



## LOW EMISSIONS COAL TECHNOLOGIES

---

### What are low emissions coal technologies?

Low emissions coal technologies (or new generation coal technologies – see <http://www.newgencoal.com.au/>) refer to technologies designed to enhance the environmental performance of coal used in power generation. These technologies aim to deliver significant reductions in greenhouse gas emissions and reduce waste.

Low emissions coal technologies to reduce greenhouse gas emissions cover two broad categories:

- CO<sub>2</sub> capture technologies (pre-combustion and post combustion) and
- CO<sub>2</sub> storage technologies.

**Post Combustion Capture (PCC) Technology** can be applied to new plant or as retrofit technology for coal fired or natural gas power plants that can dramatically reduce CO<sub>2</sub> emissions by as much as 90% through the process of removing CO<sub>2</sub> from flue gases:

- flue gases leaving a power plant are first cooled and then, using amine separation, the CO<sub>2</sub> is captured;
- the CO<sub>2</sub> is then removed from the absorbing solution allowing the absorber to be recycled and reused;
- alternatively capture can be achieved using cryogenic or membrane separation;
- the captured CO<sub>2</sub> is compressed and cooled to form a liquid which can be permanently stored using geosequestration.

This technology is at a pilot and demonstration stage of development. Current projects in Australia include the Munmorah Project (NSW), Hazelwood Project (VIC) and the Loy Yang Project (VIC).

**Oxyfuel Combustion Technology** can be applied to new plant or as retrofit technology to existing plant. While conventional power plant boilers burn pulverised coal in air (comprising oxygen, nitrogen and other gases) the oxyfuel process replaces air with a mix of oxygen and recirculated gases from the boiler, creating a highly concentrated stream of CO<sub>2</sub>. The CO<sub>2</sub> can then be liquefied and permanently stored using geosequestration.

This technology is at the demonstration stage of development. The key project in Australia demonstrating this technology is the Callide Oxyfuel Project (QLD).

**Integrated Gasification Combined Cycle (IGCC) Technology** is applied to a new plant. In the IGCC process, coal is converted into a synthetic gas (syngas), which is cooled and cleaned to remove particulates and sulphur compounds, passed through a shift reactor (to convert more of the syngas to hydrogen and to separate CO<sub>2</sub>) and then burned in a combined cycle gas turbine unit. Coal gasification technology can also be adapted for coal to liquids production.

The main components are a coal gasification facility, an air separation unit (oxygen instead of air is typically used in the gasification process), a gas cleaning facility, CO<sub>2</sub> shift reactor and a combined-cycle gas turbines (CCGT) power plant. As concentrated CO<sub>2</sub> is one of the by-products of the gasification process this technology is highly suited to carbon capture and storage.

This technology integrated with carbon capture and storage is currently at a pilot and demonstration stage of development. Current projects being proposed in Australia include ZeroGen Project (QLD) and Monash Energy Project (electricity and coal to liquids) (VIC).

### Carbon Capture and Storage (CCS)

CCS technologies could be combined with any of the generation options outlined above and can in principle be retrofitted to existing plants. While many components of the techniques and technologies are well-established in other industrial applications, their adaptation to power generation systems is currently at the pilot or demonstration stage. The type of fuel and generation technology that is used will determine the type of capture technology that is most suitable.

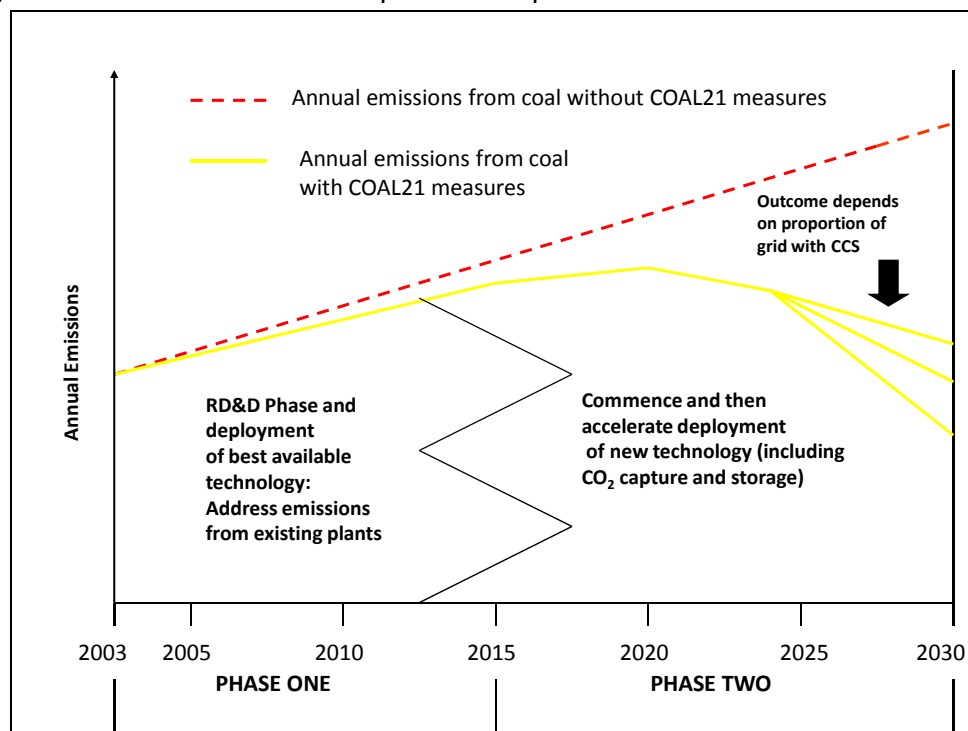
Carbon dioxide can then be transported using high pressure pipelines – a technique that has already been proven for use in enhanced oil recovery (EOR) projects since the 1980s (although on a smaller scale than would be required for transporting power generation emissions). It could also be transported in tankers similar to those used to transport LPG. Transportation costs will vary greatly depending on volume, distance, geography and method. Captured carbon dioxide has the potential to be stored in a variety of onshore and offshore geological sites including active and depleted oil and gas reserves and saline aquifers.

## The Australian Coal Industry's Role in the Development of Low Emissions Technologies

The coal industry has made the development and demonstration of low emissions coal technologies the central focus of its approach to dealing with climate change. For many years the industry has been proactive in addressing environmental issues including greenhouse gas emissions in the extraction and use of coal. These are summarised in the **Appendix**.

In 2003 the ACA took this further with the COAL21 initiative to demonstrate the technical and economic viability of the major low emissions coal technologies (see **Figure 1**). This has subsequently evolved into a target to deploy them at large-scale from 2017.

Figure 1: COAL21 National Action Plan phases and impact of COAL21 measures on emissions

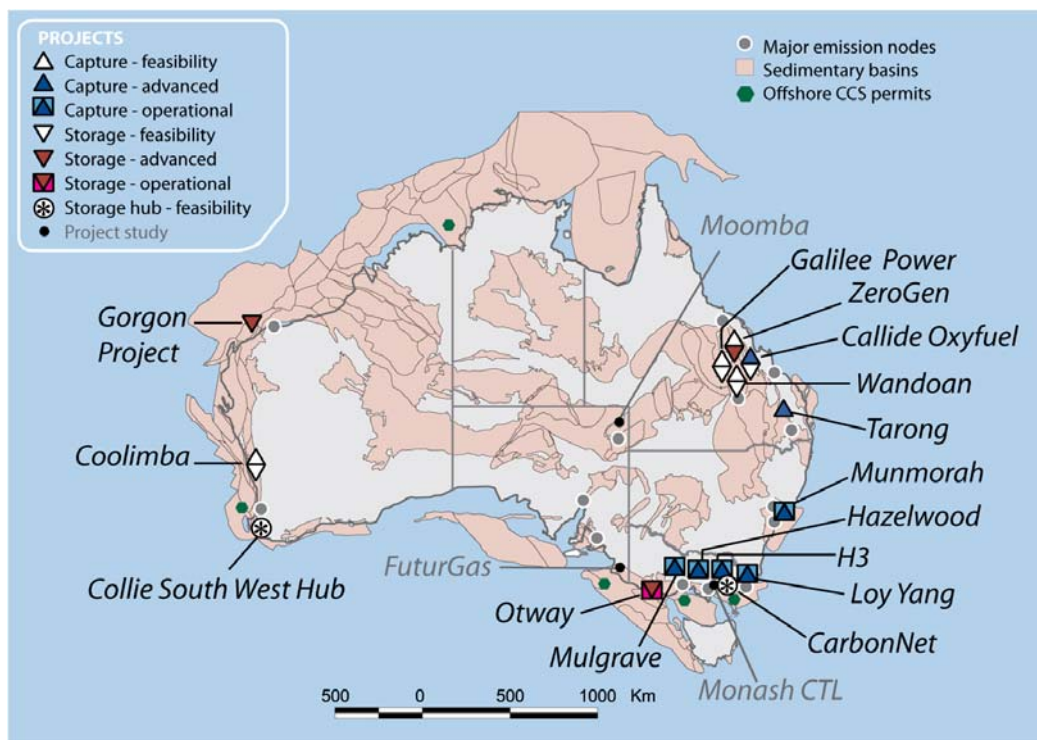


### Major carbon capture and storage technology ventures in Australia at February 2009

In order to drive this demonstration program the black coal industry in 2006 established the COAL21 Fund. The Fund is a voluntary levy on coal production and is raising more than \$1 billion over the next decade. The Commonwealth and State governments are also providing substantial funding to the demonstration program and the ACA has welcomed initial commitments by:

- the Australian Government is providing (a) \$400 million for its National Low Emissions Coal Initiative; (b) \$2 billion through the CCS Flagship Program; and (c) funding of up to \$100 million each year for four years for a global carbon capture and storage institute that would help guide the development of CCS technologies worldwide;
- Queensland Clean Coal Council – \$300 million;
- NSW Clean Coal Council – \$100 million;
- Clean Coal Victoria – \$110 million; and
- Western Australia Low Emission Energy Development Fund – \$36.5 million.

These contributions represent a cooperative approach with industry to develop and demonstrate low emissions coal technologies. Industry is actively engaged on the projects listed in **Table 1** below. Those projects are among a number of major carbon capture and storage technology ventures currently at various stages of development in Australia and indicated on the following map of Australia.



Source: Cooperative Research Centre for Greenhouse Gas Technologies, [www.co2crc.com.au](http://www.co2crc.com.au)

TABLE 1: COAL21 FUND COMMITMENTS OVER THE PAST 20 MONTHS

PROJECT	Committed Funding				Estimated Total Project Costs	Target completion date
	Coal Industry \$	Government \$	Other (including in-kind)	Total Committed Funding		
Callide Oxyfuel Project, Queensland • under way	\$68 m COAL21 Fund \$1 m Xstrata	\$50 m (C'th) \$10 m (QLD)	\$35 m Japanese Partners \$25 m CS Energy \$2 m Schlumberger \$15 m Project electricity sales	\$206 m	\$206 m	2015
Support for a Queensland Integrated Gasification Combined Cycle (IGCC) project	up to \$300 m (includes \$46m for a feasibility study for stage 1 of the revised ZeroGen)	\$300 m (QLD)	\$122.5 m	\$600 m	TBD	Stage 1: 2012 Stage 2: 2017
Queensland Geosequestration Initiatives	\$20 m	\$30 m		\$50 m	\$60 m	2014
Post Combustion Capture in NSW – a number of pilot and demonstration projects including storage. [Note: an initial project at the coal-fired Munmorah Power Station on the state's Central Coast is under way. The pilot plant will capture about 3 000 tonnes of CO <sub>2</sub> a year from the power station. A larger scale carbon capture project is also planned to be operating in NSW to capture up to 100 000 tonnes of greenhouse gases each year.]	\$50 m	\$50 m (NSW) \$50 m (C'th)	\$5 m	\$150 m	\$150 m	2015
National Low Emission Coal Council R&D program	\$75 m	\$75 m (C'th)			\$150 m	Being established
<b>TOTAL THUS FAR</b>	<b>\$512.9 million</b>	<b>\$565 million</b>	<b>\$204.5 m</b>	<b>\$1006 m</b>		

Note: In addition to the above commitments the black coal industry is providing initial funding for the CO2CRC Otway CO<sub>2</sub> storage demonstration project in Western Victoria through the ACA Research Program (ACARP).

### *COAL21 and COAL21 Fund*

In 2003, the Australian Coal Association (ACA) brought together representatives from the coal and electricity industries, unions, federal and state governments and the research community to form the **COAL21 partnership**. The COAL21 Action Plan, launched in 2004, aims to accelerate the demonstration and deployment of clean coal technologies that will reduce greenhouse gas emissions from coal-based electricity generation.

In 2006 the ACA announced the establishment of the **COAL21 Fund** as part of a world-first whole-of-industry funding approach to support greenhouse gas abatement. The COAL21 Fund is raising over \$1 Billion over 10 years from a voluntary levy on coal production to support the pre-commercial demonstration of low emissions technologies in the power generation sector (where over 95 per cent of emissions from coal occur) and supporting R&D. This initiative complements the Australian Government's \$500 million Low Emissions Coal Fund and \$500 million Low Emission Technology Demonstration Fund.

*Australian Coal Association Research Program (ACARP) see <http://www.acarp.com.au/>*

Since 1992 ACARP has been funding R&D into coal production and use. ACARP currently invests over \$14 million per annum on industry-related research via an industry-wide levy on coal production.

Through ACARP the industry also supports key research via its membership of the:

- Cooperative Research Centre (CRC) for Greenhouse Gas Technologies (CO2CRC); and the
- Queensland Centre for Low Emissions Technology (cLET).

A number of coal producers have also elected to become individual participants in these Centres.

In addition to ACARP and the COAL21 Fund individual Australian black coal producers are providing significant direct funding for demonstration projects – in Australian and international projects.

The coal industry continues to support R&D projects into the mitigation of methane in mine ventilation air (MVA) in the following areas:

- using MVA as the combustion air with another primary fuel, eg gas turbines or nearby power stations;
- using MVA supplemented with secondary fuels, with energy recovery;
- developing catalytic systems for converting ultra-lean air-methane mixtures; and
- developing a system for concentrating methane in MVA, eg by methane adsorbents or membranes.

### *Australian and International Initiatives*

The coal industry, the ACA and its members are active participants in a number of national and international programs and fora related to greenhouse issues and technology development including the:

- National Low Emissions Coal Council;
- National Carbon Storage Taskforce;
- Global Carbon Capture and Storage Institute;
- Greenhouse Challenge Plus Program;
- Asia Pacific Partnership on Clean Development and Climate;
- International Energy Agency (IEA) Clean Coal Centre;
- Carbon Sequestration Leadership Forum (CSLF);
- Methane-to-Markets Partnership; and
- Australia-China Joint Co-ordination Group on Clean Coal Technologies.