# CO2CRC'S CARBON CAPTURE AND GEOLOGICAL STORAGE DEMONSTRATION IN VICTORIA

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## INTRODUCTION

The recent Intergovernmental Panel on Climate Change (IPCC) report (*Climate Change 2013: The Physical Science Basis*) states that 'warming of the climate system is unequivocal', and that 'it is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century'. The IPCC report follows a common trend attributing increasing anthropogenic greenhouse gas emissions as the cause of this climate change. Carbon dioxide ($CO_2$), primarily from the combustion of fossil fuels for energy, is the most common greenhouse gas emitted by human activities. Reduction of greenhouse gas emission, particularly $CO_2$ to the atmosphere, is therefore a key environmental issue facing Australia and the world.

Global energy demand projections point to increased levels of fossil fuel combustion. Even with the strongest imaginable efforts to convert to alternative sources of energy, an unprecedented and growing energy demand means that fossil fuels will continue to be the primary energy source globally for decades to come. The International Environmental Agency (IEA) has stated that this will result in $CO_2$ emissions at 'quantities incompatible with levels required to stabilise greenhouse gas (GHG) concentrations at safe atmospheric levels'.

Prevention of $CO_2$ emissions from stationary sources to the atmosphere through $CO_2$ capture and storage (CCS) currently appears to be one of very few technically ready options at the required scale of hundreds of millions of tonnes of $CO_2$ annually. CCS is not a replacement for taking actions that increase energy efficiency or maximise the use of renewable or other less carbon-intensive forms of energy. A portfolio approach, taking every opportunity to cost-effectively reduce emissions, will be required to meet the challenge of minimising climate change in a world of growing energy demand.

## $CO_2$ CAPTURE AND STORAGE TECHNOLOGY

CCS involves the separation of $CO_2$ from the flue gases of major stationary emitters, followed by transport of the separated $CO_2$ and injection in deep geological formations. CCS combines various mature technologies previously applied in the oil, gas and chemical industries. Many chemical plants around the world separate $CO_2$ from other gases and the technology is well known. $CO_2$ is already transported thousands of kilometres by pipeline in North America. $CO_2$ has been injected into oil fields to enhance recovery of oil (EOR) since 1972, and commercial EOR operations are currently taking place in USA, Turkey, Brazil, Trinidad and Canada. As much of the injected $CO_2$ is deliberately retained in the depleted fields, storage has essentially been underway for 42 years. Commercial $CO_2$ storage, unrelated to EOR, has also taken place in Algeria and Norway since 2004 and 1996 respectively.

## BROWN COAL AND CCS UTILISATION IN VICTORIA

Decreasing $CO_2$ emissions is firmly on the Victorian agenda and CCS forms a vital part of the Australian mitigation portfolio, with the potential to make deep cuts in stationary $CO_2$ emissions in a safe, environmentally responsible and cost-effective manner. Several CCS demonstration projects are underway or planned and a commercial-scale CCS demonstration project is proposed.

Victoria's brown coal deposits are one of the world's largest low-cost energy sources and are key for Victoria's energy generation. On one hand, brown coal represents one of the nation's largest $CO_2$ emission sources, and with current national emissions reduction commitments the resource's commercial value is threatened. On the other hand, successful CCS deployment would allow the continuation of an economic energy resource, in an environmentally responsible manner.

CO2CRC has been actively carrying out field-scale research and development projects throughout Victoria that can be used to demonstrate the validity of a CCS option in the state.

## $CO_2$ CAPTURE RESEARCH ACTIVITY IN VICTORIA

CO2CRC is researching technologies to cost-effectively capture $CO_2$, many of which have the potential to be applied to Victoria's electricity generation facilities. A key component of this research is $CO_2$ capture demonstration projects at the Hazelwood power station in Victoria's

Latrobe Valley. Four pilot plants represent three different capture technologies, namely solvent, adsorption and membranes, which have been in operation since 2009. The large solvent plant (50 tonnes per day) was built by the then International Power (now GDF SUEZ Australian Energy) with support from the Australian Government via the Low Emissions Technology Demonstration Fund (LETDF) and the Victorian Government through the Energy Technology Innovation Strategy (ETIS), while CO2CRC's adsorption and membrane plants were funded by the Victorian Government's ETIS program and Brown Coal Innovation Australia (BCIA). While commercial solvent technology is already available, further research and demonstration is essential to bring down the cost of capture. CO2CRC built a small solvent plant (1 tpd) in 2012 to test and demonstrate its UNO MK 3 technology, with funding from BCIA and CO2CRC partners including the Australian Government, as well as the support of GDF SUEZ Australian Energy. This project tests a precipitating solvent process using potassium carbonate ($K_2CO_3$). This process has many advantages over conventional amine processes, including significant environmental benefits and much lower energy requirements. The UNO MK 3 Capture Plant is capturing one tonne of $CO_2$ per day from the power plant flue gas. All the pilot plants allow researchers to identify engineering issues and resolve them, and verify simulation results.

## $CO_2$ STORAGE RESEARCH ACTIVITY IN VICTORIA

Earlier work by CO2CRC, the National Carbon Storage Taskforce, CSIRO, GeoScience Victoria and other organisations, concluded that Victoria's geological setting offers significant $CO_2$ storage potential. It has been established that tens of millions of tonnes of $CO_2$, a substantial percentage of Victoria's emissions, could be captured and stored underground. This positions Victoria as the state with highest potential for emission reduction via CCS.

Victoria's sedimentary basins also offer an ideal setting for understanding and demonstrating CCS technology. For more than half a decade, the CO2CRC Otway Project, in south-western Victoria, has been at the forefront of the scientific investigation of geological $CO_2$ storage. The Otway Project has previously been deemed by the Victorian ministry to be a project of national significance because it is one of the world's most comprehensive $CO_2$ storage research facilities; over 65,000 tonnes of $CO_2$ have been injected and stored in a depleted gas reservoir (the Naylor Field) deep underground, and further injections into saline-water-bearing formations are in progress. The project's key contributions include novel monitoring programs, including seismic, down-hole pressure and geochemical, shallow aquifer geochemistry, soil gas and atmospheric monitoring technologies. Lessons learned from the project, particularly from the comprehensive monitoring program, as well as from the regulatory and community consultation aspects, are being adopted by other geosequestration projects around the world.

This innovative research project provides verification of safe $CO_2$ storage and lays the foundation for an emerging CCS landscape in Australia.

## CONCLUSIONS AND FUTURE ACTIVITIES

CCS is a key technology for reducing $CO_2$ emissions and holds particular applicability in Victoria, as a positive option to reduce greenhouse gas emissions from the state's brown coal energy resource and to permanently store it locally. Through successful research and development within the Otway and Latrobe/Gippsland regions, and the technology sectors' strong history in the oil, gas and chemical industries, CCS is technically ready for future application in Victoria. CCS presents a major opportunity to manage a significant portion of Victoria's current and future emissions, particularly those associated with the Latrobe Valley's energy sector, in an environmentally responsible manner.

CCS-related activities in Victoria have included targeted research and development and demonstration aimed at reducing the technical barriers to commercial deployment. Much work is still required to address the needs in policy and regulatory risk, the lack of an economic driver for any $CO_2$ abatement activity, and community acceptance.

In addition to industry funding and significant involvement of the research community, the CCS projects are supported by governments through a range of programs, including the CCS Flagship Program, the Cooperative Research Centre Programme, the Low Emissions Technology Demonstration Fund, BCIA and various state initiatives.