BROWN COAL INNOVATION AUSTRALIA

Positioning brown coal for a brighter future

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MEDIA RELEASE

Research Projects Aim to Slash Emissions from Brown Coal Power and Develop Future Hydrogen Industry

Brown Coal Innovation Australia (BCIA) today announced funding for two world-class research and development projects which offer enormous potential to significantly reduce carbon emissions from brown coal power generation and create new industry and employment opportunities for Australia from low-emissions brown coal utilisation.

The R&D projects were selected as part of BCIA's $8.3 million 2011 funding round and encompass an assessment of hydrogen production and export from Victoria and research which aims to halve carbon emissions from brown coal-fired power by significantly increasing efficiency of a direct injection coal engine.

BCIA Chair, Gerry Morvell, said: "Our 2011 R&D funding round proves that industry and leading research institutions are strongly committed to securing a low-emissions future for Australia's vast brown coal resources. The basic process we use today for power from brown coal is more than a century old. Although it has served the community well, the emission levels are no longer sustainable. We do however have an opportunity to lead the world in the development of new low-emissions coal technologies and to ensure our nation's future economic prosperity."

BCIA will provide $1.3 million for a project involving CSIRO Advanced Coal Technology and Exergen Pty Ltd which will investigate high efficiency power generation using processed Victorian brown coal in an adapted diesel engine. The project expects to deliver a step-change in fuel cycle efficiency enabling a 45 per cent reduction in CO_2 emissions, and consequent increase in productive efficiency, compared with the best existing brown coal-fired power plants.

Additionally, BCIA has committed to $300,000 for a HRL Developments Pty Ltd project in association with Japan's Kawasaki Heavy Industries Limited which will examine the technical and economic merits of various options for production of hydrogen, at both pilot and commercial-scale, from Victoria's Latrobe Valley brown coal.

The total leveraged value of the 2011 BCIA research projects is $20.6 million including industry, research institute and State and Federal Government funding. Six other projects which secured funding in this year's R&D round were announced in late June this year.

BCIA established ambitious cost and risk reduction targets as focus areas for the Company's inaugural funding round. BCIA Chief Executive, Dr Phil Gurney, said: "We believe these targets – which seek to demonstrate cost-effective technologies from brown coal utilisation by 2020 – are required to ensure a sustainable future for brown coal."

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BROWN COAL INNOVATION AUSTRALIA FUNDING ROUND FACTSHEET

Brown Coal Innovation Australia (BCIA) today announced $1.6 million in funding for two highly meritorious research and development projects in brown coal low-emissions and innovation technologies.

The total leveraged value of BCIA's 2011 R&D projects is $20.6 million including research institute, industry and State and Federal Government (via Australian National Low Emissions Coal R&D) contributions.

BCIA is continuing to negotiate research plans and contracts for a further two R&D projects submitted via the 2011 funding round; these projects are expected to be announced during the next few weeks.

ABOUT BROWN COAL INNOVATION AUSTRALIA

Brown Coal Innovation Australia (BCIA) is a not-for-profit company with a mandate to co-invest with stakeholders in brown coal innovation and emissions reduction technologies.

BCIA funds and facilitates multi-million dollar research and skills development investments to drive innovation in the brown coal value-chain, from mine-mouth to the capture of CO_2. The company's mission is to invest proactively in the development of technologies and people that broadens the use of Australia's world-class brown coal resource for a sustainable future.

Strategic management of its R&D investment portfolio underpins BCIA's innovation support and operational activities. The company is addressing the challenges and opportunities of fostering low-emissions brown coal development by:

- providing a key entry point to progress shared research and development activity between industry, research and government stakeholders
- focusing strongly on skills-development and the expansion of training opportunities to secure the scientific, engineering and trades expertise needed for development of new low-emissions brown coal technologies.

BCIA innovation funding supports research and development initiatives that are technically excellent and that will lead to increased commercial deployment of low-emissions brown coal technologies in the short, medium and long term.

Australia has vast brown coal reserves; encompassing about a quarter of the world's known reserves. However the nation lacks world-scale, private-sector companies that operate in coal exploitation generally, and in brown coal utilisation particularly.

As a result, private-sector capacity and capability for investment in brown coal R&D is restricted. Innovation of improved technology for brown coal usage involves substantial costs and time and continuing under-investment in R&D has significant implications for industry competitiveness and Australia's future economic prosperity.

To date, the vast majority of R&D activity in brown coal technologies has focused on power generation and, more recently, efficient water removal technologies. Beyond emissions reduction, current and future international price indications for oil, gas and metallurgical coal provide new exploitation opportunities for the conversion of brown coal to liquids and other high-value commodities.

In particular, Victoria's world-scale brown coal resource and acknowledged potential for geological storage of CO_2, mean that the State is well placed to generate significant returns on public investment to foster growth in innovation and low-emissions utilisation of brown coal.

BCIA's innovation support spans three key spectrums:

- R&D in low-emissions, low-cost, coal technologies and novel, high-value products derived from brown coal
- Skills development and new training opportunities to secure scientific, engineering and trades expertise
- Linkages and networks to foster international collaboration in innovation and low-emissions technologies

BCIA 2011 FUNDING ROUND FOCUS AREAS

BCIA identified cost and risk reduction as focus areas for the organisation's inaugural funding round. Successful grant applications were required to demonstrate how they would make a significant contribution to the following cost reduction targets:

COST REDUCTION

- $100/200/2020 – a levelised production cost target for electricity generation from brown coal of $100 per MWh (sent out) at a CO2 emission level of not more than 200 kg per MWh in commercial-scale demonstration by 2020
- 50%/100/2020 – a levelised production cost target for non-power generation products derived from brown coal (including novel, high-value products) that is at least 50 per cent lower than those from conventional sources, at a CO_2 emission level of not more than 100 kg per MWh in commercial-scale demonstration by 2020.

RISK REDUCTION

Risk reduction projects were required to demonstrate how they would contribute to reducing the risks likely to affect the success over the next five to seven years of proposed large-scale demonstration and/or early-deployment projects for low-emissions power generation from brown coal.

BCIA 2011 FUNDING ROUND PROCESS

The BCIA R&D funding round was undertaken in two stages: a call for Expressions of Interest, followed by an invitation for shortlisted applicants to submit full proposals. The BCIA Research Advisory Committee (RAC) assessed both EOIs and full proposals and provided advice to the BCIA Board.

The BCIA RAC assessed the merits of the EOIs against the following high-level selection criteria:

- The project: The strategic, technical, competitiveness, budgetary and 'value for money' merit of the proposed project. BCIA seeks projects that offer high value for our contribution to the total cost of the project. A minimum 1:1 funding criterion is required for R&D projects.
- The people and collaborations: The quality of the key people, including their capability and capacity to achieve the objectives of the project, together with the synergies in proposed collaborations to produce genuine, collaborative outcomes.
- The contribution to BCIA's research investment objectives and priorities.

The BCIA Board considered all submitted EOIs and full proposals; only project applications of the highest merit were selected. In all areas, industry and government partnerships that increased project funding leverage beyond the matched funding criteria and reduced commercialisation risk were viewed favourably.

The amount of funding released and the funding allocations against each focus area were at the discretion of the BCIA Board. All approved projects will be stage-gated to ensure continuing support only on the basis of demonstrable achievement of clearly-defined milestones.

BCIA 2011 RESEARCH AND DEVELOPMENT PROJECT GRANTS

- $1,300,000 funding for *'High efficiency power from Victorian brown coals';* submitted by CSIRO Advanced Coal Technology. Project participants include Exergen Pty Ltd and Ignite Energy Resources Pty Ltd.

This project will investigate high efficiency power generation using processed Victorian brown coal in an adapted diesel engine. A range of low-cost, coal processing technologies will be examined and the research program expects a step-change in fuel cycle efficiency which will enable a 45 per cent reduction in CO_2 emissions compared with the best existing brown coal power plants. The increased efficiency of the direct injection coal engine powered by lignite water fuel can be achieved at one fifth the unit capacity of proposed new low-emissions coal fired power plants; thereby substantially reducing the capital costs of low-emissions brown coal energy in the near term. The direct injection coal engine also offers the potential of increased operational flexibility to support peak load electricity demand and supply from intermittent renewable energy.

- $300,000 funding for *Hydrogen energy supply chain development*'; submitted by HRL Developments Pty Ltd in association with Kawasaki Heavy Industries Limited. Project participant HRL Technology Pty Ltd.

Hydrogen produced from the gasification of brown coal, linked with carbon capture and storage technology, can provide a valuable energy source with low CO_2 emissions. This project will examine the process design and key infrastructure requirements for hydrogen production at both the pilot and commercial-scale using both commercially available and new technologies. The market potential for the product will be examined and the cost effectiveness of the process will be assessed against alternative means of production.

- $1,500,000 funding for *'CO2CRC's Solvent-Based Carbon Capture Technology in Brown Coal Fired Power Plants – (CSCCT-BCFPP) Capture Demonstration for Cost Reduction'*; submitted by CO2CRC Limited in association with International Power Hazelwood; CO2CRC partners and Process Group.

This project will identify the best-performing and most cost-effective solvent absorbent technologies for the capture of CO_2 emissions from brown coal through modification of two existing pilot-scale facilities in Victoria. Recent research trials have demonstrated a range of benefits from the use of solvent potassium carbonate including negating the need for separate flue gas desulphurisation facilities. An experimental program and simulation studies will be used to further improve the performance of the potassium carbonate process for CO2 removal. The project will also examine CO2CRC's precipitating potassium carbonate process including the removal of sulphur and nitrogen oxide impurities; a valuable by-product which could be further processed as fertilisers. Additionally, a modified pre-combustion solvent-based capture plant will undertake world-first trials of state-of-the-art WES absorber technology. Research results will enable international benchmarking of solvent absorbent technologies against current CO_2 capture techniques, develop clear directions for large-scale deployment and create the necessary competitive tension to drive down CO_2 capture costs.

- $605,000 funding for *'Development of chemical looping process for fuels production and CO_2 capture from Victorian brown coals'*; submitted by Monash University in association with TRUenergy; CSIRO Process Science and Engineering and leading European universities engaged in chemical looping research - Chalmers University of Technology Gothenburg, Sweden and Technical University of Darmstadt, Germany.

This is the first known study of chemical looping combustion and gasification of Victorian brown coal as an emerging alternate technology for the capture of CO_2 at a lower energy and cost penalty. Chemical looping has been widely studied for the combustion of natural gas but research into its potential application for solid fuels commenced only recently. Utilising metal oxides as a major source of oxidising agent, rather than concentrated gaseous oxygen from air separation plants, the technology removes the energy and capital costs of air separation plants. It is believed the low ash content, high reactivity and high oxygen content of Victorian brown coal is particularly suited to chemical looping and the process also has the potential to advance value-added brown coal technologies such as low-emissions hydrogen production.

- $603,028 funding for *'Development of entrained flow gasification technology with brown coal for generation of power, fuel and chemicals'*; submitted by Department of Chemical Engineering, Monash University in association with Mitsubishi Heavy Industries.

This project will model the characteristics of molten slag from Victorian brown coal under gasification to enable the future use of entrained flow gasifiers for brown coal-fired power generation. Gasification is capable of producing coal-fired electricity more efficiently and with reduced CO_2 emissions; thereby lowering generation costs. The project will develop commercially-applicable models for prediction of the slag behaviour of Victorian brown coals including slag formation, slag viscosity and trace element emissions while also making preliminary assessment of coal reactivity under entrained flow gasifier conditions. The measurement of slag viscosity under gasification will be undertaken in a state-of-the-art viscometer (one of only two operating in Australia) to be built at Monash University. The project is an international collaboration combining Monash University's expertise in brown coal gasification research and Mitsubishi Heavy Industries' experience with commercial scale coal gasifiers.

- $525,000 funding for *'Improved handling of lignite-based products'*; submitted by Monash University. Project participants include Environmental Clean Technologies Ltd; LawrieCo; Keith Engineering (Australia) Pty Ltd.

Dried or de-watered lignite (brown coal) is prone to spontaneous combustion following exposure to air, making lignite-based products notoriously difficult to handle and transport. This project has the potential to open up significant new domestic and global markets for Victorian brown coal through improved control of the composition and particle size distribution of lignite products. The first part of the project will seek to identify processing methodologies that can

significantly reduce the tendency of lignite to spontaneously combust. This will involve an investigation of the physical (structural) and chemical features of lignite which correlate with the low temperature, heat-releasing oxidisation processes that result in combustion. The second part of the project will investigate and establish optimum conditions for the granulation of lignite and lignite-derived fertilisers. This research will be used to develop an integrated granulation and drying process for lignite using superheated steam.

- $500,000 funding for *'Next Generation Lower Emissions Gasification Systems R&D - Power and Products'*; submitted by HRL Technology Pty Ltd in association with Monash University and CO2CRC.

This research project will investigate options for high-efficiency, low-cost, advanced integrated drying and gasification systems for the production of power and high-value products from brown coal. Use of integrated drying and gasification technology for combined-cycle power generation has the potential for a significant improvement in plant efficiency, and consequent reduction in CO_2 emissions, compared with existing brown coal-fired power plants. Integrated drying and gasification is believed to be an economical means of producing syngas from brown coal suitable for further processing into high-value products such as liquid fuels, hydrogen, fertilisers, chemicals and advanced power systems utilising, for example, fuel-cells. The research project will investigate various existing and emerging process options that could be employed in the future. One of the key outcomes of this project will be the identification of further laboratory and pilot-scale work required to develop next generation lower emissions gasification system options utilising integrated drying and gasification technology.

- $450,000 funding for *'Coal-derived additives: a green option for improving soil carbon; soil fertility and agricultural productivity?'*; submitted by Monash University. Project participants include Clean Coal Victoria; International Power; LawrieCo; Exergen Pty Ltd and Environmental Clean Technologies.

This project will evaluate the merits of using Victorian brown coal and its derived products for improving soil health and plant yields and increasing carbon capture from the atmosphere. The study will involve glass house and field plot trials to determine the best performing brown coal derived materials, specifically humic/fulvic acid containing materials and char, for plant growth, soil health and soil carbon capture. Additionally, the project will compare char from brown coal with existing commercial char products and evaluate phosphorous fertilisers coated in a brown coal derived humate to determine improvements in soil health and associated increases in carbon uptake. The research plan will incorporate a life-cycle assessment of brown coal products for agricultural applications including all aspects of the supply chain, transport and distribution.

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