Clean technologies

pave a future for coal

Pilot-scale facilities are essential for testing fundamental research and transferring new processes and technologies to industry.

Coal is a vital and increasing source of energy worldwide, but current estimates suggest it is responsible for 20% of the world's carbon dioxide emissions.

Coal will continue to provide most of Australia's electricity well into the next century. It will also be a major export (worth over $7.5 billion in 1994), and greatly contribute to our metal-production industries.

And in the developing countries of the Asia-Pacific region, coal will provide the electricity for economic growth and improvements in community welfare and living standards.

How can we reconcile this continued growth in coal use when it is responsible for such a high proportion of greenhouse gas emissions?

Scientists at CSIRO's Division of Coal and Energy Technology believe the answer is not to stop using coal, but to use it better by reducing the quantity of gases emitted per unit of power produced. In Australia, this means ensuring our own power generation industry is performing as cleanly as possible. Overseas we can also contribute to reducing emissions by ensuring the continued export of Australia's quality coals and new technology.

The major challenges for Australia's coal industry are:

- competition from overseas coals in our export markets;
- competition from other fossil-fuel based energy sources;
- the increasing need for environmental control (especially CO_2 and other greenhouse gases); and
- new technologies that are being brought in to improve the economic and environmental performance of coal.

Research by CSIRO is helping industry meet these challenges by showing that Australian coals can be processed more effectively and used in existing and new technologies more efficiently. Together, these approaches constitute what have become known as Clean Coal Technologies.

Reducing waste

Clean Coal Technologies are processes that reduce or eliminate environmentally-harmful materials and circumstances due to coal production and use. For example, better control in mining coal can reduce the production of coal waste, water run-off, dust and noise, making a cleaner mine environment. Similarly, improved coal preparation can reduce the amount of mineral matter and sulfur content in the product coal, thus reducing solid and gaseous waste production.

Further gains can be made by increasing the efficiency of coal use in power plants and metals production. The higher the efficiency, the less coal used and hence the less input of undesired materials. Efficiency increases are therefore a major part of Clean Coal Technologies.

The aim of the coal preparation process is to produce a coal which meets the requirements of the technology in which it is to be used. This means

supplying coal with a mineral and water content within a specified range (export coals generally contain 6-14% mineral matter). While it is the carbon in the coal which translates to the amount of energy produced, it is the mineral matter which is responsible for the amount of ash produced and the trace elements and gases which are emitted.

Research and development is aimed at operating coal preparation plants more efficiently (and economically) by identifying where improvements in the processing sequence and control can be made in conventional processes, and by developing new methods of liberating and separating mineral species as a basis of new processes.

There are several ways by which the efficiency of coal use in power generation can be increased. These include:

- Increasing the steam pressure and temperature in conventional pulverised coal-fired plants, to produce ultra super critical steam which yields increased power at the turbo-generator.
- Burning coal in a pressurised fluidised bed combustor where, in particular sulfur and nitrogen oxide emissions can be reduced, and efficiency increased by recovering energy from the hot, pressurised, flue gas in gas turbine and steam turbines.
- Gasifying the coal and burning the gas in a turbine, followed by steam raising in a combined cycle (Integrated Gasification – Combined Cycle).

These technologies are being implemented worldwide and will significantly reduce the amounts of ash, sulfur and nitrogen oxide and CO_2 produced per unit of power generated.

In metallurgical processing (such as iron and steel making) blast furnace operations are being modified, and new processes are being developed that increase energy efficiency and reduce overall coal use. These changes include injecting pulverised coal directly into a blast furnace so that the amount of coke, and the use of particulate coal in ore smelting baths are reduced.

From pilot to plant

Work on coal preparation aims to build new and improved process concepts. In part these will be achieved by gaining a thorough understanding of the fluid dynamics of preparation processes and of how the minerals and water are associated with the coal. Just as important, as far as the industry is concerned, is the ability to translate this knowledge and demonstrate its application in scaled-up facilities.

Coal is cleaned by jigging, which separates coal and minerals according to their different densities, and flotation, which uses differences in their surface properties. Based on a fundamental understanding of the engineering science involved, CSIRO is carrying out pilot-scale studies to improve the jigging process for treating fine coals and to increase the throughput from the flotation process at lower cost.

Excellent results have also been obtained by cleaning coal without water (dry beneficiation) and this may be an option for new mines where expensive washeries have not yet been built or in countries such as China, where coalfields operate in areas where water is scarce.

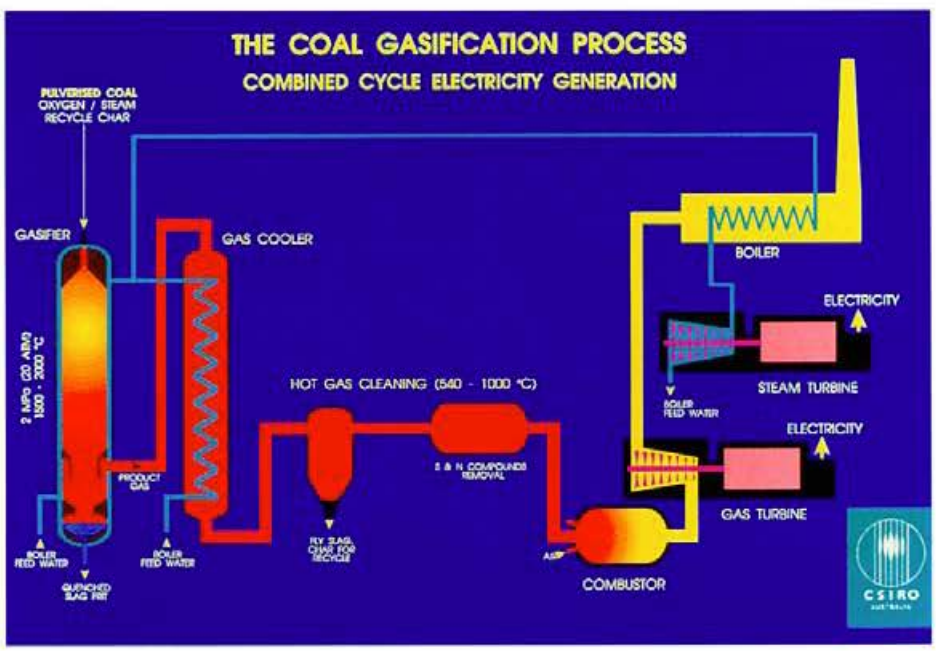
The use of coal for power generation, in both conventional and advanced technologies, is the subject of considerable basic and applied research. To use new and improved processes we need to have engineering data on the combustion and gasification of coal at high temperatures and pressures.

The division's current work on coal gasification for advanced power technologies (specifically the Integrated Gasification – Combined Cycle) will benefit Australian power generating authorities such as Pacific Power, which is providing significant funding for the project. The work will also support the coal export industry, as Australian coals will be proven in the new technologies being introduced overseas. Priority funding is also going to cleaning gases at high temperatures, essential to achieving higher process efficiencies.

In addition, the division is working in the laboratory and in industrial plants, and in collaboration with expert groups overseas, to improve the control of sulfur and nitrogen oxide and particulates. It is working to translate scientific knowledge on the formation of nitrogen oxide in flames, and its reduction by catalytic and non-catalytic methods, into better methods of pollution control.

Joint research

In response to the need to strengthen Australian work on Clean Coal Technologies, the coal producers, utilities, and research groups from CSIRO, universities, and industry are being brought together in the new Cooperative Research Centre for Black Coal Utilisation, which will support greater international competitiveness of Australian coal and bring improved capability to assess and implement new Clean Coal Technologies.



Integrated Gasification – Combined Cycle is likely to succeed the pulverised-fuel technology now used in power stations. Higher efficiencies are achieved by first reacting the coal with oxygen and steam to produce a gas which, after cleaning, is burnt in a gas turbine to generate power. This gas passes on, still at temperatures of about 500°C, into a steam generator which in turn drives a steam turbine. CSIRO is researching how Australian coals will perform under these conditions, identifying problems which arise and seeking improvements to coal processing technology which may remedy these problems.

More about coal

Commonwealth Department of Primary Industries and Energy (1994) *Coal and Climate Change*, Canberra.

Swaine D (1990) *Greenhouse and Energy*. CSIRO, Australia