17th August 2006.

Committee Secretary,
Standing Committee on Science and Innovation,
House of Representatives,
PO Box 6021,
Parliament House,
CANBERRA, ACT 2600,
AUSTRALIA.

Dear Sir/Madam,

Centre for Low Emission Technology submission to the House of Representatives Inquiry into Geosequestration Technology

The Centre for Low Emission Technology (cLET) based in Queensland wishes to make a submission to your recently announced inquiry into geosesequestration technology.

The submission we wish to make is contained in an attachment to this letter entitled ***"The role of low emission technologies with geosequestration in a future transformed energy infrastructure to mitigate global climate change"***.

An accompanying position paper recently published by cLET provides an in depth analysis of the topic covered in our current submission to your inquiry. Consequently, this paper is also included as the most relevant background reference material to our submission to your inquiry.

We believe that the cLET submission, will address the following three terms of reference of the inquiry by the House of Representatives Standing Committee on Science and Innovation;

- The potential environmental and economic benefits and risks of such technology
- The skill base in Australia to advance the science of geosequestration technology
- How to best position Australian industry to capture possible market applications

This letter and its contents will be express posted to you and has also been forwarded to via e-mail at: scin.reps@aph.gov.au

For further information on this matter please do not hesitate to contact the undersigned.

Kelly Thambimuthu

Dr. Kelly Thambimuthu,
Chief Executive Officer.

Centre for Low Emission Technology submission on

"The role of low emission technologies with geosequestration in a future transformed energy infrastructure to mitigate global climate change"

- CO_2 emissions into the atmosphere are continuing to rise and the main contributor to the rising atmospheric concentration is the use of fossil fuels.

- Human economic activity is currently 90% dependent on fossil fuels and the International Energy Agency's World Energy Outlook (IEA WEO 2004, business as usual scenario - BAU) predicts that over the next 25 years, global primary energy demand will increase by over 50%, with 83% of the increase in the future energy demand being provided by fossil fuels. Over two-thirds of this increase in energy demand is also expected to come from developing countries, particularly as these countries raise their living standards. With the increasing use of fossil fuels, CO_2 emissions into the atmosphere are expected grow by over 50% from 24 to 37 billion tonnes per year (Gt/y) in 2030.

- The corresponding data for Australia shows that by 2030, energy consumption will increase by more than 60%, with fossil fuels providing over 94% of our primary energy needs (ABARE, 2005). A significant increase in greenhouse gas emissions from this pattern of domestic energy use is also anticipated.

- A transformation away from fossil fuel use in the current global economy to prevent climate change is not an easy task. It will require many decades of concerted national and global action to implement the use of a new energy system with near zero or no carbon emissions into the atmosphere. It is a process that has yet to begin to be collectively addressed by the global community as a serious need.

- There are three recognised approaches to reduce CO_2 emissions from current and future energy use:

  a) Reducing energy use through conservation and energy efficiency measures;
  b) Deploying alternative energy technologies such as renewables and nuclear;
  c) Fuel switching to lower carbon fuels and deploying low emission fossil fuel technologies with CO_2 Capture and Storage (CCS).

- Options a) and b) above involve reducing fossil fuel consumption by reducing energy demand and by deploying renewable energy and nuclear fission technologies with low or no CO_2 emissions. Option c) enables reductions in greenhouse gas emissions to be achieved with substitution of less carbon intensive fossil fuels, or by removing between 85-95% of CO_2 emissions otherwise released into the atmosphere through the capture and underground storage *(geosequestration)* of CO_2.

- The IEA WEO 2004 has also evaluated an alternative policy scenario that examines the impact of aggressive policy measures promoting the increased use of renewable energy technologies, energy efficiency and conservation in reducing global primary energy demand. Whilst predicting a modest 10% reduction in fossil energy use and an overall reduction of 16% in global CO_2 emissions without any adverse impact on the global economy relative to the business as usual (BAU) case, the scenario does not meet any climate stabilisation goals.

- Although low emission fossil fuel technologies with CCS were not evaluated as an option in the IEA BAU and alternative policy outlook scenarios, it is an emerging energy technology option being deployed commercially today in the Sliepner gas field in Norway, In Salah in Algeria, and in the Weyburn oil field in Canada. These commercial applications of CCS technology have been initiated to demonstrate the safe storage of CO_2 and remove about 3 million tonnes per year (Mt/y) for climate change mitigation purposes.

- For the effective use of CCS technology for climate change mitigation, widespread implementation of infrastructure with trunk pipelines linking large stationary, point sources to storage sites with a capacity to retain several decades of emissions from these point sources, would be needed. A survey of the global storage capacity for CO_2 shows an ability to retain a significant proportion of several hundred years of CO_2 emissions from large point sources in the power generation and industrial sectors within depleted oil and gas fields, deep unmineable coal seams and underground saline reservoirs. Emissions from fossil fuel use in these sectors would represent over 60% of the anticipated global CO_2 emissions in 2030.

- CO_2 storage in depleting oil and gas fields and unmineable coal seams can produce commercial benefits from enhanced oil recovery (EOR), enhanced natural gas recovery (EGR) or coal bed methane recovery (ECBM; or enhanced coal seam methane recovery). These benefits could partially offset the cost of deployment of CCS technology. However, a much larger option on a scale that could address the mitigation of global climate change is in the underground storage in saline reservoirs, but this option does not yield any commercial benefits to offset the cost of CCS.

- Following the initial oil price shocks of 2-3 decades ago and concerns about the security of energy supply *(also a situation that is currently relevant)*, the global trend has been to rely on natural gas and coal as the leading fuel options for power generation and the production of hydrogen (H_2), chemicals, and liquid transportation fuels. However, the rising price of natural gas in several regions of the world coupled with higher demand, is expected to shift the balance towards the future use of coal in these sectors.

- Coal, the most abundant global fossil energy resource with reserves that exceed the combined resources of oil and gas, is relatively well distributed and accessible in many regions of the world, and unlikely to face concerns about the cost and the security of energy supply that nations with a high dependency on oil and gas are likely to endure. As a result of concerns about the cost and security of energy supplies, it is highly likely that the near to mid-term diversification of the global energy mix towards coal *(and the continuing dominance of oil and gas in this diversified mix)*, would require the deployment of CCS technology to achieve deep reductions in CO_2 emissions to mitigate climate change.

- In the longer term, transformation of the current global energy infrastructure to the comprehensive use of decarbonised electricity and hydrogen energy vectors across all sectors of the economy would be necessary to achieve significant reductions in greenhouse gas emissions into the atmosphere. *The use of fossil fuel technologies with CCS that could remove 85-95% of CO_2 emissions otherwise released into the atmosphere, provides a low emissions option to mitigate climate change. An advantage of this option is* that *it has a significant potential to achieve very deep reductions in greenhouse emissions without serious disruption of the global economy and the existing energy infrastructure.*

- In pursuing a strategy involving the initial implementation of low emission technologies to mitigate global climate change, there must be a realisation that the total global fossil fuel resource base is finite. Although it could take several decades if not centuries to reach this limit, *low emission fossil fuel technologies with CCS are therefore bridging technologies in the transformation to a future climate sustainable, energy infrastructure.*

- Ultimately, the journey towards the above goal would have to incorporate renewable energy resources as the end source of supply of electricity and hydrogen energy vectors in a radically transformed energy system. *Thus, a balanced portfolio approach involving the development and deployment of all forms of energy technologies with low or no carbon emissions is required to avoid global climate change* and to assist the transformation to a new energy system. *Early action to achieve deep reductions in greenhouse gas emissions can be met with the deployment of low emission fossil fuel technologies with CCS.*

- The Intergovernmental Panel on Climate Change (IPCC) has published in late 2005 a report evaluating CCS technologies and their potential contribution to mitigating global climate change. The IPCC report has noted that *in most scenarios for the stabilisation of global greenhouse gas (CO_2) concentrations at between 450-750 parts per million by volume using a least cost portfolio of options, the economic mitigation potential of CCS would amount to 220-2,200 Gt of CO_2 cumulatively. This would mean that CCS contributes between 15-55% to* *the cumulative mitigation effort worldwide until 2100, averaged over a range of baseline scenarios. In most scenario studies, the role of CCS in mitigation portfolios increases over the course of the century, and inclusion of CCS in the mitigation portfolio is found to reduce the costs of stabilising CO_2 concentrations in the atmosphere by 30% or more. CCS will begin to deploy at a significant level when CO_2 prices begin to reach approximately US $25-30 per tonne.*

- The assessment by the IPCC further indicates that CCS technologies currently operate on a limited scale in a mature market with CO_2 capture in industrial applications and with pipelining and utilisation for EOR in depleting oil fields. Currently, close to 40 Mt/y of CO_2 from both natural formations and industrial sources are being used globally in EOR operations, but without CO_2 storage. Opportunities were also found to exist involving the low cost capture of about 360 Mt/y of relatively pure industrial CO_2 emissions for near term storage to meet climate stabilisation goals.

- The application of capture technologies in other large sectors of the global economy such as power generation, steel production and cement manufacture with storage in depleted gas and oil fields and underground saline reservoirs are less mature - primarily due to more limited operating experience at large scale with these systems. Other applications of oxyfuel combustion for CCS, enhanced coal bed methane recovery (ECBM; or coal seam methane recovery), mineral carbonation or ocean storage are in the early demonstration or research phases of activity.

- Analysis of data reviewed by the IPCC of the cost of electricity, hydrogen and the associated cost of carbon abatement in power generation and industrial plants, shows that the cost of decarbonised electricity or hydrogen increases by 34-49% and 17-144% respectively, being dependent on fuel and plant types and locally prevailing fuel prices and plant investment costs. The cost of decarbonised electricity and hydrogen is cheapest for natural gas plants, but this situation is dependent on the cost of natural gas relative to coal in different regions of the world. With a higher anticipated rate of increase in the price of natural gas, coal-based power and hydrogen plants with CCS are expected in future to have the lowest electricity, hydrogen production and CO_2 abatement costs.

- Amongst the coal-fired power generation options, Integrated Gasification Combined Cycle (IGCC) plants based on coal gasification with CCS are expected to yield the lowest electricity and CO_2 abatement costs relative to combustion based options, with either post or oxyfuel combustion capture of CO_2. Unlike the coal combustion based CCS power plants, IGCC with CCS also permits applications with electricity production and the cogeneration of hydrogen, chemicals and/or liquid transportation fuels with the lowest carbon abatement costs.

- Data additionally show that the cost of CO_2 abatement is lowest for the production of hydrogen as opposed to decarbonised electricity from both natural gas and coal. With the lowest CO_2 abatement costs for hydrogen production it can be expected that *as technologies evolve for the more efficient distribution, storage and use of hydrogen, it would emerge as the preferred energy vector compared to decarbonised electricity in a future carbon constrained world.*

- The IPCC study notes that the cost of CCS with decarbonised electricity or hydrogen production is 9-27% and 10-32% cheaper respectively when combined with EOR, and could provide economic incentives for the early application of CCS in some regions of the world.

- In the longer term, *increased deployment of CCS on a larger scale in power generation and industrial plants, through 'learning by doing', can be expected to reduce the costs of CCS by 20-30% within a period of less than a decade.* However, much higher cost reductions are anticipated from improvements to the thermal efficiencies of power plant technologies, and with the deployment of new breakthrough concepts for CO_2 capture that are currently in the research and development phase. Moreover, energy use penalties and capital costs for CO_2 capture represent the largest cost component in any CCS system.

- The Centre for Low Emission Technology (cLET) is an unincorporated joint venture (UJV) partnership of the State of Queensland through the Department of State Development Trade and Innovation, CSIRO through its division of Energy Technology and the Energy Technology Flagship Program, Australian Coal Research Limited, Stanwell Corporation Ltd, Tarong Energy Corporation Ltd and the University of Queensland. *The mission of cLET is in progressing the development of enabling technologies for the production of low emission electricity and hydrogen from coal.*

- In recognition of the significant role that future coal-fired, IGCC plants could play in providing decarbonised electricity, hydrogen, liquid transportation fuels and chemicals at the lowest carbon abatement costs, the Centre for Low Emission Technology (cLET) has embarked on a research program to facilitate technology development and deployment. *The cLET R&D program focuses on improvements aimed primarily at the implementation of 2nd generation IGCC plants with CCS.* The work aims to achieve higher net cycle efficiencies, lower energy penalties for CO_2 capture via hydrogen separation, and the use of other improved enabling technologies for coal gasification, dry gas cleaning and gas processing optimised for plant operation with low water usage and the higher ambient temperature conditions of the Australian landscape.

- The cLET program primarily addresses bench, pilot and demonstration scale initiatives for hardware development. When the situation becomes clearer for the implementation of early, large scale IGCC projects in Australia under the Commonwealth Government's Low Emission Technology Demonstration, the

Queensland Clean Coal Projects and the Coal 21 funds, cLET will link its program initiatives to support these technology platforms and to achieve commercial outcomes. Additional funding of the cLET program would be required to address these latter outcomes.

- In parallel with its technology based R&D initiatives, cLET is also undertaking work on promoting the public awareness and the social acceptance of low emission fossil fuel technologies. This activity is based on the premise that technology alone cannot change energy behaviour if it is not taken up by society. Work undertaken elsewhere in the world shows that the lay public has a very limited understanding of the pros and cons of these technologies and the role it could play in mitigating climate change.

- cLET has conducted state wide public surveys in Queensland and New South Wales aimed at establishing the baseline attitudes of the public to low emission technologies. These have been followed by focus group workshops held with both the lay public and community leaders in several regions in Queensland, and recently in New South Wales. Preliminary analysis of the state wide surveys has confirmed that the general public has a very limited knowledge of CCS technologies, while the focus group workshops showed an increased interest and willingness to accept the use of low emissions technologies amongst a portfolio of solutions to mitigate global climate change.

- The emerging message from this study is that a major education initiative on climate change and the range of options to mitigate greenhouse gas emissions is required in the near future. The cLET study has identified an approach that could be used in embarking on this education initiative that should be national in its outreach.

The above submission by the Centre for Low Emission Technology is supported by the following reference material;

1. **Centre for Low Emission Technology,** 2006, *'Low emission technologies with geosequestration in the context of a transformed energy infrastructure to mitigate global climate change'*, Position Paper, 14 August 2006, Centre for Low Emission Technology, Brisbane, Australia.

2. **International Energy Agency (IEA),** 2004 (and revised in 2005): World Energy Outlook, International Energy Agency, Paris, France.

3. **Intergovernmental Panel on Climate Change (IPCC),** 2005: IPCC Special Report on Carbon dioxide Capture and Storage, Prepared by Working Group III of the Intergovernmental Panel on Climate Change [Metz, B., O. Davidson, H.C. de Coninck, M. Loos, and L.A. Meyer (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

4. **Australian Bureau of Agricultural and Resource Economics (ABARE),** 2006: Australian energy – national and state projections to 2029-2030, ABARE e-report 05.9, Australian Bureau of Agricultural and Resource Economics, Canberra, Australia.