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COAL IN SUSTAINABLE DEVELOPMENT AN INTRODUCTION TO COOPERATIVE RESEARCH IN AUSTRALIA

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(2 figures, 1 table)

ABSTRACT. Sustainable development presents a considerable challenge to the coal industry. Coal plays an important role in the Sustainable Future as the most widely used energy source in electricity generation and steel production. The paper outlines the cooperative coal research environment in Australia which is being managed within the framework of sustainable development: economic, social and environmental.

Keywords: Coal, Australia, Sustainable Development

1. The context

The concept of sustainable development was placed firmly on the international agenda with the release of the *Brundtland Report,* 'Our Common Future' (1987) well over a decade ago. The report defines sustainable development as: '*... development that meets the needs of the present without compromising the needs of future generations to meet their own needs….. {It is} not a fixed state of harmony, rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are made consistent with the future as well as present needs'*

In Australia, sustainable development policy is embodied in the *National Strategy for Ecologically Sustainable Development (ESD)* (1992) and addressed with respect to climate change in the *National Greenhouse Strategy* (1998), the Commonwealth Government's climate change package, *Safeguarding the Future: Australia's Response to Climate Change* (1997), and associated greenhouse reduction programs. The challenge highlighted for coal is to: *'… efficiently manage the non-renewable resources on which … [industry] depends, in accordance with the principles of ESD'* and to reduce greenhouse gas emissions. The transition path from the present 'business as usual' role for coal in energy supply to a less carbon intensive energy system scenario utilising renewable energy, is not straightforward. Research to facilitate this transition is therefore critically important.

The Australian coal and related industries share this recognition of the need for disciplined long term research to meet the challenges of sustainability at an affordable cost to industry and society.

2. The Coal future

The Past: Coal's Bad Reputation. The coal industry is still viewed with the 19th century image; dirty to dig, dirty to transport and dirty to utilise. To optimise the contribution of coal in a sustainable future, this old paradigm must be changed.

The Present: **The Greenhouse Threat.** Greenhouse gas emissions, especially from the coal-fired energy sector, are seen as a major threat to environmental sustainability. In addressing these issues and give practical effect to sustainable development, the Cooperative Research Centre for Coal in Sustainable Development (CCSD) has initiated new research related to coal, energy and environmental issues. [CCSD is part of a national program sponsored by the Australian Government and supported by universities, CSIRO and industry.]. The research program is concerned with sustainability issues along the coal chain, from sustainable coal resource management through clean coal and new utilisation technologies to utilisation of coal combustion by-products.

The Future Zero Emissions. Australia is well placed to make a significant contribution to the world's greenhouse gas reduction targets and the transition to 'zero-emission' coal technologies, by providing high quality black coals together with information and guidelines on the performance of Australian coals in new technologies.

Australia is the world's largest coal exporter, making coal vital to the national economy. Australian coal industry believes that in the decades to come, although coal's proportion of the energy mix will decrease, coal consumption will increase and hence coal will continue to play a vital role in world energy and steel production. Today, coal supplies most of the world's population with

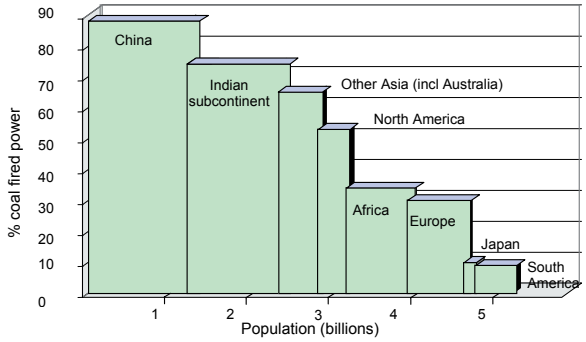

Figure 1. Coal Facts 2001 - Coal fired power generation serving world communities (Sources: IEA 1998, United Nations 1999).

Electricity Generation	98-99	In 11 years	2010	**2020**
			If	If . . .
Gas	7.0%	triples	20%	30%
Hydro	8.7%		6.0%	4.0%
Other Renewables	0.4%	13 fold	5.1%	10%
Oil	0.006%		0.004%	0.002%
Brown Coal	28%		23%	18%
			Then	Then
Black Coal	56%		46%	**38%**

Table 1. Australian Energy mix scenarios: present, 2010, 2020.
*Note: Electricity demand growth estimated at 2%/year.

their power requirements (Fig. 1) and in particular, some 84% of Australian electricity generation (black coal – 56% and lignite – 28%).

Renewable energy systems are expected to play an increasing role in the energy mix, however such energy systems will need to be underpinned by a base load energy source such as that currently provided by coal. In Australia the use of renewable energy systems has been mandated by government (Australian Government, 2000) and, additionally, gas has been included in greenhouse targets set within government emission reduction strategies (Queensland Government, 2000).

Assuming that the best aspirations for gas and renewables are achieved, Table 1 demonstrates the continued reliance in Australia on black coal as the primary fuel for electricity generation. A similar scenario can be defined for the rest of the world.

The history of coal use in steel production and energy generation demonstrates that significant reductions in greenhouse gas emissions have occurred with technology development from the commencement of use, through the Middle Ages, and up to the present day with the emerging clean coal technologies. Based on this experience, it is contended that cost reductions through research and development in black coal efficiency will provide a more economically efficient solution for CO_2 reduction than substitution by renewables.

3. Research and development and a sustainable future

Society today demands answers to issues at an ecosystem scale so as to fully understand the consequences of industry and community activities within the natural landscape. This is driven by the concepts of ecologically sustainable development such as defined in the 1992 Australian *National Strategy for Ecologically Sustainable Development: '… using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.'*
Therefore, indefinite use of current coal-based technologies is not an option for society as:

- coal is a finite, non-renewable resource; and
- current coal technologies result in a range of environmental impacts associated with mining, utilisation and waste disposal, with greenhouse gas emissions now assuming particular prominence.

Research and technological development will lead, over time, to a new energy economy that will enhance energy sustainability. However, in parallel, there is a challenge to extract energy from coal in more efficient and cleaner ways. This meets the Brundtland philosophy of moving to a sustainable future by replacing resource depleting technologies with new options of at least equivalent value.

The full understanding of the options for delivering improved environmental performance *(greenhouse tar-*

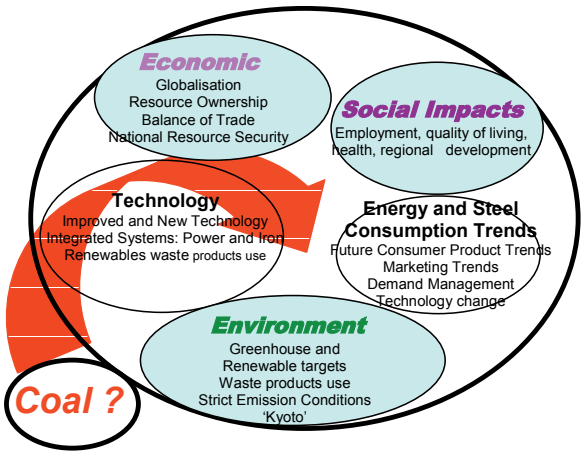

Figure 2. Coal's place in the Sustainable Future.

gets, renewables targets, waste use/disposal, emissions regulation – NO_x, trace elements, particulates) within the prevailing economic environment *(globalisation, resource ownership, balance of trade, national resource security)* and social environment (*employment, regional development, quality of living, health)* must be provided through research programs to position coal (Fig. 2) in the sustainable future.

4. Australian Clean Coal initiatives

The Australian coal industry is involved in several collaborative initiatives aimed at understanding the role of coal in the transition to sustainable development, and ensuring that the potential for reducing the environmental impacts of coal are more widely understood in the community.

The main research efforts in clean coal technologies are supported by the Australian coal industry and government and include:

4.1. Cooperative Research Centre for Coal in Sustainable Development

The Cooperative Research Centre (Homepage CRC Program) for Coal in Sustainable Development (CCSD) (Homepage CCSD) commenced operations on 1 July 2001. The Centre brings together a substantial body of Australian black coal producers and users and the major coal utilisation research groups to conduct research necessary to support coal utilisation in existing domestic and export applications, as well as to demonstrate the performance of Australian black coals in new and emerging technologies. Research is conducted in six research programs and a number of support programs:

- *Economic, Social and Environmental Assessment:* Provides a framework for: awareness of the international debate on sustainable development; information and trends in sustainable development including key indicators, policies, etc; scenarios for coal and technology pathways; and identifying and evaluating research opportunities. Research deliverables include: definitions of sustainable development; a set of sustainable development principles and KPI's; criteria for coal's place in future energy scenarios; models for planning and research; and practical tools for the coal industry to enhance its contribution to sustainable development.
- *Current power generation: P*rovides the research required by the coal industry and coal users to make informed choices in the short term on fuel, operating practices and technology improvements and new options. Research deliverables will include: established or updated industry handbooks and codes of practice; assessments of co-firing of alternative fuels including characterisation and economic, social and environmental impacts; options for increased efficiency and emissions reduction of current power generators; options for cost reduction with regard to fuel selection and clean technologies; options for the further mitigation of environmental and health risk factors; and demonstrations of technologies.
- *Transitional Power Generation: S*upports the introduction and adoption of transitional power systems by providing decision support for: new investment in the coal fired power generation industry; and the development of government's environmental and energy policy. Research deliverables will include: evaluation and optimisation of Australian coals for advanced technologies for domestic and overseas markets; decision support for new investment and policy through information, predictive tools and involvement in demonstrations of technology; and a facility for showcasing technologies.
- *Future Scenarios and Technologies: P*rovides research to: evaluate emerging technologies to identify long term technology solutions and develop pathways for risk mitigation; and develop industry scenarios for the Australian context including 'roadmaps' for new clean coal technologies. Research deliverables will include: comparisons and evaluation of advanced technologies with regular updates to all stakeholders; roadmaps for coal use in future technologies; assessment and evaluation of the economic, social and environmental performance of future energy and storage technologies; assessment of greenhouse gas agenda including the implications of the Kyoto protocol and emissions from Australian coal; innovative industry scenarios that address integration and a portfolio approach to energy and product delivery including real options assessments of promising energy scenarios; options for technology demonstration.
- *Ironmaking: S*upports coal utilisation in current and future ironmaking within the context of sustainable steel making processes. Research deliverables will include: characterisation of the performance of coal in new iron making technologies to demonstrate the value of Australian coal; scope the potential for further blast furnace fuel rate reduction; evaluation and quantification of risk factors; assessment of alternative fuel injectants in ironmaking; participation in pilot/demonstration in waste injection; and assessment of options for transitional and emerging processes in sustainable iron and steel making technologies.
- *By-Products and Waste: A*ddresses environmental issues associated with waste management and opportunities for waste utilisation. Research deliverables will include: identification of options to minimize waste and environmental impact along the whole coal chain; assessment of technical, economic, environmental and legislative barriers to widespread use of waste products; fly-ash characterisation from current and emerging technologies for sustainable use as a coal combustion product; development of cost-effec-

tive techniques for fly-ash and coal washery rejects disposal and utilisation; demonstrations of technology (e.g. fly-ash utilisation); and assessment of new opportunities in by-products utilisation.

4.2. Cooperative Research Centre for Clean Power from Lignite

The Cooperative Research Centre for Clean Power from Lignite (CRC Lignite) (Homepage CRC Lignite) was first established in July 1993, with research aimed at the development of technologies to reduce Greenhouse Gas Emissions (GHG) from lignite-fired power stations, that supply 28% of the current electricity demand, while enhancing Australia's international competitiveness from low cost energy. The technologies being developed relate to both current technologies (pulverised coal-fired boilers) to high efficiency advanced cycles. Research is conducted in five programs:

- *Coal Drying, Dewatering and Characterisation: A*ddresses the issues of drying or dewatering of low rank coal prior to gasification and/or combustion. The relatively undeveloped Mechanical Thermal Expression (MTE) process is considered the most prospective of the processes on the basis of efficiency and cost.
- *Advanced Combustion and Gasification:* Provides kinetic reaction and conversion data on a range of lignites over the range of temperatures, pressures and gas compositions for the design and optimisation of pilot and demonstration scale reactors for Advanced Pressurised Fluid Bed Combustion (APFBC) in fluid bed reactors.
- *Fluid Bed Process Development:* Determines strategies for the stable operation of pressurised fluid bed systems and to develop scale-up criteria and models to enable the physical design of large demonstration and commercial scale reactors for the APFBC process.
- *Thermal Efficiency and Operational Improvement:* Improves the thermal efficiency of the pulverised fuel power stations through implementation of the dewatering technology, and improve the operational effectiveness through technologies addressing operating cost reduction, new instruments for coal analysis and operational requirements, and modelling of burners, furnaces and related equipment.
- *Advanced Process Development:* Continuing assessments of relevant advanced power generation technologies to ensure that the most appropriate technology options for high moisture lignites are identified and ranked.

4.3. Australian Coal Association Research Program

Black coal research in Australia, for mining, preparation and utilisation applications, is funded through the Australian Coal Association Research Program (ACARP) (Homepage ACARP) through a coal industry levy of 5 cents/ton from coal producers. ACARP is the vehicle by which these funds are allocated to institutions to perform research conducted for the benefit of the coal mining industry. Areas of research include:

- Greenhouse gas mitigation.
- Safety and occupational health.
- Environment and rehabilitation of mined land.
- Community concerns and land access.
- Cost of production.
- Technical support for marketing Australian coals.

ACARP is also a participant in CCSD and most of its coal utilisation research activities are directed in support of CCSD objectives.

4.4. Other Initiatives

- *Cooperative Research Centre for Mining Technology and Equipment (CMTE):* CMTE's (Homepage CMTE) purpose is to deliver a continual stream of safety and productivity enhancing technologies to the Australian mining industry. It supports research programs addressing different aspects of coal mining operations, and is supported by a participant list well represented by coal mining companies and research institutions.
- *Australian Cooperative Research Centre for Renewable Energy (ACRE): ACRE was e*stablished to facilitate the development and commercialisation of renewable energy and related greenhouse gas abatement technologies. Also, ACRE aims to implement education and training to develop the competencies for commercialisation and technology transfer and provide policy input to facilitate the take up of sustainable energy strategies. [Post Conference Note: ACRE will cease to operate from 30 June 2004]
- *GEODISC and the Proposed Cooperative Research Centre for Greenhouse Gas Technologies:* The Australian Petroleum Cooperative Research Centre (Homepage CO2CRC) GEODISC project is researching the applicability of CO_2 disposal into geological formations within Australia. A proposal for a Cooperative Research Centre for Greenhouse Gas Technologies has been submitted to the Australian Government's Cooperative Research Centres Program and if successful, will carry out research into CO_2 capture and storage, and develop innovative technologies to offer industry new options for reducing emissions of CO_2 to the atmosphere. [Post Conference Note: The CO2CRC was funded from 1 July 2003 for 7 years]
- *Coal in a Sustainable Society (CISS) Program:* CISS (Homepage CISS) is a major program of life cycle analysis investigations and communication. It is examining the full life cycle impacts of current and developing technologies for the principal coal-based technologies

of electricity generation and iron making. Early results from the CISS program have shown that coal is not as greenhouse unfriendly as commonly perceived. This is in partly because other energy sources have significant greenhouse impacts during various stages of their life cycle which, too often in common at point of combustion assessments of energy technologies, are not included in the greenhouse gas emissions accounting.

- *The Australian Coal Association Sustainable Development Program (ACASDP):* ACASDP (Homepage ACASDP) was established to provide factual information about coal, its environmental performance, its place in the future energy mix and its important economic and social contribution to energy production in Australia and internationally.

5. Conclusion

The Australian coal research effort, through CCSD and other cooperative research centres and organisations, is clearly focussed on outcomes within a framework of sustainable development.

Research and development will be critical to making a real difference in terms of the economic, social and environmental dimensions. The statement from the 'Statement to World Leaders on Sustainable Development' by Robert Priddle, Executive Director of the International Energy Agency, at the World Summit on Sustainable Development in Johannesburg 30 August 2002, captures the essence of what R&D in coal can deliver: *'Fossil fuels, though environmentally-challenged, can meet the criteria of security and affordability. Technology, driven by the right incentives, offers possible answers to the environmental problems – clean coal technology, and technologies to safely capture and store carbon. The right mix of fuels must be determined.....'*

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Homepage CO2CRC (formerly Australian Petroleum Cooperative Research Centre) - http://www.co2crc.com.au/

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