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Professor Ross Garnaut
Submissions
Garnaut Climate Change Review
Level 2, 1 Treasury Place
East Melbourne Vic 3002

Dear Professor Garnaut,

Rio Tinto Submission to the Garnaut Climate Change Review

The Rio Tinto Group welcomes the opportunity to contribute to the Climate Change Review. The attachments to this letter incorporate the Group's most recent thoughts on how measures to reduce emissions and moderate the impacts of climate change will affect Rio Tinto's operations in Australia. The Group recognises the importance of climate change and is also aware that it is not a conventional pollution issue. Amongst other things, it is a pollutant stock problem. As such, it requires a sophisticated solution, which includes costs that start low and increase over time as the stock, or sink in this case, fills up.

All forms of economic activity ultimately contribute to global warming and climate change. Rio Tinto accepts that large minerals companies are in the frontline in the battle to reduce emissions. It is also aware that the social and economic consequences of action taken to combat climate change could bear disproportionately on Australia, where the mining sector makes a significant contribution to the nation's export earnings.

The Rio Tinto Group has minerals and metals operations in Queensland, NSW, Tasmania, Western Australia and the Northern Territory, many of them in remote and regional areas. Last year, Australian sales exceeded $US15 billion. Australian operations comprise more than a third of the Rio Tinto Group's global assets and make a substantial contribution to State and Commonwealth revenues. While capital intensive, they still employ around 16,000 people directly; eight per cent of whom are Indigenous Australians.

Rio Tinto's formal involvement in climate change matters goes back more than a decade. Today, all Rio Tinto businesses have committed to contributing to society's transition to sustainable development. Existing operations have targets for increasing efficiency and for reducing energy consumption and the emission of greenhouse gases. New projects are designed in the light of what is known about climate change. The aim is to minimise future emissions and all feasibility studies contain estimates of future carbon costs.

In addition, the Group is looking for business opportunities that, it believes, will occur as the world adjusts to the needs of a reduced carbon economy.

Rio Tinto's involvement in the climate change debate is driven by the nature of its business activities. Nearly all of the Group's activities; mining, milling, refining, smelting and ancillary operations such as railways and power stations, are energy and emissions intensive. In 2007, direct and indirect emissions from the Group's Australian managed operations were in the region of 16.5 Mt CO_2-e. After the 2007 Alcan acquisition, emissions from managed and majority owned but non-managed operations increased to 29.8 Mt CO_2e.

Rio Tinto

Equally, the Group's Australian businesses are trade exposed. In 2007, nearly 90 per cent of their products were exported. Our international competitors were as diverse as the Group's markets; they included China, Colombia, Indonesia, Brazil, Russia, South Africa and India. As noted in the appendices, Rio Tinto's chief competitors increasingly come from developing economies. As such, they are not parties listed in Annex B of the Kyoto Protocol, and are unlikely to follow the example of the Annex B countries in introducing an ETS for some time to come.

The 'developing' status of Australia's competitors in the production of minerals and energy is no obstacle to their competitiveness. In some cases, they enjoy greater proximity to markets and lower overheads. And their governments' desire to foster economic growth and higher living standards means that they are responding rapidly to current high mineral prices. New projects are being built that ensure supply increases. When, as a consequence, prices of Australia's major mineral export commodities moderate, suppliers in Annex B nations subject to an ETS will be disadvantaged.

This is not an argument against introducing an ETS. But it does suggest the importance of structuring such a scheme to minimise losses of competitiveness. In particular, this would ensure that the ETS reinforces technology support to lessen first-of-kind and learning costs. Doing so is not only in the interests of mineral producers and their shareholders, but will also protect government revenues, regional economies and help to prevent carbon leakage.

The attachments illustrate the difficulties faced by producers who are price takers in global markets for essentially homogenous products, such as coal, iron ore and aluminium. Similar points are also applicable to Rio Tinto's other Australian based businesses. While wishing to point out the possible consequences that an ETS could have for a particular industry, Rio Tinto acknowledges that policy makers must make difficult decisions. Climate change demands that we all reduce greenhouse gas emissions substantially and quickly. At the same time, we know that if Australia makes its reductions at excessive cost to its trade exposed industries, those industries will contract, with no net global environmental benefit.

Rio Tinto would be happy to enlarge on the contents of this submission, should you so wish. If you require any follow up information please contact Neil Marshman on telephone 9283 3328 or email neil.marshman@riotinto.com.

Yours sincerely

Stephen Creese

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Summary – Rio Tinto submission to the Garnaut Climate Change Review

Rio Tinto believes that minimising the extent of anthropogenic climate change is an international priority. Introducing national economic instruments to address the challenges of climate change is a necessary component of an international policy response. Rio Tinto's submission provides detail to assist in developing just such an economic instrument, an emissions trading scheme, for Australia.

Acknowledgement of trade exposures is crucial to maintaining Australia's international competitiveness. Structuring an economic instrument to minimise the potential loss of international competitiveness is not only in the interests of mineral producers and their shareholders, but will also protect government revenues, regional economies and help to prevent carbon leakage. Australia's international competitiveness will be compromised by those industries that are unable to pass on the costs of a domestic emissions trading scheme to their customers. Until there is international policy comparability, mineral commodities from lower cost countries will be at an advantage, with no net reduction in global emissions. An independent panel should recommend the list of industries to be granted emissions intensive and trade exposed status.

Domestic emission targets should be aligned with carbon abatement curves. Carbon abatement cost curves derived from the IPCC fourth assessment report show there are limits to the gains able to be made cost effectively from known technologies before 2030. A too stringent short to medium term cap risks being economically and socially detrimental to the nation.

A national low emissions technology strategy (NLETS) is an essential complementary measure that would expedite the commercialisation of new technologies. An emission trading scheme alone will not address the first mover barriers for technology development. Rio Tinto supports a NLETS that is fully funded (including hypothecated revenue from permit auctions), sustained, comprehensive, transparent and well governed, in order to accelerate technology development.

Renewable Energy Targets (RET) overlap and compete with an emissions trading scheme. An ETS with NLETS should be designed to promote the adoption of lowest cost low emissions technologies. The RET focusses on renewables, irrespective of their location on the cost curve. It is subject to similar competitiveness issues as an ETS and appears to compete with an ETS.

A poorly executed introduction of an ETS will impact business in general and the mining industry in particular. That impact will eventually be felt by every Australian. The current timeframe does not allow business adequate time to understand the ETS and to prepare properly for its introduction; the current time frame is potentially damaging to firms and to the economy overall. In the time that is available, Government and industry should collaborate to properly design, test, communicate and prepare for the introduction of the ETS.

Data quality is crucial to the relevance of the output from any model. Publicly available databases needed for analysis of trade exposed industries date back to 2001/2 and are out of date.[1] They allow the industry to draw some conclusions about the extent of its trade exposure, but it is important that Government bases climate change policy on the best possible and most current data. Rio Tinto considers that energy intensity metrics should not be used as a proxy for determining emissions intensity as they give misleading rankings for some industries.

[1] Rio Tinto understands that ABS released an incomplete update of Input-Output tables mid April. Rio Tinto has not had time to review these tables nor to fully understand the nature of the update.

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Appendix 1 – Comments on Garnaut Review interim report and emissions trading scheme discussion paper

1. Introduction

Rio Tinto welcomes the release of the Garnaut discussion papers and the discussion that continues to be generated by the Garnaut Review. This appendix comments on a number of specific matters raised in the Interim Report and the Emissions Trading discussion paper of the Garnaut Review that are not covered elsewhere in this submission. Topics covered include the overall timeframe available for careful scheme design and consultation, issues with auctioning and various permit allocation methods, funding for low emissions technology development and reducing business decision making uncertainty.

2. General comments

Schedule for scheme design - The nature of the transformation of both the global and Australian economies necessary to address climate change is unprecedented. Rio Tinto is convinced that it is necessary to tackle this transformation, and that an ETS has a key role to play. It is also convinced that such a transformation should be very well planned and due process undertaken with respect to stakeholder buy-in. However, Rio Tinto is concerned that the process of ETS design and introduction is now extremely truncated because of the complex nature of the undertaking and the delays that have occurred. The timetable for the introduction of the full scheme should be reviewed as early as possible.

Scheme simplicity - Rio Tinto agrees that simplicity is one of the criteria for a good ETS. One source of complexity that needs addressing is the treatment of trade exposed industries, given that it may be considerable time before our developing country trading competitors enter into an international emissions reduction scheme in a substantive way. This is important if Australia's trade exposed emissions intensive industries are to maintain their competitiveness. In Rio Tinto's view, it will not be possible to have complete simplicity while many countries are not involved in an international trading scheme. It follows that there will be design elements of Australia's scheme that will remain complex and difficult in the foreseeable future. This will require the Government to be flexible in designing and readjusting the scheme, as needed, to maintain Australia's export competitiveness while, at the same time, reducing greenhouse gas emissions.

Initial testing and trial of the scheme – Consideration must be given as to the best way to introduce a comprehensive ETS in Australia. In this regard, Rio Tinto believes that Australia is fortuitously able to dedicate an initial period to testing the scheme and its supporting infrastructure. Rio Tinto understands the importance to the Government of meeting its announced timetable for the introduction of the domestic scheme. It also understands that Australia is on track to meet its Kyoto first commitment period target. Rio Tinto therefore believes that the period between the announced start of the domestic trading scheme and the end of the first Kyoto commitment period should be used to test the scheme. It proposes that the price of permits be capped at a very low price for the trial period, and that the price only become unrestricted for the trading period commencing in 2013-14.

Trialing novel international cooperation methods - In Rio Tinto's judgement, international negotiations may continue to be drawn out. Its experience is that the interactions between the various developed and developing country parties, such as, for example, those involved in the Asia Pacific Partnership on Clean Development and Climate have achieved much. Rio Tinto believes that such efforts should continue, inside and outside the UNFCCC, to explore novel ways of advancing cooperation and understanding and that doing so will have positive repercussions on the UNFCCC.

3. Emissions intensive trade exposed industries and methods of permit allocation

Do administration permit allocations and permit auctions result in the same efficiency outcome? - As described below, Rio Tinto believes it is wrong to say that the choice of allocation mechanism only affects the distribution of wealth. There are many challenges in designing efficient auctions. The adverse effects of a poorly designed auction could be substantial, including aggravating other economic distortions. In saying this, it is not arguing against auctioning *per se*, but advocating care in auctioning and allocation methods more generally. It is important not to rush into what could prove to be a poorly designed allocation mechanism.

A fundamental issue in designing a permit system is whether the method of allocating permits affects efficiency, or whether it merely affects wealth transfers in the community (that is, to make some people better or worse off than others, without altering overall living standards). Many commentators assume that the various permit allocation options all have the same efficiency effects, and only differ in terms of wealth allocation.

The assumption that all allocation models will affect emitter behaviour in the same way follows from the observation that once an emitter has a permit, the marginal cost of using that permit is the implied tax on carbon - because the emitter faces a choice between using the permit to emit carbon, or selling it. The carbon price will enter into the emitter's output and pricing decisions, regardless of whether it originally paid for the permit or was allocated it. While this reasoning is correct, it assumes that the method of allocation has no effect on market structure and conduct. In practice, there are at least three mechanisms by which the method of allocation may affect market and economy structure and conduct:

- The need to finance the purchase of permits may affect the financial structure of emitters and change their investment and output decisions. For example, if firms become heavily indebted as a result of buying permits, they may be less inclined to price aggressively, for fear that a price war would undermine their viability and force them to incur restructuring costs;
- The up-front payments required to obtain permits may induce early exit of some capacity, or bring about a change in industry structure (as more liquidity constrained emitters are sold to less liquidity constrained emitters); and
- While auctioning will raise government revenues, the overall effect of the ETS will be influenced not only by carbon pricing itself, but also by the way in which the government chooses to spend any auction revenue. This issue is addressed below.

4. Funding for low emissions technology development

In our submission, we have highlighted the importance of R&D in several of our businesses. In particular, see appendix 5 (HIsmelt® and new smelting technology) and appendix 3 (new technology in aluminium smelting). In Rio Tinto's view, a significant share of any permit auction revenue should be allocated to funding an enhanced R&D effort in emissions abatement technology, with a major focus on carbon capture and storage.

Rio Tinto agrees with the insights on the role of technology and the discussion of the public good nature of much R&D expenditure (see for example Garnaut 2008a, pp.52-5). It agrees that there are positive externalities associated with innovation and that there are unpriced external benefits arising from research and development. This implies that there is a role for government in the provision of research funding. This is particularly pertinent for climate change where the external benefits from action will be large and long term in nature, and the levels of research expenditure necessary will also be large and require coordination across many firms and countries.

Fundamentally, the development and deployment of new technology will be crucial in the efficient low cost abatement of greenhouse gases. Energy efficiency improvements and energy use changes will contribute to emission reduction, but stabilising atmospheric greenhouse gas concentrations of 550ppm CO_2, or less, will require the deployment on a very large scale of new technologies, such as carbon capture and storage.

5. Addressing business uncertainty about achievable caps, trajectories and timing

Rio Tinto believes that the move to reduce business uncertainty in terms of the policy settings in Australia is commendable. However, even though the Garnaut Review has discussed achievable caps, trajectories and timing, Rio Tinto considers much uncertainty remains. Rio Tinto thinks that this uncertainty can be reduced in the near term. Six areas of policy uncertainty have been identified.

First, while the Government is yet to announce its preferred emissions reduction trajectories, it has signalled that it believes that deep cuts are called for by 2050. It is unclear to Rio Tinto how the aspirations expressed at the most recent international negotiations are going to translate into consistent emissions reduction policies across a wide range of countries, in the near term. The Australian scheme will need to allow for continuing uncertainty about progress in the international negotiations. It is therefore crucial that arrangements are put in place to preserve the competitiveness of Australia's major trade exposed emissions intensive industries (see appendices 2 - 5 for a discussion of the issues facing the aluminium, alumina, bauxite, coal and iron ore industries for example).

Second, assuming that progress is made in the international negotiations, it seems likely that emission reduction targets will be set and reset relatively frequently, as in the case of the five year commitment period embedded in the Kyoto Protocol. Whilst there appears to be no over-riding reason for five yearly updates of targets, the UNFCCC (Article 4) does refer to 'periodically update' and 'regularly update' in reference to inventories, programmes and measures to reduce emissions. Rio Tinto recognises that target updating will become necessary in the light of new scientific information. However, regular updating, as implied by the Kyoto Protocol, is excessive and generates unnecessary business uncertainty. It would be particularly helpful to Rio Tinto if the review could explain the relationship it sees between the likely target setting process under the UNFCCC and the way in which the final emission reduction trajectory in the domestic scheme will be synchronised. Garnaut (2008b, pp.24-7) sets out a series of possible trajectories, with movement to a more stringent one contingent on the actions of other players in the negotiations. It is not clear how such a system would work in practice, and the proposal may prolong uncertainty in Australia's business investment environment.

Third, at this stage it remains unclear what role linkages between the domestic emissions trading scheme and international trading, under the Kyoto Protocol, will play. Rio Tinto believes that the climate problem cannot be effectively dealt with without engaging developing countries. To this end it sees the Clean Development Mechanism (CDM) as a constructive way of engaging developing countries and sees no merit in placing limits in the domestic scheme on the number of tradable certified emission reductions (CERs), acquired in accordance with Article 12 of the Protocol. In fact, over the longer term, limits placed on acquiring CERs or, for that matter, emission reduction units acquired pursuant to Articles 6 and 17 of the Kyoto Protocol, become counter-productive.

Fourth, when establishing the domestic scheme, it is crucial that the emissions database is accurate and that there are accurate methods to measure emissions. Rio Tinto would particularly like to see rapid progress made on the more accurate measurement of fugitive emissions from coal mining, given the importance of methane in the inventory and its global warming potential. Details of this issue are set out in appendix 4.

Fifth, business uncertainty is generated by the introduction of new measures and regulations through their interactions with the domestic emissions trading scheme. In Rio Tinto's view, an appropriately designed domestic emissions trading scheme (with international linkages) that preserves the competitiveness of Australia's trade exposed emissions intensive industries, matched with a well designed R&D policy for climate change technology investment, will be the most cost effective way of achieving the desired emissions reductions. While Rio Tinto recognises that governments may wish to have a portfolio of policies, including regulations designed to reduce emissions, it is concerned that the proliferation of such policies will reduce Australian economic welfare. Rio Tinto is concerned, for example, that the recently announced renewable energy target for the electricity sector will lead to higher electricity prices. This could reduce economic welfare more than would be the case if an equivalent emission reduction were to be achieved by application of a domestic trading scheme alone.

Sixth, uncertainty surrounds the macroeconomic effects of the scheme. The impact on aggregate demand will depend, among other things, on the tightness of the target and the speed with which low or zero-carbon energy technologies become available. Rio Tinto is concerned that the potential inflationary effects have been dismissed too lightly (see for example Garnaut 2008b, p.56). Little account seems to have been taken of the impacts of the demand for capital to fund the necessary new investment in low carbon energy technology and auctioned permits. Rio Tinto believes that explicit empirical modelling is required to quantify these effects.

6. Probity in government spending

Rio Tinto understands the importance of the potential new source of government revenue arising from the auctioning of a proportion of the permits associated with a domestic trading scheme. It believes that any such new revenue should be dedicated to enhancing overall economic welfare in the Australian economy. To this end Rio Tinto believes that expenditure of such tax revenues should be transparent, economically efficient and in the long term national interest.

Rio Tinto believes that there may be a role for revenue recycling, although it wishes to draw the Review's attention to the fact that some of the economic literature on tax recycling raises doubts as to its efficacy in a practical sense. For example, in the Australian context, reductions in the distortions resulting from taxation would require reform of taxation regimes at all three levels of government. This would require a level of coordination and cooperation that is generally absent in our federal system. Rio Tinto agrees with the Review's draft findings that any compensation for low-income households must be done in such a way as to 'preserve the higher relative prices of emissions-intensive products' (Garnaut 2008b, p.53). However, it would also point out that the 'decoupling' of household decisions from any compensatory income adjustments is not a foregone conclusion, just as it has been observed that farm output in many countries has not been completely decoupled from so-called decoupled support payments.

As mentioned above, Rio Tinto is convinced that a significant share of any permit revenues must be used to increase the technology development budget for climate mitigation and adaptation.

References

Garnaut, R. (2008a), Garnaut Climate Change Review: Interim report to the Commonwealth, State and Territory Governments of Australia, Garnaut Climate Change Review, February.

Garnaut, R. (2008b), *Emissions Trading Scheme Discussion Paper*, Garnaut Climate Change Review, March.

Appendix 2: Emissions Intensive Trade Exposed Industries

1. Summary

Rio Tinto endorses the proposal outlined in Minister Wong's speech to the Australian Industry Group and in Professor Garnaut's Discussion Paper, to make provision for emissions intensive and trade exposed (EITE) industries in the emissions trading scheme. It is both economically efficient and vital for the maintenance of Australia's international competitiveness that the scheme maintains the competitiveness of these industries until Australia's international competitors face comparable climate policies.

That said, there are a number of challenges associated with identifying EITE industries for differential treatment. This paper explores some of the issues involved.

While ABS (Australian Bureau of Statistics) and AGO (Australian Greenhouse Office) industry emissions data are not currently ideal, they provide a reasonable basis for identifying EITE industries and allocating permits to them. The statistics can be quickly improved if the ABS, Department of Climate Change and research bodies collaborate and dedicate sufficient resources. Rio Tinto could willingly assist in providing information relevant to the metals and minerals sector. Top priorities should be:

- Development of an official concordance between ANZSIC codes and the AGO's industry classification for the Greenhouse Gas Inventory;
- Completion of a more up-to-date set of input-output tables; and
- Incorporation of greenhouse gas emissions into the input-output tables.

The mineral industries are among the most trade exposed and emissions intensive of all Australian industries. The EITE positions for Rio Tinto's three main commodities are discussed in appendices 3-5 of this submission, covering aluminium, coal and iron ore.

2. Rationale for differential treatment of emissions intensive trade exposed industries in the ETS

The increase in costs resulting from the ETS will particularly affect industries producing internationally traded homogeneous products such as minerals and metals. Rio Tinto in Australia faces intense competition from developing countries in its major product markets, including aluminium, alumina, iron, iron ore and coal.[2] [3]

[2]For aluminium, prices are set through the London Metals Exchange. For iron ore and coal, shipments are either sold under contract at negotiated prices or in the spot market. Alumina is a global commodity where prices are generally linked to the LME aluminium price. Some long term contracts are on fixed prices. The spot price for alumina reflects shortfalls and / or excess production related to aluminium demand. In a similar manner, pig iron prices follow the lead of iron ore prices. Pig iron is sold both on a contract and on a spot basis. At full production, HIsmelt®, at Kwinana in WA, will contribute approximately four per cent of global pig iron. In all cases, there are sufficient producers in diverse countries and large, well-informed customers to ensure fierce competition for sales between producers, and hence competitive pricing. Even though many commodity prices are buoyant and above the long term average, competition for sales and competitive pricing remains. Should market distortions occur

If no measures are taken to protect the international competitiveness of efficient Australian industries during the transition to global carbon pricing, Australian production could fall and be replaced by production in developing countries that, in some cases, have not introduced comparable mitigation measures. This transfer of production could mean that the reduction in global emissions is less than anticipated ('carbon leakage') and put Australian producers at a competitive disadvantage, which becomes progressively more acute.

Thus, introduction of the ETS without transitional measures to maintain the competitiveness of EITE industries would distort global resource allocation and lead to less efficient production. [4] Neither economic efficiency nor greenhouse gas abatement objectives would be achieved. These inefficiencies could be compounded once global prices change to reflect the real costs of carbon. Australian industry would then have to rebuild production and re-establish its international competitiveness, always assuming that it could surmount re-entry barriers.

3. How can EITE industries be identified?

Several questions should be considered in identifying those industries in need of assistance to maintain their international competitiveness during the transition:

1. How exposed is the industry to international trade (exports and imports) from countries that would not be subject to a carbon price/constraint?
2. How emissions intensive is the industry?
3. What capacity does it have to increase prices, i.e. is it a price maker or a price taker?
4. How will the increased costs affect its profitability and ability to maintain its production and markets in the long term?

If the answers to these questions indicate that an industry's international competitiveness would be severely affected and that it will lose markets to producers from non participating countries, particularly in the short term, then it is economically efficient to recognise the industry until world prices fully reflect the cost of carbon.

The concepts 'trade exposed' and 'emissions intensive' are relative. These industries are more trade exposed and emissions intensive than industry in general. Implementing such relative concepts will necessitate comparing individual industries with all others, and determining as to whether they are worthy of assistance on economic efficiency grounds. It is therefore important that the measures used have the widest possible coverage and that data be available for all economic production. The services sector, which accounts for two thirds of the economy, must be included in the analysis. So too, must small business. The

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due to uneven application of climate policy between competitor countries, Australia is likely to lose market share, which will worsen and become increasingly locked-in, the longer the distortions exist.

[3] In the time provided by the Garnaut Review, Rio Tinto has focused its analysis on its three main Australian businesses Rio Tinto Iron Ore, Rio Tinto Alcan and Rio Tinto Coal Australia. Insufficient time was available to extend the analysis to Rio Tinto's other businesses (diamonds, copper, salt and talc). Based upon the emissions and energy intensities of these other businesses relative to iron ore, aluminium and coal, Rio Tinto considers all its products to be affected. Rio Tinto is continuing its analysis of commodity level impacts and would be prepared to share them with the Garnaut review when they are completed.

[4] Transitional measures will be needed by industries with a vibrant future in a carbon constrained world until competitor countries adopt comparable measures.

requirement for consistent economy-wide data will impose constraints on the data to be used.

Identifying EITE industries can be done in three main ways:

- Use of quantitative criteria, such as benchmarks, thresholds and rules of thumb based on historical data;
- Modelling of the economy-wide effects to identify those that will be worst off; and/or
- Judgment.

Australia has a long history of policies using quantitative restrictions (quotas) in fields as diverse as natural resource management (e.g. water, fisheries and forests), international trade (imports and exports) and management of finite resources such as radiofrequency spectrum. Allocation of quotas or access rights in all of these areas has involved all three methods, usually together. Judgment must be exercised. Usually, where judgment is required on eligibility for government programs, governance needs to focus on ensuring appropriate independence.

The governance arrangements for EITE industries permit allocation within the ETS will be an important element of the scheme's design. An independent panel should recommend the list of industries to be granted EITE status to Government. Inclusion on that list would be based on clear criteria that would include consideration of the historical statistics and modelling outlined above. Rio Tinto submits that this should be a feature of any mechanism developed to assess an industry's eligibility for treatment as EITE.

Historical data on emissions and trade intensity provide the obvious starting point for identifying those industries most likely to be affected by an ETS. A statistical approach is commonly adopted as the basis for analysing the impacts of changes to quota management in natural resource based industries, such as fisheries, forests and water.

Such an approach can rank all industries by their trade exposure and emissions intensity and establish certain points relative to the median, mean or other percentile values, as thresholds or benchmarks. While different formulae can be used, this approach has the virtue of being transparent, replicable and intuitive. The statistical data are available to anyone, and it is easy to process for the intended purpose and understand. The basic industry production, value added, cost, import and export data are available at a fairly fine level of disaggregation (using ANZSIC coding).

A current drawback of the use of the Input-Output tables is that they are seriously out of date (2001-02). They therefore exclude the significant improvements in production processes of the past seven years, including energy efficiency measures and the structural changes to the economy associated with the commodities boom. Rio Tinto understands that the ABS is currently working to update the tables. This effort must be accelerated to provide a more current statistical base for the development of the ETS.

However, tables are static and based on the past. They do not show how industries respond to changes in relative prices as a result of the introduction of carbon prices and constraints. Nor do they consider economic feedback effects, as the economy overall reshapes as a result of the ETS.

Modelling can analyse how industries might respond to relative price changes resulting from the introduction of carbon prices and constraints. Australia has been a pioneer of computable general equilibrium (CGE) models that enable the direct and indirect impacts of economic policy changes to be tracked through industry sectors across the economy. The Monash suite of models developed by the Centre of Policy Studies at Monash University is well regarded, but there are other models. CGE models can be used to identify those industries that will be most advantaged or disadvantaged (refer also to comments in appendix 9 on CGE modelling). However, as noted in a later appendix, a good model can only produce good results if strict protocols are applied to modelling exercises (e.g. quality of input data, model closure, defining the reference case and scenarios, and transparency of the process). In light of the magnitude of the economic impacts of the ETS, Rio Tinto considers that it is vital that the Government invest the relatively modest resources required to enhance the data base and the models themselves, including their documentation.

4. Trade exposure metrics

Trade exposed industries are those that are price takers in world markets so that they cannot increase prices to compensate for domestic cost increases. A trade exposed industry within the context of the ETS must satisfy two tests; first, most product is sold at world prices, and second, that it is a price taker on world markets where prices are set by competitors in economies that are unlikely to implement carbon pricing or constraints in the short to medium term.

An indication of trade exposure is the proportion of market supplies exported (export orientation) or supplied by imports (import penetration). However, this does not indicate the competitive position of Australian industries or the nature of price setting in these world markets. Whether Australian producers can raise prices in domestic or export markets in response to cost increases cannot be determined simply from the proportion of production exported or market supplies imported, although those measures are useful starting points. International trade theory would suggest that, as a general rule, a small economy such as Australia is unlikely to set prices in world markets - except for a few commodities such as wool and abalone, where it is a dominant seller. And, even in the case of products like wool, history suggests that one supplier cannot dictate the price to the world because of the importance of substitutes in the market. For price takers on world markets, the higher their trade exposure, the more vulnerable they are to domestic cost increases as a result of input price rises or taxes.

Taking all these considerations into account, it is reasonable to assume that most goods produced by the agricultural, mining and manufacturing industries in Australia are exposed to international competition. Exceptions would include perishables and commodities such as bricks with low values relative to transport costs. International transport services are also likely to be considered trade exposed. On the other hand, much of the services sector in Australia is non-traded.

The next question is whether the world price will be set by markets that reflect a carbon constraint, or by producers in economies that are not subject to a carbon constraint. If the former, then there would be no basis for arguing that a trade exposed industry would be disadvantaged by the introduction of the ETS. However, if the latter, there would be a case.

Exporters of highly differentiated products that enjoy a degree of market power are not so vulnerable. For example, because of the tight regulation of international aviation, airlines are often able to raise prices to reflect cost increases by means such as fuel levies. However, for homogeneous products such as those produced by Rio Tinto's businesses, prices are generally determined by the lowest cost major producer.[5] For the majority of Rio Tinto's Australian products, these competitors are in developing countries such as Brazil, China and Indonesia, which are unlikely to impose a carbon constraint in the short to medium term.

These nuances of competition in international trade are unlikely to be accurately captured in most measures of trade exposure. The trade exposure coefficient (TEC), the sum of exports and imports as a proportion to total Australian market supply (production plus imports), is a simple static measure of trade exposure. It provides a useful starting point to identify the limited number of industries that meet the first criterion identified above. Once those industries that have high trade exposure are identified, supplementary analysis of the competitive nature of the world market can identify those with limited scope to influence their prices. ABS international trade statistics are the most timely, comprehensive and detailed of all the series needed to assess EITE industries.

5. Emissions intensity metrics

A whole of economy emissions management scheme, like the ETS, requires whole of economy emissions data to enable design of the scheme, modelling of the cap and trajectory(ies) for its reduction and for its ongoing operation. Information on GHG emissions from all sources is available at a relatively high level of aggregation. The ABS input-output tables contain information about production, value added, international trade and energy inputs by industry. This is the most complete set of consistent data available for assessing EITE industries. Unfortunately, the industry classification used by the Australian Greenhouse Office (AGO) is not identical to that used by ANZSIC.

Although the information currently available on emissions by industry is not of uniform quality, it can provide a basis for the identification of EITE industries. The first step is for the ABS and the AGO to collaborate on an official ANZSIC concordance to the AGO's emission data. This will allow emissions to be assigned unambiguously to industries and linked with various ABS data sets, particularly the input-output tables and other industry economic information. It would then be available widely for various types of analysis.

Rio Tinto Alcan commissioned such a study. This 'top down' approach takes the existing emissions inventory data and assigns it to the closest ANZSIC classifications. Emissions intensity can then be calculated.

While this is not definitive and aggregates a number of industries, it indicates that reasonable information could be quickly assembled to enable EITE to be identified once the resources of the ABS were devoted to the task.

This process would also be assisted by publication of an official input-output table with emissions. The Centre of Policy Studies at Monash University has built such a table to use in modelling climate change policies. This is a 'bottom-up' approach that has been built up from industry level transactions data and industry-specific emissions data. This enables combustion and non-combustion WBCSD Scope 1 and Scope 2 emissions to be separately identified for 55 industries. The tables however have not been transparently prepared and

[5] For the iron ore industry contract prices are based on annual "benchmark" price negotiations held between the major iron ore producers and customers.

in their current form may be unreliable for ETS design use. Resources should be quickly applied so that the Monash emissions inclusive input-output table can be verified and then made more widely available.

Mandatory reporting of emissions and energy use from 2008-09 will provide data to improve industry-level emissions statistics. However, this will not be available in the short term, as only large emitters and corporations will be covered initially. However, the availability of both emissions and energy use data from the same enterprises and facilities will enhance the ability to model emissions from a wider range of sectors, including service industries such as wholesale and retail trade.

The Government's energy information datasets are usually more complete than those for emissions. This then raises the question as to whether analysis and decision making can be based upon energy use. This does not appear possible in the analyses undertaken by Rio Tinto. Quite different conclusions as to classification and ranking of industries occur when emissions data are substituted for energy data. Presumably this is because some industries have relatively high non-energy related emissions (e.g. the coal industry). In addition, different energy forms have different emissions intensities. For this reason, Rio Tinto considers that analysis for determination of EITE status has to use emissions datasets.[6]

The emissions intensity of production can be defined in terms of the quantity of GHG emissions per unit of production. In 2005, Australia emitted 559 million tonnes (CO_2 equivalent) of greenhouse gases. The analysis of emissions intensity has to include both businesses direct exposure to the ETS i.e. through its WBCSD scope one emissions and its indirect exposure through passed through carbon changes e.g. in electricity and product transport. (i.e. through its WBCSD scope 2 and WBCSD scope 3 part only emissions).[7]

Another issue in determining metrics for emissions intensity is the measure of production or costs that should be used as the denominator for defining emissions intensity. The National Emissions Trading Task Group suggested a) a threshold of 3.5 per cent of energy costs as a proportion of total operating costs and b) 1200 t CO_2-e / million dollars revenue equivalent as a starting point definition for emissions intensive industry.

Rio Tinto suggests that the concepts and measures in the input-output tables should provide the appropriate measure of emissions intensity for the analysis of EITE if appropriate quality data tables can be developed in time. The cost of intermediate inputs, excluding labour costs, is the purest measure. This is the most direct measure of the potential impact on costs of the introduction of the ETS. This concept is not affected by changes in prices and wages in output and labour markets, like wider measures such as value added. This is the critical issue as the purpose of provision for EITE is to maintain international competitiveness of vulnerable industries in the face of cost increases.

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[6]There is a further complication in the analysis of historic data for Tasmanian electricity users. The AGO Tasmanian electricity grid emissions factor is much lower than for the mainland states. However, with the introduction of an ETS and Basslink, it is likely that electricity costs will rise far above that suggested by the Tasmanian grid factor and closer to that suggested by the emissions factor of the SE Australian grid. Additionally, the AGO grid factor continues to lag by several years and the true pass through effect of Basslink is not yet evident in the grid factors published to date.

[7] WBCSD scope 1 emissions relate to direct (on-site) emissions. Scope 2 emissions relate to indirect emissions associated with the production of purchased electricity and steam. Scope 3 emissions are other indirect emissions associated with generation, transport and use of a businesses product and include emissions from production and supply of consumables (e.g. explosives) or third party product transport (e.g. rail transport from mine to port).

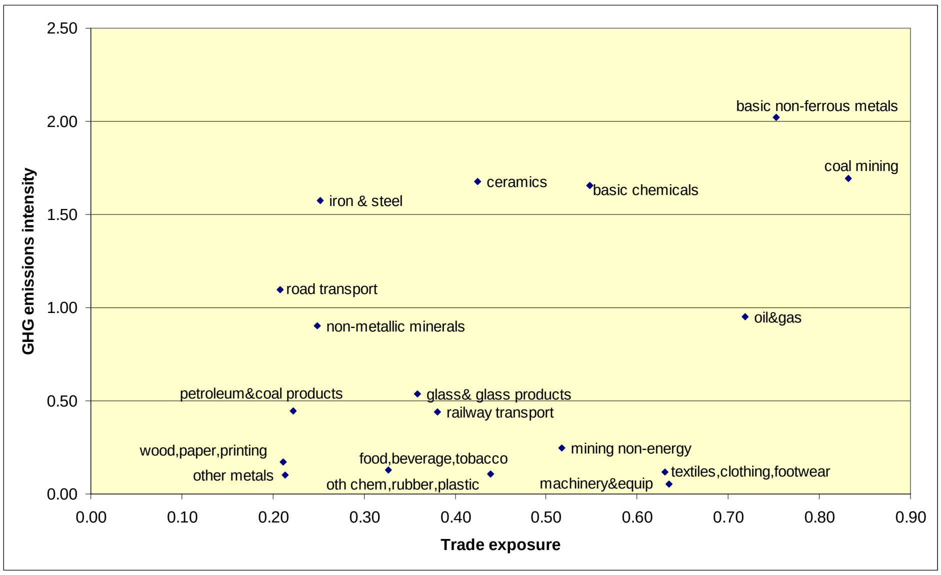
International studies of emissions intensity often use emissions or energy intensity as a proportion of value added or production. Such information is available from national accounts and may be the only production data consistently available in some countries. Australia has information on intermediate input costs that are more directly related to the purpose of the analysis and should be used if possible.

6. EITE analysis

Emissions intensity and trade exposure data can be combined to identify those industries most exposed.

The graph below (figure 1), derived from AGO and ABS input-output data shows trade exposure on the horizontal axis and emissions intensity on the vertical axis. Those industries higher up the emissions intensity scale will face significantly increased costs once the ETS comes in. Those industries to the right of the graph are likely to be less able to pass on the increased costs and will be more affected than those to the left.

Figure 1: Trade exposure and emissions intensity of selected industries



Source: ABS Input-Output Tables, 2001-02 and AGO, Greenhouse Gas Inventory 2005-06, AGEIS database

This chart shows that of the most trade exposed industries, basic non-ferrous metals and coal have the highest emissions intensity. The chart also illustrates how the high level of aggregation of 'Basic non-ferrous metals and products' hides the high emissions intensity of aluminium and alumina, which are not separately identified.

7. Industry or firm level treatment?

Rio Tinto considers that eligibility for EITE status should be determined at the industry level, not at the level of the individual firm. There are a number of reasons for this:

- The rationale for separate treatment of EITE industries is that they face particular transitional market distortions. This is essentially an industry, not a firm specific concept;
- The system must be simple, with low administration and compliance costs. Straightforward industry-level criteria can be developed for quick implementation. Firm based assessment will be resource intensive, time consuming and complex, with no compensating public policy benefits.; and

- Public confidence in the concept of temporarily insulating EITE industries requires transparency and reliance on readily available and understandable measures of trade and emissions intensity. The accounting concepts used should be economy-wide and available from public sources such as the ABS and AGO. Firm based data will inevitably contain much that is commercial-in-confidence and that cannot be publicly released.

In saying this however, Rio Tinto restates its concerns with the timeliness of input-output tables. These data must be accurate, detailed and up to date.

8. Conclusion

All of Rio Tinto's Australian businesses are export oriented, and most of their products are homogenous commodities traded at world prices. Rio Tinto's production, like that of the minerals industry as a whole, is trade exposed and emissions intensive relative to average Australian industries.

Appendix 3-5 of this submission presents the case for Rio Tinto's three main commodities for EITE status.

Rio Tinto has shown its faith in the long term competitiveness of the Australian economy through the major expansions currently underway in every sector in which it operates. Nevertheless, faith will not counteract price undercutting by developing country competitors once their current expansions come into production. While Rio Tinto supports the introduction of an ETS, emissions intensive trade exposed industries need special recognition until international markets adjust to a carbon constrained world.

Appendix 3:
Business Case Study: Issues for Rio Tinto Alcan in the development of Australia's climate policy

1. Summary

Rio Tinto Alcan (RTA) is the Rio Tinto Group's bauxite, alumina and aluminium business. In Australia, RTA has complete or majority ownership of two bauxite mines, three alumina refineries and three aluminium smelters. In addition, RTA has a part share of the Gladstone power station. In designing an Australian emissions trading scheme (ETS), the key issues for Rio Tinto Alcan are:

- Aluminium metal has a strong future in a carbon constrained world. It has a greenhouse positive lifecycle because of its light weight and its ability to be repeatedly and economically recycled.
- The Australian aluminium industry is highly efficient by world standards and should remain so after competitor nations implement comparable climate policies. It contributes considerably to national and regional income. There are some opportunities for small step changes in alumina or aluminium smelting technologies in the medium term. Moderate emissions reductions will occur as a consequence of the adoption of advanced smelting technologies as they become available. Further emission reductions will occur with the decarbonisation of the Australian electricity sector. The industry is vulnerable in the climate policy transition period as it is emissions intensive and a price taker for its product. Its main competitors are located in developing countries that, currently, have no plans to place a price on their emissions. Relatively small interim carbon prices applied in Australia would seriously compromise the competitive position of the Australian aluminium industry.
- Rio Tinto seeks 100 per cent administrative allocation of permits for emissions intensive, trade exposed (EITE) industries for best in class performance of both direct and indirect emissions. Failure to do so could see the loss of greenfield and brownfield growth in the alumina and aluminium sectors. There would also be a rundown of assets because of a reduction in sustaining capital. The ensuing plant closures would be environmentally and economically inefficient because production would transfer to other carbon intensive economies. Australia would slide down the value-adding ladder without there being any commensurate global environmental advantage.

2. Rio Tinto Alcan

Rio Tinto Alcan (RTA) manages the Rio Tinto Group's interests in aluminium, from bauxite to finished products. In 2007, Rio Tinto Aluminium and Alcan merged to create RTA, a new world leader in aluminium. A considerable proportion of RTA's global production is produced in Australia (table 1) at RTA's two bauxite mines, three alumina refineries and three aluminium smelters.

Table 1 RTA - Australian Production

Commodity	Operation (% ownership)	2007 Production ('000 tonnes)[1]	
		RTA Share[2]	Full Production[3]
Bauxite	Weipa[4] (100%)	18,209	18,209
	Gove (100%)	4,660	4,660
Alumina	Gove (100%)	1,884	1,884
	QAL[5] (80%)	3,053	3,816
	Yarwun[6] (100%)	1,260	1,260
Aluminium	Bell Bay (100%)	178	178
	Boyne Island[7] (59%)	330	559
	Tomago (52%)	266	512

Notes

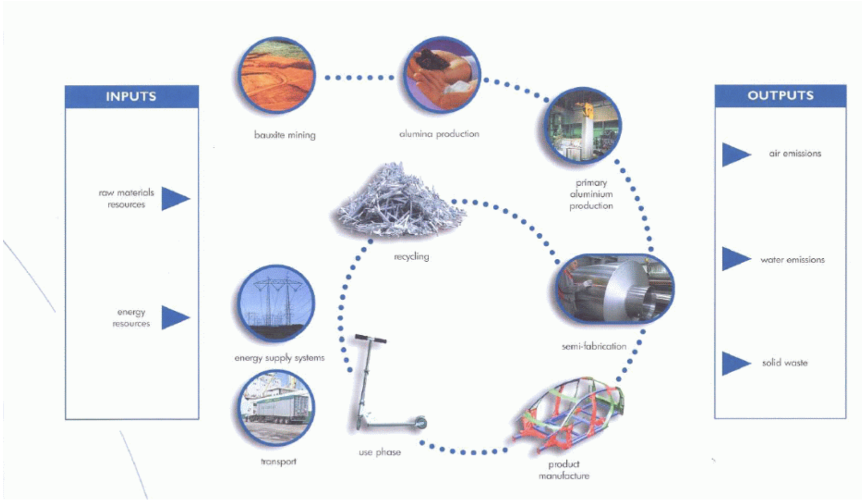
1. All data in this table is derived from http://www.riotinto.com/riotintoalcan/ENG/media/35_media_releases_1187.asp
2. RTA share represents the full percentage share of the former Alcan combined with the former Rio Tinto Aluminium, despite the Alcan acquisition being 24 October 2007.
3. Full production represents the total production from a given operation for the 2007 year regardless of its ownership.
4. Includes beneficiated and calcined bauxite production.
5. Rio Tinto held a 38.6% share in QAL until 24 October 2007; this increased to 80.0% following the Alcan acquisition.
6. Yarwun was previously known as the Comalco Alumina Refinery.
7. Rio Tinto also holds a 42 per cent equity share of the Gladstone power station, which supplies power to the Boyne Island aluminium smelter. Discussion in this document is limited to the impacts on the smelter.

2.1 Aluminium Production

Figure 1 shows the production and life cycle of aluminium. The two most emissions intensive parts of the process are alumina refining and aluminium smelting. The average emissions intensity for the Australian industry's production is 0.75 t CO_2-e / t alumina and 16.3 t CO_2e/t aluminium (including both direct emissions of 2.1 t CO_2-e / t aluminium and indirect emissions associated with the use of purchased electricity of 14.2 t CO_2-e / t aluminium). [8]

[8] Australian Aluminium Council Sustainability Report (July 2007), http://www.aluminium.org.au

Figure 1 Production and Life of Aluminium [9]



2.2 The Australian aluminium industry is already world class

International Aluminium Institute data from 2006 show that the Oceania region (predominately Australia) is a leader in the energy efficient production of aluminium. Since 1990, the Australian aluminium industry has reduced onsite emissions per tonne of production by 59 per cent, from 5.1 t CO_2-e / t aluminium in 1990 to 2.1 t CO_2-e / t aluminium in 2006. When emissions from purchased electricity are included, the reduction over the same period is 12 per cent. However, most of these savings were associated with reduction in perfluorocarbons (PFCs), associated with anode effects. The opportunity to further reduce emissions is limited in the short term.

RTA's Australian operations are pursuing reduced anode carbon consumption and incremental energy efficiency gains in the short term and brownfield retrofit of more energy efficient technologies in the longer term as the major pathways to reducing the impacts of climate change and to deliver improved business value. Australian aluminium and alumina production are competitive on a global scale (table 2 and table 3). Closure of Australian assets is likely to result in increased production by more marginal producers, who are less efficient, with a resulting increase in global emissions.

Table 2. Regional average electricity use for primary aluminium production (kWh/tonne) 2006

Africa and South Asia	**14 622**
North America	15 452
Latin America	15 030
Asia	15 103
Europe	15 387
Oceania (includes Australia)	*14 854*
Weighted average	**15 194**

Source: International Aluminium Institute Electrical Power Used in Aluminium Production ES002 21 December 2007

[9] International Aluminium Institute, http://www.world-aluminium.org/

Table 3. Regional average energy use of metallurgical alumina production (GJ/tonne) 2006

Africa and South Asia	**14.5**
North America	11.9
Latin America	11.2
Europe	13.1
East Asia and Oceania (includes Australia)	*11.8*
Weighted average	**12.0**

Source: International Aluminium Institute Form ES012 21 December 2007

2.3 Positive properties of aluminium

Aluminium has a future in a carbon constrained world. It has a greenhouse positive lifecycle in many of its applications due to its light weight and ability to be repeatedly recycled[10]:

- Weight saving:
  - Six to eight per cent fuel savings for every ten per cent reduction in vehicle weight
  - Every kilo of aluminium that replaces conventional materials can eliminate 20kg of CO_2 over the life of a vehicle
  - Aluminium used in vehicles saves energy and emissions and offsets the emissions from the production of the aluminium
- Recycling:
  - Can be recycled and repeatedly reused without loss of properties
  - Saves 95 per cent of the energy required to produce primary aluminium
  - Recycling aluminium saves an estimated 84 Mt of greenhouse gas emissions globally each year with total avoided emissions of over one billion tonnes CO_2-e[11]

The beneficial effect of a high recycling ratio and low lifecycle emissions will allow aluminium to compete successfully against steel and other products when there is a global carbon market.

The beneficial effect of a high recycling ratio and low lifecycle emissions will allow aluminium to compete successfully against steel and other products when there is a global carbon market.

3. Value of Aluminium to Australia

RTA's Australian smelters and refineries are highly efficient by world standards and contribute significantly to the Australia economy:

- In 2007, RTA's share of production from its Australian operations was 774 000 tonnes of aluminium, 6.2 million tonnes of alumina and 22.9 million tonnes of bauxite, of which over 80 per cent was exported; [12] and

[10] http://www.world-aluminium.org/About+Aluminium/Benefits

[11] International Aluminium Institute, http://www.world-aluminium.org/Sustainability/Recycling

- RTA employs more than 7000 employees and contractors in Australia.

The aluminium industry in Australia:

- Directly employs around 20,000 and, indirectly, around 60,000;
- Is geographically dispersed in regional Australia; operations are located in the Northern Territory, Queensland, New South Wales, Victoria, Tasmania and Western Australia;
- In 2007 was Australia's third largest commodity export with annual export earnings in excess of $11 billion[13];
- The export value added multiplier for alumina and aluminium compared to bauxite is broadly estimated at five and 15 respectively;
- Over the last 50 years, Australia has attracted significant investment in its aluminium industry, due to the presence of:
  - twenty five per cent of the world's bauxite reserves [14]
  - competitively priced electricity and other energy sources
  - modern infrastructure
  - a stable investment climate

RTA will pursue the growth of its value adding alumina and aluminium businesses in Australia in order to maximise the value of its bauxite assets, providing Government policies support long term capital investment in emissions intensive industries.

4. Emissions Intensive, Trade Exposed Industries (EITE)

4.1 Recognition of Emissions Intensive, Trade Exposed Industries

Trade exposed industries are those that are price takers on world markets; industries that cannot increase prices to compensate for domestic cost increases. A continued focus is needed on EITE industries to maintain their competitiveness. Continued investment is needed to prevent "leakage" of emissions by inefficient transfers of production from Australia to countries that have not introduced emissions mitigation measures.

RTA's Australian operations are clearly part of an EITE industry:

- Aluminium emissions represent eight per cent of Australia's total CO_2-e emissions;
- Aluminium competes in a global market where over 50 per cent of production is currently sourced from Non Annex B countries;
- RTA's Australian operations cannot pass on emissions trading scheme (ETS) related cost increases to its customers because aluminium prices are set through the London metal exchange (LME);

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[12] Share of production relates to that proportion of production which belongs to Rio Tinto on account of its ownership interest in each operation available from http://www.riotinto.com/riotintoalcan/ENG/media/35_media_releases_1187.asp

[13] Australian Aluminium Council, http://www.aluminium.org.au/Page.php?d=1090

[14] U.S. Geological Survey, Mineral Commodity Summaries, January 2008, http://minerals.usgs.gov/minerals/pubs/mcs/2008/mcs2008.pdf

- Carbon dioxide is an unavoidable by-product of the aluminium smelting process until such time as there is a fundamental change in the way aluminium is made;
- Unless EITE issues are adequately addressed, an ETS will have an increasing financial impact on RTA's Australian operations; and
- RTA's mining, refining and smelting operations are efficient (refer to section 2.2) and close to best in class for their respective installed technologies.

4.2 How emissions intensive is the industry?

The aluminium and alumina industries represent eight per cent of Australia's emissions:

- 2005 Australia's total emissions were 559 Mt CO_2-e[15]
- 2006 Australian aluminium industry emissions were 45.3 Mt CO_2-e[16]
  - 31 .4 Mt CO_2-e from aluminium
  - 13 .9 Mt CO_2-e from alumina
- 2006 RTA total emissions (equity share) in Australia were
  - 9.5 Mt CO_2-e from aluminium
  - 6.5 Mt CO_2-e alumina

4.2.1 Comparison with National Emissions Trading Taskforce definitions for EITE

The National Emissions Trading Taskforce (NETT) proposed two possible criteria against which the intensity of an industry could be measured, one for emissions and one for energy. [17] To illustrate the emissions intensity of the aluminium sector, intensities were calculated from publicly available datasets and compared with the NETT criteria.

Criteria 1. One thousand, two hundred tonnes CO_2-e per million dollars of revenue:

- 2006 aluminium industry export earnings were approximately $11 billion
- 2006 Australian aluminium industry emissions were 45.3 Mt CO_2-e
- 4,100 t CO_2-e per million dollars revenue

Criteria 2. Three and a half per cent of energy costs as a proportion of total operating costs (table 4). Clearly, virtually all of the metals and minerals sector is emissions intense under this NETT criteria. However, aluminium refining and smelting are particularly so.

[15] National Greenhouse Gas Inventory 2005, http://www.climatechange.gov.au/inventory/2005/index.html

[16] Australian Aluminium Council Sustainability Report (July 2007), http://www.aluminium.org.au

[17] Possible design for a national greenhouse gas emissions trading scheme: Final framework report on scheme design. A report prepared by the National Emissions Trading Taskforce. December 2007.

Table 4. Energy intensity of Australian Mining and Metals Industries

INDUSTRY	ENERGY COSTS % TOTAL INPUT COST
*Alumina Refining**	*23.6*
*Aluminium Smelting**	*19****
Other mining**	15.92
Non-ferrous metal ores**	15.65
Coal**	12.53
Iron and steel**	10.83
Iron ores**	9.07
Basic non-ferrous metals and products**	**6.44**

**CRU, 2007 where Energy is the sum of Fuel & Power inputs*
***Source: ABS Input-Output Tables, 2001-02*
****The amalgamated figure showing 19 per cent of smelting costs arising from potroom and auxiliary power varies significantly based on local circumstances and can rise to more than 25 per cent under some circumstances. Including the energy used in the alumina refinery stage, the share of energy in aluminium operating costs rises to 29.2 per cent - and for some individual facilities this is in the order of 35 per cent. Energy is also the main component in anode costs.*

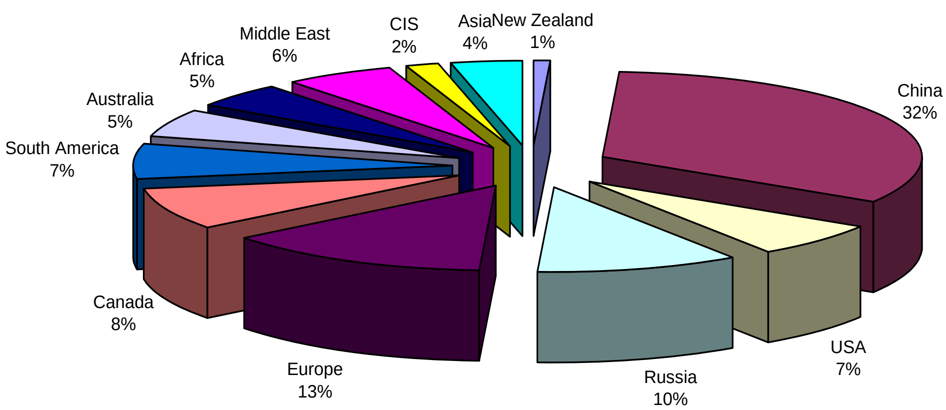
4.2.2 Energy as a proxy for emissions

Energy is often taken as a proxy for emissions, as energy data are more available. Generally, companies that have high greenhouse gas emissions are also likely to be high energy users. However, this is not always the case, as some industries have non energy related process emissions. Also different energy sources have different emissions intensities hence the relationship between energy and energy intensity for individual firms depends on the fuel mix used. The target of an emissions trading scheme should therefore not be energy, but emissions.

4.3 How exposed are RTA's Australian operations to competition from countries that will not be subject to a carbon price/constraint?

Aluminium is produced in 250 smelters worldwide with Australian smelters producing approximately five per cent of total world output (figure 2).

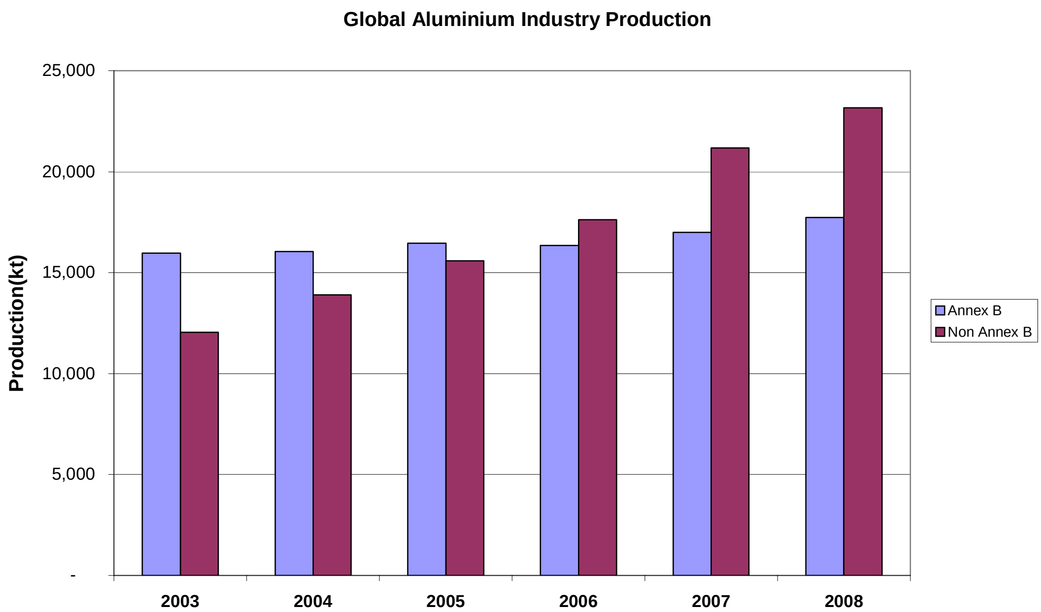
Figure 2. World Aluminium Production – 2007



Source: Commodities Research Unit

By the end of 2008, global aluminium production will have increased by around 13 Mtpa from 2003 (figure 3). Approximately 11 Mtpa will have been added in non Annex B countries with China alone contributing 8 Mtpa, using primarily coal fired electricity generation.

Figure 3. Global Aluminium Industry Production



Source:James King World Capacity and Market Report Nov 2007

The introduction of an ETS that results in the relocation of efficient aluminium production to a Non Annex B country, such as China, would not result in any decrease in global carbon emissions, simply carbon leakage, with associated negative socio economic outcomes for the Australian community. Clearly, the industry is now dominated by production from China and from other non-Annex B countries that are not contemplating climate policies comparable to Australia's in the foreseeable future.

4.4 What capacity do RTA's Australian operations have to increase prices?

RTA's Australian operations compete directly with overseas competitors in both domestic and international markets. In 2007, more than 600kt or 80 per cent of RTA's Australian production was exported. Freight from Australia's nearest competitors costs around US$15/t-$20/t, and offers little import protection to Australia's domestic producers.

RTA's Australian products are sold internationally and compete with overseas producers for market share. Aluminium prices are set internationally through the LME. RTA's Australian production is all sold under world market pricing that will not be affected by an Australian ETS. Because of this, RTA's Australian operations are trade exposed and are competitively at a disadvantage. As a price-taker, any increase in operating costs, including a carbon price, must be absorbed as it cannot be passed through to customers.

4.5 What capacity do RTA's Australian operations have to reduce their emissions?

4.5.1 Technological constraints to improvement

RTA's Australian smelters, like all other aluminium smelters, use the Hall-Heroult process to reduce alumina to aluminium. Although incremental improvements have been made to this process over time, the process remains basically unchanged since its discovery in the late 1800s. Carbon dioxide produced by the electrochemical oxidation and air burn of the carbon anode will be a by-product of this aluminium smelting process until there is a fundamental change in the way aluminium is made[18].

Australian smelters' perfluorcarbon (PFC) performance is world class; and their power efficiency is very good. Further PFC and power efficiency improvements are possible with a sustained development effort including technology investments, but will deliver limited improvement. The industry expects significant, step change improvements to come through the implementation of larger scale (AP50[19], 500kA Cell) and new technology cells including the AP-Xe. The deployment of low emissions technologies for the generation of power will have the greatest impact on the emissions foot print of the aluminium sector:

- PFC emissions from Australian smelters are currently a small percentage of smelting's direct and indirect emissions. Consequently, further improvements in PFC emissions at Australian smelters will have little effect on total emissions. That said, consistent performance well below 0.05 AE min/pot day is being targeted by RTA in Australia and this target is being supported by high priority programmes; [20]
- All RTA Australian smelters that have genuinely pushed their anode-cathode distance limits and cell lining designs are unlikely to achieve significant gains in electrical energy efficiency without large capital investment. At these smelters, improvement will depend on brownfield retrofit of busbar (2 per cent) and in the longer term the potential implementation of drained cell technology (10 – 15 per cent); and
- Complete potline replacement technology comes at a very high capital cost (> $1b and usually requires a new carbon and rodding plant) and is only of commercial interest where energy supply contracts remain highly competitive.

4.5.2 Investment in research & development

Whilst the smelting process is energy intensive, significant electricity costs are an incentive for aluminium smelters to improve their electrical efficiency. Despite a world wide search to find new smelting technologies, a step change from the current process is still many years away. RTA has invested hundreds of millions of dollars investigating such technologies and continues large scale research into high efficiency and low emission smelting technologies.

In March 2008, RTA announced that it has begun development on the next generation of its AP Technology series (AP-Xe). AP-Xe will be developed in phases, including a potentially workable "drained cathode" that, taken together with other portfolio technologies under development, could potentially result in a lowering of unit energy consumption by up to 20 per cent. Drained cathode cells are already under test on an industrial scale and the next phase will be the progressive start-up of a 10-cell AP30 test section at RTA's research facility in France. If successful, an industrial scale-up of this aluminium technology could begin in five years, however commercial viability has not yet been tested. This technology is designed to be retrofitted to previous AP series cells. While the maximum energy consumption savings are expected from greenfield applications, some savings could also be achieved in retrofitted cells.

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[18] By the implementation of a yet to be developed, commercial inert anode technology

[19] Aluminium Pechiney (AP) Technology is fully owned by Rio Tinto Alcan

[20] AE min / pot day is the measure used by the Aluminium industry to determine the frequency and duration of anode effects, which result in the emission of PFCs. This measure is directly proportional to PFC emissions.

4.5.3 Continued industry investment

Aluminium smelters and alumina refineries are capital intensive and cannot change installed technology without major costs. Also, to remain competitive, companies need the confidence to commit to ongoing investment. Australia's aluminium and alumina industry has been continuously modernised through significant capital investments. RTA in Australia has two expansion projects in advanced implementation - Yarwun 2 (US $1.8 billion, employment - peak construction 2,200, operational - additional 270) and Gove 3 (US $2.3 b). In addition, it is continuing to invest in existing assets such as the Boyne Island smelter (see case study). Furthermore, RTA has a number of projects which are under consideration, subject to an acceptable rate of return. The manner in which EITE industries are accommodated will have a major effect on project economics.

Case Study: Continued investment in Boyne Island aluminium smelter

In February 2008, Rio Tinto (59.4%) and its Boyne Island Smelter Joint Venture partners (40.6%) announced that they will spend approximately US$617 million on two projects to modernise and extend the life of the Boyne Island aluminium smelter.

- The first project is the construction of a new more efficient open bake anode furnace which will replace two existing carbon bake furnaces. Amongst other things the furnace will reduce onsite greenhouse gas emissions by approximately 20,000 tonnes CO_2-e annually.
- The second project comprises an overhead crane replacement and a crane runway upgrade. This will result in a more efficient crane/alumina transport system. As part of these projects modernised cell tending assemblies and a new alumina distribution system will also be installed to supply each cell independently of crane operations. The crane optimisation project will also improve the work safety.
- These projects will be built over three years and underpin the continued successful operation of the smelter and help to ensure the continuing reliable supply of high quality aluminium to global customers. This modernisation project will extend the life of the asset and improve efficiency.

4.6 How will the increased ETS costs affect the profitability of RTA's Australian operations?

The ETS will have an increasing financial impact on RTA's Australian operations. Although the emissions intensity of production is expected to reduce over time, further abatement comes at an increasingly higher cost. This financial exposure arises primarily from:

- Increases in the price of electricity;
- Direct process and fuel emissions; and
- A potential increase in other operating costs as a result of the flow on effects of the ETS to the wider Australian economy.

RTA's biggest exposure is to the increase in the electricity price that their Australian operations pay under long-term contract and directly to the spot market. RTA's emissions profile in Australia (~16 Mt CO_2-e in 2007) means that a relatively small interim carbon prices applied in Australia would seriously compromise its competitive position in the absence of similar schemes abroad. The greatest impact is on the Australian smelting based operations due to the indirect impact of emissions associated with electricity generation.

4.6.1 Additional implications of a Renewable Energy Target

The extension of a Renewable Energy Target (RET) will further increase costs. As an EITE industry, aluminium cannot pass through any additional costs resulting from a RET. Any modelling impacts from an ETS on the Australian aluminium industry should take into account the combined effect of both the ETS and the RET on costs and the fact that a RET may not bring about the lowest cost abatement. Treatment of EITE industries should include these costs.

4.7 Many EITE issues can be appropriately addressed through administrative allocation of permits to EITE industries

EITE industries should be identified using industry-level data, models and criteria. However, once an industry has been identified as worthy of administrative permit allocation, the permits have to be allocated to individual companies. The precise allocation mechanism may vary depending on the nature of the sector.

- As a transitional mechanism, EITE permit allocation should continue until the creation of a global carbon market;
- A list of EITE industries should be published in a schedule to the Emissions Trading Act;
- An independent panel should allocate permits to industries and to enterprises in accordance with predefined principles; and
- Allocation should be 100 per cent of "best in class" performance and would include both direct and indirect emissions. Allocations of less than 100 per cent, or which are subject to arbitrary sunset clauses, will result in "profitless survival". This would mean that the industry would not continue to invest, would lose international competitiveness and, eventually, diminish.

Appendix 4: Business Case Study: Issues for Rio Tinto Coal Australia in the development of Australia's climate policy

1. Summary

- Rio Tinto Coal Australia (RTCA) is a significant export producer of thermal and coking coal – Australia's number one export industry in 2007. It has three operating mines in New South Wales and three in Queensland, and a fourth mine under development (in Queensland).
- RTCA is convinced that in a carbon constrained world coal will continue to meet a significant proportion of global primary energy demand. Access to affordable, secure and reliable electricity supply enables economic development and rising living standards. Coal is a globally abundant, affordable and reliable energy source that is a key component of many developed and developing countries' electricity supply chain. Carbon capture and storage provides a pathway to low emissions coal use.
- The Australian export coal industry is both trade exposed and emissions intensive. It is a price taker in the global coal market and cannot pass increased production costs on to its customers. The design and operation of the ETS will influence RTCA's growth and investment behaviour. A poorly designed ETS, combined with the cyclical nature of the commodity, could see Australia lose market share to competitor nations that do not have comparable climate policies. This would be both economically and environmentally inefficient as Australia would forgo the economic and social benefits of the investment. These would shift overseas whilst achieving no net reduction in global emissions. RTCA requests that the ETS design provides transitional support to the coal industry until such time as Australia's international competitors are subject to a comparable price on greenhouse gas emissions.
- Reducing emissions during coal mining is becoming increasingly difficult. RTCA is implementing an emissions reduction and energy efficiency program. However, RTCA's experience is that without new technologies, achieving significant emissions reductions is very difficult.
- Including fugitive coal mine methane emissions in the ETS requires accurate measurement methodologies. RTCA requests that Government work with the coal industry to develop accurate methodologies prior to the inclusion of fugitive methane emissions within the scope of the ETS.
- A major issue for countries with large coal resources such as Australia is accelerating the commercialisation and deployment of carbon capture and storage at the point of coal use. RTCA supports Australian leadership through establishment of a national low emissions technology strategy.

2. Coal has an ongoing role in the global energy mix

- Today 1.6 billion people (25 per cent of the world's population) do not have access to electricity and its accompanying benefits. Affordable, secure and reliable electricity supply enables economic development, which is an essential prerequisite for poverty alleviation.

- World primary energy demand growth is projected to continue consistent with historical trends, with most of the growth and resultant emissions occurring in developing countries. China, the largest emerging economy and one of the top two emitters is a case in point. It plans to reduce annual emissions through greater energy supply diversification (including nuclear and hydropower) and efficiency improvements. However, China's priority remains economic development and poverty eradication.

- Fossil fuels currently dominate primary energy supply – they meet 80 per cent of current global needs and are likely to supply 81 per cent in 2030. Coal is the most abundant and geographically the most dispersed fossil fuel. In a time of rising energy demand, coal provides unmatched energy security. Countries with large indigenous reserves, such as the USA, Australia, China, India, and South Africa, will continue to rely on coal for decades to come. To illustrate, 93 GW of coal-fired power stations were constructed in China in 2006. This is equivalent to building Australia's entire electricity grid once every six months. These power stations are likely to operate for at least 40 years.

- Technologies that use the world's enormous coal resources whilst reducing emissions are essential. Carbon capture and storage (CCS) is projected to contribute significantly to emissions reduction and confirm coal's ongoing role. By itself, CCS reduces the cost of stabilising atmospheric concentrations of CO_2 at 550ppm by over five trillion dollars.[21] The IEA draws similar conclusions: [22]

  "*Clean coal technologies with CCS offer a particularly important opportunity to constrain emissions in rapidly growing economies with large coal reserves, such as China and India. CCS is indispensable for the role that coal can play in providing low-cost electricity in a CO_2 constrained world.*"

- Each of the component technologies of post combustion capture and geological storage of carbon dioxide is mature and commercially deployed for specific applications. Development of gas turbines designed to burn high concentrations of hydrogen will improve the efficiency of pre-combustion capture (integrated gasification combined cycle). What is required is the integration of these technologies on a commercial scale to deliver low emission coal fired electricity.

3. The design and operation of the ETS is a critical factor in determining the future contribution of coal to the Australian economy

- RTCA operates six mines in Queensland and New South Wales with a further one under construction. In 2007 it produced approximately 30 Mt of hard coking and other coals on a Rio Tinto equity share basis. Of that tonnage 85 per cent was exported. That component of Australian production that is exported is trade exposed and differentiated (in both quality and processing requirements) from the coal that is sold domestically.

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[21] Global Energy Technology Strategy Phase 2 Report. Note that Rio Tinto is not endorsing stabilisation at 550ppm CO_2e as preferable to less or more stringent targets.
[22] IEA *Energy Technology Perspectives 2006* report

- Coal matters to Australia. Not only is it used to generate 84 per cent of Australia's low cost electricity, it also provides significant export revenue. In 2007 coal was Australia's largest commodity export, responsible for approximately A$22.5 billion in export earnings.[23]

- The Australian coal industry directly employs approximately 30,000 employees and jobs servicing the Australian coal industry exceed 100,000. The coal industry is most concentrated in NSW's Hunter Valley and in Queensland's Bowen and Surat Basins, where it plays a major role in the economies of regional communities.

- Australian export coal producers' principal competitors in the international market are developing countries (including Indonesia, South Africa, and Colombia) that do not have Kyoto emission targets, or, in the case of Russia, are well able to meet their Kyoto obligations after the collapse of the economy of the former Soviet Union. None are soon likely to have emission reduction requirements equivalent to Australia's.

- Coal production is an emissions intense trade exposed industry (EITE) (appendix 2) with emissions arising from energy use (stationary and mining fleet) and fugitive methane emissions. The international seaborne coal market is transparent, driven by supply and demand with no material opportunity for product differentiation. Australian coal producers are price takers and will not be able to pass the cost of emissions on to customers, whilst our major competitors are not exposed to similar costs. Consequently an ETS could add significantly to production costs, which will reduce profits and returns to shareholders.

- RTCA has a good historic emissions database with which to consider the impact of a carbon price on business performance (in 2007 the greenhouse gas emissions from RTCA's operations were 3.0 Mt CO2-e). RTCA has used its database to calculate the impact on RTCA profit that would have occurred each year since 2000 assuming full exposure to a CO_2-e price of $15, $50 and $100 per tonne and an inability to pass on to its customers the carbon charge. In undertaking these calculations it used historical emissions and profit data. The calculations illustrate the potential for a carbon price to affect profitability of an efficient coal mining business. Calculated financial impacts would be sufficient to evoke a substantial management response to ensure the company continues to operate in the best interests of its shareholders.

- As a first step in such a response companies must consider the cost of carbon in their financial models and investment assessment processes (something which RTCA already does). A carbon price appears as an additional cost of production with a direct reduction in the net present value of all investment proposals considered in Australia. The overall effect will be to act as a disincentive to investment in business development and growth in Australia. There is a corresponding, increased incentive to invest in places with lower production costs that offer greater shareholder returns. RTCA is confident that it will be able to continue to operate profitably in Australia under a well designed emissions trading scheme. However, an ETS that does not address the EITE nature of the coal industry will reduce investment in Australia. The communities and regions in which we operate will forgo the economic and social benefits from those investments. Further, the increasing global demand for coal will be met by increased production in our major competitor countries as long as they remain carbon havens.

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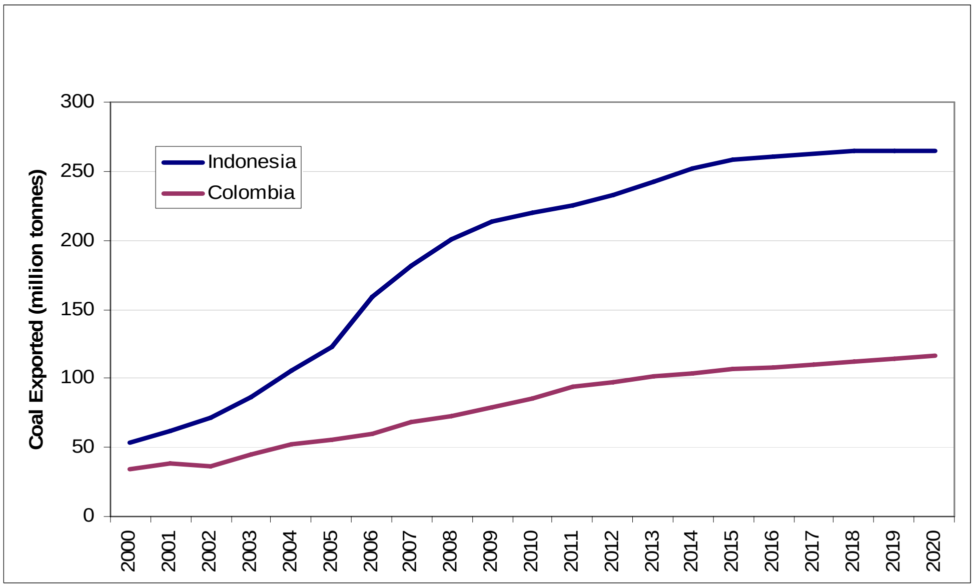
[23] Australian Coal Association Coal Facts for Australia, 2008. http://www.australiancoal.com.au/Pubs/COAL per cent20FACTS per cent20AUSTRALIA per cent202008 per cent20Feb08-4.pdf

- Companies will also seek to identify opportunities to reduce production costs, including emissions, and general overheads to offset the loss of profitability caused. RTCA and the Australian coal industry is investing heavily in low emission coal technology development including, but not limited to, the Australian Coal Association's billion dollar Coal21 Fund. Whilst RTCA will remain committed to the development of low emission coal technologies, the sustainability of this investment at current levels could be questioned by the industry if business profitability was threatened.
- As described in the case study (Box 1), the current high global demand for coal does not affect the fundamental issues concerning an ETS applied to the coal industry, and the need for careful analysis.

Box 1: Emissions trading and current market conditions

Growth in coal demand has recently driven coal prices to record highs. This is not a reason to gloss over the fundamental issues concerning the application of emissions trading to the export coal sector. This box examines why:

- Australian coal exporters' ability to increase sales into this favourable market remains tightly constrained by inadequate port and rail infrastructure. The opportunity lost to Australia has been taken up by other coal exporters, including new entrants such as the USA. This reinforces the fact that the profitability of the coal industry is affected by numerous factors in addition to the coal price. To illustrate rising spot coal prices did not translate to rising profitability in 2007;
- The current buoyant coal market has driven a significant increase in coal mine development in developing countries not subject to greenhouse gas emission constraints. Coal production in these countries is expected to grow strongly in response to increased demand. Actual coal exports from Indonesia and Colombia have increased since 2000 and are projected to continue to grow at least until 2020;[24]



[24] Barlow Jonker

- As global production increases, and supply increases to meet and then exceed demand, there will be downward pressure on coal prices consistent with the familiar cyclical nature of coal and minerals markets; and
- As additional production comes on line and coal prices fall, the higher cost of production for Australian coal exporters compared to competitors in developing countries will become a critical factor in international competitiveness. The coal industry is acutely aware of this fact and is working hard to avoid locking in production cost increases that will not be sustainable in the medium term, whilst striving to maintain market share. The cyclical nature of commodity markets and the eventual reduction in prices are factored into investment decisions by coal producers. This should equally be acknowledged in Government policy formulation.

RTCA requests that the ETS design includes transitional arrangements for the coal industry until such time as Australia's international competitors are subject to a comparable price on emissions.

4. Achieving large reductions in emissions requires new technologies

- RTCA and Rio Tinto recognise the imperative to reduce emissions and have established an internal Rio Tinto wide target of a four per cent reduction in emissions per unit of product between 2003 and 2008. Despite major effort and the application of significant resources, RTCA is not meeting this target because of the difficulties of identifying, engineering and implementing projects of sufficient magnitude over time periods that are relatively short in comparison to the life expectancy of major plant items. In 2007, RTCA programmes delivered emissions reduction of 1.5 per cent compared to business as usual.
- Approximately 35 per cent of RTCA's emissions (in CO_2-e terms) derives from energy use. The company is a large user of energy because coal mining involves the movement of millions of tonnes of earth and coal. In the case of coal mining, electricity and diesel are used. With the appropriate investment, it will be possible to achieve useful efficiency improvements, for example, through the use of diesel additives that improve fuel combustion in heavy mobile equipment. An optimistic assessment is that energy efficiency improvements could lie between five and ten per cent.
- Approximately 60 per cent of RTCA's reported emissions (in CO_2-e terms) are from fugitive methane emissions. Methane is released from the coal when it is mined. In specific circumstances, it may be feasible to pre-drain the methane prior to mining and then use it as a fuel for power generation or sell it to the natural gas market, or simply flare it. Factors which determine the feasibility of methane pre-drainage include the amount of methane present and the thickness and the permeability of the coal seam. All three of these factors vary from mine to mine, necessitating a site by site assessment. RTCA has initiated such an assessment at its Mount Thorley Warkworth mine. The study is due for completion in the first half of 2009; however, some useful information is available now. In summary:
  - Of approximately 20 coal seams present, three may be amenable to methane pre-drainage, after considering thickness, permeability and methane content
  - The maximum feasible reduction in methane emissions at Mount Thorley Warkworth that could be achieved through pre-drainage might be as high as 30 per cent
- RTCA has not conducted the studies at its other sites necessary to quantify the potential for methane pre-drainage.

5. Including fugitive coal mine methane emissions in the ETS requires accurate measurement methodologies

- The methane content in coal can vary by more than a factor of ten between mines and varies with depth. The AGO requires the use of standard state based emission factors. The factors do not represent actual emissions from individual mines. For example, the standard factor significantly overestimates methane emissions for at least one open cut RTCA operation.
- Recognising the importance of "Tax Office Standard" data to ensure the integrity of an ETS, the Australian Coal Association Research Programme commissioned CSIRO to develop a methodology for calculating fugitive methane emissions from open cut coal mines. Noting that this methodology has not yet been reviewed by the Australian coal industry to determine its efficacy and efficiency, a methodology that provides an accurate measure of emissions, must replace the current unsatisfactory and inaccurate factors.
- The CSIRO methodology requires drilling in advance of mining to collect data on methane content. If it were adopted, it would be expected to cost approximately $1million per mine. Complicating the challenge is the global shortage of drill rigs and drill crews. This would add significantly to the time required to conduct the work and develop reliable estimates from Australian open cut coal mines.
- Emissions estimation from underground coal mines also requires improvement. The calculation of fugitive methane emissions from underground mines is currently undertaken utilising ventilation rate and methane concentration measurements designed for the purpose of ensuring safety. Gross mine ventilation rates are calculated continuously using pressure measurements. Spot measurements of ventilation rates at specific locations throughout a mine are completed by mine workers during every shift. A full ventilation survey, which provides the most accurate measure of mine ventilation, is typically undertaken on a monthly basis to calibrate the ventilation rate calculated continuously from pressure measurements. These measurement protocols and the equipment utilised have been optimised for the management of safety rather than for emission inventory estimation.
- Considering the large volumes of air ventilated from an underground mine (hundreds of cubic metres per second), a small relative error in the ventilation rate will translate to a large absolute error in the calculated fugitive methane emissions. A measurement methodology optimised for the estimation of emissions is required at underground coal mines to provide data at the standard necessary for inclusion in the ETS. This methodology should deliver the accuracy of a full ventilation survey on a more frequent basis and may require the introduction of new equipment into the underground coal mine environment.
- Every piece of equipment must be certified as intrinsically safe before being permitted underground to ensure that it is not a potential ignition source. The process for testing and certification is necessarily very rigorous.
- Whilst the measurement and calculation methodology for fugitive emissions of methane from underground mines is relatively simple in concept, the challenge lies in the development of a practical methodology that will provide "Tax Office Standard" emission data and may require the certification of new equipment as intrinsically safe.
- Similar to agriculture, RTCA considers it is necessary to exclude fugitive methane emissions from the scope of the ETS until the methodological issues surrounding fugitive methane emissions from open cut and underground coal mines are

satisfactorily resolved. RTCA is confident that, with Government cooperation and commitment, a realistic programme can be developed and implemented.

6. The development of low emission coal technologies must be accelerated to stabilise atmospheric concentrations of greenhouse gases

- Stabilising atmospheric concentrations of greenhouse gases against a backdrop of rising global population and wealth requires a transformation in the way we produce and consume energy. The rate and scale of technology deployment necessary is unprecedented and well beyond what the market can deliver without government intervention.

- As noted earlier, coal will remain a major primary energy source for the foreseeable future. Low emission coal technologies must be rapidly developed and globally deployed if atmospheric concentrations of greenhouse gases are to be stabilised. There is no solution to climate change without the development of low emission coal technologies that can be economically deployed globally, especially in rapidly growing emerging economies. The Australian coal industry has recognised this and has established the Coal21 Fund to raise one billion dollars to support the demonstration and commercialisation of low emission coal technologies.

- Rio Tinto believes that a National Low Emission Technology Strategy is required to drive technology development and to coordinate it with international efforts. Funding for the implementation of the strategy should come from the revenue raised by the ETS. A full discussion of a proposed National Low Emission Technology Strategy is contained in appendix 8 of this submission.

7. Conclusion

- RTCA supports the introduction of an Australian emissions trading scheme as part of a comprehensive policy response to climate change.

- RTCA has identified four key issues that it would like the Garnaut Review and the government to consider in designing the ETS.

  - Coal will continue to meet a significant proportion of global energy demand for the foreseeable future

  - The Australian export coal industry is emissions intensive and trade exposed. Consequently RTCA requests that the ETS design provides transitional support to the coal industry until such time as Australia's international competitors are subject to a comparable price on greenhouse gas emissions

  - Government and the Australian coal mining industry should work together to resolve the methodological issues surrounding the estimation of fugitive methane emissions prior to their coverage by the ETS

  - Significantly reducing emissions of greenhouse gases requires the development and global deployment of energy efficiency and low emission technologies. A National Low Emission Technology Strategy, funded by a proportion of the revenue derived from the ETS, is required to accelerate technology development and commercialisation

Appendix 5:
Issues in the treatment of Iron Ore in an Australian emissions trading scheme

1. Summary

Through its Rio Tinto Iron Ore (RTIO) Pilbara Iron business, Rio Tinto is a major producer of iron ore for the global steel industry and, through HIsmelt®, a developer of iron making technology. To meet growing iron ore demand, particularly from China, it is expanding mining capacity rapidly, as are other producers.

In recent years global demand for iron ore has outstripped supply and whereas ABARE expects by 2012-13, the volume of Australian exports to be 90 per cent higher the real value of those exports will be 74 per cent higher. Accordingly, there is a risk to Australia's iron ore industry that margins could come under significant pressure just as costs increase from the implementation of carbon pricing through an ETS.

Iron ore and pig iron are both traded on highly competitive world markets. As production shifts increasingly to the developing world (including South America, India, China and Africa for iron ore and Brazil, Russia, China and India for steel) the influence of those developing economies on the global iron and steel industries will increase. This has major implications for the continued competitiveness of Australian iron ore and iron producers, particularly when Australia introduces carbon pricing through the ETS ahead of many of the industry's major customers and competitors. Australia cannot increase prices unilaterally to compensate for the cost increases that will result from an ETS.

Iron ore mining and transport to customers are energy and emissions intensive compared with other Australian industries, with RTIO's energy costs well above the NETT-proposed criterion, of 3.5 per cent of operating costs. Iron smelting is significantly more emissions intensive, even using the new HIsmelt® process, currently being commercialised in Kwinana, Western Australia. The HIsmelt® process holds promise as an emission reducing technology with a global application. Reducing emissions from iron ore mining is proving to be difficult, in part because of the production efficiencies achieved by the industry over the past decade.

The cost of the ETS will reduce the international competitiveness of the Australian iron ore industry. This illustrates the need for the iron ore industry to receive transitional consideration for its emissions intensity and trade exposure until the world adjusts to carbon constraints and the price of carbon is reflected in world markets.

This appendix explores the major issues the ETS poses for Rio Tinto's iron ore and pig iron production. It illustrates the extent to which iron ore mining and smelting are among Australia's most emissions intense and trade exposed industries.

2. Iron Ore

2.1 Company background

Rio Tinto in Australia is a major producer of iron ore for the global steel industry. Almost all of its production is exported. To meet the growing demand, particularly from China, Rio Tinto, along with other producers, is in the midst of major expansions.

In 2007, Rio Tinto Iron Ore's (RTIO) share of global 2007 production was 144.7 Mt, and about half of Australia's iron ore production. [25] With a network of 11 mines, three shipping terminals and the largest privately owned heavy freight rail network in Australia, the Pilbara operations are a major part of Rio Tinto's global iron ore activities. In addition, the HIsmelt® plant at Kwinana in Western Australia now produces pig iron using a new technology that promises significant reductions in emissions and energy costs. RTIO employs about 6,500 people in Western Australia (in addition to another 2,000 people overseas), a significant increase over recent years.

Rio Tinto's iron ore operations began in 1966 and have expanded to meet the growing needs of the world's iron and steel industry. In the Pilbara, RTIO wholly owns Hamersley Iron's six mines and also operates the Channar mine (Rio Tinto: 60 per cent) and the Eastern Range mine (Rio Tinto: 54 per cent). RTIO also includes a 53 per cent interest in Robe River Iron Associates' two mines, also in the Pilbara. Construction of the US$1 billion Hope Downs mine was completed in December 2007 (Rio Tinto: 50 per cent). The US$1.4 billion Dampier Port upgrade project was recently completed and the port now has a 90 per cent greater shipping capacity.

RTIO is committed to the long term future of the industry in Australia. It has announced the approval of a US$2.4 billion investment in mine extensions at Mesa A and Brockman 4 /Warramboo in Western Australia.

Over the past eight years, RTIO's integrated production platform and massive resource base have delivered a compound annual growth rate of nearly 15 per cent from its Pilbara operations. Early analysis of the trend in Chinese steel production, and its implications for iron ore demand, prompted RTIO to accelerate growth at the turn of the decade. It embarked on its first major expansion, the North acquisition, in 2000.

RTIO has an excellent reserve, resource and mineralisation position, with over 14.2 billion tonnes of iron ore JORC reserves and resources in the Pilbara.[26] Moreover, the stated reserve and resource position is thought to understate the potential total iron ore mineralisation. Rio Tinto's exploration and production experience in the Pilbara region suggest that Rio Tinto's targeted additional mineralisation in the Pilbara may be 20-30 billion tonnes. Exploration successes in recent years provide confidence that there is much more to be found on these exceptional tenement leases.

To illustrate, there is an advanced study into expanding the Pilbara operations to 320 million tonnes a year. This expansion would entail completing mining extensions worth approximately US$10 billion, by 2012. The Cape Lambert port can be further expanded by

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25 2007 Annual Report, p 42. (Total production from RTIO's Australian operations in 2007 was 163 Mt)
[26] Rio Tinto Investor Seminar 26 November 2007; also
http://www.riotintoironore.com/ENG/media/38_media_releases_1502.asp

100 million tonnes of annual port capacity, taking combined port capacity to 420 million tonnes a year.

However, other international producers are increasing production. In the medium term, Australian iron ore producers can expect increased price competition, especially from developing countries.

2.2 Industry production and trade exposure

The iron ore mining industry is currently a major contributor to the Australian economy. Both production and exports increased to 287.7 million tonnes and 257.4 million tonnes respectively in 2006-07 and the value of Australian iron ore exports was A$15,502 million, representing 9.2 per cent of the total value of Australian exports, second only to coal (DFAT 2008). RTIO accounts for about half of Australian production.

In 2005-06, the Australian iron ore industry directly employed 8 300 people, and paid A$635 million in wages and salaries. Industry value added was A$8296 million (ABS 2007). As such, it is a major contributor to the prosperity of Western Australia and Australia. RTIO alone increased employment by almost a third between December 2005 and December 2007. The industry's contribution to the growth of employment, production and exports is expected to continue for as long as the international competitiveness of the industry is maintained.

Australia is the third largest producer of iron ore in the world after China and Brazil, producing 16 per cent of world output (ABS 2008). Both China and India are expected to increase production by 4.6 per cent annually to 2011-12. However, both are experiencing strong domestic demand, and are unlikely to be significant exporters. South African iron ore production is also increasing with production of 56 million tonnes expected in 2012 (ABARE 2007a).

Iron ore is one of Australia's most trade exposed industries, with about 90 per cent of total production exported (ABARE 2007a). The trade exposure of the iron ore industry as measured by the value of exports plus imports divided by total domestic supply is 0.86 (ABS 2006b), the second highest of all industries. As such Australia faces increasingly stiff competition, with the world's largest iron ore producer, Vale, ramping up production in its Brazilian mines. Total Brazilian iron ore output is expected to reach 500 million tonnes in 2013 with almost 80 per cent of this being exported.

The largest iron ore markets are China and Japan (DFAT 2007a). Demand is increasing, with respected commentators predicting long term strong Chinese demand. In the past decade, China's steel production increased nearly fivefold to around 490 million tonnes per annum. It now produces close to five times that the United States. Demand from other developing regions, including India, the rest of Asia and the Middle East will fuel further growth. ABARE forecasts that Australian iron ore production will increase by more than 50 per cent over last year's levels by 2010-11, and that world exports will increase by more than a third over the same period, as other suppliers, particularly those in developing countries such as Brazil, ramp up production.

Iron ore prices have substantially risen for six consecutive years reflecting the very tight market conditions and the higher marginal cost of production. Spot freight rates have also contributed to the price uplift. In recent years global demand for iron ore has significantly outstripped supply, and this imbalance is not expected to be resolved in the immediate future. However, at some point the number of expansion projects under development must mean a stabilisation of this situation to a degree. By 2012-13, ABARE anticipates that export volumes from Australia will be 90 per cent higher than in 2007, but that the increase in real value will be only 74 per cent higher. There is a risk that margins could come under significant pressure just as costs could increase from an ETS.

2.3 Emissions intensity

The iron ore industry is relatively energy and emissions intensive. For the industry as a whole, energy costs represented approximately nine per cent of total input costs in 2001-02 (ABS 2006b.). However, since that time, the relative prices of petroleum and gas have increased. The cost of energy and fuel for RTIO Pilbara Iron in 2007 was between three to four times more than the 3.5 per cent of costs proposed by NETT.

In 2007, RTIO Pilbara Iron operations' emissions (including construction activities) amounted to about 1.7 million tonnes CO_2-e. Given that Australian iron ore export revenue is $15.5 billion and Rio Tinto's share is approximately half, the emissions intensity of the RTIO Pilbara Iron business is approximately 220 t per million dollars of revenue.

Without step changes in technology, the emissions intensity of production in the Pilbara is expected to increase. The ore is becoming harder to win as mines become deeper, more distant from existing mine infrastructure, further from dispatch ports and more processing-intensive as lower grade ore requires greater beneficiation. These factors will be only partially offset by efficiencies resulting from higher production rates and improved mining technologies. Recent data support this hypothesis and show that RTIO Pilbara Iron operation's emissions intensity has increased, despite considerable efforts having been made to improve the energy efficiency of individual processes and operations.

2.4 EITE status

The iron ore industry in Australia is highly trade exposed and export oriented. It competes on the world market and Rio Tinto is unable to unilaterally increase prices to compensate for domestic cost increases.

A domestic emissions trading scheme that raises the price of energy will impact on the Australian iron ore industry's ability to compete internationally for the capital required to build new iron ore supply options. It is therefore vital to the continued competitiveness of the Australian iron ore industry that it receives consideration as an emissions intensive trade exposed industry under the ETS.

3. Pig Iron (HIsmelt®)

3.1 Introduction

Over the past 20 years Rio Tinto has invested approximately A$1 billion in the research and development of new low emissions and energy metallurgical technologies. The result is a new iron making process that holds great promise for reducing global greenhouse gas and other air emissions relative to traditional iron and steel technologies. The HIsmelt®-Circofer combination offers a technology road map to low carbon steel making, potentially removing two billion tpa of CO_2 emissions globally, including 15m tpa CO_2 from Australian steel mills.

Rio Tinto has established an operating plant to demonstrate this technology on a commercial scale with the support of joint venture participants and government through Invest Australia. The world's first commercial HIsmelt® iron making facility, located at Kwinana near Perth in Western Australia, is currently ramping up to its full production rate of 800,000 tonnes per annum. The role of the plant is to demonstrate the viability of the technology through running a commercial export pig iron business. All of the Kwinana plant's pig iron production is scheduled for export. This is another feature that differentiates Rio Tinto HIsmelt's® operations from other parts of Australia's iron and steel sector.

Introduction of the ETS could affect this as world pig iron prices will not reflect the cost of carbon until China, Brazil, Russia and India introduce comparable carbon constraints. This could make production at Kwinana unviable in the short term, causing production and emissions to shift offshore. Even more damaging, it could reduce the prospects for dissemination of the technology world wide with its promise of substantial emission reductions. RTIO submits that its HIsmelt® iron production should be recognised for treatment as a emissions intensive and trade exposed industry within the ETS. HIsmelt® should also be recognised as a significant contribution by Australia to global low emissions technologies. It demonstrates the promise of metallurgical R&D to the global emissions reduction effort.

3.2 The new smelting technology

The HIsmelt® plant at Kwinana is a joint venture between Rio Tinto (60 per cent interest through its subsidiary, HIsmelt® Corporation), US steel maker Nucor Corporation (25 per cent), Mitsubishi Corporation (10 per cent), and Chinese steel maker, Shougang Corporation (5 per cent). Rio Tinto's aim is to see this technology integrated into new iron and steel plants around the world, including developing countries such as China and India.

HIsmelt® is a direct iron making process in which iron ore fines and non-coking coals are injected directly into a molten iron bath to produce quality molten pig iron. A Smelt Reduction Vessel (SRV) replaces the traditional blast furnace method of smelting iron ore. HIsmelt® produces hot metal, free of slag, which can be used as direct charge to steel making processes or cast as pig iron (96 per cent iron content).

The HIsmelt® process offers an efficient alternative to conventional iron making technology, with significantly lower environmental impact. It is also highly flexible in terms of raw materials, including ores with high phosphorus levels, non-coking coals and steel plant wastes, yet it still produces a premium quality iron. Off gas, produced as part of the smelting process, is utilised in several areas of the plant. This increases energy efficiency by reducing the overall requirement for natural gas and generating all of the plant's power requirements. Excess steam produced from off gas combustion is also supplied to third parties, while excess electricity is sold back to the electricity network.

HIsmelt® technology has many advantages for the iron and steel industry: lower operating costs; capital intensity and environmental impact, and greater raw material and operational flexibility. The small footprint of a HIsmelt® facility makes it attractive from a capital investment perspective.

The HIsmelt® technology is an emission reduction enabler. It demonstrates a fundamental shift in iron making technology that has the potential to significantly reduce global greenhouse gas emissions compared to traditional processes. It can replace less efficient coke making and blast furnace processes and has potential for carbon capture, zero dioxins and furan emissions, and produces lower levels of other gases (NOx, SOx, VOC, PAH).

Circofer technology is being developed in conjunction with Outotec. It uses coal to pre-reduce iron ore, allowing a much higher production rate and producing a waste gas stream with a high CO_2 concentration suitable for sequestration.

3.3 Trade exposure

Rio Tinto contends that especially its pig iron product, but also the Australian iron and steel sector of which it is part under ANZSIC classifications, are trade exposed. All of HIsmelt's® pig iron production is exported, and using ABS databases the trade exposure of the overall sector, as measured by the sum of exports and imports divided by total domestic supplies, is still higher than the median for all Australian industries (0.25 compared with 0.17).

In addition, pig iron is a homogeneous commodity and its price, like prices for most iron and steel products, is determined on world markets. The history of high tariffs, quotas, anti-dumping action and state assistance to the iron and steel industries in Australia, North America and Europe over the past half century testifies to the exposure of this industry to heavy international competition. HIsmelt® is responsible for a relatively small proportion of traded pig iron production. At nameplate production levels (800,000 hot metal tonnes per annum) its production will be a small percentage of competing merchant pig iron and scrap traded internationally. Australia is a small pig iron player and unable to increase prices to compensate for the cost of emission permits. HIsmelt's® main competitors are located in Brazil, India, China and Russia (non-OECD) countries that have no short term requirement to price carbon. The HIsmelt® company has no market power to influence prices.

3.4 Emissions intensity

Iron making is an emissions intensive activity and is more emissions and energy intensive than downstream steel product manufacturing processes. HIsmelt's® combined scope 1 and scope 2 emission intensity is approximately 2.3tCO_2-e/t of hot metal and, at nameplate production capacity, emissions are expected to be about 1.8 mtCO_2-e pa. Two database issues surround appropriate consideration of HIsmelt's® emissions intensity:

- HIsmelt's® production and emissions are so new that they are not recorded in ABS databases. As noted elsewhere in this submission, the only publicly available data sources that Rio Tinto has been available to identify are ABS 2001/2 and HIsmelt® was not operational at that time; and
- Even if HIsmelt's® data were present in the databases, its emissions intensity is not specifically identifiable. Statistically iron production is classified within "Iron and Steel", which includes a broad range of production, particularly of finished steel products. Iron production is the most emissions intensive step for the sector. Consequently HIsmelt's® emissions intensity would rank above those of other firms in the sector.

Energy intensity is also quite high. HIsmelt's® energy costs are expected to represent 30 per cent of input costs at full production. Coal accounts for 22 per cent of input costs as both a reductant and fuel source, with natural gas the remainder. This is extremely high relative to the rest of Australian industry, where the median level is about 3.5 per cent.

Rio Tinto therefore submits that HIsmelt® iron should be eligible for treatment as an emissions intense and trade exposed industry.

4. The importance of complementary measures

The iron ore and iron smelting industries are both relatively emissions and energy intensive as well export oriented. The ETS will reduce their international competitiveness unless transitional arrangements are introduced while global markets adjust to carbon constraints.

In the longer term, as the effects of carbon pricing work their way through the global economy, the future of Australia's iron ore and iron industries depends on finding new technologies that will reduce emissions and energy requirements. This will require a major research and development effort.

Rio Tinto has been researching a number of potential areas for emissions and energy reduction. HIsmelt® is one result of this process. Much more remains to be done to develop lower emission metallurgical techniques.

It is therefore critical that when the ETS is introduced, it be accompanied by complementary measures that will enhance the capacity of industry to make the necessary adjustments and investments. These measures should include:

- A substantial industrial research and development support program;
- Support for commercialisation and demonstration plants;
- Action at the WTO to ensure that the provision of such support is recognised as consistent with world trading rules; and
- International action to simplify and streamline the rules for accreditation of techniques under the Clean Development Mechanism.

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Appendix 6: Current and future energy technology costs

1. Summary

An accurate up to date understanding of current and future energy technology costs is essential to accurate modelling, target setting and impact assessment. Rio Tinto has done significant analytical work in this area, with the aim of making meaningful comparisons between energy generation technology options. Much of this work is commercially sensitive. Hence Rio Tinto is unable to make this information publicly available but would be happy to brief the Garnaut review team. This appendix provides a brief summary of the overall conclusion able to be drawn from the Rio Tinto work, the nature of recent cost escalation in power generation plant and other major engineering projects, and the nature of the work that Rio Tinto has undertaken.

Through its coal and uranium operations Rio Tinto is a major supplier to the electricity generation industry; and its mining and smelting operations are a major customer of the same industry. For both business and sustainability reasons Rio Tinto has, for many years, worked both internally and in collaboration with the wider mining and utility industries to better understand how its products are used, anticipated future demand for products, and how to facilitate the transition to a low emissions energy supply sector.

Since 2003, the utility sector – like all major engineering projects – has seen very significant capital cost increases. At such times, cost data dates rapidly and up to date and reliable data must come from project studies and evaluations, which are seldom published or referenced – making citing the work difficult. Cross-technology comparisons should therefore only be made after careful analysis.

Rio Tinto's analysis in this area is based on bringing all costs back to a common basis and an equivalent point in time so that meaningful comparisons can be made between technologies. The analysis relates to Australia, and the information on which it is based is a composite of US, European, Australian and Asian data. The data used comes primarily from three sources:

- US studies and reviews, which are often based upon and can relatively readily be assessed against current engineering studies;
- IEA Greenhouse Gas Program and the US Electric Power Research Institute, both of which offer reputable and thorough international analyses; and
- Engineering studies conducted by a range of organisations and industries.

Rio Tinto has taken great care to cross check the various data sources. The data used are not for initial demonstration plant, and assume that enabling legislative and social infrastructure are in place. For a number of new technology options there exist procedural and risk based barriers to deployment.

The work highlights:

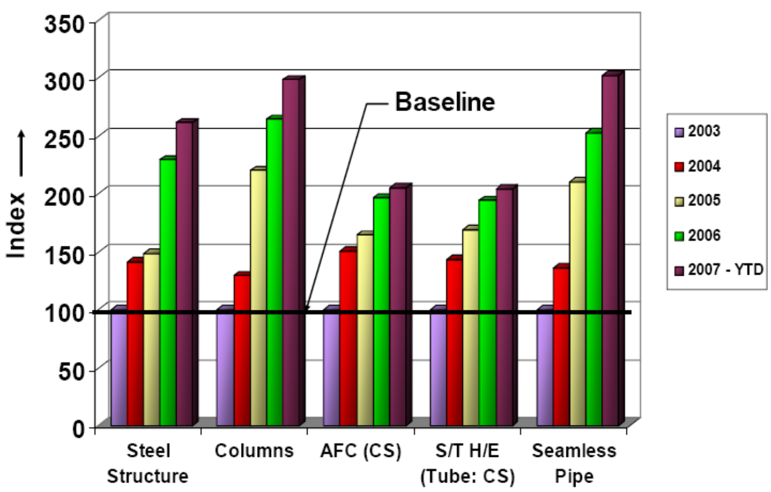
- recent significant cost escalations in major project engineering and construction necessitates considerable caution when comparing different data sets;

- existing plant will have a lower delivered cost of electricity and be in a stronger competitive position when compared to any new build plant;
- fuel costs constitute a much higher percentage of the delivered power cost for gas-fired plant – meaning gas plant is more exposed to fuel price volatility;
- a wide range of technologies that, with current information, have comparable costs (depending upon time and place of deployment);
- low emission power will not deploy without a carbon price. A wide range of technologies, with current information, have comparable costs (depending upon time and place of deployment) and most low emissions technologies are competitive roughly within a comparatively narrow carbon price band. Carbon prices need to fall within this price band as a minimum, for mature low emission technology to be deployed by an ETS alone; and
- Low emission technologies which are not mature at scale present significant first-mover technology (and legal and commercial) risks and thus require additional measures for initial deployment. For example, Rio Tinto analysis indicates that a number of emerging technologies will deploy at similar carbon prices to wind energy once the plant is shown to operate reliably at nameplate capacity. However, it takes time to commission new industrial technologies (i.e. there can be extended ramp-up periods) and for investors to understand and properly price the risks.

2. New Plant Cost Escalation

Capital costs in the utility sector have increased significantly since 2003. Figure 1 demonstrates the increases in utility components; and figure 2 the associated increase in delivery times.

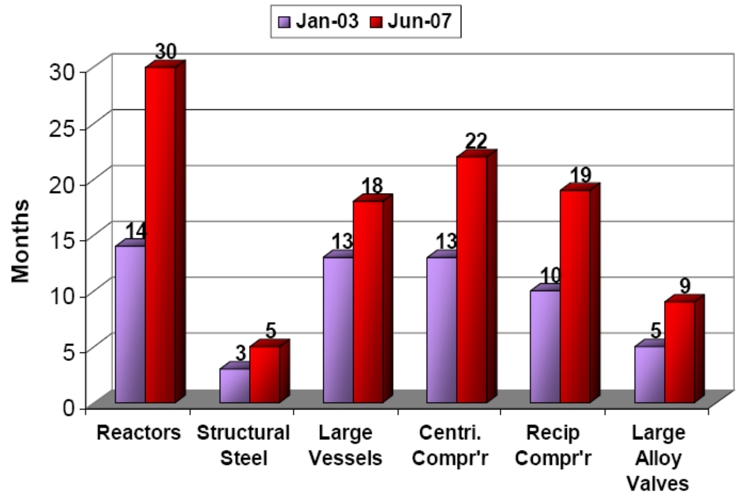
Figure 1: Post 2003 component cost increases (source: KBR*)



** Kellog Brown & Root*
Note: AFC (CS)- air finned cooler (carbon steel)
S/T H/E Tube:CS – Shell and tube heat exchanger, carbon steel tubes

Determining actual current costs and making meaningful comparisons between technologies is difficult when costs are increasing so rapidly. All costs need to be brought back to a common basis and an equivalent point in time, for such comparisons to be meaningful.

Figure 2: Increasing delivery times post 2003 (source: KBR*)



** Kellog Brown & Root*
Note: Cetri. Compr'r-Centrifugal Compressor
Recip Compr'r – Reciprocating Compressor

3. Rio Tinto Data Analysis Methodology

In Rio Tinto's analysis, costs are prepared for Q1 2008, and the levelised cost of electricity (LCOE) has been calculated assuming the plant could be built and operated today.

The LCOE is the equivalent annual power price required for an electricity asset to achieve an NPV of zero over the plant life – that is, to completely recover capital and operating costs over the life of the plant. The LCOE is calculated on a consistent basis across the technologies, using project allowances and assumptions typical of those used in the industry.

The analysis ignores the significant permitting, construction times for utility plants and risk profiles that utilities will have for different technologies due to differences in capital requirements and stages of commercialisation. However, the analysis is well suited to providing a comparison across a range of technologies.

The inputs to the model are:

- Capital costs;
- Operations and maintenance costs;
- Fuel costs;
- Carbon costs (if applicable);
- Financing charges (e.g. debt and equity rates, tax); and
- Project allowances and contingencies.

The outputs have been calibrated against a wide range of external LCOE estimates. The generating technologies included in analyses are:

- Coal fired plant, including black coal, brown coal, and coal combined with carbon capture and storage;
- Gas fired plant including integrated gasification combined cycle (IGCC), open cycle gas turbine (OCGT) and closed cycle gas turbine (CCGT);

- Nuclear; and
- Renewables including onshore wind, biomass, geothermal hot dry rocks, solar thermal and solar PV.

Analysis work has also been carried out to understand the sensitivities of the various generating technologies to changes in fuel price. This work demonstrates that gas-fired plant is more exposed to variations in fuel costs than other technologies.

Appendix 7: Marginal abatement cost curves for Australia

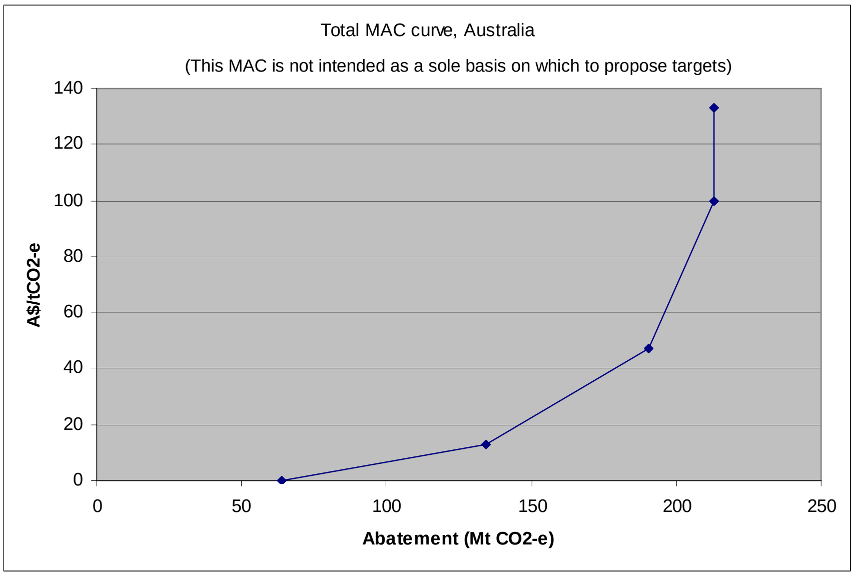
1. Summary

This appendix describes the development of marginal abatement cost curves for Australia's electricity, transport, buildings, industry, forestry and waste sectors. The curves were developed for the year 2030 and reflect the millions of tonnes of potential carbon dioxide equivalent (CO_2-e) emissions abatement in the various Australian sectors at different prices.

The purpose of the work was to use credible, publicly available data from bottom up studies to construct preliminary Australian abatement cost curves to inform Rio Tinto of some of the constraints that need to be considered as Australia sets interim emissions targets consistent with its 60 per cent reduction target by 2050, and to supplement the costings coming out of computable general equilibrium (CGE) modelling work done by others. This work is not intended as a sole basis on which to propose targets.

The sectoral marginal abatement cost (MAC) curves were combined to produce an overall national MAC curve (figure 1). This figure combines the sectoral abatement potentials and costs, indicating that up to 64Mt abatement could be achieved from across the economy for negative or zero cost, up to 190Mt at a cost of A$50/t CO_2-e and up to 213Mt abatement for $100/t CO_2-e.

Figure 1: Australian marginal abatement cost curve, 2030[27]



[27] The MAC curves presented are based on IPCC data. The IPCC data is presented in cost ranges extending only to US$100/tCO2-e and is granular in nature. The vertical segment in some of the MAC curves is accurate for the cost ranges shown however it is possible that the curves become non-vertical again at higher costs beyond the ranges for which information was available.

Placing these abatement levels in perspective, 190Mt of abatement would reduce Australia's overall emissions by 19 per cent relative to 2030 business as usual BaU levels, while 213Mt abatement equates to a 21 per cent reduction relative to 2030 BaU levels. Australia's 2030 emissions would still be 153 per cent higher relative to 2000 emissions levels assuming a A$50/t CO_2e carbon price, and 148 per cent higher than 2000 levels after accounting for abatement achieved under a A$100/t CO_2e carbon price. These abatement potentials are broadly consistent with top-down modelling work in the sense that large carbon prices will be required to induce significant abatement to levels below 2000 emissions in the absence of international permit purchases.

2. Methodology

Data on abatement potential were all derived from Working Group III's contribution to the IPCC's Fourth Assessment Report (IPCC 2007).[28] The IPCC's WG III report provided a distillation of peer-reviewed literature with respect to abatement potentials and costs by region, and included all key mitigation technologies and practices that are currently commercially available or expected to be commercial before 2030. This information was applied to projected business as usual (BaU) sectoral emissions data for Australia obtained from the Australian Greenhouse Office (AGO 2006). Since the AGO projections extend only to 2020, Concept Economics generated projections to 2030 based on average annual sectoral emissions growth rates and expert opinion to coincide with the IPCC's 2030 reporting year for abatement potentials. These actual and projected data are presented in table 1.

Table 1: Projected baseline emissions by sector, Australia

$MTCO_2e$

	1990 BAU	2010 BAU	2020 BAU	2030 BAU (CE projected)
Energy	287	476	592	741
Stationary	196	341	423	542
Transport	62	89	105	117
Fugitive	30	46	65	82
Industrial Processes	25	46	59	66
Agriculture	91	96	102	107
Waste	19	28	38	47
LULUCF	129	44	45	45
Land use change	129	65	65	65
Forestry	0	-21	-20	-20
TOTAL	**552**	**690**	**837**	**1007**

Note: LULUCF – Land use, land use change and forestry

Details of the methodologies used to derive the MAC curves for individual sectors are provided in the following sections.

[28] It is noted that the IPCC work included information from literature published only to June 2006, although some high priority works including the Stern Review were also incorporated. IPCC (2007) does not include the relatively recent escalation in large project engineering costs as noted elsewhere in this appendix.

3. Sectoral marginal cost curves

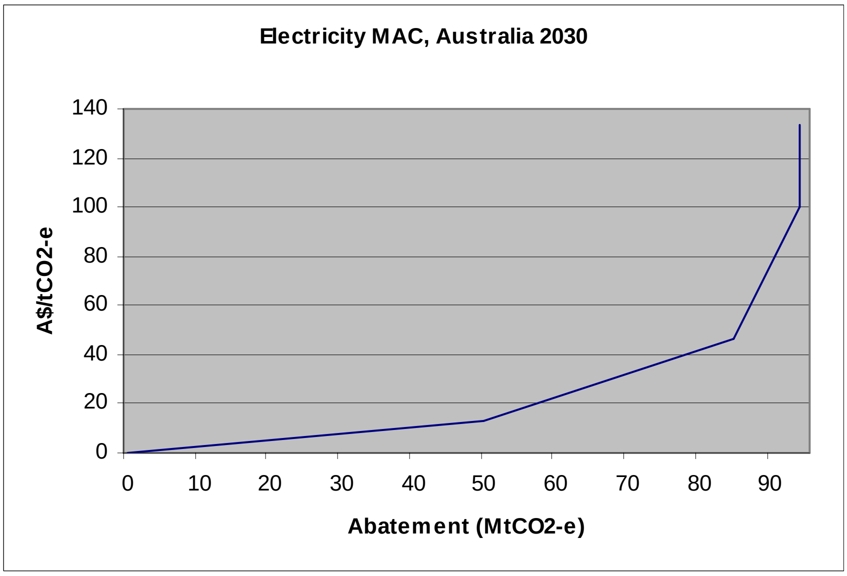
Electricity

For the electricity generation sector, the AGO's 'stationary energy' category was split into 'electricity' and 'buildings' to determine Australia's baseline emissions from those sectors in 2030.

Once baseline emissions projections for Australia's electricity sector had been established for 2030, the proportion of abatement coming from different generation technologies was derived by applying the IPCC's OECD average mitigation potentials to the data (see table 4.19 of IPCC 2007). This yielded total mitigation potentials in Mt of CO_2-e by technology in 2030. Mitigation potentials expressed as percentages from each source at different costs were then applied to the Australian emissions data (table 4.19 of IPCC 2007). Mitigation potentials expressed in US$/t CO_2-e avoided were converted into A$/t CO_2-e.

This methodology yielded the abatement cost curves presented in figure 2. It is clear from figure 2 that the electricity generation sector in Australia could abate up to 90Mt CO_2-e in 2030 for a cost of less than A$100/t CO_2-e. The bulk of abatement from the electricity sector (60Mt) occurs in the price range up to A$20/t CO_2-e.

Figure 2: Electricity marginal abatement cost curve, Australia, 2030



Note: This MAC is not intended as a sole basis on which to propose targets

Transport

To establish the benchmark for proportional emissions reductions in the IPCC's OECD Pacific region, IPCC table 5.10 was used to establish the percentage emissions reductions associated with moving from the reference case to the high efficiency and medium efficiency cases in 2030. An oil price of US$60/bbl was assumed. The results for transport abatement were derived from IPCC data on light duty vehicles and do not reflect mitigation data from other forms of transport.

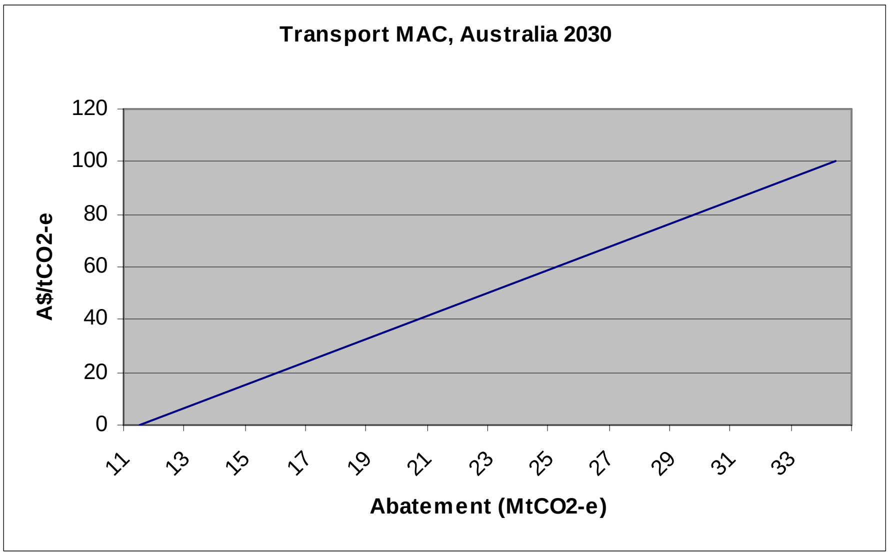
Table 5.11 was used to establish the emissions abatement cost (US$/t CO_2) for OECD Pacific under the high and medium efficiency cases, assuming an oil price of US$60/bbl.

As for all other sectors, Australia's projected 2030 emissions from transport were derived from the AGO (2006) dataset.

The proportional emissions reductions calculated above were then applied to the Australian transport emissions data in 2030 to obtain the abatement potentials from the sector assuming high and medium efficiency improvements.[29] To these abatement potentials we applied the carbon dioxide reductions costs derived from IPCC table 5.11 to generate the marginal abatement cost curve depicted in figure 3.

The ability to derive just two cost points on the marginal abatement cost curve from the available data for transport affects its shape. The curve suggests that that up to 12Mt CO_2-e can be abated from the Australian transport sector in 2030 at zero cost or for a net benefit. This result could occur, for example, where the higher cost of technologies or fuels needed to improve transport efficiency is less than the savings made in fuel costs by moving to the more efficient technology. An additional 22Mt of abatement can be achieved from transport for under A$100/t CO_2-e.

Figure 3: Transport marginal abatement cost curve, Australia, 2030



Buildings

The marginal abatement cost curve for buildings was derived from IPCC (2007) table 6.3 using projected Australian building emissions in 2030. The mitigation potentials as a share of baseline emissions for the OECD at different cost categories were applied to the Australian data to generate the MAC curve in figure 4.

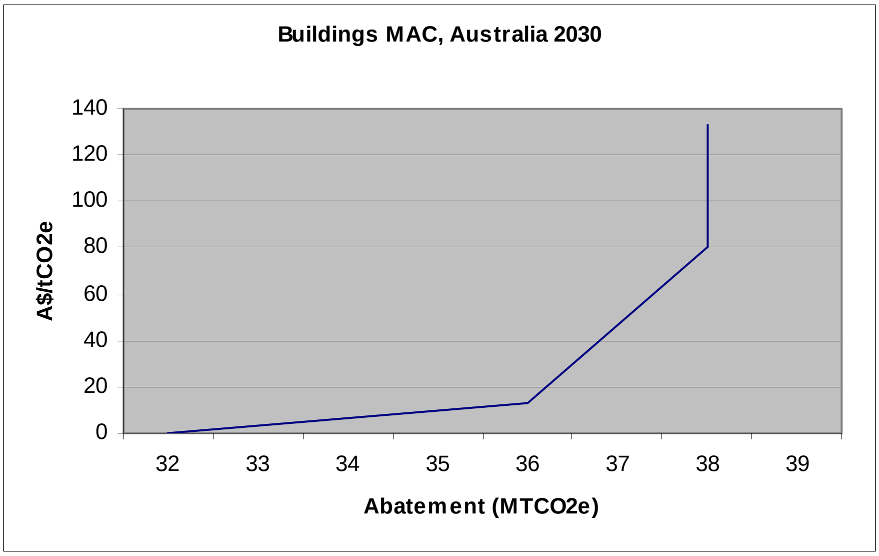
This figure indicates that around 33Mt of abatement can be achieved from the buildings sector at net negative cost. As was the case for the transport sector, this result might occur due to improvements in energy efficiency in buildings that save more in energy costs than they expend in technological change.

It is also interesting to note that the MAC curve becomes vertical at 38Mt of abatement, which suggests that beyond A$80/t CO_2-e, no further emissions reductions can be achieved

[29] It is assumed that adopting technologies that move the transport sector to high efficiency costs more than movement to medium efficiency.

from the buildings sector. Presumably this reflects that the vast bulk of abatement from the buildings sector can be undertaken for a net profit but that additional emissions savings would be extremely costly, as would be the case if old energy inefficient buildings needed to be demolished and replaced with new efficient buildings to achieve more abatement from the sector.

Figure 4: Buildings marginal abatement cost curve, Australia, 2030

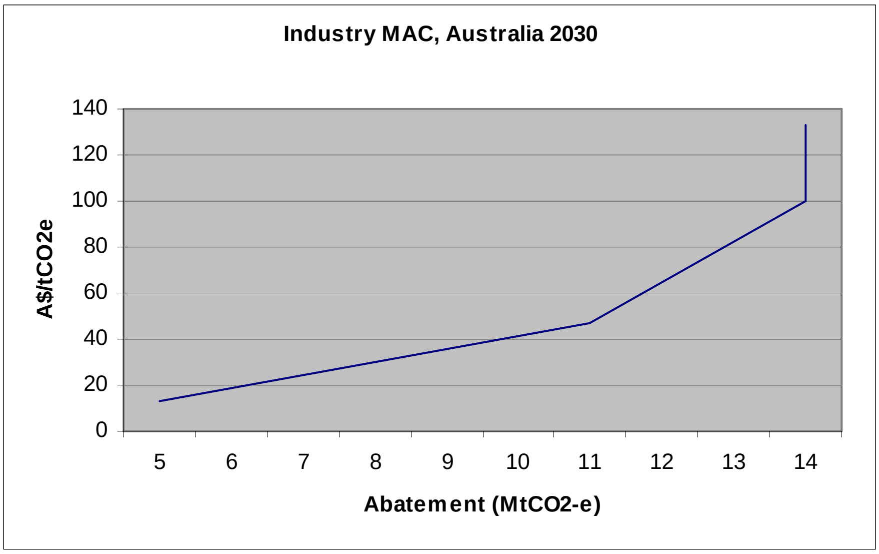


Industry

The marginal abatement cost curve for industry was derived from IPCC (2007) tables 7.8 and 7.10 using projected Australian industry sector emissions in 2030. The percentage abatement potential for the OECD industry sector in table 7.8 was applied to the Australian data in 2030 and assumed that, on average, the Australian industry sector would be able to abate an equivalent amount in percentage change terms as the OECD average in 2030.

This mitigation potential was spread across cost categories as estimated for the OECD in table 7.10 (IPCC 2007). Figure 5 indicates that, unlike some other sectors, there appears to be no negative cost abatement in the industrial sector. For around A$13/t CO_2e, it is possible to derive almost 6Mt CO_2e abatement from the sector in 2030. The bulk of potential abatement from the sector is achieved for less than A$50/t CO_2e, up to a maximum of about 14Mt CO_2e at A$100/t CO_2e.

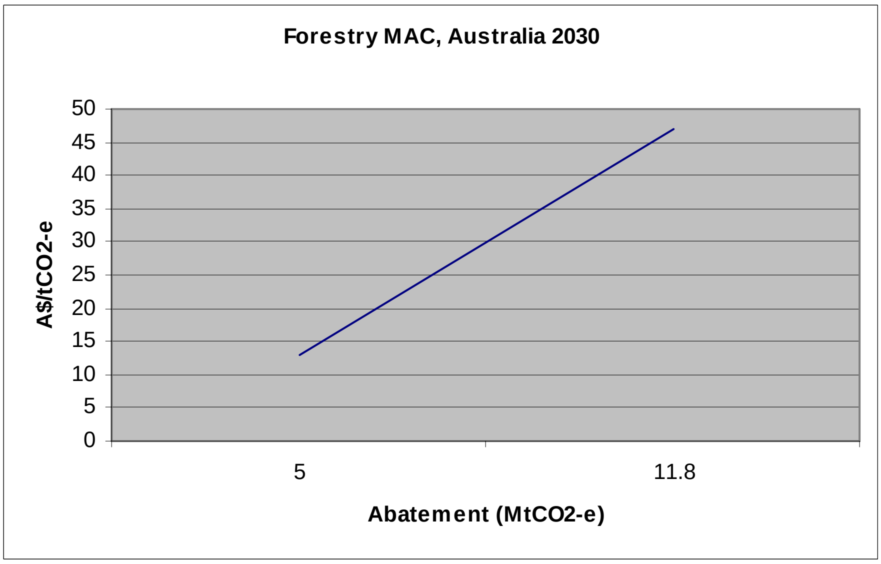
Figure 5: Industry marginal abatement cost curve, Australia, 2030



Forestry

The potential mitigation shares from different forestry activities presented in table 9.3 of IPCC (2007) were applied to the Australian projections of total emissions from forestry in 2030. Figure 6 illustrates that no abatement can be undertaken from forestry for a cost less than A$13/t CO_2-e. At an abatement cost of around A$50/t CO_2-e, a potential 12Mt CO_2-e abatement may be derived.

Figure 6: Forestry marginal abatement cost curve, Australia, 2030



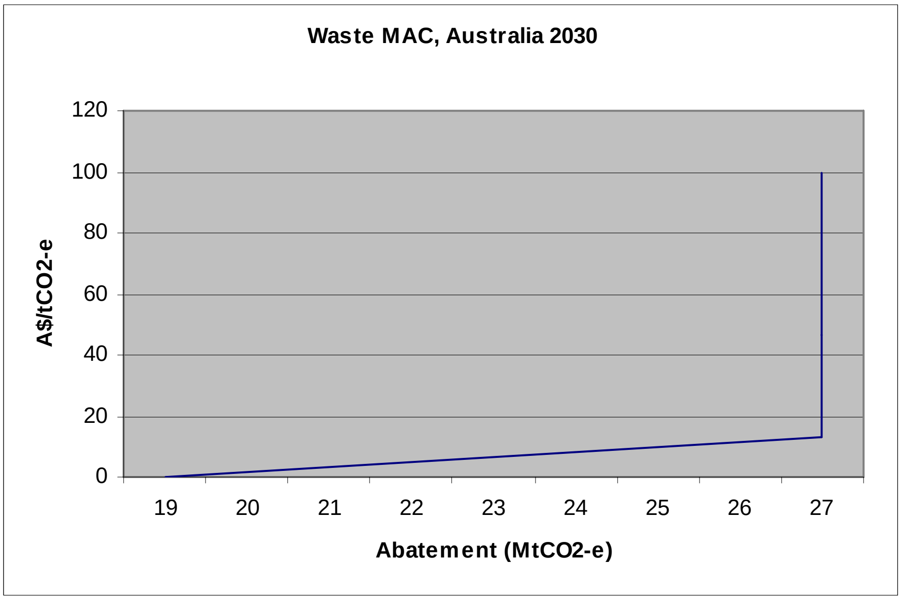
Waste

The mitigation potentials described in figure 7 were derived from IPCC (2007) data on the economic potential for mitigation of regional landfill methane emissions at various cost categories in 2030 (see table 10.5 of IPCC 2007). Given that the IPCC provides a range of economic mitigation potentials, we used the average of the estimates for our calculations.

Applying the percentage abatement potentials for the OECD to Australia's projected waste emissions in 2030 yielded results that suggest that up to 19Mt CO_2-e of abatement could be obtained from the waste sector at net negative cost. Figure 7 also suggests that beyond 27Mt

CO_2-e abatement, it becomes very expensive to derive additional abatement from the waste sector.

Figure 7: Waste marginal abatement cost curve, Australia, 2030



4. Discussion

The MAC curves developed here are based on a wide range of technologies and efficiency improving processes encapsulated in the IPCC review. They differ from some other estimates developed in the literature. For example, McKinsey and Associates (2008) suggest far higher abatement potential for the Australian economy in 2030 for lower cost.

The greatest potential exists to flatten the MAC curve for Australia through consideration of the widest possible set of technological options and emissions reducing processes available anywhere in the world. For new clean technologies that are currently pre-commercial, further development and demonstration is required to bring down the costs of their deployment. In addition, the discovery and development of new zero emissions technologies or net negative emissions technologies could also significantly affect the marginal abatement cost curves for Australia and elsewhere.

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McKinsey and Associates (2008), An Australian Cost Curve for Greenhouse Gas Reduction

Appendix 8:
National Low Emission Technology Strategy

1. Summary

- It is in Australia's interests to show leadership on climate change as Australia is among the most climate vulnerable developed nations.
- Because of its small absolute emissions (1.5 per cent of global emissions) and high emissions intensity, two high leverage areas for Australia are climate diplomacy and technology development.
- A national low emissions technology strategy (NLETS) would assist both Australia's international leadership aspirations and help bring about sustained emissions reduction in the domestic economy. Nevertheless, Australia is, and will remain, a technology taker for new generation and many other technologies. [30]
- Technology development is difficult, costly and slow. There are also various first mover barriers. An emissions trading scheme, by itself, will not bring about the necessary transformation in energy technology in the required time.
- An Australian NLETS should reflect Australia's priorities and best interests. Its development should be transparent, fully funded, and linked to international efforts. It should be an integral part of a comprehensive climate program. This requires a long term commitment and an order of magnitude increase in national funding.
- A NLETS should feature short, medium and long term emission targets and be managed by a national taskforce. All prospective technologies should be objectively considered and screened, and specific technology roadmaps prepared for those technologies most aligned to national priorities. Governance arrangements for individual work streams, and for the NLETS, are important to long term program viability. One problem is the role of vested interests promoting particular technologies.
- Ultimately Australia will have to prioritise low emission technologies and select technologies that it sees as having the greatest potential.
- Rio Tinto has an interest in specific technology work areas, which it would like included in the NLETS, but these need to be considered on their merit, once work on the NLETS has commenced.

2. Introduction

The Commonwealth Government is committed to the introduction of an emissions trading scheme (ETS) in 2010. Rio Tinto supports emissions trading as a central component of a comprehensive climate package. Emissions trading will speed the deployment of commercialised, low emission technologies; however, it will not accelerate technology development and deployment to the extent required to significantly reduce greenhouse gas emissions. Emission caps that are more stringent than is warranted by existing technology will reduce economic activity. Therefore more needs to be done to develop low emission

[30] Rio Tinto has a significant interest in generation technologies but recognises that a NLETS needs to incorporate others such as energy efficiency technologies and alternative fuels for transport. Each of those technologies will have different needs and Australia will have different roles to play in their development and deployment.

technology, consistent with the urgency of mitigating climate change. A technology development strategy should be synergistically linked with emissions caps.

Rio Tinto has considerable first-hand experience and expertise in technology development and commercialisation and is an active participant in, and contributor to, international efforts to understand and overcome the challenges to deploying low emission technologies. This experience includes:

- Development of the HIsmelt® iron making process and cathode cell technology for aluminium smelting;
- Supporting research into the role technology can play in effectively managing the long-term risks of climate change through involvement in the Global Energy Technology Strategy Program (GTSP),[31] an international public-private sponsored research programme; and
- The joint venture between Rio Tinto and BP, Hydrogen Energy,[32] which will develop decarbonised energy projects around the world. This work is initially focused on hydrogen fuelled power generation using fossil fuels and carbon capture and storage (CCS) technology to produce large scale supplies of clean energy.

Experience has reinforced Rio Tinto's view that advancing new technology takes time, money and effort, but is vital if emission reductions are to be achieved within the timeframes required, while minimising abatement costs in the long-term.

3. Why Australia needs a National Low Emission Technology Strategy

<u>Australia's leadership role in climate change</u>

- Australia is amongst the most climate vulnerable developed nations, as mentioned in the Garnaut interim report. Australia's climate is already hot and variable and its agricultural sector is a significant contributor to the economy. The nation has strong trade links to developing Asian countries that are poorly prepared to adapt to climate change, and their economies could be severely affected.
- Australia exported 245 million tonnes of coal in 2007, worth A$22.5 billion in export earnings.[33] Coal was Australia's largest single commodity export in 2007. In the long term, this economic activity is threatened by the failure to develop and implement a NLETS. In 2007, the aluminium sector was Australia's third largest export commodity and is also dependent upon low cost and low emissions electricity.
- Reducing Australian emissions is important. However, as Australia only contributes 1.5 per cent of global annual emissions, the nation's interests clearly depend upon global reductions.
- Australia's chief claim to leadership can be expressed through international diplomacy to negotiate global emissions reduction agreements, as well as through its contribution to international efforts to develop low emission and energy efficiency technologies. A national low emissions technology strategy would support this.

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[31] For further information on GTSP see www.pnl.gov/gtsp/

[32] For further information on Hydrogen Energy see www.hydrogenenergy.com

[33] Australian Coal Association Coal Facts for Australia, 2008. http://www.australiancoal.com.au/Pubs/COAL%20FACTS%20AUSTRALIA%202008%20Feb08-4.pdf

- Australia is a technology taker for power generation and many other technologies, and will remain so. This suggests contributing to international efforts that involve original equipment manufacturers (OEMs), while ensuring intellectual property (IP) is available as required. Technology taker status distinguishes Australia from the United States, Japan and the European Union.
- The Australian government has supported a number of low emissions technology programmes. These are moving in the right direction, but too slowly and with less structure than is desirable. The NLETs needs to build upon and, in some cases, reshape the existing platform. There needs to be a more strategic approach, and a substantial increase in funding, if there is to be a serious reduction in emissions.

The technology imperative

- Stabilising atmospheric concentrations of greenhouse gases against a backdrop of rising global population and wealth requires a transformation in the way people produce and consume energy. In addition to full uptake of no cost and low cost energy efficiency options, this transformation requires both the accelerated development and commercialisation of low emission technologies (LETs), an activity that received little attention before the mid 1990s. It also requires the deployment of LETs at a rate that will effectively replace existing stationary and transport energy capital stock over a timeframe set by national caps and trajectories.
- The rate and scale of technology deployment necessary to stabilise atmospheric concentrations of greenhouse gases is unprecedented. It is well beyond what the market can deliver without government intervention to correct the market failures in the R&D sector. Those have been identified many times in the past, (e.g. the “Grubb curve”) most recently by Garnaut.[34] For example, consider carbon capture and sequestration (CCS). GTSP Phase 2 considered a scenario where atmospheric concentrations of CO_2 were stabilised at 550ppm [35]. Assuming that every other emissions mitigation strategy is deployed to the fullest economic extent (e.g., renewables, nuclear, efficiency, etc.) more than sixty 500MW coal fired plants with CCS would be needed globally by 2020, more than 500 by 2050 and more than 5500 by 2090.

The technology development challenge

- Individual LETs able to deliver a minimum abatement of one billion tonnes CO_2-e per annum globally will make a meaningful contribution. In general, the time frame to develop technologies on this scale is measured in decades, and the associated costs in many billions of dollars. This has implications for ongoing support for the fundamental technical sciences and for technology development funding.
- There are clear differences between R&D and demonstration. Different issues and costs are involved. They require different management approaches.
- All technologies go through laboratory level research, pilot level development, and pre-commercial industrial level testing, followed by early commercial deployment. Irrespective of the specific technology, investment in research or small scale

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[34] See for example Garnaut R. (2008), Interim report to the Commonwealth, State and Territory Governments of Australia, February, www.garnautreview.org.au.
[35] See http://www.pnl.gov/gtsp/docs/gtsp_2007_final.pdf

demonstration must be complemented by large scale demonstration before the technology will be commercially deployed.

- Technologies that have been successfully demonstrated overseas need to be proven under Australian conditions, using Australian primary energy sources. Local demonstrations also test regulatory requirements, build community confidence and illuminate other issues, such as integration with pre-existing energy infrastructure.
- To accelerate the development and deployment of LETs, consistent with environmental needs, it is necessary to consider: a) the economic disincentives to being a 'first mover', b) the magnitude of the abatement and transformation challenge, and c) training and developing the skills needed to support an unprecedented technical challenge.
- A NLETS is, therefore, an essential component of a comprehensive climate change and energy policy response. It is essential if Australia is to contribute to global efforts to drive technology development and deployment at the rate and on the scale necessary to meet greenhouse gas abatement targets. A purely market response is insufficient. An Australian NLETS should be an international benchmark for focussed, outcome driven technology development policy.

4. Desirable attributes of a National Low Emission Technology Strategy

The NLETS should be:

- Designed in full recognition of the central role to be played by an Australian ETS. The NLETS should primarily address market failures and timing issues;
- Scoped to include stationary energy generation, alternative fuels for transport and energy efficiency technologies, including technologies associated with energy intensive industries such as aluminium production. Australia should keep both CCS and nuclear, in addition to renewables, as low emission energy technology options. This is currently not adequately recognised;
- Integrated both with: a) the international effort; and b) Australian climate change and energy policy to align technology availability with emissions reduction caps and trajectories;
- Developed transparently, utilising the best available and most rigorous analysis and modelling. Ultimately, however, Australia has to identify priorities and to support those technologies that it sees as having the greatest potential for Australia's circumstances;
- Built around Australia's priorities and best interests considering:
  - Australia's natural resources
  - Emissions abatement potential of technologies, domestically and internationally
  - Australian competitive advantage and economic interests, including opportunities for new technology-based export industries
  - Australian technology expertise
- Built to identify barriers to the commercial deployment of individual technologies and tailored to overcome them. Actions will depend on the position of the technology on the innovation pathway;
- Funded sufficiently to be fully implemented. Rio Tinto advocates that a proportion of ETS revenues should be pledged to rapidly commercialising LETs for a sustained

period. Funding of a NLETS might need to be an order of magnitude higher than existing expenditure;

- Subject to transparency and independence conditions and accountable to Government; and
- Involve the creativity, risk management skills and financial discipline of industry and bring together different companies and industries with complementary skills.

5. Pathway to a National Low Emission Technology Strategy

A NLETS must be well designed and accepted by the Australian community if it is to be effective and enjoy the longevity necessary to deliver results. This will mean a thorough, fact-based, transparent and consultative design process. Rio Tinto suggests the following steps as necessary.

- **Understand possible short, medium and long term emission reduction targets**. Targets are important to understanding the size and timing of the challenge. Targets also need to be developed in parallel with technology deployment plans, as it is these technologies that will deliver the abatement.[36]
- **Establish a national taskforce to develop the technology roadmap**. The taskforce would comprise government, industry and research institutions. The taskforce skill set would cover technical, economic and market aspects and have a strong understanding of international low emissions technology and the challenges faced by technology developers/deployers. It would be able to clearly articulate Australia's particular development and deployment roles.
- **Review abatement technologies**. The taskforce would review promising abatement technologies, including those under development, and objectively screen them to identify those best suited to Australia's interests. Issues to be considered would include:
    - The abatement potential of each technology, globally and domestically
    - Stage of technical development and deployment
    - Technology costs, and the extent to which costs might fall with development and deployment
    - Suitability for deployment in view of Australia's natural resources and operating conditions
    - Australia's commercial interests in each technology, including the extent to which the technology underpins current Australian exports, and the opportunity for new technology based export industries
    - Australia's competitive position in developing each abatement technology

This review stage would result in the identification of Australia's priority low emission technologies.

- **Identify barriers to deployment**. The barriers to deployment for each of the priority technologies would then be identified and analysed. Barriers may include:

[36] The present process is not designed to let this happen. Consideration should be given to a future target adjustment to bring them into line with technological reality.

  - Commercial; the commercial risks are too great or returns are too small (or negative) to allow the investment required to deploy the technology
  - First mover; there is a commercial incentive not to be the first mover
  - Technology risk; the technology is not proven and bankable in an industrial context
  - Policy or legal risk; regulation and government policy related to the technology are immature or have not been tested
  - Public concern; public concerns may make deployment more difficult
  - Skills deficit; skills and expertise critical to the technology are lacking
  - Legal impediments to deployment, for example, the need to develop a legal framework to deal with the very long term liability associated with holding CO_2 in geological traps for thousands of years
  - Lack of available technology to monitor emissions mitigation. An important feature of low emissions technology development is the simultaneous development of the associated technologies to measure, monitor and verify emissions mitigation. This could be particularly important for CCS. Without this technology it is not possible to gain full credit for the emissions mitigation the technology achieves
- **Develop the National Low Emission Technology Strategy**. The taskforce would develop Australia's NLETS to drive the development and deployment of low emission technologies at the rate required for Australia to meet emission reduction commitments in a manner that is in the national interest. Central to the strategy would be specific actions and programmes that systematically dismantle deployment barriers including:
  - Fund technology development, demonstration and initial commercialisation projects. This would consider public and private funding models. For example, the hypothecation of permit auction revenues from the ETS. A particular design issue that needs consideration is ensuring that the measure is confined to addressing market failures in the lead up to technology commercialisation and is not applied to mature, but expensive, technologies. Measures that directly compete with an emissions trading scheme are grossly inefficient. Large scale and capital intensive abatement technology requires particular attention, as the cost of such technology only falls after multiple demonstration facilities and development programmes (at different scales) deliver the expected improvements. Public investment in common user infrastructure, necessary to enable some low emission technologies, will be another consideration
  - Coordination of national and international research, development & demonstration (RD&D) efforts, for maximum benefits and complementarity, and minimal overlap and duplication
  - Establish appropriate regulatory frameworks and amend existing regulations that have unintended impacts on technology development and deployment
  - Public education, information and consultation programmes on Australia's priority low emission technologies, including why they are a priority
  - Addressing any skills deficit through tailored education, training and targeted immigration policy

- **Implement a suitable governance system**. Climate change mitigation will extend over many decades. A NLETS needs an efficient governance model, designed for longevity and insulated from short term political goals, to maximise its effectiveness. Elements of such a governance model may include:
    - Rigorous reporting and transparency mechanisms, including pre-defined stage gates for review of the NLETS and the progress of priority technologies
    - Linkages with the international community to ensure that those responsible for Australian activities are aware of international developments and the potential for leverage these afford
    - Involving the potential technology customers in the governance system to ensure that technology development occurs in a way that facilitates the rapid deployment of the technology in the private sector

Appendix 9: Some critical elements and assumptions in the use of computable general equilibrium modelling for climate change policy analysis

1. Summary

Introducing an emissions trading scheme in Australia will have profound economic effects. For this reason, the best analytical tools must inform the scheme's design. Computable general equilibrium (CGE) modelling is a powerful tool and must be at the core. Rio Tinto supports a rigorous and open approach to modelling and, in this appendix, sets out its understanding of key issues associated with high quality CGE modelling.

CGE modelling has limits. It is best suited to analysis of economy-wide effects. It can be successfully adapted to detailed sector and regional analysis, but care is needed. Rio Tinto considers the following technical modelling features need special consideration:

- ensuring that the data are sufficient to properly undertake the task;
- model closure conditions;
- reproducibility; and
- the detailed specification of possible future technologies likely to become available to the energy sector - technology assumptions need to be carefully tested by experts and well documented sensitivity analysis should be undertaken.

Finally, there are two important checks that need to be applied around modelling:

- Transparency of process. Directly affected parties and the general community need to feel that there has been due process. The current government work programme deadlines mitigate against this; and
- A review process needs to be incorporated into the ETS governance arrangements to confirm that modelling results were reasonably accurate. The review process should specify the way that any unintended consequences in ETS performance can be quickly corrected.

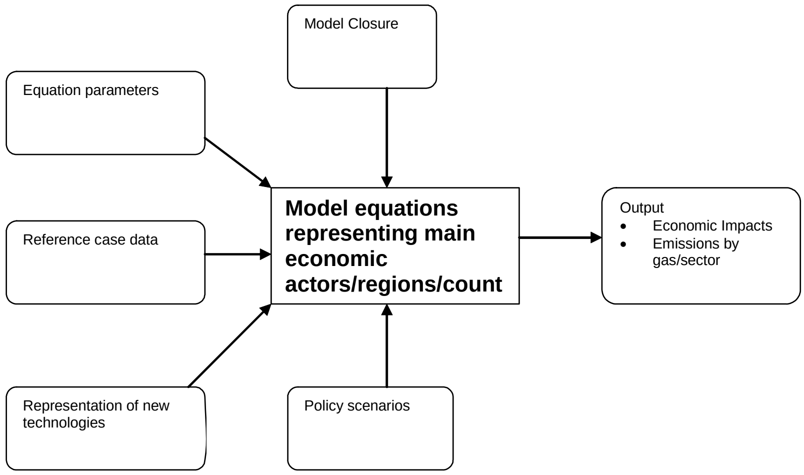
2. Introduction

This appendix sets out what Rio Tinto believes are the essential elements of a robust, transparent modelling process that government should follow in analysing the impacts of a domestic ETS on industries and on the general economy. It sets out the key steps that need to be taken and presents pitfalls that challenge a successful outcome for all major players. In addition, it documents the constraints, disadvantages and implications of using a CGE framework, as well as addressing some technical issues, such as the effects of model closure assumptions.

3. Modelling Schema

There are several steps that may be taken in quantitative analysis of policy to significantly enhance process transparency and assist in engaging stakeholders. The key inputs into the modelling process are set out in figure 1. The following sections present the steps that would ideally be followed. However, the Government proposes to commence emissions trading in 2010 and this may prevent these steps being followed in their entirety.

Figure 1: Representation of Modelling Process



3.1 Data

Rio Tinto sees the necessary steps in data collection and verification as follows:

- liaise with industries to review existing base year data and parameters with a view to improving information where necessary;
- engage industry representatives in projections for baseline or reference case scenarios associated with their industry;
- develop a systematic approach for reporting reference case assumptions across models if more than one model is to be used in the analysis; and
- clearly define the sensitivity of emissions pathways arising from using different assumptions in the reference case, including assumptions about climate change mitigation built into the reference case.

Issues

High quality data sets are crucial as model inputs as well as in other process steps, such as permit allocation. Data collected by government statistical agencies are not necessarily designed for modelling purposes. In addition, industry data are of variable quality, particularly for industries with many small firms. Data compilation could prove challenging, because CGE models do not tolerate inconsistent data sets.

Consistency can be a problem when data is derived from multiple sources. Inconsistent data obtained from firms within an industry can be rectified relatively easily, using a weighted average approach. However, information inconsistencies that result from data coming from different sectors will require modellers to make judgements about accuracy. An example would be an inconsistency between data provided by an input sector and data from the corresponding output sector.

Given the time available, the domestic ETS model input will rely on existing ABS input/output data. These data are relatively old (2001). Some industries could provide recent industry level data, but there is no guarantee that the Government has the capacity to incorporate this into its analysis. There are two main reasons: first, there is limited time for the data analysis, and second, not every industry will be in a position to provide new data. Unless all industry data are updated together, major inconsistencies are likely.

The definition of the reference case is crucial. For example, the chosen reference case trajectory has significant implications for the estimated total cost of abatement. This is because the higher the reference case emissions, the greater the reduction in emissions needed to hit a fixed target, such as a 60 per cent reduction below the 1990 level by 2050.

3.2 Modelling framework

In Rio Tinto's view, there are three key elements here:

- document and publish full model codes (including data sets) to ensure frameworks are transparent;
- use more than one model for each scenario or policy outcome to be tested and use well established models. (It is best to use a mixture of modelling methodologies to ensure that abatement costs are not over- or under-reported. For example, the IPCC reported results from both top down and bottom up models. The true costs of abatement will most likely fall somewhere between the estimated ranges from the two model groups); and
- document model closure assumptions (addressed in detail below).

<u>Issues</u>

The main issue associated with documenting CGE modelling frameworks is that stakeholders are unlikely to understand them in the time available - even if they are made public. Nevertheless, in Rio Tinto's opinion, the process will be more reliable, and the policy process outcomes more acceptable, if the basis on which the analysis was conducted is made public.

If multiple modelling frameworks, such as a range of top down and bottom up models, were used in the analysis of climate policy, inconsistent results would occur. This is clear from the analysis in the IPCC Fourth Assessment Report, where the documented abatement opportunities from the bottom up studies exceed those identified in the top down models at similar marginal costs.

In Australia, recently released model results do not reveal the assumptions that underpin them. This is a major failing. Total abatement costs crucially depend on both the future level of the reference case and on the stringency of the target. They also depend on assumptions about when low or zero emissions technologies will become commercially viable. The choice of the cost and level of deployment of a low emissions backstop technology will determine the long term permit price (see next section).

3.3 Scenarios

In developing policy scenarios, Rio Tinto has identified the following actions as crucial to the process:

- develop a consistent analytical structure and format for reporting the main assumptions that underlie the chosen scenarios (see box 1);

- undertake runs using the different models, with these assumptions as closely aligned as possible, to better understand how various models produce different costs/impacts for a given abatement level;
- undertake a sensitivity analysis of key assumptions to ascertain which parameters are crucial to determining results (see box 2); and
- undertake 'common sense' post-modelling checks on results.

Box 1: Important model and scenario parameters

The key model and scenario parameters are:

- population growth and economic growth;
- underlying technological developments, for example, autonomous energy efficiency improvements;
- fuel and technology substitution and fuel prices;
- cost of backstop technologies – the price at which technologies that decouple energy use from economic growth are available in infinite supply;
- learning by doing – the rate at which technology cost declines related to time and market scale;
- sectoral energy intensities and structural change assumptions;
- behavioral or lifestyle assumptions that alter energy demand;
- demand elasticities associated with energy prices and income;
- flexibility of climate change mitigation policies, including timing of reduction policies, GHG emissions included, and international co-operative mechanisms; and
- tax recycling and any implementation of no regrets options.

Box 2: Desirable sensitivity analysis

Sensitivity analysis with the following coverage would be desirable:

- Undertake policy analysis using several different reference case trajectories for emissions (i.e. high, medium and low). The choice of reference case significantly alters the modelled costs for a given abatement pathway; and
- Undertake policy analysis using several different assumptions about international cooperation. The tendency has been to assume that all Annex B countries will participate in an international ETS. Yet this appears unlikely in the near term. Many scenarios also assume full international participation (i.e. developed and developing countries), which dramatically reduces the cost of reaching a given abatement target. In addition, virtually all studies ignore transaction costs and assume that monitoring and compliance are perfect. Clearly, this is not realistic.

Issues

One challenge, associated with the scenario modelling approach advocated here, is that not all models have the same equation structure, so parameters in one model may not be represented in another. That said, most, if not all of the key assumptions outlined above, would be represented in some form in the three CGE models used by the Treasury.

Undertaking sensitivity analysis helps to determine how sensitive results are to specific input assumptions. Uncertainty about input assumptions makes it difficult to pick the most accurate input.

Post modelling 'common sense' result checking is important because the available models are not perfect representations of reality. For example, in many models capital is fungible and assets are costlessly retired. In addition, most models are not forward looking and do not anticipate price changes. As a result they sometimes produce results that do not pass the 'laugh test'. An example is where large capital investments are made in one period, only to be removed a few years later when the carbon price escalates beyond some threshold. For example, in the case of coal mining, large capital investments in mines and rail and port infrastructure would not be made if carbon prices were expected to rise in the near term in domestic and international markets, resulting in Australian coal becoming uncompetitive. In this sense, the model views only operating costs when calculating the effects on sectoral outputs, and discounts all sunk costs. These models typically deal poorly with large, lumpy investments.

3.4 Model output

Rio Tinto thinks that model outputs should have the following characteristics:

- key outputs should estimate the impact of the chosen policy on GNP, GDP, real wages and industry output, compared with what would otherwise have occurred;
- there should be estimates, at a sufficiently dis-aggregated level, that show impacts on the retail prices of key goods, such as petrol and electricity; and
- the effects of the chosen policy on key regions should also be estimated.

3.5 Constraints in CGE modelling

Rio Tinto firmly believes that models should only be used if they are 'fit-for-purpose' and makes the following observations about the appropriate uses of CGE modelling.

- The results obtained from any CGE model will only ever be indicative. The quality of outputs from any model will be determined by the quality of the input data and assumptions, as well as the degree to which the framework is understood by the modeller and the results are interpreted without post hoc rationalization.
- CGE models are aggregate (or 'top down') by nature. As such, they are best suited to determining economy-wide and industry-wide effects, rather than the effects of policy changes at firm or plant levels. Specialist models need to be constructed for the latter.
- The top-down nature of CGE models means that their results differ markedly from bottom-up (or engineering) models. Typically, CGE models give higher costs for a given abatement target than bottom-up models. The key reason for this difference is that bottom-up models specify many more detailed technology response options than those typically specified in CGE models. In addition, bottom-up models do account for second order effects, or interactions between industries.

- CGE models invoke the economic concept of market equilibrium in that market clearing equations equate demand with supply in each commodity market, and in capital formation and other primary factor markets. In reality, however, markets are dynamic, with only a long-run tendency toward equilibrium.
- CGE models assume perfect competition in production, capital formation and international trade. Of course, this simplifies reality and has important consequences when modelling climate policy, particularly for industries with a limited numbers of firms.
- The CGE models typically available in Australia do not have integrated assessment capacity and so cannot optimize abatement against the cost of climate damage.
- CGE models do not account for the full costs of implementing new technologies or retrofitting old technologies. This is because capital is typically assumed to be costlessly retired, which would only be the case if capital assets were fully depreciated and there were no scrapping or demolition costs.

3.6 Model closure

In addition to transparent parameter assumptions and data sources, Rio Tinto believes that it is important that other technical assumptions are clearly stated. In particular, model closure assumptions should be specified clearly and comprehensively.

CGE models contain n variables and m equations where $n>m$. Since there are more variables than equations, n-m variables must be set exogenously (outside the model), leaving m variables to be solved endogenously (determined by the model). When choosing variables to set exogenously, care must be taken that all equations can be solved for all endogenous variables. The choice of which variables to set exogenously is called the model closure.

Model closure assumptions should be made explicit since the choice of closure provides flexibility in the economic conditions under which various policy shocks occur and can lead to controversy. This is because differences in model closure can lead to differences in results between models that appear difficult to reconcile if the closures have not been specified.

There are two main considerations in choosing model closure: the first is the timeframe over which the policy being modeled is to be evaluated; the second is the variables of greatest interest in the policy analysis or the hypothesis to be tested.

If the analysis is to model the effects of policy shock in the short run, capital stocks are usually held to be fixed, because capital typically takes time to adjust to economic shocks. Since firms can employ more labour in the short run, employment is usually endogenously determined, while wages are held fixed. If the objective of the modelling exercise is to examine the effects of policy over the long term, then capital stock would typically be endogenous and labour supply fixed (while wages vary). This assumption reflects the fact that, over the long term, capital stocks can vary but labour supply is constrained by demographic considerations.

It is important to note that there is no single ‘correct’ closure for any simulation. However, closures referred to as short run may often incorporate the following assumptions:

- the real wage is fixed and employment is endogenously determined;

- the average propensity to consume is fixed;
- the nominal exchange rate acts as the numeraire while the CPI is endogenous. (Note however that the CPI in CGE models does not closely resemble the CPI in the traditional sense - the CGE version reflects relative price changes across all commodities defined in the model, rather than those in a 'basket' of goods);
- current capital stocks and investment are fixed, while the rate of return to capital is variable; and
- all government outlay and trade accounts, except transfers to households by government, are endogenous.

Long run closures will often differ from short run closures in the following key respects:

- employment (proportion of the labour force in work) is fixed, while real wages are variable;
- rate of return to capital is fixed, while capital stocks are endogenously determined; and
- foreign trade balance is fixed, while the average propensity to consume is endogenous.

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