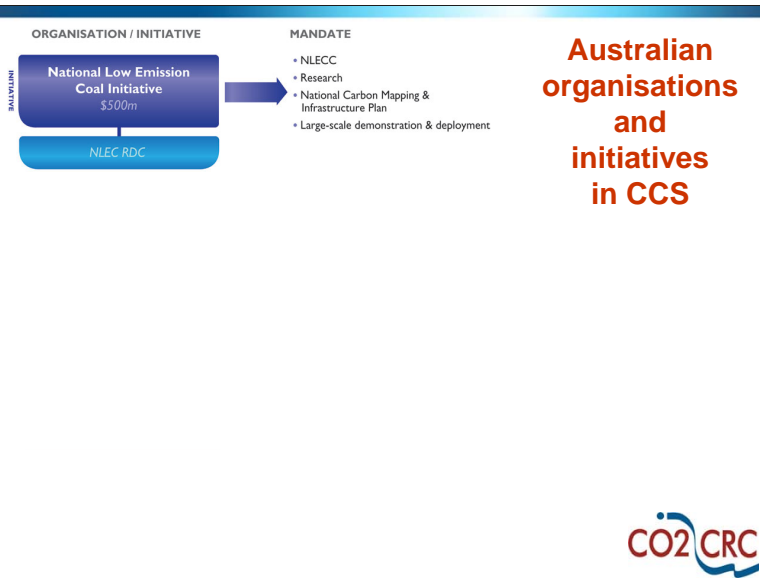
- Climate change / global warming is real
  - is happening now (geological time too abstract)
  - caused by greenhouse gas (GHG) emissions
  - GHG from anthropogenic activities
  - fossil fuel industry is main contributor
  - “something” can be / must be done
- Lawmakers responsive to public sentiments
- Industry positioning for carbon constrained world

## Solutions ?

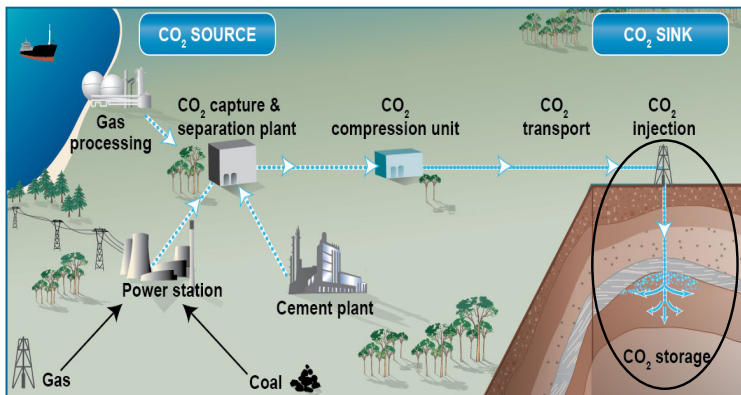
## A Portfolio Approach...

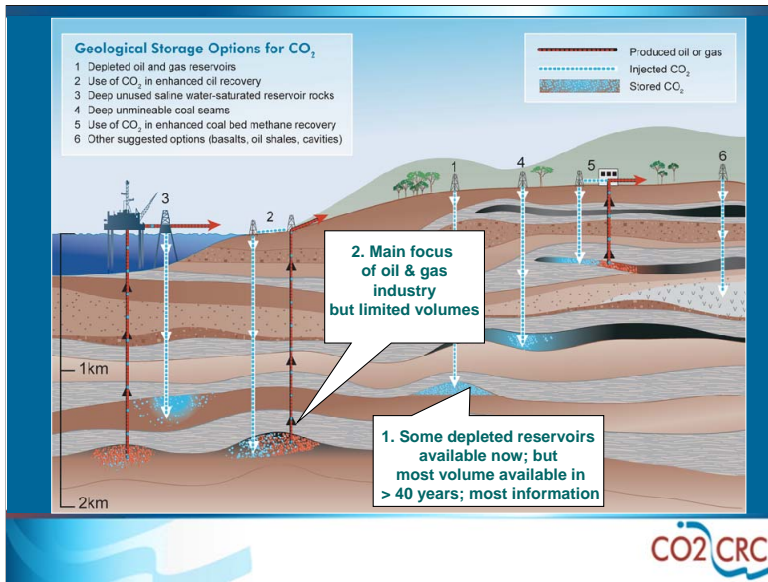






## The CCS “Value Chain”



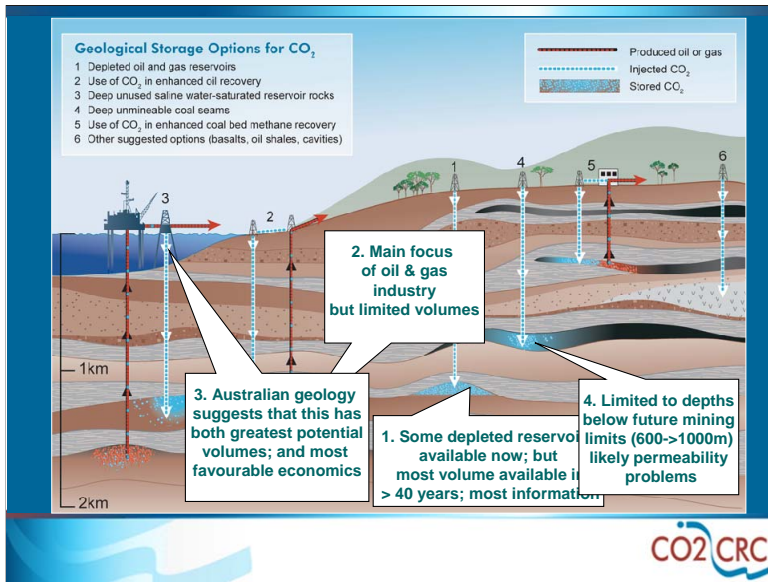


**Presenter's Notes:** This diagram indicates the popularly recognised six geological sequestration options, each of which will be addressed within GEODISC for each sedimentary basin in Australia.

I will now show the preliminary conclusions reached for each option, based on knowledge of Australian geology, and concentrating on large volumes of CO<sub>2</sub> and the most favourable economics.

(Advance next six boxes and read)

Thus GEODISC has been focussing on this option.

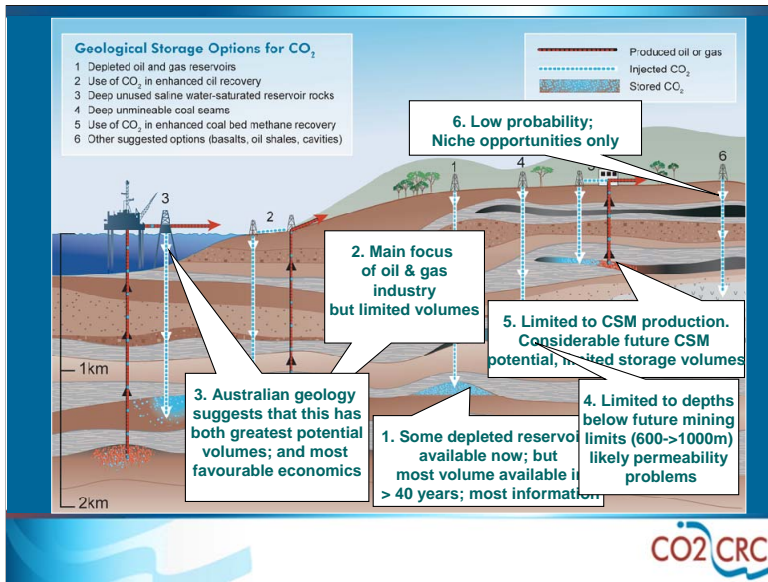


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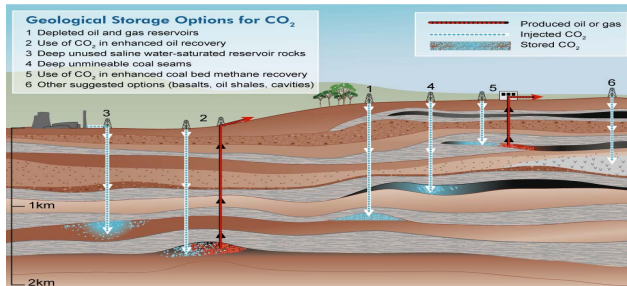


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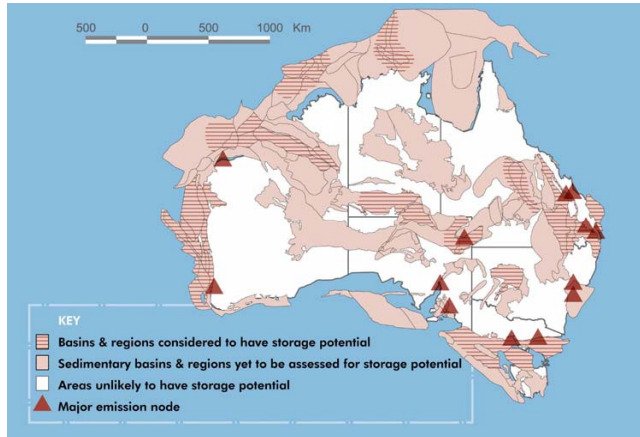
Thus GEODISC has been focussing on this option.



**All geological storage options require  
screening and site specific studies  
including geo-characterisation, injection-migration  
modelling & monitoring, economics and risk analysis...**

**technologies commonly employed by the petroleum industry**

## Australian regions with CO<sub>2</sub> storage potential



## Australian Federal Regulatory Initiatives

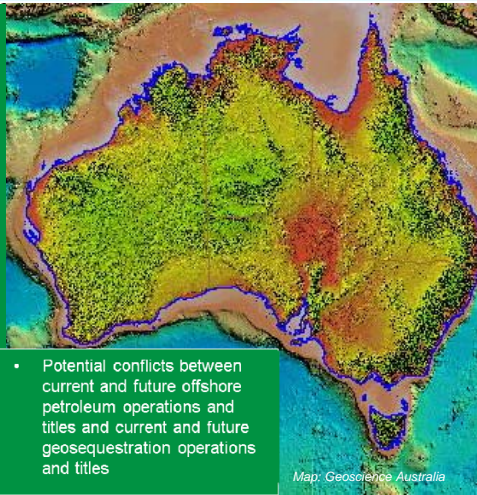
Federal Offshore petroleum amendment (greenhouse gas storage) Bill 2008.

Purpose:

To create a legislative regime for the potential geosequestration of greenhouse gases in suitable geological formations in the seabed under Commonwealth waters.

The Bill regulates:

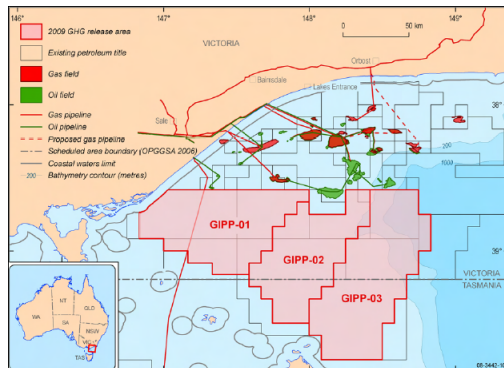
- Exploration, assessment and testing of geological formations for GHG storage
- The transportation to, and injection of GHG in such formations.
- Potential conflicts between current and future offshore petroleum operations and titles and current and future geosequestration operations and titles



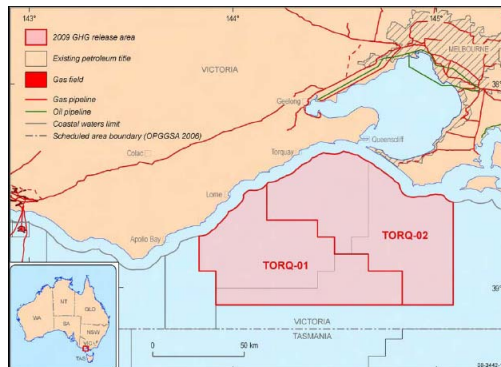
Map: Geoscience Australia



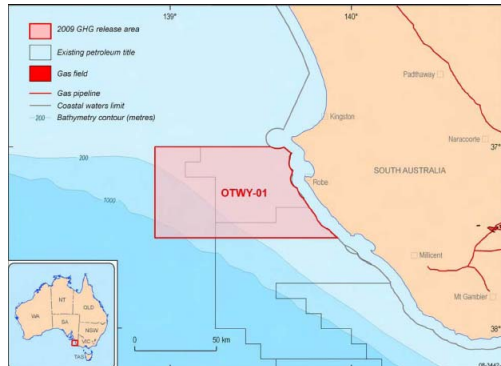
# Gippsland Basin



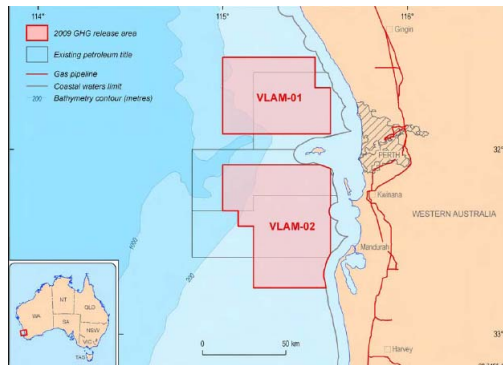
# Torquay Sub-basin



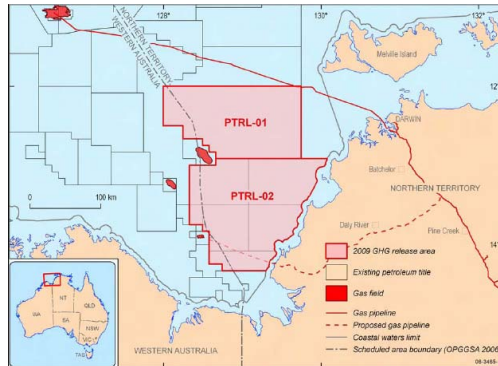
# Otway Basin



# Vlaming Sub-basin



## Petrel Sub-basin



## Australian Regulatory Initiatives

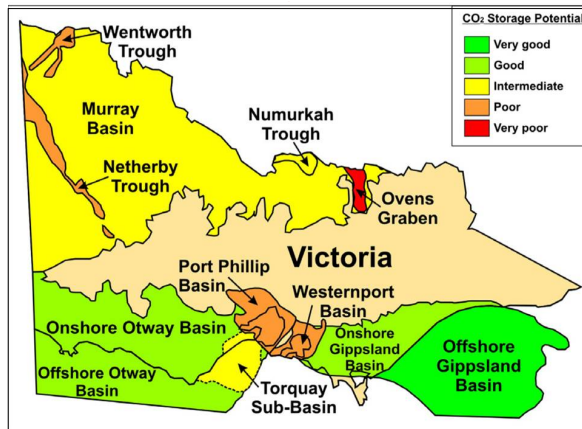
Victorian Greenhouse Gas  
Geological Sequestration Act 2008



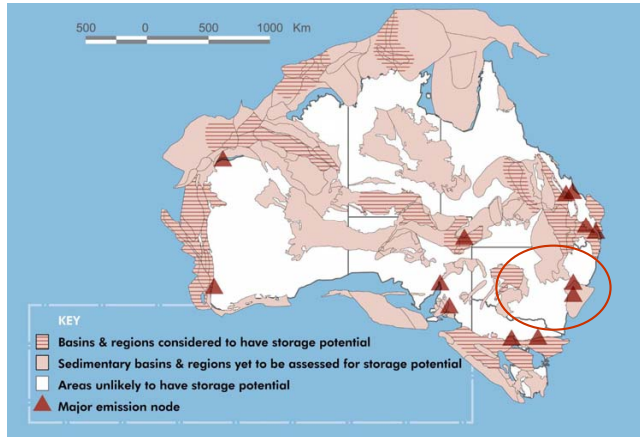
### Purpose:

To facilitate and regulate the injection of greenhouse gas substances into underground geological formations for the purpose of permanent storage of those gases, including to facilitate and regulate the exploration for suitable sites

## Ranking Victorian Basins for Storage Potential



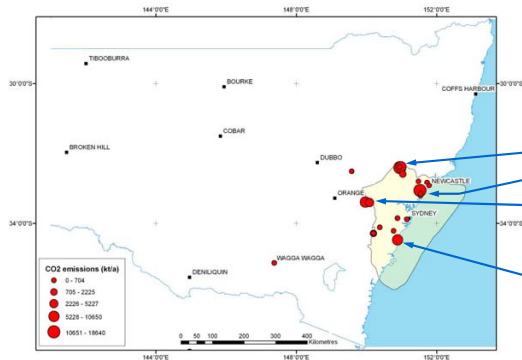
## Australian regions with CO<sub>2</sub> storage potential





# Stationary emission sources in New South Wales

Majority of NSW's stationary CO<sub>2</sub> emitters lie within the Sydney Basin.  
This is the biggest CO<sub>2</sub> emissions node in Australia



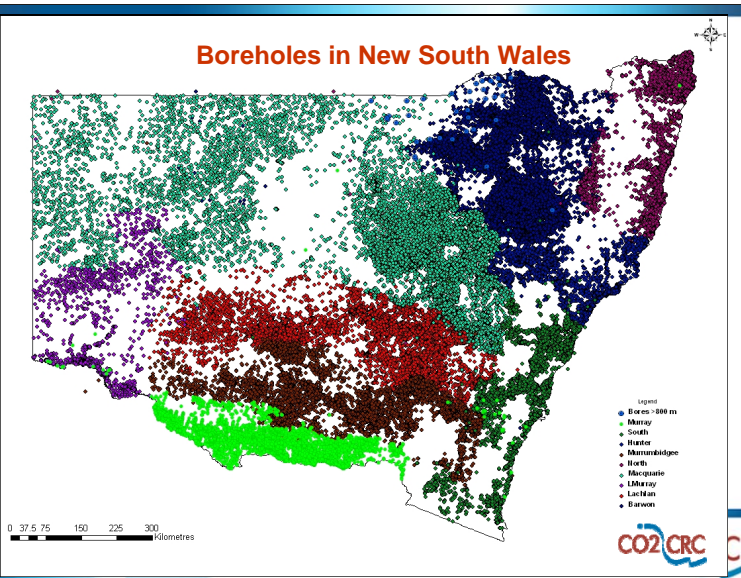
Largest stationary CO<sub>2</sub> emitters in NSW:

Major power stations  
in the Hunter Valley  
near Lake Macquarie  
in the western Sydney  
Basin

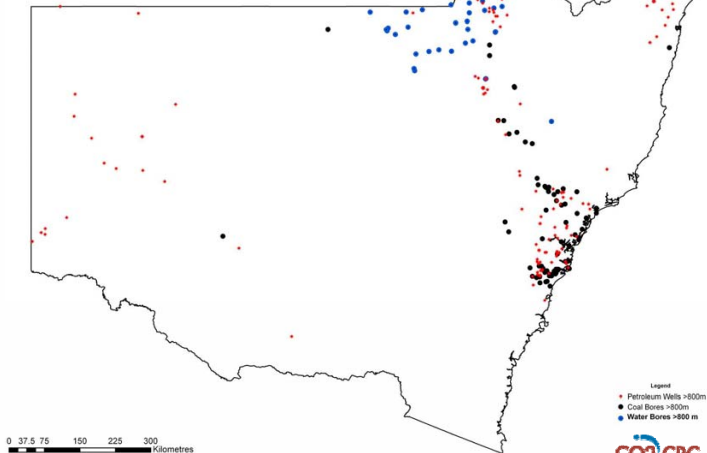
Port Kembla  
Steelworks near  
Wollongong

**Where are the corresponding storage sites?**

## Boreholes in New South Wales

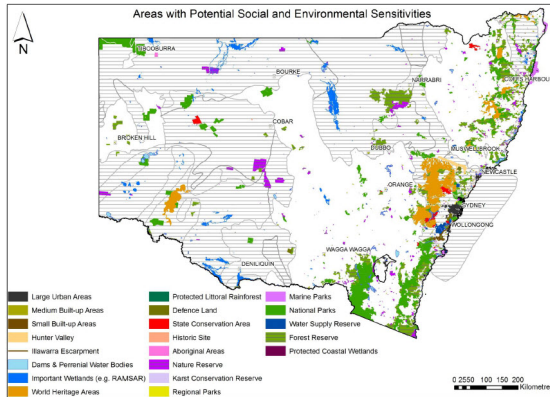


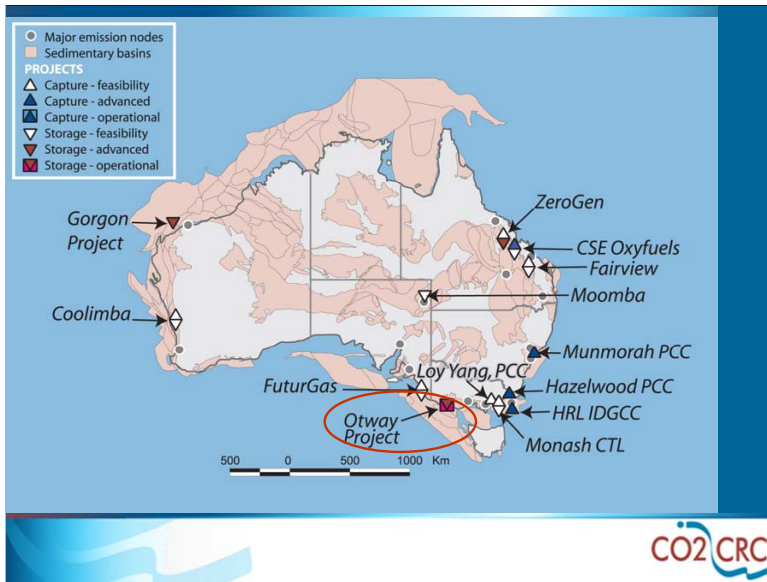
## Boreholes > 800 m in New South Wales



CO<sub>2</sub> CRC

# Areas with Potential Social and Environmental Sensitivities





**Presenter's Notes:** There are a dozen projects proposed in Australia, only one is actually injecting CO<sub>2</sub> into the ground at this time CO<sub>2</sub>CRC Otway project

## CO2CRC Otway Project, Victoria



**Description** – Australia's only operational storage project, involving demonstration of geological storage of CO<sub>2</sub> and monitoring and verification of the behaviour of the stored CO<sub>2</sub>.

**Storage** – Depleted gas field at 2000m depth

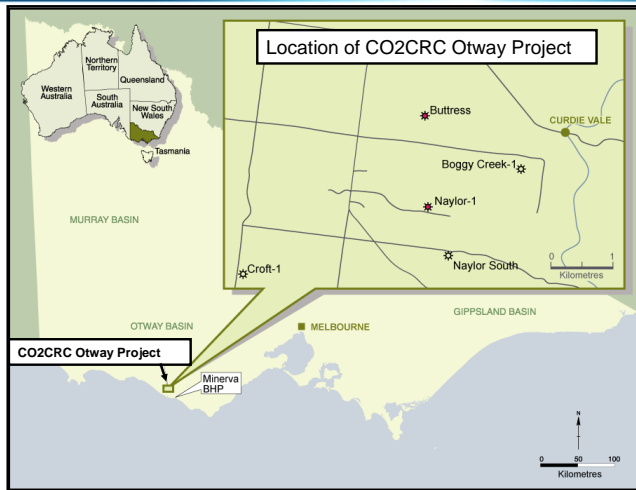
- **Storage Commence** – April 2, 2008
- **Storage Rate** – 100,000 tonnes total over 1-2 years; (50,000 tonne milestone reached 01 May, 2009)!

**Cost** – \$A 40M plus

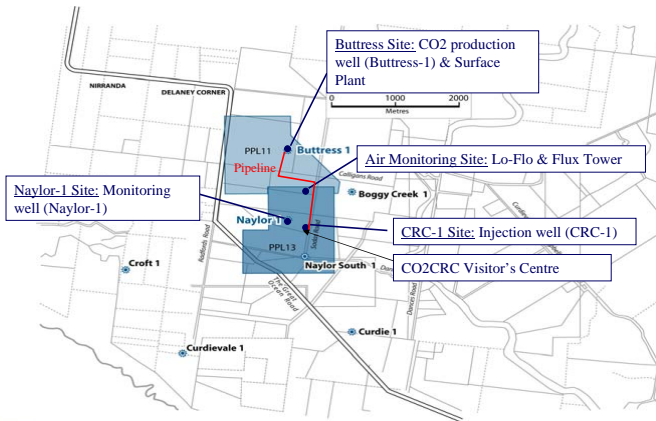
**Partners** – CO2CRC, Industry, Government and Researchers (Universities, CSIRO, GA, LBNL, ARC, GNS, KIGAM),

**Participating countries** Australia, New Zealand, USA, Korea, Canada



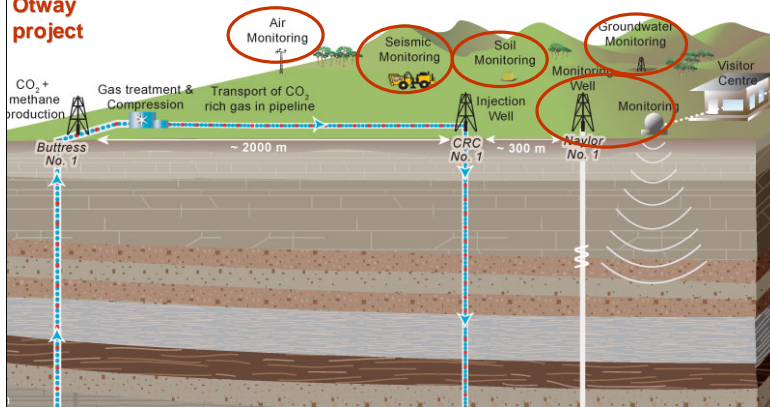


## CO2CRC Otway Project facilities



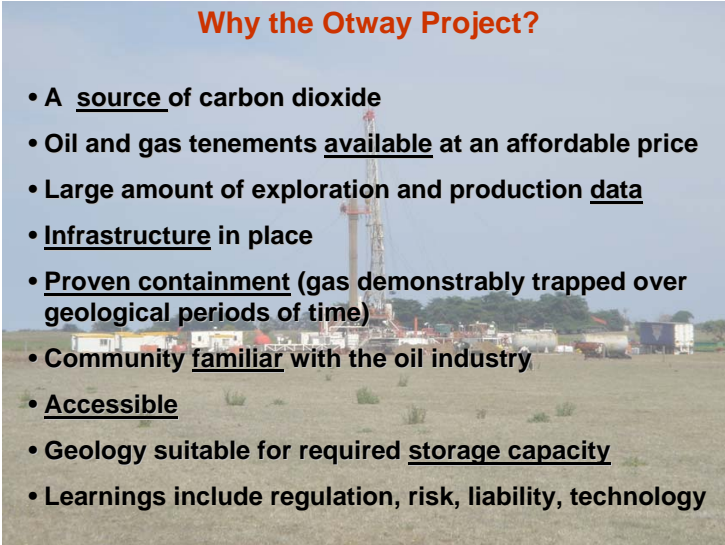


**Monitoring and verification:  
key components  
of the  
Otway  
project**



## Why the Otway Project?

- A source of carbon dioxide
- Oil and gas tenements available at an affordable price
- Large amount of exploration and production data
- Infrastructure in place
- Proven containment (gas demonstrably trapped over geological periods of time)
- Community familiar with the oil industry
- Accessible
- Geology suitable for required storage capacity
- Learnings include regulation, risk, liability, technology



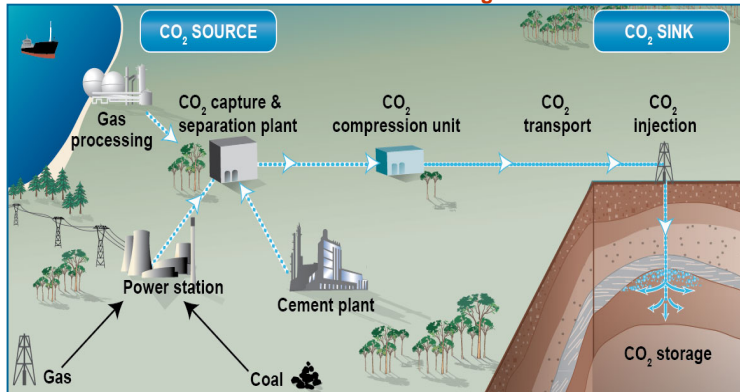
**A Few Final Thoughts...**

**Challenges & Opportunities in  
a Carbon-Constrained World**

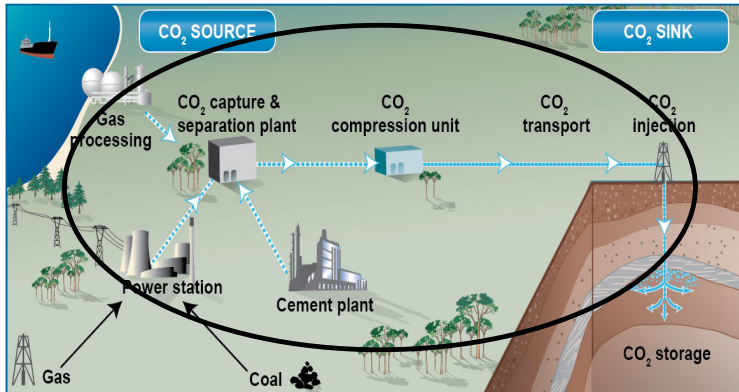
## **Carbon-Constrained World**

- **An Environmental Necessity**
- **A Socio-political Reality**
- **A Business Challenge or Opportunity?:**
  - **Carbon Price / Emissions Trading:**  
**Not “if” ....but “when” ....& “how much”!**
  - **Many questions still to consider:**

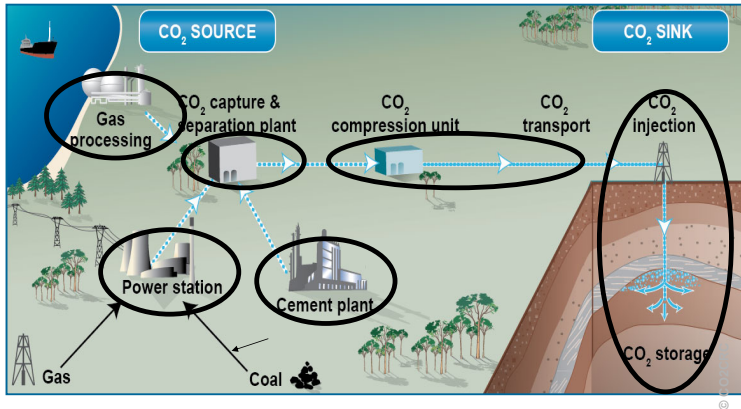
**The cost-effective linking of sources & sinks  
will be the business model for taking CCS forward**



## Integrated operation?



## Or different providers along the value chain?



## Carbon Constrained World: a Resource Industry-style Business Model?



- Exploration (plays, prospects)
- Permitting (acreage release)
- Reserves-style certification
- Unitization / equity determination
- Development (infrastructure...\$\$)
- Regulatory regimes
- Legal / liability issues



## Carbon-Constrained World: a New Economic Sector Business Model?



*"Australia has the opportunity to play a leadership role in funding and co-ordinating a major global effort to develop and deploy carbon capture and storage technologies, and to transfer those technologies to developing countries,"*  
Prof. Ross Garnaut, 04 July, 2008

## Conclusions

- Australia's response to climate-change concerns will include a range of mitigation measures, including greater energy efficiency, more renewables, lower carbon fuels and CCS –there is no single answer
- But we will continue to use fossil fuels, so we need to do it in cleaner and smarter ways, and CCS is the only option that we have at present for doing this
- CCS demonstration projects such those underway in Victoria provide us with confidence that CCS is technically feasible, and will accelerate commercial deployment
- Commercial deployment of CCS will foster an industry equal in size or larger than the present oil and gas industry
- CCS will require skills in engineering, geoscience, economics, legal areas and will offer broad career opportunities

