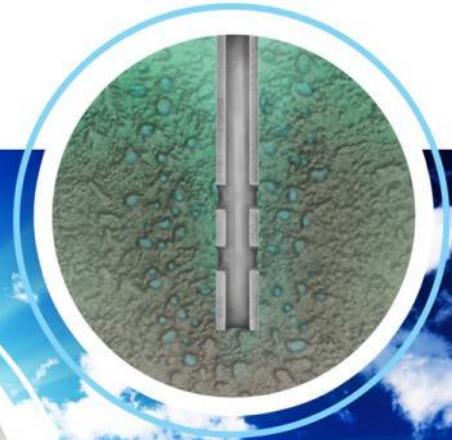


# CCS, a solution for deep emission cuts in Australia?



**Dr Matthias Raab**

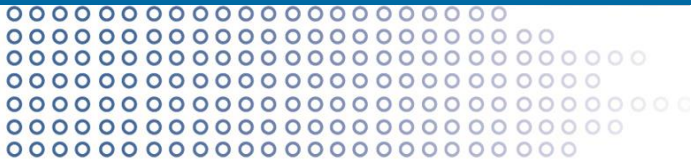
*Program Manager Storage*

Cooperative Research Centre  
for Greenhouse Gas  
Technologies (CO2CRC)

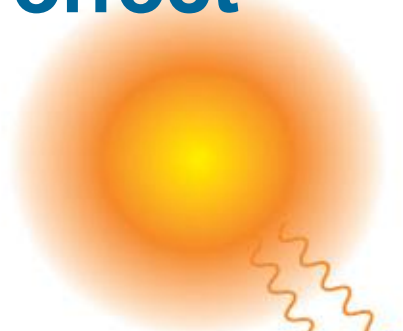
26 March 2014

Australian-German College of Climate  
and Energy Transitions, The University  
of Melbourne

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# The greenhouse effect



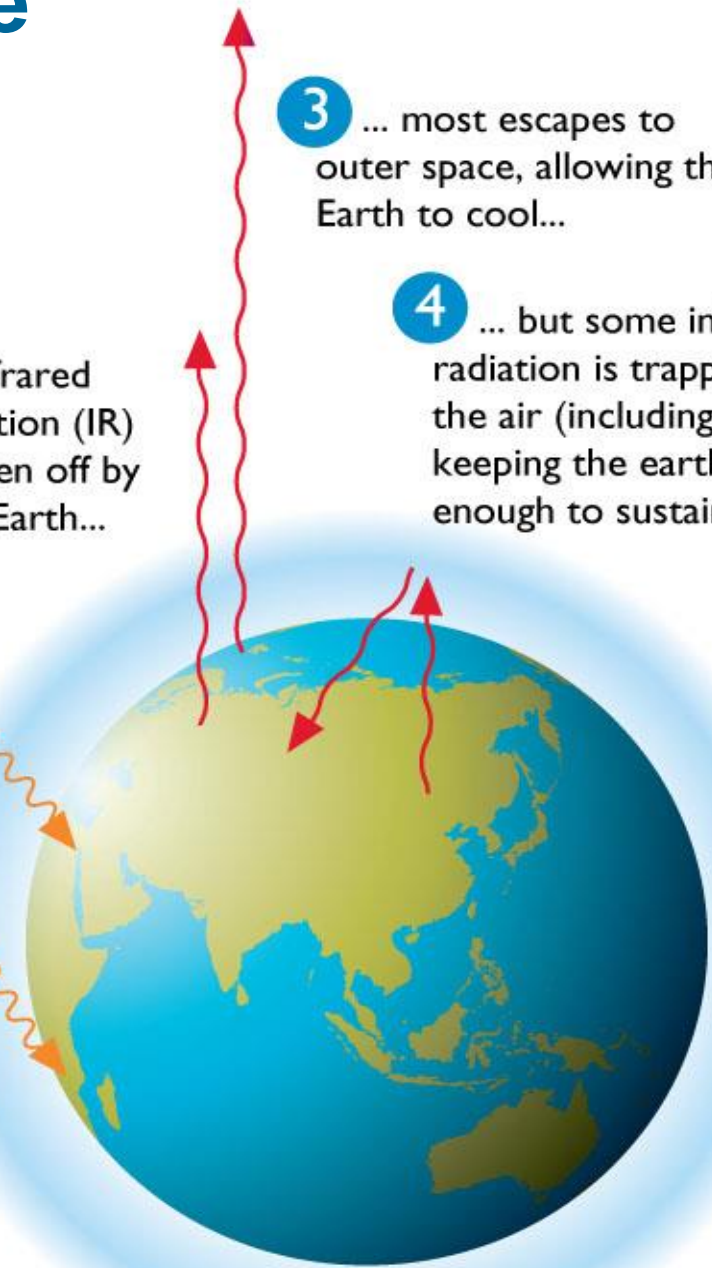
**1** Sunlight passes through the atmosphere and warms the earth.

**2** Infrared radiation (IR) is given off by the Earth...

**3** ... most escapes to outer space, allowing the Earth to cool...

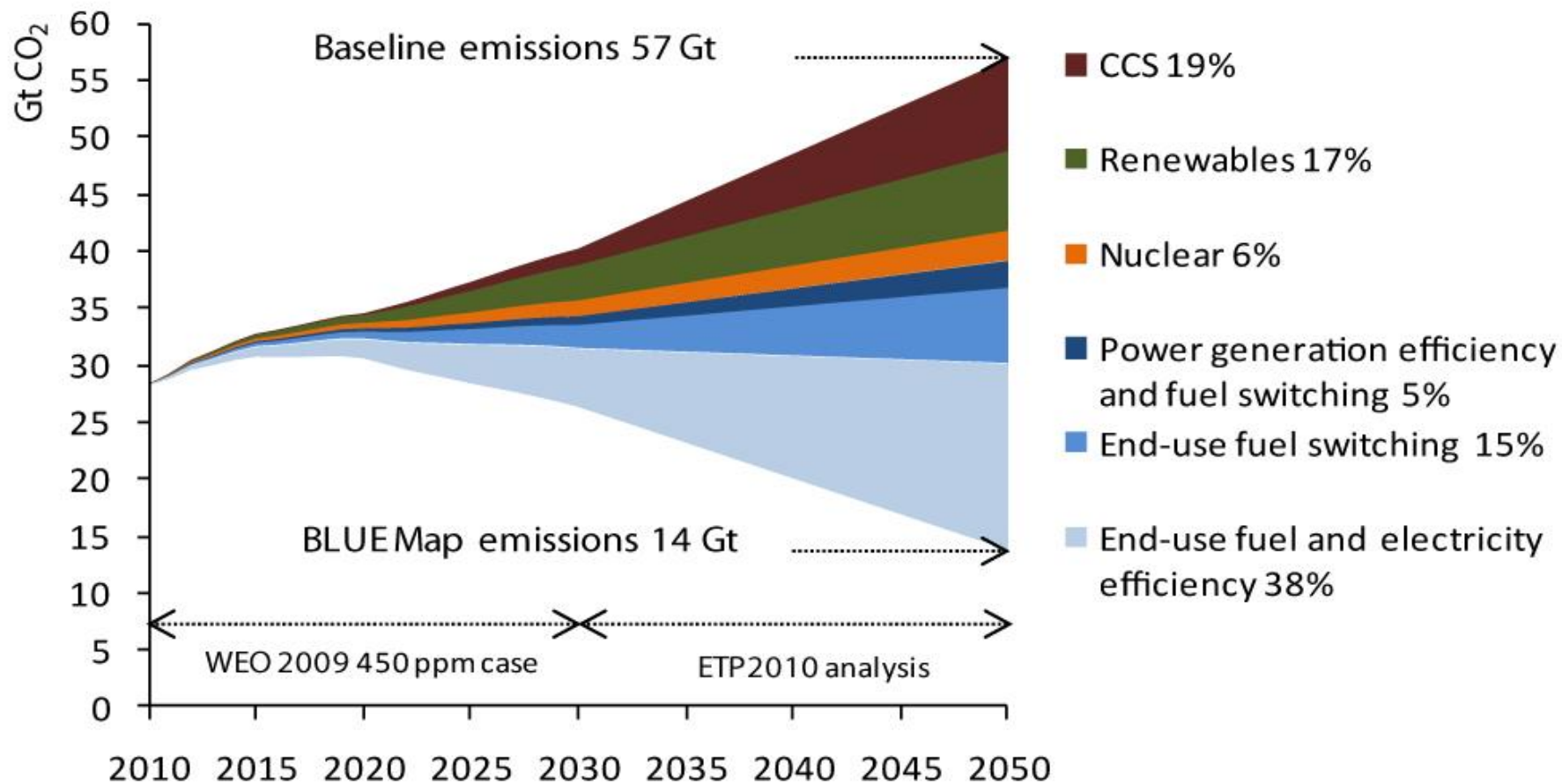
**4** ... but some infrared radiation is trapped by gases in the air (including CO<sub>2</sub>), keeping the earth warm enough to sustain life.

**5** **ENHANCED GREENHOUSE EFFECT**  
Increasing levels of CO<sub>2</sub> increase the amount of heat retained, causing the atmosphere and Earth's surface to heat up.

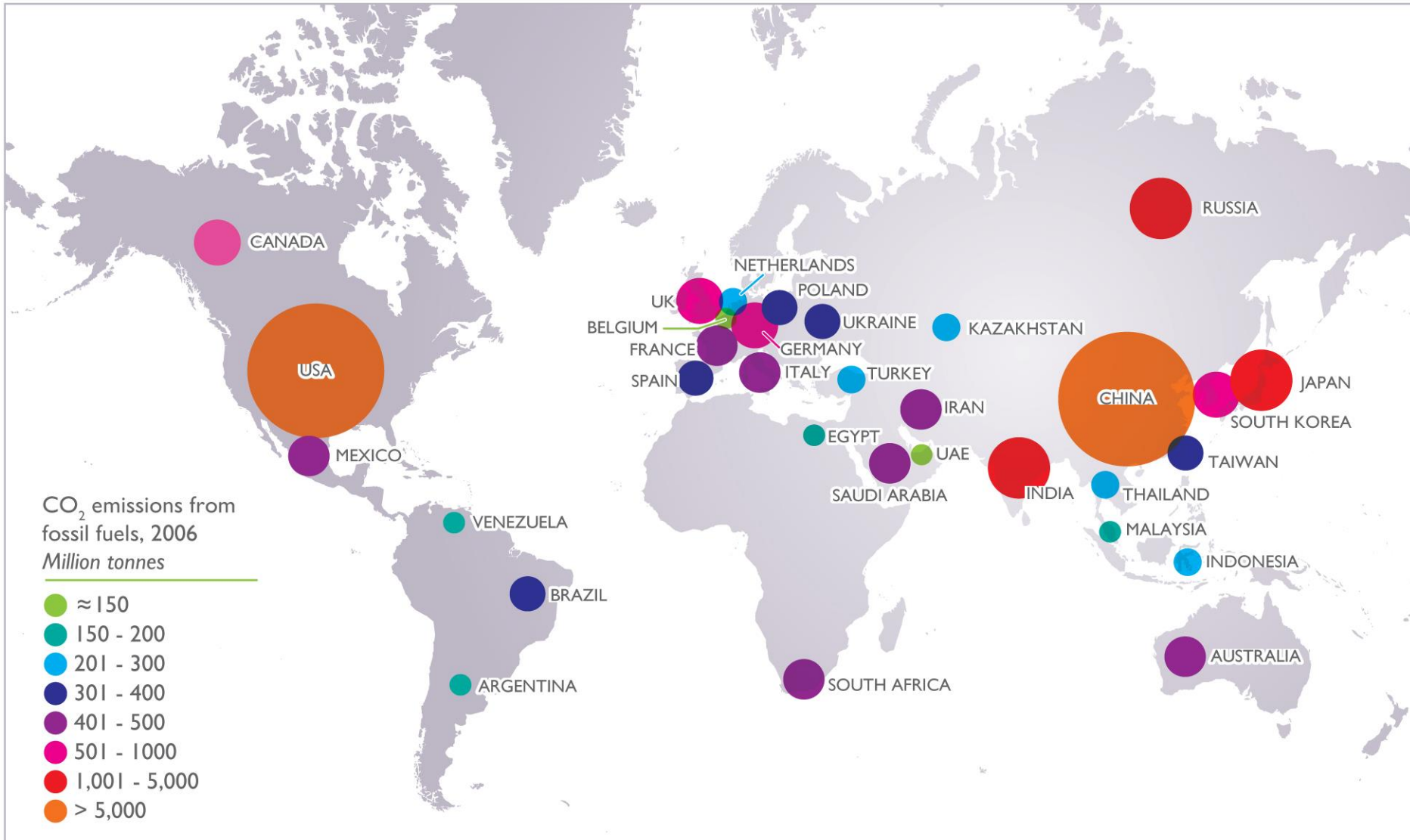


**Natural greenhouse effect  
versus  
man-made greenhouse effect**

# Global CO<sub>2</sub> emissions and key technologies for reducing these emissions



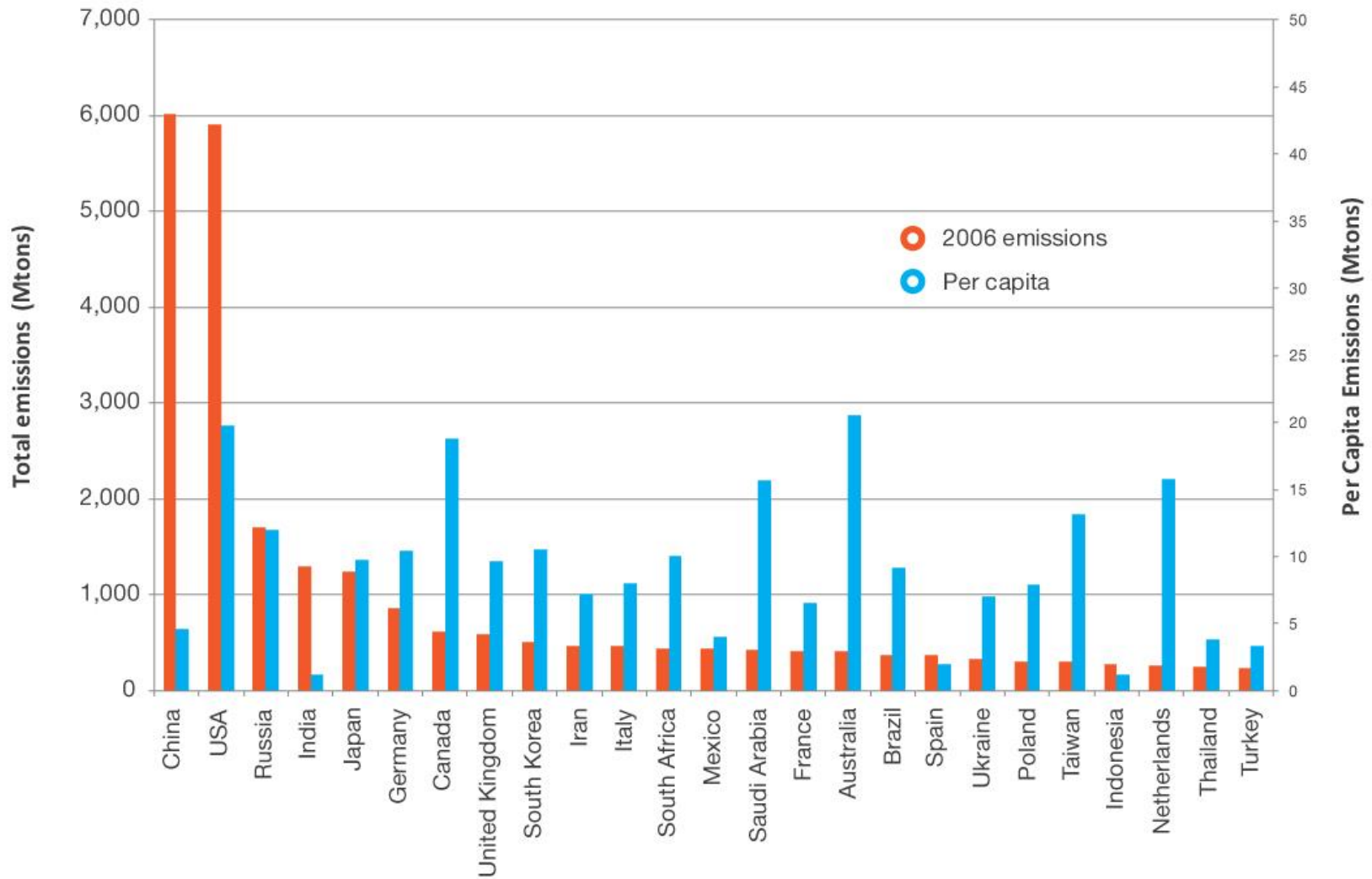
Energy Technology Perspectives 2010 © OECD/IEA 2010, Figure 2.2 p75



Data from Energy Information Administration *International Energy Annual 2006*  
© CO<sub>2</sub>CRC

1000 Km  
Scale at Equator

The **geographic distribution of emissions** (mainly stationary sources) is shown for all major emitting countries. China and the United States are clearly the dominant emitters, re-enforcing the point that if there is to be any global greenhouse agreement, it will not be effective unless it includes both these countries. (Data source: Boden *et al.* 2011)

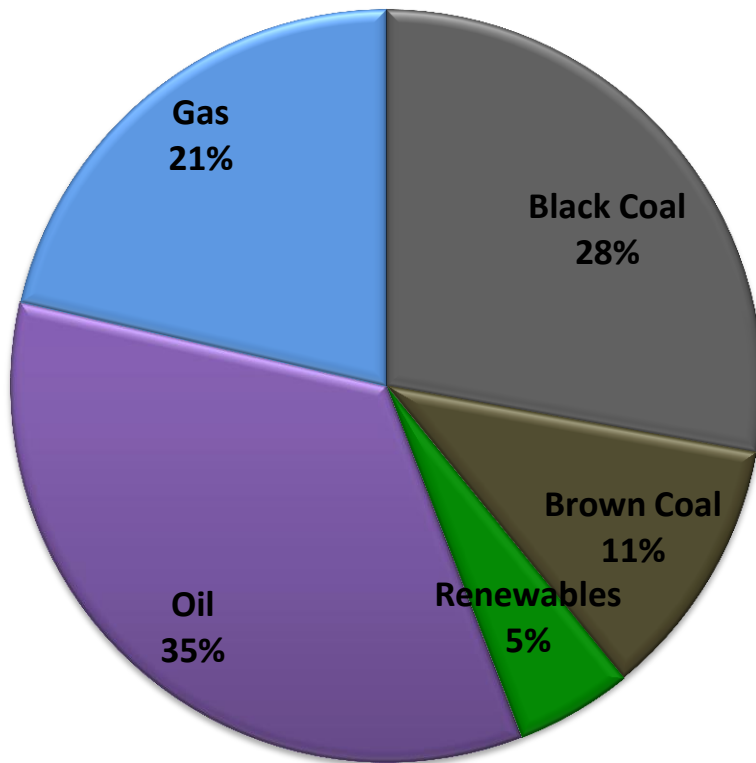


**CO<sub>2</sub> emissions for various countries showing total and per capita emissions for 2006. (data source: Boden et al/ 2011)**

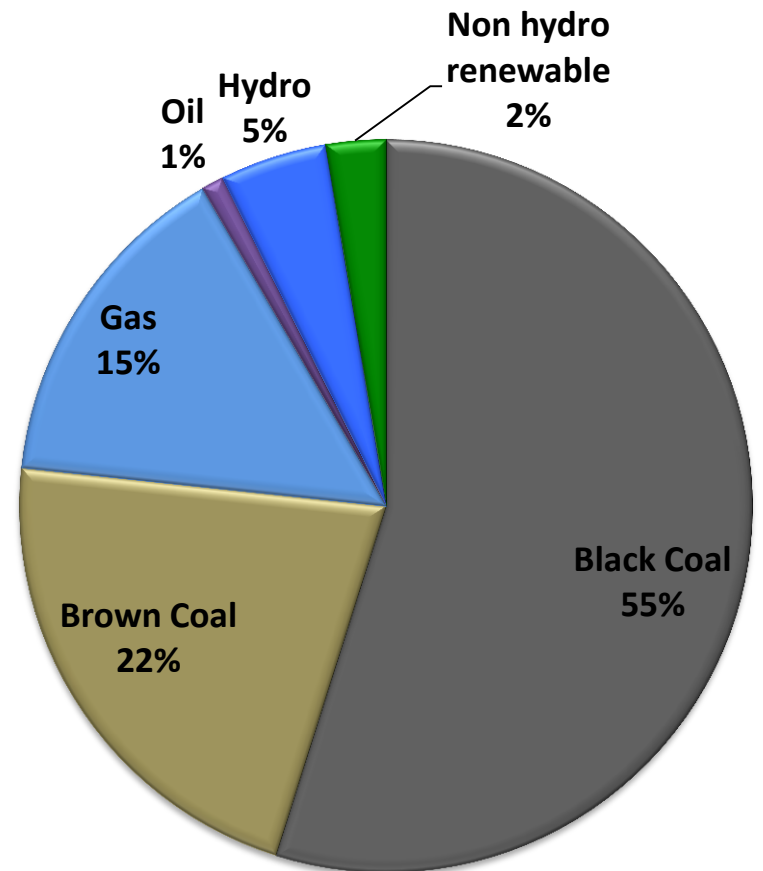
# The inconvenient truth

- Australia is one of the top 20 polluting countries in the world.
- Australia produces more carbon pollution per person than any other developed country in the world.
- Australia's emissions are projected to increase by 24 per cent between 2000 and 2020.
- Recognising the importance of responding to the climate change challenge, countries all over the world are acting to reduce their emissions.
- The message is clear: Australia needs to reduce its carbon pollution and do its fair share.

# Australian Energy Stats



Total Primary Energy



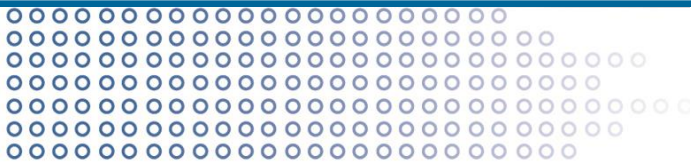
Electricity generation by fuel type

# Australia's dependency on coal

- Australia contains 76 billion tonnes of coal reserves
- Approximately 8% of known worldwide deposits.
- Australian coal deposits include both lignite (brown coal) and black coal.
- In Victoria 66 million tonnes brown coal are mined each year for electricity generation in the Latrobe Valley
- The world's largest brown coal deposit is in Victoria

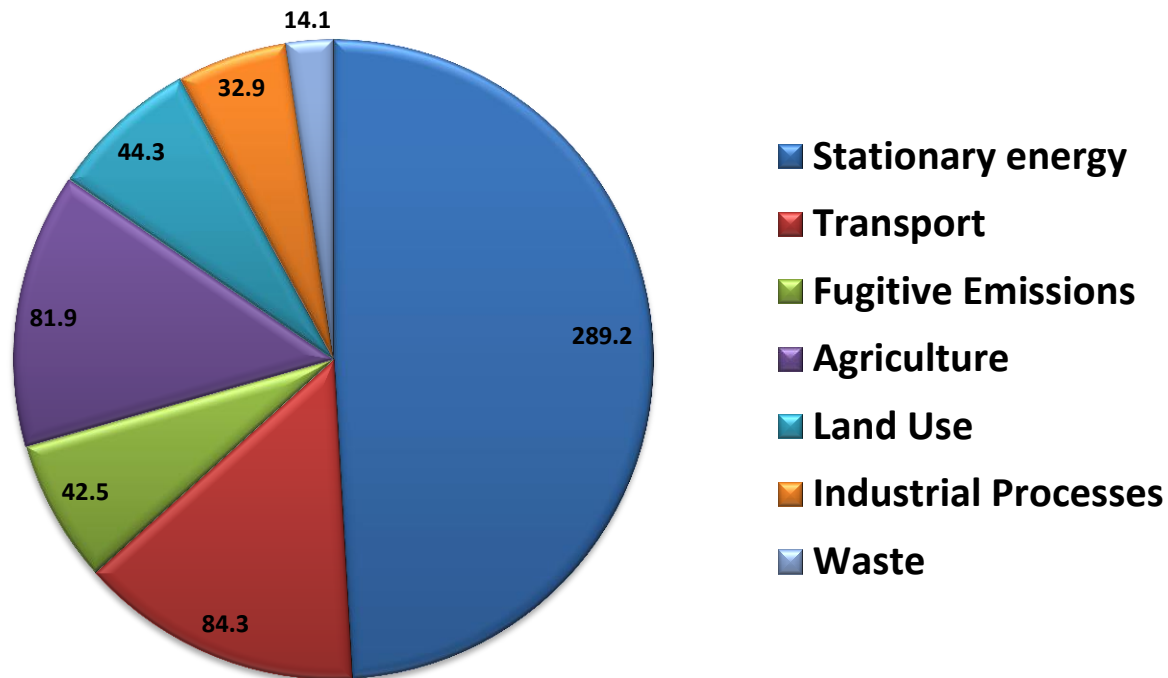
<b>Victorian brown coal resources</b>	
Total estimated in situ brown coal in Victoria	430 billion tonnes
Measured brown coal in the Latrobe Valley	65 billion tonnes
Potentially economic brown coal in the Latrobe Valley	33 billion tonnes

Source: VicDPI





# Australian GHG Emissions – CO<sub>2</sub>eq (includes non-CO<sub>2</sub> emissions)

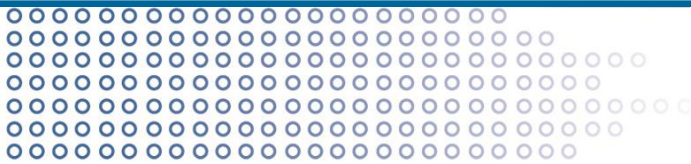


**Total: 589.2 Mtpa**

# Dependency on coal

- **Germany: >50% of energy from coal, built more coal fired power stations in 2013 than in any other year in the past two decades**
- **Poland: 86% of energy from coal**
- **Indonesia, Australia, South Africa, Israel even higher.**
- **WRI: more than 1,200 big new coal facilities in 59 countries are proposed for construction**

“Coal is too low-cost, too plentiful, and too available from reliable sources to be replaced”



# The Driver: Risks to economic prosperity



## Economic costs of climate change from:

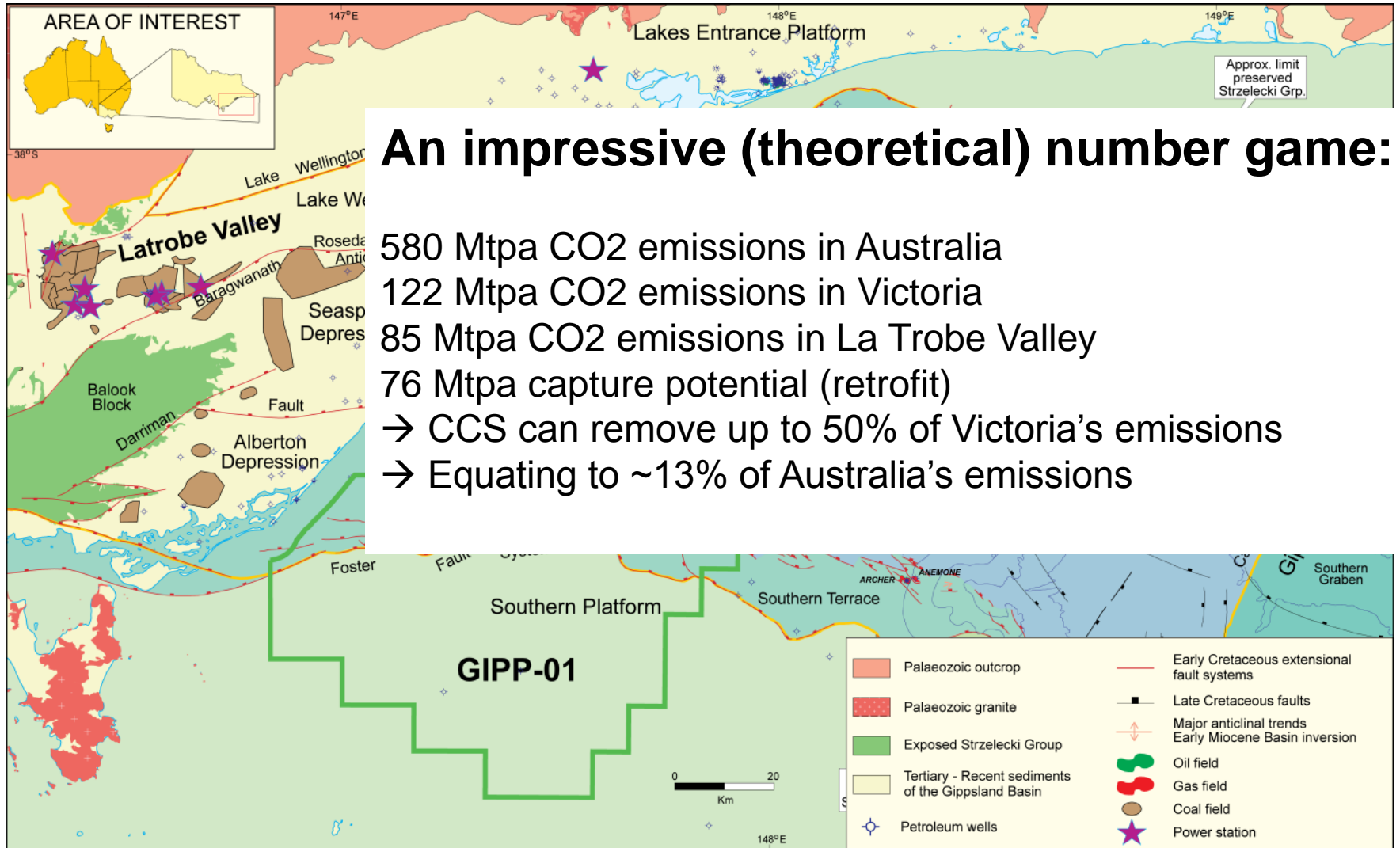
- floods,
- droughts,
- heat waves and
- other extreme weather events.

- Climate change will lead to sea level rises that can damage coastal property and infrastructure.
- About 85 per cent of Australia's population lives near the coast, which means that these regions are of immense economic, social and environmental importance.
- The Australian Government has estimated that coastal assets valued at more than \$226 billion are at risk of damage from inundation and erosion by 2100

# Greenhouse reduction commitments

- Australia is committed to emission reduction targets
  - By 2020: 5% below 2000 levels
  - Proposed: 80% below 2000 levels by 2050.
- These targets are a major challenge given our heavy reliance on fossil fuels
  - Coal 77% of electricity and 32% of emissions
  - Improvements in generating efficiency important
  - However carbon capture and storage (CCS) essential to achieve major cuts in emissions
  - Responsibilities as a major international energy supplier
  - and growing profile of gas/LNG developments

# Carbon Storage in Victoria – a sound concept



## An impressive (theoretical) number game:

580 Mtpa CO<sub>2</sub> emissions in Australia

122 Mtpa CO<sub>2</sub> emissions in Victoria

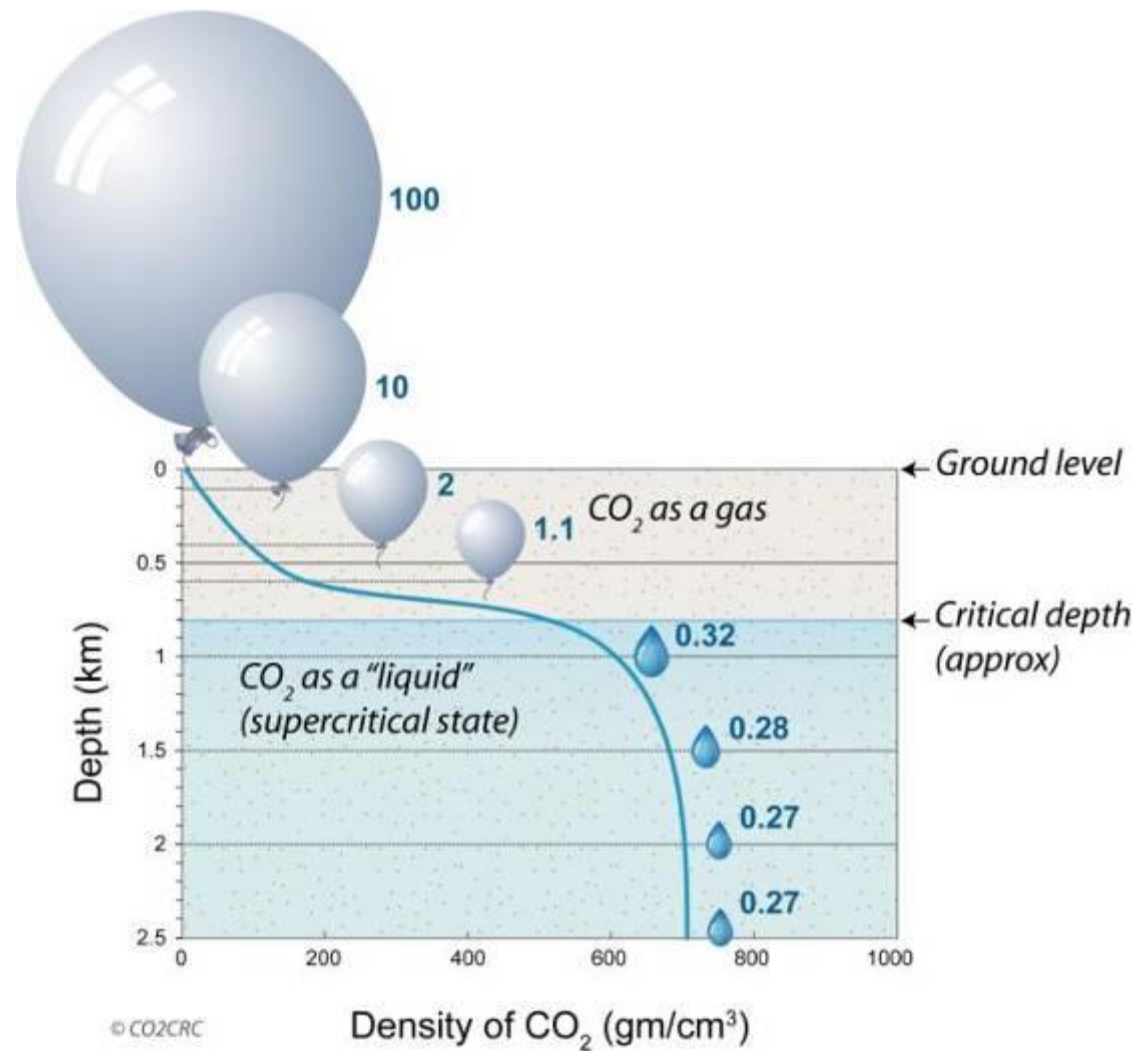
85 Mtpa CO<sub>2</sub> emissions in La Trobe Valley

76 Mtpa capture potential (retrofit)

→ CCS can remove up to 50% of Victoria's emissions

→ Equating to ~13% of Australia's emissions

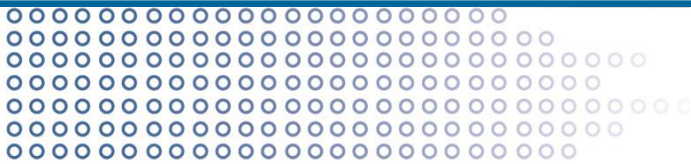
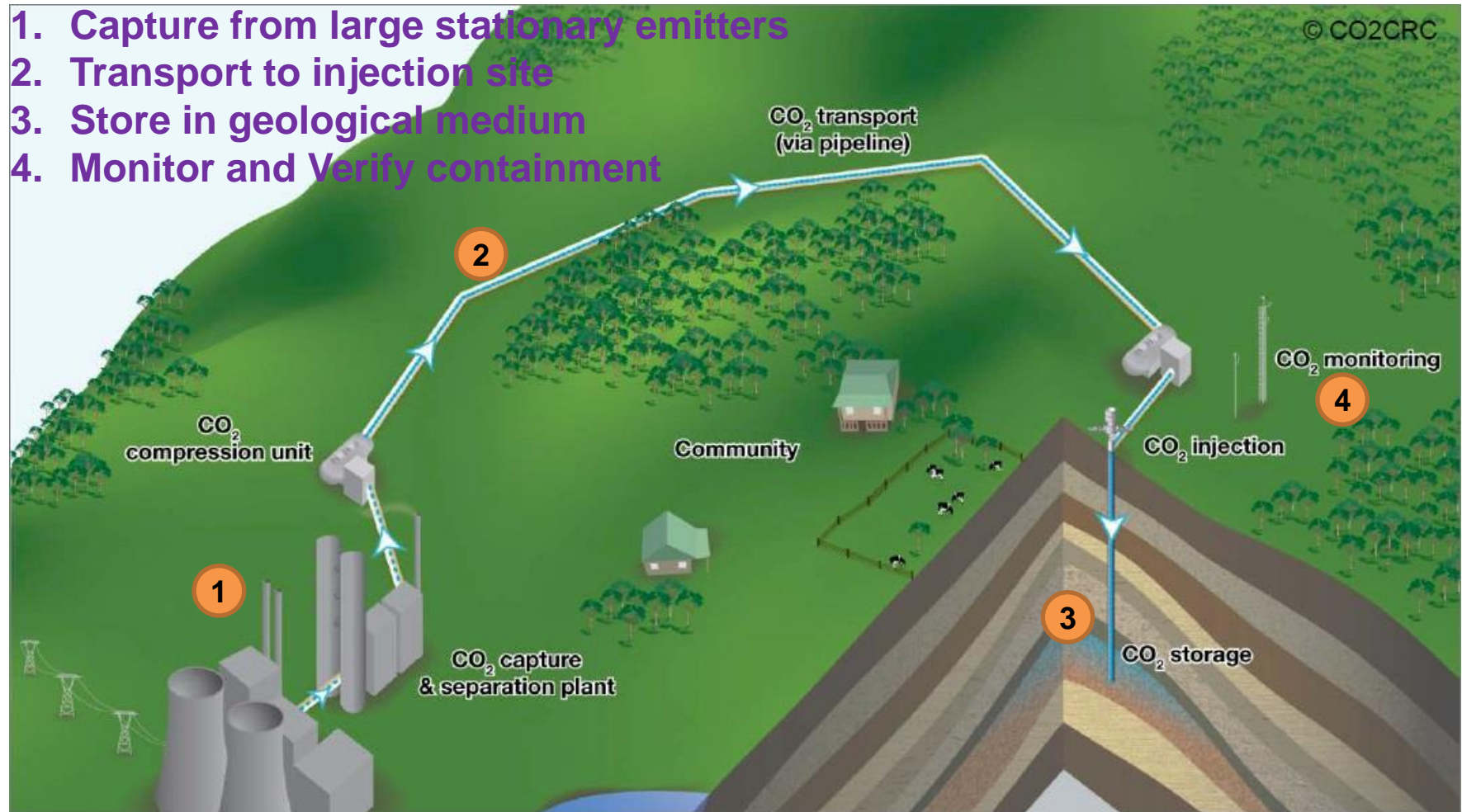
# CO<sub>2</sub> storage efficiency increases with depth



© CO<sub>2</sub>CRC

# Carbon Capture and Storage Concept

1. Capture from large stationary emitters
2. Transport to injection site
3. Store in geological medium
4. Monitor and Verify containment



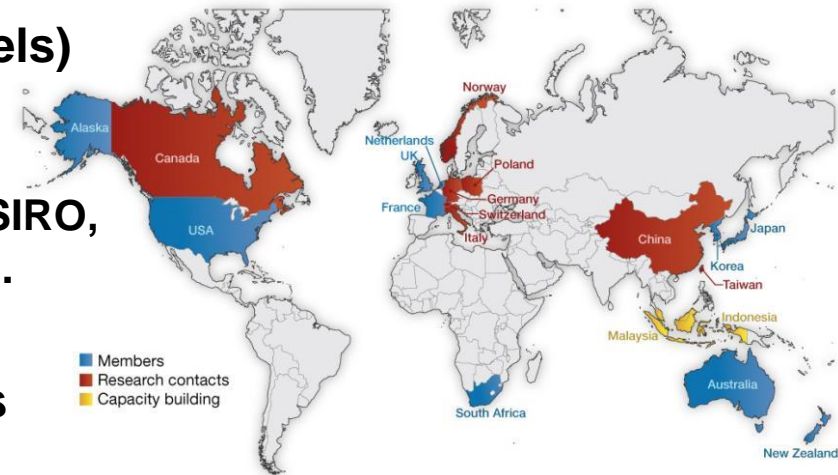
# What is the CO2CRC?

*CO2CRC is one of the world's leading CCS Research organisations*

- Research & Development across the CCS value chain
- Over 150 researchers in CCS
- Broad international perspective and experience in CCS technology
- Successful track record in running major CCS facilities

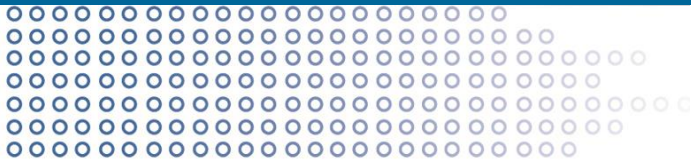
## Collaboration:

- Industry sectors (coal, gas, power, syn-fuels)
- State, Federal and local governments
- Major research institutions (Universities, CSIRO, Geoscience Australia, overseas institutions e.g. LBNL (USA) , KIGAM (Korea))
- Specialist advisors on many CCS Projects around the world
- International training and outreach

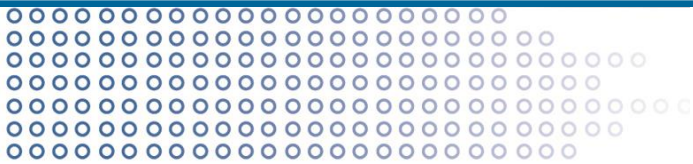




# CO2CRC research providers



# Our Research Portfolio



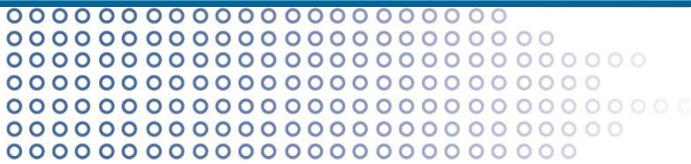
# Die Welt, 25 Dec 2013

## Renewables Fiasco: Doldrums and clouds bring green electricity production to a halt

Die Welt - Daniel Wetzel - December 25, 2013 \* **Opinion**

📌 Energy Policy 📌 Germany

*Germany's wind and solar power production came to an almost complete standstill in early December. More than 23,000 wind turbines stood still. One million photovoltaic systems stopped work nearly completely. For a whole week coal, nuclear and gas power plants had to generate an estimated 95 percent of Germany's electricity supply.*



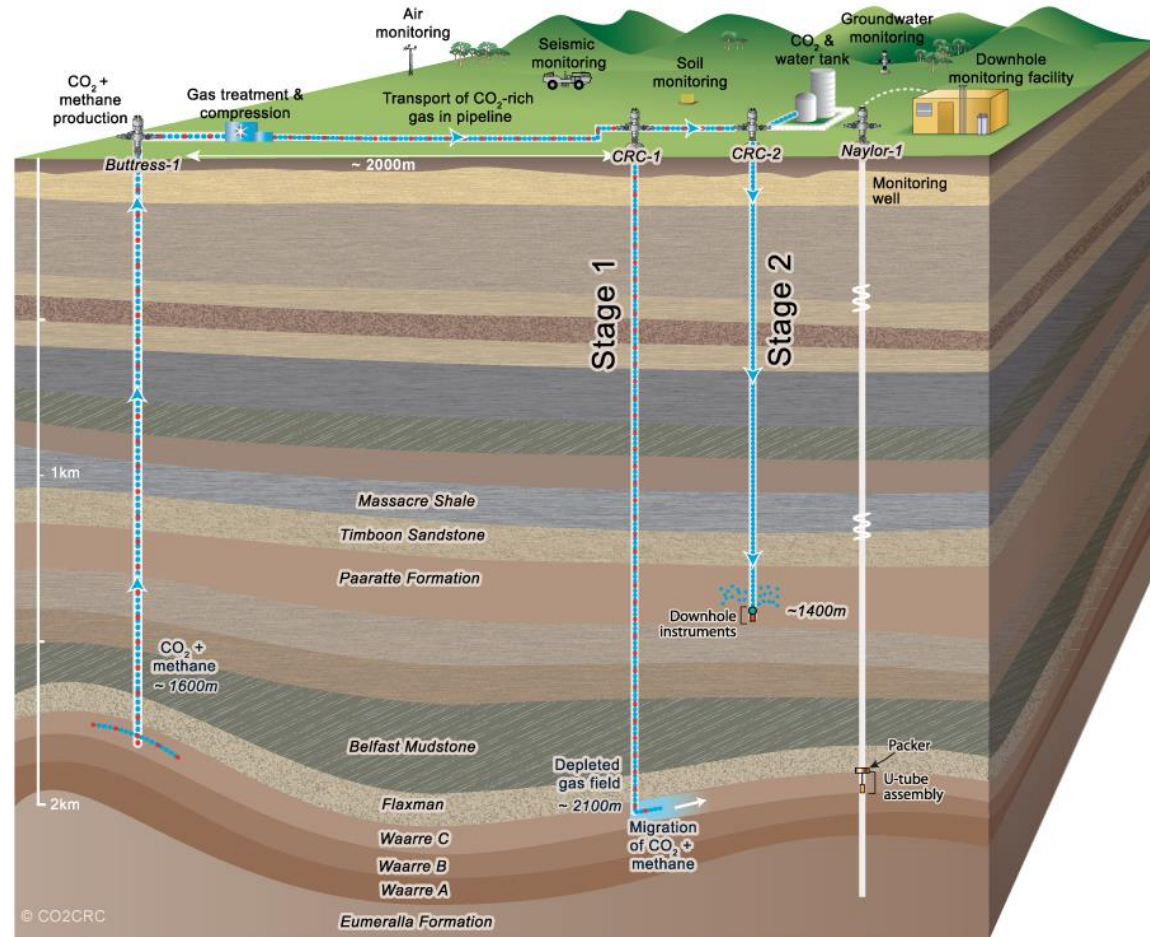
# The CO2CRC Otway Project

- **Stage 1: 2004 – 2009**

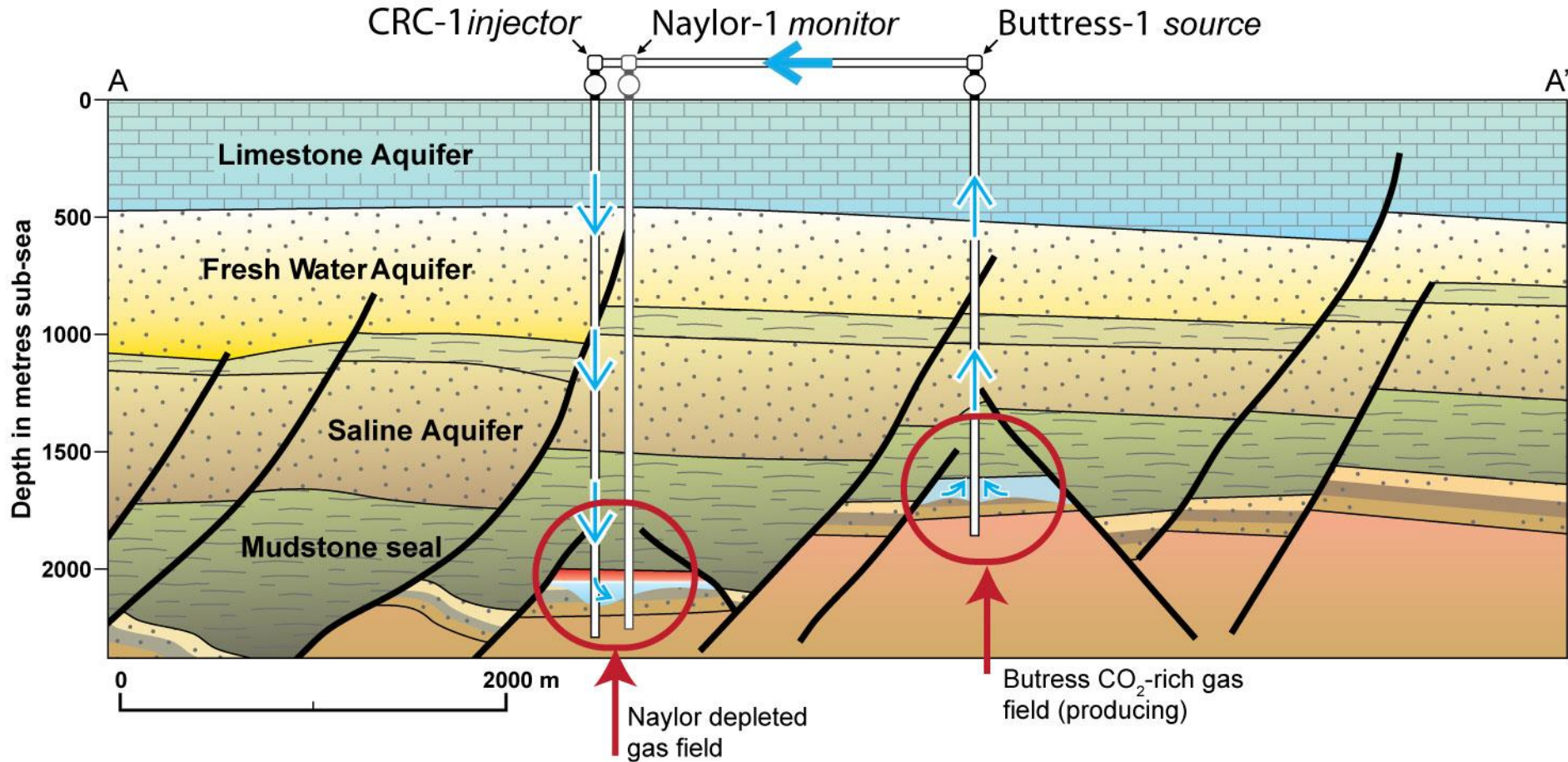
- ✓ Demonstrated safe transport, injection and storage of CO<sub>2</sub> into a depleted gas reservoir

- **Stage 2: 2009 – 2019**

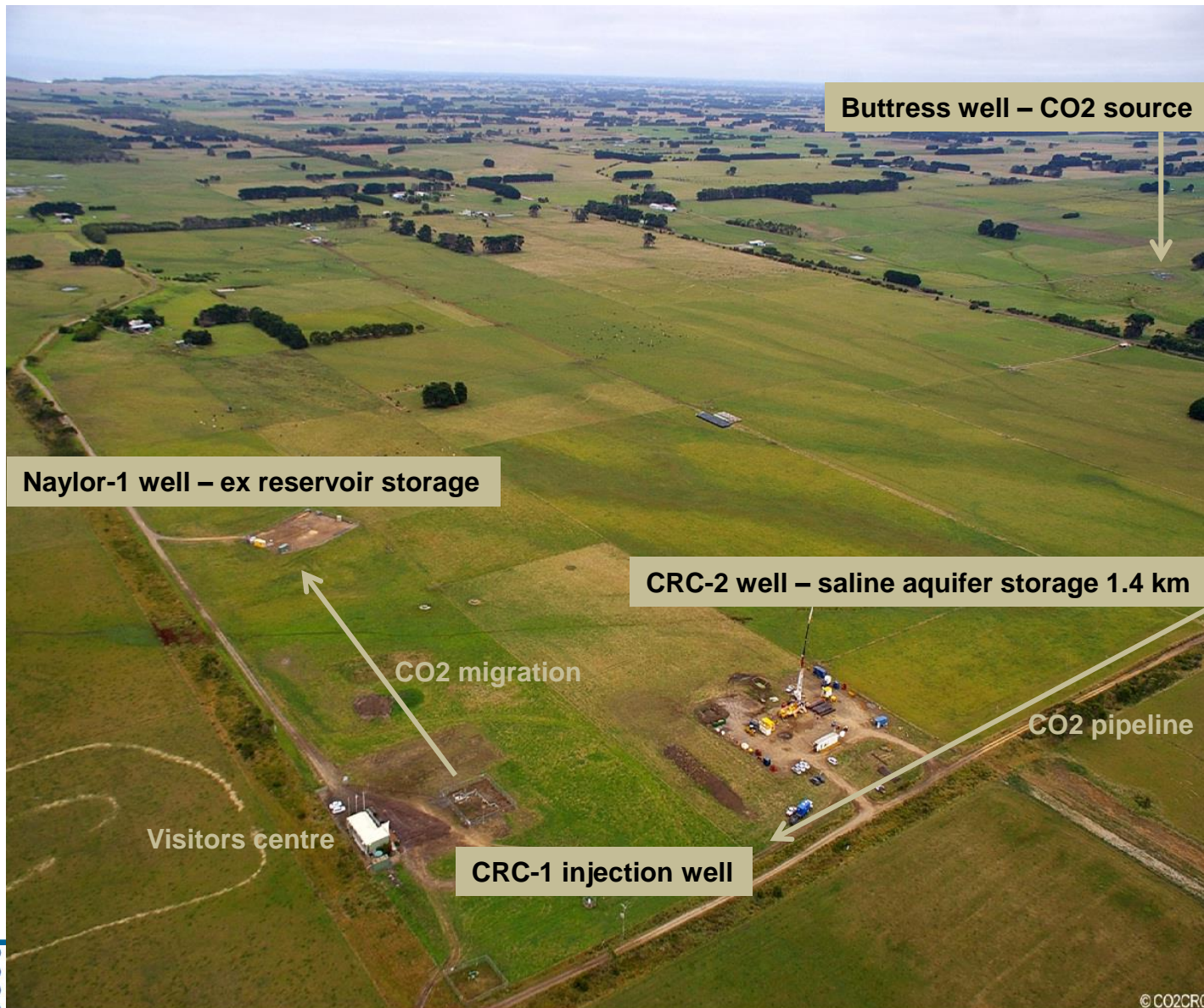
- ✓ Demonstrate safe injection into a saline formation



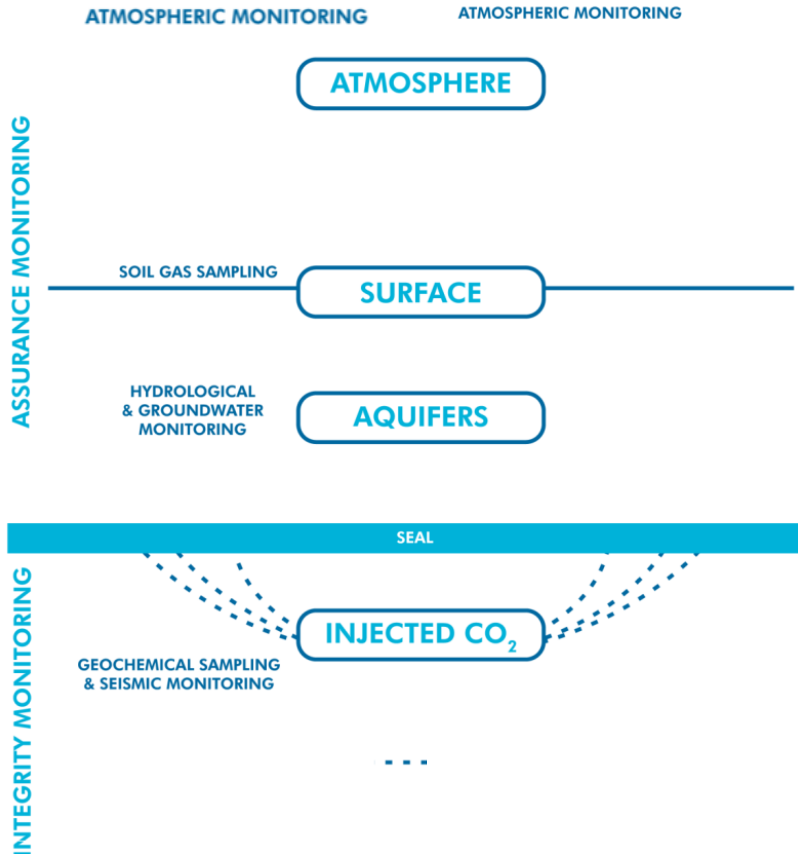
# Otway geological model



# CO2CRC Otway Project from the air...



# Assuring the community – a monitoring plan



- Measuring the atmospheric concentration of CO<sub>2</sub>
- Measuring the concentration of CO<sub>2</sub> in the soil
- Analysing the groundwater
- Measuring the temperature and pressure, recording sound waves and detecting chemical changes

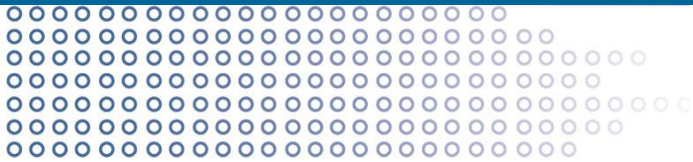
# Major challenges for CCS

- Decreasing the cost of capturing and separating CO<sub>2</sub> from major stationary sources
- Identification of safe and secure geological sites for the safe storage of CO<sub>2</sub> from major sources
- Ensuring public confidence in CCS technology through communication, community consultation, education and the establishment of an effective regulatory regime
- Large scale deployment of CCS



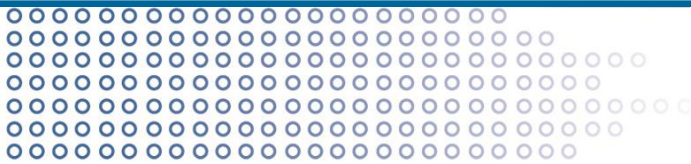
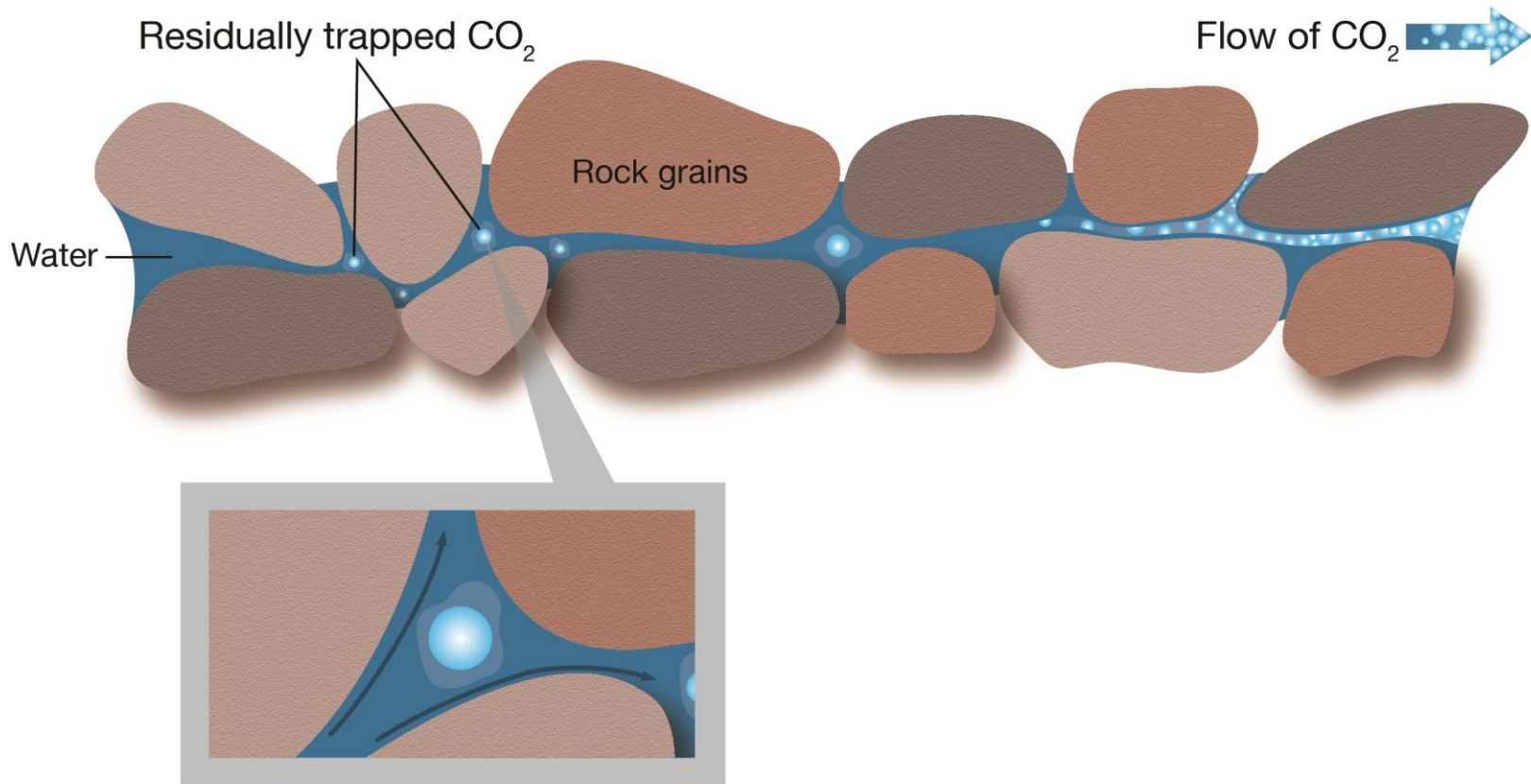


# Kotoku gas seep, West Coast: 86% CO<sub>2</sub>

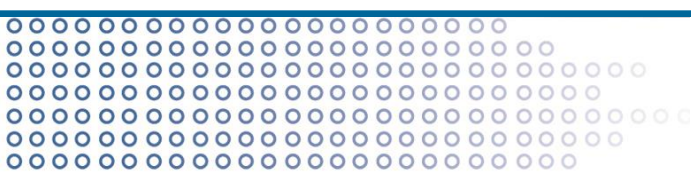


# Trapping in a saline formation

Residual trapping is where small amounts of CO<sub>2</sub> are disconnected from each other, trapped in the pore space.



# Capillary Trapping



# CO2CRC Participants



**Supporting Partners:** [The Global CCS Institute](#) | [The University of Queensland](#) | [Process Group](#) | [Lawrence Berkeley National Laboratory](#)  
[CANSYD Australia](#) | [Government of South Australia](#) | [Charles Darwin University](#) | [Simon Fraser University](#)

