



**Trade &
Investment**
Resources & Energy

Report to NSW Parliament

Coal Innovation NSW Fund

**Income, Expenditure
&
Evaluation of Projects**

2011-2012

Coal Innovation NSW Fund

Income and Expenditure, and Evaluation of Projects Report 2011/2012

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Annual Report 2011-12

Coal Innovation NSW Fund

Outcomes Achieved to 30 June 2012

A. BACKGROUND

On 22 August 2011 the Coal Innovation Administration Act 2008 (Act) was assented to, renaming the Council and Fund to the Coal Innovation NSW Fund (Fund) and Coal Innovation NSW (CINSW) respectively. The amending Act, caused the phrase "Clean Coal" to be replaced with "Low Emissions Coal".

Part 2, section 5 of the Act establishes the Purpose of the Fund, as follows:

- (a) to provide funding for research into, and development of, low emissions coal technologies,
- (b) to provide funding to demonstrate low emissions coal technologies,
- (c) to provide funding to increase public awareness and acceptance of the importance of reducing greenhouse gas emissions through the use of low emissions coal technologies, and
- (d) to provide funding for the commercialisation of low emissions coal technologies.

Part 2, section 7 of the Act, details Payments out of the Fund, to include:

- (1) There is payable from the Fund:
 - (a) payments approved by the Minister for the purposes of the Fund,
 - (b) administrative expenses incurred in relation to the Fund or CINSW, and
 - (c) payments directed or authorised to be paid from the Fund by or under this or any other Act or law.
- (2) Any money paid into the Fund on the condition that is to be used only for a specified purpose, including any proceeds of the investment of that money in the Fund, is only payable from the Fund for the specified purpose and a proportionate share of the administrative expenses payable from the Fund.
- (3) The Minister is to produce an Annual Report detailing fund allocations and the projects and other activities that received funding under this Act during the year.
- (4) The Annual Report is to include an evaluation of the effectiveness of each of the projects and other activities that received funding under this Act.
- (5) The Annual Report is to be tabled in each House of Parliament within 6 months after the end of the financial year to which it relates.
- (6) The Minister is to publish each Annual Report, so as to promote low emissions coal technologies to the NSW public.

Part 3, section 10 of the Act, prescribes the Membership of CINSW, as follows:

- (1) CINSW is to consist of the following members appointed by the Minister:
 - (a) an independent person appointed by the Minister to be the Chairperson of CINSW,
 - (b) 2 persons, each of whom is employed in or by a government agency,
 - (c) 2 persons who are nominated jointly by the Australian Coal Association and the Minerals Council to represent the New South Wales black coal industry,
 - (d) such other persons (up to a maximum of 4) as the Minister may appoint from time to time, being persons whom the Minister considers have qualifications or experience relevant to the functions of CINSW.

Part 3, section 11 of the Act establishes Coal Innovation NSW (CINSW) and prescribes its functions.

- (1) The functions of CINSW are as follows:

- (a) *to give advice and make recommendations to the Minister concerning the funding from the Fund of projects and other activities for the purposes of the Fund, including advice about priorities for funding and recommendations concerning applications for funding,*
 - (b) *to advise the Minister on policies to encourage the development and implementation of low emissions coal technologies,*
 - (c) *to make recommendations to the Minister concerning opportunities for involvement by private and public sector entities in interstate, national and international research projects involving low emissions coal technologies,*
 - (d) *to advise the Minister on such other matters concerning low emissions coal technologies as the Minister may refer to the CINSW,*
 - (e) *such other functions with respect to low emissions coal technologies as the Minister may from time to time direct.*
- (2) *CINSW may give its advice and make its recommendations either at the request of the Minister or without any such request.*
- (3) *CINSW has such other functions as are conferred or imposed on it by or under this or any other Act.*

CINSW members have been appointed for a term of two years, ending 31 December 2013.

The purpose of this report is to fulfil the requirements of the Act's Part 2, Sections 7(3) to 7(6) inclusive. That is to produce an Annual Report detailing Coal Innovation NSW's Fund allocations and to provide an evaluation of the effectiveness of each of the projects.

B. PAYMENTS RECEIVED

In the 2011/12 financial year, payments to Coal Innovation NSW Fund totalled \$18.5 million from the NSW Climate Change Fund, (via the Office of Environment and Heritage). Payments were received as follows:

- 1 payment of \$18.5 million was received on 30 June 2012.

C. EXPENDITURE

Coal Innovation NSW has dispersed funds received from the Climate Change Fund across the key areas as set out below:

1. Coal Innovation NSW (formerly Council) & Technical Working Group costs

For the financial year ending 30 June 2012 the following funds have been expended in relation to the costs of Coal Innovation NSW (CINSW). (It is noted that the Technical Working Group did not meet during this period):

DESCRIPTION	VALUE \$
TOTAL COSTS OF COAL INNOVATION NSW (COUNCIL).	10,189.65

Coal Innovation NSW met on the following dates during the 2011/12 financial year and discussed the following matters:

DATE OF MEETING	KEY ISSUES OF THE MEETING
14 MARCH 2012	FIRST MEETING OF CINSW - OPERATIONAL AND FORWARD PLANNING.
13 JUNE 2012	COMMUNITY ENGAGEMENT & FUNDING ARRANGEMENTS.

2. Coal Innovation NSW Secretariat – Salary costs

The Coal Innovation NSW Secretariat employs four staff:

- Director,
- 2 Senior Project Officers, and
- Project Officer

For the financial year ending 30 June 2012 the following funds have been expended against salaries and on costs:

DESCRIPTION	VALUE \$
SECRETARIAT COSTS INCLUDING SALARIES	553,827.49

3. Delta Carbon Capture and Storage Project (Delta Electricity).

For the financial year ending 30 June 2012 the following funds have been expended in relation to the Delta CCS project:

DESCRIPTION	VALUE \$
DELTA CCS PROJECT MILESTONE 6: PROJECT DELIVERY VEHICLE FORMED.	101,480.17
DELTA CCS PROJECT MILESTONE 10: CAPTURE PLANT CAPACITY CONFIRMED.	160,000.00
TOTAL CCS DELTA DEMONSTRATION PROJECT	261,480.17

4. Research Projects.

For the financial year ending 30 June 2012 the following funds have been expended in relation to the Research and Development projects:

APPLICANT	PROJECT DESCRIPTION	VALUE \$
UCC ENERGY P/L	UCC BURNING EFFICIENCY	0
CENTENNIAL COAL (MANDALONG) P/L	FUGITIVE EMISSIONS (VENTILATION)	795,809
CSIRO	CAPTURE TESTING SOLVENTS	545,026
CSIRO	FUGITIVE EMISSIONS (OPEN CUT)	0
UNI OF NEWCASTLE	CHEMICAL LOOPING – OXYFUEL	342,907
UNI OF NEWCASTLE	SOCIAL RESEARCH/PUBLIC AWARENESS	330,972
CSIRO	NOVEL CAPTURE & ENERGY EFFICIENCY	329,986
UNI OF NEWCASTLE	DIRECT CARBON FUEL CELL	137,697
TOTAL		2,482,397

5. NSW CO₂ Storage Assessment Program

For the financial year ending 30 June 2012 the following funds have been expended in relation to the CO₂ Storage Assessment Program (renamed from the NSW Data Acquisition & Drilling Program):

DESCRIPTION	VALUE \$
TOTAL STATE WIDE STORAGE ASSESSMENT PROJECT	364,338.65

DESCRIPTION	VALUE \$
GREENHOUSE GAS LEGISLATION WORK	28,242.17

DESCRIPTION – TRAINING	VALUE \$
FIRST AID COURSES	508.50
RISK ASSESSMENT	950.00
DRILLING & SEISMIC 2 DAY COURSE (12- 13 PEOPLE)	10,148.18
GOCAD & SKUA (DAY 1: UP TO 10 PEOPLE, DAY 2: 3-4 PEOPLE)	7,231.28
	18,837.96

6. Membership of CO2CRC

For the financial year ending 30 June 2012 the following funds have been expended in relation to membership of CO2CRC

DESCRIPTION	VALUE \$
MEMBERSHIP OF CO2CRC	250,000.00

7. Community Engagement

For the financial year ending 30 June 2012 the following funds have been expended and accrued in relation to Community Engagement:

DESCRIPTION	VALUE \$
COMMUNITY ENGAGEMENT - ACTUAL EXPENSE	18,290.00
COMMUNITY ENGAGEMENT - <u>ACCRUAL</u> JUNE 2012	17,110.00
TOTAL	35,400.00

D. EVALUATION

8. Evaluation of the effectiveness of each of the projects & other activities that received funding under the Act.

8.1 Coal Innovation NSW (CINSW)

The *Coal Innovation Administration Act 2008 (Act)*, which was assented on 22 August 2011, requires the formation of Coal Innovation NSW (CINSW). As prescribed in Part 3, section 10 of the *Act*, CINSW is to comprise a Chair, and up to eight members. This has meant that Coal Innovation NSW has been streamlined and now consists of two ministerially appointed members from government and two from industry (rather than 5 from government and five from industry as was the case in the previous Clean Coal Council). The Minister is able to appoint up to four additional members (rather than an unlimited number) and an independent person (rather than a member) appointed by the Minister as Chairperson.

As at the 30 June 2012 the membership of CINSW was (and has been the same since the inaugural meeting):

- Dr Neil Shepherd, Chair
- Prof Mary O’Kane, NSW Chief Scientist
- Mr Brad Mullard, ED, Mineral Resources, Department Trade and Investment
- Dr Nikki Williams, Chief Executive, Australian Coal Association
- Mr Michael Buffier, Chairman NSW Minerals Council
- Prof Michael Dureau, Deputy Chairman, Warren Centre for Advanced Engineering
- Prof Jim Galvin, Mining Engineer Consultant and Academic
- Prof Dianne Wiley, Program Manager (CO₂ Capture) CO2CRC and Professor UNSW

CINSW met twice in the 2011/12 financial year, the meeting on 14 March 2012 being the inaugural meeting of the newly formed CINSW, with the second meeting taking place on 13 June 2012.

Of the \$10,189.65 expenditure, \$10,000 was remunerated to the Chair as 50% of the yearly fee of \$20,000 due.

Evaluation:

As the Clean Coal Council (CINSW predecessor) had not met since 2 December 2010, the inaugural meeting of CINSW focused on: the status of low emissions coal technologies; an update on NSW programs; and an examination of current funding arrangements and possible future options for NSW.

The second meeting of CINSW received a detailed presentation from the project managers of the Delta Carbon Capture and Storage Demonstration Project, a NSW primary funding project.

CINSW initial focus is reviewing existing projects, evaluating their progress against expectations and gaining insight into the NSW research profile. This will be ongoing.

8.2 Coal Innovation NSW Secretariat – Salary costs.

Coal Innovation NSW Secretariat employs four staff:

- Director,
- 2 Senior Project Officers (Scientist and Economist), and
- Project Officer.

Evaluation:

Employment at the Secretariat has again been stable. This has allowed the Unit to maximise its efforts in utilising the skills of the staff. Significant tasks for the financial year have centred on:

- management of existing projects
- finalising data collection and modelling of Stage 1A (Sydney Basin) of the NSW CO₂ Storage Assessment Program
- preparation of drilling program for Stage 1B (Darling Basin), examining the risk factors;
- involvement of policy debate at a National level; and
- development a community engagement strategy.

8.3 Delta Carbon Capture and Storage Demonstration Project.

In August 2009, the then Minister, approved \$9.43 million from the NSW Clean Coal Fund for Stage 1 of the Delta Carbon Capture and Storage (CCS) project, being the 'Development and Approvals' phase.

The total for Stage 1 of the project is \$28.3 million. Two thirds of the funding is being provided from the Commonwealth Department of Resources, Energy and Tourism, and ACA Low Emissions Technologies Limited (ACALET) in equal shares, pending conditions of the Funding Agreement being met.

Stage 1 of the Delta CCS project is essentially an approvals and planning stage, the development of a storage site for CO₂ and the Front End Engineering and Design (FEED) stage. Stage 1 will pioneer in NSW:

- community engagement on a CCS project
- gaining exploration permits for CO₂ storage
- establishment of storage leases
- planning and environmental approvals for CCS

Stage 2 will demonstrate the integrated process:

- validate Post Combustion Capture Technology on NSW coals
- verify geological storage techniques

This will provide a road map that is directly applicable to next generation and scale of plant.

NSW has committed \$40 million to Stage 2 of the project, Construction and Operation, along with similar commitments from the Commonwealth and ACALET. NSW's commitment has been allocated within the existing Coal Innovation NSW Fund budget.

Evaluation:

During 2011/12 Delta has met milestones 6 and 10 only in the Funding Agreement, primarily due to no adequate storage site for the CO₂ carbon capture and storage demonstration project being found to date. The project therefore is significantly under

budget. However, the Funding Partners recognise that this under-spending will be corrected in later stages once a storage site for CO₂ is found.

During the year considerable planning work has continued on the environmental aspects of the project, community engagement strategy development, transport logistic options, procurement options, capture infrastructure options and legal aspects.

8.4 Research Projects

A “Call for Expressions of Interest under the NSW Clean Coal Fund” closed on 4 December 2009, and 29 applications were received and assessed. In May 2010, the then Minister approved 10 successful projects as follows:

APPLICANT	BRIEF PROJECT DESCRIPTION	FUNDING, UP TO (\$)	DURATION
UCC ENERGY P/L	UCC BURNING EFFICIENCY	2,581,000	4 YRS
CENTENNIAL COAL (MANDALONG) P/L	FUGITIVE EMISSIONS (VENTILATION)	2,200,000	2 YRS
CSIRO	CAPTURE TESTING SOLVENTS	1,300,000	3 YRS
CSIRO	FUGITIVE EMISSIONS (OPEN CUT)	1,000,000	2 YRS
UNI OF NEWCASTLE	CHEMICAL LOOPING – OXYFUEL	886,618	3 YRS
UNI OF NEWCASTLE	SOCIAL RESEARCH/ PUBLIC AWARENESS	618,930	2 YRS
CSIRO	NOVEL CAPTURE & ENERGY EFFICIENCY	613,711	1.5 YRS
UNI OF NEWCASTLE	DIRECT CARBON FUEL CELL	608,719	5.5 YRS
UNI OF NEWCASTLE & GREENMAG #	MINERAL CARBONATION.	3,040,000	3.5 YRS
OURSUN P/L ##	COMBINED BRAYTON RANKINE CYCLE.	159,200	7 MTHS.
TOTAL		\$ 13,008,178	

University of Newcastle & GreenMag Group – are yet to sign their funding agreement as they are seeking funding support from industry. The Commonwealth Government has confirmed matching funding support for this project.

ourSUN P/L withdrew their application on 1 December 2010.

Funding Agreements are in place for 8 of the above projects for “up to” the approved funding. Funding Agreements were signed in late 2010 and early 2011.

8.4.1 Project: UCC Fired Diesel Engines in the generation of electricity Grantee: UCC Energy Pty. Ltd

UCC Energy Pty Ltd has received initial grant funding for a Life Cycle Assessment (LCA) of their project. The project itself is to further develop their process of producing Ultra Clean Coal (UCC) and assess its use as coal-water fuel for firing in diesel engines to generate electricity. As diesel engines have higher thermal efficiencies than most stationary power plant combustion engines, funding will assess whether UCC can efficiently and effectively operate in diesel engines large enough to generate electricity in a distributed energy network.

The UCC process already removes most of the coal’s impurities and ash through a chemical cleaning process. The end product is micronised refined coal that can be mixed with water and additives to form a slurry fuel for use in diesel engines. Further testing however needs to establish if the long term use of this fuel is viable and can operate effectively in diesel engines.

This project has the potential to fuel small power stations (50-250 MW) based on diesel engines which could be strategically located within the grid. The advantages of this distributed power generation include reduced transmission line losses, fast start capability, and the potential to provide baseload power to support intermittent renewable power sources like wind and solar. This project could provide an alternative pathway to low emissions power based on coal.

Evaluation:

Funding for this project is in two stages with a decision gate at the completion of Stage 1 prior to the approval of Stage 2. Stage 1 was to undertake a Life Cycle Assessment (LCA) on the production of UCC and its proposed use in diesel engines against a baseline of current NSW electricity grid including transmission.

An LCA was prepared by Worley Parsons (WP) that examined and analysed the combustion efficiency of UCC fuel and its greenhouse gas intensity. In accordance with the funding deed agreement, the results of the LCA needed to be assessed by the Coal Innovation NSW and a recommendation made to the Minister.

At the second meeting of the newly reformed Coal Innovation NSW in June 2012, members reviewed the status of this project and agreed to form a technical committee to assess UCC suitability whether to progress to Stage 2, that is a demonstration of UCC in a diesel engine. The technical committee was asked to report back to CINSW 2 weeks prior to the next meeting in August 2012.

8.4.2 Project: Fugitive emissions abatement from ventilation air

Grantee: Centennial (Coal) Mandalong Pty Ltd

Centennial Mandalong P/L has received initial grant funding to trial an exciting new technology termed a VAM-RAB (Ventilation Air Methane Regenerative After Burner) that has potential to mitigate fugitive methane emissions escaping from underground coal mines. These emissions are notoriously difficult to abate because this naturally-occurring gas becomes diluted by the large volumes of ventilation air that is flushed through the mine during standard mining operations. As methane typically constitutes less than 1% of the ventilation air expelled from the mine, the gas concentration is too low to burn-off (often referred to as flaring) or process for electricity generation.

The VAM-RAB system overcomes this problem by directing the ventilation air through what is essentially a large industrial oven where it is heated up to approximately 1000° C. By using this oxidation technique almost all of the methane (> 99%) is converted to carbon dioxide and water. A key feature of the technology is the ability to be self-sustaining without the need for additional energy to maintain the temperature in the combustion chamber. This is accomplished by preventing the heat from migrating out of the chamber via a periodic change in direction of the flow of the ventilation air through the system; hence the title 'Regenerative After Burner'.

Evaluation:

This project progressed well against its quarterly milestone tasks until the end of Quarter 4, 2011, when delays in receiving Environmental Approval delayed the commencement of civil works, which was further hampered by inclement weather. In the lead up to on-site work, it had however achieved important tangible outcomes in

the design of the VAM-RAB (Civil, Structural, Process and Electrical) and carrying out Risk Assessments. Importantly it has manufactured the VAMRAB Unit (refractory, steelwork, precast concrete, instrumentation and equipment) to be ready for delivery to site.

The site has been prepared for the installation of the VAMRAB Unit, but unfortunately there has been a delay in the supply of drainage gas for the experimental stage of the program, which has significantly delayed the project. Hot commissioning and first experimental period is now being scheduled to be completed by the end of 2012/2013.

8.4.3 Project: Further development of post combustion capture

Grantee: CSIRO Energy Technology

CSIRO Energy Technology has received initial grant funding to support a research and development program dedicated to the chemical capture of CO₂ emitted in the flue gas from NSW coal-fired power stations. The program is specifically tailored to focus on NSW black coals and the power stations which they fuel and aims to optimise and improve the aqueous ammonia absorbent process under real working conditions (i.e. operating on an existing power station). This innovative project continues to be the only current research and development pilot program on liquid-based absorbent PCC technologies suitable for NSW power stations. The results also have applicability across the Australian black coal electricity generation sector.

The pilot-scale CO₂ capture plant used in the research is currently located at Delta Electricity's Munmorah Power Station on the Central Coast, north of Sydney. The Coal Innovation NSW Fund will assist in upgrading the pilot plant and moving it from Munmorah to Delta Electricity's Vales Point Power Station so that this critical research program can continue.

Evaluation:

The program for this project was extended slightly to allow for contractual arrangements to be put in place with Delta Electricity permitting CSIRO to work on-site with their plant and equipment for the duration of this project and for a period beyond this project. There was also the need to meet additional safety requirements and a new obligation to complete a Review of Environmental Factors. These requirements were settled in the first half of 2012 allowing CSIRO access to prepare the site for receiving the pilot scale CO₂ capture plant. Modifications were made to refurbish the pilot plant and its relocation is expected to be completed by Quarter 3 2012, by which time it is to be hot commissioned and be ready for planned experimental research.

8.4.4 Project: Reducing Fugitive Emissions -Enhanced Drainage techniques

Grantee: The CSIRO Centre for Environment, Social and Economic Research

The CSIRO Centre for Environment, Social and Economic Research has received initial grant funding to undertake a 'world-first' trial to confirm whether the volume of methane gas drained from a NSW coal mine can be dramatically increased before open-cut mining commences. The 'enhanced drainage' technique embraces recent advances made overseas in effectively extracting methane from deep un-mineable coal seams by pumping inert (ie non-reactive) gases such as nitrogen, carbon

dioxide or flue gas into the seam. The inert gases act to flush out the methane from the coal seam where it is then drained using bore wells.

The novel Coal Innovation NSW funded project is, in essence, a step towards creating a 'greenhouse gas-less mine'. The experiment involves injecting inert gases into a shallow coal seam in an attempt to flush out a much larger volume of methane than would otherwise be extracted by current 'primary drainage' techniques. The drained gas can be used for power generation rather than being uncontrollably released during the mining process into the atmosphere where it is a problematic greenhouse gas.

Evaluation:

This project was put on hold and restructured to account for the delays to the original timeline brought about by unforeseen circumstances completely outside of the control of CSIRO and CINSW. Specific program negotiations re-commenced with CSIRO and its industry partner earlier in the year to refine the project, obtain exact details of project requirements and the extent of the onsite, in-kind commitments. In June 2012 CSIRO were informed by its industry partner that it was no longer prepared to host the trial. Coal Innovation NSW will work with CSIRO to consider its options, as this is a significant research project for the reduction of fugitive emissions.

8.4.5 Project: A Novel Chemical Looping Based Air Separation Technology

Grantee: The University of Newcastle Priority Research Centre for Energy

The University of Newcastle Priority Research Centre for Energy has received initial grant funding to undertake research into a novel way of producing pure oxygen for use in the efficient burning of coal to generate electricity. The technology relies on the principles of 'chemical looping' and uses the cyclic interaction of a metallic compound (called a metallic oxide carrier) with air as a means of separating out the oxygen. The proposed technology promises to be a cost effective means of mitigating one of the major barriers to the adoption of carbon capture technologies such as oxy-firing as conventional air separation is notoriously expensive. The specific power requirements of the Chemical Looping Air Separation (CLAS) system is about 26% of that of the most advanced cryogenic air separation unit. This equates to a corresponding oxygen production cost of 0.64 vs 2.4 cents/m³ and greenhouse gas emissions of 72 vs 270 gCO₂-e/m³ oxygen produced.

In addition to greatly reducing the greenhouse gas emissions from air separation processes, the CLAS technology could accelerate the commercial-scale deployment of low emissions electricity generation utilising cost effective highly-advanced coal technologies currently being developed such as Oxy-Fuel Combustion. With support from the Coal Innovation NSW Fund, a five-year program will be pursued to get this innovative air separation technology commercially ready.

Evaluation:

This project has progressed well and met all the tasks and activities set out in the project plan, and in some instances achieved this ahead of schedule. The research team has made significant advances on a number of fronts. In developing the experimental setups both at bench scale and pilot scale, the fluidised bed reactor setup was commissioned in mid Nov 2011, one quarter ahead of the agreed schedule. A comprehensive thermodynamic study was conducted on twenty different metal oxides for use in the CLAS process. This study found that six of these oxides appeared to be potentially suitable for the CLAS process. Solid progress has also

been made on modelling work and hydrodynamic studies which examined particle mixing and segregation. The project remains on target in time and budget, and is expected to successfully achieve the project's aims and objectives by December 2013.

8.4.6 Project: Managing Project Risk: The Role of Public Awareness

Grantee: University of Newcastle

The University of Newcastle's Research Institute for Social Inclusion and Well-being has received initial grant funding to use an innovative approach to understand the network of relations between industry, society and government that impact on public acceptance of low emission coal technologies.

Using a contemporary methodology of the Actor-Network Theory (ANT) which can explain how technology and people interact over time, the research aims to identify and implement those contemporary public awareness methods, beyond traditional consultation and public relations, to increase the public awareness and positive social attitudes to support the adoption and applications of low emission coal technologies.

This project will undertake research in regional and metropolitan areas, and look at varying technological applications to implement solution focused mechanisms and strategies for government, society and industry to increase public awareness and acceptance.

Evaluation:

This project has progressed well and met all tasks and activities set out in the project plan for this period. As a social research project, it has completed a literature review of social research evidence in relation to low emissions coal technologies. It has completed a policy framework analysis on how different jurisdictions, globally, regionally and local, have developed laws and regulations in relation to Carbon Capture and Storage projects. To analyse how different community, policy/expert and media networks interact at local, regional and global levels to constitute public opinion on low emissions coal technologies, it has carried out online and 'offline' social science research methods to understand how habits, practices and opinion form. It has made significant advancements in the mapping of online issues and how these are formed around breaking news and reports, and online campaigns. This project has also carried out ethnographic field work, the results of which will be provided in the final report due at the end December 2012.

8.4.7 Project: Site Trials of Novel CO₂ Capture Technology

Grantee: CSIRO Coal Technology

CSIRO Coal Technology has received initial grant funding to investigate the ability of a novel, patented technology to physically separate out CO₂ emitted from NSW coal-fired power stations. The technology uses Honeycomb Monolithic Carbon Fibre Composite (HMCFC) adsorbents which are a type of nano-structured adsorbent material. The technology enables dry CO₂ capture at room temperature and atmospheric pressure and in dusty environments with low pressure drop, reducing the operational and maintenance cost of the post-combustion capture process. In addition, the heat in the flue gas can be utilised in the process thereby further reducing the electricity requirements of capturing CO₂. Thus this technology promises

to play a key role in the cost effective and environmentally responsible generation of electricity in the future.

Through the support provided by the Coal Innovation NSW Fund, an adsorption test unit will be installed at Delta Electricity's Vales Point power stations on the Central Coast, north of Sydney. The effect of real flue gas on the operation and performance of the test unit will be tested and CO₂ capture process demonstrated. Information on the commercial application of the technology will also be generated from the field trial.

Evaluation:

This project was to begin in January 2011, however as the contract was executed on 25 February 2011 the proponent requested the project be rescheduled by 3 months to start on 1 April 2011 to ensure the milestone to complete power station site investigation and project plan could be achieved. This request was approved and the proponent met the milestone within this new period.

This project's progress has been slowed due to similar access issues and its proposed sharing of infrastructure with Project 8.4.3 above. An unexpected resignation of a mechanical technician has also caused delays to the fabrication of the Test Unit. Importantly the project has resolved these issues by developing its independence in servicing its own infrastructure needs and outsourcing construction that was necessary to construct the Prototype Test Unit. There have also been modifications and improvements made to the existing cylindrical adsorbent column used in the Test Unit which will be tested. The Test Unit is expected to be constructed and installed on site by the end of quarter 3, 2012.

**8.4.8 Project: Development and Optimisation of the Direct Carbon Fuel Cell
Grantee: University of Newcastle's Discipline of Chemistry**

The University of Newcastle's Discipline of Chemistry has received initial grant funding to research and develop a Direct Carbon Fuel Cell (DCFC). This technology is yet to be commercialised but is widely promoted as being the 'holy grail' of coal-fuelled electricity generation as it has the capacity to generate electricity with much higher thermal efficiencies (~70-80%) than engines and turbines (~35-55%). In addition, the fuel cell emissions are almost entirely pure CO₂ which is therefore ready for capture and storage without the need to firstly separate out other gases such as nitrogen which are present in the flue gases emitted from power plants.

In a DCFC, electricity is generated directly from coal through the chemical oxidation of coal which has been ground and purified of ash and other contaminants. This differs substantially to the way electricity is traditionally generated – coal is burnt to boil water to make steam to turn a turbine, to turn a generator, to produce electricity. In essence, a fuel cell can be compared to an electrochemical battery. They differ in that a battery stores electrical energy chemically whilst a fuel cell relies on the external supply of a fuel (in this case coal) which must be continually replenished.

Like many fuel cell types, DCFCs are susceptible to cell degradation from contaminants originating from the fuel source. An important aspect of the experimental work is to understand the different structural aspects of coal to understand its performance in the DCFC.

Evaluation:

This project has made good overall progress on most of the tasks and activities set out in the project plan. However, due to difficulties in recruiting suitable students to undertake the experiments the program had initially incurred slight delays. It has however since successfully completed recruitment activities and with the aid of additional assistance has been getting back on-schedule. Steady progress has been made in analysing how coal impurities affect electrolyte properties and therefore performance as a battery cell. Efforts have also focused on analysis of various NSW coal properties to understand their viability and gain a better understanding of coal properties that influence performance. Importantly, a bench scale DCFC has also been constructed, tested and further optimised.

8.4.9 Project: Permanent Large Scale CO₂ Storage by Mineral Carbonation **Grantee: GreenMag Group and the University of Newcastle**

The GreenMag Group and University of Newcastle Priority Research Centre for Energy will receive grant funding to develop and optimise a promising method of storing carbon dioxide gas emitted from NSW coal-fired power stations. The Mineral Carbonation process takes advantage of a natural process whereby CO₂ is captured in mineral deposits resulting in it being stored in rocks. A key advantage of this process is that the CO₂ is permanently stored in the rocks. It would only re-enter the atmosphere if the rocks were subjected to extremely high temperatures. Building products and the extraction of noble metals left over from the mineral carbonation process may also assist in offsetting the economic costs of sequestering CO₂.

This cutting edge project will be a 'world first' in the building and operation of a mineral carbonation pilot plant. The pilot work will be supported by laboratory research to optimise and demonstrate the technical and economic feasibility of two mineral carbonation processes to speed up the chemical reaction between concentrated CO₂, (that has been captured from power station flue gas, stripped and then pressurised) and finely ground rock (serpentinite mined in NSW). The underlying aim is to optimise the processes with a lower energy penalty.

Evaluation:

This project has received in-principle matching funding support from the Commonwealth Government and has sought matching funding from industry. This will make up a total of \$9 million for the project. There are current negotiations with an industry partner which may eventuate with an agreement prior to the end of 2012.

8.4.10 Project: A Simple Heat Engine for Sustainable Coal Generation **Grantee: ourSUN Pty Ltd – application WITHDRAWN December 2010.**

8.5 NSW CO₂ Storage Assessment Program

The drilling program is being developed in 3 stages as follows:

- Stage 1A – Sydney Basin (4 wells)
- Stage 1B – Darling Basin (4 wells)
- Stage 2 – to be determined based on results from Stage 1 and further desktop analysis.

Funding Agreements between NSW Trade & Investment, the Commonwealth Department of Resources, Energy and Tourism (DRET) and industry, ACA Low Emissions Technologies Limited (ACALET) were signed and announced on 4 June

2012. This announcement also advised of commencement of Stage 1B of the program.

The total budget for the NSW CO₂ Storage Assessment Program is estimated at \$54.3 million, with all 3 funding partners contributing equally at \$18.1million.

Evaluation:

The NSW Government undertook a program of seismic surveys and stratigraphic drilling in the Sydney-Gunnedah Basin as fulfilment of Stage 1A of a NSW CO₂ Storage Assessment Program aimed at filling gaps in knowledge of the deeper geology of the NSW sedimentary basins, assessing the CO₂ geological storage potential of these basins, and at shedding light on the reservoir and sealing characteristics of these strata.

Drilling Commenced in Dec 2008 and was completed in February 2011, with testing and modelling completed in 2011/2012.

Two holes, *Munmorah 1* and *Vales Point 1*, were drilled to assess the potential for storage close to CO₂ emitters and in conjunction with a demonstration of a post combustion CO₂ capture plant planned for one of Delta Electricity's black coal-fired power station on the NSW Central Coast. The two additional holes, *Merriwa 1* and *Cattle Creek 1*, were located in an underexplored region northwest of Muswellbrook along the boundary of the Sydney and Gunnedah Basins. They were sited close to transport infrastructure and relatively proximal to the Hunter Valley power stations.

Complementary to the drilling program was the Sydney Basin Regional Deep Seismic Survey. This involved the acquisition of a total of 220 km of 2D seismic data along a predominantly east-west line, with the north-south cross line, passing through the *Merriwa 1* well. The survey was designed to image structures surrounding the *Merriwa 1* site.

All four holes were stratigraphically and geophysically logged and fully cored. Selective analyses were undertaken to assess the porosity and permeability potential of the reservoir units. In addition, where coal was intersected, the opportunity was taken to gather information on this potential resource included coal rank and quality, and coal seam gas quantity and composition. Petrophysical testing of *Merriwa 1* cores indicated that there were intervals where porosity and permeability were promising, initiating CO₂ injectivity modelling of a sandstone section. Although modelling of a horizontal completion did indicate that the injectivity target required for the Delta Demonstration Project (up to 100,000 t CO₂ p.a) may be achievable under a hypothetically ideal situation, subsequent investigation of the depositional environment concluded that it was likely to be a laterally restricted sedimentary package unsuitable for CO₂ sequestration.

Stage 1A in the Sydney-Gunnedah Basin achieved its aims and objectives within time and budget constraints. The sites investigated were deemed as likely to not be prospective CO₂ storage sites. Nevertheless, a great number of learnings were acquired that will assist in enhancing the outcomes of further exploration undertaken as part of the NSW CO₂ Storage Assessment Program. Concomitantly, an enhanced understanding of the geology of the basin has been gained, and a large volume of subsurface data and drill core (5303m) were acquired. These data and cores are now available for continued assessment and study by government agencies, academia

and industry involved in Carbon Capture and Storage and mineral/petroleum exploration activities.

A full and comprehensive report of Stage 1A including Well Completion Reports, testing and modelling reports is in the last phase of being finalised and will be presented to the next Funding Partners Steering Committee (20 November 2012) for approval for public release.

A Steering Committee with representatives from Geoscience Australia, ACALET and NSW Trade & Investment, has been formed to oversee the NSW CO₂ Storage Assessment Program.

Processes are underway to facilitate Stage 1B (Darling Basin). The data acquisition program in the Darling Basin consists of the drilling of four (4) stratigraphic wells to a depth in the order of 2500m, to acquire up to 800m of core and to complete significant downhole testing. There will be no injection or storage of CO₂ gases. The raw data is interpreted in computer models that will predict the suitability of the site for storage options. If the sites prove to be prospective, the collection of written reports will form the pre-competitive data that will be released publicly to establish a CO₂ injection and storage industry in NSW in the future.

Timelines for the procurement strategy include:

- Call for Expression of Interest 4th June 2012
- Expressions of Interest close 26th June 2012
- Workshop with potential tenderers 12th August 2012
- Invitations to tender issued 2nd October 2012
- Tenders close 15th November 2012
- A tender evaluation panel will selected the successful tenderer and it is envisaged the awarding of contracts will occur in December
- Drilling will commence early 2013 and be completed within the year.

NSW Public Works has been engaged to manage the procurement process and to project manage the administration of contracts. The Expression of Interest process has enabled the establishment of three tender panels (1) drilling rigs, (2) site project management, including geological services and (3) down hole testing services.

The planning, procurement and execution of the Stage 1A drilling program has provided a sound footing for the improved planning, procurement and execution necessary for the larger scale remote drilling program of Stage 1B. The experience gained by Department geologists in Stage 1A will also be valuable in:

- determining when coring and testing are to be conducted
- producing geologic models in underexplored areas and
- in the interpretation of new information and results.

Staff training has occurred with two significant courses being delivered:

- Drilling and seismic training course was delivered to the Coal Innovation NSW Secretariat staff, selected staff from Minerals Branch and Public Works assisting in understanding latest drilling techniques and technologies that would assist in developing appropriate procurement strategies.
- GOCAD and SKUA software training was delivered to staff within the Minerals Branch to assist in the development of modelling techniques for the Darling

Basin reservoirs. This is new software and is producing accurate 3D modelling that will feed into the procurement strategy and development of well designs.

8.6 Membership of CO2CRC

“The Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC) is one of the world's leading collaborative research organisations focused on carbon dioxide capture and geological sequestration (geosequestration, carbon dioxide capture and storage, carbon capture and storage, or CCS). CO2CRC is a joint venture comprising participants from Australian and global industry, universities and other research bodies from Australia and New Zealand, and Australian Commonwealth, State and international government agencies. Its resources come from the Federal Government Cooperative Research Centres Program, other Federal and State Government programs, CO2CRC participants, and wider industry”.¹

Evaluation:

NSW has had a long-standing commitment of membership to the CO2CRC with a fee structure of \$250,000 per year. An Accession Deed was signed that admits the State of NSW represented by the then, Department of Industry and Investment NSW, to the Cooperative Research Centre for Greenhouse Gas Technologies.

Membership of this world leading research organisation has been and will be of further benefit to NSW as it commences and develops its carbon capture and storage research and demonstration programs. The Coal Innovation NSW Secretariat Scientific Officer attended the CO2CRC Research Symposium in Adelaide and exchanged valuable information on NSW programs.

The Secretariat's Scientific Officer and its Economist also attended the National R&D workshop in Melbourne. The workshop was organised primarily by the National CCS Council with the CO2CRC instigating the workshops and assisting with the planning.

A significant return on membership will be gained once NSW commences drilling, testing and modelling in the Darling Basin with services and advice being provided by CO2CRC experts.

8.7 Community Engagement

A stated Purpose of the Coal Innovation NSW Fund, under Section 5 Purpose of Fund, of the *Coal Innovation Administration Act 2008*, is to “(c) to provide funding to increase public awareness and acceptance of the importance of reducing greenhouse gas emissions through the use of low emissions coal technologies”.

With this Purpose in mind, the Coal Innovation Secretariat sought consultancy advice on initial strategic options that delivers an effective communications strategy which:

- Promotes Coal Innovation NSW in achieving NSW policy outcomes, national interest and global emission reduction strategies
- Promotes the funding of innovation and projects and the aims of projects
- Promotes the development of low emissions coal technologies and Carbon Capture and Storage (CCS) as a greenhouse gas mitigation strategy

¹ <http://www.co2crc.com.au/about/>

- Promotes the use of CCS as an ongoing partner in the future energy mix by understanding and addressing the future of coal fired generation in a carbon constrained society
- Differentiates CCS from other mining / petroleum activities
- Promotes working collaboratively with industry and other tiers of Government
- Identifies regional and urban stakeholder groups
- Outlines best forms of communications and engagement with regional and / or urban stakeholders
- Analyses the costs and benefits of communication options put forward
- Formulates a collection and analysis methodology of communication outcomes

During the period September to December 2011, six small to medium sized community engagement consultancies were invited to submit a proposal indicating their firm's ability to satisfy the aim and scope of the project, the team that would work on the project and their qualifications, and the price at which the services would be offered. At this stage, instructions were given to focus on developing options to deliver a communications / stakeholder engagement strategy; not the actual development, implementation and delivery of the strategy.

SMC and Associates were successful in gaining this initial project and presented their initial report to Coal Innovation NSW at the 13 June 2012 meeting. That meeting resolved to have further discussions with the consultant in further developing the strategy options.

E. CONCLUSION

Expenditure for financial year 2011/12:

TOTAL COSTS OF THE COAL INNOVATION NSW (COUNCIL)	10,189.65
SECRETARIAT COSTS INCLUDING SALARIES	553,827.49
TOTAL CCS DELTA DEMONSTRATION PROJECT	261,480.17
TOTAL COSTS OF R&D PROJECTS	2,482,397.00
TOTAL STATE WIDE STORAGE ASSESSMENT PROJECT	364,338.65
CCS LEGISLATION	28,242.17
STATE WIDE STORAGE ASSESSMENT PROJECT – TRAINING	18,837.96
CO2CRC MEMBERSHIP	250,000.00
CONSULTANCIES	35,400.00
PROJECT COSTS (INTERNAL PAYMENTS, DEPARTMENT EQUIPMENT)	246.40
GRAND TOTAL	4,004,959.49

Overall Financial Balance:

Opening balance as at 1 Jul 2011 (Credit)	38,760,461.88
Total expenditure 2011/12 (Debit)	4,004,959.49
Journal (M/V cars & trucks) #	26,278.43
Income from OEH (Credit)	18,500,000.00
TOTAL as at 30 June 2012 (Credit)	53,281,780.82

Includes an error in journal adjustment of \$26,278.43 for mv-cars & trucks.

The overall forecasted expenditure budget for the 2012/13 financial year for the Coal Innovation NSW Fund is approximately \$27.3 million.

**Independent Audit Report
For the Coal Innovation NSW Fund to the
NSW Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS)**

Scope

We have audited the Statement of Income and Expenditure of the Coal Innovation NSW Fund for the period 1 July 2011 to 30 June 2012. The Resources and Energy Division is responsible for the preparation and presentation of the information contained therein. We have conducted an independent audit of the Income and Expenditure Statement in order to express an opinion on it.

The Income and Expenditure Statement is for distribution to the NSW Department of Trade and Investment, Regional Infrastructure and Services for the purpose of fulfilling the reporting obligations in respect of funding received under the Coal Innovation NSW Fund. We disclaim any assumption of responsibility for any reliance on this report, or on the Income and Expense Statement to which it relates to any other person other than the NSW Department of Trade and Investment, Regional Infrastructure and Services or for any purpose other than that for which it was prepared.

Our audit has been conducted in accordance with Australian Auditing Standards to provide reasonable assurance as to whether the Income and Expenditure Statement is free of material misstatement. Our procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the Income and Expenditure Statement. These procedures have been undertaken to form an opinion as to whether, in all material respects, the Income and Expenditure Statement is presented fairly in accordance with Accounting Standards.

The audit opinion expressed in this report has been formed on the above basis.

Statement

In our opinion, the Statement of Income and Expenditure for the period 1 July 2011 to 30 June 2012 that has been prepared on a cash basis is in agreement with the accounting records of the Resources and Energy Division.


RSM Bird Cameron


Cameron Hume
Director

Dated at Sydney 19th September 2012

COAL INNOVATION NSW FUND
STATEMENT OF INCOME AND EXPENDITURE
1 JULY 2011 to 30 JUNE 2012

Funds paid to the Coal Innovation NSW Fund from the NSW Climate Change Fund (Office of Environment & Heritage)

Surplus Funds Carried Forward per 2010/11 Report to Parliament	\$ 38,760,462
Total Funds Received	\$ 18,500,000
Expenditure	
Total Costs of the Coal Innovation NSW (Council)	\$ 10,190
Secretariat Costs including salaries	\$ 553,827
Total CCS Delta Demonstration Project	\$ 261,480
Total Costs of R&D projects	\$ 2,482,397
Total State Wide Storage Assessment Project	\$ 364,339
CCS Legislation	\$ 28,242
State Wide Storage Assessment Project -Training	\$ 18,838
CO2CRC Membership	\$ 250,000
Consultancies	\$ 35,400
Project Costs (Internal Pay, Department Equipment)	\$ 246
Total Expenditure	\$ 4,004,959
Plus journal (M/V cars & trucks)	\$ 26,278
Surplus Funds Carried Forward 2011/12	\$ 53,281,781