Coal in a Sustainable Society

Comparing greenhouse gas emissions from different energy sources

A summary of findings from stage one of the Coal in a Sustainable Society Project

The challenge facing coal…

The challenge facing the coal industry in the new century is to continue to deliver the many economic and social benefits of coal, while also reducing greenhouse gas emissions and other environmental impacts associated with its production and use.

In responding positively to this challenge, the world coal industry has embarked on a long-term process to understand the role of coal in the transition to a more sustainable society.

The Coal in a Sustainable Society Project…

As part of this process, the Australian coal industry (supported by the World Coal Institute and the Electric Power Research Institute*) has commissioned a three-year study - ***Coal in a Sustainable Society (CISS)***.

Establishing an accurate baseline…

The first stage of the study, now completed, measured the greenhouse gas emissions of different electricity generation and steel making technologies, the primary uses for coal. The objective was to establish an accurate baseline from which to compare the environmental credentials of different technologies.

From 'cradle to grave' – taking account of all emissions…

The method used is known as ***life cycle analysis (LCA)***. Life cycle analysis involves a 'cradle to grave' measurement or accounting of all emissions. It provides a complete picture of impacts, not just those occurring at the point of combustion or, in the case of a technology like solar, the point of conversion of sunlight to electricity. Examples could include emissions that may occur during coal mining, or in the production of silicon for photovoltaic cells, or emissions from natural gas production and transport.

Key Findings

Electricity Generation

➢ *On a full life cycle basis, gas–based electricity generation may have similar or even higher greenhouse gas emissions than coal-based generation.*

- At the point of combustion, conventional coal-based technologies produce higher greenhouse gas emissions than natural gas-based technologies.
- Over the full life cycle, however, total emissions from natural gas may be substantially higher than at the point of combustion. This depends on whether the source of gas is high or low in carbon dioxide, the extent of venting and flaring during production, and the extent of losses during transport and distribution. By contrast, 97 per cent of life cycle emissions from coal occur at the point of combustion.
- The relative greenhouse emissions of gas relative to coal cannot therefore be generalised and should be established on a case-by-case basis using full life cycle analysis.

➢ *Emerging clean coal technologies will significantly reduce the difference in greenhouse gas emissions between the best gas technologies and coal at the point of combustion.*

- Most of the new clean coal technologies under development have 10–20 per cent lower greenhouse gas emissions than conventional pulverised fuel (pf) coal-fired power plants.
- New clean coal technologies include supercritical and ultrasupercritical steam, fluidised bed combustion and a range of coal gasification systems. These technologies significantly increase thermal efficiency. This means less coal is required to produce a given amount of energy.

➢ *Synergies between coal, biomass and solar thermal can significantly increase the efficiency of these renewable energy technologies and may be the most cost-effective way to increase the use of renewable energy.*

- Co-firing biomass with coal in conventional coal-fired power plants can increase the efficiency with which biomass can be converted to energy from 20 per cent for stand-alone biomass plants to 35 per cent. Approximately 30 per cent biomass co-firing with coal would match natural gas on a greenhouse gas emissions basis at the point of combustion.
- Linking steam from solar thermal technology with the steam cycle of existing coal-fired power plants offers the potential to convert 40 per cent of solar energy into electricity. This compares with 13 per cent for large-scale photovoltaic systems. Capital costs are also much lower than for photovoltaic systems.

➢ *By-products can be utilised to further lower life cycle greenhouse emissions from coal-based generation.*

- Up to 10 per cent reduction in overall greenhouse emissions could be obtained if fly ash produced in coal-fired power plants was reused in other industries, for example in the production of cement. This would reduce the amount of raw material required from other sources, resulting in reduced overall greenhouse emissions from cement manufacturing.
- Less than 3 per cent of fly ash is currently used in Australia, compared with up to 50 per cent in some other countries. Considerably more could be utilised, either alone or in combination with slag (a by-product of steel making and smelting).

➢ *Utilising coal seam methane is a relatively easy way to reduce total greenhouse gas emissions.*

- Methane released during coal mining contributes to total greenhouse gas emissions from the use of coal. Total methane emissions from world coal mining are approximately 30 million tonnes, of which only five per cent is utilised. Utilising this valuable resource would be equivalent to a five per cent reduction of carbon dioxide emissions from the use of coal. The technology for extracting and utilising coal bed methane is well developed, and is being progressively implemented.

➢ *Non-hydro renewables (including solar, wind and biomass) have low greenhouse gas emissions compared with both coal and gas-based generation.*

- All renewable energy technologies with the exception of hydro (see below) have low total emissions, although all have some emissions associated with certain stages of their life cycle. For example, the production of solar panels is the highest emission point in solar electricity generation. Emissions from photovoltaic systems depend on cell life and the technology used to produce the wafers. It should be noted that the analysis excluded electricity storage, a critical long-term issue for the renewables industry.

➢ *Greenhouse gas emissions from hydro-electricity may be significant.*

- Life cycle greenhouse gas emissions from hydro-electricity are appreciable, with carbon dioxide and methane being produced from drowned vegetation and organic inflow from the catchment.
- The analysis concluded that hydro-electricity cannot be automatically assumed to emit less greenhouse gas than the thermal alternatives. Net emissions should be established on a case-by-case basis'.

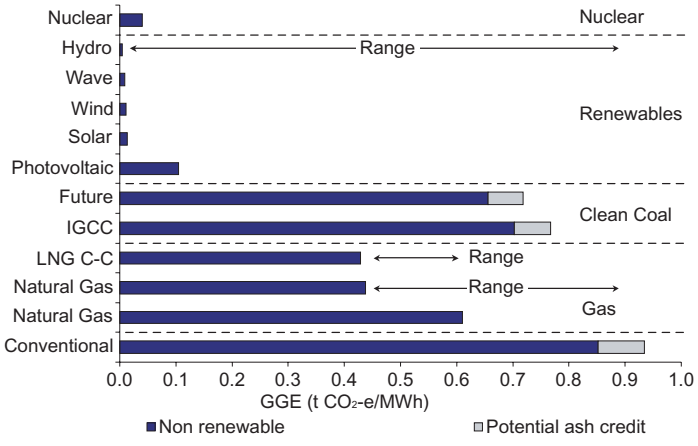
➢ *Emissions from nuclear power are very low, however…*

- The study was not able to consider the plant decommissioning phase of the nuclear fuel cycle due to a lack of available data. This may increase the overall greenhouse impact of nuclear power.

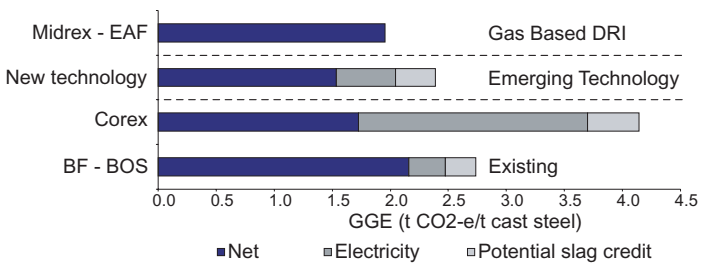
Steel Production

➢ *Coal can equal or exceed the greenhouse performance of natural gas in the production of steel.*

- While conventional coal-based steel production emits approximately 20 per cent more emissions than gas-based production, several coal-based technologies can be configured to achieve lower emissions than gas.
- Significant reductions in full life cycle emissions of coal-based technologies could be achieved by:
  - utilisation of blast furnace slag (an inert by-product of the steel making process) in the production of cement. This would significantly reduce emissions compared to conventional cement production.
  - integrating coal-based iron and electricity generation by using off gases from the steel making process to generate electricity.
  - the use of some biomass (as charcoal) in coal-based steel making. A joint NSW State Forests – BHP project is currently examining this option. Further information on the project can be found at www.sustainabletechnology.com.au
  - increased capture and use of coal bed methane.
- The CISS assessment of different steel making technologies underlines the importance of using life cycle analysis for measuring greenhouse gas emissions. For example, COREX, an emerging coal-based technology, has the highest emissions of all if measured in a conventional manner, but the lowest over the full life cycle.



Greenhouse gas emissions for power generation technologies



Greenhouse gas emissions for steelmaking technologies

CISS - the next steps…

The CISS life cycle study identified many opportunities for improvements in the environmental performance of coal. Many of these opportunities may be more cost effective in reducing greenhouse gas emissions than investing in alternative energy sources.

The next stage of the CISS project, to be concluded in 2002, will include the following studies:

Iron and Steel

- The environmental credentials of alternative coke making technologies

Electricity

- Life cycle analysis of brown coal power generation
- Sustainability assessment of natural gas
- Synergies between coal and renewable energy technologies
- The history of power generation from an LCA perspective

Energy scenarios

- Future energy supply scenarios for Australia

Further information on the Coal in Sustainable Society Project can be found at www.ciss.com.au

Copies of this summary and other CISS publications can be obtained from:

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* The Electric Power Research Institute (EPRI) is a non-profit organisation providing science and technology-based solutions to the global energy and energy services industry.