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***Rail and Climate Change:
A Scoping Paper***

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Executive Summary

The starting point for this project is the hypothesis that there would be major economic, social and climate benefits from a substantial modal shift of both passenger and freight traffic from road to rail, together with an extensive modernisation of rail transport and a reduction in its energy use and greenhouse emissions. Over the next decade price effects are likely to support such changes – fuel prices will remain high, and the introduction of a price for carbon through an Emissions Trading Scheme (ETS) will increase the competitiveness of rail relative to road. Yet this hypothesis that a modal shift towards an enhanced rail sector will be important is nowhere to be seen in the climate debate in Australia, which focuses mainly on electricity generation and use, on the efficiency of road and air transport and on other related matters. Nor are the relative price changes arising out of higher energy prices and an ETS alone likely to be sufficient to generate either extensive modernisation of Australia's rail sector or such a modal shift within transport. Especially in this sector, prices do not operate in a vacuum, but in a context heavily influenced by infrastructure constraints, the sunk costs required for track and equipment, the diverse incentives facing companies, agencies and governments, and other factors.

The aims of the project are to understand the pre-conditions for a substantial modal shift and upgrading of Australian rail transport, in the context of high global fuel prices and a carbon price; to estimate the economic, social and environmental benefits arising from these two changes, and the net costs and benefits; and to assess the policy options and the corporate responses required for these changes to occur.

This scoping paper is intended to identify some of the main issues that need to be addressed in the broader research process, and to provide some indication of how they might be approached. It is in four sections. In the first section, a number of key issues, propositions and questions related to the overall task are noted and briefly discussed. These issues mainly concern the implications of the emissions challenge facing Australia for the transport industry, and the role of a substantial modal shift within Australia's response. The second section highlights a key issue which is the subject of much debate and is critical to the issues concerning rail, namely the justification for complementary policies in conjunction with an emissions trading scheme. The third section briefly discusses the long term options for the role of an efficient, modernised rail industry within Australia's response, and what might be required to test the viability of those options. Finally, the concluding section outlines the process proposed for the full project, and the ten research papers which will be the main vehicle for reporting the results of the research prior to the delivery of the final report.

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Abbreviations and Acronyms

AR4	Fourth Assessment Report
BTRE	Bureau of Transport and Regional Economics
DCC	Department of Climate Change
ETS	Emissions Trading Scheme
GHG	Greenhouse Gases
IEA	International Energy Agency
IPCC	International Panel on Climate Change
MRET	Mandatory Renewable Energy
Ntkm	Net tonne per kilometre
Npkm	Net passenger per kilometre
NHS	National Highway System

1. Some Key Issues, Propositions and Questions

1.1. Australia faces a major challenge in terms of emission reductions

There is accumulating scientific evidence that global warming in excess of 2°C relative to pre-industrial temperatures would have a wide range of highly adverse impacts around the globe, and many governments have concluded that action to limit warming to this level is an urgent priority. The Fourth Assessment Report (AR4) of the International Panel on Climate Change (IPCC 2007) concluded that, for a 50% probability of holding warming to no more than 2°C, the total atmospheric concentration of greenhouse gases (GHG) needs to be stabilised at 450 ppm CO₂-e, while stabilisation at 550 ppm CO₂-e implied a 50% chance of warming of 3°C. AR4 also concluded that, to stabilize the GHG concentration at 450 ppm CO₂-e reductions of 25-40% in emissions from developed countries (relative to the 1990 level) by 2020 were necessary, while cuts of 10-30% were necessary to achieve stabilisation at 550 ppm CO₂-e (see Table 1). These figures represent reductions relative to the 1990 base, and imply different reductions for different base years, such as 2000.

Table 1. The range of the difference between emissions in 1990 and emission allowances in 2020/2050 for various GHG concentration levels for Annex I and non-Annex I countries as a group

Scenario category	Region	2020	2050
<i>A-450 ppm CO₂-eq²</i>	Annex I	-25% to -40%	-80% to -95%
	Non-Annex I	Substantial deviation from baseline in Latin America, Middle East, East Asia and Centrally-Planned Asia	Substantial deviation from baseline in all regions
<i>B-550 ppm CO₂-eq</i>	Annex I	-10% to -30%	-40% to -90%
	Non-Annex I	Deviation from baseline in Latin America and Middle East, East Asia	Deviation from baseline in most regions, especially in Latin America and Middle East
<i>C-650 ppm CO₂-eq</i>	Annex I	0% to -25%	-30% to -80%
	Non-Annex I	Baseline	Deviation from baseline in Latin America and Middle East, East Asia

Source: IPCC (2007, Box 13.7, Section 13.3.3.3).

The Fourth Assessment Report is based, in the main, on the literature up to about 2006. The most important change since these studies were undertaken has been the emergence of sustained rapid economic growth in large developing countries, such as China and India. This rapid growth is heavily based on fossil fuels, and especially coal, and for this reason is leading to rapid growth in GHG emissions. Table 1 shows one set of projections of global emissions of CO₂ from fuel combustion and cement to 2030, designed to take full account of these trends (Sheehan and Jones 2008 forthcoming). Similar projections are to be found in Garnaut (2008) and underlie the Interim Report of the Garnaut Climate Change Review (2008). These projections show rapid growth in emissions out to 2030, and that CO₂ emissions, on unchanged policies, are likely to be more than double their 2004 level by 2030. Emissions are growing much more rapidly than previously thought, and a larger and more urgent response is required if they are to be contained to levels consistent with acceptable levels of global warming.

Table 2. CO₂ emissions from fuel combustion and cement production, selected countries and world, actual 1971–2004, projected on unchanged policies to 2030

	CO ₂ emissions (GtC)			Annual change (% per annum)			
	1971	2004	2030 (projected)	Actual	Projected		
				1971-2004	2004-15	2015-30	2004-30
OECD	2.6	3.6	4.3	1.0	1.0	0.5	0.7
Transition	0.6	0.7	0.9	0.4	1.4	0.5	0.9
China	0.2	1.4	6.8	5.8	7.9	4.9	6.2
India	0.1	0.3	1.4	5.4	5.8	5.7	5.7
Other countries	0.4	1.5	3.3	3.9	3.8	2.6	3.1
World	3.9	7.5	16.6	2.0	3.5	2.8	3.1

Note: The table covers CO₂ emissions from fuel combustion, including bunkers, and cement production, measured in gigatonnes of carbon (GtC).

Source: Sheehan (2008), based on Sheehan, Jones et al. (2008 forthcoming), using historical data to 2004 from IEA website (IEA 2008) (<http://data.iea.org/ieastore/statslisting.asp>).

One implication of these projections (Sheehan 2008) is that the conclusions summarised in Table 1 cannot be taken as a reliable guide for immediate policy determination. If urgent steps are to be taken to achieve specific stabilisation targets, the overall reductions relative to a realistic base case are likely to be larger than suggested in Table 1, and the disposition of those reductions across regions may be quite different. In particular, to achieve a given stabilisation goal (such as 450 ppm CO₂-e or 550 ppm CO₂-e) substantially higher reductions in emissions from the developed countries by 2020 than shown in Table 1 (25-40% for 450 ppm CO₂-e) will be required. This has important implications for the targets that Australia is likely to be forced to adopt in international negotiations.

1.2. Achieving even a modest target for 2020/2030 will require a significant reduction in transport emissions relative to business as usual

While the analysis above suggests that, for the developed countries as a whole, reductions in emissions above the 25-40% range by 2020 are likely to be necessary to achieve stabilisation at 450 ppm CO₂-e, the Australian Government is committed to a reduction of 60% relative to 2000 levels by 2050 but is waiting on advice from the Garnaut Review before determining a target for 2020. Table 3 summarises the latest official projections of Australia's GHG emissions, showing a level of emissions in 2020 (on an unchanged policy basis but including the Mandatory Renewable Energy Target (MRET) of 20% by 2020 but not the ETS) of 664 Mt CO₂-e, an increase of 20% on 1990 and about 18% on 2000¹. Emissions excluding land use and related changes are still projected to grow significantly, by 1.6% per annum over 2005-10 and by 1.1% per annum over 2010-20.

¹ Australia's emissions increased only marginally between 1990 and 2000, with strong growth in energy related emissions being largely offset by reduced emissions from land clearing.

Table 3. Australian greenhouse gas emissions, actual 1990 and 2005, projected (business as usual with measures) to 2020

	1990	2005	2008- 12	2020	Average annual growth rate		
					1990- 2005	2005- 10	2010- 20
	Mt CO ₂ -e				(% pa)		
Energy	287	396	429	475	2.2	1.6	1.0
Stationary	196	283	304	320	2.5	1.4	0.5
Transport	62	81	88	104	1.8	1.7	1.7
Fugitive	29	32	37	52	0.7	2.9	3.5
Industrial Processes	25	30	38	49	1.2	4.8	2.6
Agriculture	88	90	93	100	0.1	0.7	0.7
Waste	18	15	15	15	-1.2	0.0	0.0
Land use etc	136	52	24	24	-6.2	-14.3	0.0
Land use change	130	74	44	44	-3.7	-9.9	0.0
Forestry	0	-22	-21	-20			
Total	554	583	599	664	0.3	0.5	1.0
Note:							
Emissions ex land use etc.	418	531	575	640	1.6	1.6	1.1

Source: Department of Climate Change (2008).

In interpreting these projections two matters must be noted. First, the projections assume that the MRET commitment of 20% of electricity generation from renewable sources is achieved in full by 2020: this measure alone reduces emissions by 29 Mt CO₂-e by 2020, a saving of 9% of stationary energy emissions at that time. Achieving this outcome requires generation from renewable sources to rise from about 4,500 GWh at the present time to 45,000 GWh by 2020. The (correct) inclusion of such a large policy measure in the projection means that the scope for additional savings in the stationary energy sector will be limited. Fugitive emissions are also growing strongly, with the growth of the mining industry from which they mainly arise, and it is difficult to make large emissions reductions in such a dispersed sector as agriculture. These factors mean that if Australia is to achieve even modest reductions in emissions by 2020 (say a 20% reduction in emissions relative to the projection, taking total emissions to about 5% below 2000 levels) a more than proportionate share will need to be found in transport. Thus a viable emissions outcome for Australia is likely to require a reduction of at least 30% in transport emissions relative to the business as usual projection by 2020.

1.3. This will require both efficiency improvements in all transport modes but also a substantial modal shift to rail

The section point to be noted about the projections in Table 3, the transport details of which are provided in Table 4, is that they assume a substantial slowdown in passenger car usage as a result of higher fuel prices. The rate of growth of emissions from cars over 2005-20 (0.8%) is expected to be only half that over 1990-2005 (1.5%), although the growth of freight emissions is on balance about the same, given the rapid growth in freight volumes.

Table 4. Actual and Projected Emissions from Transport, by Mode 1990-2020

	1990	2005	2020	Average annual growth rate	
				1990-2005	2005-2020
	Mt CO ₂ e			(% pa)	
Cars	35.2	44.0	49.3	1.5	0.8
Motorcycles	0.2	0.2	0.3	0.0	2.7
Buses	1.2	1.3	1.6	0.5	1.4
LCVs	7.5	11.1	17.9	2.6	3.2
Rigid Trucks	4.1	5.6	6.9	2.1	1.4
Articulated Trucks	6.1	8.8	12.8	2.5	2.5
Total Road	54.3	71.0	88.8	1.8	1.5
Domestic Aviation	2.9	5.1	8.7	3.8	3.6
Domestic Shipping	3.0	2.4	2.8	-1.5	1.0
Rail	1.7	2.1	3.3	1.4	3.1
Total Transport	61.9	80.6	103.6	1.8	1.7

Source: Department of Climate Change (2008).

Another relevant consideration is that as these projections include ongoing increases in oil prices (although not in the long term to the level currently being experienced) the impact of further increases in fuel prices through an ETS will be muted. The percentage increase in fuel prices arising from a carbon price of (say) \$30 per tonne will be much lower with an oil price of US\$90 per barrel than with one of US\$30 per barrel.

This brief analysis seems to suggest that, if the transport sector is to achieve a reduction in emissions of 30% relative to the base case by 2020, measures in addition to further increases in fuel prices through the ETS are likely to be necessary. The most obvious such measure, of course, is a modal shift from road to rail.

1.4. But a modal shift is not on the agenda, in terms of standard estimates of emissions reductions

However it is notable that, in the standard analyses of emissions abatement and the modelling work in which those analyses are often embodied, a modal shift from road to rail is not considered, and is indeed not on the agenda. One standard form of analysis, which is often included in climate models, is the climate abatement cost curve. The figure below shows an example of such a curve, taken from the US Greenhouse Gas Mapping Abatement Initiative, led by McKinsey and Co and the US Conference Board (McKinsey & Company 2007, p. 20). Figure 1 shows such a curve for transport in the US, and it is notable for excluding any mention of rail or of modal shifts from road to rail. Similar curves are widely used in Australia also and are embodied in climate assessment models. It should be noted that in one respect these estimates are entirely theoretical, in spite of being built up by detailed technical analysis and consultation. This is because they assume that a given technical advance can be delivered to and adopted by the whole of the relevant population, without any adoption barriers, transition costs of other problems.

The reasons for this exclusion are fairly clear. Rail has a low share of total transport emissions, because of both a low emissions intensity and a modest share of transport activity, and so does not present itself as a prime area for major emissions savings. Perhaps more importantly, however, these analyses are all carried out on an individual technology or

industry sector basis, with no capacity for studying shifts or transfers between sectors. Hence the methodology does not consider modal shifts such as that from road to rail, as other techniques are required to study these shifts. But this may mean that an important option is excluded from the debate.

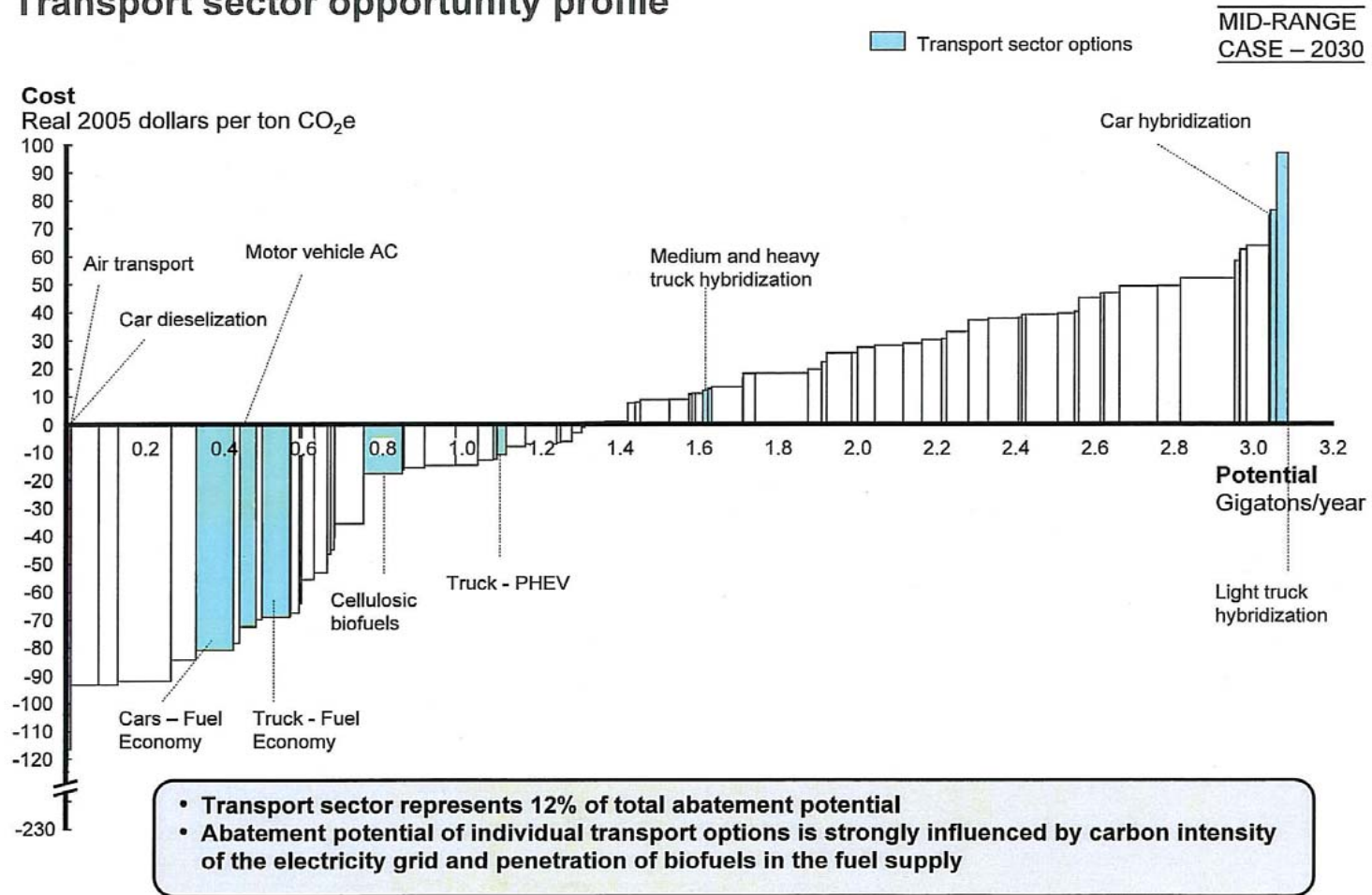
1.5. Is a modal shift possible? What proportion of the transport task is contestable by rail?

The possibility of a significant modal shift requires that a good proportion of existing freight and passenger road traffic is, or could become, contestable by rail. This is a matter about which views differ. In terms of freight, both rail and road transport offer specific advantages over each other. The balance of these relative advantages leads to the current modal split. Rail offers advantages in long distance, heavy loads and hence rail currently carries 80% of the bulk freight (ntkm) in Australia (Sirikijpanichkul and Ferreira 2006). Conversely road freight offers advantages in terms of time and flexibility of delivery and it currently carries over 70% of the non-bulk freight (ntkm); this appears likely to increase if current trends continue (Gargett and Perry 1998; Department of Climate Change 2008). The advantages of road freight have increased over the past three decades due to such things as improved truck technology and extensive investment in the National Highway System (NHS), together with a corresponding neglect of the railway system. Before this NHS investment, rail had a modal share of over 50% of non bulk freight (BTE 1990). This suggests that a modal shift back to rail may be possible with appropriate investment. In addition, other factors such as the charging system for freight influence the modal split. The introduction of a mass distance charging system for road freight similar to that in New Zealand may increase rail's modal split (Mackie, Baas et al. 2006). The current flat fee system for road freight encourages road freight operators to haul their freight the longest possible distance, with the heaviest possible loads. Conversely, the rail system currently has a mass distance type scheme.

In terms of passenger travel, private cars currently have over 70% of the total domestic passenger travel (npkm) (BTRE 2008). This figure rises to over 80% when domestic aviation is excluded, and rail only has approximately 10%. Various state governments have identified a 20% mode share target for public transport by 2020. A number of cities around the world achieve a modal split much higher than this, so therefore it would appear possible to achieve this figure (Laird, Newman et al. 2001). Nevertheless, in Australia the issues for choice of transport mode for passenger travel, where alternatives are available, have been identified as parking problems; lack of vehicle access; cost; comfort and convenience; travel time; accessibility and environmental reasons; in many areas no viable public transport alternative is available (Perkins and Hamnett 2005). This suggests that for public transport to increase its mode share many complex issues of service availability, quality and amenity need to be addressed (Corpuz 2007).

Figure 1

Transport sector opportunity profile



1.6. Will emissions trading initiate a substantial modal shift in transport? If not, why not?

Emissions trading will impact on transport mainly through a higher fuel price, and by a relative shift in cost from road and air to rail. One issue, that can readily be examined further, is how much the relative price of road freight and passenger transport will rise relative to their rail competitors with the introduction of a given price on carbon. The more important issue is the cross price elasticity between road and rail transport for each mode, and what determines this elasticity. If, as seems likely from the historical record, this elasticity is low, then even substantial increases in relative prices will not generate a substantial modal shift.

Among the reasons for a low cross price elasticity are the importance of sunk cost in relation to rail and the necessity for an alternative, competitive source of rail transport to be available for it to be possible for businesses or consumers. If the sunk cost investment required to build capacity are greater in rail than in road, then there are entry barriers to increased rail capacity, and changes in relative prices may not be sufficient to overcome those barriers. Equally, if governments or town planners do not facilitate an adequate supply of high quality of public transport, the ability of consumer to respond to changes in relative prices is limited. In Melbourne, for example, the train network only services about one-third of the population (Mees 2000). If the remaining population do not have access to an alternative then this may lead to an inelastic price for transport costs and hence no modal shift despite a high price on carbon.

1.7. What is required, on the demand and supply sides, to bring about a substantial modal shift to transport?

This is one of the fundamental questions that need to be researched in detail in the study; many factors are undoubtedly involved, and the answer will differ for freight and passenger traffic and across regions. On the demand side, issues for freight surround the ability of rail to satisfy the current trends for business to outsourcing non-core activities including logistics, and towards smaller more frequent shipment (time sensitive supply); just-in time inventory; and direct-to customer business (Sirikijpanichkul and Ferreira 2006). Scheduling issues and road user charges may be important issues influencing freight demand (Starrs and Van Geldermalsen 2002). On the passenger side, certain cities have introduced large programs in order to change travel demand. One of the most notable is the Congestion Charing scheme in London. Whilst this scheme has reduced car travel in central London it remains to be seen whether such an approach is suitable in Australia (Hensher 2003). However, other instruments have been used to influence demand for private vehicle use such as reducing parking provision and road space reallocation (Corpuz 2007). These schemes need to be investigated more closely in order to determine which would be the most effective in bringing about a modal shift.

On the supply side there are many complex issues, affecting both types of rail transport (Hensher 2007). Many of these have been addressed in the existing literature and commentary, but a thorough review and analysis of these will be an important part of the overall study.

1.8. What emissions reductions could a modernised, competitive rail sector deliver, within rail and in terms of substitution of road and air traffic? Could rail be substantially powered by (additional) renewable energy sources?

The issue in terms of emission reduction is how much more energy efficient rail transport is than road transport, and how this is affected by changing infrastructure and vehicle

investment patterns. Despite the extensive investment in the NHS in the past 30 years and vastly improved truck technology, rail freight still produces at least 3 times fewer emissions than articulated road freight (Laird 2007). The iron ore freight trains are 12 times fewer emissions than road freight (Laird 2004). The question is not whether rail could deliver large emissions reductions but rather to what extent. Even the current rail freight emissions could be reduced by improved track alignment and grades leading to shorter transit times (Laird, Michell et al. 2002).

Passenger travel on rail also produces far fewer emissions than private vehicle travel. The extent of which depends on the occupancy rates of the train. The addition of regenerative braking on passenger trains is also worth examining to further increase energy efficiency (Kilsby, Laird et al. 2004). Due to the dominance of the private vehicle for transport there exists great potential for rail to increase its mode share and deliver considerable emissions reductions. For rail to take some of the current aviation mode share, questions of cost, time and convenience would need to be examined. In Europe and Japan it is faster to travel by high speed train between some cities than by plane due to the airport and road congestion (Laird, Newman et al. 2001). Whether this would be the case between Australian cities remains to be seen.

In 2005 rail used only about 1% of total Australian electricity supply, on far from complete electrification (Apelbaum Consulting Group 2007). Even with much more extensive electrification and a pronounced modal shift rail would only account for about 3-4% of total electricity production. Under the MRET renewable energy generation is required to go from about 4.5% of total generation at present to 20% by 2020. In this context is conceivable that rail could become powered by renewable sources, although there are many issues to be addressed about the feasibility of electrifying the freight network as well as the most suitable type and location of the renewable sources.

Table 5 presents some simple calculations to illustrate the potential orders of magnitude involved. In the discussion of Tables 3 and 4 above it was argued that, for Australia to achieve even modest emissions reductions by 2020, a cut of over 30% in transport emissions would be necessary, and that this was likely to require a substantial modal shift within the transport sector. The assumptions used in constructing the 'renewable rail strategy' estimates in Table 5 are that by 2020 rail captures 50% of non-bulk freight and 30% of urban passenger traffic; that by that date rail is entirely powered from renewable sources and that a 25% improvement in emissions intensity per unit of activity is achieved in all road transport and aviation modes, over and above those included in the DCC projections.

Table 5. Total transport emissions, Australia: actual 1990 and 2000 and projected 2020

	Total emissions (Mt CO ₂ e)	Per cent change relative to renewable rail strategy (%)
1990	62.1	4.0
2000	74.0	-12.8
2020: DCC projection	103.6	-37.7
2020: Renewable rail strategy	64.6	

Source: Department of Climate Change (2008), and estimates of the authors.

These numbers are only notional at this stage, and illustrative of orders of magnitude. It is not being claimed that these assumptions are indeed achievable. But they do suggest that a combination of modernisation and reduction in emissions intensity in rail, a pronounced modal shift to rail and further technological and efficiency gains in road and air transport could make a major contribution to reducing Australia's emissions.

1.9. What economic and social benefits, other than reduced emissions, would be delivered by greatly increased use of rail?

It is generally accepted that road transport produces more external costs than rail. These external costs include accident costs, air pollution, urban amenity, land use, visual amenity, noise pollution and increased wear on urban roads (Evans 2006). In addition, transferring mode share to rail would decrease road congestion costs, bringing further benefits (Gillen, Lawson et al. 2006). These external costs need to be examined in more detail to identify their relative importance and how much benefit could be gained for each for each with increased use of rail.

2. Is There a Case for Complementary Policies with an ETS?

There is a widespread argument put by many economists that any policies to achieve particular ends in conjunction with an ETS are at best pointless, in that they will not affect the level of emissions reduction, and at worse harmful, in that they will increase the cost of achieving a given level of emissions reduction. The most recent statement of this has been in the submission by the Productivity Commission (2008) to the Garnaut Review. This position is particularly important for the transport sector, given the argument above that the relative price changes arising from the ETS will have little impact in inducing a modal shift in transport, and that complementary measures will be necessary if this is to be achieved.

This position starts with the hypothesis of a competitive economy, without sunk costs or other distortions, in which prices clear the market. Suppose further that, in such an economy, the government needs to limit the production of carbon emissions on social grounds. If it does so by a cap-and-trade scheme, it will require any producer to hold a permit prior to production of a unit of emissions, will issue a limited number of permits and allow the price of such permits to adjust until the demand for emissions, through the demand for goods embodying emissions, is equal to the permitted level of supply. The resulting level of output will represent the most efficient way of controlling the output of emissions and, given assumptions about the social optimality of the pure market outcome, is also the socially optimum method.

Suppose that, in such a situation, the government also decides to intervene in the market to influence the supply of or the demand for emissions. This might be by prohibiting one form of emissions-intensive production (e.g. electricity from brown coal), by requiring a minimum level of zero emissions production (e.g. electricity from renewal energy) or by assisting or regulating other forms of production and consumption. These measures will have the effect of either reducing the supply of emissions relative to the permit level or reducing the demand for them, and will reduce the gap between the demand for emissions and the permitted supply. Hence they will reduce the rise in the price of carbon, so that there will be smaller reductions elsewhere. Given that the final level of emissions is determined by permit level, the only effect will be to reduce the price required to clear at the permit level. However, given that the equilibrium achieved by the full price adjustment is both efficient and socially optimal, these measures cannot achieve a better outcome on these fronts, but may be less efficient and less than optimal outcomes, if the complementary measures bring about changes that are less than optimal. That is, such interventions serve no purpose in terms of final outcomes in an emissions trading regime, but may incur economic and social costs.

Two of the major problems with this position are that it does not recognise the role of sunk costs and other market distortions, and that it does not allow for cases in which the price elasticity of demand for energy related products is a function of infrastructure or other factors affecting supply. Sunk costs are high in many energy and energy intensive industries (large, irrecoverable costs need to be incurred in building power stations or railway systems), and these sunk costs create substantial entry barriers. Equally the price elasticity of road passenger transport demand will be quite different in an area with good public transport than in an area with none.

To illustrate the role of sunk costs, let us consider an alternative economy. In this economy 90% of emissions are produced in one sector (electricity), and production in this sector involves long lead times and heavy sunk costs, with marginal costs well below average costs, and the price elasticity of demand for electricity is low. Assume further than existing producers are coal based, many with old plants for which the capital costs have been written off. New, fossil-free forms of production are available, but also require meeting substantial sunk costs. For old producers production just above marginal cost is economic, but new producers need to recover both capital and marginal costs. When the government introduces the cap-and-trade system and a carbon price is established, at initial levels new producers cannot compete with the pure marginal cost basis of existing producers and the

cost is fully passed to consumers, with little impact on demand. Hence the initial burden falls entirely on other sectors. The result is that, to clear the market the price of carbon must rise further, either to achieve the required emissions reduction in 10% of the economy or to a level that makes the return to new producers adequate to cover both capital and operating costs, and greater than marginal costs of old producers plus the cost of carbon permits. For particular values of the parameters, the carbon price required might be very high, and the impact on non-electricity industries much greater than the optimal.

In this second economy, establishing a regulatory requirement for non-fossil fuel production may have quite different effects. If, by a certain date, all electricity producers are required to produce say 20% of their output from renewable energy they will be forced to invest, directly or indirectly, in generation from renewal sources. The price paid by the consumer for electricity will rise to cover the higher costs of renewal energy, and this will lead to some (small) reduction in demand. But the demand for carbon permits will be reduced and hence the carbon price will be lower than it would otherwise have been, reducing the adjustment in other sectors. Relative to the pure emissions trading case, the result will be adjustment to the required level with a lower carbon price and with less adjustment in other sectors. As well as being achieved with a lower emissions price, the outcomes with complementary policies may well be more efficient and socially desirable outcome than with pure emissions trading.

Similar points apply to cases in which the price elasticity of demand is a function of infrastructure or constrained supply. In transport both of these effects seem to be present. There is limited supply of rail freight and passenger services, for reasons to do with limited investment and infrastructure, themselves linked to the problem of sunk costs. This means that the cross price elasticity between road and rail traffic is relatively low (EMCT 2002) – if road prices increased relative to rail prices users have limited ability to shift to rail services. This means that there is a prima facie case that appropriate complementary measures in rail could make the ETS more efficient and improve the social outcome. But the technical issues here need to be further analysed, as this will be an important issue in more the impact of complementary policies for rail.

3. The Role of Rail in a Low Emissions Australia: Potential Outcomes

In considering the enhanced role of a modernised rail system in a low emissions future for Australia, there are many different potential means to achieve this outcome to be defined and analysed. One such means, at the highest impact level, would be a sustained, long-term modal shift, for both freight and passenger traffic, to a modern, electrified rail system powered from non-renewable sources (outside and in addition to the MRET commitments). Such a means would provide some transport that was virtually permanently emissions free, and hence insulated from the vagaries of future trends in fossil fuel supply and carbon prices. It would also lower the carbon price in the ETS, and hence reduce the burden of adjustment to other sectors in the economy. To the extent to which such a means provided large economic, social and environmental benefits, these benefits could provide the justification for the massive long-term program of investment, by both governments and companies, needed to make it a reality.

Such an outcome would be a first best outcome, in terms of emissions reduction alone. But it may not be viable due to unacceptable economic and business outcomes, and may not be a socially cost-effective way of reducing emissions. In our view such an intervention needs to be assessed, but in the context of a range of other, less ambitious outcomes involving an increased rail share.

4. Proposed Research Process and Working Papers

To achieve these aims the project would proceed in several stages:

- The first draft of this scoping paper has been provided on 30 May 2008, for review and comment. In the light of such comments and further work, the paper needs to be finalised by mid June 2008.
- Between mid June 2008 and the end of September 2008 a series of 10 working papers would be prepared, as outlined below, to present for discussion initial analysis and results.
- By the end of October 2008, a full final report would be prepared.

The currently proposed list of working paper is provided below. This list may be revised either prior to the start of full project or during its progress, as circumstances or needs change.

4.1. The Australian transport sector and climate change

Descriptive analysis of the Australian transport sector, with special emphasis on modal issues, on energy issues and on greenhouse gas emissions. This paper will:

- provide a review of the data available on Australian transport patterns and emissions, and of the limitations of those data;
- analyse the factors influencing emissions from transport (including an assessment of the quality of the data about them) and the factors constraining change within the Australian transport sector;
- review the likely targets for Australian emissions for 2020, 2030 and 2050, and their potential implications for transport;
- analyse the effect of different transport outcomes (e.g. substantial modal shift) on overall emissions (cf Table 5 above); and
- place the Australian transport sector, and the Australian emissions debate, within the broader international context.

4.2. Social, economic and environmental impacts of transport modes

This paper will involve a through review and analysis of the diverse social, economic and environmental costs and benefits of rail and road use, with particular emphasis on external costs benefits, which are not internalised in the decisions of firms and consumers. The paper will be based on the extensive review of the international and Australian literature in this area, and of the available evidence on the relevant parameter values. On this basis it will seek to produce, within the inevitable constraints, an updated and comprehensive assessment of these costs and benefits for different transport modes, as a basis for subsequent analyses in the project.

4.3. Emissions trading and transport

This paper will define the likely operation of an Emissions Trading System, and its impact on the transport sector, based on the latest information from the Garnaut Review and other sources. This will include an analysis of the factors determining the carbon price, including how it might vary over time, and how the various trading mechanisms likely to be included in the ETS will impact on different parts of transport over time.

4.4. The case for complementary issues with an ETS

This is an important technical issue, which needs to be thoroughly researched to provide a sound basis for the quantitative analysis. At issue here is not only documentation of the

various market failures involved, such as entry barriers from sunk costs and the dependence of cross price elasticities on infrastructure and supply issues, but analysis conditions under which complementary policies might produce an economically and socially preferred outcome to pure emissions trading. This will relate in particular to the conditions under which complementary policies in transport (such as infrastructure and other spending to support a modal shift) will produce an overall community benefit.

4.5. Transport companies and agencies

The Australian transport sector consists of many different types of firms and agencies, from large companies operating in the road and rail areas and large government instrumentalities to a range small companies and operators. The paper will attempt to document the companies and agencies involved in rail transport in Australia, the issues and incentives they face and how they do or might interact with firms or agencies in other transport modes (eg intermodal linkages). This analysis is critical to providing a clear view of which policy options might be effective in terms of different types of company and agency.

4.6. Freight infrastructure issues

This paper is an important one in documenting the key infrastructure and related issues affecting the distribution of the freight task between road and rail, as well as assessing and costing the options for addressing them. It will draw on some existing Australian literature and an extensive international literature, and cover the following issues among others:

- track capacity and quality, by comparison with road network, and in the light of the use of advanced locomotive and other technologies;
- the costs of track upgrading, in different sectors;
- intermodal issues, including exchanges and other forms of complementary facilities; and
- supply chain structures within Australia, and their location and transport mode implications.

4.7. Passenger infrastructure issues

This paper will be the counterpart of paper 6 for the passenger network, addressing analogous issues such as the infrastructure and other issues affecting the modal split of passenger movements in the major cities, and of the options for major change. It will also include an analysis of particular examples in which investments in modal change infrastructure have been undertaken, such as the case of Perth.

4.8. Powering rail – electrification and fuel use

This paper will look specifically at the issues involved in increased electrification of the rail network, and of the practicality and/or willingness of the industry to influence the generation fuel used. Thus it will consider the options for increased electrification, and the likely costs of such investments; the prospects for new, cleaner modes of rail transport other than by electrification; and the issues and costs involved in having electricity use by railways provided entirely by renewable sources (in addition to the current 20% Mandatory Renewable Energy Target).

4.9. Technology and commercialisation developments

This paper will draw on a wide range of national and international sources to describe recent and prospective technology developments relevant to transport, and the extent to which

they are or could be implemented in Australia. The emphasis will be on the key technologies affecting rail infrastructure and operations, and technologies related to rail-road linkages and to road technologies that might be especially relevant to competition with rail. An important focus will be on the timing of possible implementation of such technologies, and on the capital and operating cost implications.

4.10. Assessing the policy options and the business case

This final paper will pull together the various forms of empirical analysis in the preceding papers to an overall definition of key policy options, and modelling of their net economic, social and environmental benefits.

On the basis of the preparation and discussion of these working papers, the final report would be prepared and submitted during October 2008.

From within the Centre for Strategic Economic Studies the following research personnel will contribute to the papers, and to the final report:

- Professor Peter Sheehan, Centre Director: overall coordination, selected papers (especially 1, 3, 4 and 10) and final report;
- Mr Bruce Rasmussen, Centre Deputy Director: work on transport companies and agencies, and supply chains;
- Mr Ainsley Jolley, Senior Research Fellow: overall rail economics, technology development and commercialisation, power use issues;
- Professor John Houghton, Professorial Fellow: supply chains and industry analysis;
- Mr John Symons. Research Analyst: overall project management and data assembly, selected papers (especially 1, 2, 6, 7 and 10).

Other staff members within the Centre will provide information gathering, data assembly and analysis and administrative support as required. In preparing the papers and the final report the Centre will also draw on two sources of expertise external to but associated with it, namely:

- Mr Bruce Mountain and Mr Rob Jolly of Carbon Market Economics, who have considerable expertise in the operation of tradeable permit markets for electricity and carbon, and in the economics of renewal energy; and
- Mr Jim Lang of TradeData International: Mr Lang has considerable skill in the assembly and analysis of transport data, particularly in the freight area.

These resources will be provided within the Centre's overall fee for the project, and the Centre will remain responsible for the quality of final output.

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