Annual Report Coal Innovation NSW Fund 2018/19

Income, Expenditure and Project Evaluation

November 2019

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More information

The Coal Innovation Fund can be contacted c/:

Department of Planning, Industry and Environment

320 Pitt Street, Sydney NSW 2000

Phone: 1300 305 695

Email: ccs.info@planning.nsw.gov.au

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Income and Expenditure

A Background

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

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.

Section 7 of the Act, details Payments out of the Fund as follows:

(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.

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) two persons, each of whom is employed in or by a government agency,

  (c) two 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.

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 membership of the Ministerial Advisory Council to Coal Innovation NSW (CINSW) expires on 31 December 2019. Members are listed under Section D1.

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

The Fund was established as a fund in the Special Deposits Account under Section 4 of the Act. The Fund receives funds and expends monies in accordance with the Act. The Fund has prepared a special purpose financial report for the year ended 30 June 2019 containing: statement of net assets; statement of comprehensive income; and associated note disclosures.

NSW Treasury has requested the Auditor-General audit the special purpose financial report under Section 27B (3) (c) of the Public Finance and Audit Act 1983.

The signed Financial Report is included (Section G).

A Machinery of Government (MoG) modification occurred in July 2019, whereby the Coal Innovation NSW Fund (CIF), serviced by Department of Planning and Environment (DPE) Division of Resources and Geoscience, was transitioned to the Department of Planning, Industry and Environment (DPIE).

B Payments Received (income)

During the 2018-19 financial year the Fund received:

- Interest earnings of $1,197,253 deposited directly into Coal Innovation NSW Fund's bank account. The interest is calculated on the daily balance of the bank account and paid at the cash rate, on a monthly basis, using the Westpac Interest Apportionment Service.
- Other revenue of $4,362 is a refund from the Blaze advertising company.

Table 1: below summarises the income calculated as follows:

Table 1: Income[1]

Description	Value ($)
Interest revenue	1,197,253
Other revenue	4,362
Total income (2018-19)	**1,201,615**

[1] *These financial figures (and other financial figures within this report) vary slightly from the Statement of Income and Expenditure attached to this Report. It is standard accounting practice in producing a Statement of Income and Expenditure to round (up or down) figures, for example, the correct 'other revenue' amount is $4,362 and the rounded amount is $4,000. During the audit process all figures are fully disclosed.*

C Expenditure

Coal Innovation NSW has dispersed funds across the following key areas:

C1: Coal Innovation NSW Ministerial Advisory Council and sub committees

For the financial year ending 30 June 2019, Table 2 outlines the funds expended in relation to the costs of Coal Innovation NSW meetings, sitting fees, Technical Working Group (TWG) for Research, Development and Demonstration (RD&D) projects and Steering Committee meetings in relation to the NSW Future Electricity Generation study.

Table 2: CINSW meetings, TWG and Peer review costs

Description	Value ($)
Total cost of Coal Innovation NSW Ministerial Advisory Council.	20,095
Steering Committee for the Future of NSW Coal Fired Electricity Generation Industry Study	3,000
TWG for RD&D round 2018	1,422
Total	**24,517**

C2: Coal Innovation NSW Secretariat salaries and costs

For the financial year ending 30 June 2019, Table 3 provides an overview of the funds expended against Secretariat salaries and on costs:

Table 3: CINSW Secretariat costs

Description	Value ($)
Secretariat costs including salaries and on costs, professional fees not listed elsewhere, telecommunications, training, travel, and office supplies (Audit costs disclosed separately)	522,396
Total	**522,396**

The $321,995 reduction in Secretariat expenses from 2017/18 financial year is due to a decrease in administration and salary costs. The Senior Project Officer (Economics) position has been vacant since July 2018 and Assistant Research Officer since April 2018.

The Partnership Agreement between CIF and DPE has not been re-established, therefore the administration expenditure has not occurred in that regard.

C3: Research and Development (R&D) projects funded under 2009 Expressions of Interest

For the financial year ending 30 June 2019 the funds in Table 4 have been expended in relation to the R&D Round 2009 projects:

Table 4: Project expenditure from R&D Round 2009

Applicant	Project description	Value ($)
MCi – GreenMag (Uni of Newcastle)	Mineral Carbonation	96,250
Centennial Coal (Mandalong) P/L	Fugitive Emissions (ventilation)	301,747
Total		**397,997**

The final report for the Mineral Carbonation (University of Newcastle - GreenMag) R&D Round 2009 project has been received and the final payment of $96,250 was made in the FY 2018-19 financial year.

The final payment of the $301,747 for the Centennial Coal the RD&D Round 2009 was made in the FY 2018-19.

See Section D3, Table 10 for details of previous actual expenditure.

C4: Research, Development and Demonstration (RD&D) projects funded under 2015 Expressions of Interest

For the financial year ending 30 June 2019 the funds in Table 5 have been expended in relation to the RD&D Round 2015 projects:

Table 5: Project expenditure from RD&D Round 2015

Applicant	Project description	Value ($)
CO2CRC (Qader)	Membrane Gas-Solvent Contactors	355,713
CSIRO (Wardhaugh)	Rotating Liquid Sheet Contactor	517,010
Uni of NSW (Chen)	Third Generation Membrane Development	317,345
CSIRO (Halliburton)	Aerosol Formation Case Study	146,212
CSIRO (Hai Yu)	Advanced aqueous ammonia-based carbon capture technology	900,000
Uni of Newcastle (Donne)	Direct Carbon Fuel Cell Demonstration	550,300
CSIRO (Feron)	Energy Harvesting from CO_2 Capture	202,647
Uni of Newcastle (Moghtaderi)	Combining Redox Energy Storage at a coal-fired power generation	78,797
Total		**3,068,024**

C5: NSW CO2 Storage Assessment Program

For the financial year ending 30 June 2019 the funds in Table 6 have been expended in relation to the NSW CO2 Storage Assessment Program:

Table 6: NSW CO2 Storage Assessment Program

Description	Value ($)
Total NSW CO2 Storage Assessment program – Stage 2- Aboriginal heritage and ecological assessment	5,130
CBA – Darling Basin Drilling Program	84,366
Total	**89,496**

Cost Benefit Analysis (CBA) for the Darling Basin Drilling Program:

- $84,366 – Deloitte Access Economics

C6: Future of NSW Coal Fired Electricity Generation Industry Study

For the financial year ending 30 June 2019 the funds in Table 7 have been expended in relation to the Future of NSW Coal Fired Electricity Generation Industry Study.

Table 7: Consultancy expenditure into Future of NSW Coal Fired Electricity Generation Industry Study

Description	Value ($)
Generation Study Stage 3 and 4 Consultancy and other professional service	338,799
Total	**338,799**

The Generation Study costs are related to the following:

- $255,928 - Frontier Economics: The Future of NSW Coal Fired Electricity Generation Industry Study, Stages 3 and 4.
- $10,000 – Red Vector and Gamma Energy Technology: Decarbonising NSW – Model of Energy and Grid Services Study, Data inputs for the Frontier Economics study.
- $72,871 - Imperial College London: peer review, Gamma Energy Technology: independent advice.

C7: Research, Development and Demonstration (RD&D) projects funded under 2018 Expressions of Interest

For the financial year ending 30 June 2019 the funds in Table 8 have been expended in relation to the RD&D Round 2018 projects:

Table 8: Project expenditure from RD&D Round 2018

Applicant	Project description	Value ($)
Uni of Newcastle (Wall)	Manufacture of carbon fibres	156,075
Sunset Power (Callen)	Battery energy storage system at Vales Point Power Station	218,500
CSIRO (Su)	Ventilation air methane catalytic mitigator	454,099
CSIRO (Feron)	Water production from an amine based post-combustion CO_2 capture process	275,099
CSIRO (Thiruvenkatachari)	Harnessing energy with CO_2 utilisation	25,492
CSIRO (Milani)	Highly-integrated solar heat in carbon capture technology	104,196
CO2CRC (Qadar)	Reduction of greenhouse gas emissions in steel production	184,106
Toshiba (Byak)	Ultra supercritical hybrid solar/coal pathway	146,375
CSIRO (Yin)	CO_2 capture at a cement plant	30,000
Uni of Newcastle (Doroodchi)	Assessment of geothermal assisted power generation	29,750
UTS (Zhang)	Solar photovoltaic and concentrated solar power for coal-fired power plants	28,917
USYD (Ho)	Bioenergy carbon capture and storage feasibility study	27,485
UNSW (Walsh)	Silica gels for improved CO_2 containment and mitigation	27,000
Total		**1,707,095**

C8: Audit Fees

For the financial year ending 30 June 2019 the funds in Table 9 have been expended in relation Audit Fees.

Table 9: Audit Fees

Description	Value ($)
Audit Fees for FY 2018-19	26,650
Total	**26,650**

Evaluation and Conclusion

D Evaluation

Evaluation of the effectiveness of each of the projects and other activities that received funding under the Coal Innovation Administration Act 2008 (Act):

D1: Coal Innovation NSW (CINSW)

The Act requires the formation of Coal Innovation NSW (CINSW), a Ministerial Advisory Council (Council). As prescribed in Section 10 of the Act, CINSW is to comprise an independent Chair, and up to eight members appointed by the Minister, consisting of two appointed members from government and two nominees from industry to represent the NSW black coal industry, and up to four additional members appointed by the Minister.

For the financial year 2018/19, the membership of CINSW comprised:

- Prof. Jim Galvin, *Independent Chair*
- Prof. Michael Dureau, *Deputy Chairman, Warren Centre for Advanced Engineering*
- Prof. Hugh Durrant-White *NSW Chief Scientist and Engineer (from 1 January 2019)*
- Dr Chris Armstrong, *Acting NSW Chief Scientist and Engineer (to 31 December 2018)*
- Dr Chris Yeats, *Executive Director, Geological Survey NSW*
- Mr Michael Buffier, *Group Executive, Glencore*
- Mr John Richards, *Managing Director, The Bloomfield Group*
- Prof. Dianne Wiley, *Head of School, University of Sydney*
- Dr Noel Simento, *Managing Director, Australian National Low Emissions Coal R&D*
- Mr Greg Everett, *Managing Director, Sunset Power International (Delta Electricity).*

CINSW held five meetings in the 2018/19 financial year:

- 10th July 2018 - 23rd meeting
- 25th September 2018 - 24th meeting
- 7th November 2018 - 25th meeting
- 11th February 2019 - 26th meeting
- 13th May 2019 - 27th meeting

On CINSW expenditure in this financial year, $20,000 was paid to the Chair as renumeration, $95 for sitting fees of Council members and $3,000 for the Steering Committee for the Future of NSW Coal Fired Electricity Generation Industry Study.

Evaluation:

At the 23rd meeting of CINSW, held on 10 July 2018, Council was advised the CINSW CO_2 Storage Assessment Program was suspended pending a cost benefit analysis, with Council reviewing the Terms of Reference of the independent consultant. Frontier Economics presented the Stage 3 results of their modelling work. The peer review by Imperial College, London was also provided to Council, which suggested further sensitivity analysis be undertaken as part of Stages 3 and 4. The Technical Working Group (TWG) reported to Council noting 29 research, 6 VAM projects and 19 seed funding applications were received. TWG recommended 14 projects be funded, with Council acknowledging $1.5 million underspend of the RD&D Round 2018.

At the 24th meeting of CINSW, held on 25 September 2018, Frontier Economics presented the findings of their modelling work for the Future of NSW Coal Fired Electricity Generation Industry Study Stages 3 and 4. Council also reviewed the findings of the Electric Power Research Institute (EPRI) Study and Model for Energy and Grid Services(MEGS) Study. Council was informed the RD&D Round 2018 projects were before the Minister to support thirteen (13) research projects; seven Research Grants, one VAM project, and five Seed Funding. A VAM Strategy Roadmap study was also approved.

The 25th meeting of CINSW, held on 7 November 2018, focused on the results of the Stage 3 and 4 sensitivity analysis by Frontier Economics. It was agreed that a draft Executive Summary Report would be compiled and distributed to Council. A proposal on cooperative initiatives with the Department of Planning, Industry and Environment's Renewable Energy Branch (REB), including opportunities to seek joint funding, was discussed by Council. Council was advised the Minister accepted funding recommendations for RD&D Round 2018.

At the 26th meeting of CINSW, held on 11 February 2019, Council was advised Frontier Economics submitted the final report titled 'Future of NSW Coal Fired Electricity Generation Industry Study'. Council also discussed the future strategy, planning and budget of CINSW. In principle support for the University of Melbourne's social science study (the 14th RD&D Round 2018 project recommended for funding by the TWG) was also given by Council, with the recommendation to be provided to the Minister. Council was advised the tender for the CO_2 storage Cost Benefit Analysis (CBA) to engage an independent consultant was open, with the proponent to be selected in the coming weeks.

The 27th meeting of CINSW, held on 13 May 2019, had Dr Paul Feron present on his findings from the Energy Harvesting from a CO_2 Capture Process project, funded through a RD&D Round 2015 grant. The independent consultant selected for the CBA of the CO_2 Storage Assessment Program, Deloitte Access Economics, outlined to Council their proposed work packages and presented the initial findings of Package 1. Due to the uncertainties of the CBA, members agreed discussions on the future strategy of CINSW would be delayed. CINSW's contribution to the National Hydrogen Strategy was raised, with the Secretariat to contribute to this working group.

D2: Coal Innovation NSW Secretariat

Coal Innovation NSW Secretariat employs five staff:

- Program Director
- 2 Senior Project Officers (Economist and Scientist)
- Project Officer (Finance).
- Assistant Research Officer.

Evaluation:

After almost ten years of stability, employment at the Secretariat was less steady. Following the retirement of the geoscientist in April 2018, the economist and assistant research officer moved to other roles within the public service. Despite the constraints of the staffing resources, a comprehensive work program was completed in accordance with recommendations by the Council.

Significant tasks for the financial year centered on:

- managing existing projects, including working with researchers in the development of final R&D reports and engaging independent peer reviewers.
- finalising assessments of applications received through the Expressions of Interest (EOI) Round 2018, negotiations of contracts with successful applicants, and project establishment.
- conducting an industry workshop on the abatement of ventilation air methane from underground coal mining to identify technology, research and development pathways.

- working collaboratively with the selected tenderers on Stages 3 and 4 of the Future of NSW Coal Fired Electricity Generation Industry Study, CCS Cost Benefit Analysis, and the Repowering NSW Subcritical Coal Unit to Advanced Steam Conditions Study.
- ongoing work with the Ministerial Advisory Council in developing options for the CINSW Fund's budget and future programs.
- consultation with industry and the Commonwealth on future research options.
- involvement in the policy debate at a national level.
- upgrades to the CINSW website.

Overall the Secretariat met the goals and timelines recommended by Council, particularly in establishing the new research and study programs.

D3: 2009 Research and Development (R&D) Projects

A "Call for Expressions of Interest under the NSW Clean Coal Fund" closed on 4 December 2009, with 29 applications received and assessed. In May 2010, the then Minister approved 10 projects as shown in Table 9. After negotiations of funding agreements, some of the awarded amounts varied slightly:

Table 10: R&D Projects 2009

Applicant	Project description	Awarded funding up to ($)	Duration	Restructured funding	Amount expended at closure or at 30/06/2019
Uni of Newcastle / GreenMag	Alternative CO_2 storage	3,040,000	4.5 yrs	3,040,000	3,040,000
UCC Energy (1)	Combustion	2,581,000	4 yrs	closed early	38,174
Centennial Coal	Fugitive emissions	2,200,000	2 yrs	2,200,000	2,196,526
CSIRO	Capture technology	1,300,000	3 yrs	1,582,319	1,582,319
CSIRO (2)	Fugitive emissions	1,000,000	2 yrs	closed early	39,451
Uni of Newcastle	Combustion alternative	886,618	3 yrs	851,296	851,296
Uni of Newcastle (3)	Social research	618,930	2 yrs	661,946	655,795
CSIRO	Capture technology	613,711	1.5 yrs	613,711	613,711
Uni of Newcastle	Carbon fuel cell	608,719	5.5 yrs	564,748	564,748
OurSun P/L	Combustion technology				did not commence
Total Funding Awarded		**12,848,978**			
Total Funding Committed				**9,514,020**	
Total Funding Expended (as at 30 June 2019)					**9,582,020**

Notes:
1. UCC Energy received $50,000 in their first instalment to carry out a greenhouse gas life cycle assessment of their process. On a 1:1 shared costs basis for this study, $11,826 was returned to CINSW Fund as unspent monies on this study.
2. CSIRO received $115,000 in their first instalment for this project. The Department terminated this agreement because the project was no longer viable without an industry partner. As a result $75,549 in unspent monies was returned to the CINSW Fund.
3. The University of Newcastle completed this project without incurring the costs associated with publications, and so $6,151 was retained by the CINSW Fund.
4. Centennial Coal was slightly underspent by $3,474 relative to budget due to the contract variation.

A detailed evaluation of each project follows:

D3.1: Project: UCC Fired Diesel Engines in the generation of electricity

Grantee: UCC Energy Pty. Ltd

Project closed by mutual agreement.
See 2012-13 Report to Parliament for details.

D3.2: Project: Fugitive emissions abatement from ventilation air

Grantee: Centennial (Coal) Mandalong Pty Ltd

Centennial Mandalong Pty Ltd received initial grant funding to trial a 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 a mine during standard mining operations. As methane typically constitutes less than 1 per cent of the ventilation air expelled from the mine, the gas concentration is too low to burnoff (often referred to as flaring) or process for electricity generation.

The VAM-RAB system attempts to overcome this problem by directing the ventilation air through what is essentially a large industrial oven where it is heated to approximately 1000^{o} C. By using this oxidation technique almost all the methane (> 99 per cent) 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:

Initial heat-up trials of the VAM-RAB plant in 2014 showed several issues with the demonstration plant requiring an extensive remediation program to be undertaken. Work continued over the next two years resulting in the plant’s recommissioning in August 2016. However, follow-up heating trials in the 2016-17 fiscal year remained unsuccessful as temperatures required to undertake the research trials were not reached. CINSW and the grantee negotiated two contract variations (November 2012 and August 2017) to manage the delays noted and an initial delay in gas supply. Because of the failure to reach required temperatures, CINSW requested details on options to achieve a safe and stable system.

Following further discussions with the grantee it has been decided to close this current CINSW-funded project and work with the Commonwealth and industry in developing a research plan involving the Commonwealth-funded research outcomes and learnings from the CINSW-funded project. The grantee has committed to continue being involved with the research but not on the Mandalong site. This may require the VAM-RAB plant to be moved. The Deed of Termination (clause 8.2) provides the Department sole discretion to remove the VAM-RAB within five years.

Project closed by mutual agreement.

D3.3: Project: Further development of Post Combustion Capture (PCC)

Grantee: CSIRO Energy Technology

Project successfully completed.
See 2014-15 Report to Parliament or Coal Innovation NSW website for full details.

D3.4: Project: Reducing Fugitive Emissions - Enhanced Drainage techniques

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

Project closed December 2012 and unspent moneys returned.
See 2012-13 Report to Parliament for full details.

D3.5: Project: A Novel Chemical Looping Based Air Separation Technology

Grantee: The University of Newcastle Priority Research Centre for Energy

Project successfully completed.
See 2014-15 Report to Parliament or Coal Innovation NSW website for full details.

D3.6: Project: Managing Project Risk: The Role of Public Awareness

Grantee: University of Newcastle

Project successfully completed.
See 2014-15 Report to Parliament or Coal Innovation NSW website for full details.

D3.7: Project: Site Trials of Novel CO_2 Capture Technology

Grantee: CSIRO Coal Technology

Project successfully completed.
See 2014-15 Report to Parliament or Coal Innovation NSW website for full details.

D3.8: Project: Development and Optimisation of the Direct Carbon Fuel Cell (DCFC)

Grantee: University of Newcastle's Discipline of Chemistry

Project successfully completed.
See 2016-17 Report to Parliament or Coal Innovation NSW website for full details.

With the successful completion of this project, the further development of DCFC technology has been supported by CINSW through a new project as one of the eight successful projects under CINSW Fund EOI Round 2015 (see item D4.6 for details).

D3.9: Project: Permanent Large-scale CO_2 Storage by Mineral Carbonation

Grantee: Mineral Carbonation International

The GreenMag Group and University of Newcastle Priority Research Centre for Energy was awarded grant funding, dependent 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. GreenMag and the University of Newcastle formed Mineral Carbonation International Pty Ltd (MCI) with a commitment from Orica to match funding as the industry partner. This joint venture has undertaken further research into mineral carbonation technology and established a CO_2 mineral carbonation pilot plant at the University of Newcastle. The project aims to transform captured CO_2 emissions into forms of carbonate rock that will be trialled as new green building materials for the construction industry.

The Mineral Carbonation process takes advantage of a natural process whereby CO_2 is captured in mineral deposits resulting in it being stored in rocks. A key advantage of this process is that the CO_2 is permanently stored in the rocks. It would only re-enter the atmosphere if the rocks were subjected to extremely high temperatures.

The Project has taken existing known processes for mineral carbonation from bench scale to demonstration plant scale and conducted complementary R&D activities, which each could reduce the overall cost of mineral carbonation that could eventually operate at industrial scale. The major goal for the Project is to reduce the cost of existing mineral carbonation processes and to demonstrate the process involved can be scaled up from the laboratory to this pilot scale and beyond.

The MCI project extends over a four-year period and encompasses three main strands, including:

- pilot plant construction and operation.
- intensive research and development.
- program governance, communication and commercialisation.

The pilot plant was officially launched on 23 August 2017 by the Minister for Resources at the Newcastle Institute of Energy and Resources, University of Newcastle (NIER).

Evaluation:

Work has been completed on the design, development, commissioning and experimental operation of the largest mineral carbonation research pilot plant built to date.

The draft final report has been submitted and has been subject to an independent review. The peer review assessed the scientific rigour, methodology and experimental design, data acquisition, analysis and interpretation. Feedback from the reviewer was that the original goals of the project have been met. The revised final report has been submitted and is under review by the Project Steering Committee.

D3.10: Project: A Simple Heat Engine for Sustainable Coal Generation

Grantee: ourSUN Pty Ltd

Application withdrawn by applicant, December 2010.
See 2010/11 Report for full details.

D4: 2015 Research, Development and Demonstration (RD&D) Projects

In 2016 the Minister approved the awarding of up to $8,646,655 (GST exclusive) in grant funding from the Coal Innovation Fund to be distributed to eight successful project applicants to the 'Expressions of Interest' (EOI) Round 2015 for RD&D projects (see Table 11). The eight projects span across different investigations into low emissions coal technologies, and five of them involve technology testing using real flue gas at Vales Point Power Station.

Table 11: RD&D Projects 2015

Applicant	Project description	Awarded funding up to ($)	Completion date	Amount expended at 30 June 2019 ($)
CO2CRC Pty Ltd	Membrane Gas-Solvent Contactors	1,216,900	June 2019	1,034,366
CSIRO (Wardhaugh)	Rotating Liquid Sheet Contactor	1,274,045	June 2019	1,274,045
Uni of NSW (Chen)	Third Generation Membrane Material Development	862,803	June 2019	862,803
CSIRO (Halliburton)	Aerosol Formation Case Study	687,252	June 2019	584,164
CSIRO (Hai Yu)	Advanced aqueous ammonia-based carbon capture technology	2,000,000	June 2019	1,700,000
Uni of Newcastle (Donne)	Direct Carbon Fuel Cell (DCFC) Demonstration	1,643,001	June 2019	877,822
CSIRO (Feron)	Energy Harvesting from CO_2 Capture	578,991	Dec 2018	578,991
Uni of Newcastle (Moghtaderi)	Combining Redox Energy Storage with coal-fired power generation	383,663	Dec 2018	326,113
Total Funding awarded / expended		**8,646,655**		**7,238,304**

One of the successful applicants (CSIRO) from the first round of grants for R&D projects in 2009-10 received grant funding to relocate and refurbish a post-combustion capture (PCC) pilot plant from Munmorah Power Station to Vales Point Power Station. This pilot plant is now a critical piece of infrastructure that has established a test facility that can stage many different experimental campaigns on real flue gas under real power station operating conditions. This includes the five previously mentioned projects conducting testing at Vales Point Power Station (the first five projects listed in Table 10.

The other three funded projects are conducted at the University of Newcastle and CSIRO Energy Centre in Newcastle.

All eight projects started in 2017. A detailed evaluation of each project follows:

D4.1: Project: Membrane Gas-Solvent Contactors Demonstration Project

Grantee: CO2CRC Pty Ltd

This project is investigating a new type of technology, known as a Membrane Gas-Solvent Contactor, for the capture of CO_2 from the flue gas from a coal-fired power station. Membrane contactors are a hybrid technology incorporating the advantages of both solvent absorption and membrane separation. The project aims to establish the viability of this new hybrid technology and provide the necessary data to enable design scaling to support a potential large-scale CO_2 capture demonstration. If the technology can be achieved at scale, it would enable it to be cost competitive and help drive down the costs of capturing CO_2 for Carbon Capture and Storage (CCS).

The trials were undertaken at Vales Point Power Station using a refurbished pilot plant with a 100 kg/day CO_2 capture capacity, the largest known of its kind. Commercially available membranes and conventional absorption liquid (30 per cent Monoethanolamine Diethanolamine Triethanolamine were used in the study to ensure CO_2 capture and subsequent regeneration of this liquid (i.e. removal of the CO_2) could be achieved.

Evaluation:

The project commenced in January 2017, with a draft final report submitted in May 2019. The report is going through a rigorous review process including independent evaluation by a subject matter expert.

Over the course of the project, work progressed from initial screening studies of suitable membranes in the laboratory through to the pilot plant campaigns, where the effectiveness of the technology in separating out CO_2 from a slipstream of flue gas from Vales Point Power Station was assessed. Favourable results were achieved for each section of work. Commercially available membrane contactors successfully separated out CO_2 from the flue gas in combination with conventional solvent liquids. The pilot plant campaign determined the optimal operational conditions to enable efficient CO_2 capture and solvent regeneration over an extended period. This information was used to undertake a limited economic and lifecycle analysis, which determined the developed contactor technology was competitive with traditional carbon capture technology.

D4.2: Project: Rotating Liquid Sheet Contactor pilot scale testing project

Grantee: CSIRO

This project involves designing and testing a new and potentially more efficient type of gas separation technology referred to as a "Rotating Liquid Sheet (RLS) contactor" for the capture of CO_2 from power station flue gas. The aim of the project is to validate the design, costs and performance of the RLS contactor in a PCC cycle using real flue gas in a pilot plant at Vales Point Power Station.

The RLS contractor is a device in which continuous thin liquid sheets of absorption liquid are sprayed out from slots in a specially designed rotating central tube. The liquid sheets come into contact with, and absorb the CO_2 from, flue gas emitted from industrial processes such as coal combustion. One of

the project's objectives is to provide a liquid surface area for the CO_2 to come into contact with, that is equivalent to conventional CO_2 capture technology but with less equipment and fewer process steps. In doing so, this would significantly reduce capital and operating costs. If proven, this novel technology could then be incorporated into a conventional CCS process and be retrofitted to existing coal-fired power stations to reduce their carbon emissions by more than 90 per cent.

Evaluation:

The project began in January 2017, and, following a successful two-year research program, a draft final report was submitted in late April 2019. The report is undergoing a rigorous peer review including independent evaluation by a subject matter expert.

The research comprised of an experimental laboratory program involving design and performance testing of the rotating central tube, and a pilot testing campaign using a single unit retrofitted to the existing CSIRO pilot CO_2 capture plant at Vales Point Power Station. Favourable results were achieved for each stage of the research. The approach taken to improve the design and functionality of the rotating central tube was comprehensive and resulted in all the lab-based performance targets being met. Successful completion of the pilot-scale testing regime allowed existing process and cost models to be updated for an up-scaled demonstration-sized plant. The modelling shows the novel RLS contactor technology had an 11 per cent lower total investment cost than an equivalent plant using conventional carbon capture technology.

D4.3: Project: Third Generation Membrane Material Development

Grantee: University of NSW

This project is developing a new method of CO_2 capture using high-performance membrane material that physically separates or sieves out CO_2 from the flue gas of a coal-fired power station. The aim of the project is to provide an accurate technological and economic assessment of the high performance membranes for CO_2 capture based on pilot testing using real flue gas from Vales Point Power Station. This will allow the potential commercialisation of this carbon capture technology to be evaluated.

Membrane technology is a physical separation process somewhat akin to sieving currently used in the gas industry for separating gas mixtures into different gases. This project is developing a new generation of high performance membranes for capturing CO_2 that offer the prospect of reducing CO_2 capture costs. The trial is considered of critical importance as the technical information from the few similar field tests globally is not readily available.

A unique feature of this project is all the materials used for membrane development are commercially available and therefore the process developed is amenable to existing large-scale fabrication used in membrane production. This project has the potential to provide a pathway for translating membrane technology for carbon capture into industrial scale manufacturing in NSW.

Evaluation:

The project began in January 2017 with the research completed by early 2019 and a draft final report submitted in late April. The report is going through a rigorous review process including independent evaluation by a subject matter expert.

During the initial phases of the study high performance hollow fibre membranes were successfully fabricated by applying a state-of-the-art coating technique to inexpensive water treatment membranes. Following this, a comprehensive laboratory screening process identified four membranes suitable for pilot-scale testing that met performance targets in terms of CO_2 separation.

A pilot-scale testing facility was designed, constructed and tested at the University of NSW and then relocated to Vales Point Power Station. Results from a four-month onsite testing campaign using the selected membranes and flue gas were satisfactory in meeting specified performance targets. As part of the trials it was determined the flue gas required partial pre-treatment to mitigate any performance declines in the membranes. Using the on-site results, an economic study was undertaken showing both the membrane performance and process design required optimisation to enhance CO_2 recovery.

D4.4: Project: Aerosol Formation Case Study

Grantee: CSIRO

This study is evaluating the potential for pollutant emissions being produced whilst using a PCC process on coal-fired power stations. The project aim is to provide an understanding of the generation of aerosol emissions to address any knowledge gaps or potential environmental issues in CO_2 capture plants that use an amine-based absorbent.

This project will answer the question of where, and under which conditions, aerosols are formed in the conventional CO_2 capture process. The findings will provide new information on whether aerosol emissions are a potential issue, and potentially lead to techniques for reducing airborne emissions and consequential reductions in the cost of plant operations.

Evaluation:

This project started in January 2017 and passed its first stage gate assessment through the delivery of a state-of-the-art review of aerosol genesis and absorbent loss in PCC processes. The review also critically evaluated the effectiveness and limitations of current aerosol sampling methodologies, enabling the most appropriate research approaches to be selected for the experimental testing phase of the project.

Over 1,400 laboratory experiments were completed to investigate the principal drivers and aerosol forming potential of several gases present in the flue gas stream and various absorption-based PCC operational processes. The trace gas sulphur trioxide (SO_3) was found to be the primary driver of aerosol formation. In addition, aerosols formed when nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) reacted together to form SO_3. These findings were validated in the pilot scale experiments at Vales Point Power Station. The results are being carefully analysed for inclusion in the final report.

D4.5: Project: Advanced aqueous ammonia-based carbon capture technology

Grantee: CSIRO

This project focussed on demonstrating the benefits of an advanced aqueous ammonia-based PCC process, developed by CSIRO using the pilot plant located at Vales Point Power Station. Parallel to the pilot plant trials, lab-based research will develop ‘proof of concept’ and prototyping of an entirely new ‘Trimonia Process’ utilising high concentration aqueous ammonia (NH_3) as a CO_2 capture medium.

The pilot stream aims to demonstrate how advanced aqueous NH_3-based PCC technology can be applied to new and existing coal-fired power stations in NSW to significantly reduce CO_2 emissions in an affordable and environmentally benign way. The technology uses NH_3, a cheap, stable and locally available chemical, as the chemical solvent to remove CO_2, SO_2 and other pollutants from the flue gas in power stations and other industries. It aims to deliver a locally developed carbon capture technology concept based around a locally available solvent suitable for NSW power plants.

If successful the project will help prepare the technology for a large-scale demonstration in NSW and ultimately benefit the NSW coal industry by providing a cost-competitive, low-emission coal technology for capturing CO_2 emissions, for carbon capture, utilisation and storage.

Evaluation:

This project started in January 2017 with the experimental work completed in early 2019 and a draft final report submitted in May. Peer review of the report is underway including expert review by an independent consultant.

Following the development of a technology roadmap for the aqueous NH_3-based PCC process, the project team commenced work on both the advanced NH_3 process pilot testing and laboratory trimonia process work in parallel. The pilot plant trials demonstrated a number of benefits brought about by improvements to the capture process, including enhanced removal of sulphur dioxide (SO_2), a reduction in the amount of absorbent lost during the capture process, and an improved process for removing the captured CO_2 from the absorbent. A subsequent techno-economic assessment showed the avoided CO_2 capture cost for an Australian coal-fired power station integrated with the advanced NH_3-PCC process would be 31 per cent lower than a conventional amine-based capture process. The pilot plant study has laid a solid foundation for a future large-scale demonstration.

Each of the three individual operations of the Trimonia process were tested separately in laboratory-scale and mini-pilot scale equipment to determine the range of operation and technical limits of each component. This included the use of NH_3 in a vapour form to capture CO_2 from flue gases, followed by a reverse osmosis process to separate out the NH_3 that had absorbed CO_2 from unreacted NH_3, and finally an operation to re-heat the unreacted NH_3 to return it to a vapour ready for the next capture cycle. In each case the components achieved degrees of capture or separation exceeding the requirements of the project. The design of an integrated process has been proposed for possible future work.

D4.6: Project: Direct Carbon Fuel Cell (DCFC) Demonstration

Grantee: University of Newcastle

This project is building on previous studies on the Direct Carbon Fuel Cell (DCFC) — funded under the 2009 R&D Round— with further fundamental research to support the ultimate development of a DCFC demonstration plant. The project aim is to develop a first-of-kind fuel cell converting the chemical energy from coal into electricity through an electrochemical reaction. The DCFC technology has potential to be one of the most efficient ways of producing electricity with significantly less CO_2 emissions.

The DCFC technology has undergone a major boost in international research interest in recent years; however, technical barriers have meant commercialisation has not occurred at this early stage. This project will bridge a crucial gap between research and commercialisation of DCFC technology.

Evaluation:

While the other seven projects under CINSW EOI Round 2015 started in January 2017, this project commenced in June 2017 following the successful completion of the previous project funded under the 2009 EOI Round titled '*Development and Optimisation of the Direct Carbon Fuel Cell*'.

The project includes two discrete streams. The first stream includes fundamental/pilot-scale work predominately building on the successful work of the previous project. A small DCFC test rig has been built in the laboratory to allow testing of fundamental aspects of the electrochemical generation of

electricity from coal. Significant progress has been made in understanding the processes operating within the DCFC, with the work culminating in a three-fold increase in the electrical output from that achieved in the first project funded by CINSW in 2009.

The second stream is focused on the build and operation of a demonstration fuel cell system. The design and fabrication of a 1kW unit is complete and testing is underway to optimise operations based on the findings from the first stream.

D4.7: Project: Energy Harvesting from a CO_2 capture process

Grantee: CSIRO

This project aims to develop a CO_2 capture process generating electricity directly through electrochemical reactions occuring when amines (liquid solvents used to separate out CO_2 from power station flue gas) laden with captured CO_2 are mixed with specific metals (e.g. copper). This CO_2 capture and energy harvesting process could provide a significant technological breakthrough for CCS by providing a new source of electrical power that can be used to offset the energy demand of PCC processes.

The project involves the development of a conceptual design of the CO_2 capture and energy harvesting process based on process performance data from laboratory experiments and modelling. A techno-economic assessment of the overall process is also included in the analysis.

Evaluation:

This project commenced in January 2017 and progressed well, meeting all milestones within specified timeframes. A final report was submitted in December 2018 and underwent a critical peer review process. CINSW accepted the final report and will make a recommendation to the Minister to publish the report on the CINSW website on acceptance by the Minister in the next financial reporting year.

Project highlights include the completion of a literature study delivering a database and basic information on 100 metal-amine complexes and their amine-CO_2 chemistry, and investigating the ammonia-based energy harvesting process through lab-based experiments and process modelling. The maximum energy that can be harvested from the ammonia-based capture process was estimated and a flow battery designed, constructed and operated to test its performance under various scenarios.

The best practical energy performance achieved in the lab-scale flow battery was 0.041 MWh per tonne of CO_2 for a copper-ammonia based flow battery system. This output is similar to the electrical energy requirement for a typical CO_2-capture process. Based on the literature study there is potential for improvement if other metal-amine combinations are considered. A techno-economic assessment was carried out for a coal-fired power station, with one of the key findings being that, based on the energy performances achieved, the reduction in power plant output (brought about by the energy demand of a CO_2 capture process) can be brought down to 13 per cent, albeit at higher capture costs because of the higher investment costs of the battery system. There is potential for further improvement of the energy harvesting system to limit the reduction of the power plant output to 11 per cent, i.e. only 70 MW for a 670 MW power station. This is the lowest efficiency reduction reported for any amine-based CO_2-capture process, indicating the significance of this break-through concept. With these improvements the costs of capture could come down by 30 per cent compared to the state-of-the-art system.

D4.8: Project: Combining Redox Energy Storage with coal-fired power generation

Grantee: University of Newcastle

This project focuses on developing an energy storage unit termed “Redox Energy Storage” which performs a role akin to a large-scale battery. This technology could help coal-fired power stations better manage their load by storing energy in off-peak periods for later dispatch. The aim of the project is to determine the key science and engineering issues underpinning the performance of the Redox Energy Storage unit for energy storage.

A Redox Energy Storage unit works by storing large amounts of electricity as chemical energy at off-peak times when electricity demand is low, which can then be converted back to electrical energy and supplied to the grid during peak times when demand is high. In this way, the peaks and troughs in power generation imposed on power stations by the electricity grid can be reduced allowing the plant to run more smoothly and efficiently.

The Redox Energy Storage unit has potential to provide flexibility to coal-fired power plants to operate in the cycling mode without disrupting their baseload operation. This reduces the need for more high cost capital generation equipment for serving times of peak electricity demand only, whilst reducing greenhouse gas emissions.

Evaluation:

This project commenced in January 2017 with all of the research successfully completed in early 2019. A draft final report was submitted in March and is going through a peer review process including expert review by an independent consultant.

Following a thorough literature review on energy storage technologies, two thermochemical energy storage processes were selected for further modelling investigations. These included a Redox energy storage (RES) cycle and a calcium carbonate-calcium oxide looping (CaL) cycle. For modelling purposes these two processes were coupled to two different power blocks, being an open cycle gas turbine (OCGT) and a secondary steam cycle (SSC). Thus, the modelling work included process modelling of four different energy storage configurations, followed by techno-economic evaluation and greenhouse gas life cycle analysis of the considered processes. Whilst all four cases were found to be technically capable for storing electrical energy, the CaL+SSC configuration was found to be the most economically viable meeting all the required performance targets set for the project. The results from the life cycle analysis supported the adoption of the CaL+SSC configuration over Lithium-ion batteries as an energy storage solution as it had a lower environmental impact (e.g. one third of the CO_2/MWh emitted due to its higher energy density).

The experimental work involved a sequential series of tests from the laboratory scale to large pilot scale to demonstrate the effects of scaling-up. The main finding from this testing was the calcium-rich particles could be successfully used as the energy carrier in the thermochemical energy storage process to produce energy, thereby preventing the cycling of the power plant and decreasing its maintenance and operational costs.

D5: NSW CO_2 Storage Assessment Program as of 30th June 2019

The drilling program has been developed in three stages as follows:

- Stage 1A – Sydney Basin data acquisition and assessment, 4 wells (completed)
- Stage 1B – Darling Basin data acquisition and assessment, 2 wells (completed)
- Stage 2 – further data acquisition in the Darling Basin (planning phase put on hold pending the outcomes of an independent cost benefit analysis of the Program).

The 2014 drilling campaign in the Darling Basin (Stage 1B) met its aims and objectives and successfully discovered the first prospective site in NSW for the storage of CO_2 captured from coal-fired power stations and other industrial sources. Specifically, analysis of data from the Mena Murtee-1 well in the Pondie Range Trough, north-west of Cobar, revealed multiple sandstone reservoirs with the potential to store hundreds of millions of tonnes of CO_2 overlain by competent layers of top seal rocks.

Planning of the Stage 2 Darling Basin exploration program has progressed in line with a developed work plan based on the consolidation and synthesis of existing data, development of a peer-reviewed seismic acquisition program to fill existing data gaps, and the drilling of exploration holes located in key locations based on the outcomes of the new seismic acquisition.

In late March 2018, the Darling Basin drilling program was placed on hold whilst the effectiveness of the program was reviewed. Deloitte Access Economics has been awarded the contract after competitive tender to undertake the Cost Benefit Analysis of the NSW CO_2 Storage Program, commencing in March 2019.

Evaluation:

Deloitte Access Economics proposed to undertake four work packages as part of the wider study.

Package 1 provides a forecast of NSW CO_2 emissions from electricity generation and industrial processes from 2015 to 2050 under two reference cases (RCs):

- RC1: a ‘business as usual’ scenario within the current Commonwealth Government 2030 emissions reduction policy and Renewable Energy Targets with no new carbon policy, but including VRET and QRET, and
- RC2: based on the assumption of the commencement of stronger emission reduction targets from 2020 and 2030, at the Commonwealth level (in accordance with AEMO’s ‘strong’ scenario), and all state targets including an aspirational net-zero target for NSW.

Package 2 examines the Cost Benefit Analysis of the estimated net financial, social and environmental costs and benefits of CCS implementation in NSW:

- For the purposes of the CBA, the base case is defined as RC1: ‘business as usual’ without NSW CCS in place.
- Three Project Cases were specified for the CBA, with each defined as investment in NSW CCS, with transport to storage sites in three different locations.

The aim of Package 3 is to model the effects of an introduced emissions reduction scheme from 2020, while Package 4 would compare the results derived across packages 1, 2 and 3.

The key findings of Package 1 were:

- Similar outcomes occurred under both Reference cases in terms of the long-term energy generation mix, new capacity and CO_2 emissions. However, electricity prices are much higher in Reference Case 2.
- Under both reference cases, there is no coal-fired power in NSW by 2050, with renewables representing around 80 per cent of the mix.

A sensitivity analysis using a uniform weighted average cost of capital (WACC) (as used in modelling by the Australian Electricity Market Operator [AEMO]) for all the different power generation technologies coupled with allowing the repowering and/or upgrading of existing black coal generators

was also completed. Under these conditions, it was found that the existing coal-fired generators in NSW would be refurbished.

The Cost Benefit Analysis (CBA) of CCS in NSW commenced in April 2019, with the cost framework agreed. The key findings of the draft Package 2 report indicate the NSW Darling Basin has the lower cost for capture, transport and storage of CO_2 compared to CCS storage in the Surat (Queensland) or Gippsland (Victoria) basins.

Following the completion of packages 1 and 2, an independent stage-gate review has been undertaken before commencing packages 3 and 4.

D6: Future of NSW Coal Fired Electricity Generation Industry

In 2015, the CINSW Ministerial Advisory Council recommended to the Minister a 'Future NSW Coal Fired Electricity Generation Industry Study' project be undertaken. The initial study comprised two stages. Stage 1 involved the development of a comprehensive baseline data set and used this baseline to examine two reference scenarios. Stage 2 modelled and investigated several options and scenarios that NSW could put in place to optimise generation under a carbon constrained future.

In 2017, the CINSW Ministerial Advisory Council recommended to the Minister the original study was incomplete, and an additional two stages of analyses be undertaken. Stages 3 and 4 were established to model an optimised allocation of the electricity generation mix in both the National Energy Market (NEM) and NSW out to 2050, with a focus on understanding the longer-term role for coal in NSW's generation mix. The objective of the modelling was to assess impacts on wholesale electricity prices and the wider economy.

After a process of competitive tender, Frontier Economics was awarded the contract to deliver Stages 3 and 4 of the study for a fee of $285,868 (GST incl) with costs for additional modelling at $11,000 per scenario. Peer review of the final report was provided by Imperial College London.

Both Stages 3 and 4 work packages are complete. The Final Reports have been submitted to the Minister.

Evaluation

Frontier Economics modelled a number of different scenarios of electricity generation mix. The constraint imposed on the model was that the resulting NEM had to be stable, with a secure grid coupled with overall emissions reductions meeting a 28 per cent reduction target in 2005 emissions by 2030 and a 90 per cent reduction by 2050.

The modelling highlights there will be little incentive for new investment in generation capacity within the State until the mid-2030s, due to the current Victorian and Queensland renewable initiatives driving excess capacity in those states, which will export electricity to NSW. This dampened investment environment in NSW presents as a risk.

A shortfall in power generation due to the retirement of coal fired generators in the mid-2030s requires significant investment within the State. Depending on the scenario modelled, a range of technologies could be built to mitigate the shortfall. Most scenarios require the building of high efficiency low emissions coal plants (HELEs).

The modelling forecasts spikes in wholesale prices when existing coal fired generation retires. Price increases are also predicted when a more aggressive emissions reduction scenario (compared to base case) is tested.

D7: 2018 Research, Development and Demonstration (RD&D) Projects

In 2018 the Minister approved the awarding of up to $6,534,069 (GST exclusive) in grant funding from the Coal Innovation Fund to be distributed to thirteen successful project applicants of the 'Expressions of Interest' (EOI) Round 2018 for RD&D projects (see Table 12). The grant funding was distributed across two funding streams. This included a research stream capped at $1.5m per project and a maximum duration of three years, and a seed stream capped at $100,000 of one-year duration. The research stream aimed at supporting projects demonstrating they could reduce the time to deployment of a specific technology to garner market advantage or share, whilst the seed stream aimed to support projects generating new ideas to achieve a specific goal, test an innovation or undertake essential desktop studies.

Table 12: RD&D Projects 2018

	Project description	Awarded funding up to ($)	Completion date	Expended at 30 June 2019 ($)
CSIRO (Yin)	CO_2 capture at a cement plant	100,000	Dec 2019	30,000
University of Newcastle (Doroodchi)	Assessment of geothermal assisted power generation	99,165	Dec 2019	29,750
University of Technology Sydney (Zhang)	Solar photovoltaic and concentrated solar power for coal-fired power plants	96,390	Dec 2019	28,917
University of Sydney (Ho)	Bioenergy carbon capture and storage feasibility study	96,630	Dec 2019	27,485
University of NSW (Walsh)	Silica gels for improved CO_2 containment and mitigation	90,000	Dec 2019	27,000
Uni of Newcastle (Wall)	Manufacture of carbon fibres	753,468	Dec 2020	156,075
Sunset Power (Callen)	Battery energy storage system at Vales Point Power Station	460,000	Dec 2019	218,500
CSIRO (Su)	Ventilation air methane catalytic mitigator	1,496,424	Sept 2020	454,099

	Project description	Awarded funding up to ($)	Completion date	Expended at 30 June 2019 ($)
CSIRO (Feron)	Water production from an amine based post-combustion CO_2 capture process	1,347,874	Dec 2020	275,099
CSIRO (Thiruvenkatachari)	Harnessing energy with CO_2 utilisation	154,923	Mar 2020	25,492
CSIRO (Milani)	Highly-integrated solar heat in carbon capture technology	505,145	Dec 2020	104,196
CO2CRC (Qadar)	Reduction of greenhouse gas emissions in steel production	387,550	Dec 2019	184,106
Toshiba (Byak)	Ultra supercritical hybrid solar/coal pathway	946,500	July 2020	146,375
Total Funding awarded / expended		**6,534,069**		**1,707,095**

D7.1 Retrofitting calcium carbonate looping to an existing cement plant for CO_2 capture: A techno-economic feasibility study

Grantee: CSIRO

This project involves a techno-economic feasibility study of retrofitting a novel calcium looping process to an existing cement plant to reduce CO_2 emissions. The CO_2 capture cost of calcium looping has the potential to be significantly lower than other post-combustion capture (PCC) technologies. Globally, there has been no research on retrofitting existing cement plants with calcium looping in an industrial setting. Successful completion of this project would help bridge this gap and possibly lead to a near-zero emission cement plant in NSW.

The project includes a technology survey of pilot-plant development of calcium looping, site visits to the Berrima cement plant in southern NSW to collect relevant technical information and understand its current operation, and techno-economic feasibility assessment to understand the capital costs against economic return and CO_2 emissions reduction.

The production of cement involves sintering of carbonate minerals producing clinker and CO_2 and accounts for about 8 per cent of total GHG emissions worldwide. Calcium looping exploits the reaction taking place at medium temperatures (650 to 700º C) between lime (CaO) and CO_2 to form limestone ($CaCO_3$), which can be reversed at higher temperatures (900-950º C) to release a relative pure stream of CO_2 ready for utilisation or geosequestration. The process is tolerant to sulphur dioxide (SO_2) and has the potential to reduce nitrogen oxide (NO_x) emissions.

The Boral Berrima cement plant in NSW is the reference plant for this study. It is envisaged its CO_2 emissions can be reduced by >90 per cent by retrofitting the calcium looping process.

Evaluation

The half yearly review for this project has been submitted with work progressing well. Work on the technology survey was carried out at a broader scope than initially proposed to include a review of current CO_2 capture technologies. A literature review and site survey of Berrima cement plant to collect operational data are complete and a techno-economic assessment is underway.

D7.2: An in-depth assessment of geothermal assisted power generation for NSW coal-fired power plants

Grantee: University of Newcastle

This project is studying the feasibility of applying geothermal assisted power generation (GAPG) to NSW coal-fired power stations. The GAPG concept is designed to directly reduce the greenhouse gas (GHG) emission intensity of these plants by partly replacing coal with geothermal heat. The GAPG concept refers to the use of low-grade geothermal heat (between 70°–170°C) to provide a thermal boost to the existing coal-fired power plants via feedwater preheating. This rather simple yet effective concept could enable either an increase in generating capacity without increasing coal consumption, or the ability to maintain capacity whilst reducing coal consumption. In both cases, emissions of GHGs per unit of generation capacity are reduced. Economically, co-locating a geothermal power plant with an existing coal-fired power plant enables the sharing of existing power generating facilities, land uses and transmission lines, helping to save significant cost and the time required for developing geothermal resources.

The project consists of four main tasks, including: characterisation of NSW geothermal resources and coal-fired power plants, thermodynamic study and optimisation of retrofit options and operation modes, techno-economic assessment of two selected coal-fired power stations upgraded with a GAPG system, and consolidation and dissemination of project findings. Should the project demonstrate a feasible GAPG, the team intends to undertake a larger program of study to demonstrate the benefits of the GAPG concept.

Evaluation:

The half-yearly review of this project identified that all the milestones were on track with the project to be completed in December 2019. An Aspen model has been developed using heat and mass balance data from Liddell Power Station and geothermal resources have been studied. Multicriteria analysis has been used to select the two most viable NSW power plants, which are Bayswater and Eraring Power Stations. Thermodynamic and optimisation studies have also been completed.

D7.3: Optimal design of solar photovoltaic and concentrated solar power system for coal-fired power plants in NSW

Grantee: University of Technology, Sydney

This study involves designing the optimal capacity and size of solar photovoltaic (PV), concentrated solar power (CSP) and energy storage systems integrated with coal-fired power plants to minimize coal consumption and spinning reserve cost. Renewable designs at coal-fired power plants will assist NSW to optimise the electricity grid with a balanced energy portfolio in the near future. Long term, hybrid solar/coal power plants could help in the transition to a low-carbon electricity system.

The project investigates the optimal sizing problem for PV, CSP and the corresponding energy storage for the hybrid solar and coal-fired power plant by considering solar irradiance, investment, life cycle cost, payback period, power demand, generation capacity, and uncertainties of solar energy. An optimal trade-off between generation capacity, economic investment, life cycle cost, and carbon reduction will be achieved. This project also aims to simulate technical and financial constraints in the planning model.

Evaluation

The project is progressing well with the mid-project report accepted. A literature review and data study has been completed and a paper published. Vales Point Power Station was selected to be modelled in the project. Operational data on the coal plant and an existing trial PV unit, along with two sets of air quality monitoring data, were organised as inputs for computer models. The modelling of optimal system integration is ongoing.

D7.4: Feasibility assessment of BECCS deployment with municipal solid waste (MSW) co-combustion at NSW coal power plants

Grantee: University of Sydney

The aim of this project is to assess the feasibility of co-combustion of coal, Metropolitan Solid Waste (MSW), and commercial/industrial waste biomass in conventional coal-fired power plants in NSW. The project is developing this assessment coupled with an evaluation of negative emissions gained through implementation of bioenergy carbon capture and storage (BECCS). The outcomes from the project will demonstrate the technical and economic feasibility of MSW co-combustion and CCS, which may aid in facilitating the uptake of low emissions coal technologies.

It has been demonstrated that wide-scale co-combustion of biomass waste feedstocks at coal power plants could lead to reducing Australia's GHG emissions by 9 million tonnes of CO_2 each year by 2020. Preliminary assessment suggests that wide-scale biomass with 10 per cent co-combustion in NSW's existing coal power plants could see the state's emissions reduced by up to 7 million tonnes. If this is coupled with CCS, the emissions reduction potential could be over 54 million tonnes each year.

Evaluation:

The project is progressing well with the mid-project report accepted. A literature review of co-combustion technologies and modelling of fuel-flexible combustion data has been completed. Mapping of existing and proposed MSW sources, coal power plants and geological storage sites in NSW has also been completed along with computer modelling of fuel-flexible power generation. The project is on track to be completed by December 2019 with final report writing currently ongoing.

D7.5: Deployment of silica gels for improved CO_2 containment and risk mitigation

Grantee: University of New South Wales

This project involves a preliminary investigation into the feasibility of deploying silica sols in fractured wellbore cement to mitigate CO_2 and carbonated brine leakage from wells used to store captured CO_2 underground. Long-term sequestration of CO_2 requires robust and effective caprock barriers and wellbore seals to prevent vertical migration of carbonated brines or supercritical CO_2 from the storage reservoir. This project investigates the potential for colloidal silica gels to serve as an effective barrier to the leakage of carbonated brines and supercritical CO_2.

If successful, this technology could provide a mitigation strategy to reduce the risks associated with long term CO_2 storage, or a rapid-response to prevent leakage, and will be a massive breakthrough in the area both scientifically and operational-wise. Importantly, by reducing the risk of leakage, silica gels have the potential to reduce the costs of CO_2 sequestration even if not deployed, as this technology would lower insurance costs associated with long-term sequestration sites, by reducing the potential hazard of adverse events.

Evaluation:

This project is progressing well with the mid-project report accepted. A large number of cement samples (145) have been prepared, imaged and had their rock properties measured. Sub-samples have also been subjected to hydraulic stress to simulate realistic tensile fractures. Core flood testing to study the effects of supercritical CO_2 on cement fracture permeability is underway.

D7.6: Low emission coal in the manufacture of carbon fibres

Grantee: University of Newcastle

This project is further developing a low emission industrial process for the manufacture of carbon fibres from coal. If coal could be substituted for polyacrylonitrile (a petroleum-derived material currently used in the manufacture of 90 per cent of carbon fibres) it would reduce the industry's emissions by ~34 per cent (minimum estimate) and significantly reduce the cost of production (by at least 50 per cent). Coal is uniquely placed to overcome this cost barrier but requires the extrusion process to be further developed for fibre production.

This project builds on advanced research into coal conducted at the University of Newcastle, whereby carbon fibres are manufactured by separating and concentrating coking coal's vitrinite component and then thermally extruding this material as it softens and becomes fluid. The extruded material is then drawn down to commercial fibre size (~7µm) and strengthened by annealing at high temperature.

Evaluation:

This project is progressing well with the first and second quarter reports accepted. Coal samples have been acquired and preparation techniques to concentrate vitrinite have been explored. The characterisation of feed samples has been completed and early work has started ahead of schedule on producing 3mm fibres.

D7.7: Battery storage at Vales Point Power Station

Grantee: Sunset Power International Pty Ltd

This project includes a techno-economic assessment of integrating a battery energy storage system (BESS) with an existing turbo-generator at Vales Point Power Station. The proposed system will enhance the generation capability of the plant and provide frequency stabilising support to the electricity network to compensate for instability attributable to the increasing proportion of intermittent forms of renewable energy generation. The BESS will contribute to a reduction of greenhouse gas emissions from the power station and the NEM overall. This is achieved by reducing losses in the turbo-generator caused by constant frequency oscillations of up to 10 MW required to provide frequency services to the NEM while minimising plant ramping and cycling operations.

Evaluation:

This project is progressing well with the quarter one and two reports accepted. The Front-End Engineering Design (FEED) study and business case have been completed with a 80MW/40MWh battery system proposed at A$40m CAPEX. Approval pathways have also been identified whilst BESS integration and grid connection studies are underway.

D7.8: Development and site trials of a novel pilot ventilation air methane catalytic mitigator

Grantee: CSIRO

This project is undertaking the further development of a novel technology that aims to reduce the greenhouse gas emissions (GHG) from underground coal mining. Approximately 50-85 per cent of coal mining methane, a potent GHG, is emitted to the atmosphere through mine ventilation air (VA), depending on mine site specifications. Ventilation air methane (VAM) is very challenging for the coal industry to mitigate or use as an energy source because the air volume is large, and the methane resource is dilute and variable in concentration. CSIRO has previously successfully trialled a novel VAM mitigator (VAMMIT) at the Appin coal mine in southern NSW and is using the current funding to improve the performance and safety of this technology.

This project aims to reduce the operating temperature of the VAMMIT to much safer levels by incorporating two layers of catalysts inside the refractory bed of the existing VAMMIT unit at Appin. Then, the unit will be commissioned and trialled with actual VAM to demonstrate its performance.

Evaluation:

The project is progressing well with the quarter one and two reports accepted. Lab testing shows the catalytic RTO can be operated at 300-600 ºC (i.e. below the 450-750 ºC originally planned). Test unit designs are complete and fabrication is underway. Some temporary delays have been experienced in procuring catalysts; however, other aspects of the project, such as the fabrication of pilot plant components and establishment of on-site supporting infrastructure are ahead of schedule.

D7.9: Water production from CO_2 capture

Grantee: CSIRO

This project is undertaking a pilot plant demonstration of a desalination process integrated with an amine-based CO_2-capture process. This addresses the obstacle of increasing specific cooling load, and hence increased water requirement of coal fired power plants, as a result of the implementation of CO_2-capture. The project includes establishing principles underpinning the process and equipment design, identification of the most suitable or best performing desalination membrane for incorporation into amine carbon capture, and a techno-economic evaluation of the process concept for NSW coal fired power plants.

Evaluation:

The project is progressing well with both the quarter one and quarter two reports accepted. A selection of suitable amines and membranes has been completed. Membranes for water recovery have also been selected. Forward osmosis process and equipment design work has started ahead of schedule.

D7.10: Harnessing energy with CO_2 utilisation: A feasibility study

Grantee: CSIRO

This project involves undertaking a feasibility study of a novel method of simultaneously using CO_2 with wastewater brine rejects from coal mines, while harvesting electrical energy and producing a saleable product in bicarbonate soda. The fundamental principle behind this technology is harnessing the mixing energy of two aqueous electrolytes through porous carbon composite electrodes, as well as using the CO_2 mineralisation process to produce a useful carbonate salt. CSIRO has previously developed electrodes made from carbon composites considered suitable for this process. This feasibility study aims to conduct a life cycle assessment to provide an estimate of potential CO_2 emissions reductions from the process, evaluate the economic viability of this technology, and assess its commercialisation pathway.

Evaluation:

The project is progressing well with the quarter one and quarter two reports accepted. A life cycle analysis for the electrochemical process with CO_2 use is currently ongoing and is focussing on a technical review of electrochemical processes, CO_2 utilisation with bicarbonate production, and the associated LCA methodologies. Process configurations, simulations and cost estimates are being developed. This project is expected to be completed by the first quarter of 2020.

D7.11: A novel platform for highly-integrated solar heat in carbon capture technology

Grantee: CSIRO

This project involves a desktop investigation of the use of a customised Solar Stripper (So-St) array as an alternative means of stripping out captured CO_2 from the CO_2-loaded solvent in a post-combustion capture process. The novel process involves replacing the conventional, energy intensive desorber unit with a specially developed solar array in which a rich solvent is heated directly with solar energy to strip out the captured CO_2. This innovative approach has the potential to enhance the techno-economics of carbon capture, thus aiding in advancing commercialisation of this technology.

Evaluation:

The project is progressing well with the quarter one and quarter two reports accepted. Modelling to identify and optimise the key design parameters for a single solar stripper is ongoing. The methodology for, and the key findings from, sizing a solar preheating section (to preheat the CO_2 rich solvent) has been written up and recently submitted to the *Journal of Renewable Energy*. A reaction kinetics and physico-chemical study has also commenced.

D7.12: Reduction of greenhouse gas emissions in steel production

Grantee: CO2CRC Limited

This project is exploring the pathways for reducing CO_2 emissions in steel production. The main cause of CO_2 emission from a steel plant is the essential use of coal in the steel making process. The pathways for reducing CO_2 emissions will analyse and discuss the application of carbon capture in the steel making process and the use of innovative technologies to improve efficiency and productivity of the process. The utilisation of CO rich gases to provide high quality value added products will also be explored. Thus, the proposed project will investigate the measures which, if implemented, would

result in the efficient use of coal, reduction in greenhouse gases and generation of new revenue streams.

Evaluation:

The project is progressing well with the quarter one report accepted. A review of the Australian and global steel industry and GHG emission reduction initiatives has been completed. The most promising pathways for emissions reduction were identified and the next step is to analyse these considering operational and emission data from the Port Kembla Steel Works in NSW.

D7.13: 300-200MW ultra supercritical hybrid solar/coal R&D pathway study

Grantee: Toshiba International Incorporation Pty Ltd

This project is developing a design pathway for USC Solar/coal plants. This pathway is set to reduce emissions substantially as compared to the existing sub-critical plants in NSW, initially by adopting a 300 MW class USC Hybrid solar/coal plant with an energy ratio of 25 per cent/75 per cent. The long-term objective is for a horizon pathway to enable the transition to a 200 MW USC hybrid solar/coal plant with an energy ratio of 75 per cent/25 per cent, which includes molten salt storage and CO_2 capture using oxyfiring.

A key aim of this research is to show that coal can be an integral part of the energy mix, that it can remain competitive in the rapidly changing low emission market where a large focus in the future is on dispatchable generation. The USC Hybrid solar/coal plant will show that it is has significant commercial and technical advantages over alternative hybrid dispatchable solutions such as solar or wind plus battery storage solutions.

Evaluation:

The project is progressing well with the quarter one report accepted. Hybrid designs have been refined based on technical input from Abengoa, IHI, and Toshiba. The cycle definition is complete and design and the sizing of the solar subsystems, boiler systems and steam turbines is underway. Refining of some technological parameters has led to variations in the final designs of the hybrid pathways.

E: Conclusion

The financial year 2018-19 was a successful year for CINSW, with significant progress achieved.

The highlights of the financial year include the completion of the research projects from the 2015-funded RD&D grant (see D.4 above), and the commencement of thirteen (13) new research and seed funded projects from the 2018 RD&D grant (see D.7 above). A VAM Strategy Roadmap was also approved (See D.1 above). The finalisation of Stages 3 and 4 of the NSW Coal Fired Electricity Generation Industry study has also been a significant outcome. Completed research projects have had their Final Reports assessed and peer reviewed.

CINSW has undertaken significant forward project planning with an emphasis on the development of new research programs and the evaluation of the NSW CO_2 Storage Assessment Program.

These outcomes contribute to achieving the functions of CINSW and purpose of the CINSW Fund as outlined in the Act.

F: Overall Financial Balances

Table 10: Coal Innovation NSW Fund financial summary

Extract from Financial Statement	Value ($)
Opening balance as at 1 July 2019 (credit)	80,039,993
Interest and other revenue	1,201,615
total	81,241,608
Less expenditure	6,174,974
Total as at 30 June 2019 (credit)	**75,065,634**

Table 11: Expenditure for financial year 2018-19

Major expenditure incurred	Value ($)
Coal Innovation NSW (Advisory Council) costs and TWG cost	24,517
Secretariat costs including salaries	522,396
R&D projects grants (round 2009, 2015, 2018)	5,173,116
CO_2 Storage Assessment Program Stage 2	5,130
Future of NSW Coal Fired Electricity Generation Industry Study and CBA analysis-CO2 Drilling Program	423,165
Audit Fees	26,650
GRAND TOTAL	**6,174,974**

Financial Report

G: Financial Report for Coal Innovation 2018/19

Coal Innovation NSW Fund

Financial Report

for the year ended 30 June 2019

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Coal Innovation NSW Fund
Statement by the Deputy Secretary
for the year ended 30 June 2019

I declare, on behalf of the Coal Innovation NSW Fund (the Fund) that in my opinion:

1. The accompanying financial report provides details of the transactions of the Fund for the year ended 30 June 2019;
2. The financial report has been prepared as a special purpose financial report in accordance with the basis of preparation described in Note 1(b); and
3. The accompanying financial report exhibits a true and fair view of the net assets of the Fund as at 30 June 2019 and of its income and expenditure for the year ended on that date.

Further, I am not aware of any circumstances which would render any particulars included in the financial report to be misleading or inaccurate.

Michael Wright
Deputy Secretary, Division of Resources and Geoscience
Department of Planning, Industry and Environment

Date: 19 October 2019

Coal Innovation NSW Fund
Statement of income and expenditure
for the year ended 30 June 2019

	Notes	Actual 2019 $'000	Actual 2018 $'000
Revenue			
Interest revenue		1,197	1,223
Other revenue		4	10
Total revenue		**1,201**	**1,233**
Expenses			
Auditor's remuneration - audit of financial report		27	26
Research and development grants		5,173	1,960
Other contractors and professional expenses	1(c)	437	62
Salaries and wages (including recreation leave)		432	642
Superannuation		42	61
Payroll tax and fringe benefits tax		27	39
Other operating expense		26	19
Travel		7	14
Administration fees		2	47
Training and staff development		2	3
Advertising and promotion		-	4
Consultancy		-	472
Total expenses		**6,175**	**3,349**
Net result		**(4,974)**	**(2,116)**

The accompanying notes form part of the financial report.

Coal Innovation NSW Fund
Statement of net assets
as at 30 June 2019

	Actual 2019 $'000	Actual 2018 $'000
ASSETS		
Current assets		
Cash and cash equivalents	76,535	82,164
GST receivable	151	5
Department of Planning and Environment	41	-
Total current assets	**76,727**	**82,169**
Total assets	**76,727**	**82,169**
LIABILITIES		
Current liabilities		
Creditors	1,662	1,347
Department of Planning and Environment	-	783
Total current liabilities	**1,662**	**2,130**
Total liabilities	**1,662**	**2,130**
Net assets	**75,065**	**80,039**

The accompanying notes form part of the financial report.

Coal Innovation NSW Fund
Notes to the financial report
for the year ended 30 June 2019

1. Summary of significant accounting policies

(a) **Reporting entity**

The Coal Innovation NSW Fund (the Fund) is a not-for-profit fund (as profit is not its principal objective) and the Fund does not have a cash generating unit.

The Fund has been established and is governed under the *Coal Innovation Administration Act 2008 (the Act)*. Part 2 Section 4 of the Act establishes the Fund as a special deposits account.

The financial report has been prepared on the basis that the Fund is not a reporting entity under the Australian Accounting Standards. The financial report for the Fund is therefore a special purpose financial report with the financial period being from 1 July 2018 to 30 June 2019.

This financial report for the year ended 30 June 2019 has been authorised for issue by the Deputy Secretary, Division of Resources and Geoscience on the date the accompanying Statement by the Deputy Secretary was signed.

Key activities

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.

Funding sources for the Fund

Part 2 Section 6 of the Act states that:

1) There is payable into the Fund:
a) all money advanced by the Treasurer to the Fund, and
b) all money appropriated by the Parliament for the purposes of the Fund, and
c) the proceeds of the investment of money in the Fund, and
d) all money directed or authorised to be paid into the Fund by or under this or any other Act or law, and
e) all money received for voluntary contributions to the Fund made by any person or body.

2) A voluntary contribution to the Fund may be made on the condition that the contribution is to be used only for a specified purpose.

Payments out of the Fund

Part 2 Section 7 of the Act states that:

1) There is payable from the Fund:
a) payments approved by the Minister for the purpose of the Fund, and
b) administrative expenses incurred in relation to the Fund or Coal Innovation NSW (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 it 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.

Coal Innovation NSW Fund
Notes to the financial report (cont'd)
for the year ended 30 June 2019

1. Summary of significant accounting policies (cont'd)

(b) **Basis of preparation**

This financial report is a special purpose financial report that has been prepared in order to account for the transactions of the Fund under the Act.

This financial report has been prepared in accordance with the significant accounting policies disclosed below. Such accounting policies are consistent with the previous period unless stated otherwise.

The statement of net assets and the statement of income and expenditure have been prepared on an accruals basis and based on historic costs and do not take into account changing money values or, except where specifically stated, current valuations of non-current assets.

All amounts are rounded to the nearest one thousand dollars and are expressed in Australian currency.

(c) **Research and development expenses (Contractors and Professional expenses)**

The Fund engages contractors to conduct work for site preparation, drilling, engineering, project management research activities and peer review of research results. This activity is classified as in the research phase for the project and no expenses have been capitalised. An asset will not be recognised until clear and quantifiable future benefit is established. However, there is acknowledgement that any grant is from the Fund and any future economic benefits (assets) arising out of it may belong to NSW Government and/or the research partner.

The Fund engages professional companies to conduct modelling and research (and peer review) for the 'Future NSW Coal Fired Electricity Generation Industry Study'. The Study aims to provide the NSW Government with a technical and economic evaluation of future options for the role of coal in providing a sustainable, safe, reliable and competitive form of electricity generation for NSW, whilst reducing its carbon emissions and maintaining State economic growth.

(d) **Accounting for the Goods and Services Tax (GST)**

Income, expenses and assets are recognised net of the amount of GST, except that the:

- amount of GST incurred by the Fund as a purchaser that is not recoverable from the Australian Taxation Office is recognised as part of an asset's cost of acquisition or as part of an item of expense and
- receivables and payables are stated with the amount of GST included.

(e) **Income recognition**

Income is measured at the fair value of the consideration or contribution received or receivable. Additional comments regarding the accounting policies for the recognition of income are discussed below.

(a) Grants and contributions

Grants and contributions include industry contributions and grants from Commonwealth and New South Wales government. They are generally recognised as income when the Fund obtains control over the assets comprising the grants and contributions. Control over grants and contributions are normally obtained upon the receipt of cash.

(b) Interest Revenue

Interest income is recognised using the effective interest rate method. The effective interest rate is the rate that exactly discounts the estimated future cash receipts over the expected life of the financial instrument or a shorter period, where appropriate, to the net carrying amount of the financial asset.

(f) **Receivables**

Trade receivables and other receivables that have fixed or determinable payments that are not quoted in an active market are classified as receivables. Receivables are measured at amortised cost using the effective interest method, less any impairment. Changes are recognised in the net result for the year when impaired, derecognised or through the amortisation process.

Short-term receivables with no stated interest rate are measured at the original invoice amount unless the effect of discounting is material.

Coal Innovation NSW Fund
Notes to the financial report (cont'd)
for the year ended 30 June 2019

1. Summary of significant accounting policies (cont'd)

(g) **Payables**

Payables represent liabilities for goods and services provided to the Fund and other amounts. Short-term payables with no stated interest rate are measured at the original invoice amount where the effect of discounting is immaterial.

(h) **Personnel services**

The Fund does not have any employees and received administrative, secretarial support and operational assistance from the Department of Planning and Environment during the year. The Fund had an arrangement with the Department of Planning and Environment to reimburse the Department for personnel services expenses and other costs incurred on behalf of the Fund. Due to the Machinery of Government changes effective from 1 July 2019, the functions of the former Department of Planning and Environment will be carried out by the Department of Planning, Industry and Environment. Refer to Note 3.

2. Cash receipts and payments

	Actual 2019 $'000	Actual 2018 $'000
Opening cash balance	**82,164**	**82,052**
Cash receipts:		
The Fund is authorised to receive amounts in accordance with Section 6 of the Act.		
(1) (a) the proceeds of the investment of money in the Fund	1,196	1,848
(b) all money directed or authorised to be paid into the Fund by or under this or any other Act or Law	4	-
BAS receipt	329	272
Cash payments:		
Payments from the Fund are in accordance with Section 7 of the Act.		
(1) (a) payments approved by the Minister for the purpose of the Fund	(5,610)	(1,959)
(b) administrative expenses incurred in relation to the Fund or CINSW	(1,548)	(49)
Closing cash balance	**76,535**	**82,164**

Coal Innovation NSW Fund
Notes to the financial report (cont'd)
for the year ended 30 June 2019

3. Events after the reporting period

Under the Administrative Arrangements (Administrative Changes – Public Service Agencies) Order 2019, dated 2 April 2019, in pursuance of part 7 of the Constitution Act 1902 and provisions of the Government Sector Employment Act 2013, the Department of Planning and Environment (DPE) was abolished with effect from 1 July 2019 and its status as an employing and a reporting entity has ceased. DPE's functions have been transferred to the newly formed Department of Planning, Industry and Environment (DPIE).

This Administrative change will have no financial impact other than the staff allocated to administer the Fund's activities being transferred to DPIE.

End of audited financial report.