SUBMISSION:

HOUSE OF REPRESENTATIVES STANDING COMMITTEE ON SCIENCE AND INNOVATION INQUIRY INTO GEOSEQUESTRATION TECHNOLOGY

SEPTEMBER 2006

A JOINT SUBMISSION BY THE AUSTRALIAN COAL ASSOCIATION AND THE MINERALS COUNCIL OF AUSTRALIA

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EXECUTIVE SUMMARY

Importance of fossil fuels as the major energy source

Climate change is a global problem requiring a global solution. Global action needs to be environmentally effective, equitable and economically efficient, covering all greenhouse gases, all emission sources and sinks, and all economic sectors.

Regardless of measures taken to respond to climate change, coal and other fossil fuels will form the basic feedstock for electricity generation both in Australia and overseas for the foreseeable future. Fossil fuels will also continue to generate significant export income, employment and investment for Australia.

While Australia derives major benefits from its endowment of coal and other fossil fuels, the Australian black coal industry and the minerals industry more broadly acknowledge the challenge posed by climate change and recognise the need to reduce greenhouse gas emissions over time. It is essential, however, that this objective is achieved in ways that maintain the advantages of an affordable, secure and reliable energy supply and do not undermine Australian industry competitiveness.

'Here and now' focus – developing technology solutions

The clear focus now must be on developing a portfolio of technologies to reduce emissions. With this in mind the Australian minerals sector is investing significant resources into R & D and demonstration activities including through the major black coal initiatives – Coal21 and Coal21 Fund.

One of the difficulties of achieving significant reductions in emissions at least cost is this is only achievable when economic agents have alternatives: that is when behaviour can be changed or when substitutes are available. Developing technology solutions to achieve significant reductions in greenhouse emissions over the next 50 years requires the development of step-change low and near zero emission technologies capable of application around the world.

The capture and permanent geological storage of CO_2 offers important possibilities for making the further use of fossil fuels more compatible with climate change mitigation. This submission emphasises the crucial role of research, development and demonstration (RD&D), particularly for the improvement of technologies to capture CO_2 from power generation, over the next decade and beyond. This is the key area of challenge for the widespread deployment of Carbon Capture and Storage (CCS) and is critical to the reduction of emissions particularly associated with strongly growing fossil fuel energy generation in both China and India.

There is a finite amount of national wealth that the Australian community will be willing to invest in responding to climate change over the next few years. Given that Australia accounts for less than 1.4 per cent of total global emissions, it is very likely that the proportion of that finite investment allocated to RD&D – developing new technologies in both the renewable and fossil fuel areas – will eventually prove to be by far the most cost-effective and significant contribution Australia makes to solving the global problem.

The ACA and MCA therefore support encouragement for innovation, demonstration and 'clean development', both in domestic policy and in cooperation internationally, as the immediate and appropriate response to managing greenhouse emissions. The Asia Pacific Partnership for Clean Development and Climate – in which Australia is participating with the United States, Japan, China, India and the Republic of Korea – is an initiative with currently the greatest prospect of delivering real progress to abate greenhouse gas emissions. Other international collaboration on relevant innovation and technology is being pursued through: multilateral and bilateral activities, including the Carbon Sequestration Leadership Forum

The science underpinning CCS

The various individual components of CCS – capture, compression, transport and storage – are already proven in various industrial applications. Integration of these into a CCS system at power station scale requires further demonstration. In addition, work is needed on the potential viability of storage in low permeability geological formations, particularly those located close to emission sources.

Regulatory, environmental and economic issues

The domestic and also global economic implications of any abrupt curtailment of the use of fossil energy without viable economic alternative energy sources would be economically and socially catastrophic. **Without a viable alternative like CCS there is potential for existing assets to be stranded and this could pose significant energy security risk and impose very large replacement costs.**

Potential environmental risks can be managed through robust monitoring and verification protocols modelled on existing safeguards for other industrial operations and taking into account the *Australian Regulatory Guiding Principles* that were endorsed in 2005 by the Commonwealth/States/ Northern Territory through the Ministerial Council on Mineral and Petroleum Resources.

Nationally consistent legal and regulatory framework for CCS activities both onshore and offshore in Australia is urgently needed.

The skill base in Australia to advance CCS

Australia has a concentrated but well established scientific R&D capability in the area of CCS, and is recognised as a world leader in some aspects (e.g. geological characterisation).

There are some emerging areas of critical skills shortage, particularly for petroleum geoscientists who are essential for geological storage mapping and characterisation.

There is a need to support development of a broader skill base for CCS activities and to consider the role of government in assisting to address shortages in the skill base for geosequestration.

Positioning Australia to capture market applications

Ongoing investment in RD&D and related expertise from both government and industry is needed to not only accelerate the deployment of CCS technology but also to position Australia to bundle this expertise with energy exports increasing our overall international competitiveness.

1. APPROACH TO THE SUBMISSION

There is a wide body of existing information on carbon dioxide capture and storage (CCS) already available to the Standing Committee. This includes, for example, the Cooperative Research Centre for Greenhouse Technologies (CO2CRC) CCS Technology Roadmap, the IPCC Special Report on CCS released in late 2005 and the Carbon Dioxide Capture and Geologic Storage Report by Battelle's Global Energy Technology Strategy Program released April 2006. The ACA and MCA urge the Inquiry to access and incorporate these sources (and those listed in useful links section of this submission) into its deliberations and conclusions.

The Inquiry will be receiving a number of authoritative submissions from science and technology bodies such as CO2CRC and the Centre for Low Emissions Technologies, and from CCS project proponents such as Monash Energy. We also commend these submissions to the Committee.

Given the existence of these authoritative sources, this submission does not attempt a comprehensive treatment of the subject, but rather focuses on key points we believe should be emphasised when considering the potential role of CCS in the national and global response to climate change. These have been set out according to the criteria established for the Inquiry.

2. INTRODUCTION

2.1 THE AUSTRALIAN COAL ASSOCIATION AND COAL21 PERSPECTIVE

Black coal and the industry that produces it plays a vital role in the Australian economy. Black coal is Australia's biggest commodity export (~ A$22 billion in export revenue in 2005), directly employs approximately 20,000 Australians (100,000 indirectly) and provides 56 per cent of our electricity generation. The comparatively low-cost of Australia's coal-based electricity supply (derived from both black thermal and brown coal) underpins the competitiveness of a significant proportion of Australian industry and provides affordable power for domestic consumers.

Regardless of measures taken to respond to climate change, it is clear that for the foreseeable future at least, coal and other fossil fuels will need to continue to play a strong role in meeting growing global energy demand, providing energy security, and, in Australia's case, generating significant export income, employment and investment.

While Australia derives major benefits from its endowment of coal and other fossil fuels, the Australian black coal industry acknowledges the challenge posed by climate change and recognises the need to reduce greenhouse gas emissions over time. It is essential, however, that this objective is achieved in ways that maintain the advantages of an affordable, secure and reliable energy supply.

As an energy intensive economy with a strong dependence on all fossil fuels, reducing emissions that arise from the use of coal is just one of a broad suite of responses that will be needed if Australia is to make significant cuts in stationary energy sector emissions in the foreseeable future. Other measures will need to include reductions in emissions from gas, improvements in end use efficiency, greater use of renewable technologies where they are most practical, and, in particular, a very strong commitment to Research, Development and Demonstration (RD&D) in all areas.

Carbon Capture and Storage (CCS) is the key to significantly reducing greenhouse gas emissions from coal. However all fossil fuels used in the stationary energy sector, including natural gas, will eventually need to adopt CCS if long term targets for atmospheric CO_2 concentrations being suggested by the IPCC and others are to be met.

Early opportunities for commercial-scale deployment of CCS in Australia, as elsewhere may centre on the processing of natural gas, coal seam methane and coal syngas rather than on power generation. Concentrated CO_2 is a by-product of these processes, so there is no material additional cost for capture, offering the potential for early commercial scale CCS deployment at relatively lower cost – the Western Australian Gorgon and Victorian Monash Energy Projects being cases in point.

The ACA wishes to emphasise the crucial role of RD&D, particularly for the improvement of technologies to capture CO_2 from power generation, over the next decade and beyond. This is the key area of challenge for the widespread deployment of CCS and is critical to the reduction of emissions particularly from growing fossil fuel energy generation in China and India. While Australia's effort to reduce its own emissions cannot in itself have a significant impact on global climate outcomes, as a developed country it is in a position to make a major contribution over the longer term through well-targeted RD&D aimed at developing and applying low emissions technologies, particularly high-efficiency low cost capture from power generation, including advanced renewables and CCS.

The Australian black coal industry has long been proactive in addressing environmental issues associated with the extraction and use of coal. Since 1992, the Australian Coal Association Research Program (ACARP) has been funding R&D into coal and since 2001, has been carrying out R&D related to Clean Coal Technologies. ACARP currently invests over $10million per annum on industry-related research. This is raised via an industry-wide levy on coal production.

Through ACARP, the industry also supports key research through membership of the Cooperative Research Centre (CRC) for Coal in Sustainable Development (CCSD) and the CRC for Greenhouse Gas Technologies (CO2CRC) and the Queensland Centre for Low Emissions Technology (cLET). A number of coal producers have also elected to become individual participants in these Centre's.

In March 2003, the Australian Coal Association brought together representatives from the coal and electricity industries, unions, federal and state governments and the research community to form the COAL21 partnership. The COAL21 Action Plan, formally launched in March 2004, aims to accelerate the demonstration and deployment of clean coal technologies that will reduce greenhouse gas emissions from coal-based electricity generation.

On 16 March 2006 the ACA announced the establishment of the COAL21 Fund as part of a world-first whole-of-industry funding approach to support greenhouse gas abatement. The fund, being raised by a voluntary levy on coal producers based on their production levels, will raise up to $300 million over 5 years to support the demonstration of key clean coal technologies and to fund supporting RD&D. The COAL21 Fund complements the existing ACARP levy. Further information on COAL21 and the COAL21 Fund can be found at www.coal21.com.au

2.2 THE MINERALS COUNCIL OF AUSTRALIA PERSPECTIVE

The Minerals Council of Australia (MCA) represents Australia's exploration, mining and minerals processing industry, nationally and internationally, in its contribution to sustainable development and society. MCA member companies produce more than 85% of Australia's annual mineral output. Mineral product coverage is base metals (Cu, Pb, Zn), precious metals (Au, Ag), coal (thermal, metallurgical, lignite), iron ore, uranium, heavy minerals (Ru, Zr, Il, $Ti0_2$), light metals (Al, Ni, Mn, Mg) – to the stage of primary transformation, eg. iron ore to pig iron, bauxite to alumina to aluminium.

The MCA's strategic objective is to advocate public policy and operational practice for a world-class industry that is safe, profitable, innovative, environmentally and socially responsible, attuned to community needs and expectations. To this end, the MCA considers the minerals industry can and must contribute directly to solutions to climate change problems within a strategic framework for collective and collaborative action for global solutions to a global problem.

The industry's commitment to continuous improvement in minimising and remediating its environmental impact is a fundamental plank of the industry's broader commitment to sustainable development. This is demonstrable by the MCA's requirement that member companies are signatories to *Enduring Value – the Australian Minerals Industry's Framework for Sustainable Development.*

Enduring Value provides the principal framework for supporting the uptake of policies to ensure that current activities in the minerals sector do not compromise the ability of future generations to meet their own needs. Companies that embrace sustainable development effectively create value by reducing their risk profile, improving productivity, and sustaining access to land and the ore resource, capital, markets and skilled people – coupled with regulatory compliance, this is what constitutes a continuing licence to operate. *Enduring Value* is an effective tool for the industry in managing social and

environmental impacts and pursuing sustainable solutions covering, for example, the climate change challenge. The Framework assists companies translate the principles of sustainable development into relevant, risk-based activities at the minerals site level.

Like all nations, Australia is vulnerable to climate change and the Australian minerals sector has a very significant exposure.[1] The MCA is committed to supporting a global response to managing climate change that will deliver real greenhouse gas emissions abatement that does not undermine Australian industry's competitiveness and promotes real business opportunities. Such global action needs to be environmentally effective, equitable and economically efficient, covering all greenhouse gases, all emission sources and sinks, and all economic sectors.

One of the difficulties of achieving significant reductions in emissions at least cost is this is only achievable when economic agents have alternatives: that is when behaviour can be changed or when substitutes are available. The 'here and now' focus must be on developing technology solutions to achieve significant reductions in greenhouse emissions over the next 50 years. The MCA strongly supports the Australian Government's encouragement for innovation, demonstration and 'clean development', both in domestic policy and in cooperation internationally, as the immediate and appropriate response to managing greenhouse emissions.

The Asia Pacific Partnership for Clean Development and Climate – in which Australia is participating with the United States, Japan, China, India and the Republic of Korea – is an initiative with currently the greatest prospect of delivering real progress to abate greenhouse gas emissions. Other international collaboration on relevant innovation and technology is being pursued through:

- multinational fora such as the United National Framework Convention on Climate Change and the International Energy Agency; and
- focussed multilateral and bilateral activities, including the Carbon Sequestration Leadership Forum, the Methane-to-Markets Partnership, the 'Generation IV' nuclear power forum, "Iter" (the international project on nuclear fusion) and the International Partnership for a Hydrogen Economy, together with the various Climate Action Partnership bilateral arrangements in place with Australia.

The MCA advocates a nationally consistent and coordinated approach to manage climate change and supports the Council of Australian Governments (COAG) goal of reducing compliance costs and unnecessary duplication of effort associated with differing energy and greenhouse reporting requirements across the nation. The MCA has concerns with State and Territory Government proposals to promulgate unilateral greenhouse policy measures as these will adversely impact Australia with no discernible impact on global emissions. While the MCA supports rational early action, it believes that this should form part of a longer term coherent emissions reduction strategy.

Seeking to reduce greenhouse gases by establishing an Australian or other sub-regional carbon price in the current environment will simply act as a blunt and largely ineffective instrument of change and a tax impost. Moreover, in the absence of suitable step-change technologies, costs imposed in one zone will merely drive activity to a different zone that does not have the same restrictions.

The clear focus now must be on developing a portfolio of technologies to reduce emissions. With this in mind the Australian minerals sector is investing significant resources into R & D and demonstration activities. These include investment in research, demonstration and deployment of technologies that will reduce greenhouse gas emissions from minerals companies' operations and those of our customers. One of the important areas of research relates to Carbon Capture and Storage – the process by which CO2 from combustion or other gases is removed (captured) and then stored long-term in geological structures. This technology offers important possibilities for making the further use of fossil fuels more compatible with climate change mitigation policies.

[1] It is estimated that greenhouse gas emissions directly related to the Australian minerals industry in 2004 (the latest available information) represented about 8.2 per cent of Australia's total greenhouse emissions. The industry has an exposure to a further 10 per cent of emissions indirectly through purchased electricity and is a major exporter of coal.

3. KEY ISSUES

3.1 GENERAL

Much of the public debate over Australia's response to climate change centres on how to encourage the deployment of low emissions technologies including both renewables and CCS. This debate tends to be a binary one between those who favour market based approaches and those who advocate policy and regulatory approaches, including the provision of public subsidies for various forms of technology deployment.

As set out in the COAL21 Action Plan and MCA's latest annual report, we contend that, in the case of CCS technologies associated with large scale stationary energy production, there is a critical intermediate step – an RD&D phase – that must be vigorously pursued before mechanisms to encourage commercial deployment of these technologies can be sensibly considered. While not the only factor in determining the duration of this phase, the time it takes will depend to a large extent on the level of effort and resources devoted to the RD&D challenge over the next few years.

The RD&D phase is critical. While the various individual components of CCS – capture, compression, transport and storage – are already proven in various industrial applications, there are significant technological challenges to be overcome in integrating these into a CCS system at power station scale. Some of these challenges include:

1. Determining the most efficient and cost effective capture technology options for different power station configurations (i.e. sub-critical, supercritical and ultra-supercritical pulverised fuel plants and gasification plants), and different operating environments (including coal types).
2. Ensuring that injection and storage can be carried out successfully and economically in a wide range of geological environments associated with the location of Australia's major point-source emissions.
3. Discovering true "at scale" individual component and system costs and significantly reducing these over time.
4. Achieving public acceptance of new technologies, in particular on-shore CO_2 storage.

These challenges must be overcome through R&D and replicated large-scale demonstrations before wide-scale commercial deployment will occur. It is important to note that, until this is the case, it will not be possible to access commercial finance on normal terms for large-scale power projects incorporating CCS due to perceptions of technology risk. This is the case for all new technologies, not just CCS.

As a major coal and gas using and exporting country, Australia has a lot at stake if CCS is not pursued, including the stranding of most of our current electricity generation assets and our largest and most important fossil energy resources. However Australia is also in an excellent position to make a major contribution to the growing global RD&D effort around CCS. We have world-leading expertise in the areas of coal, oil and gas production and use; and related research.

Our interest lies in harnessing this expertise, in collaboration with researchers around the world, to accelerate the emergence of CCS as a viable option in the effort to reduce emissions to the atmosphere.

There is a finite amount of national wealth that the Australian community will be willing to invest in responding to climate change over the next few years. Given that Australia accounts for less than 1.4 per cent of total global emissions, it is very likely that the proportion of that finite investment allocated to RD&D - developing new technologies in both the renewable and fossil fuel areas - will eventually prove to be by far the most cost-effective and significant contribution Australia makes to solving the global problem.

In this context the ACA and MCA contend that the premature introduction of a carbon price signal in the Australian stationary energy sector risks the perverse outcome of driving private sector investment away from vital RD&D towards "quick fix" responses designed purely to minimise the impact of the

carbon price impost. There is emerging evidence from the European Emissions Trading Scheme that the price signal in that market has not stimulated RD&D aimed at developing longer term solutions that are not yet commercially viable.[2]

The premature introduction of a market-based signal in Australia would also risk all levels of government abandoning their commitment to supporting RD&D on the basis that "the market will sort it out". This could effectively end Australia's involvement in developing "breakthrough" technologies for both the fossil fuels and renewables. It has the potential to severely limit the available energy sources and technology options and have a flow on effect to energy security and electricity prices.

During the next few years, a range of innovative policy measures will be needed to support R&D and large scale demonstrations of key technologies for power generation and for the first-of-a-kind commercial deployments associated with natural gas and coal syngas processing. A range of incentives may be required to address the first-of-a-kind deployment challenges which have to be overcome to enable early commercial scale deployment of low emission technologies. Such incentives should recognise the general public good benefits flowing from the early deployment and be designed to avoid placing a disproportionate cost burden on particular sub-sets of the economy, including electricity consumers.

3.2 THE SCIENCE UNDERPINNING GEOSEQUESTRATION TECHNOLOGY

Carbon capture and storage systems are one element of a broader global portfolio of low emission technologies that will be required to manage greenhouse gas emissions and address climate change.

The component technologies that underpin CCS, encompassing capture, transport and deep underground storage of carbon dioxide are well understood and in some cases are already in commercial use in different industrial applications. The ***integration*** of these various technologies into a single end to end power generation + CCS system is less developed in and requires repeated "at scale" demonstration to prove technical viability and reduce costs.

There are already many Enhanced Oil Recovery Projects around the world where CO_2 is being routinely injected underground to improve oil recovery in depleting fields. There are also a number of advanced CO_2 storage demonstration projects associated with natural gas and coal syngas processing (e.g. Sleipner, In Salah, and Dakota-Weyburn) that have been undertaken to demonstrate CO_2 storage under different conditions.

Australia has near-term potential for the commercial scale deployment of CCS associated with natural gas, coal seam methane and coal syngas processing (associated with coal-to-liquids). Substantial improvement and cost reductions to the capture systems applicable to power generation will be necessary for general and widespread deployment of CCS.

Australia appears to have significant geological storage capacity (estimated at approximately 700 Gt CO_2) to potentially accommodate large scale CCS projects. This capacity could theoretically store current Australian total greenhouse gas emissions for more than 1000 years. There is however still a need for additional geological assessment programs to define the best and most cost efficient storage sites in some areas of eastern Australia.

The IPCC Special Report found that for large scale operational CO_2 storage projects – (assuming that sites are well selected, designed, operated and appropriately monitored); the balance of available evidence suggests that it is likely the fraction of stored CO_2 retained would be more than 99 per cent over the first thousand years.

[2] *EU Emissions Trading Scheme: Taking Stock and Looking Ahead*" report by the European Climate Platform (July 2006).

3.3 THE POTENTIAL ENVIRONMENTAL AND ECONOMIC BENEFITS AND RISKS OF SUCH TECHNOLOGY

3.3.1 Environmental benefits and risks

Large scale CCS systems are the only available means of significantly reducing greenhouse gas emissions from fossil fuel based power generation in Australia and elsewhere.

CCS may deliver multiple environmental benefits given that other types of pollutants often associated with coal-based energy systems (e.g. SOx, NOx and particulates) are virtually eliminated through coal gasification and when applying alternative post combustion capture technologies.

Potential environmental risks of CCS are mostly associated with the transport and storage aspects. However transport of CO_2 in pipelines is already routinely practised (e.g. for EOR operations there are some thousands of kilometres of pipelines in the US) and the potential for leakage from well-characterized CO_2 storage sites is considered minimal. Any leakage that did occur would likely take place over thousands of years and involve only a small proportion of the CO_2 originally injected.

Potential environmental risks can be managed through robust monitoring and verification protocols modelled on existing safeguards for other industrial operations.

3.3.2 Economic benefits and risks

The major economic benefit of CCS is that it potentially enables continued exploitation of Australia's abundant fossil energy resources in the face of carbon emissions constraints. This is particularly so in relation to coal, although it should be stressed that CCS will also need to be applied to natural gas-fired power generation and natural gas processing, if greenhouse abatement targets being suggested by the IPCC are to be met. It can with time also potentially be applicable to heavy industry (eg smelting, refining, foundry and forging emissions). The domestic and also global economic implications of any abrupt curtailment of the use of fossil energy without viable alternative energy sources would be economically and socially catastrophic.

CCS technology can be adapted and integrated with existing power generation assets and energy infrastructure (eg. pipelines, injection wells).

CCS may be achieved through post combustion capture as a retrofit option for existing coal fired power generation assets. Without a viable alternative like CCS there is potential for existing assets to be stranded and this could pose significant energy security risk and impose very large replacement costs.

Introduction of any new advanced energy technologies will lead to an increase in electricity cost of production. However with RD&D and eventual large scale deployment that cost will decline over time as the technology matures. It is likely that demand for large scale CCS systems will lead to the emergence of a CCS service sector for each stage of the CCS process. This will create new industries with significant employment and export potential.

3.4 THE SKILL BASE IN AUSTRALIA TO ADVANCE THE SCIENCE OF GEOSEQUESTRATION TECHNOLOGY

Australia has a concentrated but well established scientific capability in the area of CCS, and is recognized as a world leader in some aspects (e.g. geological characterization).

The skills employed in the oil, gas, coal and electricity industry are compatible with those needed for CCS – particularly those associated with the injection / storage process. There are some emerging areas of critical skills shortage however, particularly for petroleum geoscientists who are essential for geological storage mapping and characterization. There is a need to support development of broader skill base for CCS activities and consider the role of government in assisting to address shortages in the skill base for geosequestration as well as the impact of higher costs for drilling and construction activity for pilot plant. These costs have risen substantially over the past 18 months.

3.5 REGULATORY AND APPROVAL ISSUES GOVERNING GEOSEQUESTRATION TECHNOLOGY AND TRIALS

All low emission technologies for power generation (those capable of achieving <150kgCO_2/MWh) are non-commercial in the current policy context.

Government has made a positive step towards developing a suitable regulatory framework for CCS through the *Carbon Dioxide Capture and Geological Storage Australian Regulatory Guiding Principles* that were endorsed in 2005 by the Ministerial Council on Mineral and Petroleum Resources (MCMPR). These Principles were developed in association with the ACA, MCA and other stakeholders to facilitate a nationally consistent approach to the application of Carbon Dioxide Capture and Geological Storage and are reproduced at **Attachment A** of this document.

Integration of these principles into a flexible but nationally consistent legal and regulatory framework for CCS activities both onshore and offshore in Australia is needed and should recognise:

a) The distinction between pilot, demonstration and commercial scale CCS projects

b) National interest aspect of CCS projects

c) The variability of CCS projects – (one size does not fit all in a regulatory sense, therefore any regulatory regime for CCS needs to be flexible enough to adapt with each project and not act as a deterrent to investment in a project.)

d) The desirability of a nationally consistent approach (regulatory frameworks for both onshore and offshore CCS projects would provide certainty and transparency for project proponents and contain appropriate safeguards for the broader community with respect to the environment, health and safety).

To encourage consistency in regulations and limit duplication between jurisdictions, the following should be considered:

- an ongoing process of reviewing legislation (proposed and existing) and reinvigoration of COAG's role in this area;
- a regulatory approach which adopts the concept of "minimum effective regulation";
- minimisation of all regulatory costs, such as compliance and adverse side-effects; and
- adoption of the best regulatory approach available to address a defined problem (including an assessment being undertaken of whether self-regulation or no regulation may be more appropriate public policy choices).

3.6 HOW BEST TO POSITION AUSTRALIAN INDUSTRY TO CAPTURE POSSIBLE MARKET APPLICATIONS

Ongoing investment in RD&D and related expertise from both government and industry is needed to not only accelerate the deployment of these technologies but also to position Australia to bundle this expertise with energy exports increasing our overall international competitiveness.

Australian industry involvement in each phase of RD&D for CCS and ongoing involvement in multilateral fora such as the Asia Pacific Partnership for Clean Development and Climate and Carbon Sequestration Leadership Forum will be needed to best position Australia to capture possible market opportunities.

4. FURTHER BACKGROUND

4.1 CCS TECHNOLOGY STATUS

The following Table from the *International Panel on Climate Change, Special Report on Carbon Dioxide Capture and Storage* attempts to summarise the state of technological development of CCS system components. The X's indicate the highest level of maturity for each component.

CCS Component	***CCS Technology***	***Research phase***	***Demonstration phase***	***Economically feasible Under specific conditions***	***Mature market***
Capture	Post combustion			**X**	
	Pre combustion			**X**	
	Oxyfuel combustion		**X**		
	Industrial separation (natural gas processing, ammonia production)				**X**
Transportation	Pipeline				**X**
	Shipping			**X**	
Geological storage	Enhanced Oil Recovery (EOR)				**X**[a]
	Gas or oil fields			**X**	
	Saline formations			**X**	
	Enhanced Coal Bed Methane recovery (ECBM)		**X**		
Ocean storage	Direct injection (dissolution type)	**X**			
	Direct injection (lake type)	**X**			
Mineral carbonation	Natural silicate minerals	**X**			
	Waste materials		**X**		
Industrial uses of CO_2					**X**

Source: *International Panel on Climate Change,* ***Special Report on Carbon Dioxide Capture and Storage, Summary for Policymakers****, as approved by the 8th Session of IPCC Working Group III, 25 September 2005*

Note: *(a) CO_2 injection for EOR is a mature market technology, but when used for CO_2 storage, it is only "economically feasible under specific conditions".*

There are three key elements involved in the CCS process for power generation:

(a) Capture: A number of CO_2 capture systems are available [3]: post-combustion, pre-combustion and oxyfuel combustion. Factors that impact the selection of the capture system include the percentage concentration of CO_2 in the gas stream, its pressure and whether the fuel type is gaseous or solid:

- **post-combustion capture** of CO_2 in power plants involves the capture of CO_2 from the flue gases of conventional power plants using chemical capture processes. The natural gas processing industry already separates CO_2 using similar technology;
- **pre-combustion capture** through gasification is existing technology being adapted for power generation. Although the initial fuel conversion steps of pre-combustion are more elaborate and costly, the higher concentration of CO_2 in the gas stream together with the higher pressure make the separation more straightforward; and

[3] *Thambimuthu, K, 2002, Zeroing emissions with CO2 capture and storage, paper presentation at the Eighth Conference of the Parties to the Untied Nations Framework Convention on Climate Change.*

- **oxyfuel combustion** is in the demonstration phase and uses high purity oxygen for the combustion process. This results in high CO_2 concentrations (i.e. lower nitrogen) in the gas stream, and hence in lower cost capture of CO_2.

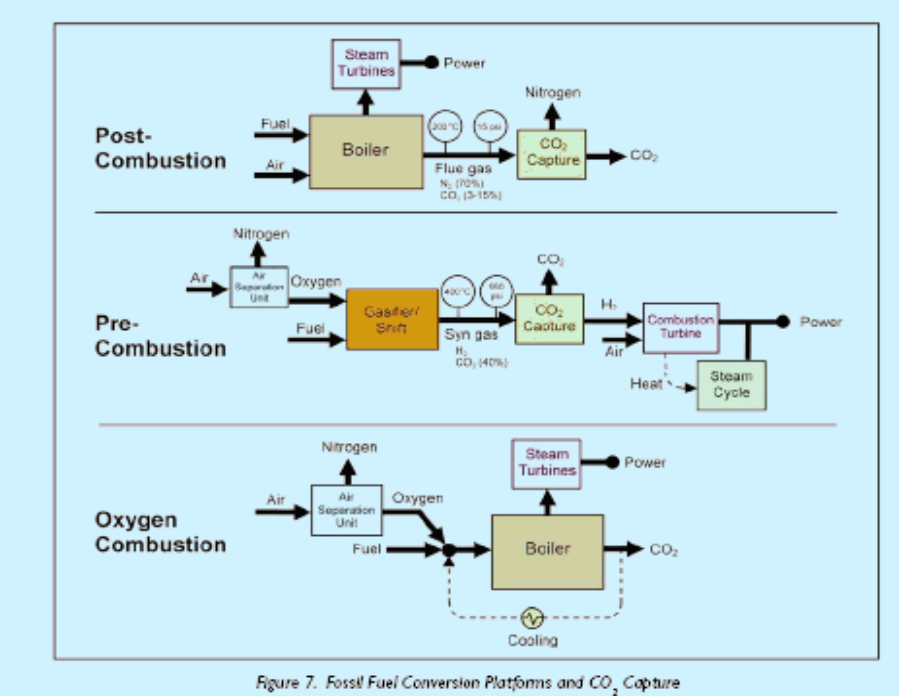
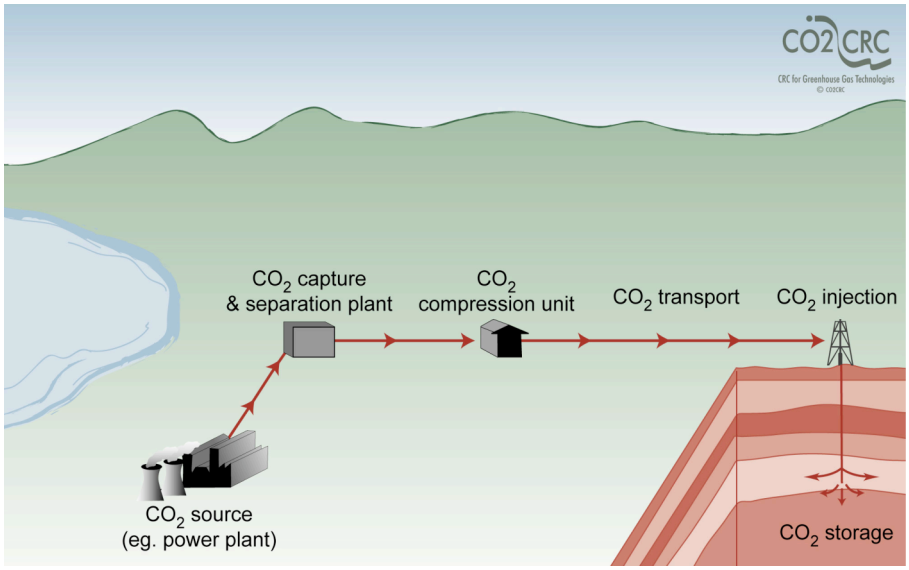


Figure 7. Fossil Fuel Conversion Platforms and CO_2 Capture

(b) Transport: The transport of CO_2 by pipeline under high-pressure has many similarities to the transport of chemical and petroleum products by pipeline. The CO_2 first needs some pre-treatment such as desulphurisation, dehydration and compression. The compression may involve some technical problems to be overcome but these are not insoluble.

(c) Injection and storage: Injection and storage of CO_2 in deep, onshore or offshore, geological formations or reservoirs uses many of the technologies that have been developed by the oil and gas sector. Such technologies have been demonstrated and applied technically and economically under specific conditions for oil and gas fields and saline formations.

The diagram below illustrates a conceptual integrated CCS system.



CCS conceptual diagram courtesy of CO2CRC

There are significant opportunities to capture CO_2 from existing industrial processes, for example the natural gas industry generates a CO_2 stream capable of capture – as natural gas is extracted from the ground it is routinely stripped of CO_2 before shipment by pipeline or tanker. Likewise gas to liquid and coal to liquid technologies are capable of producing a concentrated stream of CO_2 capable of capture and storage.

While some components of a CCS system employ mature technologies, there are other less mature components, for example large scale CO_2 capture from power generation. The integration of these various technologies into a single end to end power generation +CCS system is less developed and requires repeated "at scale" demonstration to prove viability and discover actual costs.

4.2 POLICY AND REGULATORY FRAMEWORKS

Large scale demonstration and deployment of CCS systems in Australia will require a regulatory framework that delivers ***certainty***, ***equity*** and as our knowledge base on CCS evolves – ***flexibility***. This highlights the need for effective communication between policymakers, industry proponents and researchers in relation to the political timeframes, nature of "breakthrough" technology, and drivers for commercial deployment.

Most activity on CCS regulation in Australia has focused on adapting existing resources legislation to incorporate CCS activities. This approach has both merits and challenges.

Very few countries, including Australia have gone beyond broad regulatory principles to develop a stand alone legal or regulatory framework for long term CO_2 storage. The issue is further complicated in Australia by cross jurisdictional issues where CO_2 capture occurs onshore but storage may occur offshore in Commonwealth waters and vice versa (eg Barrow Island).

Any regulatory regime for CCS will need to acknowledge the national interest aspects of CCS activities, provide industry with investment certainty, but maintain flexibility over the operational life of a project.

While the current range of low emission technology programs will assist some projects and deliver some progress, most of this is still focused on proof of concept and demonstration of technology.

A menu of policy options that stimulate large scale demonstration and deployment projects as well as the larger commercial scale projects will be needed.

4.2 CHALLENGES FOR DEPLOYMENT

4.2.1 Timing

Timing is a critical factor in delivering clean coal technologies through to the market place. The Australian Coal Association and the Minerals Council considers the introduction of an emission trading scheme in Australia is premature.

Most clean coal technologies for power generation are still at the pilot and demonstration phase of development and will require significant ongoing development and demonstration before they can be deployed on a large commercial scale. The European experience suggests that an emission trading scheme is not conducive to stimulating large scale investment in the deployment of clean coal technologies. Further work on large scale demonstration projects will provide industry and government with a greater level of confidence on both technology and cost. There needs to be an appreciation of the large scale, long timeframes and major investment required for some of these technologies

4.2.2 Cost

The costs of a fully integrated power generation + CCS system is dependant on a number of factors and will vary depending on type of power generation, concentration of CO_2 stream, capture technology, distance to selected storage site, the characteristics of the storage site, injection profile, the amount of carbon dioxide to be stored and other considerations (particularly insurance and post closure monitoring and verification). For natural gas and coal syngas processing (in association with Coal-to-Liquids), the high front-end capture cost is largely eliminated, and costs will depend on mainly on the location and cost characteristics of the storage site.

Estimated costs in current literature tend to vary significantly and include ranges of costs that are so broad that they are inconclusive. This highlights the urgent need to proceed with major real world demonstration projects in order to discover true costs and identify cost reduction opportunities.

For integrated power generation + CCS systems the cost of capture and compression is likely to be the largest cost component (provided that the storage site has reasonable injectivity) – as further development and demonstration projects are conducted and the scale increases it is expected that the relative costs will decline as the technology matures.

4.2.3 Community perceptions

A global convergence of public interest in energy security, climate change and rising energy prices has resulted in growing interest in low emission technologies and climate change as a global problem requiring a global solution. Addressing community perceptions of CCS and effective community engagement will be an important part of broader CCS acceptance

The Queensland Centre for Low Emission Technology recently completed a stakeholder study on perspectives regarding low emission technologies in Queensland. While this work is only preliminary and the first of a series of similar studies across Australia, initial findings in relation to CCS indicate that a majority of the general community have little awareness or understanding of CCS. When asked what they understood by the term carbon capture and storage, 70 per cent of respondents admitted that they did not know the answer to the question.

The main aims of the research are to:

- establish a baseline of attitudes to low emission technologies;
- understand the issues and concerns associated with clean coal in more depth;
- inform the decision making processes;
- provide an opportunity for the social shaping of low emission technologies;
- engage with environmental organisations and influential stakeholders.

There are only a small number of studies, worldwide, to date that measure public perceptions of carbon capture and storage (CCS) with the majority using large scale surveys for their methodology. The resounding finding, of all of these studies, confirms the limited knowledge the public holds about the technology. There is clearly a need for increased education and dialogues around CCS to ensure the public is well informed about its risks and benefits.

The early demonstrations of CCS technology will be the first critical test of public opinion regarding low emission technologies. Transparency about CCS projects and possible impacts on the environment and community will be critical in avoiding the “not-in-my-backyard” or NIMBY sentiment.

5. USEFUL LINKS

We would like to draw the Committee's attention to following reports and website links which provide important information on the global development of carbon capture and storage technology.

International

- **United Nations Framework Convention on Climate Change**
  http://unfccc.int/methods_and_science/items/2722.php
- **Intergovernmental Panel on Climate Change**
  "2005 Special Report on Carbon Dioxide Capture and Storage"
  http://www.ipcc.ch/
- **Carbon Sequestration Leadership Forum**
  http://www.cslforum.org/
- **IEA Greenhouse Gas R&D Programme**
  http://www.ieagreen.org.uk
- **IEA Clean Coal Centre**
  http://www.iea-coal.org.uk/site/ieaccc/home
- **Global Energy Technology Strategy Program**
  Carbon Dioxide Capture and Geologic Storage: A core element of a Global Energy Technology Strategy to address climate change. (April 2006)
  http://www.globalchange.umd.edu/pub_db/files/ccs_report.pdf
- **World Energy Council**
  "Carbon Capture and Storage: A WEC Interim Balance" [DRAFT ONLY!]
  http://www.worldenergy.org/wec-geis/global/downloads/ccs/CCSBrochure.pdf#search=%22carbon%20capture%20and%20storage%3A%20a%20WEC%20interim%20balance%22
- **US Department of Energy – Office of Fossil Energy & National Energy Technology Laboratory**
  "Carbon Sequestration Technology Roadmap and Program Plan 2006"
  http://www.fossil.energy.gov/programs/sequestration/publications/programplans/2006/2006_sequestration_roadmap.pdf
  "Carbon Sequestration Project Portfolio"
  http://www.fossil.energy.gov/programs/sequestration/publications/programplans/2006/project_portfolio_sequestration_06.pdf

Australia

- **Ministerial Council on Petroleum Resources : CCS Australian Regulatory Guiding Principles**
  http://www.industry.gov.au/content/sitemap.cfm?objectID=643977B1-B0D0-D18A-17D8C5AD1A31B179
- **Cooperative Research Centre on Greenhouse Gas Technologies (CO2CRC)**
  http://www.co2crc.com.au/
- **Queensland Centre for Low Emission Technology**
  http://www.clet.net/
- **Australian Coal Association**
  http://www.australiancoal.com.au/ and http://www.coal21.com.au/
- **CRC for Coal in Sustainable Development**
  http://www.ccsd.biz/

ATTACHMENT A: MINISTERIAL COUNCIL ON MINERAL AND PETROLEUM RESOURCES (MCMPR): CCS REGULATORY GUIDING PRINCIPLES

The following guiding principles facilitate a nationally consistent approach to the application of Carbon Dioxide Capture and Geological Storage (CCS). These guiding principles should take account of Council of Australian Governments (COAG) agreed principles relating to Ecologically Sustainable Development, the Intergovernmental Agreement on the Environment, Principles of Good Regulation and relevant COAG agreed Occupational Health and Safety Principles.

Assessment And Approvals Process

> Assessment and approvals processes should be consistent with agreed national protocols and guidelines.
> Existing legislation and regulations relating to CCS should be identified and modified and augmented where necessary.

Access And Property Rights

> Surface and subsurface rights for CCS should provide certainty to rights - holders of their entitlements and obligations.
> These rights should be based on established legislative and regulatory arrangements, custom and practice and accommodate the likely evolution of multi-user CCS infrastructure and facilities.
> In granting rights to inject the CCS stream into subsurface formations, governments should give due consideration to land use planning issues that may arise as a consequence.

Transportation Issues

> Regulation relating to the transport of a CCS stream should be consistent where possible, using agreed national protocols and guidelines.

Monitoring and Verification

> Regulation should provide for appropriate monitoring and verification requirements enabling the generation of clear, comprehensive, timely, accurate and publicly accessible information that can be used to effectively and responsibly manage environmental, health, safety and economic risks.
> Regulation should provide a framework to establish, to an appropriate level of accuracy the quantity, composition and location of gas captured, transported, injected and stored and the net abatement of emissions. This should include identification and accounting of leakage.

Liability and Post-Closure Responsibilities

> Current regulatory principles and common law should continue to apply to liability issues for all stages of CCS projects.
> Governments' overall consideration of post-closure storage of CCS streams must aim to minimise exposure to health, environmental and financial risks for project operators, governments and future generations.

Financial Issues

> For all stages of a CCS project, wherever practical, established legislative, regulatory and accounting processes should be used in preference to introducing new regulations.
> The income from, capital and operating costs associated with a CCS project should be treated in the same way as for any other business venture for taxation purposes.
> Regulation should recognise the potential for post-closure liabilities for CCS activities and consider appropriate financial instruments to assist in the management of such risk.