HOUSE OF REPRESENTATIVES INQUIRY INTO GEOSEQUESTRATION TECHNOLOGY

Responses to questions for Department of Industry, Tourism and Resources

1. If clean coal technology is going to be part of the GHG emission abatement program in the years to come then why is it taking so long to get clean coal projects up and running? As a first step should every new coal power plant constructed from today be "capture-ready"?

Significant progress is being made in bringing forward projects to demonstrate the application of carbon capture and storage to coal power generation. There are a number of Australian projects that support the development and demonstration of clean coal technologies using carbon capture and storage technology:

- The HRL 400 MW Integrated Drying Gasification Combined Cycle (IDGCC) Power Station in Victoria will be carbon capture and storage ready.

- There are various trials and demonstrations of post combustion capture technology including the Fairview coal seam gas project in Queensland (which will also demonstrate the storage of CO_2 to enhance coal seam gas recovery), the retrofit of lignite drying technology to the Hazelwood power station in Victoria (which will use the captured CO_2 to trial a mineralisation process for storing CO_2), and CSIRO trials of post combustion capture at existing coal power stations in New South Wales and Queensland.

- A world first retrofit of oxy-fuel technology to an existing power station at CS Energy's Callide A power station in Queensland.

- The proposed ZeroGen project in Queensland will demonstrate the integration of black coal gasification with carbon capture and storage. The CO_2 storage aspects of this project will demonstrate the feasibility of transporting CO_2 over large distances.

- The deep underground storage of CO_2 will be trialled at the Otway pilot CO_2 storage project in Victoria and full scale storage of CO_2 is part of the proposed Gorgon LNG project in Western Australia.

Post combustion capture and oxyfuel technology can both be retrofitted to existing coal fired power stations to capture and store carbon dioxide. Demonstration and trial projects support the application of these technologies to older conventional power stations. These technologies are expected to be even better suited to new advanced super critical plants currently being built on a commercial basis in Australia.

It is important to note, however, that capture ready will only be an effective response where there is access to viable geological storage potential with a sufficient capacity to match the supply from local sources of CO_2 emissions.

2. Why have no LETDF funding proposals been approved for clean coal initiatives in relation to existing coal-fired power stations? Monies allocated to date

have gone to new projects (ZeroGen (IGCC), Gorgon (Natural Gas), Monash (Coal to liquids)) but nothing seems to be happening with respect to existing coal-fired power generation plants. This seems to be the same scenario worldwide?

A major focus of the clean coal technology work being done in Australia is the development of technology that can be retrofitted to existing power stations. A LETDF grant of $50m has been offered to International Power for the Hazelwood 2030 project and a $50m grant has been offered to CS Energy for the retrofit of existing coal fired power plant. A LETDF grant has not been offered to the Stanwell ZeroGen project or the Monash Energy project.

Also the application of Post Combustion Capture technology to existing coal power stations in Australia is being trialled by CSIRO under the Asia Pacific Partnership on Clean Development and Climate (AP6). This work will support cooperative exchanges in other AP6 countries, particularly in China and India where there is the potential to use international carbon financing to support the application of emission abatement technology to existing plants.

3. What would it take in Australia to get a full-scale commercial project up and running and enable the operators to realise a reasonable rate of return on their investment?

A commercial CCS project would require R&D to have progressed past the demonstration phase and for the technology to be commercially accepted. From a storage perspective, a project would first require land rights tenure for storage permits to be in place (this is already happening) and for the area to be proven geologically and geophysically by drilling wells, acquiring seismic data and undertaking associated detailed technical studies.

Such opportunities are being pursued with the Gorgon Project where the CO_2 from the natural gas stream is proposed to be separated and geologically stored at Barrow Island. Other similar natural gas operations are under consideration in the high CO_2 natural gas provinces along the North West Shelf of Australia. Nearly 50% of Australia's booked reserves of hydrocarbons (on an oil equivalent basis) are associated with high CO_2 content, and thus research into geological storage of CO_2 in these provinces has been strategically targeted by Geoscience Australia since 1999, and has assisted companies that are operating in these areas with their geological storage assessments. Similar detailed geological studies are required in other parts of Australia where emissions from onshore coal operations are likely to occur.

A range of policy instruments has been applied to projects overseas. For example, the commercial capture and geological storage of CO_2 contained in natural gas from the Sleipner gas field in Norway has been in response to EU regulations limiting the CO_2 content of pipeline natural gas and the Norwegian government applying a CO_2 emissions tax. In the United States, the *Energy Policy Act* of 2005 has initiated a wide range of actions, including a loan guarantee program for bringing new clean energy technologies to market and the authorisation of tax credits and incentives to spur investment in advanced clean coal facilities and advanced gasification projects.

4. In particular, what would it take to get a full scale project up and running that involves the burning of coal for the production of electricity? Most projects, even worldwide, involve natural gas, not coal!

A number of requirements would need to be met to get a full scale coal-based project up and running. Further research, development and demonstration are required to verify that relevant technologies can work on a commercial scale and for them to be accepted. Regulatory arrangements need to be finalised (this is being pursued by the Australian Government in conjunction with the States and Territories) and land right tenure for storage permits would need to be secured. The allocation of storage permits requires any proposed site to be proven up geologically and geophysically. Such geological storage assessments will require initial regional studies, followed by detailed assessments at a more local and prospect (site specific) level.

Most of the costs of coal carbon capture and storage projects are incurred in capturing and separating out the CO_2 rather than in transportation and storage. In contrast, for most of the natural gas carbon capture and storage projects worldwide the separation of CO_2 from natural gas is a standard part of the process and is not an additional cost as the CO_2 needs to be separated prior to treatment and/or delivery to the customer. The impact of government incentives, regulatory arrangements and greenhouse penalties will initially encourage lower cost abatement options such as natural gas carbon capture and storage ahead of higher cost abatement options.

Where there is a commercial value on CO_2, such as for enhanced oil recovery, there is growing international interest in capturing CO_2 from coal power stations. For instance, the SaskPower Clean Coal Power Project in Canada proposes to sell CO_2 captured from a new 300MW oxyfuel coal power station to support enhanced oil recovery. Non-discriminatory greenhouse abatement programs will normally support lower cost abatement options first, but schemes that put a market value on CO_2 may provide an additional inducement for coal power projects.

5. In the absence of a carbon trading system or a carbon tax, could it be done by averaging the additional cost of "clean" electricity produced across all forms of electricity? Everyone pays a little extra for cleaner energy.

The Australian Government's Mandatory Renewable Energy Target (MRET) scheme, which commenced in April 2001, requires the sourcing of 9,500 gigawatt hours of extra renewable electricity per year by 2010. MRET places a liability on wholesale purchasers of electricity to proportionately contribute towards the generation of the additional renewable energy. The target applies nationally, and is implemented through the *Renewable Energy (Electricity) Act 2000.* In Queensland, electricity retailers and other liable parties are required to source at least 13% of their electricity from gas-fired generation**.** In both these examples, consumers have paid the higher costs of gas and renewable energy.

6. If the government has a long term commitment to either stabilising or reducing CO_2 emissions what would be the estimated $ value (upfront and ongoing) for government to encourage industry to invest in this technology in the absence of a carbon trading policy?

There are inherent uncertainties in predicting a value for the uptake or deployment of a new technology. Costs would depend on how they were defined and what was included (direct and indirect), the development and uptake of the technology over time, as well as prevailing market conditions.

The Australian Bureau of Agricultural and Resource Economics (ABARE) has indicated that if a market based policy such as a carbon tax were implemented, industry would invest in the CCS technology up to a level where, in net present value terms, the total costs of the technology was equal to the total tax avoided. ABARE's view is that CCS investment would be unlikely if the tax were not sufficiently high to warrant investment in CCS technology.

If a non-market policy such as industry emissions standards were implemented, ABARE has indicated industry would invest in the CCS technology up to a level where, in net present value terms, total investment was equal to the amount of penalty for non-compliance.

In the United States, the *Energy Policy Act* of 2005 authorised US$1.65 billion in tax credits for clean coal projects. In November 2006 nearly US$1 billion of tax credits were allocated to nine projects. The other US$650 million will be allocated in 2007.

The Australian Government's immediate policy objective is to achieve its Kyoto Protocol target of limiting emissions to 108% of 1990 levels in the period from 2008 to 2012. The most recent estimates indicate that Australia is broadly on track to meet this target.

Australia's progress in reducing greenhouse gas emissions is the result of a range of Government programmes that provide a comprehensive strategy for meeting Australia's climate change objectives. The Australian Government's total commitment to addressing climate change is now more than $2 billion. Key measures include:

. the $500 million Low Emissions Technology Demonstration Fund (LETDF)

. action on energy efficiency to increase the uptake of opportunities that will reduce greenhouse gas emissions, reduce energy demand and improve Australia's competitiveness

. further investment in renewable energy including a $75 million Solar Cities Trial and a $100 million Renewable Energy Development Initiative.

The Australian Government is also working with business, local government, communities and individual households to implement practical actions to reduce their emissions.

The LETDF, for example, is playing a key role in enabling Australia to reduce the cost of meeting any future greenhouse emission constraints. By facilitating excellence in the demonstration and domestic application of low emissions technologies (including CCS), Australia is also creating opportunities to export these technologies and associated intellectual property, expertise and skills.

The programme is providing industry with a means to invest in a low emissions future by exploiting commercial opportunities while simultaneously helping to improve the capacity of low emissions energy technologies to lower Australia's greenhouse gas emissions. These opportunities include improving technology economies of scale by building more high capacity generation systems, improving the reliability of technology manufacture and installation through better integration of system components and making these systems more cost-effective to construct, install and operate. The Australian Government is also committing significant expenditure for research, development and demonstration of low emissions technologies, including CCS.

7. If full-scale commercialisation was to get underway today, what sort of lead times would be involved?

Full scale commercialisation already exists in some parts of the world for high CO_2 natural gas and enhanced oil recovery (EOR) operations, and similar high CO_2 natural gas operations are well advanced in planning in Australia at sites along the North West Shelf. For EOR operations to begin in Australia, large reliable pure sources of CO_2 would first be required in proximity to near depleted suitable oil fields, or the promise of ship transport of CO_2 would need to be realised.

The lead times for full scale commercialisation of carbon capture and storage technologies from a coal fired power station need to take into account the requirement to first demonstrate these technologies in a commercial operating environment. The low emission technology demonstration projects currently being formulated may become operational over the next 2 to 3 years and may need to run for at least 3 years to build up the necessary operational expertise. Feasibility studies and advance engineering and design work could take another two to three years so the earliest commitment to construct a new full scale commercial coal carbon capture and storage plant is not expected to be made until 2015. Realistically, the first full scale coal carbon capture and storage plants are expected to become operational between 2015 and 2020. These and subsequent plants are expected to make a major contribution to reducing Australia's greenhouse gas emissions in the period between 2020 and 2030.

However, we are currently seeing examples overseas where industry is considering investments in full scale commercial plants, including a new full scale oxyfuel combustion coal plant (SaskPower in Canada) and several coal gasification plants that will be carbon capture and storage ready. The adoption of carbon capture and storage at these plants could occur before 2015 in response to greenhouse abatement requirements and the development of geological carbon storage sites for CO_2. Similarly, there is the potential to compress the lead times associated with retrofitting carbon capture and storage to existing coal power stations in Australia, especially where there is access to storage sites developed for gas projects or coal to liquid fuel plants.

8. You said in evidence before the committee (transcript p.8) that one of the criteria for LETDF was that technologies funded under this scheme had to demonstrate significant emissions reductions in the period 2020 to 2030 but other technologies could possibly come on stream earlier than this. Doesn't this

demonstrate that putting this time frame on projects there is an expectation that nothing of significance will happen until the later half of the 21st century?

The 2020 to 2030 timeframe does not apply to the demonstration projects, but rather the wide scale deployment of the technologies they are demonstrating (at a realistic uptake rate), with substantial abatement outcomes expected in the period between 2020 and 2030. These criteria require demonstration projects to be completed prior to this period, to provide for the subsequent commercial deployment and large scale emission reductions. The first round demonstration projects could be commissioned before 2010. The suggested timeframes provide common performance metrics against which applicants claim their technology commercialisation pathways and consequent emission reductions.

9. How long before we could realistically achieve measurable CO_2 reductions as a result of CCS commercial uptake by industry?

As soon as the first projects such as Gorgon, Browse Basin and Monash commence (within the next 5 to 10 years).

10. If the government is not in the business of subsidising industry in order to get CCS fully operational within the fossil fuel generating sector what other measures can be put in place to achieve the same outcome?

In addition to providing financial support to help cover the non-commercial costs of low emissions technology, there are a number of policy options which could be considered by government including regulatory arrangements such as mandatory limits and associated penalties, carbon pricing and emissions trading. Governments may also introduce grants and incentives for research and development including the establishment of demonstration projects.

11. If no decision is made in the short term with respect to a carbon trading scheme there will come a point where decisions have to be made regarding replacement and construction of new power stations in order to meet the projected growing demand for electricity. The type of new power plant will therefore likely to be influenced by "what if" scenarios and this may bias decisions towards CCGT plants simply because they will be less costly to retrofit pre-combustion capture technology if and when a carbon trading scheme is given the green light. If coal is to be kept in the mix over the medium to long run what steps will the government need to take to ensure the most appropriate long-term investment decisions are taken?

The Government is supporting research and development on a whole range of low emission technologies. The approach is focussed on ensuring the availability of 'ready' technologies that achieve least cost solutions while maintaining the secure and reliable supply of competitively priced energy. Australia's demand for energy will continue to grow strongly, even when the impact of demand side management measures and improvements in energy end use efficiency are taken into account. Australia's future energy supply mix will change over time. For instance, the relative contribution of natural gas and renewable energy is expected to grow while coal's relative share in the energy mix is expected to decline. However, in order to meet the

overall increase in Australia's future energy needs, the demand for most energy sources, including coal, is expected to grow.

The support that is going into the development of clean coal technologies is aimed at improving the environmental and greenhouse performance of coal that will be needed to meet Australia's future energy needs, rather than to favour coal use over other energy sources.

12. How much money has the government spent on carbon capture and storage R & D? Is it being spread over a range of possible technologies or is it being allocated to similar technologies but under different project specific conditions?

In 2003-04 the Australian Government approved $5,800,000 to fund the CSIRO and the Cooperative Research Centre for Greenhouse Gas Technologies to undertake research on CCS. A further $7,300,000 in funding was approved for these organisations in 2004-05. This data was gathered for the Energy White Paper technology assessments report (2006) and represents funding approvals, not annual expenditure. State Governments have also provided funding for carbon capture and storage R&D.

Under the LETDF the Australian Government has provided $60 million in funding to Chevron for the development of the commercial scale Gorgon CCS demonstration project at Barrow Island in Western Australia, $50 million for CS Energy Limited's oxy-fuel retrofit demonstration (CO_2 fuel gas capture) in Central Queensland, $75 million for Fairview's demonstration project involving electricity generation from natural gas and long term underground CO_2 storage in Central Queensland and $50 million for the Hazelwood project (brown coal drying combined with post-combustion CO_2 capture and storage).

13. Is there a timetable the government has set down for the uptake of CCS or is it a case that the technology has to be fully demonstrated before any decisions are taken with regard to clean coal technology?

Technology roadmaps for carbon capture and storage and clean coal technology have been developed by the Cooperative Research Centre for Greenhouse Technologies (CO_2CRC) and as part of the COAL21 National Action Plan respectively. These roadmaps give indicative timetables for the development and deployment of clean coal technologies involving carbon capture and storage.

For instance, the COAL21 National Action Plan broadly divides actions into two phases. The first phase running through to around 2015 focuses on research, development and demonstration (RD&D) of priority technologies to the point where they are commercially deployable. This phase is also focused on ensuring there are incremental improvements in the greenhouse performance of existing plants and that any new base load coal plants developed in this period should use the most efficient technology available that is competitive in the Australian electricity market. The second or deployment phase running from around 2015 will focus on the commercial deployment of carbon capture and storage technologies for coal.

14. What will happen post 2030 if CCS is found to be too costly and questions still remain about the long-term secure storage of CO_2?

If the costs of CCS are not competitive with other greenhouse mitigation tools, it will not be taken up.

Long term secure storage of CO_2 is not a question of viability at a general level, but at a case specific level. There are many sites and operations that are likely to be viable and others that clearly will not be viable, for either technical or competing land use reasons. Thus it is a matter of identifying sites that are both technically viable and close enough to the emission locations to be commercially viable. The use of long distance pipelines to large capacity secure storage sites, assuming that there is a driver to allow their construction, would reduce the risk of security of storage, and facilitate more emission locations to be considered for capture of CO_2. Long distance large pipelines, constructed in a hub network, may also have a considerable impact on costs due to economies of scale.