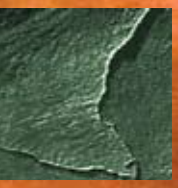
Updated January 2007






CCSD

Cooperative Research Centre for Coal in Sustainable Development

Established and supported under the Australian Government's Cooperative Research Centres Program

Cooperative Research Centre for

Coal in Sustainable Development

Vision

Vision

To optimise the contribution of COAL to a sustainable future.

Mission

Mission

Provide solutions and pathways for coal in sustainable development through:

- collaborative and responsive research focusing on utilisation and by-products; *together with*
- related synergistic research opportunities in other coal chain areas.

Values

Values

- Sustainable Development
- Scientific Integrity and Excellence
- Solutions Orientation
- Collaboration
- Innovation

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Russell Higgins
Chairman

Chairman's Message

Coal in Sustainable Development

Access to affordable energy is intrinsically linked with the sustainable social development of humankind. The United Nations Energy Program calls for

"...emphasis on building human capacities and increasing opportunities for development while contributing towards significant reductions in the harmful effects of energy production and use."

The supply of energy in a carbon constrained world is a massive challenge facing governments, industry and society in general. Our effectiveness in reducing and eventually stabilising greenhouse gas (GHG) emissions will be measured not only in terms of meeting targets set for atmospheric concentrations of carbon dioxide but also societal response to climate change.

Electricity generation accounts for 37.5% of global carbon emissions and therefore, power generation in particular must take up this challenge through innovation and sustained strategic action.

There is some measure of uncertainty in how industry and governments will respond to unprecedented growth forecasts in global energy demand. This presents an ideal opportunity for the coal utilisation industry to deliver energy solutions that fulfill sustainable environmental, economic and social criteria on an unprecedented scale both nationally and internationally.

The Cooperative Research Centre for Coal in Sustainable Development (CCSD) plays an active role in supporting and delivering such energy technology outcomes required for the future.

I take pleasure in commending this joint venture research initiative that brings together Australian black coal suppliers, power generators and major research providers.

Our effectiveness in reducing and eventually stabilising greenhouse gas emissions will be measured not only in terms of meeting targets set for atmospheric concentrations of carbon dioxide but also societal response to climate change.

Frank van Schagen
Chief Executive Officer

CEO's Message

International Energy Agency Projections show that due to a sustained growth in energy demand – especially in developing nations – coal will be part of the energy mix for at least the foreseeable decades. If such societal demand is to be met in an environmentally and economically responsible way, the reduction in carbon emissions using emerging technologies such as carbon capture and storage is not only a pre-requisite, but an opportunity for coal fired power generation to make the quantum reductions necessary in GHG emissions – projected to be as high as 60% for CO_2.

While global effort in developing carbon capture and storage (CCS) technologies is gaining momentum, the necessary advanced power generation technologies required at the front end must also be developed, demonstrated and deployed at the same time. CCSD is committed to supporting the implementation of clean coal technologies (CCT) such as Integrated Gasification Combined Cycle (IGCC) and oxygen fired Pulverised Fuel (PF) combustion as options for a near zero emissions future.

Sustainable Development has become a unifying ethic and an important driver for change in a global environmental agenda that goes beyond the Kyoto Protocol. CCSD research shows that our understanding of sustainable development has itself become more sophisticated. While initially motivated by the need for impact reduction it has grown to include the preservation of natural capital and may in future embrace a richer concept of sustainability through adaptation. Specifying such robust measures of sustainable performance in the provision of energy services are elements of CCSD research presented in this brochure.

The Centre's technical research is built on a foundation of understanding coal performance in the major utilisation technologies – pulverised fuel combustion, gasification and ironmaking. Over eleven years of operation, CCSD has acquired unique and valuable knowledge for characterising, testing and predicting coal performance in these technologies.

The quality and effectiveness of CCSD research is underpinned by the Centre's privileged access to world class scientists in sustainability and chemical, metallurgical and environmental engineering. Combined with robust and enthusiastic industry engagement, this research program is testament to their creativity, innovation and collaboration.

Carbon capture and storage is not only a pre-requisite, but an opportunity for coal fired power generation to make the quantum reductions necessary in GHG emissions.

CCSD RESEARCH DELIVERS *superior return* ON INVESTMENT

The work of CCSD represents a substantial investment in R&D expenditure by participant organisations, including Commonwealth and State governments, coal mining and electricity generation companies, and academic and research institutions. An independent evaluation of CCSD research in 2005 by economic consultants ACIL Tasman estimated that potential improvements in plant availability resulting from CCSD pre-investment research could result in capital cost savings of between $500 and $1,600 million for the Australian power industry. The value of savings was potentially higher depending on the cost of CO_2 emissions. The study showed that for even very modest improvements in plant availability (0.5% to 1.1%) positive benefits arose that more than offset the costs of research.

CCSD's research is conducted in six research programs; Economic, Social and Environmental Assessment, Current Power Generation, Transitional Power Generation, Future Scenarios and Technologies, Ironmaking, and By-Products and Waste (Figure 1). These programs are aligned to deliver outcomes that Inform Strategic Decisions, Improve Environmental Performance and Understand Coal Performance in current and emergent technologies.

Figure 1

Program Themes

INFORMING STRATEGIC DECISIONS | **IMPROVED ENVIRONMENTAL PERFORMANCE** | **UNDERSTANDING COAL PERFORMANCE**

Australian coal as a globally traded commodity is by far the nation's richest export earner and there is a need to support its markets and responsibly secure its future, mindful that the stage is set in an international theatre. By contrast, coal fired electricity generation while played out in a much more domestic locale, is no less important in its economic, environmental and social impact on Australian society.

In this context, CCSD undertakes research that informs the strategic decisions required of the coal and electricity generation businesses in Australia whose investment decisions are driven by separate and different commercial dynamics.

In measuring, monitoring and predicting emissions from coal utilisation, CCSD research has the skills, capabilities and research portfolio to serve both emissions reduction strategies and proactively inform policy decisions for the longer term regulation of the coal supply and utilisation industries.

Understanding the intrinsic nature and characteristics of coal fuel and how they relate to performance in a suite of present and emerging technologies is the basis from which CCSD has grown its research reputation and credibility. Built over twelve years of research into coal matter, mineral matter and environmental issues, the Centre's capability is supported by a foundation in coal and combustion science. The Centre's current research program focuses on coal performance in IGCC, Oxy-fuel and Ironmaking technologies.

PROGRAM 3
TRANSITIONAL POWER GENERATION

- **PROJECT 3.1** Entrained-flow Gasification
- **PROJECT 3.2** Fluidised Bed Combustion (concluded)
- **PROJECT 3.3** Power Systems Evaluation
- **PROJECT 3.4** Oxy-fuel Science and Technology
- **PROJECT 3.5** Oxy-fuel Feasibility Study (concluded)

PROGRAM 4
FUTURE SCENARIOS & TECHNOLOGIES

- **PROJECT 4.1** Portfolio Options and Risk Assessment
- **PROJECT 4.2** Greenhouse Gas Reduction and Options (concluded)
- **PROJECT 4.3** Barriers to Coal Utilisation Technology Change (concluded)
- **PROJECT 4.4** Membrane Reactors for Water Gas Shift Reactions

PROGRAM 5
IRONMAKING

- **PROJECT 5.1** Coal Use in Blast Furnaces

PROGRAM 6
BY-PRODUCTS & WASTE

- **PROJECT 6.1** Waste Management
- **PROJECT 6.2** Utilisation of Solid Waste By-Products
- **PROJECT 6.3** Environmental Assessment of Fly-Ash Use in Mine Backfill Applications

Improve Understanding of the Place of Coal in Sustainable Development

Identify Appropriate Transition Paths and Support the Development of Policies for Coal Use

1 Program 1

Economic, Social and Environmental Assessment

THIS PROGRAM ASSESSES STRATEGIC OPTIONS FOR COAL IN SUSTAINABLE DEVELOPMENT. IT UNDERTAKES TECHNO-ECONOMIC RISK ASSESSMENT AND LIFE CYCLE ANALYSIS FOR EMERGING TECHNOLOGY OPTIONS. THE PROGRAM MONITORS NATIONAL AND INTERNATIONAL DEVELOPMENTS WHICH COULD SHAPE THE ENERGY FUTURE, WHILE PROVIDING INFORMATION TO ASSIST THE PLANNING AND MANAGEMENT OF THE CENTRE'S RESEARCH ACTIVITIES.

OBJECTIVES

The program provides the framework to assess future CCSD research portfolio through:

- Awareness of the international debate on sustainable development;
- Information and trends in sustainable development;
- Scenarios for coal and technology pathways; and
- Identifying and evaluating research opportunities.

DELIVERABLES

1. Established definitions of sustainable development that integrate the economic, social and environmental dimensions of the international debate.
2. Established set of sustainable development principles and KPIs:
   - Global context;
   - CCSD context; and
   - Quantify sustainable development criteria.
3. Established criteria for coal's place in future energy scenarios including:
   - Demand management;
   - Extended product stewardship by producers; and
   - Social structures.
4. Accepted models for CCSD planning and research, which:
   - Quantify trends and drivers for research evaluation;
   - Provide information for stakeholder forums; and
   - Provide case studies for technology comparisons.
5. Practical tools for the coal industry to enhance its contribution to sustainable development, based on:
   - Eco-efficiency; and
   - Cleaner production, sustainable technology development.

LEFT TO RIGHT
DR LOUIS WIBBERLEY
PROF CLIFF HOOKER

Project 1.1

COAL IN SUSTAINABLE SOCIETY – LIFE CYCLE ANALYSIS

Leader: *Dr Louis Wibberley*
CSIRO

The project uses life cycle assessment (LCA) to develop a better understanding of coal's role in energy supplies and reduction processes. It identifies opportunities to improve coal's environmental performance, as well as innovative areas of research. The life cycle components involve extending classical LCA methodology and tools to incorporate social and economic dimensions.

Project 1.2

SUSTAINABILITY DIMENSIONS AND IMPACTS

Leader: *Prof Cliff Hooker*
The University of Newcastle

The project delivers the conceptual, assessment and planning frameworks for determining the contribution of coal chain industries to a sustainable Australia. It assesses present and future sustainability–relevant impacts of selected coal use scenarios from a global, regional and Australian industry viewpoint and thereby also identifies future research needs.

Project 1.3

LONG-TERM SUSTAINABILITY OF COAL

Leader: *Dr Louis Wibberley*
CSIRO

The project provides cradle-to-grave assessments of coal-based energy systems with increasing focus on large step reductions in GHG mitigation. It includes analyses of a matrix of combinations of electricity, hydrogen and chemicals production. It seeks to understand the synergies between coal and renewable energy on a system-by-system basis.

Project 1.4

SOCIAL FRAMEWORK, BROADER SUSTAINABILITY REVIEW – CONCLUDED

The coal and power generation industries recognise it is essential to keep abreast of leading edge thinking on sustainable development and the role of coal in moves towards sustainability. The project sought to address this complex but critical issue by bringing together key thinkers in the coal and sustainability area from across Australia and internationally to focus on what the sustainability 'principles' mean for the coal industry over the short, medium and longer terms.

Project 1.5

CLEANER PRODUCTION PRINCIPLES AND TOOLS – CONCLUDED

Cleaner Production and Eco-Efficiency are complementary strategies, essentially dealing with the wise use of materials, energy and water while conducting business, regardless of the nature of the business. This research sought to assess the applicability and uptake of Cleaner Production and Eco-Efficiency in the coal industry, in particular among the CCSD industry partners, and catalyse their further application across the coal industry.

2 PROGRAM 2

CURRENT POWER GENERATION

THE CURRENT GENERATION ASSETS FOR COAL FIRED POWER STATIONS IN AUSTRALIA AND ASIA HAVE AN ECONOMIC LIFE OF UP TO 40 YEARS, AND WILL REMAIN IN OPERATION FOR THE SHORT TO MEDIUM TERM. THIS PROGRAM PROVIDES THE MEANS TO IMPROVE THE NEAR-TERM ENVIRONMENTAL AND ECONOMIC PERFORMANCE OF THESE POWER STATIONS.

OBJECTIVES

The program provides the research required by the coal industry and coal users to make informed choices on coal quality and its impact on improving power stations operating practices, technology improvements and new technology options. In particular, the program seeks to improve environmental performance by reducing emissions and GHG intensity.

DELIVERABLES

- 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.

LEFT TO RIGHT
PROF PETER NELSON
PROF DONG-KE ZHANG
DR DAVID FRENCH



Project 2.1

Emissions from current power generation

Leader: *Prof Peter Nelson*
Macquarie University

The project evaluates current and emerging environmental impacts of coal use in a PF fired plant. These include emissions of trace elements and fine particles to the atmosphere, and potential release of trace elements to water. The Centre's research uses measures of emissions and releases as inputs to techniques for the assessment, quantification and reduction of any environmental impacts. The most reliable sources of data are used to assess and reduce the actual environmental impact and inform judicious policy development.

Project 2.2

Coal quality assessment – concluded

The project sought to develop the science and application of advanced techniques for characterising coal and its combustion products for predictive and forensic applications. The project built on the Centre's historical expertise in coal mineral matter research to address ash and slag issues in current and emergent technologies.

Project 2.3

Improvements in PF operations

Leader: *Prof Dong-Ke Zhang*
Curtin University of Technology

The project applies advanced performance predictors and characterisation techniques for coal burnout, nitrogen oxide (NO_x) emissions, heat transfer and other ash effects, primarily in Western Australian power stations. In so doing it is extending the capability of existing Centre expertise and tools to encompass the lower rank coals prevalent in the Western Australian Basin.

Project 2.4

Development of PF operations – concluded

The project provided technical support for greenhouse-gas-abatement, in current Australian power generation assets. It focused primarily on co-combustion technologies including: direct and indirect co-firing of coal and renewable energy sources such as biomass, co-firing of coal and waste materials such as Refuse Derived Fuels (RDF) and co-combustion of natural gas and coal.

Project 2.5

Advanced process modelling tools for coal power generation applications – concluded

The project developed the capability to predict the behaviour of slags over a wide temperature range. Using advanced mathematical processes to describe high temperature phase chemistry and physico-chemical properties of complex inorganic systems, the research product can be used to target improved process control and efficiencies in a wide range of current power, transitional power and iron making technologies.

Project 2.6

QEMSCAN for characterisation of coal and utilisation by-products

Leader: *Dr David French*
CSIRO

The project is developing new QEMSCAN analytical techniques for coal and coal by-product characterisation, providing a unique source of information that can be used by the coal industry to optimise existing preparation and utilisation technologies, and assist in the development of new technologies with attendant cost savings. The outcome will be an advanced phase-specific characterisation tool that can be used to provide quantitative mineralogical, textural and morphological data for the development of more cost-effective strategies for coal utilisation and to address technical and marketing issues of coal preparation and utilisation.

3 PROGRAM 3

TRANSITIONAL POWER GENERATION

ADVANCED POWER GENERATION TECHNOLOGIES WILL BE INTRODUCED OVER THE MEDIUM TERM - THE NEXT SEVERAL DECADES. THE PROGRAM SUPPORTS THE INTRODUCTION OF CLEAN COAL TECHNOLOGIES (CCT) THAT TARGET STEP-CHANGE REDUCTIONS IN GREENHOUSE GAS EMISSIONS. THE PROGRAM DEVELOPS AN UNDERSTANDING OF COAL PERFORMANCE IN PROCESSES SUCH AS INTEGRATED COAL GASIFICATION COMBINED CYCLE (IGCC) POWER GENERATION AND OXYGEN FIRED PULVERISED COAL COMBUSTION (OXYFUEL). RESEARCH IS DESIGNED TO SUPPORT THE EARLY DEMONSTRATION OF THESE TECHNOLOGIES TO FACILITATE MARKET UNDERSTANDING OF SUCH SYSTEMS AND THE FEATURES THAT MAKE THEM COMMERCIALLY ATTRACTIVE.

OBJECTIVES

The program provides research that supports the introduction and adoption of transitional power systems by providing decision support for:

- New investment in the coal fired power generation industry; and
- Development of government's environmental and energy policy.

DELIVERABLES

- Evaluation and optimisation of Australian coals for advanced technologies for domestic and overseas markets;
- Decision support for new investment and policy through information sharing, predictive tools for coal performance and involvement in demonstrations of emergent technology; and
- A facility for showcasing clean coal technologies.

LEFT TO RIGHT
DR DAVID HARRIS
PROF TERRY WALL
PROF COLIN WARD



Project 3.1

ENTRAINED-FLOW GASIFICATION

Leader: *Dr David Harris*
CSIRO

The project examines the performance of Australian coals in IGCC by investigating the effect of coal properties on gasifier engineering and operating variables and its impact on associated downstream processes such as gas treatment and cleaning. The project uses established Centre capabilities, facilities and techniques to provide performance assessments of Australian coals under conditions used by the leading gasification technologies being implemented in IGCC power generation systems. This work will also include the performance of coals in conjunction with the likely co-gasification fuels that will be increasingly used in IGCC systems.

Project 3.2

FLUIDISED BED COMBUSTION – CONCLUDED

The Centre has delivered and retains substantial capability and facilities for modelling and testing the performance of coals in pressurised fluidised bed combustion (PFBC) systems. The project also examined the character and effects of ash in such fluidised beds.

Project 3.3

POWER SYSTEMS EVALUATION

Leader: *Prof Colin Ward*
The University of New SouthWales

The project reviews the developing status of transitional energy technologies with a focus on systems solutions for the Australian power and coal export industry. In particular, the gasification of coal and other hydrocarbon fuels is a key enabling technology that is expected to be developed in conjunction with advanced energy systems. Progressively advanced flow sheets of potential application including hybrid gasification/combustion and fuel cell technologies are being considered.

Project 3.4

OXY-FUEL SCIENCE AND TECHNOLOGY

Leader: *Prof Terry Wall*
The University of Newcastle

The research examines the impact of oxygen and recycled flue gas on combustion and boiler design and provides flow sheet options with the associated gas cleaning required for carbon capture and storage. The research is providing the capability to predict oxyfuel combustion performance and associated heat transfer and emission characteristics, by extrapolating laboratory and pilot-scale measurements to industrial scale applications.

Project 3.5

OXY-FUEL FEASIBILITY STUDY – CONCLUDED

The project evaluated the science and technology of oxygen fired pulverised fuel combustion (Oxy-fuel), with a focus on providing a storage ready CO_2 product stream. The Oxy-fuel Feasibility Study was based on a single Callide A boiler located in central Queensland to demonstrate the technology using Australian coals. The primary deliverable of the feasibility study was a reference design with comprehensive technical and cost details for the retrofit of the existing boiler as the basis for a first-of-kind demonstration plant. The results of this project will be used in CS Energy's recently announced $188 million world-first Oxy-Fuel Demonstration Project.

Improve Understanding of the Place of Coal in the Transition to Sustainable Development

Identify Appropriate Transition Paths

4 Program 4

Future Scenarios and Technologies

THE FUTURE SCENARIOS PROGRAM IS DESIGNED TO ENSURE THAT AS RISK AND UNCERTAINTY AROUND THE INTRODUCTION OF DEVELOPMENTAL AND EXPERIMENTAL TECHNOLOGIES INCREASE, THERE IS REALISTIC AND OPEN ASSESSMENT OF ALL THE BENEFITS AND COSTS OF THE ALTERNATIVES, BOTH AS THEY EXIST NOW AND HOW THEY MAY EXIST IN THE FUTURE. IT INVESTIGATES THE NATURE OF CHANGE AND OPTIONS THAT MAY PERMIT INCREASED INTERLINKING OF 'ENERGY SYSTEMS'. THIS COULD OPEN NEW OPPORTUNITIES FOR ENVIRONMENTAL CREDITS AND SPAWN INDUSTRY CLUSTERS THAT SHAPE THE DEVELOPMENT OF THE COAL AND ITS CUSTOMERS TOWARDS MORE SUSTAINABLE ENERGY OPTIONS BOTH NATIONALLY AND INTERNATIONALLY.

OBJECTIVES

The program provides research to:

- Evaluate emerging technologies, 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.

DELIVERABLES

- 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's 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; and
- Options for technology demonstrations.

LEFT TO RIGHT
MR PETER COOMBES
DR JOE DA COSTA

Project 4.1

PORTFOLIO OPTIONS AND RISK ASSESSMENT

Leader: *Mr Peter Coombes*
Delta Electricity

The project consolidates technology and trading options into integrated portfolio possibilities, using scenario analyses and process engineering tools to optimise mass, energy and cash flows. This information is being used to provide information that places value on flexibility within options and assess the benefits likely to flow from adapting an investment over its life to changing circumstances. The project is examining possible portfolio mixes of technology which minimise business exposure to carbon emissions, and identifies opportunities to minimise other emissions by integrating industries in Energyplexes.

Project 4.2

GREENHOUSE GAS REDUCTION AND OPTIONS – CONCLUDED

The project reviewed up-to-date knowledge of international developments related to zero emission technologies. It examined coal technologies with carbon capture and storage options relevant in an Australian context. Research also sought to develop simplified models for various CO_2 capture technologies that can be readily incorporated into the system studies being undertaken by other Centre projects.

Project 4.3

BARRIERS TO COAL UTILISATION TECHNOLOGY CHANGE – CONCLUDED

The project was designed to look more broadly at barriers to introduction of new concepts and at methodologies for their evaluation. Undertaken as a range of minor projects to test fresh areas for research that may exist beyond existing horizons, the project has concluded its current tasks.

Project 4.4

MEMBRANE REACTORS FOR WATER GAS SHIFT REACTIONS

Leader: *Dr Joe da Costa*
The University of Queensland

High temperature membrane reactors show great potential for gasification systems for hydrogen production. The project focuses on the development of a high temperature water gas shift membrane reactor for gasification systems. It aims to develop catalyst films to interface with silica films in membrane reactors and optimise catalyst and silica films for the water gas shift reaction.

Improve Understanding of the Role for Coal in Sustainable Ironmaking Processes

PROF VEENA SAHAJWALLA

5 PROGRAM 5

IRONMAKING

LONG TERM STRATEGIES ARE REQUIRED IN ORDER TO MAKE A SIGNIFICANT CHANGE IN GREENHOUSE GAS EMISSIONS IN IRONMAKING. LCA STUDIES SUGGEST THAT EMERGING COAL BASED TECHNOLOGIES CONSUME UP TO 14% LESS ENERGY THAN THE CONVENTIONAL BLAST FURNACE ROUTE TO STEELMAKING. IRONMAKERS ARE INVESTING IN MORE SUSTAINABLE PROCESS ALTERNATIVES SUCH AS A LOW TEMPERATURE OPERATION, WHICH COULD PROVIDE UP TO 50% REDUCTION IN ENERGY CONSUMPTION. COKE QUALITY IS OF FUNDAMENTAL IMPORTANCE IN THE OPERATION OF BLAST FURNACES. UNDER SUCH INNOVATIVE CONDITIONS CURRENT MEASURES OF FUEL QUALITY AND PERFORMANCE MAY NOT BE RELEVANT. THIS PROGRAM OF RESEARCH SEEKS TO UNDERSTAND THE PERFORMANCE OF COAL AND COKE IN SUCH EMERGENT CONDITIONS AND DEVELOP NEW MEASURES FOR FUEL PERFORMANCE IN NEW AND DIFFERENT IRONMAKING PROCESSES.

OBJECTIVES

The program provides research that supports coal utilisation in current and future ironmaking within the context of sustainable steel making processes.

DELIVERABLES

- Characterisation of the performance of coal in new ironmaking technologies to demonstrate the value of Australian coal;
- Scope the potential for blast furnace fuel rate reduction and quantify risk factors for adoption;
- Assessment of alternative injectants in ironmaking through participation in pilot demonstrations of waste injection; and
- Assessment of options for transitional and emerging processes in sustainable iron and steel making technologies.

PROJECT 5.1

COAL USE IN BLAST FURNACES

Leader: *Prof Veena Sahajwalla*
The University of New South Wales

The project is developing a fundamental understanding of coke reactions for innovative low temperature Blast Furnace (BF) processes which seek to significantly reduce fuel consumption in blast furnaces. The project investigates coke reactions with gas, metal and slag under current and future process conditions. It will deliver an improved understanding of what constitutes acceptable performance of coke made from Australian coals in emergent ironmaking processes.

Improve Understanding of the Place of Coal in the Transition to Sustainable Development

Conduct Scientific Research to Improve the Environmental Performance of Current Technologies



LEFT TO RIGHT
PROF PETER NELSON
PROF DONG-KE ZHANG
PROF COLIN WARD

6 PROGRAM 6

BY-PRODUCTS AND WASTE

THIS PROGRAM DELIVERS VALUE BY IDENTIFYING WAYS TO USE COAL BY-PRODUCTS OR RESPONSIBLY MANAGE THEIR DISPOSAL AS WASTE. COAL USE IN POWER PRODUCTION AND IN METALLURGICAL PROCESSES RESULT IN BOTH AIRBORNE AND SOLID WASTE MATERIAL STREAMS. CAREFUL MANAGEMENT AND APPLICATION OF APPROPRIATE TECHNOLOGY TO THESE STREAMS IS REQUIRED IF THEIR IMPACT ON THE ENVIRONMENT IS TO BE KEPT BENIGN OR BETTER STILL BE PUT TO GOOD USE. THE PROGRAM MEASURES THE ENVIRONMENTAL IMPACT OF WASTE DISPOSAL, IDENTIFIES TECHNICAL, LEGISLATIVE AND ECONOMIC FACTORS MITIGATING AGAINST BY-PRODUCT USE, AND, WHERE APPROPRIATE, CONDUCTS RESEARCH TO UNDERSTAND THE LONGER-TERM LIABILITY OF WASTE DISPOSAL STRATEGIES AND PRACTICES.

OBJECTIVES

The program provides research that addresses environmental issues associated with waste management and opportunities for waste utilisation.

DELIVERABLES

- Identify options to minimise 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-effective 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.

PROJECT 6.1

WASTE MANAGEMENT

Leader: *Prof Peter Nelson*
Macquarie University

The project investigates technical issues in the management of liquid and solid wastes associated with coal utilisation. It focuses on strategies for solids waste minimisation or transformation of the waste products from coal combustion. This reduction of impact is necessary if coal is to be recognised as a legitimate contributor to a sustainable energy mix into the future. The project also undertakes assessments of ash quantities and properties along with utilisation and disposal options both for conventional power generation routes and those proposed to meet the needs of future generation capacity and pollutant controls.

PROJECT 6.2

UTILISATION OF SOLID WASTE BY-PRODUCTS

Leader: *Prof Dong-Ke Zhang*
Curtin University of Technology

The project is investigating methods to increase the use of coal derived ashes and slags which are used as inputs to other processes. The research is targeted at bulk utilisation applications with an emphasis on removing the barriers to widespread coal combustion by-products (CCB) use.

PROJECT 6.3

ENVIRONMENTAL ASSESSMENT OF FLY-ASH USE IN MINE BACKFILL APPLICATIONS

Leader: *Prof Colin Ward*
The University of New South Wales

The project aims to provide a scientifically sound basis for removing some of the potential regulatory and perceived environmental risk issues that might otherwise act as impediments to the economic use of coal ash in mine backfill applications, and at the same time develop a generic protocol for matching individual ashes with specific mine-site requirements.

CCSD is a unique joint venture of black coal producers, users and scientists that delivers world class research through effective and industry focused collaboration.

CCSD Research Services and Capabilities

CCSD offers a range of scientific research services to its participants and external customers. Undertaken as part of the Centre's technology transfer and commercialisation program, products are available in a range of categories as listed below:

REPORTS

- Scientific Research
- Technical Assessments

EVENTS

- Annual Conferences
- Workshops/Seminars/Colloquia
- Eminent Visitor Program
- Training Courses
- Reviews and Updates

PREDICTIVE MODELLING

- Slagging in IGCC Gasifiers
- Coal Behaviour in PF Boilers:
  - Ash slagging, fouling and erosion effects;
  - Carbon Burnout; and
  - Hydro-geochemical implications of ash emplacement

ASSESSMENT MODELLING

- Life Cycle Assessment
- Electricity Market Models
- Techno-Economic Assessment
- Scenario and Real Options Assessment

FORENSIC ANALYTICAL FACILITIES AND SERVICES

- Coal Characterisation
- Trace Element Analyses
- Evaluating Coals for PF combustion, IGCC and PFBC

STRATEGIC INSIGHTS

- Status of Advanced Power Generation Technologies
- Linkage to an International Research Network
- Emerging Trends affecting Coal:
  - Sustainable Development; and
  - Climate Change.

Benefits to CCSD Participants

INFORMED STRATEGIC DECISIONS THROUGH:

- Understanding the drivers for future power generation asset portfolios;
- Mitigating the risks in asset investment;
- Informing the policies that lead to sustainable coal use; and
- Leveraged research investment.

IMPROVED ENVIRONMENTAL PERFORMANCE THROUGH RESEARCH THAT:

- Reduces greenhouse gas and other emissions;
- Minimises waste through innovation; and
- Responsibly addresses longer term waste disposal.

UNDERSTAND COAL PERFORMANCE IN CLEAN COAL TECHNOLOGIES SUCH AS:

- Coal Gasification in IGCC;
- Oxygen-Fired Pulverised Fuel Combustion; and
- Ironmaking.

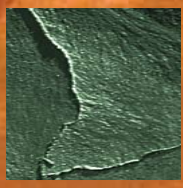
Glossary of Terms

BF	Blast Furnace
CCB	Coal Combustion By-Products
CCS	Carbon Capture and Storage
CCSD	Cooperative Research Centre for Coal in Sustainable Development
CCT	Clean Coal Technologies
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CO_2	Carbon Dioxide
GHG	Greenhouse Gases
IGCC	Integrated Gasification Combined Cycle
LCA	Life Cycle Assessment
NO_x	Nitrogen Oxides
OXYFUEL	Oxy-fired Pulverised Coal Combustion
PF	Pulverised Fuel
PFBC	Pressurised Fluidised Bed Combustion
RDF	Refuse Derived Fuels

CCSD

COOPERATIVE RESEARCH CENTRE FOR
COAL IN SUSTAINABLE DEVELOPMENT



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CCSD IS A RESEARCH COLLABORATION BETWEEN:

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COAL & ALLIED
cs energy
CSIRO
Curtin University of Technology
Delta electricity
GRIFFIN COAL
MACQUARIE University
Premier Coal
Queensland Government Natural Resources and Mines
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