WE HAVE SHOWN THAT AS LITTLE AS 5,000 TONES OF CO2 CAN BE DETECTED IN THE SUBSURFACE PROVIDING STORAGE ASSURANCE TO REGULATORS & THE COMMUNITY.

WE PROVED THAT CO2 CAN BE SAFELY STORED BELOW GROUND FOR 1,000 YEARS OR MORE.

$3 MILLION IN SPONSORSHIP OF THE OTWAY RESEARCH FACILITY OVER 3 YEARS FROM THE GLOBAL CCS INSTITUTE.

A SCALABLE AND EFFICIENT CAPTURE SKID WAS DESIGNED AND ASSEMBLED FOR USE IN OFF-SHORE GAS EXTRACTION FROM FIELDS WITH HIGH CO2 CONCENTRATIONS.
CHAIRMAN’S REPORT

2015 was the year the world drew a line in the sand on climate change. At the Paris climate conference (COP21) in December 2015, a total of 195 countries committed to a climate deal that would reduce global warming to 2°C above pre-industrial limits. All available carbon abatement strategies are required to meet this ambitious target, including wind, solar and carbon capture and storage (CCS).

The argument proposed by some that CCS is too expensive to employ is economically false and environmentally damaging. Inclusion of CCS in the suite of low-carbon technologies is the lowest-cost route to decarbonisation. The International Energy Agency shows that without CCS, the cost of meeting a 50 per cent global CO2 reduction target by 2050 would increase by 40 per cent.

CCS has the ability to decarbonise the most prevalent and reliable fossil fuel energy sources in the world—oil, gas and coal. It is clear that for the foreseeable future that fossil fuels will provide the 24/7 reliable and cost effective energy requirements for Australia and for much of the globe. The argument against fossil fuels is an argument against a fuel source, rather than reducing emissions; the two don’t need to be linked. The South Australian and Tasmanian examples of electricity shortages, massive price spikes and potential disruption to homes and businesses is a perfect example of the need to have diversity in our energy mix.

We need look no further than CO2CRC’s second home in Gippsland to see the opportunity to save vibrant communities through the potential of CCS. We can take the carbon out of Gippsland’s power stations by retro-fitting and connecting some existing power plants to a CCS hub in one of the best storage sites in the world. In turn we will reduce significantly Victoria’s emissions.

CCS is a pathway to use 500 years’ worth of brown coal sustainably by and creating a suite of business and job opportunities beyond energy production including the manufacture of hydrogen and urea. This is an outcome we want for Gippsland and its residents.

To ensure that CO2CRC is best positioned to deliver CCS outcomes for our Australian and international partners the Board and staff established nine high-reaching milestones for the year. Each of the milestones were connected to outcomes we wanted to see for the business by 2020; these included a credible portfolio of investible projects, secured and sustainable funding, and engagement in key international projects, among others. I am happy to report that not only were our milestones reached, but significant effort was put in to ensure they were exceeded. Examples of our milestones and how we met them are highlighted throughout this report.

These successes would not have been possible without the dedication of our Board and staff. I would like to place on record my thanks to the CO2CRC Board for their commitment to CCS over the past 12 months and admiration for the hard work of our staff. Through their combined efforts CO2CRC remains at the forefront of the global effort to realise the full potential of carbon capture and storage.

Despite a difficult year for the resources sector, CO2CRC and our partners remain confident that our work is not only essential, but is more relevant than ever. The global demand for a CCS solution has gained renewed enthusiasm following COP21. This report shows that the faith of our industry partners is justified and we thank them for their ongoing support.

Martin Ferguson
Chairman

CEO’S REPORT

Commercial carbon capture and storage operators, regulators, and the communities in which they reside, demand the highest assurance that the long-term storage of CO2 is safe. This year our research teams have proven that the safe storage of CO2 can be stored deep underground for more than 1,000 years. Without a doubt, it is this fact that provides the peace of mind that millions of tonnes of CO2 can be stored without long term risk.

Our work demonstrates that long-term CO2 storage is safe and the release of CO2 from a storage site is highly unlikely but it is prudent that regulators and operators expect that even small volumes of CO2 should be detectable. For this reason through late 2015 to early 2016 we stored and detected an amount of CO2 that equated to less than one percent of a commercial project. Our aim was to find the minimum detection levels of CO2 in the subsurface; we achieved that goal: a high resolution at 5,000 tonnes of CO2.

Further in our research portfolio, the monitoring of CO2 now enters a critical cost-effectiveness phase. Monitoring through permanently deployed arrays, resulting in less invasive activity shows the potential to save tens to hundreds of millions of dollars for onshore and offshore projects respectively. We are already testing the reliability and accuracy of fibre optics to better understand the movement of CO2, as an alternative to more costly geophysical receivers. These methods and our upcoming Stage 3 project will be the largest undertaken by CO2CRC, with more than $40 million invested to turn this into reality.

New gas provinces around Australia have increasingly high CO2 content. Through this year work on a capture skid began which will allow us to trial new methods for capturing CO2 from these high-CO2 gas fields. The skid will be installed at our Otway Research Facility in late 2016 and will complement our gas and storage facilities. The skid will be scalable, efficient and robust enough for offshore use.

Furthermore, the technologies tested will be applicable to other capture applications and industrial sectors. Since its founding, CO2CRC has sought to be the leading source of information on CCS in Australia, and a world leader in carbon reduction strategies. More than 2,500 reports and papers over the past decade have been written or co-authored by our staff. In November 2015, the organisation released the Australian Power Generation Technology Report, the collaborative effort of 45 organisations from industry, government, consumer groups, peak representative bodies and others to provide an unbiased, technology-neutral review of power-generation technologies, their capabilities and costs in 2015 and projected to 2030. The report is the most comprehensive and reliable reference of energy generation in Australia. The report’s key finding is that no single energy technology is capable of meeting the energy needs of Australia while also reducing carbon dioxide emissions – a consistent position of CO2CRC for more than a decade – and that technology solutions like CCS are essential to the energy mix.

For CCS, we found that in the 15 years to 2030, plant capital costs are projected to fall by 30-50 per cent, which translates into a reduction in levelised cost of 10-25 per cent when operating costs are taken into account. Our success is evident in the continuing support of our corporate partners, and the addition of new global members who support our work and the communities of Otway and the Latrobe Valley where we work. With the generous support of the Global CCS Institute (GCCSI) we redeveloped the Visitor Centre at the Otway Research Facility to make it more practical for researchers and welcoming and informative for visitors. The centre has attracted more than 300 foreign dignitaries interested in our work, including our CCS work and how the technology can be advanced in their own countries.

Our people and our partnerships are our strengths. We continue to invest in building technical capacity within our ranks and training staff in safety, risk and project management.

As we move forward into 2017, we intend to continue our initiatives and strengthen our message more broadly on the clean energy stage. The research we have undertaken at the Otway Research Facility is a game-changer for CCS: our research into the movement of subsurface CO2 has proven the safety and reliability of CCS, and will result in significantly lower-cost storage and monitoring in the future. As you read this report – or visit our relaunched co2crc.com.au website – I am sure you will agree that we have a great message worth telling.

Tania Constable PSM
Chief Executive Officer

“The International Energy Agency shows that without CCS, the cost of meeting a 50 per cent global CO2 reduction target by 2050 would increase by 40 per cent.”

“This year our research teams have proven that the safe storage of CO2 can be stored deep underground for more than 1,000 years.”
Knowing how CO₂ acts in real-world migration during and after injection and accurately forecast gas CO₂ content natural gas wells.

OTWAY RESEARCH FACILITY

The Otway Research Facility is one of the world’s leading research and geosequestration demonstration projects showing real-world injection, storage and monitoring of CO₂.

Researchers conducted four seismic surveys at the site across the properties of seven individual landholders in 2016. The monitoring project has been designed to detect minimal amounts of CO₂ and accurately forecast gas migration during and after injection. Knowing how CO₂ acts in real-world conditions is essential to reinforcing trust in the long-term storage of CCS. Monitoring and analysis of the injected CO₂ continues through various surveys.

In addition to the monitoring project, we began preparations for the installation of a new capture skid. The skid is the centrepiece of our installation of a new capture skid. While we continue with our scientific work we also have been planning for the decommissioning of our Naylor monitoring well. The planning for any significant works requires long-term planning to account for risk and hazards and the integration of new equipment on the site. Even though this work is rarely seen by the public it is critical to the operation of a site that is ultimately safe for our workers and the community.

These projects could not have been undertaken without the continuing backing of our corporate and government partners, and support and understanding of landowners around the Otway site.

We acknowledge and appreciate that the subsurface project needs to have the support of landholders and we are grateful for their cooperation and help in achieving this massive task - it would not have been possible without their understanding.

We continuously strive to maintain close relationships with the local community. CO₂CRC employs a Community Liaison Officer who lives locally and maintains strong relationships with local councils, residents, landowners, businesses and sporting clubs.

We always strive to engage the services of wide range of local tradespeople and service providers injecting significant income into the economy.

The surrounding community and regulators were provided with regular information through community newsletters, Community Reference Group meetings, an enhanced website and letters advising of major activities. Community Reference Group meetings in particular were valuable for people to directly engage with our research leaders on upcoming projects and how they may effect or provide value to the local community.

Media releases were provided to local papers on key issues and we briefed the Councillors of both the Moyne and Corangamite Shires on our latest experiments.

With a $3 million sponsorship from the Global CCS Institute we have upgraded the Otway Research Facility to improve amenity for visitors to the site. Works included increasing accessibility between internal areas of the Visitors Centre, improving lighting, constructing storage, creating a foyer area incorporating personal protection equipment storage, facilitating improved views from the internal areas out to our wells, and improving audio visual and display technologies. We also created designated seating and work areas making the Visitor Centre a first-class working environment for visiting scientists, befitting CO₂CRC’s global reputation.

It was necessary to schedule this work between seismic surveys and visits to the Site so we are grateful to UPS, our Site administrators, and the local building team whose flexibility enabled us to achieve such a good result despite these constraints. The redeveloped Centre was officially opened by Richard Riordan MP, Member for Polwarth on 22 April 2016.

CO₂CRC’s position as a leading researcher makes us an important advocate for CCS to government and the private sector. Visitors throughout the year included representatives of governments at varying stages of CCS adoption, from initial investigation to advancing and enhancing existing CCS projects. This year, more than 600 delegates visited the Otway Site – more than double the number in the previous year. Visitors included representatives of industry (Petronus, JPower and Hyundai); international academics, and representatives of the governments of Iceland, Pakistan, the UK and China; and a delegation of 30 from the Asia Development Bank.

“This year, more than 600 delegates visited the Otway Site – more than double the number in the previous year”
The capture technology is flexible, meaning it can provide a range of feed compositions ranging from 10 per cent to 80 per cent \( \text{CO}_2 \) in natural gas. In late 2015 CO2CRC officially joined the International Test Centre Network (ITCN). Administered in Wilsonville, Alabama, the centre works with scientists and technology developers from government, industry and universities to evaluate, demonstrate and advance emerging carbon capture technologies to reduce greenhouse gas emissions from coal and natural gas-based power generation. The ITCN aims to share knowledge of technological developments, construction and operational experience, establish performance indicators, and promote technology standardisation for carbon capture. Current members include the National Test Facility in the US; the CO2 Technology Centre Mongstad in Norway; CSIRO test facilities in Australia; and the UK CCSR&D test facilities in the UK.

CO2CRC has been part of discussions with Japanese industrial and other partners focusing on the conversion of brown coal to hydrogen as a clean fuel for motor vehicles. Carbon capture and storage will be used to mitigate the emissions from burning the brown coal to produce hydrogen, with CO2CRC leading the capture component of the project. The initial aim of this program is to power the vehicle fleet for the 2020 Tokyo Olympics with the possibility that the learnings will be taken to a commercial scale.

In 2016–17 the Capture Team will undertake additional initiatives to expand our capture focus from coal-based flue gas to natural gas, and other industry-based emissions such as steel furnace off gas. These activities will build on, and complement, our current capture facility at the Otway site. In addition, we are working hard to modify and re-deploy our existing capture facilities at the Hazelwood power station to more appropriate locations with industry partners.
STORAGE RESEARCH

CO2CRC’s storage research teams are developing and validating techniques and methodologies to safely enhance the cost-effective utilisation and management of geologic resources for long term CO2 storage.

Our Storage program has four areas of research priority: Geological Integrity, Engineering Storage, Fit-for-Purpose Monitoring and Verification, and Geochemical Engineering.

In 2015-16 we expanded our portfolio to 11 distinct desktop and in-field projects.

Otway Stage 2C – investigate CO2 storage migration in saline formations

The most significant activity undertaken by the storage team in 2015-16 was the safe commencement and completion of the CO2 injection, and monitoring for the Otway Stage 2C Project. Injection of CO2 into a saline formation represents the greatest possible resource for CO2 storage globally. An improved understanding of monitoring technology thresholds, and demonstrated capabilities in CO2 plume migration and stabilisation forward prediction in saline formations, will strongly assist with decision making for future commercial CO2 storage operations.

Injection of 15,000 tonnes of CO2 occurred between December 2015 and April 2016 at a rate of approximately 140 tonnes per day. During this time, four seismic surveys were directly linked to injection, and then after 5,000 tonnes and 10,000 tonnes were injected, and at the conclusion of the injection phase) as well as daily acquisition using a pair of permanent seismic sources and semi-continuous passive seismic acquisition. Seismic signals were received using both fibre-optics and geophones within a 1 x 1 km buried seismic receiver array and using downhole sensors.

The observed CO2 plume acted as forecast within the range of probability. Reservoir pressure measured at our CRC-2 well is also within the expected range and the plume is predicted to stabilise as modelled. Monitoring at very high resolution to observe the evolution of the plume through time has resulted in more than 120 terabytes of data collected from the study. Curtin University and Lawrence Berkeley National Laboratories are currently working together with the full Otway 2C science team to interpret the data.

The quality of the signal and data provided by the high sensitivity buried geophone array, is significantly superior to previous data collection methods, requires less acquisition time, and fewer resources. The data allows the application of cutting edge quantitative interpretation techniques to improve CO2 saturation quantification. The result, we believe, will allow us to understand quantitatively the distribution of CO2 injected into the subsurface. With future active seismic acquisitions planned over the next two years, as well as continual pressure monitoring, this project will ultimately provide a demonstration of plume stabilisation, the first of its kind internationally, and a validated workflow for verifying plume behaviour in saline formations.

Further to these scientific benefits, the permanent receiver array we deployed has had a lower impact on the landowners, making monitoring a less intrusive process for them. Further cost reductions are being investigated by using less expensive fibre-based receiver arrays and unmanned continuous monitoring (both active and passive).

Storage research & maturing storage technologies

Fault seal characterisation

The Fault Seal Integrity Characterisation Project, led by Geoscience Australia, has undertaken geomechanical studies of core and logs from our Otway Project, resulting in the development of a correlation that allows us to interpret geomechanical fault seal properties. 80 metres of core from the CRC-2 well was assessed for unconfined compressive rock strength. Analysis found a correlation with wireline well log data; in particular, porosity, photoelectric and density logs. A transform was then developed so that wells without a core can be assessed for rock strength. This was tested on CRC-1 well logs, focused on the well intersection with the Naylor South Splay fault. This work provided information on the fault cohesion and the coefficient of friction, key parameters for understanding fault seal.

Near surface characterisation

Being able to confidently deploy a monitoring regime for assessing the near surface environment is important for any future onshore CO2 storage project. Over the last few years, we have developed an improved capability to understand CO2 migration processes and monitoring capabilities in the near surface. In 2015-16, work commenced to characterise the Otway near surface geology, with a future plan of trialling near surface migration prediction and monitoring capabilities. A large portion of this work utilises the outcomes from our success at Ginninderra, a controlled-release facility where injection monitoring and assessment techniques were trialled to detect and quantify CO2 in the near surface.

Near surface electromagnetic imaging of the Otway Research Facility. The hypothesised fault zone is detected in the eastern segment of the survey (right).

A major geophysical investigation of the top 500 metres of the Otway site was undertaken with assistance from Curtin University and Geoscience Australia. The anticipated near-surface fault was hypothesised from seismic surveys conducted in 2013 by the Leibniz Institute for Applied Geophysics. Curtin University and GA located and interpreted the fault to around 50 metres from the surface. This fault forms the structural control for a planned shallow migration and monitoring study by CO2CRC.

Near wellbore characterisation

The operational phase of the Stage 2B Expansion Project was completed in 2014-15, with the resulting data examined and final reports delivered by June 2016. Stage 2B involved the injection of around 140 tonnes of CO2 of which 21.9 tonnes was provided by Calide Oxysul Services (IOSPIL). COSPL and our Melbourne University research partners to perform an investigation of the effect of impurities in geological reservoirs, using the Paaratte Formation at the Otway site (Phase 1). CO2CRC furthered our investigation of near well reservoir characterisation with CSIRO, refining some aspects of earlier experiments (Phase 2).

Phase 1 geochemical results showed that the buffering of the reservoir inhibits the degree of change in formation water pH and changes to the formation halide is minimal. It was further discovered that impurities have no effect on the geological reservoir into which it was injected, giving further certainty to commercial users that CCS is a safe, long-term storage solution under a range of uncertain circumstances. Phase 2 retesting of residual trapping refined the characterisation methodologies re-confirmed the observations made in the earlier Otway Stage 2B experiment and highlighted the non-uniform nature of residual trapping and key considerations for the variability in reservoir modelling.

Future otway operations and R&D Otway Stage 3

The next major project at the Otway Research Facility, currently underway planning, is CO2CRC’s Otway Stage 3. Many Australian and international CO2 storage regions coincide with physical, social, technical and/or environmental impediments to monitoring from the surface. Our facility provides an unmatched opportunity for developing, testing and validating “sub-surface” monitoring. Otway Stage 3 will expand on the Otway facilities and Otway Stage 2C Project learnings to develop a suite of sub-surface tools and methodologies that can be applied to storage projects to overcome surface monitoring impediments and achieve cost savings in the region of 10s to 100s of millions of dollars in monitoring operations.

We have entered the evaluation phase for Stage 3 and are investigating a new location for CO2 storage, just to the west of the Stage 2 project. Novel subsurface monitoring approaches are being modelled to show the CO2 plume development, ensuring that it is behaving as expected, and demonstrating the benefits of this subsurface monitoring approach. Primary monitoring methods being evaluated are pressure tomography and downhole seismic on fibre optics, and we are engaging with many research groups internationally to consider what other monitoring and operation methods we can test at our site to reduce costs in commercial operations and improve the safe utilisation of the geology for CO2 storage.

CO2CRC is currently defining the location of an injection well, named CRC-3, and future monitoring wells. We anticipate that we will drill the CRC-3 well in early 2017 and use the resulting data to help evaluate the likely plume distribution and decisions for the future monitoring well locations.
Basins & regions considered to have very high storage potential
Basins & regions considered to have high storage potential
Basins & regions considered to have storage potential
Sedimentary basins & regions yet to be assessed for storage potential

National major power stations
Oil & gas pipelines

WA
- Large offshore natural gas fields with CO₂, but very close to basins with high storage potential.
- Well suited to a hub approach including industrial sources of CO₂ emissions

South West Hub
Storage – feasibility

Gorgon
Storage – advanced

Darling Basin
Storage – feasibility

QLD
- Close proximity to basins with high storage potential
- Existing oil and gas pipeline corridors can be used for CO₂ transport

CTSCo
Storage – feasibility

Tarong
Capture – operational

NSW
- Close proximity to basins with high storage potential
- Existing oil and gas pipeline corridors can be used for CO₂ transport

Darling Basin
Storage – feasibility

VIC
- Existing oil and gas infrastructure can be converted for CCS application
- Ideally situated for a hub approach including industrial sources of CO₂ emissions

Tarons Island project
Capture – operational

Torrens Island project
Capture – operational

Hazelwood
Capture – operational

Loy Yang
Capture – operational

Otway
Storage – operational

POTENTIAL FOR INTEGRATED CARBON CAPTURE AND STORAGE IN AUSTRALIA
For carbon capture and storage to be a widely deployed carbon reduction solution, and to have the support of the community, it is essential that it be reliable − reliable in safely storing CO₂ over the long-term. With a number of energy applications CCS must also be cost effective against a suite of renewable technologies which are becoming cheaper each year.

To meet these reliability and cost-reduction goals, and to provide research support to flagship CCS projects within Australia, the Australian Government’s Education Investment Fund provided CO₂CRC with $1.1 million to develop a competitive tender basis among CCS leaders. The funding is being used to establish a national network of CCS research assets across all phases of the CCS chain. A number of the assets launched through 2015-16 include:

**The Dynamic CCS Modelling Platform** − A comprehensive system-wide modelling platform specifically built for studying the full CCS value chain, allowing for analysis and decision-making by multiple stakeholders in a capture project, including the emissions producer. The capture plant, the compression system, the transport network and the storage site are all examined as part of this model. The purpose of the platform is to optimise all stages of the value chain, and seek and prove technical efficiencies which can be applied at post-combustion sites in Australia and around the world. The result will be cost savings embedded in the design and construction of the CCS plant.

**The Atmospheric Monitoring Network** which allows CO₂CRC and The University of Melbourne, supported by the University of Wollongong, to develop an open-path measurement system for atmospheric trace gases including CO₂ and CH₄ by using two instruments at a single site along with a series of reflectors, all deployed within the Gippsland Basin. The project leaders are pioneers of open-path techniques using Fourier Transform Spectroscopy and world leaders in the use of such measurements to infer emissions. These assets will establish regional baseline CO₂ levels and inform the design and installation of the optimal network for monitoring sources and sinks of CO₂, in a proposed storage area.

The Baseline Submarine Monitoring Network will allow for validation of monitoring and verification technologies in the marine environment. This is an important consideration when developing offshore storage projects. Marine monitoring research assets will be operated by the CSIRO based on the world-leading marine monitoring expertise of their Oceans and Atmosphere Flagship.

The Baseline Submarine Monitoring Network will provide certainty to regulators and the community that CCS is safe to the environment in which it operates − specifically marine environments.

Through the Bioreactor & Geomicrobiology Laboratory CO₂CRC will establish Australia’s only purpose-built laboratory for studying the effects of supercritical CO₂ on subsurface microorganisms under realistic conditions, enabling a new and complementary research direction for Australia that parallels international research efforts. The project will advance general research into CO₂ storage optimisation strategies through innovative and experimental geo-microbiological approaches. The bioreactor will research the microbial and biogeochemical processes that can affect aquifer porosity, mineralogy and chemistry, and investigate direct and indirect microbial responses to elevated CO₂ in geological formations. Benefits for industry include being able to understand the existing microbial environment of a storage site to understand how the injection of CO₂ may impact microbial activity on the formation or dissolution of minerals and the effects of co-injected SOₓ and NOₓ.

**The Fluid Flow Equipment & Geochemistry Laboratory** will enable a large range of geochemical and coupled transport-geochemical research projects related to CO₂ storage, such as impact of contaminants and trials of various corrosion-resistant materials. This will further the understanding of fluid interactions within the injected CO₂ plume as well as of fluid-rock reactions at the plume fringe. Trials of injected CO₂ with impurities is of interest to better understand the potential role of impurities for long-term CO₂ storage.

The Capture Analytic Equipment and Laboratory at the University of Melbourne is now capable of handling the corrosive solvents and the dangerous gases that are fundamental to safe, best practice carbon capture research. In March 2016 renovations were completed to complement this new infrastructure to create a world-class facility. The renovation will house the CO₂CRC solvent capture and membrane technology research groups.

The Capture Analytic Equipment and Laboratory are responsible for six specific research projects with clear objectives around cost reduction, technical optimisation and scale-up.

The Capture Analytic Equipment and Laboratory at Federation University will focus on reducing capture system degradation and plant corrosion by examining samples of chemicals built up in an experimental capture plant attached to an electricity power plant in the Latrobe Valley. The laboratory is uniquely positioned given its location only a few kilometres from the capture site.

This in-field research provides a unique opportunity to determine how different materials may be used to reduce or halt corrosion of capture plant components.

The Seismic Network will provide cheaper and more accurate seismic monitoring of CCS in complex, ‘noisy’ ocean settings such as the Gippsland Basin. The network will allow a detailed understanding of the background seismicity, and coastal and ocean noise levels within the entire basin with a level of fidelity that is currently not possible in either the Gippsland or Otway Basins. With the lead taken by the University of Melbourne, the Seismic Network will improve CO₂CRC’s understanding of seismic activity at a lower cost with greater accuracy, and will provide data for the flagship CarbonNet project which intends to act as a CCS hub for emissions from Victoria’s coal fired power plants.

**MICP Replacement** − The provision of a contemporary Mercury Injection Captivity Porosimetry (MICP) is important for the Australian School of Petroleum, which is the primary location to conduct accelerated research that will drive the cost of CCS plant construction and maintenance, and CO₂ monitoring down.

### ASSET NUMBER ORGANISATION BUDGET [\$M] CONTRACT STATUS

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Note 1 – Dued to variation to subcontract between CO₂CRC and University of Melbourne amongst September 28, 2015. Note 2 – Subcontract between CO₂CRC and CSIRO at sign-off stage. Note 3 – Subcontract between CO₂CRC and University of Adelaide at final draft and review stage.
A levelised cost does not capture long-run costs. All new low- and zero-emissions technologies are projected to reduce in cost by 2030. In general, the more mature the technology, the less opportunity for further cost reductions.

The scope of cost reduction for a given technology depends heavily on the global take-up of that technology, along with learning-by-doing. The overall ranking of LCOEs for technologies in 2030 is not projected to change from 2015, but there is likely to be convergence in LCOEs across most technologies. Just as critical as assessing the current market is understanding of technology costs and capabilities are likely to go in the future. The scope and rate of technology improvements, whether incremental or breakthrough, depend on how much of each technology is deployed—which itself depends on the technology cost—so iterative modelling is needed. Because all technologies used in Australia are also deployed globally, it is the global deployment levels that will drive technology and manufacturing cost breakthroughs.

To capture these learning-by-doing effects, this study used GALLM, a global and local model from the CSIRO, informed by data from EPRI and industry partners (Figure E2). GALLM considers learning curves for each technology in a global context and projects future costs under various scenarios. A key input is the current development status of the technology.

Generation costs in 2015

- No single technology is optimal across metrics.
- Of the renewable technologies, wind has the lowest LCOE in 2015.
- Of the fossil-fuels, natural gas combined cycle and supercritical coal have the lowest LCOEs.
- All new technologies have significantly higher LCOEs than the current Australian grid average wholesale price.
- A levelled cost does not capture the total cost of operating an electricity grid. The LCOE and current electricity pool prices are not comparable, as LCOE covers long-run costs.

Changes to LCOE rankings caused by pricing carbon emissions

To examine the effect of pricing carbon emissions on the LCOE ranking, the study applied a carbon price to 2015 LCOEs. In the base case study in this report, fossil-fuel technologies are the lowest cost generators, being lower than wind and significantly lower than solar PV. In order to alter the LCOE ranking of carbon-emitting technologies, a sensitivity analysis on pricing carbon emissions was conducted (Figure E4).

The sensitivity cases showed that a high carbon price is currently required to significantly change the ranking of low-emissions generation technologies. This situation is likely to change by 2030.

Every electricity generation option has strengths and constraints

Each technology has different strengths and weaknesses, and a viable electricity grid must ensure that we manage all inevitable constraints (such as those on emissions and resource use, or a lack of flexibility or availability) by using the strengths of the various technologies. Table E1 shows how they perform on a range of criteria.

Evaluating electricity generation technology options should not be seen as a competition, in which ‘the winner takes all’. No single lowcost technology or single class of generation (intermittent renewables, traditional baseload generators, or so on) will be able to supply 100% of our future needs. Indeed, none would be physically able to provide the reliable, environmentally acceptable 24/7 electricity demanded by consumers.

CO₂ transport and storage

CCS is an enabling technology for reducing emissions from large stationary sources of CO₂. The implementation of CCS requires a significant CO₂ transport, storage and monitoring network.

The lowest projected cost for transport and storage from power plants in Australia ($5-14/t CO₂) involves a short transport distance to sites with good storage characteristics. The highest projected cost (up to $70/t CO₂) involves transport over long distances to storage formations with poor characteristics.

Variations in industry activity, exchange rates, macroeconomic cycles and owner’s costs all have a significant effect on estimated CCS costs. Other major factors affecting the costs are related to variability in storage site characteristics (especially for larger and longer term injection of CO₂) and the incorporation of trade-offs in pipeline network design and storage site design.

Table E1: Electricity technology comparisons.
BUSINESS MANAGEMENT & GOVERNANCE

Finance

During 2016, we rolled out Reckon accounting software, allowing us to streamline and bundle a number of our finance processes, creating a number of efficiencies for our team. Undertaken in conjunction with the Finance, Risk and Audit Committee (FRAC), and external advisors where appropriate, we reviewed and updated our financial policies and procedures to improve the effectiveness and efficiency of internal controls.

In 2017, the Finance team will be introducing procurement and forecasting practices that will add to existing annual budgeting and medium to long-term cash flow management. These practices will ensure that corporate and project expenditure remains well controlled while increasing the speed and effectiveness of financial decision making. Such improvements will be particularly important as the organisation moves into the execution phase of a number of projects requiring significant investment sums.

Revenue

CO2CRC added two new and strategically valuable members in the 2016 year – JPower, one of the largest electricity generators in Japan, and the Korea Institute of Geoscience and Mineral Resources (KIGAM). Both countries are highly industrialised and use fossil fuels in power generation; they recognise that CCS will be crucial to their emissions mitigation strategies.

Over the same period we obtained significant new project and sponsorship funding, while continuing to receive the benefit of large-scale government and industry project funding carried forward from 2015 and prior years. Substantial work has also been done to map out diversified funding opportunities and channels for 2017 and beyond, for which we will hire a dedicated Business Development Manager.

Human Resources

The organisation will continue to support and invest in its people through improvements to its attraction, training, engagement, retention and development programs. We have made key hires through the year in strategic positions, with more to come over the 2017 year as the company continues to invest in building capability.

All staff have been involved in the implementation of the company’s 2021 Strategy Plan and have had their work plans aligned to their individual and team roles. Career development and performance coaching initiatives are scheduled to add even further to the staff retention and productivity gains experienced over the past year.

Information Technology

We have made small-scale investments in IT hardware and software over the 2016 year to improve productivity and manage risk, including introducing project management and Customer Relationship Management software. This work has been done in conjunction with an independent IT support business with relevant sector expertise, selected after a competitive review. We are also currently conducting a full-scale IT Needs and Risk review to identify areas where more substantial IT investments may be justified and executed on a cost and risk-effective basis.

Company Secretariat

The company is privileged to have a Board of Directors who each contribute valuable and complementary skills, and exercise critical oversight of the company’s strategy and operations. These contributions are made through both formal Board and Committee meetings and processes, and through support with discrete projects and activities. Much of this important work is done with the assistance of four key Committees which deal with specialist issues and provide recommendations to management, each other and to the full Board as required:

- The Finance, Risk and Audit Committee
- The Operations, Safety and Environment Committee
- The Program Advisory Committee, and
- The Appointments and Remuneration Committee.

The first three Committees are strengthened by the addition of independent experts who bring technical skills and key relationships that support and appropriately challenge the capability of company employees and Directors.

The company has made three important appointments during the 2016 year:

- Mick Buffer (appointed 10 August 2015)
- Dr Fiona Wild (appointed 23 September 2015), and
- Bill McKenzie (appointed 25 February 2016)

The Board is also planning for further appointments, including to supplement skill sets with financial qualifications to ensure that it will remain fully equipped to serve the needs of CO2CRC and its stakeholders.

Administration

The company made important progress towards increasing the efficiency of its operations by bringing all of its Melbourne-based staff together in its new Corporate Office in December 2015. Our close physical and stakeholder relationships with the University of Melbourne and CSIRO (where our Canberra-based staff are located) enable us to benefit from their resources, while our scale and independence ensures that we remain able to pursue commercial opportunities that best suit our financial resources and risk appetite.

Matt McDonald was appointed as our Business Manager & Company Secretary in July 2016, and is accountable for CO2CRC’s broad business and administrative functions.

Matt is a qualified Chartered Accountant and Chartered Secretary with over 30 years’ experience in professional services and senior commercial leadership roles. He has extensive post graduate qualifications in corporate governance, internal audit and commercial law, and brings broad experience earned across a range of industries.
Advisory Board. Board, and Chairman to the APPEA Resources at Seven Group Holdings, currently Group Executive in Natural the mining sector. Mr Ferguson is sector, and the rapid expansion of ever investments in the oil and gas Minister he oversaw the largest March 2013. During his time as Resources and Energy, and Minister Ferguson was appointed Minister for of Shadow Ministerial portfolios including Resources and Energy. Upon the Rudd Government’s election in December 2007, Mr Ferguson was appointed Minister for Resources and Energy, and Minister for Tourism, positions he held until March 2013. During his time as Minister he oversaw the largest ever investments in the oil and gas sector, and the rapid expansion of the mining sector. Mr Ferguson is currently Group Executive in Natural Resources at Seven Group Holdings, Non-Executive Director of the BG Board, and Chairman to the APPEA Advisory Board.

Martin Ferguson AM
B Ec (Hons)
Chairman

Martin Ferguson joined the CO2CRC as Chairman in September 2014, bringing decades of experience working with the resource sector from a government and private sector perspective. Mr Ferguson served as the Member for Batman from 1996 to 2013 and held a variety of Shadow Ministerial portfolios including Resources and Energy. Upon the Rudd Government’s election in December 2007, Mr Ferguson was appointed Minister for Resources and Energy, and Minister for Tourism, positions he held until March 2013. During his time as Minister he oversaw the largest ever investments in the oil and gas sector, and the rapid expansion of the mining sector. Mr Ferguson is currently Group Executive in Natural Resources at Seven Group Holdings, Non-Executive Director of the BG Board, and Chairman to the APPEA Advisory Board.

Tania Constable PSM
Mint Law, MBA GAICD, Grad Cert Econ
Chief Executive Officer

Ms Constable has held senior Australian Public Service roles at Treasury as well as the Department of Industry. Ms Constable was the Head of Resources for more than four years. She had responsibility for policy advice to the Minister for Industry on oil and gas regulation, exploration and development, and mining activities. During this time Ms Constable also had the privilege of being the Australian Joint Commissioner and Sunrise Commissioner for Australia and Timor Leste leading joint activities on the development of the Joint Petroleum Development Area and Greater Sunrise Project. She was awarded the Public Service Medal in 2014 for outstanding public service in the development of Australia’s liquefied natural gas and other resource and energy industries.

Tim Walton
BA, MBA GAICD
Director

Tim Walton is the Director, Energy Research Initiatives, in Curtin University’s Office of Research and Development in Perth, Western Australia. With a background in corporate communications, government policy and strategy, Mr Walton has worked in science administration and resources development within the Western Australian Government’s minerals and petroleum, and science and innovation portfolios. Previously he has worked in a diverse range of areas including conservation education, natural resources management, policy and regulation, heavy industry and port logistics. Mr Walton is on the Board of the Western Australian Energy Research Alliance which oversees a joint venture in offshore oil and gas research engagement between CSIRO, Curtin and the University of Western Australia. The National Geosequestration Laboratory is also managed by the Alliance.

Dr Alex Wonhas
Physik Diplm (equiv BSc and MSc), PhD, GAICD
Director

Alex Wonhas is Executive Director, Energy and Resources at CSIRO with responsibility for $200 million a year research and development portfolio which aims to provide science and technology solutions that will enhance the value Australia derives from its energy and mineral resources while enabling the transition to a lower emissions economy. Dr Wonhas was formally a consultant with McKinsey & Company where spent several years advising national and international energy and resources companies on questions of strategy and operations. He also currently serves on the Australian National Low Emissions Coal Council, the Energy and Minerals Institute of the University of Western Australia, and the Federal Government’s Energy White Paper Reference Group.

Dr James Johnson
BSc (Hons), PhD
Deputy CEO of Geoscience Australia and Chief of Resources Division Director

James Johnson is a geologist (BSc Hons, PhD) with decades of experience in mining and mineral exploration, including nine years as a Division Chief at Geoscience Australia. At Geoscience Australia, he managed the five-year $59 million Onshore Energy Security Program from submission through program design and implementation. The program stimulated considerable investment in exploration and was instrumental in mineral discoveries. From 2011 to early 2014 Dr Johnson managed the Australian Government’s Petroleum Pre-Competitive Geoscience Australia programs. He now has carriage of both the Minerals and Energy Resources programs at Geoscience Australia.

Greg Lewin AM
B Eng (Chem), MBA, FIEAust, FIChemE
Director

Greg Lewin came to CO2CRC following a distinguished 35-year career with Royal Dutch Shell, culminating in his appointment as President, Shell Global Solutions International. He is a Member of the Order of Australia, a Fellow of the Royal Academy of Engineering, a past President of the Institute of Chemical Engineers, and the current President of the World Chemical Engineering Council. He is also Chairman of the Wildlife Art Museum of Australia Foundation and Leofwine, non-executive Director of Alinta Energy and Executive Director of Sapphire Global.

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BSc (Hons), PhD
Deputy CEO of Geoscience Australia and Chief of Resources Division Director

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B Eng (Chem), MBA, FIEAust, FIChemE
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Dr Fiona Wild
PhD
Director
Fiona has almost 20 years’ experience in multinational oil and gas and resources companies, ranging from frontline operational management to corporate strategic development. She joined BHP Billiton in 2010 as Senior Manager, Environment and Climate Change in February 2013. In these roles, she has been accountable for developing and maintaining the framework that enables BHP Billiton to deliver excellence in environmental performance. She now leads the design and implementation of BHP Billiton’s climate change strategy. In 2015, she led the development of BHP Billiton’s Climate Change Portfolio Analysis report, that describes the impact of both an orderly and a rapid transition to a low carbon future on the valuation of the company’s portfolio.

Bill McKenzie
BE (Chem) Hons 1A, RPEQ, FIChemE, CEng, MAICD
Director
Bill is the General Manager, Development, for Shell’s QGC venture and is a director of a number of Shell’s subsidiary companies including BG International (AUS) Pty Ltd and QGC Pty Limited. Bill is accountable for Shell’s exploration, appraisal and development activities in eastern Australia.

Bill is a chartered chemical engineer and RPEQ with significant experience in project development, process engineering, operations, process safety and management. After a 16-year career in BP in refining, Bill joined Origin Energy’s oil & gas division in 2008 as the head of safety, then head of engineering and operations before becoming GM Technical. In 2011 Bill was appointed to GM Queensland CSG, accountable for the APLNG Joint Venture’s Upstream assets.

Mick Butffer
BE (Civil), MBA
Director
Mick has 35 years’ experience in the coal mining industry in Australia. He joined Glencore Coal in 2001 as the Director of Open Cut Operations in NSW. Subsequent to the Xstrata IPO in 2002 Mr Butffer was Chief Operating Officer of Xstrata’s coal mining operations in NSW. In 2009 he was appointed Group Executive for Sustainable Development and Industry Relations, across the company’s global coal operations. Mr Butffer continues in this role following the merger of Glencore and Xstrata. He is a Director of ACALET ACA Low Emission Technologies Ltd and Australian National Low Emissions Coal (ANLEC) R&D Limited. Mr Butffer is Chairman of the World Coal Association, an Associate of the IEA Coal Industry Advisory Board and a peer reviewer of the IEA World Energy Outlook.
CO2CRC acknowledges and appreciates the strong relationships it has with industry, community, government, research organisations, and agencies in Australia and around the world.

INDUSTRY
- ANLEC R&D (on behalf of ACALET)
- Chevron Australia
- Coal 21
- Global CCS institute
- INPEX Browse Ltd
- J-POWER
- Shell Development (Australia) Pty Ltd
- J-POWER

COMMUNITY
- Landowners at the Otway Site
- Moyne Shire
- Nirranda South

GOVERNMENT
- Australian Government: Department of Education and Training
- Australian Government: Department of Industry, Innovation and Science
- CarbonNet Project
- NSW: Department of Industry
- SA: The Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE)
- Victoria: Department of Economic Development, Jobs, Transport and Resources
- WA: Department of Mines and Petroleum

RESEARCH
- Australian National University
- Charles Darwin University
- CSIRO
- Curtin University
- Federation University Australia
- Geoscience Australia
- GNS Science
- Imperial College of London
- Korea Institute of Geosciences & Mineral Resources
- Lawrence Berkeley National Laboratory (LBNL)
- University of Adelaide
- University of Edinburgh
- University of Melbourne
- University of NSW
- University of Queensland
- University of Western Australia
- UK CCS Research Centre