The Parliament of the Commonwealth of Australia

Between a rock and a hard place

The science of geosequestration

House of Representatives
Standing Committee on Science and Innovation

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Foreword

There is now compelling evidence that human activity is changing the global climate. While Australia remains a relatively minor emitter of greenhouse gases, our emissions, particularly in the stationary energy and transport sector, have been rising since 1990. Geosequestration or carbon capture and storage (CCS) technology has the potential to play an important role in the global effort to reduce CO_2 emissions. It may also prove to be of particular importance to Australia.

Australia is between a rock and a hard place. For many years, Australia has benefited from being able to produce very cheap electricity from our vast reserves of both black and brown coal. Australia has approximately 8.6 per cent of world black coal reserves, which, at current production levels, would last 215 years. Australia also has enough brown coal to last for another 800 years at current production levels.

Australia's energy sector is heavily reliant on black and brown coal with over 83 per cent of total electricity generated from this source. Australia is also the largest exporter of coal in the world—in 2005, Australian coal exports were worth $24 billion, representing Australia's largest commodity export.

It is expected that Australia, and the world, will continue to rely on coal well into the future. This presents us with the challenge of reducing greenhouse gas emissions whilst remaining dependent on coal. CCS provides a possible solution to these competing demands. In a carbon-constrained world, if Australia is able to demonstrate and commercialise CCS technology it will protect both the environment and the coal industry.

Carbon capture and storage comprises three broadly defined stages: (i) CO_2 separation and capture at the source; (ii) transportation of CO_2 to the storage site; (iii) long-term storage of the CO_2, largely in an underground geological facility or a depleted oil or gas field, for thousands of years.

There are three possible ways to approach the first stage of the process, that of the separation and capture of CO_2: post-combustion, oxyfuel combustion and pre-combustion. Each process differs in either the way in which the CO_2 is separated from other gases or at which point in the process the CO_2 is captured. Whilst oxyfuel and pre-combustion technologies are viewed more favourably as their processes are more efficient, the current stock of Australia's power plants are most suited to be adapted to post-combustion technology.

In Australia and internationally there is currently a large stock of pulverised coal-fired power stations. Many of these plants are expected to operate for up to 40 more years. If serious cuts in emission are to be achieved by 2050, some form of post-combustion capture technology will need to be part of the CCS strategy.

Once the CO_2 has been separated and captured, it must be transported to a storage site. This is a relatively simple process and could occur via pipeline, road, ship or rail. Further research will be required, particularly to ascertain which distances make transport options economical. Storage options include: saline aquifers; depleted gas and oil fields; unmineable coal seams; or the injection of CO_2 into existing oil and gas reservoirs for enhanced recovery purposes.

In Australia, deep saline aquifers represent 94 per cent of our feasible geological storage capacity and have therefore become a key focus of storage research. However, all storage options need to be considered. In particular, the storage potential in the Wollongong-Sydney-Newcastle region needs to be further explored. The Committee recommends that the Australian Government provide funding to CSIRO to progress research into the storage potential for permanent CO_2 sequestration in sedimentary basins in New South Wales.

Once CO_2 has been stored underground, effective and accurate technologies to measure and monitor the CO_2 are essential for the purposes of regulation, carbon accounting and public safety. The greatest environmental risk associated with CCS concerns the potential for CO_2 leakage, which could have serious consequences for the environment and people's health. These risks can be mitigated through further research, rigorous site selection and post-injection management.

The extent of the environmental benefits of CCS continues to be debated. Some argue that CCS has the potential to reduce global CO_2 emissions by 7.8 per cent with potentially greater benefits to be seen in the later half of the 21st century. Others contend that, given the environmental risks, there are more viable options. The Committee concludes that there are substantial positive environmental benefits to be gained from the deployment of CCS, providing there is also appropriate regulation and scrutiny of environmental risks. The Committee recommends the implementation of a rigorous regulatory environmental risk mitigation framework for CCS.

While a great deal of confidence is being expressed about CCS technology, there are no major projects currently underway to demonstrate the integration of technologies with coal-fired power plants. In Australia, a number of smaller CCS demonstration projects are underway such as the Gorgon project, Hazelwood 2030 and ZeroGen. These and other projects will enhance our knowledge base.

However, the major challenge is to mount a project at the 500MW scale which demonstrates all stages in the process—from coal conversion, carbon capture, and transport, through to sequestration and long-term monitoring. This raises logistic coordination and environmental and technical challenges that are not tested or resolved by small-scale demonstrations. The Committee recommends that the Australian Government fund one or more large-scale CCS projects utilising a competitive tender process to ascertain which project will receive the funding. It is also expected that these demonstration projects will provide an ideal opportunity to subject CCS to rigorous environmental, health and safety regulations before any future long-term commercial operations are in place.

Alongside its investigation of the potential environmental benefits and risks associated with CCS, the Committee also examined the economic benefits and costs. It is difficult to accurately estimate the economic impact of CCS. The IPCC estimates that, in the long-term, including CCS in a range of mitigation strategies will reduce the cost of stabilising global CO_2 emissions by 30 per cent.

Equally as challenging is accurately measuring the economic cost of inaction. Available research indicates that the Australian economy may be more adversely affected by climate change than other developed countries.

The predicted actual costs of implementing CCS technology also vary. Capturing CO_2 is the most expensive aspect of the process, accounting for between 70 and 80 per cent of the total costs. The cost of capture will vary depending on a range of factors which are outlined in the report. Costs associated with the transport of CO_2 will also vary depending on the distance transported, the pressure used to transport the CO_2 through a pipeline and the terrain through which the pipeline passes. Storage and monitoring is expected to be the least costly component of the process and the total cost is expected to reduce over time.

There is also the question of what impact CCS deployment will have on electricity costs. Clean energy comes at a price but in the case of CCS, the size of a price increase is not clear. Available data suggests that CCS might double the cost of electricity generation from coal. However, as CSIRO notes, the cost of implementing capture technology is ‘only a proportion of the costs consumers pay’.[1] Conversely, Robert Socolow has predicted that as ‘the costs of distribution and transmission [of electricity] are hardly affected [by CCS] … the retail cost of electricity would increase by just 20 [per cent]’.[2]

1 CSIRO, *Supplementary Submission No. 10.1*, p. 2.

2 Robert Socolow quoted in, Quirin Schiermeier, *Putting the carbon back: the hundred billion tonne challenge*, Nature Vol. 442, Issue. 7103, (10 August 2006), p. 623.

It has been advised that the technological unknowns in cost estimates make industry investment in CCS on a wide-scale unlikely in the current environment. Industry has called for economic incentives, including a carbon price signal, to foster the development of CCS technology. The Committee recommends that the Australian Government employ financial incentives, both direct and tax based, in an effort to encourage science and industry to continue developing and testing CCS technology.

The Committee also maintains that the Australian and state governments must develop appropriate legal and regulatory frameworks covering the injection of CO_2 and subsequent operational monitoring, site closure and post-abandonment monitoring. This will provide confidence for investors to undertake large-scale CCS development. The issue of long-term liability is of particular concern. Regulations need to be flexible and robust enough to apply to the sequestration and storage of CO_2 which is intended to be in place for hundreds, if not thousands, of years. Regulations for financial liability need to be designed to cover both the period during which the CO_2 is being sequestered and the period after the injection process has ceased. Therefore, the Committee recommends that the Australian Government, following industry consultation, develop legislation to define the financial liability and ongoing monitoring responsibilities at geosequestration sites.

The Committee concludes its report with a discussion on how best to position Australian industry to capture possible market applications of CCS. Australia has a solid skills base in this area and a reputation as a world leader in the development of CCS science and technology. A number of programs administered by various universities and research centres are in place to ensure that our skill base keeps developing and expanding. Greater funding in this area will assist in retaining skilled people who may be attracted to more lucrative jobs. Nurturing and further developing a skills base will be key in further developing CCS technology and demonstrating it on a large scale. If Australia is successful in this regard, then it is expected that global marketing and export opportunities will arise.

Confidence in the potential environmental benefits of CCS technology is growing. Nevertheless, the technology underpinning this climate change strategy is yet to be fully proven. Modelling and general scientific optimism is not enough to guarantee the success of CCS. A great deal more demonstration work is needed for this technology to be part of the suite of options that will need to be rolled out if Australia, and the world, are to make serious inroads into significantly reducing the current levels of anthropogenic greenhouse gas emissions. Australia has the opportunity to play a key role in the development of this technology which could provide enormous environmental and economic benefits both domestically and internationally.

I would like to thank all those who contributed to this inquiry through submissions and discussion with the Committee. I would also like to thank Committee members and the Secretariat staff for their efforts throughout the inquiry process.

Petro Georgiou MP
Chair

Membership of the Committee

Chair	Mr Petro Georgiou MP	
Deputy Chair	Mr Harry Quick MP	
Members	Mr Harry Jenkins MP	Mr David Tollner MP
	Mr Chris Hayes MP	Hon Danna Vale MP
	Dr Dennis Jensen MP	Mr Roger Price MP (until 08/05/07)
	Hon Jackie Kelly MP	Mr Kelvin Thomson MP (from 08/05/07)
	Dr Mal Washer MP	

Terms of reference

The House of Representatives Standing Committee on Science and Innovation is to inquire into and report on the science and application of geosequestration technology in Australia, with particular reference to:

- The science underpinning geosequestration technology;
- The potential environment and economic benefits and risks of such technology;
- The skill base in Australia to advance the science of geosequestration technology;
- Regulatory and approval issues governing geosequestration technology and trials; and
- How to best position Australian industry to capture possible market applications.

List of abbreviations

ABARE	Australian Bureau of Agriculture and Resource Economics
ACA	Australian Coal Association
AGO	Australian Greenhouse Office
AP6	Asia Pacific Partnership on Clean Development and Climate
APCRC	Australian Petroleum Cooperative Research Centre
BIA	Barrow Island Act
CCS	Carbon Capture and Storage
CCSD	Cooperative Research Centre for Coal in Sustainable Development
cLET	Centre for Low Emission Technology
CO_2	Carbon Dioxide
CO2CRC	Cooperative Research Centre for Greenhouse Gas Technologies
$CO_{2\text{-}e}$	Carbon Dioxide Equivalent
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSLF	Carbon Sequestration Leadership Forum
EOR	Enhanced Oil Recovery
EPA	Environmental Protection Agency
GCEP	Global Climate and Energy Project

GDP	Gross Domestic Product
GEODISC	Geological Disposal of Carbon
GHG	Greenhouse Gas
GSL	Gas Storage Licenses
IDGCC	Integrated Drying and Gasification Combined Cycle
IEA	International Energy Agency
IGCC	Integrated Gasification Combined Cycle
IPCC	Intergovernmental Panel on Climate Change
ISC	Industry Skills Council
LETDF	Low Emissions Technology Demonstration Fund
LVCSA	Latrobe Valley CO_2 Storage Assessment Project
MCMPR	Ministerial Council on Mineral and Petroleum Resources
MIT	Massachusetts Institute of Technology
MRET	Mandatory Renewal Energy Target
MW	Megawatts
PEL	Petroleum Exploration Licenses
PMSEIC	Prime Minister's Science, Engineering and Innovation Council
PPL	Petroleum Production Licenses
PPM	Parts Per Million
R&D	Research and Development
RIISC	Resources and Infrastructure Industry Skills Council
TAR	Third Assessment Report
ZCP	Zero Carbon Project

List of recommendations

3 Carbon capture and storage

Recommendation 1

The Committee recommends that the Australian Government provide funding to the CSIRO to progress research being conducted through the CO2CRC to assess the storage potential for permanent CO_2 geosequestration in sedimentary basins in New South Wales, particularly the off-shore Sydney Basin, and the economic viability of these sites.

4 Australian CCS demonstration projects

Recommendation 2

The Committee recommends that the Australian Government fund one or more large-scale projects which will demonstrate the operation and integration of the CCS—capture, transportation and sequestration and monitoring. The Government's assessment of which project(s) will receive funding will be based on a competitive tender process.

5 The environmental benefits and risks of CCS and public perception

Recommendation 3

The Committee recommends that the Australian Government implement a rigorous regulatory environmental risk mitigation framework for CCS which covers:

- Criteria for CCS site selection and an assessment of the environmental impact at selected sites;
- Assessment of the risk of abrupt or gradual leakage, and appropriate response strategies; and
- Requirements for long-term site monitoring and reporting.

6 The economic benefits and costs of CCS

Recommendation 4

The Committee recommends that the Australian Government, as part of its broader fiscal response to climate change, employ financial incentives, both direct and tax based, in an effort to encourage science and industry to continue developing and testing CCS technology.

7 Legislative and regulatory framework

Recommendation 5

The Committee recommends that the Australian Government, following industry consultation, develop legislation to define the financial liability and ongoing monitoring responsibilities at a geosequestration site.

The Committee recommends that financial liability and site responsibility should consist of three phases:

- Full financial liability and responsibility for site safety and monitoring should rest with industry operators for the injection phase and a subsequent length of time (this time to be determined by the Australian Government subject to specific site risk analysis);
- Following the above specified time, shared financial liability and responsibility for site safety and monitoring should rest equally with industry operators and state, territory and Australian governments in the longer term. The exact length of this shared responsibility and liability

phase should be determined by the governments subject to specific site risk analysis; and

- Following the determined phase of shared liability and responsibility, full financial liability and responsibility for site safety and monitoring should be transferred to the two spheres of government in perpetuity.