

Clean coal technologies





Queensland's strong economy and population growth coupled with strong global demand for minerals, are driving increased demand for electricity and the requirement for new investment in electricity generation.

At the same time, the Queensland Government has committed to significantly reducing greenhouse gas emissions from the energy sector through initiatives outlined in the *Smart Energy Policy*.

The *Smart Energy Policy* is a landmark document that sets the direction for meeting Queensland's energy and emissions challenges today and in the future.

This policy is a commitment to reducing carbon emissions and a commitment to Queensland's ongoing economic prosperity.

Through initiatives outlined in the policy, it is intended greenhouse gas emissions from energy generation in Queensland will be reduced to 60 percent below 2000 levels by 2050.

Low-carbon energy technology initiatives outlined in the policy include the accelerated research, development and deployment of clean coal, solar thermal and geothermal energy.

These technologies are part of a phased approach to addressing greenhouse gas reductions along with gas, renewables and energy efficiency measures for the community and industry, that secure the State's energy future.

The Department of Mines and Energy is responsible for the implementation of the Queensland Government's *Smart Energy Policy* to reduce greenhouse gas emissions from energy generation. The policy was outlined in the Queensland Government's climate change strategy, *ClimateSmart 2050*.

Other sectors responsible for significant greenhouse gas emissions in the State are land use, agriculture and transport. Initiatives to reduce emissions from these sources are also being addressed by relevant Queensland and Federal Government agencies.

The Queensland Government recognises that:

- Queensland's robust economic growth is dependent on secure and affordable energy which has to-date been mostly supplied by coal-fired power stations
- Queensland has an abundant supply of low-cost, high-quality black thermal coal (approximately 250 years supply at current production levels)
- global demand for Queensland coal is expected to increase throughout the next three decades as the world's resources become less economic to mine
- alternative sources of energy like biomass and renewables cannot currently or in the near future, provide affordable electricity base-load electricity supply
- there is no 'quick fix' for reducing greenhouse gas emissions
- power stations are responsible for about 40 per cent of Queensland's total greenhouse gas emissions, ahead of land use, agriculture and transport
- global carbon dioxide (CO₂) emissions from power stations are likely to increase by about two-thirds between now and 2030, if there are no technological breakthroughs, and
- greenhouse gas emissions can be averted by applying a range of initiatives such as the development of clean coal technologies which rely on carbon capture and storage.



The aim

The Queensland Government's low-carbon energy initiatives outlined in the *Smart Energy Policy*, aim to:

- significantly reduce the level of greenhouse gas emissions generated from Queensland's coal-fired power stations
- secure the retail energy future for Queenslanders—both industry and consumers
- support continued strong economic growth
- preserve our quality lifestyle
- assist developing economies, e.g. China and India, to develop low-emission electricity and reduce global greenhouse gas emissions through collaboration on technology development.

Leading the way

Queensland is well placed to build on existing capabilities in our research and development institutions by investing in the research, development and demonstration of new technologies that will ultimately reduce emissions from power stations.

In Australia, Queensland has been an early adopter of supercritical power generation plant which has been used internationally for a long time.

Supercritical plants use higher steam pressure and higher temperatures (when compared to older technology subcritical plants), resulting in improved thermal efficiency.

In greenhouse gas emission terms, that efficiency equates to a reduction of at least 50 kilograms of greenhouse emissions per megawatt hour of electricity produced, which is about 40 per cent (or 450 kilograms per megawatt hour) less than the emissions currently produced by some brown coal generators elsewhere in Australia.

Emission rates will reduce even further as new technology is developed and applied.

All of Australia's supercritical coal-fired power stations (four in total) are located in Queensland. They include: Callide C, Millmerran, Tarong North and Kogan Creek which represent 26 per cent of the State's coal-fired electricity generation capacity.

The outcomes of low-carbon emission energy technology development and demonstration projects (e.g. clean coal, solar thermal and geothermal technologies) will provide industry with a solid scientific and technical skills foundation on which commercial decisions can be based.

\$900 million for clean coal technology

In September 2007 the Queensland Government formalised a flagship partnership with the coal industry to fund accelerated research, development and deployment of clean coal technologies in Queensland.

This partnership and the associated \$900 million funding by the Queensland Government (\$300 million) and coal industry (\$600 million over 10 years) is by far the most significant commitment in the region to clean coal technology development.

The world:

According to the *International Energy Agency 2006 World Energy Outlook*, global electricity demand is projected to almost double over the next 25 years, from 14,376 terrawatt hours in 2004 to more than 28,000 terrawatt hours in 2030.

The engineering challenges this presents are immense. It is one thing to capture the greenhouse emissions, it goes much further to identify suitable storage areas in the Earth's geology and to do all this with technical efficiency and cost effectiveness.

Queensland:

It is expected by 2015–16, Queensland will require more than 13,500MW of grid-connected installed generation capacity with total sent-out generation (on a medium growth projection) of 66,800 gigawatt hours (GWh). Current installed generated grid-connected capacity is more than 11,200MW (including Kogan Creek) and sent-out generation in 2005–06 was 47,322 GWh.

Why clean coal technologies?

This long-term energy solution aims to secure Queensland's future energy needs, support the continued development of the state's \$18 billion a year coal industry which employs more than 18,000 people, as well as reduce greenhouse gas emissions.

With growing electricity demand and an abundant supply of low-cost, high-quality black thermal coal, Queensland is well-placed to pioneer clean coal technologies.

When combined with carbon capture and storage, clean coal technologies have been found to be capable of achieving cuts of more than 75 per cent in greenhouse gas emissions.

The challenge now is to make sure clean coal technologies along with carbon capture and storage, work in Queensland conditions using Queensland's resources.

Importantly, by showing leadership in Queensland on this critical issue, we are in a better position to assist some of the world's largest emitters—economies like China, Europe and the United States which are also some of our most important trading partners—reduce their greenhouse gas emissions.

Queensland is already partnering on clean coal technology research and development in Europe, China and the United States.

Clean coal technologies

Clean coal technologies improve the use of coal for power generation, typically by:

- improving thermal efficiency to reduce coal consumption in electricity production
- ultimately significantly reducing emissions of CO₂.

Clean coal technologies being explored in Queensland also include modifying the way electricity is produced to accommodate either pre or post combustion capture and storage of CO₂ in deep underground rock formations (geosequestration) to achieve near zero emissions.

Timeline

Various clean coal technologies' approaches are expected to be commercially operational by 2020. Achieving this will be dependent on the continued commitment of governments and industry to research, develop and demonstrate the technology to reduce uncertainty and pave the way for more commercial investment.

Research

Queensland is on the cutting-edge of global clean coal technology development and offers exciting prospects for international investors and strategic partnerships.

The Queensland Government provides funding to the \$26 million Centre for Low Emission Technology and the Cooperative Research Centre for Coal in Sustainable Development, as a collaborative investment with industry.

Queensland research and development capability for clean coal technologies includes:

The Queensland Centre for Advanced Technologies (QCAT)

QCAT is a collaboration between the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Queensland Government. The Centre's aim is to expand and diversify the research and development activities of the CSIRO in Queensland. The Centre has a reputation as world-class in the areas of:

- mineral exploration
- geophysics
- coal mining, processing and utilisation
- metalliferous mining and processing
- minesite rehabilitation
- foundry technology.

Cooperative Research Centre for Coal in Sustainable Development (CCSD)

CCSD, based at QCAT brought together the majority of Australia's coal research skills base as well as experts in sustainable development. The Centre's vision has been to optimise the contribution of coal to a sustainable future.

Research focused on the three dimensions of sustainable development—economic, social and environmental—conducted under program areas that included:

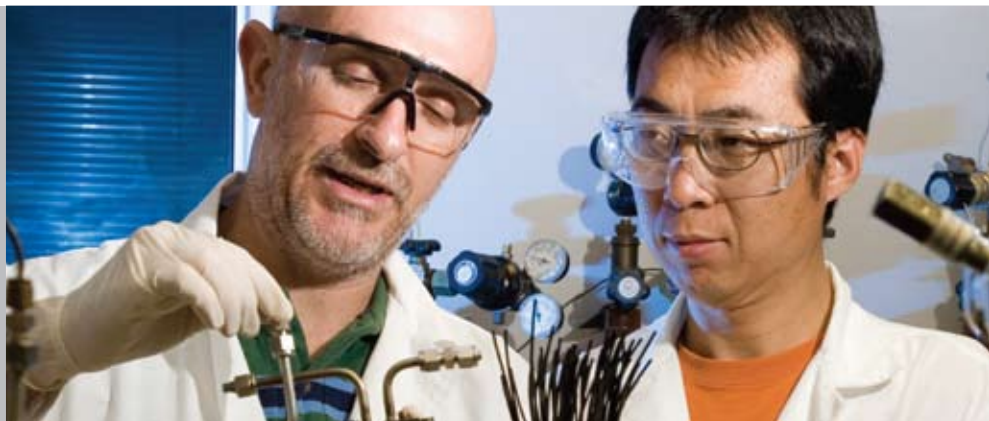
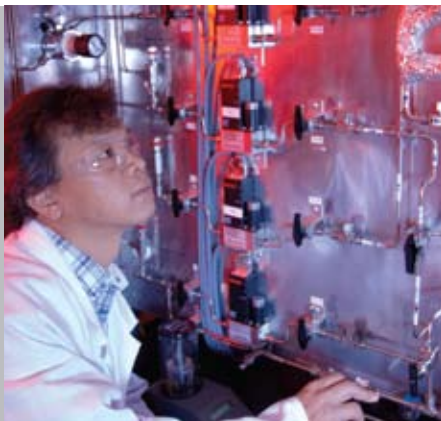
- current power generation
- transitional power generation
- future scenarios and technologies
- by-products and waste
- economic, social and environmental assessment.

The Centre for Low Emission Technology (cLET)

cLET is a \$26 million joint-venture between the Queensland Government, CSIRO, Stanwell Corporation, Australian Coal Research Limited, Tarong Energy and the University of Queensland. Based at QCAT, the Centre's work focuses on five program areas:

- gasification
- gas cleaning
- gas processing
- gas separation
- social and economic integration of these technologies.

The Queensland Government has provided \$9 million in funding to cLET, and in 2007 is providing a further \$200,000 to support a scoping study into the creation of a National Low Emissions Gasification Test facility in Queensland.



The University of Queensland

The University of Queensland has a number of research units focussed on clean coal technology.

Projects include:

- sequestration of CO₂ in deep coal seams
- enhanced recovery of coal seam methane, through CO₂ sequestration
- optimisation of underground coal gasification.

Australian Institute of Bioengineering and Nanotechnology (AIBN)

The Australian Institute of Bioengineering and Nanotechnology is a major research centre at the University of Queensland dedicated to a range of research fields including clean coal technologies. The Queensland Government provided \$20 million towards the \$60 million establishment costs.

Australian Research Council Centre for Functional Nanomaterials

This centre at the University of Queensland and the AIBN are collaborating on clean coal research. They received a \$1 million grant from the Queensland Government to progress research into nano membranes for gas separation in the gasification process for clean coal technologies. This project links to research in Germany.

Projects

Queensland's commitment to clean coal technologies is underscored by three demonstration projects of national and international significance.

The projects will use integrated carbon capture and storage, the key technology recommended by the Intergovernmental Panel on Climate Change.

ZeroGen

The world-first ZeroGen project will demonstrate integrated gasification combined cycle (IGCC) power plant (pre-combustion carbon capture) with carbon capture and storage (CCS) to generate near zero emission electricity from coal.

The ZeroGen project was reconfigured in March 2008 into two stages. In Stage One an 80MW net IGCC demonstration plant with CCS will be developed by 2012, designed to capture 75 per cent of CO₂ emissions. Stage Two, scheduled for completion in 2017, will draw on the technical improvements gained through Stage One to demonstrate the technologies on a commercial-scale 300MW IGCC plant, projected to achieve 90 per cent carbon capture. Stage Two of the project is expected to capture approximately 2 million tonnes of CO₂ a year.

The project has conducted significant test drilling in the Northern Denison Trough to identify suitable sites to demonstrate permanent and safe storage of carbon dioxide.

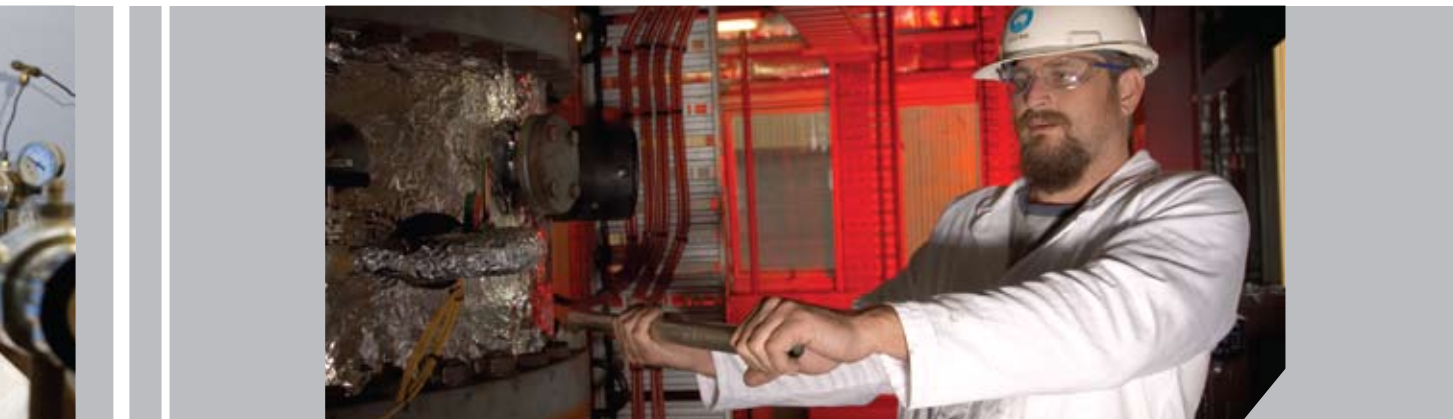
Callide Oxyfuel Project

The \$206 million CS Energy lead Oxyfuel Project at the existing Callide A Power Station in Central Queensland, has the potential to significantly reduce the cost of capturing CO₂ from conventional coal-fired plants. The technology is of particular importance to the coal and electricity industries because it can be retrofitted to existing boilers. It has been endorsed by the Asia Pacific Partnership on Clean Development and Climate (AP7) and is supported by a diverse consortium of global partners.

The project is funded by the Queensland Government owned CS Energy, the Australian Coal Association, the Commonwealth's Low Emission Technology Demonstration Fund, and a large and active consortium including Schlumberger, Xstrata Coal, the Japanese IHI Corporation, JCoal, JPower, the CO₂CRC and the Cooperative Research Centre for Coal in Sustainable Development.

Fairview Power Project

The \$445 million Fairview Power Project at Injune near Roma is a Santos and GE Energy proposal that aims to generate electricity from methane extracted from coal seams located too deep underground to be mined and combusted in gas turbines. The proposed power station would capture the CO₂ emissions generated in the process and inject them back into the depleted coal seams for permanent storage underground.



New clean coal-fired generation

While low-emission coal and next generation renewable energy technology projects are being demonstrated, coal and gas will continue to provide base-load power generation in Queensland. Under the *Smart Energy Policy* any new base-load electricity generation application will be required to balance economic and environmental outcomes. New coal-fired generation projects will only be considered if they can demonstrate:

- how the generator represents a technology and efficiency improvement over other existing plant
- how the generator would integrate with carbon capture and storage technology
- it is tied to foreign investment in trade-exposed energy-intensive projects which would otherwise be attracted to a country with less-stringent emission standards for electricity generation, or
- Queensland's energy supply security is compromised and alternative energy sources are not economical in the timeframe.

What is carbon capture and storage?

Carbon capture and storage is the process of capturing the CO₂ released from the combustion or burning of fossil fuels, including coal. Once captured, the gas is compressed and transported via pipelines to locations with suitable geological (rock) formations for the gas to be injected into and safely stored long-term, a process typically referred to as geosequestration.

What is integrated gasification combined cycle?

Integrated gasification combined cycle (IGCC) is the process of converting solid coal into a synthetic gas (syngas) that is cleaned of the ash (mineral matter in the coal) and other impurities and then combusted in a gas-fired combined cycle power plant to produce electricity.

The gasification of coal is a chemical conversion process that allows specific treatment of the syngas to remove compounds of contaminants such as sulphur. The syngas can also be treated to remove carbon from the fuel prior to combustion to achieve a significant reduction in the production of CO₂. The carbon is removed from the syngas as carbon dioxide which can be captured for storage.

The opportunity that IGCC offers for the sustainable use of coal is that a concentrated stream of the components of coal can be treated pre-combustion to reduce emissions, thus reducing the relative size and cost of the necessary equipment compared to post-combustion treatment.

What is oxyfuel?

Oxyfuel or oxy-firing technology involves the combustion of coal using recirculated exhaust flue gas combined with oxygen. This process produces a highly concentrated stream of CO₂ gas, which can be more easily captured for transport and storage.

Further information

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