



**Trade &
Investment**
Resources & Energy

Report to NSW Parliament

Coal Innovation NSW Fund

**Income, Expenditure
&
Evaluation of Projects**

2012-2013

Coal Innovation NSW Fund

Income and Expenditure, and Evaluation of Projects Report 2012/2013

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Annual Report 2012-13

Coal Innovation NSW Fund

Outcomes Achieved to 30 June 2013

A. BACKGROUND

The Coal Innovation NSW Fund (the Fund) has been established and is governed under the *Coal Innovation Administration Act 2008 (Act)*.

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.*

The current Coal Innovation NSW (CINSW) membership has 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

During the 2012/13 financial year the Fund received income via two streams:

- the final instalment of the Government commitment of \$100million to the Fund
- under the CO₂ Storage Assessment Program Funding Agreement with the Commonwealth and ACALET Ltd, which is to be expended on the CO₂ Storage Assessment Program over the coming 12 months (along with income received in the following financial year).

The Fund also received a repayment from an R&D research grant as the research program was closed. (see D4.4)

The tables below summarise the income received as follows:

description	value \$
Last instalment from OEH Climate Change Fund	31,500,000
<i>additional income received (set aside for the CO₂ Storage Assessment Program)</i>	
The Commonwealth Government (Geoscience Australia)	2,500,000
Australian Coal Association Low Emission Technologies Ltd	300,000
Total	34,300,000

Other income as follows:

CINSW CSIRO–Fugitive Emissions Connell Project (repayment)	75,549
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C. EXPENDITURE

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

C1: Coal Innovation NSW (Advisory Council) & Technical Working Group costs

For the financial year ending 30 June 2013 the following funds have been expended in relation to the costs of Coal Innovation NSW meetings and sitting fees. (It is noted that the Technical Working Group did not meet during this period):

description	value \$
Total costs of Coal Innovation NSW (Council).	22,338

C2: Coal Innovation NSW Secretariat

Coal Innovation NSW Secretariat employs five staff:

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

For the financial year ending 30 June 2013 the following funds have been expended against salaries and on costs:

description	value \$
Secretariat costs including salaries	739,790

Note, this year has an extraordinary expenditure of \$91,180 redundancy payment.

C3: Delta Carbon Capture and Storage Project (Delta Electricity).

For the financial year ending 30 June 2013 the following funds have been expended in relation to the Delta CCS project:

description	value \$
Milestone part payment	45,454
Milestone part payment	75,000
Total CCS Delta Demonstration Project	120,454

C4: Research & Development (R&D) projects funded under Expressions of Interest process.

For the financial year ending 30 June 2013 the following funds have been expended in relation to the R&D projects:

Applicant	project description	value \$
UCC Energy P/L	Project cancelled at end of Stage 1	
Centennial Coal (Mandalong) P/L	Fugitive Emissions (ventilation)	309,671
CSIRO	Capture Testing Solvents	658,100
CSIRO	Fugitive Emissions (open cut)	refund
Uni of Newcastle	Chemical Looping – oxyfuel	215,724
Uni of Newcastle	Social Research/Public Awareness	165,488
CSIRO	Novel Capture & Energy Efficiency	152,957
Uni of Newcastle	Direct Carbon Fuel Cell	102,338
Total		1,604,278

C5: NSW CO₂ Storage Assessment Program

For the financial year ending 30 June 2013 the following funds have been expended in relation to the NSW Data Acquisition & Drilling Program:

description	value \$
Total State Wide Storage Assessment project	678,280

Note: The CO₂ Storage Assessment Program is a \$54.3 million jointly funded agreement. Currently the Darling Basin drilling program has a \$20.2 million budget and will receive income from the funding partners along with CINSW Funds. The income received from the funding partners within this financial year will be expended exclusively on this project over the next financial year and will be fully reported in that years evaluation report.

C6: Membership of CO2CRC

For the financial year ending 30 June 2013 the following funds have been expended and accrued in relation to membership of CO2CRC

description	value \$
Membership of CO2CRC	250,000.00

C7: Legal Fees

description	value \$
University of Newcastle- GreenMag project (funding agreement)	95,375
CO ₂ Storage Assessment Project (access agreements)	2,070
Total	97,445

D. EVALUATION

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

D1 Coal Innovation NSW (CINSW)

The *Coal Innovation Administration Act 2008 (Act)*, which amendments were 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 appointed by the Minister, Coal Innovation NSW now consists of two appointed members from government and two from industry to represent the NSW black coal industry, and up to four additional members and an independent person as Chairperson appointed by the Minister.

As at 30 June 2013 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 (CO₂Capture) CO₂CRC and Professor UNSW

CINSW held three meetings in the 2012/13 financial year. The first was on 15 August 2012, then 3 December 2012 and on 27 March 2013.

Evaluation:

The first meeting of CINSW for this financial year reviewed the progress on the R&D projects and sought further reviews for two projects that appeared not to be meeting expectations. The Board also considered a community engagement program to increase public awareness and acceptance of low emission coal technologies, and directed further development of this proposal.

The second meeting received a report on public engagement activities arranged by the Secretariat in National CCS week. CINSW reviewed Secretariat reports on the two R&D projects subject to further review and determined to recommend to the Minister that one project be terminated and unspent funds be returned. The Board also received a presentation on the status of CINSW funds and funding arrangements. The Secretariat were directed to prepare an assessment of lessons learnt from management of current R&D projects and a gap analysis on possible research areas not being funded.

At the third meeting the Secretariat reported back on its development of the community engagement strategy and the proposed communication framework was endorsed for further detailed development and costing. The lessons learnt paper was presented and discussed. It was recommended the findings be developed into a set

of principles to assist groups in the future involved in managing programs or grant funding. The Secretariat report on the remaining R&D project subject to further review resulted in the Board determining to recommend to the Minister that the funding agreement for this project be terminated.

In all three meetings, there were presentations provided by CINSW Funded R&D projects, as well as Commonwealth and Industry presentations on issues relevant to the development on low emissions coal technologies in NSW.

D2 Coal Innovation NSW Secretariat – Salary costs.

Coal Innovation NSW Secretariat employs five staff:

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

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), engaging NSW Public Works and assisting in the procurement strategy to gain contractors for the drilling program, examining the risk factors and development of risk registers;
- involvement of policy debate at a National level; and
- development of a community engagement strategy.

D3 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; and
- planning and environmental approvals for CCS.

Stage 2 will provide a roadmap that is directly applicable to next generation and scale of plant by:

- demonstrating the integrated process;
- validating Post Combustion Capture Technology on NSW coals; and
- verifying geological storage techniques.

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 2012/13 Delta has partially met milestones 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 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 strategy options, capture infrastructure options and legal aspects. The project has also engaged independent geological advisors who have been working with the Department in assessing storage options. At the moment the project is effectively 'on-hold', minimising spending, and awaiting the outcomes of the Darling Basin drilling program. The project is ready to recommence once a prospective storage site has been found.

D4 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	4 YRS
OURSUN P/L #	COMBINED BRAYTON RANKINE CYCLE.	159,200	7 MTHS.
TOTAL		\$ 13,008,178	

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.

A detailed evaluation of each project follows.

D4.1 Project: UCC Fired Diesel Engines in the generation of electricity
Grantee: UCC Energy Pty. Ltd

UCC Energy Pty Ltd had received initial grant funding for a Life Cycle Assessment (LCA) of their project. The project itself was 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 (which equates to lower greenhouse gas emissions per megawatt produced), funding would assess whether UCC can efficiently and effectively operate in diesel engines large enough to generate electricity in a distributed energy network.

This project had 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 was 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 the current NSW electricity grid including transmission.

The grantee completed Stage 1 in early 2011. Substantial changes in both CINSW and UCC Energy delayed assessment of the LCA until August 2012. In the interim, the new owners of UCC (Yancoal) progressed the project independently to a stage beyond that contemplated in the original funding agreement. Consequently, CINSW and Yancoal agreed to withdraw the project from funding support. Coal Innovation NSW determined that allocated monies be returned to the Fund. The termination of the funding agreement was by mutual consent.

D4.2 Project: Fugitive emissions abatement from ventilation air
Grantee: Centennial (Coal) Mandalong Pty Ltd

Centennial Mandalong P/L 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:

In this period there was an operational need to re-tender and re-schedule the work to provide drainage gas from the whole site for flaring and also for use in this project. This has significantly delayed the project from entering the experimental phase. A contract variation to extend the project was requested and approved.

Despite this delay the development of the VAM-RAB unit was completed and relocated to the site. Commissioning of the unit was expected to commence by the end of this period, however the constructor of the gas flare and the consequent supplier of gas to the VAM-RAB failed to meet their contractual milestones. This has delayed the commissioning and experimental phase into the next 2013/14 financial year. The program is now expected to be completed by end of 2014.

<p>D4.3 Project: Further development of post combustion capture Grantee: CSIRO Energy Technology</p>
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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 Post Combustion Capture technologies suitable for NSW power stations. The results also have applicability across the Australian black coal electricity generation sector and to the NSW Carbon Capture and Storage Demonstration project.

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

Evaluation:

The pilot scale aqueous ammonia CO₂ capture plant was relocated and erected on site during 18-25 July 2012. Further issues were however encountered which has delayed the full commissioning of the plant. This included the development of new protocols for CSIRO to operate in an industrial setting, estimated time and quantity of pipework for the refurbishment of the pilot plant, electricity supply and labour issues. In particular, connecting to the power station's flue gas stake was delayed until pipework was completed and safety protocols had been approved for CSIRO to manage the safety of its projects on the site. Initial stages of commissioning did occur. However, it highlighted a few issues with the pipework, electrical connections and control system and instrumentation which have been found to be faulty. The plant is now expected to be fully commissioned and operating by the beginning of 2014 for the integration of

concentrated solar thermal energy for the regeneration of liquid absorbents in carbon capture systems.

**D4.4 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 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 initially put on hold and restructured to account for the delays to the original timeline brought about by unforeseen circumstances (fire) at the mine site. In late 2011, specific program negotiations re-commenced with CSIRO and its industry partner to refine the project, obtain exact details of project requirements and the extent of the onsite, in-kind commitments. However, in June 2012 CSIRO were informed by its industry partner that it was no longer prepared to host the trial. Further time was given for CSIRO to source another industry partner. No new partners were found and CINSW recommended terminating this project at the December 2012 board meeting. Unspent monies were returned to the CINSW Fund.

**D4.5 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 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 method 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 three-year program will be pursued to get this innovative air separation technology commercially ready.

Evaluation:

This project has progressed well and met all milestones in the project plan. All analytical tests have been completed to gain a deep understanding of the structural evolution of metal oxide particles during repeated reduction-oxidation cycles. In addition, the preliminary pilot-scale experiments were completed as part of the commissioning of the pilot-plant setup. This highlighted several minor issues in the electronics and instrumentation that were resolved prior to the full pilot-scale experimental campaign in 2013. This component of the project is still well ahead of the agreed schedule. The design and fabrication of the 7 m high cold-flow demonstration unit (equivalent of a 500 kW CLAS system) has also been completed and the unit has been installed and commissioned in the high space shed at the NIER (Newcastle Institute for Energy & Resources) precinct.

The research team has made significant advances on a number of fronts and has made solid progress towards the successful completion of the project. The project remains on target to achieving the stated aims and objectives by the planned completion date of December 2013.

<p>D4.6 Project: Managing Project Risk: The Role of Public Awareness Grantee: University of Newcastle</p>

The University of Newcastle's Research Institute for Social Inclusion and Well-being has received 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 undertook research in regional and metropolitan areas, and studied varying technological applications to develop a set of recommendations and strategies for government, society and industry to increase public awareness and acceptance for low emissions coal technologies.

Evaluation:

This two year project has generally performed well, met all of its agreed milestones and produced a draft final report that draws attention to the many complex social dimensions of the policies and practices associated with low emissions coal technologies and related industries. Four stages of research were undertaken,

including: interviews with key technical and policy experts; a large Internet based survey of the NSW population; online social media network analysis of low emissions coal technology and related industry issues; and ethnographic research of public engagement with two energy issues. The report incorporates all the different stages of research to outline a Network Solutions Model that suggests methods to manage public risk by monitoring and responding to public concerns in the development of the technology. This model establishes key tasks for policy-makers, civil society and project proponents in the form of recommendations.

The project has met its research objectives and the report and its findings are currently being considered by Government.

D4.7 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 has been 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:

In this period this project has managed to overcome several constraints from the sharing of infrastructure with Project D.4.3 above (*Further development of post combustion capture CSIRO*). The rescheduling of the timelines for relocating and testing the aqueous ammonia pilot unit (Project D.4.3) has required the development and construction of a separate pre-treatment system in order to operate the solid sorbent prototype unit as a stand-alone unit. The prototype test unit, separate pre-treatment system, and control and monitoring system was successfully constructed, transported and installed at the Vales Point Power Station site by the end of quarter 3, 2012. The project team pre-commissioned the prototype unit with simulated flue gas at the site, and fixed several technical problems, and the prototype test unit was ready for trials with actual flue gas in line with the project timeline. Results obtained showed the performance of the solid sorbents under capture and regeneration modes with simulated flue gas to be very effective as tested under laboratory conditions.

Unfortunately access to actual flue gas to commission the unit did not occur until May 2013 due to delays in connecting to the flue gas which was being provided for by Project D.4.3. The unit was fully commissioned at the site in early June 2013. Favourable results from a number of test runs have demonstrated that over 95% of the CO₂ in actual flue gas can be captured in almost 100% purity. The next phase of this project will see a series of site trials and data processing and analysis to validate the unit's promising performance. The project is expected to be completed by the end of quarter 1, 2014.

D4.8 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 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%). The higher efficiencies equate to substantial reductions in greenhouse gas emissions as less fuel is used per unit of electricity generated. In addition, the fuel cell emissions are almost entirely pure CO₂ which is therefore ready for sequestration 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 two primary objectives: 1) to understand and optimise the fundamental electrochemical reactions and processes occurring when coal is oxidised to generate electricity; and 2) develop operational bench-scale and pilot-scale DCFCs. To date, solid progress has been made on each of these key objectives. There have been some delays experienced since the project began, brought about by difficulties in recruiting suitable post-graduate students, sourcing specialised materials for the project, and in meeting reporting standards specified under the funding agreement. The Secretariat has coordinated with the grantee and the university to effectively resolve each of these issues, thereby allowing the project to progress.

Most of the laboratory-based experimental research has either been completed or is nearing completion, with several scientific publications pending. At this stage this project is progressing in accordance with the project schedule.

D4.9 Project: Permanent Large Scale CO₂ Storage by Mineral Carbonation
Grantee: Mineral Carbonation International (previously GreenMag Group and the University of Newcastle)

The GreenMag Group and University of Newcastle Priority Research Centre for Energy has been awarded grant funding, contingent on the receipt of matching Commonwealth and industry 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 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:

The CINSW funding condition of matching Commonwealth and industry funding has been met with Orica Investments Pty Ltd forming a consortium with GreenMag and Newcastle Innovation (the commercial arm of the University of Newcastle). The aim of the consortium, known as Mineral Carbonation International or MCI, is to project manage the research project and eventually commercialise the intellectual property rights.

The Secretariat pursued a funding agreement between the three project funding partners, being NSW Trade and Investment, the Commonwealth Department of Resources, Energy and Tourism, and Orica Investments Pty Ltd. The Funding Agreement for the MCI project was signed on Thursday 27 June 2013. The effective commencement period of the project is 3rd quarter 2013. The MCI project extends over a four-year period and encompasses three main strands including: 1) pilot plant construction and operation, 2) intensive research and development, and 3) program governance, communication and commercialisation.

The project will be officially launched on 23 August 2013 by the NSW Minister for Mineral Resources at the Newcastle Institute of Energy and Resources, University of Newcastle.

D4.10 Project: A Simple Heat Engine for Sustainable Coal Generation
Grantee: ourSUN Pty Ltd – application WITHDRAWN December 2010.

D5 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.

Evaluation:

Having commenced in 2008, the Program is expected to run until the end of 2015. Program status is as follows:

- Stage 1A – Sydney Basin data acquisition and assessment (completed)
- Stage 1B – Darling Basin data acquisition and assessment (in progress)
- Stage 2 – further data acquisition (to be defined based on Stage 1 outcomes)

Stage 1A in the Sydney-Gunnedah Basin was completed in 2011/12 and 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 (5,303m) 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 now publicly available.

A Steering Committee with representatives from Geoscience Australia, ACALET and NSW Trade & Investment held its inaugural meeting in May 2012. The committee meets regularly on a quarterly basis (or earlier if required) 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 stratigraphic wells to a depth in the order of 2,400m, 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.

NSW Public Works has been engaged to manage the procurement process and to project manage the administration of contracts. Procurement commenced through an open Expression of Interest process and then more detailed tender process to award contracts for (1) drilling rigs, (2) site project management, including geological services and (3) down hole testing services. The procurement strategy was as follows:

- The Drill Site Project Manager would be the 'Principal Contractor'
- Drill Site PM would procure all drill site services
- NSW Public Works would procure pre and post drilling services, e.g. site establishment and remediation in consultation with Drill Site PM

Aztech Well Construction was awarded the Drill Site Project Manager contract on the 28th March 2013. Upon awarding of the contract, the Aztech staff quickly became engaged and commenced detailed planning and on-site contractor procurement activities. As of the end of the second quarter of 2013, the program had experienced some procurement issues associated with the withdrawal of the drilling contractor. These issues were resolved early in July 2013 and will be reported on in the 2013-2014 Annual Report.

During the year, a wide range of planning activities was also undertaken by the Department, including: drill site selection; acquisition of Mineral Exploration Licences, environmental approvals, and land access agreements; development of drilling operations manuals, risk management plans, flood response plans, and community engagement strategies); tendering for core analysis services; and planning for the analysis and modelling of the newly acquired drill data.

At the end of 2012-13, all planning activities associated with Stage 1B were on-track with the approval of the REF, drafting of the detailed budgets, and signing-off of the well designs for the 1st well. Improvement and refinement of the geological information was continuing, the tendering process for core analysis laboratory services was near completion, and negotiations were progressing well for the newly acquired well data to be analysed by the CO2CRC. A range of other research projects were also being negotiated. Together, these projects will value add to the Darling Basin Drilling Program and ultimately provide enhanced insight into CO₂ storage potential in NSW.

D6 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

¹ <http://www.co2crc.com.au/about/>

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 is current until June 2015. Future membership beyond June 2015 is currently under review.

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 and Geoscientist attended the CO2CRC Research Symposium in Queensland and exchanged valuable information on NSW programs.

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. During the year, a verbal agreement between the Secretariat and the CO2CRC was reached on the scope of a collaborative work program. Four separate work packages are being developed focussing on the comprehensive analysis and geological modelling of data acquired from the Darling Basin drilling program. The analyses and modelling will be undertaken by the CO2CRC and its affiliated research institutes (CSIRO, Geoscience Australia, University of Adelaide, and University of Melbourne).

E. CONCLUSION

Expenditure for financial year 2012/13:

Coal Innovation NSW (Advisory Council) costs	22,338
Secretariat costs including salaries	739,790
Delta CCS Demonstration Project	120,455
R&D projects grants	1,604,278
CO ₂ Storage Assessment Program	678,280
Legal fees	97,445
CO2CRC membership	250,000
GRAND TOTAL	3,512,586

Overall Financial Balance:

Opening balance as at 1 Jul 2012 <i>(Credit)</i>	53,281,781
Total expenditure 2012/ 13 <i>(Debit)</i>	3,512,586
Income from OEH, Commonwealth & ACALET <i>(Credit)</i>	34,300,000
<u>other income</u>	
CSIRO CINSW- Connell project (Refund) <i>(Credit)</i>	75,549
TOTAL as at 30 June 2013 <i>(Credit)</i>	84,144,744

F. Attachment -Audit Certificate



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**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 from 1 July 2012 to 30 June 2013. 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 Statement of Income and Expenditure in order to express an opinion on it.

The Statement of Income and Expenditure 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 Statement of Income and Expenditure 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 Statement of Income and Expenditure is free of material misstatement. Our procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the Statement of Income and Expenditure. These procedures have been undertaken to form an opinion as to whether, in all material respects, the Statement of Income and Expenditure is presented fairly in accordance with the cash basis of accounting.

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 2012 to 30 June 2013 that has been prepared on a cash basis is in agreement with the accounting records of the Resources and Energy Division.

RSM Bird Cameron

RSM Bird Cameron

A. D. Dickinson

Angus Dickinson

Dated at Sydney 16 October 2013

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**COAL INNOVATION NSW FUND
STATEMENT OF INCOME AND EXPENDITURE
1 JULY 2012 to 30 JUNE 2013**

	\$
Surplus Funds Carried Forward per 2011/12 Report to Parliament	<u>53,281,781</u>
Income	
Grant Received	34,300,000
Refund of Grant from CSIRO	<u>75,549</u>
Total Receipts	<u>34,375,549</u>
Expenditure	
Research & Development Projects	1,604,278
CO2CRC Membership	250,000
Delta Demonstration Project	120,454
CO2 Storage Assessment Project	678,281
Secretariat Costs including salaries	739,790
Legal Fees	97,445
CINSW Council Project	<u>22,338</u>
Total Expenditure	<u>3,512,586</u>
Excess of Income over Expenditure for the year ended 30 June 2013	<u>30,862,963</u>
Surplus Funds carried forward as at 30 June 2013	<u>84,144,744</u>