RIO TINTO

Submission to Australian Government Inquiry into Geosequestration Technology

Introduction and Rio Tinto Background

Rio Tinto is a diversified mining company with operations around the globe and with over half its assets in Australia. Rio Tinto is a significant consumer of energy in its smelting operations, and a producer of energy through its production of thermal (energy) and metallurgical coal and uranium.

Rio Tinto believes that greenhouse gas (GHG) emissions resulting from human activities are contributing to changes to the earth's climate. Urgent action is required to reduce global greenhouse gas emissions and technology has a key role in achieving this goal.

Rio Tinto recognises that addressing the challenge of climate change will impose costs for GHG abatement and necessitate a change in the way the world uses energy. A full and comprehensive portfolio of policy and technology options will be required to achieve the lowest overall cost for society.

Rio Tinto is committed to helping develop low GHG emission pathways that will allow its products to continue to meet the needs of society. As a major producer of coal, and with smelting operations dependent on coal, Rio Tinto is working collaboratively to accelerate development and deployment of near "zero emissions" power generation and hydrogen production from coal. The use of carbon capture and storage associated with the production and combustion of fossil fuels will be essential if this vision for a low emission future is to be realised.

Coal plays a vital role in Australia generating over 80% of the nation's power. Compared with other OECD countries, this provides an important competitive advantage arising from a lower than average power price. Coal is Australia's largest commodity export. The capture and storage of CO_2 is an essential response to continued use of fossil fuels and is therefore a vital technology for Australia.

Rio Tinto and its coal subsidiaries Rio Tinto Coal Australia, Coal & Allied and Rio Tinto Energy America participate in a number of world class research efforts. In Australia, the Co-operative Research Centre for Greenhouse Gas Technologies (CO2CRC) is a world leader in this area, and Rio Tinto is directly involved in its Otway Basin pilot geo-sequestration project. Rio Tinto is also a member of the Co-operative Research Centre for Coal in Sustainable Development (CCSD) in Australia, the Battelle Global Technology Strategy Program (GTSP) and the FutureGen zero emissions coal demonstration in the US. Rio Tinto has created a subsidiary, Post Combustion Capture Ltd, to undertake a research and demonstration program with CSIRO and CO2CRC into the post combustion capture of CO_2 from conventional power stations as part of the Australian COAL21 program.

Rio Tinto is a participant in numerous international forums to advance action on reducing greenhouse gas emissions, including the International Energy Agency (IEA) GHG program, the Carbon Sequestration Leadership Forum (CSLF) and the Asia Pacific Partnership for Clean Development and Climate (AP6). Rio Tinto is also a member of the Australian Coal

Association COAL21 Programme, a partnership between coal producers, Governments and utilities aimed at the elimination of GHG emissions and other environmental impacts associated with coal fired power generation.

Key Points:

1) Rio Tinto is a major global energy producer and recognises that the future of its coal businesses will depend on the timely development of low emission technologies which will rely upon the availability of Carbon Capture and Storage (CCS)[1].
2) Rio Tinto is a strong supporter of many world class research initiatives into technology generally and CCS specifically. The Australian CSIRO and CO2CRC are recognised internationally as world class research institutions in geo-sequestration.

The Importance of Coal to the Future World Energy Mix

Numerous studies[2] have forecast that coal will remain pivotal in providing the developed world and developing countries like China and India with a secure, reliable and affordable energy supply. Internationally, nearly two fifths of the world's electricity comes from coal fired power stations (but they account for 38% of global CO_2 emissions[3]). Over the past two years, coal demand has risen at a faster rate than for any other fuel. The IEA predicts that world energy demand will increase by about 60% by 2030 with fossil fuels meeting more than 80% of this demand[4].

Coal is therefore going to be a major part of the energy mix in the future but generating electricity from thermal coal emits significant levels of carbon dioxide. Significant improvements in the energy efficiency of conventional power stations have been achieved over time, and this trend will continue with the development of new materials and higher pressure boilers. However such incremental improvement will not achieve the deep GHG emission reductions which are expected to be required to stabilise atmospheric concentrations of CO_2. To achieve major reductions in GHG emissions, three major pathways of promising technological development for coal fired power generation have been identified to secure step change emission performance (refer section on carbon capture and storage technologies below).

Regardless of the choice of technology to capture CO_2, it will need to be stored. Hence the vital role geo-sequestration will play for the continued use of coal in the energy mix.

A full and comprehensive portfolio of policy and technology options will be required if society is to change the trajectory of the world's future global emissions at the lowest overall cost for society. This will mean, depending on location and costs, an energy mix comprising renewables, nuclear and fossil fuels with CCS.

Key Points:

1) Coal will remain a major source of world energy for the future, especially for developing countries.
2) Geo-sequestration will play a vital role in enabling the continued use of coal with near zero emissions.

[1] In this paper, the terms geo-sequestration and carbon capture and storage (CCS) are used interchangeably and both include the capture of the CO2 as well as its geological storage.
[2] IEA World Energy Outlook; IEA Energy technology Perspectives 2006; Battelle GTSP2 – CO2 Capture and geologic Storage
[3] IEA – CIAB "Road mapping Coal's Future" 2005
[4] IEA World Energy Outlook 2005

Carbon Capture and Storage Technologies

Carbon capture and storage (CCS) technologies can make a significant contribution to reducing GHG emissions. The 'IPCC Special Report on CO_2 Capture and Storage'[5] approved by governments (including Australia) and a number of recent studies by the IEA, Battelle and the Electric Power Research Institute (EPRI) in the US have concluded that CCS will significantly reduce the global cost of reducing emissions of CO_2, and enable a more rapid reduction of emissions. Further, carbon capture and storage is the key enabling technology for reducing CO_2 emissions from coal.

Carbon capture and storage refers to the process of capturing carbon dioxide from sources such as power stations, and transporting it for storage in geological formations. There the CO_2 either dissolves or forms stable carbonate minerals and remains largely in place for long periods of time. It has been shown that CCS could reduce CO_2 emissions from power stations by up to 85%.

The storage options for CO_2 include depleted natural gas fields, unmineable coal seams and deep saline aquifers. A recent Inter-governmental Panel on Climate Change (IPCC) report estimated that over 100 years storage is available in suitable underground repositories. Much work is being done on the investigation of naturally occurring geological concentrations of CO_2, which can give valuable insights into how gas can be isolated for thousands of years. The process of capture of CO_2 from coal seams releases coal seam methane and represents an important commercial ancillary source of gas.

There has been much media focus on the storage issues of CO_2. However it is the carbon capture technologies that account for over 70% of the costs of CO_2 and are in most need of development.

There are three major technology pathways[6] being pursued to capture carbon dioxide emissions from the low emission power plant of the future. These are:

- Coal gasification in integrated combined cycle (IGCC) systems. Coal is converted into a gas which is then used as a fuel in a combined cycle gas/steam turbine plant. Emissions from IGCC systems are significantly lower than for conventional combustion-based plants because sulphur oxides, nitrogen oxides and ash/slag are removed from the gas before combustion. IGCC efficiencies can approach 50%. It is easier to capture CO_2 emissions in an IGCC plant than in a conventional plant because the CO_2 is more concentrated.

- Oxyfuel combustion is a process very similar to conventional coal-fired generation except that nearly pure oxygen is used in the boiler instead of air, thus concentrating the CO_2 in the exhaust gas stream by removing nitrogen. This technology has been demonstrated at pilot scale, and a larger scale project is being planned in Queensland.

- Post combustion capture (PCC) technology involves the capture of CO_2 from cooled flue gases in an amine scrubber. The CO_2 is stripped from the amine, which is then recycled, and the CO_2 is compressed and stored. A major advantage of PCC is the potential to retrofit existing plant. These processes have been in use for over 70 years. Recently a consortium involving Rio Tinto, CSIRO and CO2CRC has established a national program as part of the COAL21 Program that will facilitate the introduction of PCC technology into Australia.

[5] IPCC "Special Report on Carbon Dioxide Capture & Storage" Sept 25th 2005, Montreal Canada

[6] IEA – CIAB "Road mapping Coal's Future" 2005

All capture and storage options will be attractive in different circumstances however they are all immature technologies if evaluated for immediate use in large-scale utility power generation applications. Additionally the eventual commercial implementation of geo-sequestration will require the use of all types of prospective geology if employed at scale.

Rio Tinto's view is that the immediate priority is to accelerate the development and deployment of CCS and to gain wider public acceptance of the technologies. This will require considerable investment in numerous international demonstrations under varied conditions. The widespread application and ultimate success of CCS will depend on reducing its cost; which will require significant investment in research to accompany the demonstration, and in the subsequent deployment. Inevitably these costs will flow through into higher power costs than would otherwise be the case.

Key Points:

1) CCS is the key enabling technology to reduce greenhouse gas emissions from coal potentially removing up to 85% of CO_2 from power station emissions.
2) There are three major CCS technology options and all require further development and demonstration in order to be utilised at commercial scale.
3) The investment required is considerable and this will impose costs on industry and users alike.

The Costs and Risks of Carbon Capture and Storage

The IPCC report mentioned above suggests the major contribution of CCS to reduced greenhouse gas emissions will be in the electricity sector. Application of CCS to electricity production, under 2002 conditions, is estimated to increase electricity generation costs by between one and five US cents per kilowatt hour; this equates to a price on CO_2 of about US$25-30 per tonne, depending on the fuel, the specific technology, the location, and the national circumstances. The Report also concludes -

1. The health, safety and environment risks of CO_2 pipeline transport and subsequent geological storage are comparable with existing hydrocarbon operations and practices. While a sudden and large release of CO_2 would be of concern, the evidence to date shows this can be addressed through normal care and diligence in the siting, construction and operation of pipelines.

2. The global geological storage capacity for captured CO_2 has been estimated to be sufficient so that CCS could contribute up to 55% of the cumulative CO_2 mitigation effort worldwide until 2100. The actual amount as specified in the report is about 2,000 $GtCO_2$. There could in fact be a much larger storage potential especially in saline formations but the volume is uncertain.

3. The risk of potential leakage of geologically sequestered CO_2 is very low. Observations and models have shown that fractions retained in well chosen reservoirs are likely to exceed 99% over 1000 years.[7]

There are currently three industrial scale CO_2 storage projects around the world[8], the oldest being Statoil's Sleipner West field in the North Sea. In this process, carbon dioxide is stripped from natural gas with amine solvents and disposed of by injecting it into saline formations 1000 metres below ground. Australia needs to demonstrate that the same technology can be applied for use with coal fired power generation.

[7] The actually statistical probability as calculated in the report is between 66-90% which they translate to the qualitative term 'Likely'.
[8] The other two are the Weyburn project in Canada and the In Salah project located in Algeria, which like Sleipner, is a natural gas reservoir.

A major research programme in the US, FutureGen, is building a coal based IGCC plant to produce gas for electricity generation in combined cycle turbines, and hydrogen for use in fuel cells. The CO_2 emissions will be captured and stored in geological reservoirs, resulting in a low emissions coal-based power plant.

Key Points:

1) The cost of deploying CCS technologies as estimated by the IPCC is approximately US$25-30 per tonne.
2) There are risks and concerns for certain parts of CCS technology but generally they are well understood conventional processes.
3) There are currently three industrial scale sequestration projects with many more in the planning stage.

Carbon Capture and Storage in Australia

In Australia, the Australian Coal Association's (ACA) COAL21 is a well recognised industry lead programme which seeks to eliminate greenhouse gas emissions associated with coal fired power generation. COAL21 brings together coal producers, federal and state government agencies, electricity generators and key research organisations.

Additionally, in 2006 the ACA announced the creation of an A$300 million fund for low emission technology demonstration, called the COAL21 Fund. Australian coal producers have recognised that the viability of CCS needs to be urgently demonstrated to give Australia the operational experience that will lead to a second generation of more affordable plants. Australia has a unique opportunity to show leadership and to be at the forefront of clean coal technologies. With world leading CCS research institutions such as CSIRO and CO2CRC and an excellent transferable skills base from professionals in the oil and gas industry, the opportunity exists to deploy and coordinate this intellectual resource and leverage off work done in other larger economies.

Australia's first CCS demonstration project is about to commence in Victoria's Otway Basin under the supervision of the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC). This project will take carbon dioxide from an old gas field, pipe the gas several kilometres and then pump it underground into a depleted gas reservoir about two kilometres below the surface.

On the capture side, as part of the ACA's COAL21 Program Rio Tinto is seeking industry partners to work with CSIRO and CO2CRC to demonstrate post combustion capture at a power station. This is part of a larger national programme that includes a concurrent PCC pilot evaluation program and a laboratory research programme that will develop and test new sorbents, physical separation technologies and process integration concepts. Most importantly this program will address capture of CO_2 under Australian power station operating conditions, which often do not have installed SOx and NOx control equipment. China and India have similar operating conditions and any technology developed will be highly prospective for application in those markets, which are growing strongly.

Key Points:

1) ACA, CSIRO and CO2CRC and others are actively involved in many CCS initiatives.
2) As part of COAL21, Rio Tinto is seeking industry participants to work with CSIRO and CO2CRC to demonstrate post combustion capture.
3) There is an opportunity for Australia to show world leadership in demonstrating CCS technologies which will have significant potential application internationally.

Governments have a Key Role in Overcoming Market Failures and Providing Direction on Regulatory and Approval Issues

A 2005 report by the UK Department of Trade and Industry[9] showed there is significant danger of under-investment in carbon abatement technologies due to the very high costs of initial demonstration plant and the long time frames involved before commercial returns can reasonably be expected. Additionally, inconsistent national approaches and the need for collaboration among countries require governments to intervene. Spill-over of benefits to competitors and regulatory uncertainty are also of concern to industry and could delay the required investment in CCS technologies.

To accelerate the momentum for development of these technologies, public and private investment must be coordinated. Most importantly, a strong core of countries (including the large developing economies) will need to collaborate and share costs and knowledge to accelerate development and particularly to demonstrate the potential of CCS.

The global community as a whole needs to recognise and address the climate change challenge. Industry on its own cannot be expected to meet the full cost of developing and demonstrating new technologies.

In Australia, state and federal governments have an important role to play in promoting practical solutions. In addition, the Federal Government has an international role in collaboration with other governments. The Federal Government is to be congratulated on its involvement with the Asia-Pacific Partnership on Clean Development and Climate, which held its inaugural meeting in Sydney in January 2006. Additionally the Federal Government's Low Emissions Technology Demonstration Fund is another positive initiative that will encourage the speedy demonstration of these key technologies in Australia.

While the main imperatives for CO_2 capture technology development relate to funding and investment issues, the storage of captured CO_2 requires a suitable regulatory regime to ensure safety and reliability. Long-term liability attached to sequestered CO_2 remains unresolved. Some existing regulations concerning subsurface operations of mining, oil and gas operations and pollution control may be relevant to geo-sequestration, but there are no developed legal or regulatory frameworks specifically for long term storage and property rights of CO_2. The areas of uncertainty that need specific attention include:

- The legality of CO_2 storage under national and international laws governing waste management.
- The absence of regulations and standards for the licensing of CO_2 storage sites.
- Determination of liability and ownership associated with any long term CO_2 leakage and potential insurance coverage.

To address these issues, governments must be in general agreement that the risk of not addressing climate change outweighs the risk of deploying and operating CCS-enabled systems. These issues need to be resolved to assure the public that CCS is safe and not a major risk to the environment.

The Department of Industry, Tourism and Resources has commenced a process to develop a regulatory framework for geo-sequestration in Commonwealth waters. Rio Tinto welcomes this initiative; however terrestrial geo-sequestration also requires a uniform national approach.

[9] "Strategy for Developing Carbon Abatement Technologies for Fossil Fuel Use"

Key Points:

1) The main impediments to the development of CCS are funding and investment issues. Governments have a key role to overcome potential funding shortfalls.
2) The storage of CO_2 requires regulation to resolve liability, waste management and long term property rights issues. This will help achieve wider public acceptance of CCS.

Summary and Conclusion

In response to the growing demand for power generation, CCS has been identified as a key and promising technology to reduce greenhouse gas emissions to limit the anthropogenic effect of climate. These technologies require massive investment in research, development and demonstration to make them commercial at scale. Significant environmental and regulatory challenges need to be overcome before CCS technologies can be implemented however Australia is well placed with the skills, expertise and international linkages to solve these issues and potentially take a global lead.

Finally, Rio Tinto believes governments can further assist in the advancement of CCS by:

(a) Promoting an increase in the number, pace and scope of CCS projects specifically addressing all the major capture techniques and geo-sequestration scenarios.

(b) Adequately resourcing and providing incentives for CCS projects.

(c) Raising the profile of CCS within the domestic and international community.

(e) Supporting attempts to increase global acceptance of CCS.

(f) Developing the policies and legal frameworks to enable rapid development, commercialisation and deployment of CCS.